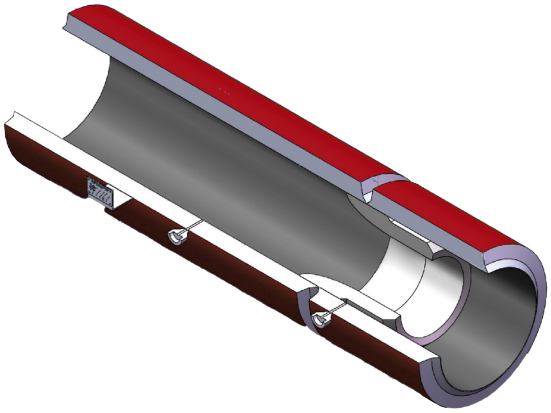
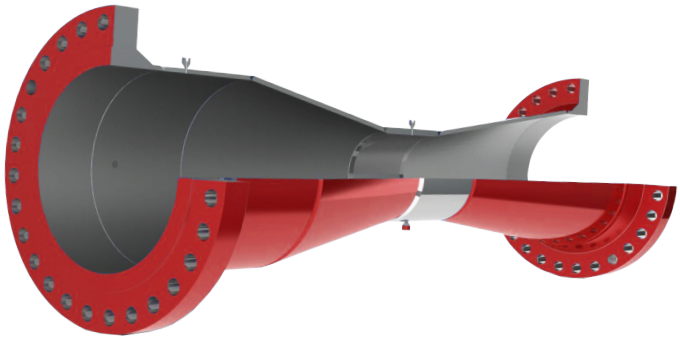
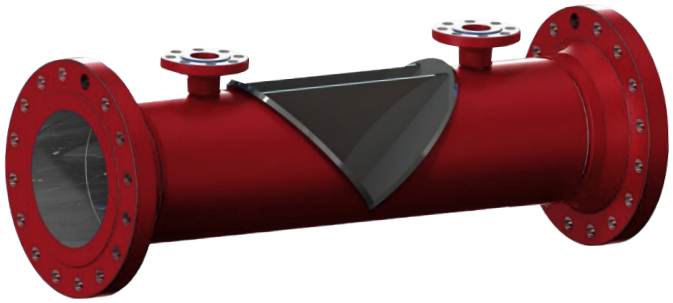
DANIEL®
PRIMARY FLOW ELEMENTS
USER MANUAL







Decades Proven. Field Chosen.™

AUGUST 2025

INTRODUCTION

Operation, Installation, and Maintenance of Daniel® Orifice Meters, Flow Nozzles, Venturis, and Wedge Meters, herein called PFE (Primary Flow Elements) must be completed in accordance with all appropriate industry or purchaser piping specifications, welding specifications, flow meter specifications and under the direction of appropriate purchaser Instrumentation and Mechanical Engineers. The information below is provided for the benefit of the appropriate Engineers, but is not authoritative and may not fit the needs of the multitude of installation configurations. Operation, Installation and Maintenance of Triad PFEs is the responsibility of the purchaser.

The purchaser must determine the applicability of the product for its desired use and assumes all risks in connection there with. Daniel® assumes no responsibility or liability for any omissions or errors in connection with the use of its products. Daniel® will under no circumstances be liable for any incidental, consequential, contingent or special damages or loss to any person or property arising out of the improper operation, installation or maintenance of its products

Installation, inspection, and maintenance of Daniel® Orifice Meters, Flow Nozzles, Venturis, and Wedge Meters, herein called PFE (Primary Flow Elements) must be performed by authorized and trained personnel who have a working knowledge of piping configurations.

HANDLING

Care should be taken to prevent damage to the components. The inner surfaces are critical to the effectiveness of the parts. Care must be taken to prevent damage to the inner surfaces. Never insert a device into the interior of the PFE in order to lift or move the part. Lift using straps or other devices to ensure that the units are not damaged. Any damage to the exterior coatings should be addressed immediately by removing any areas of rust or other corrosion and the reapplication of an appropriate piping coating system.

STORAGE

If the PFE is required to be stored prior to installation, care should be taken to prevent damage and corrosion. All PFE items are shipped with appropriate exterior base coating systems and interior corrosion preventative systems (this does not apply for stainless steel components). These systems are not intended for long term outdoor storage.

The PFE should be stored indoors with a relative humidity of less than 20% to minimize the impact of weather impacts on corrosion. All units shall be shipped with appropriate end cap systems. These end caps should be maintained at all times and only removed for periodic inspection and reapplication of corrosion prevention system. The meters shall be periodically inspected. Inspection should include at a minimum an external corrosion inspection and inspection of all potential leak paths. Documentation of this inspection shall be maintained and recorded on a monthly basis. Any findings shall be documented. All identified corrosion shall be mechanically removed and appropriate coatings shall be made to prevent further corrosion.

PREVENTIVE MAINTENANCE

Annually check all flange connections, tap connections and tubing connections for leaks. Check exterior surfaces for blistering and scrapes.

CORRECTIVE MAINTENANCE

In case of erratic output or loss of signal, check taps and impulse piping to secondary instrumentation for blockage or debris. Check impulse piping for leaks, trapped condensation (in case of compressible gas flows), or trapped air (in case of liquid flows). In case of blockage, purge lines with air or water pressurized to approximately 30 PSI above pressure. In no case should flushing pressure exceed the design pressure of the process or impulse tubing.

In case of trapped condensate or trapped air, remove by use of bleed valves or plugs, or through the manifold at the transmitter.

Stop leaks by tightening, re-sealing, or re-gasketing as necessary.

No special tools are required for corrective maintenance and maintenance can be performed by qualified plant personnel.

PFE COMPONENTS

A transmitter, valve manifold, shut-off valves, and impulse tubing are typically required for the operation of any PFE. If the meter is used to measure steam, a condensate pot may also be required. Before installing any PFE review the following installation tips:

- Make sure the piping, tubing, or manifold installed between the PFE and the transmitter complies with national and local standards, regulations, and codes of practice to ensure safe containment of fluid.
- A hydrostatic or pneumatic test may be required for piping systems to prove the integrity of the pressure containing components.
- In installations that are prone to plugging, a rod or other device may be used to remove materials blocking the impulse tubing.

DIFFERENTIAL PRESSURE TRANSMITTER

A differential pressure transmitter records the differential pressure signal generated by the PFE and provides an analog or serial output to a flow computer or data control system. The transmitter(s) selected for an installation must be appropriate for operating conditions of the process in terms of both accuracy and safety. DP devices must be zeroed following installation. The procedure varies somewhat for liquid, gas, and steam applications.

SHUT-OFF VALVES

Choose a block valve that is rated for the operating pressure of the pipe in which it will be installed. Where dangerous or corrosive fluids or gases like oxygen are likely, the block valve and packing must provide ample protection. The valves must not affect the transmission of the differential pressure signal. Install block valves next to the PFE pressure taps. Never use a globe valve for differential pressure transmission lines.

VALVE MANIFOLDS

A 3-way or 5-way valve manifold isolates the transmitter from the process lines (5-valvemanifolds recommended). They allow the operator to calibrate the transmitter without removing it from the impulse tubing, drain the transmitter and impulse tubing or vent it to atmosphere. Valve manifolds must be oriented according to the manufacturer's instructions to prevent trapping of air or liquid.

IMPULSE TUBING CONSIDERATIONS

Before connecting impulse tubing between the PFE and the transmitter, consider the following tips for optimizing your system's measurement accuracy. In a well designed installation, fluids will drain freely from the process lines and gases will vent to the atmosphere.

TUBING SIZE SELECTION

Impulse tubing (that connects the PFE tap holes to the transmitter) diameters vary with service conditions. The bore should be no smaller than ¼" (6 mm); a minimum diameter of 3/8" (10 mm) is recommended. The internal diameter (ID) must not exceed 1in. (25 mm). For steam applications, the ID should be 3/8" (10 mm) to 1 in. (25 mm). In most process control applications, the primary concern is flow reliability. If the pressure taps or the impulse tubes become plugged, the reliability of the flow measurement is lost. This creates a safety risk and the cost incurred in regaining control can be substantial. High reliability is required for flow signals used in process safety management. A minimum tubing ID of 5/8" (16 mm) is recommended in industrial applications. For high temperatures in condensing vapor service, 1 in. (25 mm) is recommended.

PIPE CONFIGURATIONS

The configuration of pipe and fittings on either side of the PFE can affect the metering accuracy of PFE. To achieve optimum results, plan for a sufficient straight run in accordance with the recommendations published in ISO 5167, AGA Report No. 3, ASME MFC 3M, and ASME PTC-6 Standards.

The minimum straight lengths required are the lengths between various fittings located upstream or downstream of the PFE. Straight lengths shall be measured from the downstream end of the curved portion of the nearest (or only) bend or tee or the downstream end of the curved or conical portion of the reducer or the expander.

Any PFE can be installed in a vertical or horizontal pipe section, and the configuration of piping and valves, etc. will depend on several factors, including available space and the type of product being measured (gas, liquid, or steam). Before installing the PFE, consider the recommended installation methods for measuring dry gas, wet gas, liquid, and steam described in this section.

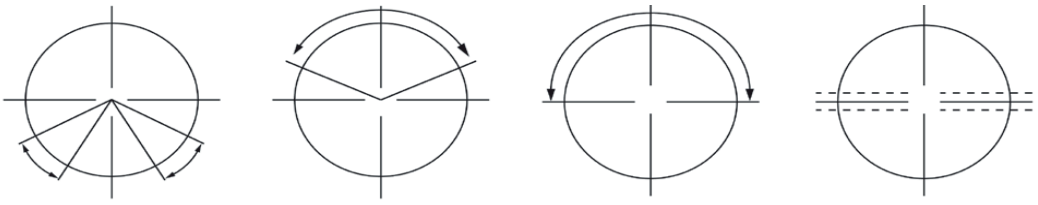
PRESSURE TAP LOCATION

Location of the static pressure and differential pressure taps will vary with the product flowing through the pipeline (liquid, gas, or steam) and the orientation of the meter (vertical or horizontal).

For horizontal installations, the following installation guidelines:

- • For measuring liquid, differential pressure taps should be located in the bottom half of the pipeline, between 4 o'clock and 5 o'clock positions, or between 7 o'clock and 8 o'clock positions.
- For measuring dry gas, differential pressure taps should be located in the top half of the pipeline. For wet gas, taps should be located between the 10 o'clock and 2 o'clock positions to allow proper drainage of liquids present.
- For steam, differential pressure taps should be located in the side of the pipeline.

RECOMMENDED TAP LOCATIONS FOR HORIZONTAL METER INSTALLATIONS



For vertical installations, the location of differential pressure taps is unrestricted, as long as the static pressure tap is upstream of the lower-pressure tap.

GAS SERVICE

HORIZONTAL INSTALLATION (DRY GAS OR WET GAS)

The pressure taps on the PFE should be between the horizontal centerline and the top of the pipe (3 o'clock to 12 o'clock or 9 o'clock to 12 o'clock), as shown in Figure 2.2, page 7. If the fluid is a "wet gas" (i.e., a gas containing small quantities of liquids), the pressure taps should be situated in a vertical position (12 o'clock) to allow all liquids to drain away from the transmitter (Figure 2.3, page 7). If the connecting tubing extending from the PFE to the transmitter is not installed in a vertical position, it should slope upward (at least 1 inch per foot) to ensure proper drainage.

HORIZONTAL INSTALLATION (WET GAS WITH A CONDENSATE CHAMBER)

A condensate chamber is a collection vessel that helps prevent liquid pockets from collecting in gas instrument tubing. If condensate chambers are used, they should ideally be mounted immediately following the shutoff valves installed near the upstream and downstream pressure taps of the meter (Figure 2.3, page 7). The piping from the meter connects to the condensate chamber in a 3 o'clock or 9 o'clock position on a horizontal plane. The chambers are positioned vertically so that the meter connection and instrument connection points are at the top and drain points are at the bottom of the chambers.

VERTICAL INSTALLATION (DRY GAS ONLY)

When the meter is installed in a vertical position, the operator must take special care to ensure that no trap forms in the downstream tap such that gas is trapped in a liquid or liquid is trapped in a gas.

When measuring dry, non-condensing gases, where there is absolutely no risk for liquid being present, the piping from the downstream pressure tap of the PFE can be extended horizontally and then angled upward to connect to the manifold block (Figure 2.2, page 7). The manifold block must be mounted horizontally, and the tubing from the upstream tap of the PFE must slope at least 1 inch per foot to the same level as the downstream tap piping to connect to the manifold.

Vertical installation is not recommended for measuring wet gas.

FIGURE 2.2: DRY GAS INSTALLATION METHODS

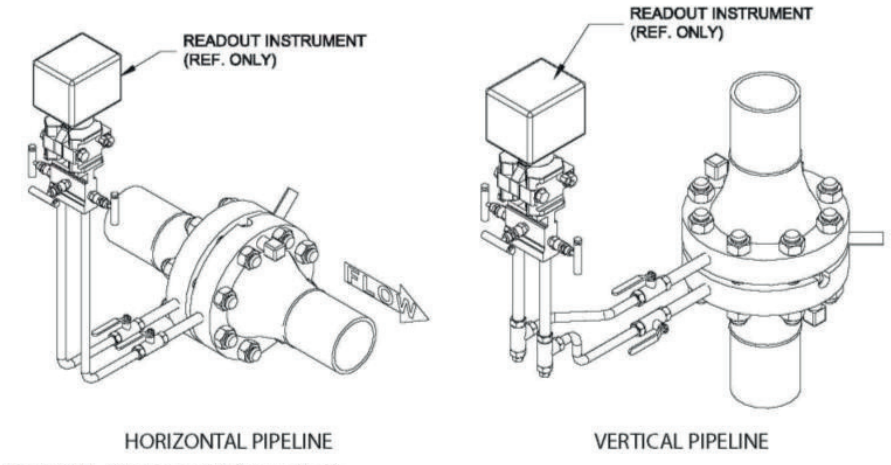
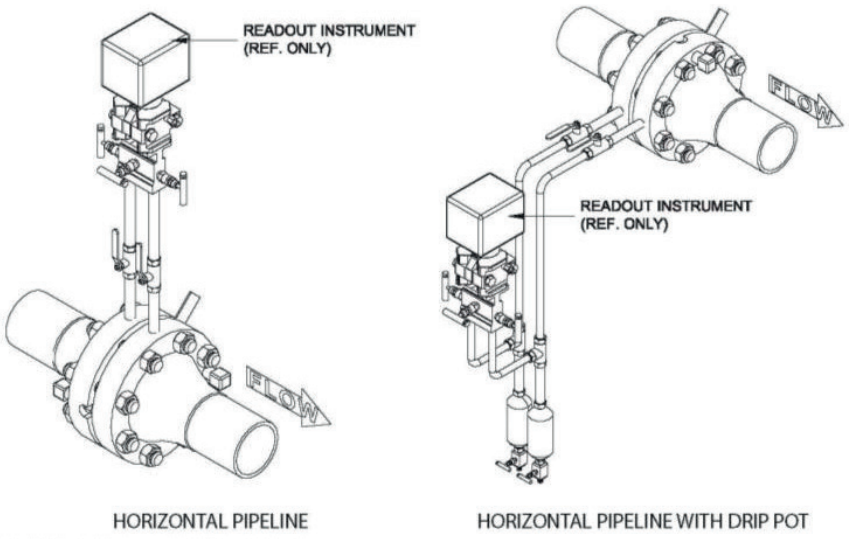


FIGURE 2.3: WET GAS INSTALLATION METHODS



LIQUID SERVICE

HORIZONTAL INSTALLATION

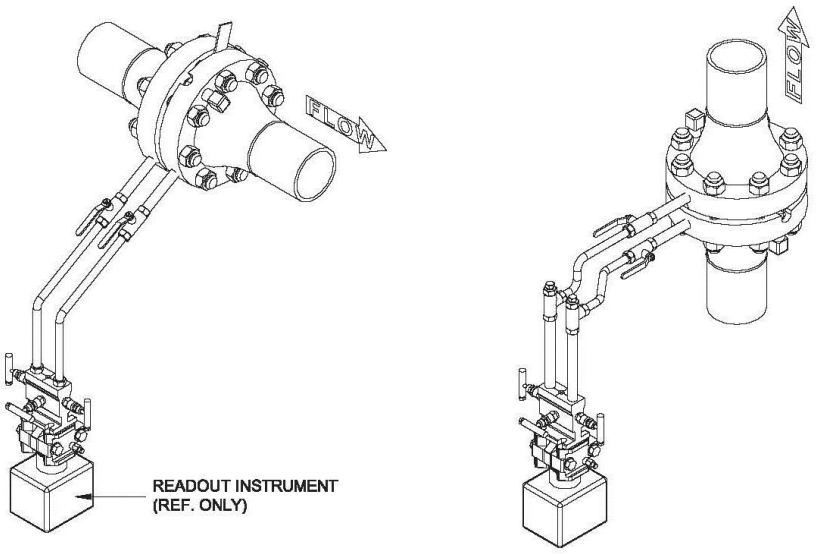
For horizontal installations, pressure taps must be positioned 30° to 60° below the horizontal centerline (4 o'clock to 5 o'clock or 7 o'clock to 8 o'clock), as shown in Figure 2.4. Taps at the bottom of the pipe may become plugged with solids from the liquid; taps above the centerline can accumulate air or non-condensing gases. The connecting lines from the meter shall slope downward to the transmitter with no upturns or pockets. The minimum recommended slope for self-venting is 1 inch per foot.

VERTICAL INSTALLATION

In most process applications, the operator should assume that some level of gas or vapor exists in a liquid service, even if the liquid is water. As a result, the piping configuration must be designed to allow gas to rise back into the flow stream. The process piping should be extended horizontally a very short distance from the downstream tap and then sloped at a nominal 1-inch-per-foot angle to the top of the manifold block (Figure 2.4). The manifold block should be mounted horizontally below the upstream tap so that piping from the upstream tap to the manifold slopes downward also.

When the process is turned off, particulates may fall into the low-pressure port. It is advisable to flush the low-pressure port with an inert fluid before starting the meter.

FIGURE 2.4: LIQUID INSTALLATION METHODS



HORIZONTAL PIPELINE VERTICAL PIPELINE

STEAM SERVICE

HORIZONTAL INSTALLATION

The pressure taps shall be above the horizontal centerline (9 o'clock to 3 o'clock) of the primary device. In condensing hot vapor service such as steam, the fluid in the impulse lines is liquid condensed from the vapor. The use of a condensate chamber is mandatory to prevent hot process fluid from damaging the transmitter. The impulse tubing should slope upwards from the orifice flange union to the condensate pots. A condensate pot can be a tubing tee (for low-volume DP instruments) as shown in Figure 2.5, or a full-size condensate chamber (for high-volume DP instruments). In either case, the condensate pots should be at exactly the same level to ensure accurate differential pressure readings. The line from the bottom of the tee to the transmitter mounted below the tee should be filled to the point where excess fluid can drain back into the meter.

In many cases, water (condensed steam) is used for this fluid fill. However, in cold weather, the fluid must be protected from freezing. The fluid fill requires careful design with heat tracing and insulation to keep it in the liquid phase and to keep both the high-pressure and low-pressure legs of the tubing at the same temperature (maintaining the liquid fill at the same density). A liquid leg fill fluid other than water should be used if practical. Methanol is a possible substitute, but di-butyl phthalate is the recommended fill fluid because it is immiscible with water and remains liquid throughout a broad temperature range, -31°F to 644°F (-35°C to 340°C). CAUTION: Care should be taken when using di-butyl phthalate. Follow all hazardous material guidelines.

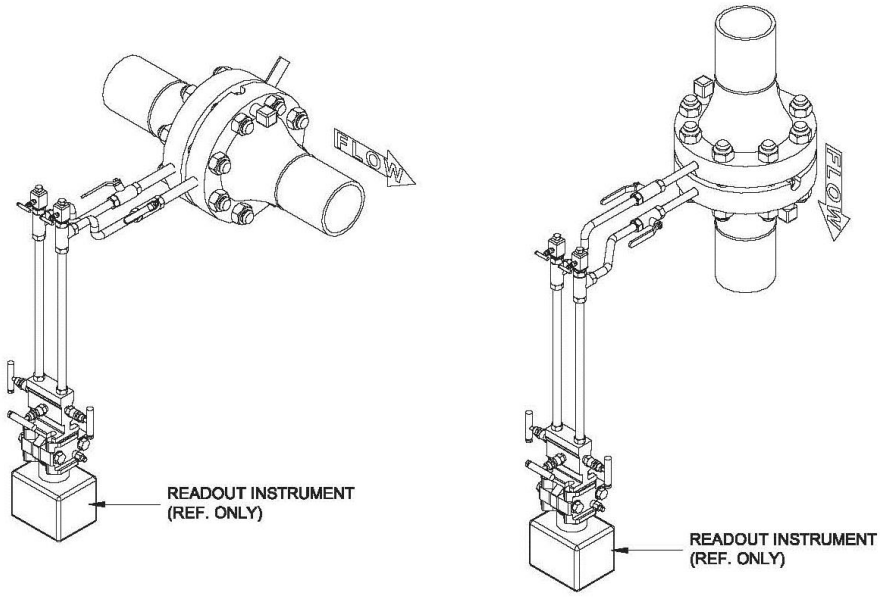
VERTICAL INSTALLATION

For steam service installations in which the meter is oriented vertically, piping from the upstream pressure tap is extended horizontally to an "T" connector (Figure 2.5, page 9). The "T" connector enables a plug to be installed at the top for liquid filling purposes to avoid overheating of the differential pressure cell. The manifold block is positioned directly below at a distance that ensures the steam will be at a safe operating temperature by the time it reaches the differential pressure transmitter. Both lines are extended to the "T" pieces.

Note: This configuration results in a head difference in the differential pressure lines and the differential pressure transmitter must be zeroed when zero flow has been established in the main line.

When the process is turned off, particulates may fall into the low-pressure port. It may be advisable to flush the low-pressure port with an inert fluid before starting the meter.

FIGURE 2.5: STEAM INSTALLATION METHODS



HORIZONTAL PIPELINE VERTICAL PIPELINE

SAFETY

Never open a manifold valve or flange connection unless you have first verified that the system is completely depressurized.

During liquid or wet gas service, open valves very slowly to avoid slugging in the meter run.

Always use proper procedures and equipment for lifting and moving the Primary Flow Element to avoid risk of injury.

Secure all connections properly before starting up a system. Keep a safe distance away from the process upon startup.

Be mindful of static electricity generated by insulated footwear etc., and always ground yourself before touching pipes in the hazardous area where flammable gas is being metered.

Never exceed the maximum pressure or temperature recommended for the measured process. Exceeding proper pressure or temperature ratings can lead to personal injury or equipment damage. The process piping flanges should be identical to those on the PFE. The process temperature and pressure should never exceed those for which the element has been designed. Design pressure and temperature can be found on the Daniel® submittal drawing.

LIMITED WARRANTY AND DISCLAIMER

Daniel® warrants that the goods delivered under this contract will be free from defect in material and workmanship for a period of 18 months from shipment or 12 months from installation whichever is earlier. The sole remedy for breach of this warranty is the repair or replacement (at the option of the Daniel®) of the defective goods, and Daniel® will not be liable under this warranty for labor to remove or reinstall the goods, for transportation or freight on the good or any replacement good, for down time or for any other costs. Goods which the Daniel® determines to have been subjected to abuse or other improper use will not be entitled to the benefits of any warranty by the Daniel®. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE FACE OF THIS AGREEMENT. Any parts or equipment which Daniel® supplies and does not manufacture shall be subject only to the warranties of its vendors. Unless repair to, alterations of, or work done on products in question by the Buyer shall be specifically authorized in writing by Daniel®, any warranty applicable thereto shall become null and void. Any breach of warranty or other action under this agreement must be commenced within one (1) year after such cause of action arises.

The purchaser must determine the applicability of the product for its desired use and assumes all risks in connection there with. Daniel® assumes no responsibility or liability for any omissions or errors in connection with the use of its products. Daniel® will under no circumstances be liable for any incidental, consequential, contingent or special damages or loss to any person or property arising out of the failure of any product, component or accessory.

All expressed or implied warranties, including the implied warranty of merchantability and the implied warranty of fitness for a particular purpose or application are expressly disclaimed and shall not apply to any products sold or services rendered by Daniel®.

The above warranty supersedes and is in lieu of all other warranties, either ex pressed or implied and all other obligations or liabilities. No agent or representative has any authority to alter the terms of this warranty in any way.

RETURN OF GOODS

No product or part shall be returned to the Seller without written authorization and shipping instructions first having been obtained from the Seller. The product must be thoroughly cleaned and any process chemicals removed before it will be accepted for return. Standard catalog items returned for credit after invoice date, or items returned in damaged condition will be subject to restocking charges. All engineered items are subject to 100% restocking charge.

With over 90 years of experience, Daniel is the only manufacturer that has the knowledge and experience to engineer and offer superior products that are trusted to provide the most reliable and accurate measurements in the global oil and gas industry.

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