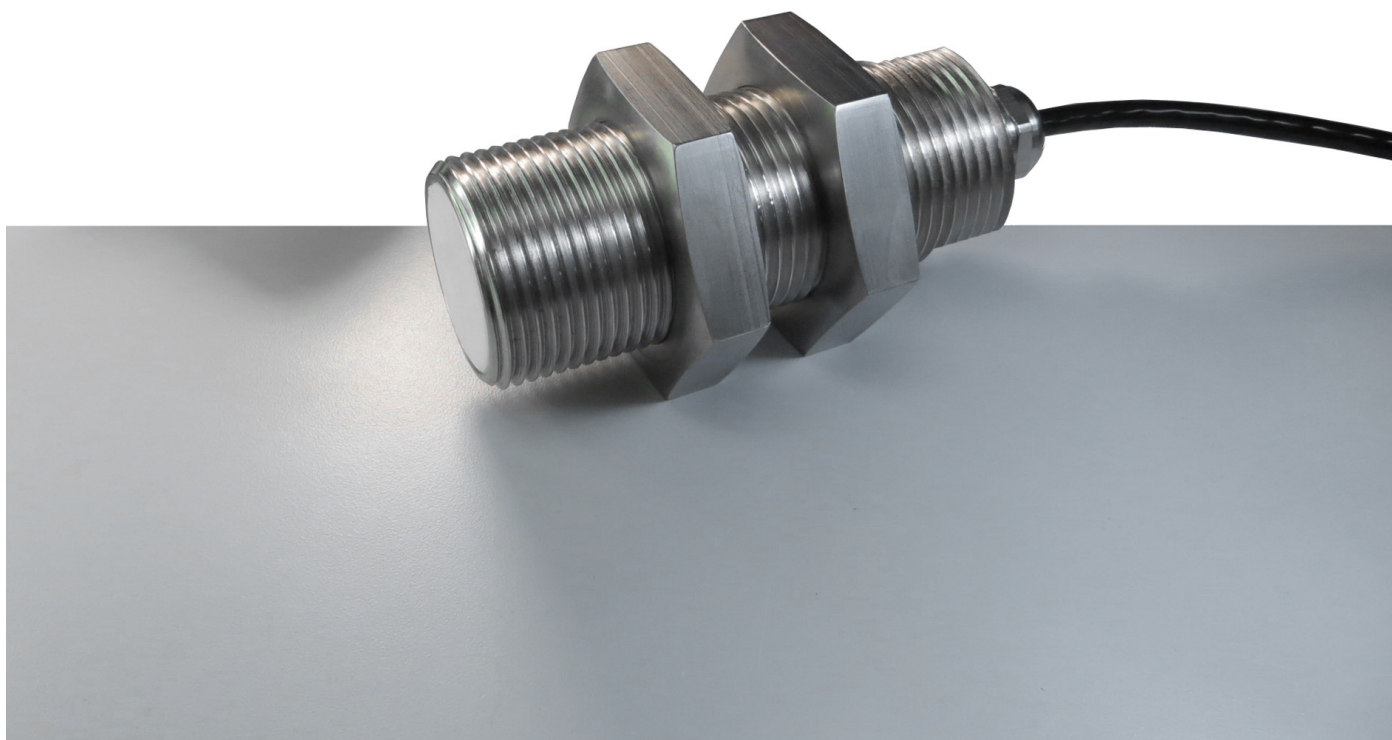




SPES™-117

Underwater Eddy Current Proximity Sensor User's Manual





Safety Information

The following manual contains information and warnings. They must be followed in order to keep the instrument in a working condition and ensure safe operation.

Safety and Electrical Symbols

	Warning - Danger - Identifies conditions or practices that could cause physical harm or death.
	Caution - Identifies conditions or practices that could result in a permanent loss of data or damage the measuring chain and/or other equipment to which it is connected.
	Important Information - Identifies important information, hints, and tips that must be read and applied.
	Shield connection location

Safety Precautions

Warning - Danger Caution
<ul style="list-style-type: none">• To use the described product correctly and safely, read and follow all safety instructions or warnings that appear throughout this manual.• This product is intended to be used by qualified operators and maintenance personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read and follow all installation, operation, and maintenance information before using this product.• Install and use this product only as specified in this manual or the protection provided by this product might be impaired.• When in doubt that safety protection has been impaired, make this product inoperative and secure it against any unintended operation.

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This manual is provided solely for guidance. VibrosystM Inc. takes no responsibility or liability for any damage caused by accidents, improper installation or misuse. Liability is limited to the repair and/or replacement of defective products.

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APPENDIX: TEMPLATE FOR RECORDING DISTANCE VALUES VS I_{out}





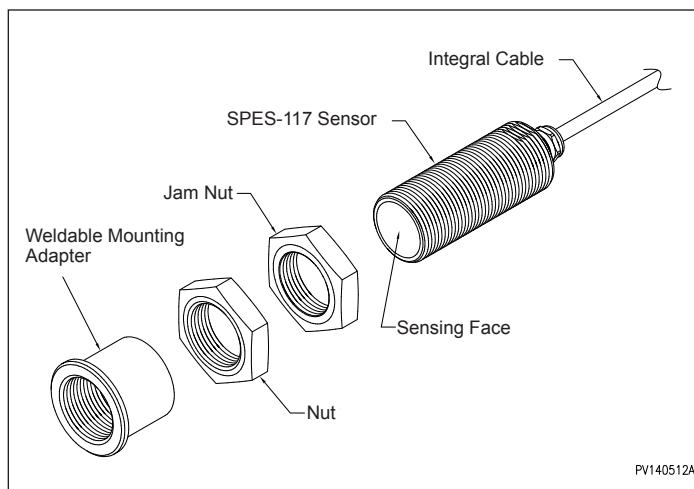
1. SPES-117 SENSOR OVERVIEW

1.1 Description

The SPES-117 proximity sensor is designed to measure the relative distance of an underwater metallic target surface. It is usually used to measure blade tip clearance in Kaplan turbines as well as runner band clearance in Francis turbines. The sensor can sustain high levels of underwater pressure and is equipped with built-in conditioning circuitry allowing it to be directly connected to processing instrumentation.

The SPES-117 covers a 0 to 17 mm [0 to 670 mils] measuring range.

SPES-117 Underwater Proximity Sensor



1.2 Main Unit Interventions

- A hole must be bored in the throat ring or bottom ring.
- Integral cables must be routed and protected from the sensor all the way to the acquisition unit.

Caution

- Installation guidelines and connection instructions must be thoroughly followed to ensure a safe and proper operation.
- In order to complete the commissioning, VibroSystM must be contacted when Section 2.2 (Assessing the actual sensitivity) is reached.



2. SENSOR OPERATION

2.1 Connecting the SPES-117 Sensor

The SPES-117 sensor must first be connected to a 24VDC power supply and a receiving instrument. It is important to confirm the sensor's functionality before proceeding with a permanent installation.

Integral Cable Color Code	Designation	Specifications
Red	Power Supply	+24 VDC
White	Current Output	6.4-20 mA (proportional to sensor's full range)
Blue	Common	0 V
Yellow	Voltage Output	1.5 - 10 V (proportional to sensor's full range)

Load at current output: 500 Ω max.

Load at voltage output: 10 k Ω min.

Important Information

- The integral cable shield on the SPES-117 **is not** connected to the sensor side. It must always be connected to the ground on the instrumentation side.



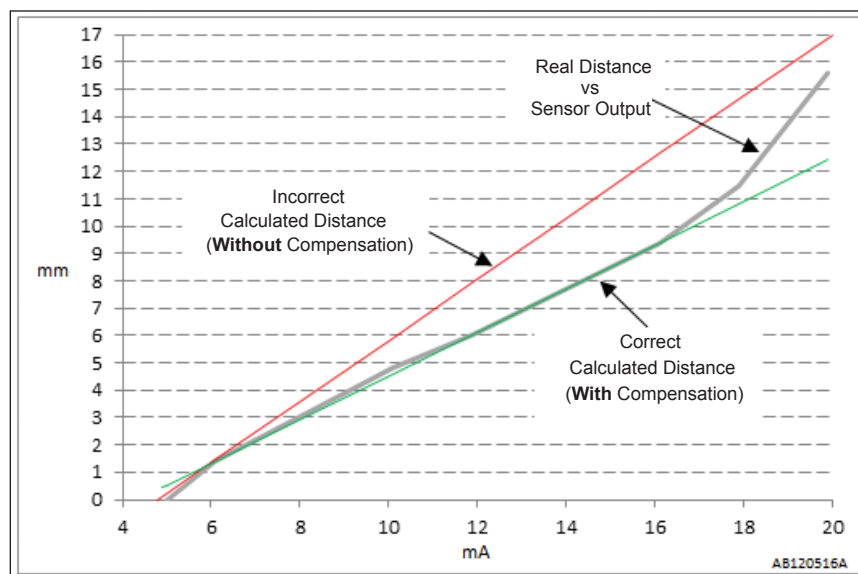
2.2 Assessing the Actual Sensitivity

The SPES-117 proximity sensor is calibrated to produce a linearized output based on an FE360 steel target. Because the sensitivity of eddy-current sensors is affected by the target's material, the actual sensitivity must be determined.

! Important Information

- Failure to correctly assess and compensate the sensitivity will result in incorrect measurement results as presented in the illustration below.

SPES-117 Calculated Distance vs Sensor Current Output





! Important Information

- Section 2.2.1 must be completed **BEFORE** installing the sensor. Sections 2.2.2, 2.2.3, and 2.2.4 must be completed **AFTER** installing the sensor.
- In the examples below, calculations are in metric form. All distances may also be measured in inches with the resulting values measured in the same formulas.

2.2.1 Measuring Current Output (I_{out}) and Corresponding Distance

To assess the sensor's actual sensitivity, physical distance and current measurements must first be taken using a target made of the **same material** as the real target. Minimum dimensions for the target are: 75mm x 75mm x 2mm [3" x 3" x 1/16"].

Proceed as follows:

Fill the table with measurements (distance vs current), equally distributed on the full current scale. Add **non-metallic** spacers between the sensor's tip and the target until I_{out} max. is approximately reached. Note down the current value and the distance (total spacer thickness) in the table. Gradually remove spacers to approximately reach the next I_{out} level and again, write down the current value and distance. Repeat until the table is filled. The last I_{out} value is measured without spacers (0mm), with the sensor's tip placed directly against the target.

Recorded Distance Values vs I_{out}

Ideal level of I_{out} (mA)	20	17.73	15.46	13.2	10.93	8.66	6.4
Measured I_{out} (mA)							
Measured distance (mm)							0

Example of Recorded Distance Values vs I_{out}

			$I_{out B}$	$I_{op} = 11.5mA$	$I_{out A}$		
			↓	↓	↓		
Measured I_{out} (mA)	19.9	17.5	15	12.5	10.1	7.5	5
Measured distance (mm)	15.6	10.9	8.45	6.45	4.8	2.65	0
			↑		↑		
			d_B		d_A		



2.2.2 Taking a Measurement with the Sensor Installed

With the sensor now installed, take a measurement and note the real operating current (I_{op}).

! Important Information

- For Kaplan turbines, I_{op} has to be measured with the blade positioned in front of the sensor.

Example with SPES-117: $I_{op} = 11.5$ mA

2.2.3 Calculating the Sensitivity

Select two points in the table on either side of the value closest to I_{op} . These two points (A & B) will be used to define the linear equation. The selected points should be at an equal distance from I_{op} . Ideally, point A should be at $I_{op} - 2.5$ mA and point B at $I_{op} + 2.5$ mA.

For example, if $I_{op} = 11.5$ mA:

Point A: $I_{op} - 2.5$ mA = 9 mA (closest correspondence in the table: $I_{out A} = 10.1$ mA, $d_A = 4.8$ mm)

Point B: $I_{op} + 2.5$ mA = 14 mA (closest correspondence in the table: $I_{out B} = 15$ mA, $d_B = 8.45$ mm)

a) Using selected points A and B, calculate «m» (the sensitivity or gain).

	Example	
$m = \frac{d_B - d_A}{I_{outB} - I_{outA}}$	$m = \frac{8.45 - 4.8}{15 - 10.1}$	= 0.745

b) Using the formula below, calculate «b» (the y-intercept) of the linear equation.

	Example with values closest to I_{op}	
$b = d - (m \times I_{out})$	$b = 8.45 - (0.745 \times 15)$	= - 2.725 mm

c) The equation to calculate the compensated distance corresponding to the sensor current output is the following:

$$d_C = (m \times I_{out}) + b$$

Where:

d_C is the calculated distance (in mm)

d) Verify the «m» and «b» calculated values by applying the following formula on the measured value between the A and B coordinates:

for I_{out} to equal 12.5 mA, verify that $d_C = 6.45$ mm ($\pm 10\%$ of range):

$$d_C = (0.745 \times 12.5) - 2.725 = \mathbf{6.59 \text{ mm}}$$



2.2.4 Adjustment Through the ZOOM Configuration Software

Proceed with the final adjustment through the ZOOM Configuration software. Select **Sensor Configuration**, then in the **Range** tab of the dialog window, enter the **Maximum** and **Minimum** values of the **Raw output range**.

Formulas for Adjusting the Raw Output Range

Sensor Configuration [SPES-117]

Monitored ☒

General | **Range** | Alarm | Alarm settings | Modbus | OPC

Unit: mm

Trending and alarm range

Processing: Minimum

Maximum: 17

Minimum: 0

Raw output range

Maximum:

Minimum:

Offset: 0

Advanced... OK Cancel

Maximum = (m x 20 mA) + b

Minimum = (m x 4 mA) + b

Note: in the **Trending and alarm range** section, the **Maximum** and **Minimum** values must be within the limits of the raw output range.

Example with Calculated Values

Sensor Configuration [SPES-117]

Monitored ☒

General | **Range** | Alarm | Alarm settings | Modbus | OPC

Unit: mm

Trending and alarm range

Processing: Minimum

Maximum: 12.175

Minimum: 0

Raw output range

Maximum: 12.175

Minimum: 0.255

Offset: 0

Advanced... OK Cancel

Trending and alarm range adjusted to the limits of the raw output range

Maximum = (0.745 x 20 mA) - 2.725

Minimum = (0.745 x 4 mA) - 2.725



3. SENSOR INSTALLATION OVERVIEW

3.1 Sensor Positioning

Caution

- The SPES-117 sensor must be connected correctly with the cable well protected against any sort of mechanical damage.

Before deciding where to install the sensor, consider the following:

- The sensor's sensing face must face the target.
- The maximum cable length (integral cable + extension) must be established. From the SPES-117 sensor to the acquisition unit, the maximum distance is 300 m [984 ft] for the current output and 100 m [328 ft] for the voltage output.
- The cable and the back of the sensor must be protected against debris and turbulence. The submersible cable must be firmly secured to prevent premature aging.

Important Information

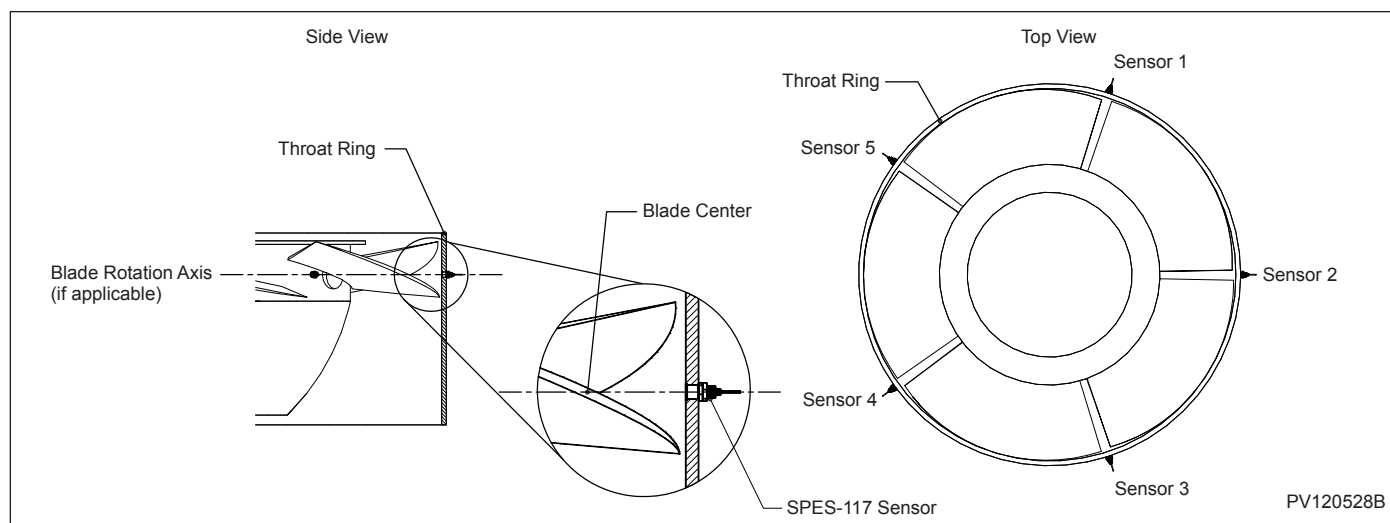
- VibroSystM recommends relying on the services of a trained technician for supervising the installation of these proximity sensors and finalizing configuration of the ZOOM Software.

3.2 Positioning in a Kaplan Turbine

VibroSystM recommends using one SPES-117 sensor per turbine blade. If the turbine is in place, install the sensors between the blades to avoid damage.

Sensors must be equally distributed around the unit. All sensors must be aligned at exactly the same vertical height, corresponding to the center of the blades (or the blades' rotation axis, if applicable).

Kaplan Turbine Sensor Positioning



Caution

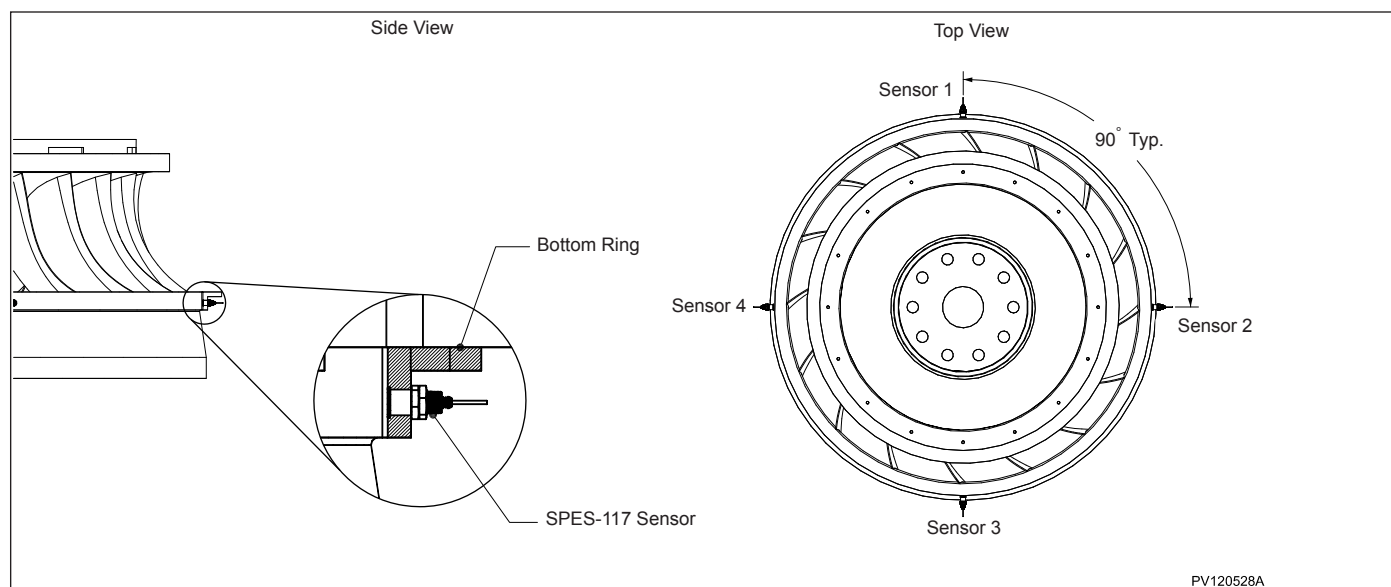
- The SPES-117 and the blade's angular positions in relation to the synchronization probe must be established. This information will be required during configuration in the ZOOM software.



3.3 Positioning in a Francis Turbine

To monitor turbine displacement in a Francis turbine installation, sensors must be installed at a 90-degree angle from each other, facing the runner band. The sensors' angular position in relation to the synchronization must also be established.

Francis Turbine Sensor Positioning

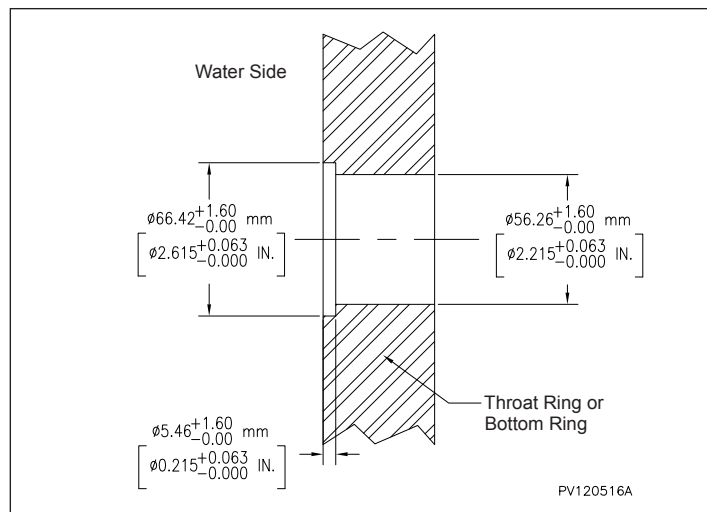




3.4 Preparing the Chamber for the Weldable Mounting Adapter

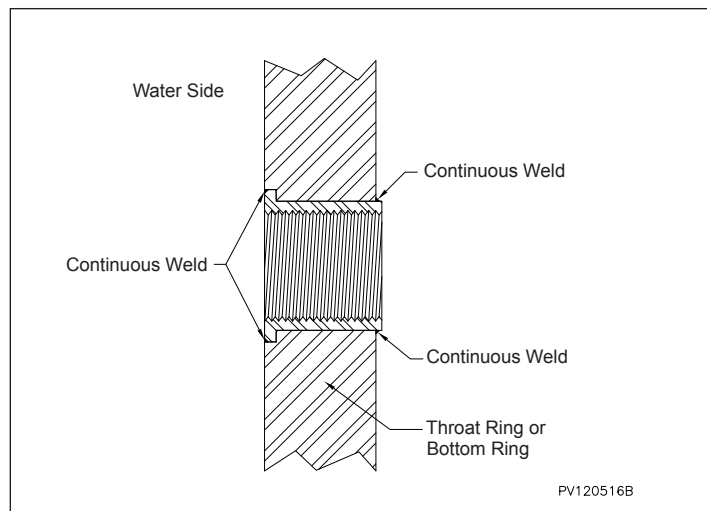
The chamber must be perpendicular to the throat ring or bottom ring. When preparing the chamber for the weldable mounting adapter, the precision of the boring is critical for a tight fit installation.

Chamber Preparation



1. Drill the chamber into the ring.

Fitting the Sensor Inside the Chamber



2. Using a continuous weld, weld the mounting adapter in place on both sides of the ring.



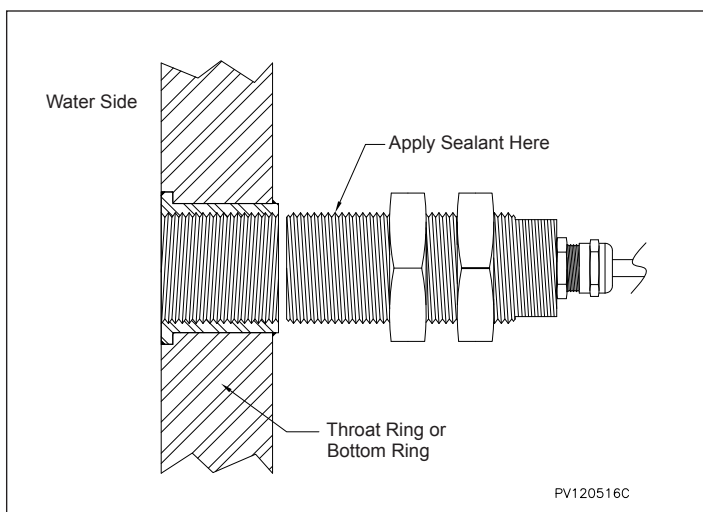
3.5 Installing the Sensor

After installing the weldable mounting adaptor, proceed with installing the sensor.

Caution

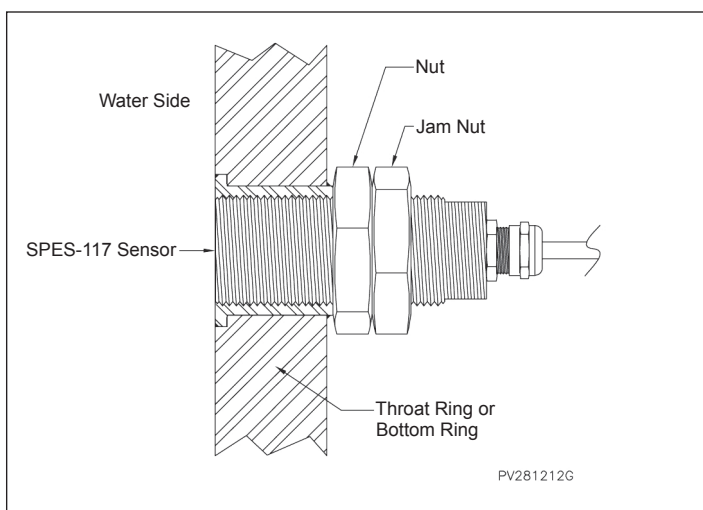
- To preserve the sensor's long-term waterproofness, do not install it if the integral cable's outer sheathing shows any signs of damage.

Thread Sealant Application



1. To ensure waterproofness, apply sealant around the threaded section.
2. Use the sensor's flattened portion to turn clockwise until the sensor is flush with the inner surface of the ring.

Tightening Jam Nuts



3. Complete by first tightening the nut, followed by the jam nut to secure the first in place.
Recommended torque: 34Nm (25 lb-ft).



APPENDIX: TEMPLATE FOR RECORDING DISTANCE VALUES VS I_{out}

Unit no.: _____ Sensor S/N: _____ Position: _____

<i>Measured I_{out} (mA)</i>							
<i>Measured distance (mm)</i>							0

Unit no.: _____ Sensor S/N: _____ Position: _____

<i>Measured I_{out} (mA)</i>							
<i>Measured distance (mm)</i>							0

Unit no.: _____ Sensor S/N: _____ Position: _____

<i>Measured I_{out} (mA)</i>							
<i>Measured distance (mm)</i>							0

Unit no.: _____ Sensor S/N: _____ Position: _____

<i>Measured I_{out} (mA)</i>							
<i>Measured distance (mm)</i>							0

Unit no.: _____ Sensor S/N: _____ Position: _____

<i>Measured I_{out} (mA)</i>							
<i>Measured distance (mm)</i>							0

Unit no.: _____ Sensor S/N: _____ Position: _____

<i>Measured I_{out} (mA)</i>							
<i>Measured distance (mm)</i>							0

