

NUFLO Differential Pressure Cone Meter



Cameron's differential pressure-based NUFLO™ Cone Meter is a process control and multifluid meter that provides accurate, repeatable and cost-optimized measurement solutions. Designed to work in unprocessed and processed applications, the NUFLO Cone Meter is ideal for upstream, midstream and downstream applications that present a wide range of measurement challenges.

Supported by decades of experience – and a broad and complementary base of instrumentation capabilities – the NUFLO Cone Meter strengthens Cameron's capability to provide the best solution for any measurement situation.

The NUFLO Cone Meter provides a unique solution outside the scope of traditional technologies, due to the hydrodynamic shape of the cone.



NUFLO DP Cone Meter shown with the Scanner® 2000 microEFM

Wide Ranging Applications

Oil and Gas: Upstream and Midstream

- Natural gas custody transfer measurement (CTM)
- Wellhead and separator measurement (both produced water and gas)
- Compressor control and fuel gas
- Wet gas and steam¹
- Natural gas allocation metering²
- White oil blending
- Seawater pump control, crude oil pump control allocation and injection metering (all forms)
- Enhanced oil and gas recovery (CO₂ and steam)³
- Coal bed methane (CBM) for low pressure systems (circa 5 to 20 sig)
- Pure product metering opportunities in refining applications

¹ By using the Stevens wet gas correlation
(Published: NSFMW 2004 and Flomeco 2005 with betas at 0.55 and 0.75 only)

² To ISO TC 193 allocation draft standard

³ SAGD processes in Canada and other areas around the world or world wide

Oil and Gas: Downstream

- Gas processing
- Butane
- O₂
- CO₂
- Liquid Natural Gas (LNG)

Wastewater

Municipal Water

Pharmaceuticals

Wide Range

The NUFLO Cone Meter is designed to operate over large turndowns which allows differential pressures to be measured down to < 1" water column. The cone meter also generates a low noise differential pressure signal at the center and back of the cone.

High Performance Characteristics

The NUFLO Cone Meter achieves accuracies of up to ± 0.5% of reading (Reynolds number and fluid dependent) with a nominal repeatability of 0.1% under many conditions and modes of operation. The meter can operate with turndowns nominally up to 10 to 1. These specifications meet custody transfer performance requirements for natural gas transmission measurements with sizes to > 36" (Contact Cameron for exact ranges per process fluid).

Technical Flexibility

The NUFLO Cone Meter can be manufactured in diameters from 1/2" to 48" with flanges ranging from Class 150 to 2500 in accordance with ASME B31.3 (see *Tables 1 & 2, pp 3-4*). This sizing flexibility, plus the availability of special materials (duplex stainless steel and hastelloy), offers a new solution for specialty fluid metering requirements. Custom designs for higher pressure ratings are available upon request.

Also available are threaded NPT connections in diameters from 1/2" to 4" (*Table 3, page 5*) and butt-weld body in diameters from 1/2" to 24" (see *Table 4, page 6*).

Space Savings and Weight Reduction

Differential pressure systems usually require long upstream and downstream lengths which add high overall cost to most metering installations. The NUFLO Cone Meter has the ability to re-distribute and change the velocity profile upstream of its cone. This flow conditioning allows for the use of a shorter meter run which in turn reduces installation and setup costs. This is especially significant in the offshore environment where space and weight issues are relevant and where real estate is at a premium.

Low Cost of Ownership

The NUFLO Cone Meter has no moving parts nor does it require the replacement of primary spare parts for the operational life of the unit.⁴ The meter is constructed from high-grade traceable materials and both high-quality welding and NDT techniques are strictly applied throughout the manufacturing process.

Minimum wear occurs at the beta edge of the cone because this edge is downstream of the flow which helps to maintain a constant stable geometry through the meter's operating life.

⁴ Provided the device is not used outside of its design criteria

Table 1 – Class ANSI B16.5 Raised-Face Slip-on Flange, B31.1 & B31.3 Body

ANSI Size	150#		300#		600#		900#		1500#		2500#		E (in)(mm)		F (in)(mm)	
	L (in)(mm)	A (in)(mm)	L (in)(mm)	A (in)(mm)	L (in)(mm)	A (in)(mm)	L (in)(mm)	A (in)(mm)	L (in)(mm)	A (in)(mm)	L (in)(mm)	A (in)(mm)	3000#	6000#	3000#	6000#
15A 1/2"	8.27[210]	3.15[80]	8.27[210]	3.15[80]	9.06[230]	3.54[90]	9.45[240]	3.74[95]	9.45[240]	3.74[95]						2.13[54]
20A 3/4"	8.66[220]	3.35[85]	8.66[220]	3.35[85]	9.45[240]	3.74[95]	9.84[250]	3.94[100]	9.84[250]	3.94[100]						2.13[54]
25A 1"	7.87[200]	2.56[65]	8.07[205]	2.76[70]	11.81[300]	4.72[120]	12.60[320]	5.12[130]	12.60[320]	5.12[130]				Ø1.18[30]	2.13 [54]	2.13[54]
40A 1-1/2"	10.24[260]	2.95[75]	10.43[265]	3.15[80]	12.60[320]	5.12[130]	13.39[340]	5.51[140]	13.39[340]	5.51[140]				Ø0.87[22]	2.13 [54]	2.13[54]
50A 2"	11.81[300]	3.54[90]	11.81[300]	3.54[90]	13.39[340]	5.12[130]	15.75[400]	6.30[160]	15.75[400]	6.30[160]				Ø1.18[30]	2.13 [54]	2.76[70]
65A 2-1/2"	11.81[300]	3.54[90]	11.81[300]	3.54[90]	14.17[360]	5.51[140]	15.75[400]	6.30[160]	15.75[400]	6.30[160]				Ø1.18[30]	2.13 [54]	2.76[70]
80A 3"	14.17[360]	3.54[90]	14.57[370]	3.94[100]	16.14[410]	5.51[140]	16.93[430]	6.30[160]						Ø1.18[30]	2.13 [54]	2.76[70]
100A 4"	15.75[400]	3.94[100]	16.14[410]	4.33[110]	18.11[460]	6.30[160]	18.50[470]	6.69[170]						Ø1.18[30]	2.13 [54]	2.76[70]
125A 5"	22.05[560]	4.33[110]	22.44[570]	4.72[120]	24.41[620]	6.69[170]	24.80[630]	7.09[180]						Ø1.18[30]	2.13 [54]	2.76[70]
150A 6"	22.05[560]	4.33[110]	22.44[570]	4.72[120]	24.41[620]	6.69[170]	25.59[650]	7.87[200]						Ø1.18[30]	2.13 [54]	2.76[70]
200A 8"	25.98[660]	5.12[130]	26.38[670]	5.51[140]	28.35[720]	7.48[190]	29.53[750]	8.66[220]						Ø1.18[30]	2.13 [54]	2.76[70]
250A 10"	27.95[710]	5.12[130]	28.74[730]	5.91[150]	31.10[790]	8.27[210]	32.28[820]	9.45[240]						Ø1.18[30]	2.13 [54]	2.76[70]
300A 12"	29.92[760]	5.12[130]	30.71[780]	5.91[150]	33.07[840]	8.27[210]	35.04[890]	10.24[260]						Ø1.18[30]	2.13 [54]	2.76[70]
350A 14"	31.50[800]	6.30[160]	32.28[820]	7.09[180]	36.37[920]	9.84[250]	42.52[1080]	11.81[300]						Ø1.18[30]	2.13 [54]	2.76[70]
400A 16"	35.43[900]	7.09[180]	36.22[920]	7.87[200]	42.91[1090]	10.63[270]	45.28[1150]	12.20[310]						Ø1.18[30]	2.13 [54]	2.76[70]
450A 18"	39.37[1000]	7.87[200]	40.16[1020]	8.66[220]	46.06[1170]	10.63[270]	49.21[1250]	12.60[320]						Ø1.18[30]	2.13 [54]	2.76[70]
500A 20"	43.31[1100]	7.87[200]	44.09[1120]	8.66[220]	50.39[1280]	11.02[280]	52.76[1340]	13.39[340]						Ø1.18[30]	2.13 [54]	2.76[70]
600A 24"	53.15[1350]	7.87[200]	53.94[1370]	8.66[220]	57.87[1470]	11.42[290]	61.81[1570]	15.35[390]						Ø1.18[30]	2.13 [54]	2.76[70]

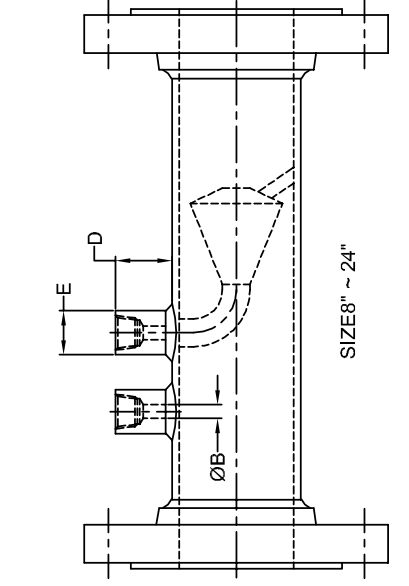
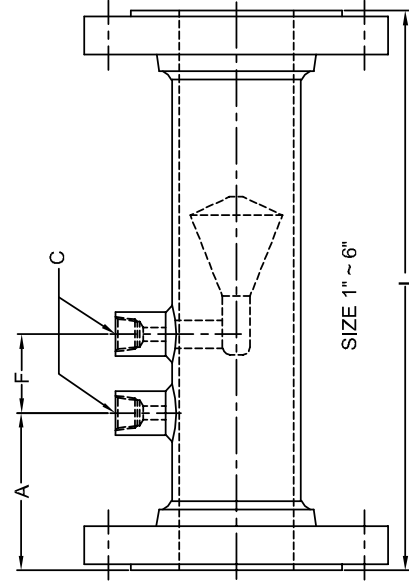
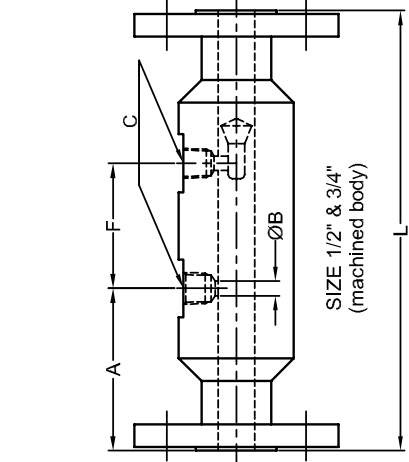


Table 2 – Class ANSI B16.5 Raised-Face Weld-Neck/Ring-Type Joint Weld-Neck Flange, B31.1 & B31.3 Body

ANSI Size	150#		300#		600#		900#		1500#		2500#		B (inch)	C (NPT)	E (in[mm])		F (in[mm])	
	L (in[mm])	A (in[mm])	L (in[mm])	A (in[mm])	L (in[mm])	A (in[mm])	L (in[mm])	A (in[mm])	L (in[mm])	A (in[mm])	L (in[mm])	A (in[mm])			3000#	6000#		
15A 1/2"	8.27[210]	3.15[80]	8.27[210]	3.15[80]	9.06[230]	3.54[90]	9.45[240]	3.74[95]	9.45[240]	3.74[95]	9.84[250]	3.94[100]	1/8	1/4			6000#	2.13[54]
20A 3/4"	8.66[220]	3.35[85]	8.66[220]	3.35[85]	9.45[240]	3.74[95]	9.84[250]	3.94[100]	9.84[250]	3.94[100]	10.24[260]	4.13[105]	1/8	1/4				2.13[54]
25A 1"	11.02[280]	4.33[110]	11.42[290]	4.72[120]	11.81[300]	4.72[120]	12.60[320]	5.12[130]	12.60[320]	5.12[130]	14.17[360]	5.91[150]	1/4	1/4	0.98[25]	Ø1.18[30]	2.13[54]	2.13[54]
40A 1-1/2"	11.42[290]	4.72[120]	12.20[310]	5.12[130]	12.60[320]	5.12[130]	13.39[340]	5.51[140]	13.39[340]	5.51[140]	15.75[400]	6.69[170]	1/4	1/4	0.98[25]	Ø0.87[22]	2.13[54]	2.13[54]
50A 2"	12.99[330]	4.72[120]	13.39[340]	5.12[130]	13.39[340]	5.12[130]	15.75[400]	6.30[160]	15.75[400]	6.30[160]	17.32[440]	7.48[190]	3/8	1/2	1.54[39]	Ø1.18[30]	2.13[54]	2.76[70]
65A 2-1/2"	13.39[340]	5.12[130]	13.39[340]	5.12[130]	14.17[360]	5.51[140]	15.75[400]	6.30[160]	15.75[400]	6.30[160]	18.90[480]	7.87[200]	3/8	1/2	1.54[39]	Ø1.18[30]	2.13[54]	2.76[70]
80A 3"	15.75[400]	5.12[130]	16.14[410]	5.51[140]	16.14[410]	5.51[140]	16.93[430]	6.30[160]	17.72[450]	7.09[180]	21.26[540]	9.06[230]	3/8	1/2	1.54[39]	Ø1.18[30]	2.13[54]	2.76[70]
100A 4"	16.93[430]	5.12[130]	17.32[440]	5.51[140]	18.11[460]	6.30[160]	18.50[470]	6.69[170]	18.90[480]	7.09[180]	23.62[600]	9.84[250]	3/8	1/2	1.54[39]	Ø1.18[30]	2.13[54]	2.76[70]
125A 5"	23.62[600]	5.91[150]	24.02[610]	6.30[160]	24.41[620]	6.69[170]	25.20[640]	7.48[190]	25.98[660]	8.66[220]	29.53[750]	11.81[300]	3/8	1/2	1.54[39]	Ø1.18[30]	2.13[54]	2.76[70]
150A 6"	23.62[600]	5.91[150]	24.02[610]	6.30[160]	24.80[630]	7.09[180]	25.59[650]	7.87[200]	26.77[680]	9.45[240]	32.28[820]	13.78[350]	3/8	1/2	1.54[39]	Ø1.18[30]	2.13[54]	2.76[70]
200A 8"	27.17[690]	6.30[160]	27.56[700]	6.69[170]	28.35[720]	7.48[190]	29.53[750]	8.66[220]	31.50[800]	11.02[280]	37.40[950]	15.75[400]	3/8	1/2	1.54[39]	Ø1.18[30]	2.13[54]	2.76[70]
250A 10"	29.13[740]	6.30[160]	29.92[760]	7.09[180]	31.10[790]	8.27[210]	32.28[820]	9.45[240]	35.43[900]	12.60[320]	51.18[1300]	21.65[550]	3/8	1/2	1.54[39]	Ø1.18[30]	2.13[54]	2.76[70]
300A 12"	31.50[800]	6.69[170]	32.28[820]	7.48[190]	33.07[840]	8.27[210]	35.04[890]	10.24[260]	38.58[980]	13.78[350]	55.12[1400]	22.44[570]	3/8	1/2	1.54[39]	Ø1.18[30]	2.13[54]	2.76[70]
350A 14"	37.40[950]	8.27[210]	38.19[970]	9.06[230]	39.37[1000]	9.84[250]	42.52[1080]	11.81[300]	49.21[1250]	15.35[390]			3/8	1/2	1.54[39]	Ø1.18[30]	2.13[54]	2.76[70]
400A 16"	40.55[1030]	8.27[210]	41.34[1050]	9.06[230]	42.91[1090]	10.63[270]	45.28[1150]	12.20[310]	53.15[1350]	16.14[410]			3/8	1/2	1.54[39]	Ø1.18[30]	2.13[54]	2.76[70]
450A 18"	44.49[1130]	9.06[230]	45.28[1150]	9.84[250]	46.06[1170]	10.63[270]	49.21[1250]	12.60[320]	57.09[1450]	16.93[430]			3/8	1/2	1.54[39]	Ø1.18[30]	2.13[54]	2.76[70]
500A 20"	48.43[1230]	9.06[230]	49.21[1250]	9.84[250]	50.39[1280]	11.02[280]	52.76[1340]	13.39[340]	61.02[1550]	17.72[450]			3/8	1/2	1.54[39]	Ø1.18[30]	2.13[54]	2.76[70]
600A 24"	55.91[1420]	9.45[240]	56.69[1440]	10.24[260]	57.87[1470]	11.42[290]	61.81[1570]	15.35[390]	70.87[1800]	20.08[510]			3/8	1/2	1.54[39]	Ø1.18[30]	2.13[54]	2.76[70]

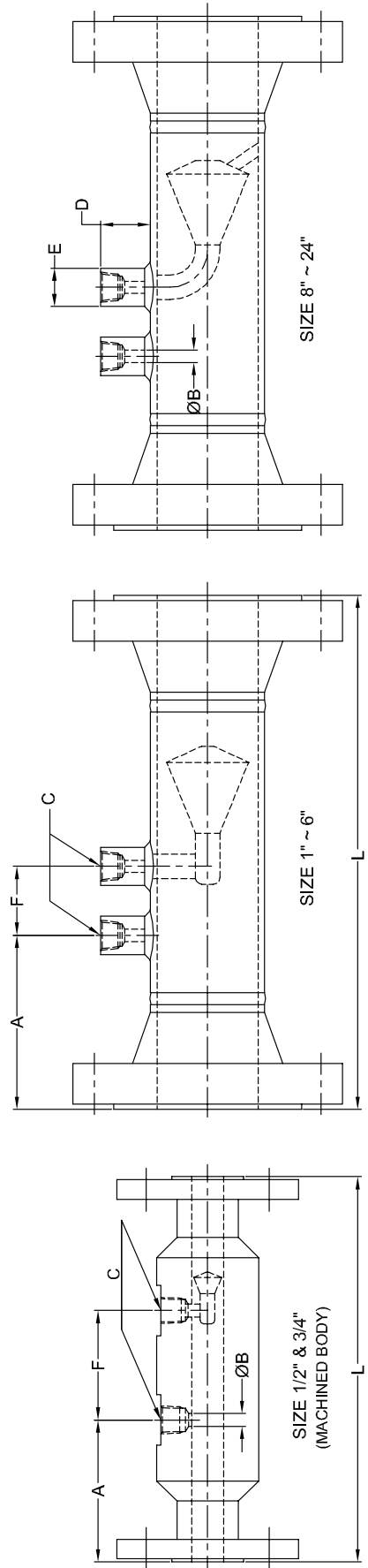


Table 3 – Threaded NPT Connection, B31.1 & B31.3 Body

Size		L (IN[MM])	A (IN[MM])	B (INCH)	C (NPT)	D (IN[MM])	E (IN[MM])		F (IN[MM])	
JIS	ANSI						3000#	6000#	3000#	6000#
15A	1/2"	7.87[200]	2.56[65]	1/8	1/4					2.13[54]
20A	3/4"	7.87[200]	2.56[65]	1/8	1/4					2.13[54]
25A	1"	7.87[200]	2.56[65]	1/4	1/4	0.98[25]	Ø0.87[22]	Ø1.18[30]	2.13 [54]	2.13[54]
40A	1 -1/2"	10.24[260]	2.95[75]	1/4	1/4	0.98[25]	Ø0.87[22]	Ø1.18[30]	2.13 [54]	2.13[54]
50A	2"	11.81[300]	3.54[90]	3/8	1/2	1.54[39]	Ø1.18[30]	Ø1.50[38]	2.13 [54]	2.76[70]
65A	2-1/2"	11.81[300]	3.54[90]	3/8	1/2	1.54[39]	Ø1.18[30]	Ø1.50[38]	2.13 [54]	2.76[70]
80A	3"	14.17[360]	3.54[90]	3/8	1/2	1.54[39]	Ø1.18[30]	Ø1.50[38]	2.13 [54]	2.76[70]
100A	4"	15.75[400]	3.94[100]	3/8	1/2	1.54[39]	Ø1.18[30]	Ø1.50[38]	2.13 [54]	2.76[70]

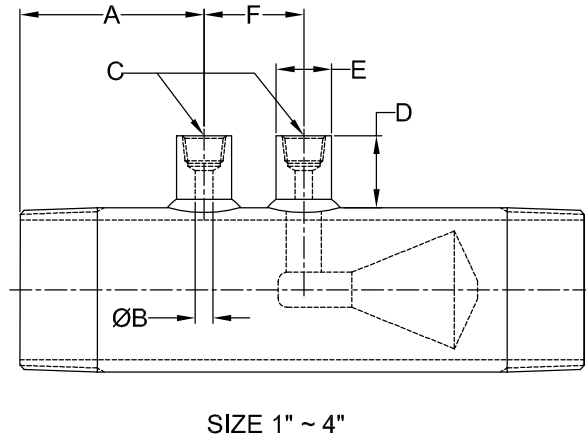
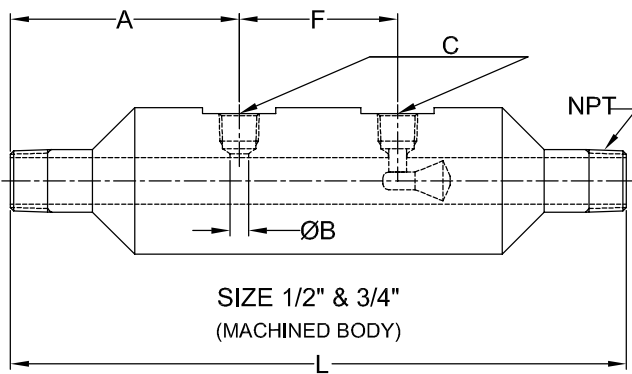
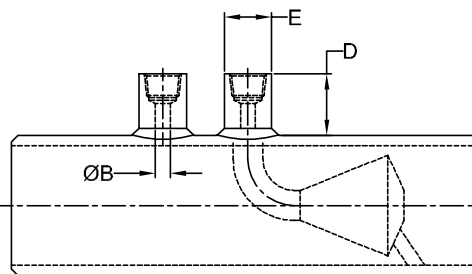
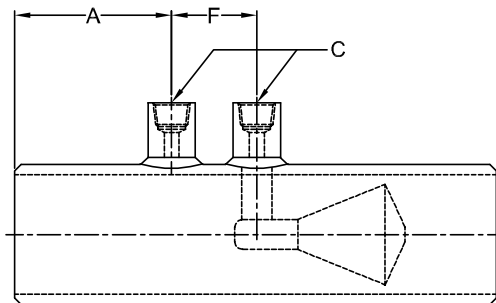
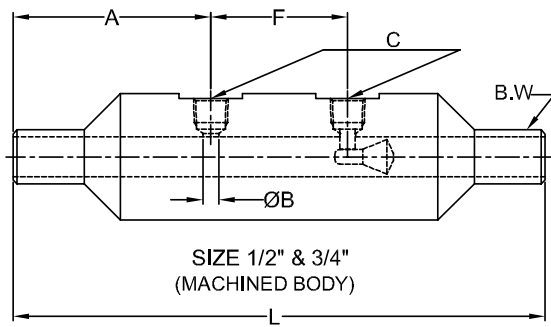


Table 4 – Class ANSI B16.25 Butt-Weld Body

SIZE		L (IN[MM])	A (IN[MM])	B (INCH)	C (NPT)	D (IN[MM])	E (IN[MM])		F (IN[MM])	
JIS	ANSI						3000#	6000#	3000#	6000#
15A	1/2"	7.87[200]	2.56[65]	1/8	1/4					2.13[54]
20A	3/4"	7.87[200]	2.56[65]	1/8	1/4					2.13[54]
25A	1"	7.87[200]	2.56[65]	1/4	1/4	0.98[25]	Ø0.87[22]	Ø1.18[30]	2.13 [54]	2.13[54]
40A	1 -1/2"	10.24[260]	2.95[75]	1/4	1/4	0.98[25]	Ø0.87[22]	Ø1.18[30]	2.13 [54]	2.13[54]
50A	2"	11.81[300]	3.54[90]	3/8	1/2	1.54[39]	Ø1.18[30]	Ø1.50[38]	2.13 [54]	2.76[70]
65A	2-1/2"	11.81[300]	3.54[90]	3/8	1/2	1.54[39]	Ø1.18[30]	Ø1.50[38]	2.13 [54]	2.76[70]
80A	3"	14.17[360]	3.54[90]	3/8	1/2	1.54[39]	Ø1.18[30]	Ø1.50[38]	2.13 [54]	2.76[70]
100A	4"	17.72[450]	3.94[100]	3/8	1/2	1.54[39]	Ø1.18[30]	Ø1.50[38]	2.13 [54]	2.76[70]
125A	5"	20.47[520]	4.33[110]	3/8	1/2	1.54[39]	Ø1.18[30]	Ø1.50[38]	2.13 [54]	2.76[70]
150A	6"	23.62[600]	4.33[110]	3/8	1/2	1.54[39]	Ø1.18[30]	Ø1.50[38]	2.13 [54]	2.76[70]
200A	8"	25.98[660]	5.12[130]	3/8	1/2	1.54[39]	Ø1.18[30]	Ø1.50[38]	2.13 [54]	2.76[70]
250A	10"	27.95[710]	5.12[130]	3/8	1/2	1.54[39]	Ø1.18[30]	Ø1.50[38]	2.13 [54]	2.76[70]
300A	12"	29.92[760]	5.12[130]	3/8	1/2	1.54[39]	Ø1.18[30]	Ø1.50[38]	2.13 [54]	2.76[70]
350A	14"	31.50[800]	6.30[160]	3/8	1/2	1.54[39]	Ø1.18[30]	Ø1.50[38]	2.13 [54]	2.76[70]
400A	16"	35.43[900]	7.09[180]	3/8	1/2	1.54[39]	Ø1.18[30]	Ø1.50[38]	2.13 [54]	2.76[70]
450A	18"	39.37[1000]	7.87[200]	3/8	1/2	1.54[39]	Ø1.18[30]	Ø1.50[38]	2.13 [54]	2.76[70]
500A	20"	43.31[1100]	7.87[200]	3/8	1/2	1.54[39]	Ø1.18[30]	Ø1.50[38]	2.13 [54]	2.76[70]
600A	24"	53.15[1350]	7.87[200]	3/8	1/2	1.54[39]	Ø1.18[30]	Ø1.50[38]	2.13 [54]	2.76[70]



Differential Pressure Measurement Principles

When a cross sectional area of a closed conduit (or pipe) is reduced by a diametric change or by the use of a differential producer element, the velocity of fluids passing through the conduit are increased across the boundary change area (continuity equation). Pressure decreases (Bernoulli equation) and a differential pressure is generated across the reduction or producer (A1 and A2 shown below in figure 1).

The differential pressure (DP) and flow rate (Qv) have a proportional relationship such that $Q_v \propto K \cdot \sqrt{P/\rho}$ and it is by this universal relationship that flow rate can be determined.

While this principle is used by other differential pressure flow meters, the NUFLO Cone Meter generates a differential pressure by creating an area of reduction using a cone-shaped flow element located on the center line of a pipe section as opposed to a reduced diameter pipe wall or orifice.

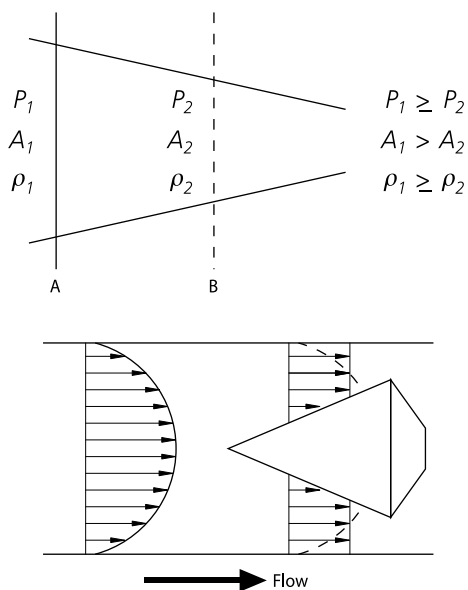


Figure 1

Calibration and Coefficient of Discharge (C.d.) Determination

Each NUFLO Cone Meter is pre-calibrated with water to four points at the factory to determine its Coefficient of Discharge which allows for enhanced performance. Further enhanced C.d. determination is available at various approved laboratories in the US and Europe. This enables higher Reynolds numbers to be determined (larger meter sizes may be limited by test laboratory flow rates and uncertainties).

Basic Equations

1.0 Effective Area Ratio (A_t), Velocity of Approach (E) and Beta Ratio (β) defined as:

$$A_t = \frac{\pi}{4} (D^2 - d^2)$$

$$E = \frac{1}{\sqrt{1 - \beta^4}}$$

$$\beta = \frac{\sqrt{D^2 - d^2}}{D}$$

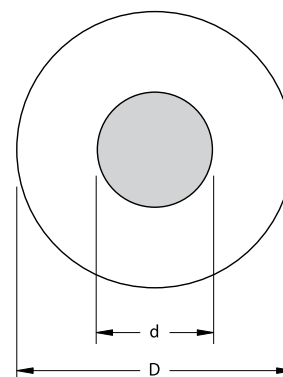


Figure 2

2.0 Volumetric Flow defined as:

$$Q_v = C_d A_t E \varepsilon \sqrt{\frac{2 \Delta P}{\rho}}$$

3.0 Mass Flow defined as:

$$Q_m = C_d A_t E \varepsilon \sqrt{2\rho \cdot \Delta P}$$

Where:

Q_v = Volumetric Flow

Q_m = Mass Flow

C_d = Coefficient of Discharge

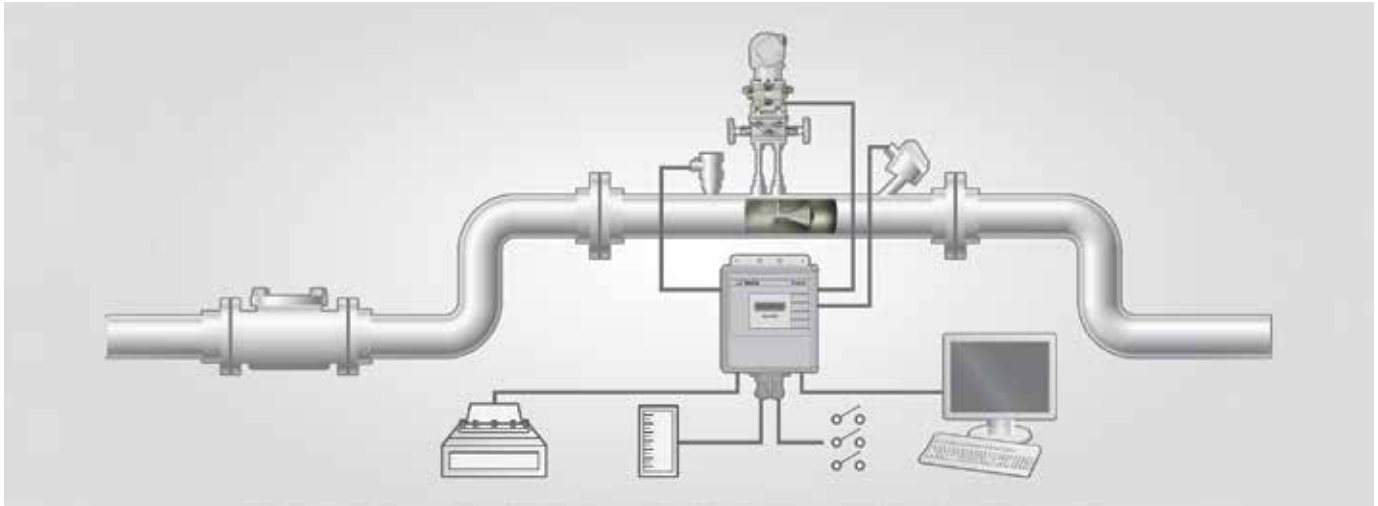
E = Velocity of Approach

A_t = Meter Throat (Minimum Cross Section Area A)

ε = (Y-factor) Expansibility Coefficient
(gaseous fluids only)

ρ = Fluid Density

ΔP = Differential Pressure ($P_1 - P_2$)



The Cameron Approach to Measurement

The NUFLO Cone Meter is a valuable addition to Cameron's system of measurement solutions. Cameron's in-depth understanding of measurement and knowledge of their customers' requirements differentiates Cameron from its competitors.

From simple sensors to complex automation and custody transfer projects, Cameron has been measuring and controlling the flow and level of oil and gas, and collecting, transmitting, analyzing and reporting data since the early 1950s. The NUFLO Cone Meter represents the on-going refinement of these core capabilities.

Cameron and Quality

The NUFLO Cone Meter is manufactured in a facility registered to ISO 9001. All equipment is subject to rigorous quality assurance plans and all sub-contractors or suppliers are quality audited to ensure that Cameron continues to either meet or exceed product standards. This philosophy is applied to all facets of the supply chain, including but not limited to material selection and traceability, welding and NDT inspections.

Specifications subject to change without notice.

Contact us

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