

# Micro Motion™ Heavy Fuel Viscosity Meter (HFVM) Viscomaster™

High-performance multi-variable viscosity meter



## World-wide marine-approved design for aggressive environments

- Continuous, multi-variable measurement of viscosity, density, and temperature
- Accurate measurement of viscosity ( $\pm 1\%$  of full scale) and density ( $\pm 1 \text{ kg/m}^3$ )
- Optimized design that is insensitive to vibration, temperature, and pressure variations
- Durable Diamond-Like Carbon (DLC) coating that is resistant to friction, chemicals, impact, and mechanical damage

## Superior multi-variable I/O and meter health

- Hazardous-area approved, head-mounted transmitter that supports local configuration and display
- Internal diagnostics for fast verification of meter health and installation

## Installation flexibility and compatibility

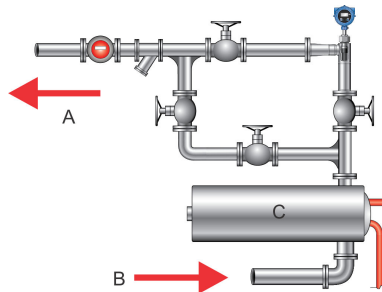
- Direct-insertion design for inline measurement
- 4-20 mA, HART, and Modbus protocol connection to control systems and external devices
- Retrofit kits for replacing capillary and torsional meters
- Upgrades for 7829 Viscomaster systems

## Micro Motion™ HFVM meters

The HFVM measures liquid viscosity, density, and temperature in aggressive environments. These meters use vibrating fork technology for reliable direct-insertion measurement. HFVMs provide Heavy Fuel Oil (HFO)/Marine Gas Oil (MGO) combustion control, and oil-fired heater and boiler control.

### Marine and power applications

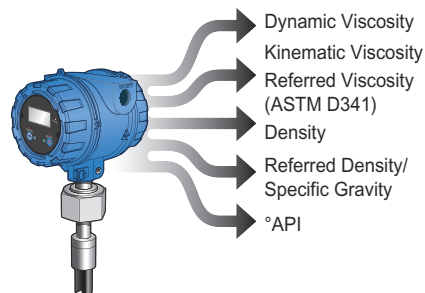
Rugged, reliable, and low maintenance, these meters are the industry standard for HFO measurement applications.



- A. To engine
- B. Fuel oil
- C. Fuel oil heat exchange

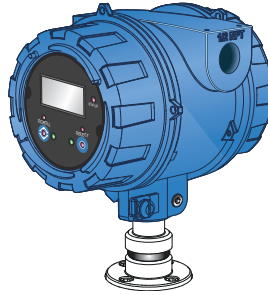
### Application configurations

Integral HART® I/O direct input of external temperature and pressure measurements provide enhanced readings.



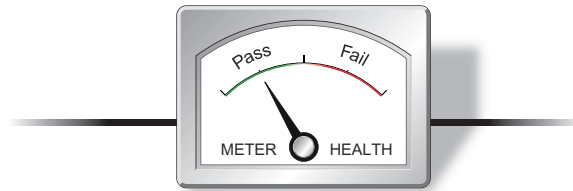
### Integral transmitter

Supports Analog (4-20 mA), HART, WirelessHART®, and Modbus® RS-485 communications.



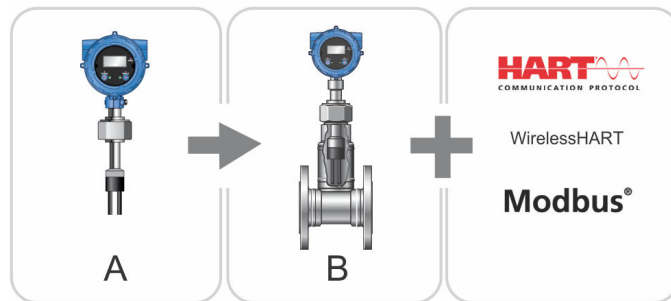
### Meter diagnostics

Ensure measurement health through known density verification (KDV) and other meter and installation diagnostic capabilities.



### Retrofit capabilities

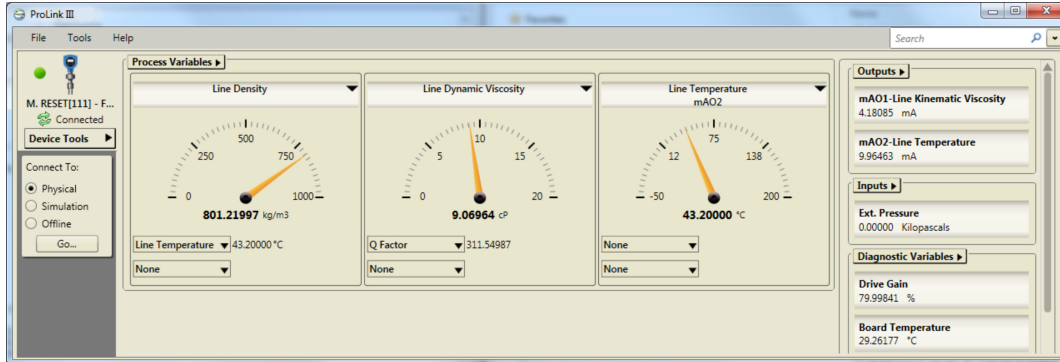
The HFVM has installation options for replacing capillary and torsional meters that give you the performance you need.



- A. Power, RS-485 2 x mA outputs
- B. Retrofit adapters

## ProLink™ III software: a configuration and service tool

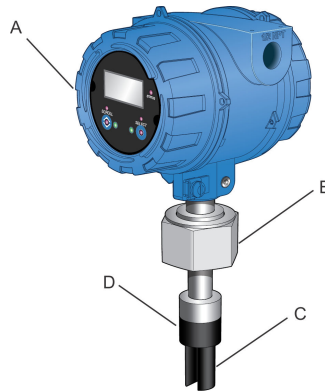
ProLink III software is an easy-to-use interface that allows you to view key process variables and diagnostics data for your meter. For more information on ordering the software, contact your local sales representative or email customer support at [flow.support@emerson.com](mailto:flow.support@emerson.com).



## Operating principle

### Fork vibration

- A fully welded fork assembly is inserted directly into the liquid to be measured.
- Using piezoelectricity, the fork tines vibrate at natural frequency.



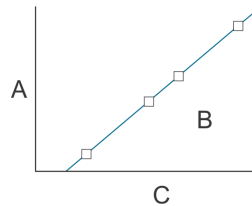
- A. Integral transmitter with optional local operator interface
- B. Cone seat compression fitting
- C. Vibrating tines
- D. RTD measures temperature

### Temperature measurement

- An integral class "B" RTD measures the vibrating fork temperature.
- Micro Motion transmitters use this reading to optimize performance over a wide range of process conditions.

## Density calibration

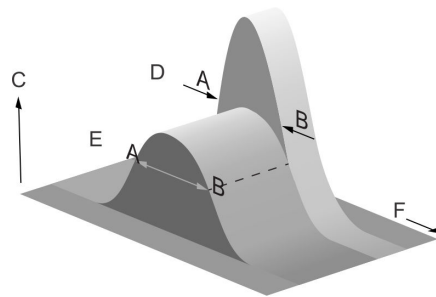
- The tines' natural frequency changes with the density of the surrounding liquid.
- Micro Motion transmitters accurately measure time period.
- Measured time periods are converted into density readings using meter calibration coefficients.



- A. Density ( $\text{kg/m}^3$ )
- B. Time period =  $1 / \text{frequency}$
- C.  $[\text{Time period}]^2$  ( $\mu\text{s}^2$ )

## Viscosity calibration

- The bandwidth of the tines' natural frequency changes with the viscosity of the surrounding liquid.
- Micro Motion transmitters accurately measure bandwidth.
- Bandwidth measurements are converted into viscosity readings using meter calibration coefficients.



- A. Point A
- B. Point B
- C. Response amplitude
- D. Product 1 = low viscosity
- E. Product 2 = high viscosity
- F. Frequency (Hz)

### Note

- Bandwidth = point B - point A
- Resonant frequency =  $(\text{point A} + \text{point B}) / 2$
- Quality factor = resonant frequency / bandwidth

## Performance specifications

### Viscosity measurement

| Specification                      | Value            |                                  |
|------------------------------------|------------------|----------------------------------|
| Calibration range and accuracy     | Calibration code | Accuracy                         |
|                                    | 0.5 to 10 cP     | ±0.2 cP                          |
|                                    | 10 to 100 cP     | ±1% of calibration range maximum |
| Standard calibration range options | 0.5 to 100 cP    |                                  |
| Repeatability                      | ±0.5% of reading |                                  |

### Density measurement (calibration code B only)

| Specification                          | Value                         |                                  |
|--|-------------------------------|----------------------------------|
| Accuracy                               | ±1 kg/m <sup>3</sup>          | ±0.001 g/cm <sup>3</sup>         |
| Operating density range                | 0 to 3000 kg/m <sup>3</sup>   | 0 to 3.0 g/cm <sup>3</sup>       |
| Calibration range                      | 600 to 1250 kg/m <sup>3</sup> | 0.6 to 1.25 g/cm <sup>3</sup>    |
| Repeatability                          | ±0.1 kg/m <sup>3</sup>        | ±0.0001 g/cm <sup>3</sup>        |
| Process temperature effect (corrected) | ±0.1 kg/m <sup>3</sup> per °C | ±0.0001 g/cm <sup>3</sup> per °C |
| Process pressure effect (corrected)    | None                          |                                  |

### Temperature measurement

| Specification                    | Value  |                   |
|----------------------------------|--|-------------------|
| Operating temperature range      | -50 °C to +200 °C  | -58 °F to +392 °F |
| Integral temperature measurement | <ul style="list-style-type: none"> <li>■ Technology: 100 Ω RTD</li> <li>■ Accuracy: BS1904 Class, DIN 43760 Class B</li> </ul> |                   |

### Pressure ratings

Actual maximum operating pressures are limited by the process connection rating.

| Specification              | Value  |                                |
|----------------------------|--|--------------------------------|
| Maximum operating pressure | 100 bar  | 1450 psi (cone-seated fitting) |
| Test pressure              | Tested to 1.5 times the maximum operating pressure |                                |
| PED compliance             | Not applicable                                     |                                |

# Transmitter specifications

## Transmitter features and process variables

|                                   | Feature            |                        | Process variables                         |  |
|-----------------------------------|--------------------|------------------------|---|--|
|                                   | Calibration code B | Calibration code R     | Calibration code B                        | Calibration code R                       |
| Process measurement               |                    |                        |   |  |
| Viscosity measurement             | Yes                | Yes                    | Dynamic viscosity<br>Kinematic viscosity  | Dynamic viscosity<br>Kinematic viscosity |
| Density measurement               | Direct             | Derived <sup>(1)</sup> | Density                                   | Density <sup>(2)</sup>                   |
| Two-phase flow detection          | Yes                | No                     | N/A                                       | N/A                                      |
| Internal temperature              | Yes                | Yes                    | Temperature                               | Temperature                              |
| Ignition quality                  | Yes                | No                     | CCAI<br>CII                               | N/A                                      |
| Measurement applications          |                    |                        |   |  |
| Referred viscosity <sup>(3)</sup> | Yes                | No                     | Referred viscosity (dynamic or kinematic) | N/A                                      |
| API referral                      | Yes                | No                     | Referred density (API)                    | N/A                                      |
| Measurement diagnostics           |                    |                        |   |  |
| Known Density Verification (KDV)  | Yes                | No                     | N/A                                       | N/A                                      |

(1) Calculated from reference density and reference temperature using the API equations for crude oil.

(2) Derived value

(3) Three methods: ASTM D341 single-curve, ASTM D341 multi-curve, and matrix referral.

## Transmitter I/O and communications

### Note

mA Output is linear with process from 3.8 to 20.5 mA, per NAMUR NE-43 (February 2003).

| Typical application  | Transmitter version | Output channels |         |               |
|--|---------------------|-----------------|---------|---------------|
|  |                     | A               | B       | C             |
| Marine and power HFO combustion control, and oil-fired heater and boiler control | Analog              | 4-20 mA + HART  | 4-20 mA | RS-485/Modbus |

## Local display

| Design    | Features  |
|-----------|---|
| Physical  | <ul style="list-style-type: none"> <li>■ Segmented two-line LCD screen.</li> <li>■ Can be rotated on transmitter, in 90-degree increments, for ease of viewing.</li> <li>■ Suitable for hazardous area operation.</li> <li>■ Optical switch controls for hazardous area configuration and display.</li> <li>■ Glass lens.</li> <li>■ Three-color LED indicates meter and alert status.</li> </ul> |
| Functions | <ul style="list-style-type: none"> <li>■ View process variables.</li> <li>■ View and acknowledge alerts.</li> <li>■ Configure mA and RS-485 outputs.</li> <li>■ Supports Known Density Verification (KDV).</li> <li>■ Supports multiple languages.</li> </ul>   |

## Additional communication options




The following communications accessories are purchased separately from the meter.

| Type           | Description  |
|----------------|--|
| WirelessHART   | WirelessHART is available via the THUM adapter                                   |
| HART® Tri-Loop | Three additional 4-20 mA Outputs are available via connection to a HART Tri-Loop |

## Hazardous area approvals

Ambient and process temperature limits are defined by temperature graphs for each meter and electronics interface option. Refer to the detailed approval specifications, including temperature graphs for all meter configurations, and safety instructions. See the product page at [www.emerson.com](http://www.emerson.com).

## ATEX, CSA, and IECEx approvals

| ATEX              |  |                             |
|-------------------|--|-----------------------------|
| Zone 1 Flameproof | Without display<br> | ■ II 1/2G Ex d IIC T6 Ga/Gb |
| Zone 2            | Without display<br> | ■ II 3G Ex nA IIC T6 Gc     |
|                   | With display<br>    | ■ II 3G Ex nA IIC T4 Gc     |



| CSA             |   |
|-----------------|---|
| Explosion proof | Without display <ul style="list-style-type: none"> <li>▪ Class I, Division 1, Groups C &amp; D</li> <li>▪ Class I, Division 2, Groups A, B, C &amp; D</li> <li>▪ Class II, Division 1, Groups E, F &amp; G</li> </ul> |
|                 | With display <ul style="list-style-type: none"> <li>▪ Class I, Division 2, Groups A, B, C &amp; D</li> </ul>  |

| IECEX             |   |
|-------------------|---|
| Zone 1 Flameproof | Without display <ul style="list-style-type: none"> <li>▪ Ex d IIC T6 Ga/Gb</li> </ul> |
| Zone 2            | Without display <ul style="list-style-type: none"> <li>▪ Ex nA IIC T6 Gc</li> </ul>   |
|                   | With display <ul style="list-style-type: none"> <li>▪ Ex nA IIC T4 Gc</li> </ul>      |

## Marine approval classifications

| Marine approval             | Country |
|-----------------------------|---------|
| Det Norske Veritas          | Norway  |
| Bureau Veritas              | France  |
| American Bureau of Shipping | USA     |

## Environmental specifications

| Type                          | Rating  |
|-------------------------------|---|
| Electromagnetic compatibility | All versions conform to the latest international standards for EMC, and are certified compliant with EN 61326 |
| Ambient temperature           | -40 °F (-40 °C) to 149 °F (65 °C)   |
| Ingress protection rating     | IP66/67, NEMA Type 4X   |

## Power requirements

| Type                  | Description  |
|-----------------------|--|
| DC power requirements | <ul style="list-style-type: none"> <li>▪ 24 VDC, 0.65 W typical, 1.1 W maximum</li> <li>▪ Minimum recommended voltage: 21.6 VDC with 1,000 ft (305 m) of AWG (300 m of 0.20 mm<sup>2</sup>) power-supply cable</li> <li>▪ At startup, power source must provide a minimum of 0.5 A of short-term current with a minimum of 19.6 V at the power input terminals.</li> </ul> |

## Physical specifications

### Construction materials

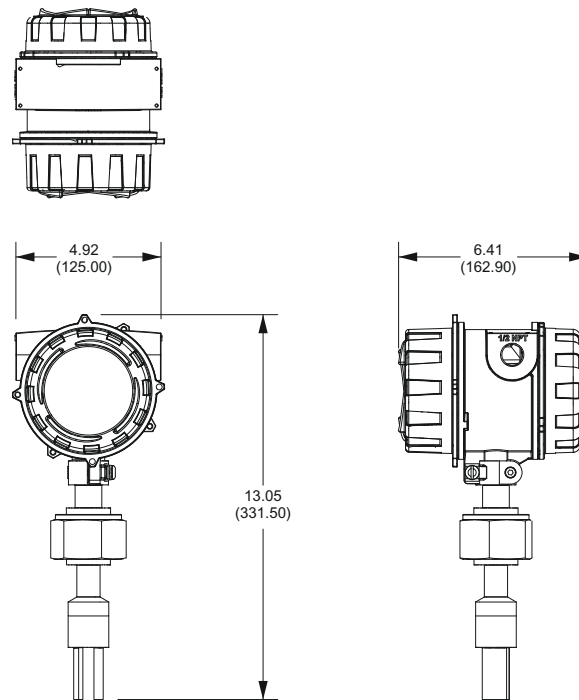
| Component           | Material                         |
|---------------------|----------------------------------|
| Wetted parts        | 316L stainless steel             |
| Tine finish         | DLC (Diamond-Like Carbon) coated |
| Transmitter housing | Polyurethane-painted aluminum    |

### Weight

| Specification    | Value  |        |
|------------------|--------|--------|
| Weight (typical) | 6.7 kg | 15 lbs |

### Dimensions

Use these dimensional drawings as a basic guideline for sizing and planning. For information about obtaining complete and detailed dimensional drawings, go to [www.emerson.com/density](http://www.emerson.com/density).

**Note**

Dimensions are in inches (mm)

## Installation and retrofit accessories

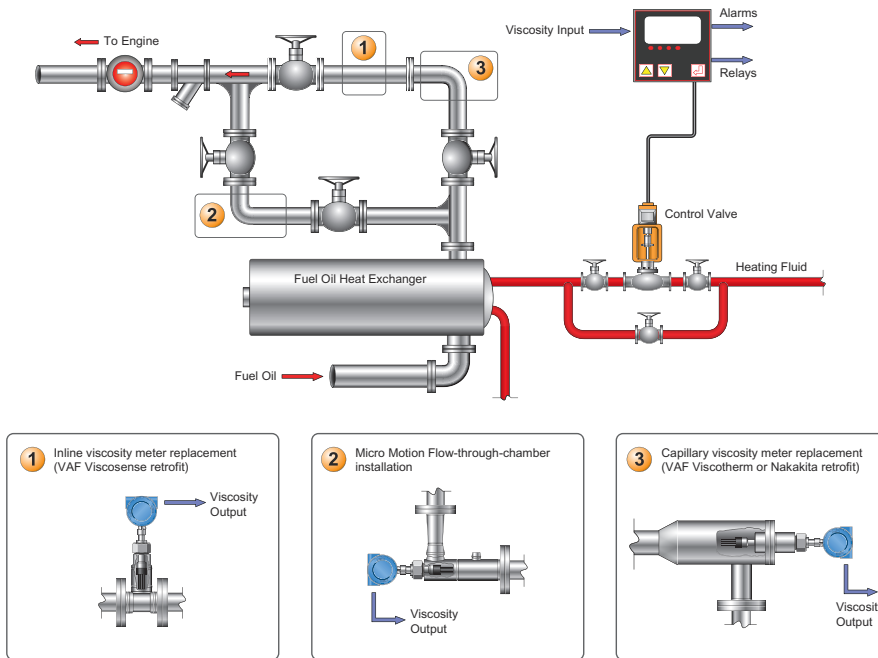
A variety of installation accessories are available for both inline and slipstream/bypass installations. Additionally, you can replace other viscosity measurement technologies using retrofit adapter kits. For more information on these installation accessories, see the Micro Motion Insertion Density and Viscosity Meter Accessories product data sheet available at [www.emerson.com/density](http://www.emerson.com/density).

### Fuel heater control example

Most marine and land-based engine/burner applications use a fuel booster module to precondition the heavy fuel oil (HFO) prior to injection. These modules usually consist of a number of supply pumps fed by either HFO or MDO, a flow meter, inline filters to remove the impurities, and a holding/mixing tank.

Following the supply section, the fuel is usually sent to booster pumps that increase the flow rate up to a maximum of 20 m<sup>3</sup>/hr, and then through a series of liquid or electric heat exchangers to change the product viscosity for efficient combustion.

The following graphic shows different installation options for the HFVM in a fuel booster module.



## Ordering information

| Model | Description  |
|-------|--|
| HFVM  | Heavy Fuel Viscosity Meter (HFVM) Viscomaster  |
| Code  | Sensor calibration code and performance  |
| 1     | Viscosity accuracy $\pm 0.2\text{cSt}$ (0-10cSt range) then $\pm 1\%$ FS, viscosity limit 100cSt |
| Code  | Stem length  |
| 1     | 0 mm: no stem extension and with standard spigot   |
| Code  | Materials of wetted parts (including process connection)   |
| L     | 316L stainless steel, Diamond-Like Carbon (DLC) coated tines                                     |
| X     | Special order (ETO) material of wetted parts   |
| Code  | Process connections  |
| 729   | 1-½ inch, cone-seat compression fitting, 316/316L  |
| 999   | Special order (ETO) process connection   |
| Code  | Sensor calibration types   |
| B     | 2-inch schedule 40 boundary  |
| E     | 3-inch schedule 80 boundary  |
| H     | 2-½ inch schedule 40 boundary  |

| Code | Sensor calibration types   |
|------|--|
| J    | DN80 boundary – Viscosity limits = 1000cSt (782791 Flow Through Chamber) |
| X    | Special order (ETO) calibration type: Requires X factory option          |

| Code | Transmitter housing option |
|------|----------------------------|
| A    | Integral, aluminum alloy   |

| Code | Transmitter outputs option   |
|------|--|
| C    | Integral transmitter, Channel A = mA + HART, Channel B = mA output, Channel C = RS485 Modbus |

| Code  | Display option                          |
|---|---|
| Available with approvals codes M, 2, V and 3 only |   |
| 2   | Integral two-line display (non-backlit) |
| Available with all approvals codes                |   |
| 3   | No display                              |

| Code | Approvals  |
|------|--|
| M    | Safe area - no hazardous area approval   |
| 2    | CSA Class 1, Div 2 (US and Canada)   |
| V    | ATEX equipment category 3 (zone 2)   |
| 3    | IECEEx zone 2  |
| A    | CSA (US and Canada) explosion-proof  |
| F    | ATEX - zone 1 flameproof   |
| I    | IECEEx - zone 1 flameproof   |
| G    | Country-specific approval. Requires an R1 or R2 selection from the <i>Special tests and certificates, tests, calibrations and services (optional)</i> table. |

| Code | Primary mA output (Channel A): Default process variable and scaling                             |
|------|---|
| H    | Line viscosity (4 mA = 0 cSt, 20 mA = 25 cSt)   |
| J    | Line viscosity (4 mA = 0 cSt, 20 mA = 50 cSt)   |
| E    | Line viscosity (4 mA = 0 cSt, 20 mA = 100 cSt)  |
| X    | Special order (ETO) mA output configuration (customer data required): Requires X factory option |

| Code | Calibration code  |
|------|---|
| B    | 0.5 to 100 cP viscosity and density calibration                 |
| R    | 5 to 50 cP viscosity calibration only                           |
| X    | Special order (ETO) calibration code: Requires X factory option |

| Code                                 | Language (manual and software) |
|--------------------------------------|--------------------------------|
| Transmitter display language English |                                |

| Code                                 | Language (manual and software)                               |
|--------------------------------------|--|
| E                                    | English installation manual and English configuration manual |
| I                                    | Italian installation manual and English configuration manual |
| M                                    | Chinese installation manual and English configuration manual |
| R                                    | Russian installation manual and English configuration manual |
| Transmitter display language French  |  |
| F                                    | French installation manual and English configuration manual  |
| Transmitter display language German  |  |
| G                                    | German installation manual and English configuration manual  |
| Transmitter display language Spanish |  |
| S                                    | Spanish installation manual and English configuration manual |

| Code | Future option 1         |
|------|-------------------------|
| Z    | Reserved for future use |

| Code | Conduit connections                        |
|------|--|
| Z    | Standard ½-inch NPT fittings (no adapters) |
| B    | M20 stainless steel adapters               |

| Code | Factory options             |
|------|-----------------------------|
| Z    | Standard product            |
| X    | Special order (ETO) product |

| Code  | Special tests and certificates, tests, calibrations and services (optional)  |
|---|--|
| Material quality examination tests and certificates         |  |
| MC  | Material Inspection Certificate 3.1 (Supplier Lot Traceability per EN 10204)   |
| NC  | NACE Certificate 2.1 (MR0175 and MR0103)   |
| Pressure testing  |  |
| HT  | Hydrostatic Test Certificate 3.1 (Pressure-retaining parts only)   |
| Dye penetrant examination                                   |  |
| D1  | Dye Penetrant Test Package 3.1 (Sensor only; Liquid Dye Penetration NDE Qualification)   |
| Weld examination  |  |
| WP  | Weld Procedure Package (Weld Map, Weld Procedure Specification, Weld Procedure Qualification Record, Welder Performance Qualification) |
| Positive material testing (select only one from this group) |  |
| PM  | Positive Material Test Certificate 3.1 (without carbon content)  |
| PC  | Positive Material Test Certificate 3.1 (including carbon content)  |
| Sensor completion options                                   |  |
| WG  | Witness General  |

| <b>Code</b>   | <b>Special tests and certificates, tests, calibrations and services (optional)</b> |
|---|--|
| SP  | Special Packaging  |
| Instrument tagging  |  |
| TG  | Instrument Tagging - customer information required (max. 24 characters)            |
| Country-specific approvals<br>(Select only one when Approvals option G is selected) |  |
| R1 <sup>(1)</sup> (2)   | EAC Zone 1 - Hazardous area approval - intrinsically safe                          |
| R2 <sup>(1)</sup> (2)   | EAC Zone 1 - Hazardous area approval - flameproof terminal compartment             |

(1) Available only with approval G

(2) Not available with Transmitter Output Options code F or Transmitter Housing Option B

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