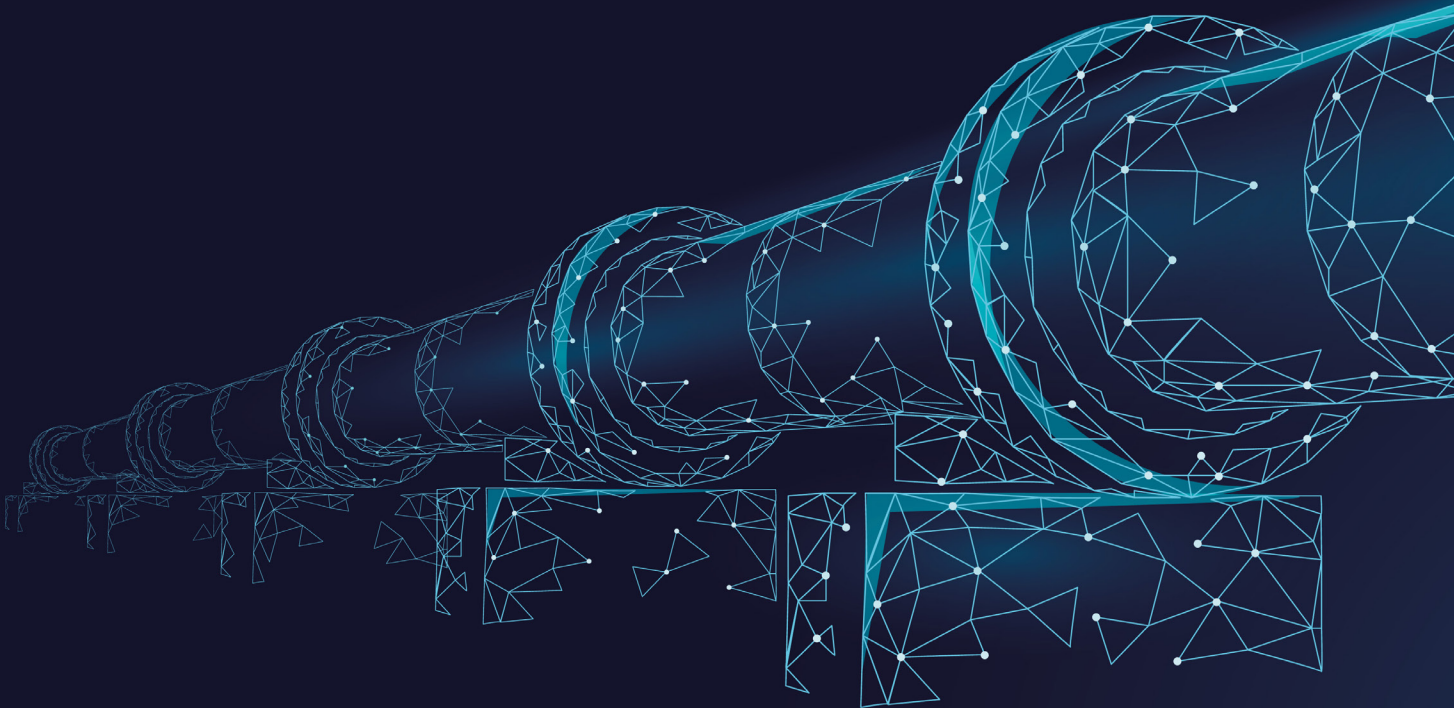


WHITE PAPER

**Precision in Flow supervision:
The Critical Role of
DP Flowmeters in
Nuclear Industry Applications**



01 EXECUTIVE SUMMARY

02 BACKGROUND & CONTEXT

03 PROBLEM / CHALLENGE

04 TECHNICAL SOLUTION

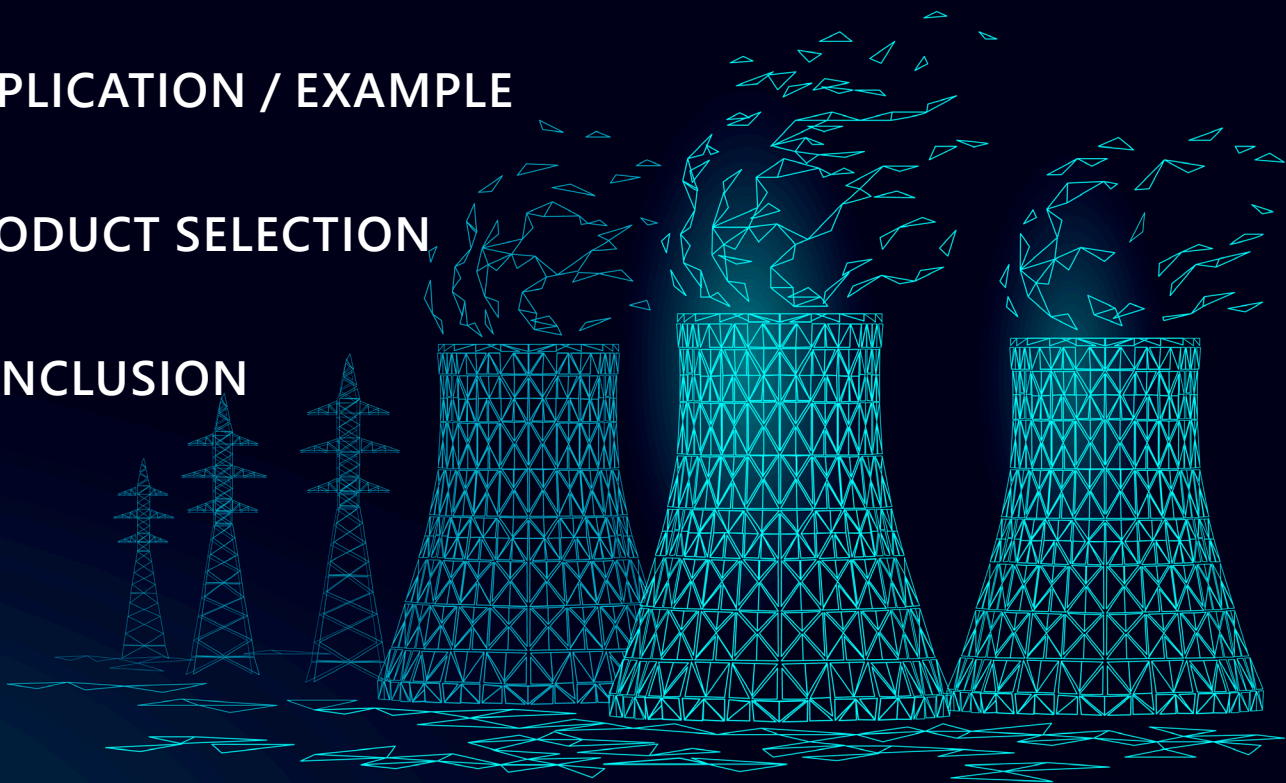
05 SOLUTION FEATURES & BENEFITS

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01 EXECUTIVE SUMMARY

In nuclear energy applications, safety and precision are paramount. Differential pressure (DP) flowmeters are widely used to monitor and control fluid and gas flows in safety-critical nuclear systems.

This report describes the operating principles behind DP flow measurement, explains why Eletta Flow's DP flowmeters are particularly suitable for nuclear environments, and outlines their use in key applications such as reactor cooling, emergency core cooling, fuel processing, and radiation-resistant gas flow control. The paper also highlights product families, technological advantages, and future developments relevant to nuclear facilities.

02 BACKGROUND & CONTEXT

Nuclear power plants operate under extreme conditions where process stability, system redundancy, and regulatory compliance are essential. Fluid flow measurement plays a central role in reactor cooling systems, safety systems, auxiliary processes, and fuel cycle operations.

Failures or inaccuracies in flow supervision can lead to serious safety risks, regulatory violations, or equipment damage. For this reason, nuclear facilities rely on proven and robust measurement principles that can function reliably in environments exposed to radiation, high temperatures, strong magnetic fields, pressure transients, and vibration.

03 PROBLEM / CHALLENGE

Flow measurement in nuclear installations faces several challenges:

- Exposure to radiation that degrades conventional electronics and materials
- High temperatures and pressures
- Strict safety and qualification requirements
- Limited access for maintenance in radiation zones
- Long design lifetimes and low tolerance for failure

Inadequate or unstable flow measurement can compromise cooling efficiency, safety system performance, and containment integrity. Therefore, measurement instruments must deliver long-term accuracy, mechanical simplicity, and predictable behavior under extreme conditions.

04 TECHNICAL SOLUTION

Differential pressure (DP) flowmeters operate by measuring the pressure drop across a restriction in the flow pipe. This pressure difference is directly related to flow rate and provides a stable, well-understood measurement principle. It is also the only flow measurement principle that relies on an approved international standard, ISO 5167, and can be back traced to this for control.

In nuclear applications, DP flowmeters are commonly implemented using:

- **Orifice plates** – Simple and reliable primary elements
- **Venturi tubes** – Reduced permanent pressure losses
- **Flow nozzles** – Designed for high flow velocities and durability
- **Pitot and averaging pitot tubes** – Used for large pipes or localized measurements

The simplicity of the DP principle makes it especially suitable for nuclear use, as it minimizes dependencies on sensitive components while delivering predictable performance.

05 SOLUTION FEATURES & BENEFITS

What differentiates nuclear-grade Eletta Flow DP flowmeters from other measurement principles is their adaptation to extreme operating environments. Key characteristics include:

- **No moving parts**, which reduces wear, maintenance, and radiation sensitivity
- **High reliability and long service life**, proven through decades of nuclear installations
- **Immunity to magnetic fields**, ensuring stable operation
- **Radiation resistance**, maintaining functionality in radiation-prone areas
- **Material flexibility**, allowing adaptation to cooling water, high-pressure systems, and corrosive media
- **Compact designs** with minimal leakage points

Eletta Flow DP flowmeters have been installed in nuclear power plants worldwide since the early 1960s, demonstrating their long-term operational stability.

06 CONDITIONS & LIMITATIONS

When applying DP flowmeters in nuclear environments, the following factors must be considered:

- Temperature and pressure limits
- Radiation levels
- Fluid or gas properties
- Installation requirements and straight-run conditions
- Accessibility for inspection and maintenance

Incorrect installation or application can affect accuracy, particularly in safety-critical processes.

07 APPLICATION / EXAMPLE

Reactor Coolant Flow Monitoring

Eletta Flow DP flowmeters provide critical data on coolant flow rates in both primary and secondary cooling loops. Their robust construction ensures reliable operation under severe thermal and hydraulic conditions, supporting efficient heat transfer and preventing overheating.

Emergency Core Cooling Systems (ECCS)

Within the ECCS, DP flowmeters verify that emergency pumps operate with sufficient flow during abnormal temperature conditions. This ensures that pumps are not running dry and can sustain long-term emergency operation.

Key ECCS functions include:

- Decay heat removal after reactor shutdown
- Redundant cooling systems (HPCI, LPCI, containment spray)
- Passive cooling concepts in advanced reactor designs

Reliable flow monitoring is essential to prevent catastrophic core damage and maintain containment integrity.

Safety Systems and Passive Cooling

DP flowmeters are used in passive safety systems such as Core Makeup Tanks (CMTs) in advanced reactors like the AP1000. Flow measurement validation is required for safety analysis and regulatory approval.

Fuel Processing and Waste Handling

In nuclear fuel reprocessing facilities, DP flowmeters monitor chemical solution transfers and air-lift systems. Digital output versions integrate with modern DCS and PLC systems to ensure controlled and documented process flows.

Radiation-Resistant Gas Flow Control

DP flowmeters are also used for gas flow measurement, including hydrogen and inert gases. Their ability to detect small flow variations allows early detection of abnormal system behavior, contributing to plant safety.

V-SERIES - FLOW SWITCH

- Single adjustable SPDT microswitch for flow alarms
- Repeatability < 2%
- Rugged industrial design
- Same material and size range as S-Series
- IP65 as standard

**S-SERIES – INDICATORS & FLOW MONITORS**

- Large 120 mm dial for easy readability
- Two independently adjustable SPDT microswitches (high/low alarms)
- Repeatability < 2%
- No moving parts; insensitive to radiation and magnetic fields
- Pipe sizes: DN15–DN550
- Materials: brass, powder-coated steel, stainless steel, seaworthy stainless steel, bronze
- IP65 protection
- Switch ratings up to 15 A @ 480 VAC

**D-SERIES - DIGITAL FLOW TRANSMITTERS**

- Microprocessor-based with back-lit, rotatable display
- Includes totalizer, flow linearization, and simulation mode
- No moving mechanical parts
- Accuracy better than $\pm 2\%$ of full scale
- Mounting in vertical or horizontal orientation
- IP65 / IP66, NEMA 4
- Outputs: isolated 4–20 mA, HART, frequency, relay alarms

**M-SERIES - FLOW METER / DP TRANSMITTER**

- USB programmable
- Functions as gas meter, liquid meter, or DP transmitter
- Temperature and pressure compensation for gas measurement
- Accuracy $\pm 1\%$ FS
- Pressure ratings up to 50 bar
- IP66 / IP67 / NEMA 4X
- Materials: 316L stainless steel, bronze, copper alloys

**RC -SERIES – ALL-CERAMIC INTERNAL DESIGN**

- All-ceramic potentiometer and terminals
- No internal electronics
- Factory pre-calibrated
- Resistant to radiation and magnetic fields
- Direct connection to DCS/PLC via resistance signal
- Accuracy $\pm 2\%$ FS



09 CONCLUSION

Eletta Flow's DP flowmeters play a critical role throughout nuclear facilities, from reactor cooling and safety systems to fuel handling and gas monitoring. Their mechanical simplicity, radiation tolerance, and proven long-term reliability make them well suited for nuclear applications. As nuclear technology evolves toward next-generation reactors and increased digitalization, DP flow measurement will continue to build on established principles while incorporating smarter diagnostics, advanced materials, and enhanced digital integration.

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