KUWAIT 3RD FLOW MEASUREMENT TECHNOLOGY CONFERENCE

19 - 21 NOVEMBER 2017

HILTON KUWAIT RESORT , AL DORRA BALLROOM

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شركة نفط الكويت
Kuwait Oil Company

إحدى شركات مؤسسة البترول الكويتية
A Subsidiary of Kuwait Petroleum Corporation

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DOES DP FLOW MEASUREMENT HAVE A PLACE IN TODAYS TECHNOLOGY DRIVEN WORLD ?

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Craig McLaren
JWF Group

- **Graduated in Electronic and Electrical Engineering**
- **Early career with IBM**
- **Worked for 12 years within O&G industry**
- **Based in Glasgow , Scotland**

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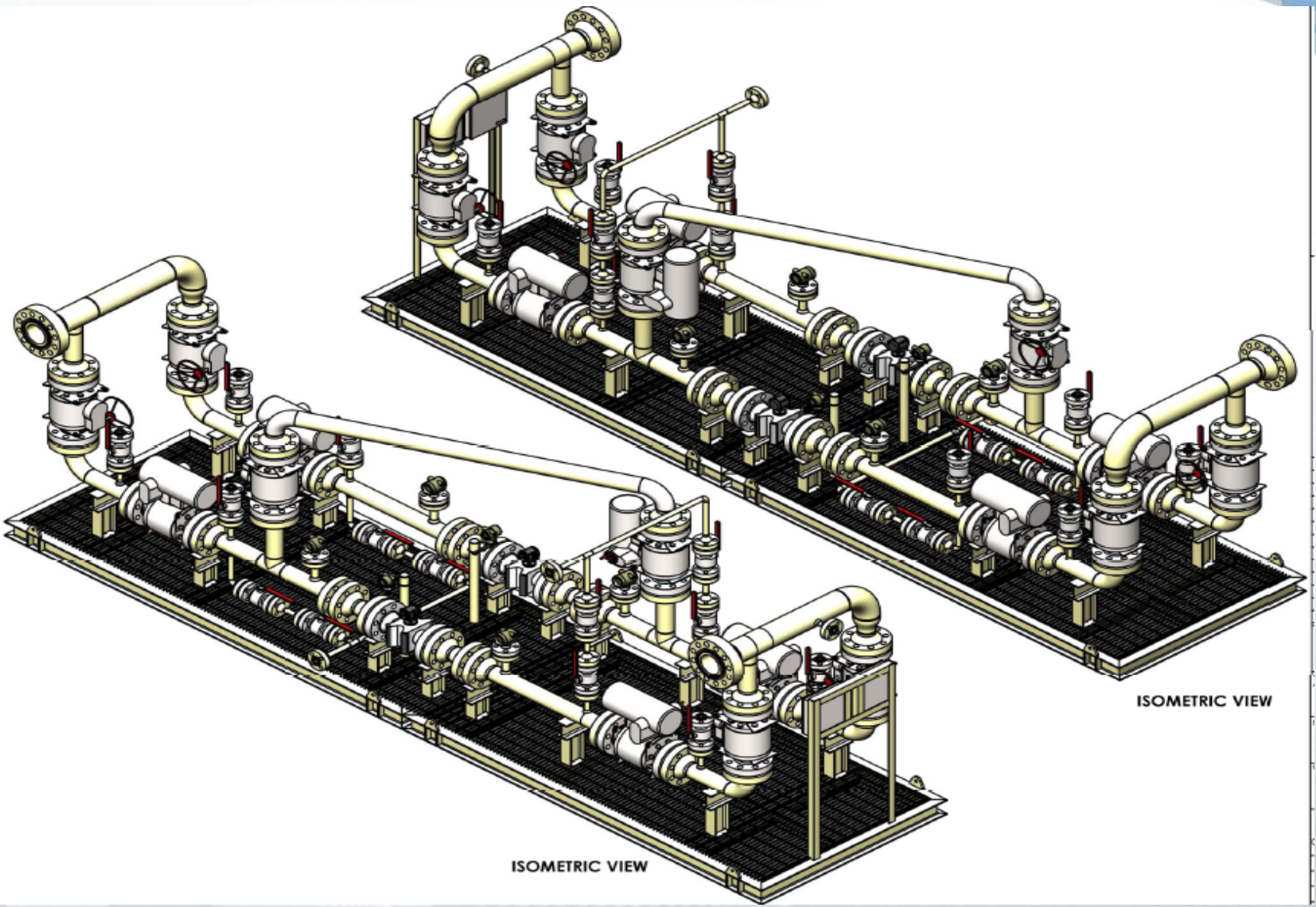

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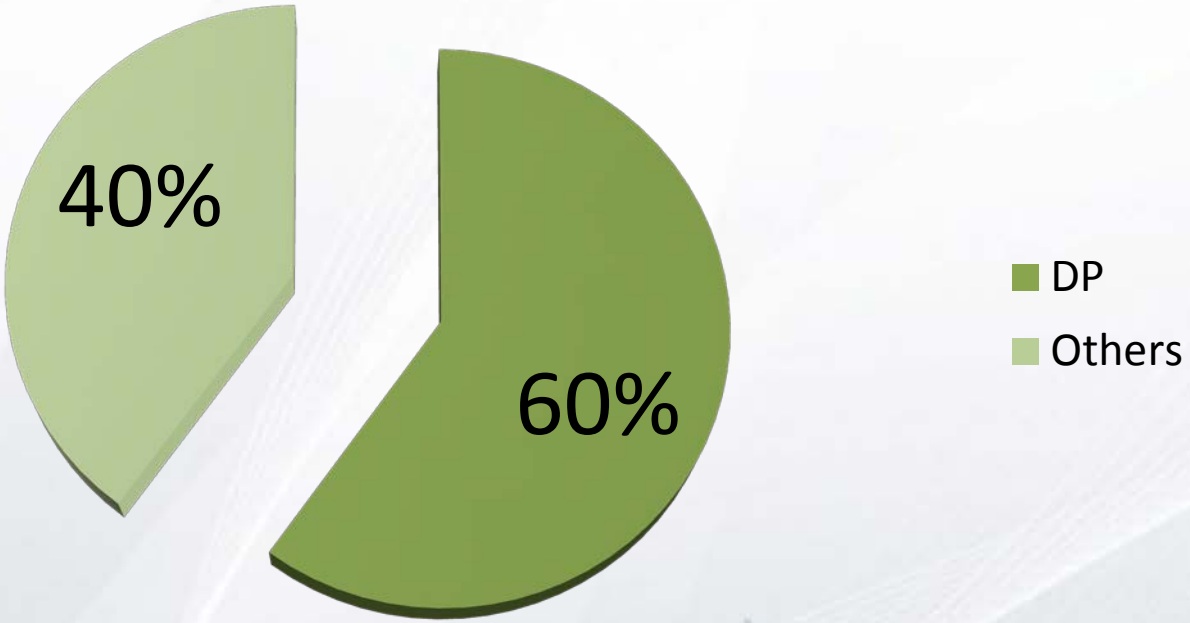
Flow Technology



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- Turndown/Rangeability
- Uncertainty / Accuracy
- Pressure Loss
- Wet Gas Performance
- Diagnostics / Validation
- Opex / Capex

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$$\text{Turndown Ratio} = \frac{\text{Full Scale Flow}}{\text{Minimum Flow}}$$

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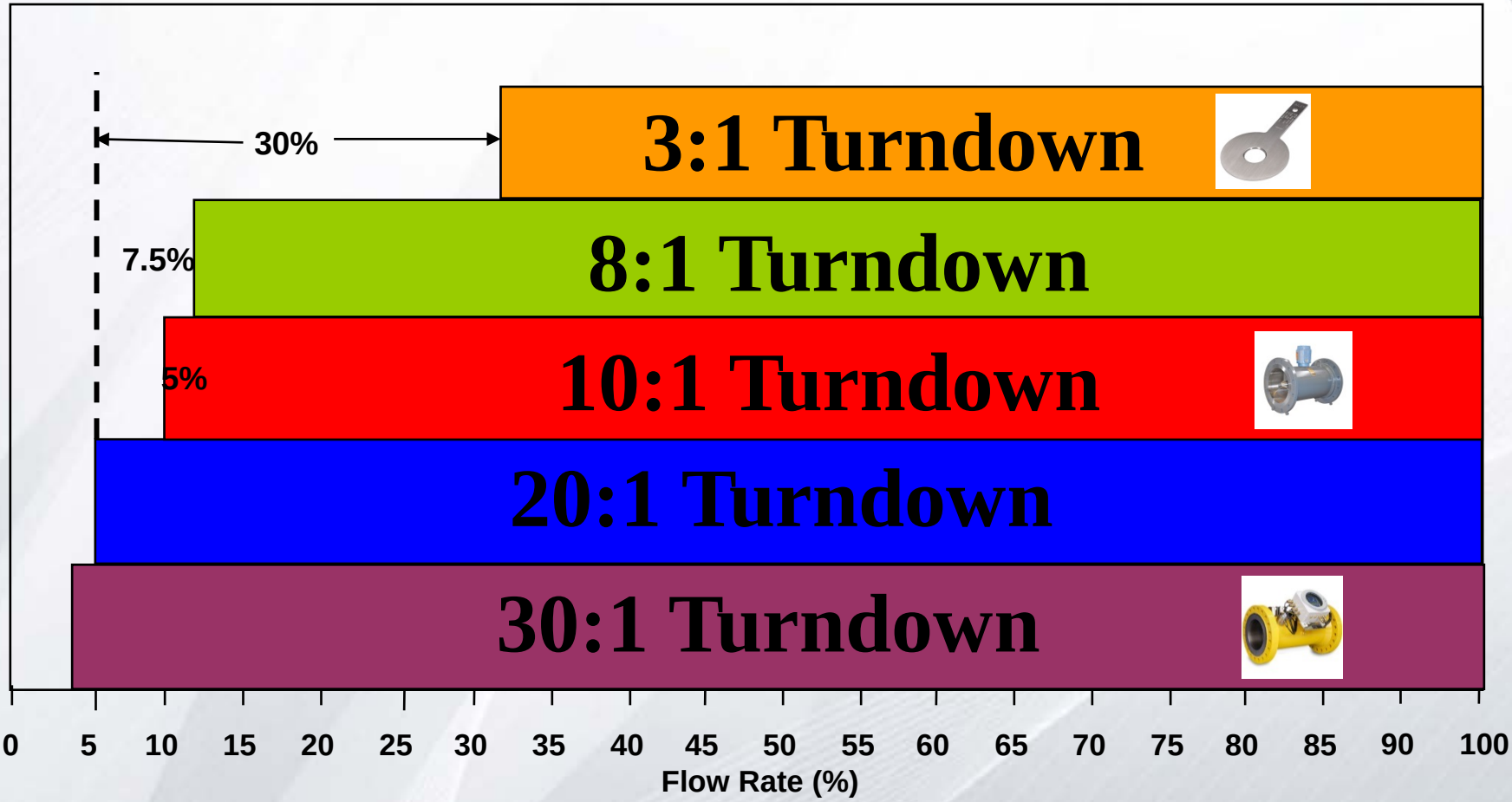
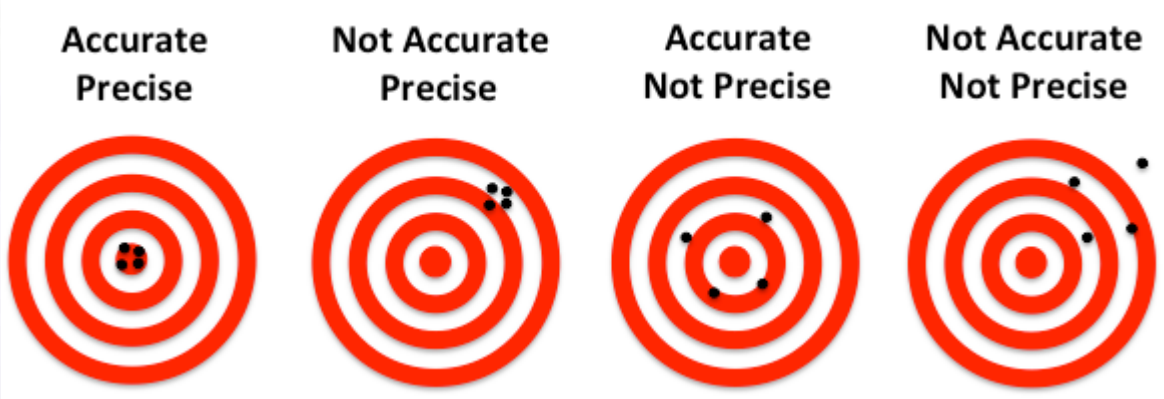


Uncertainty / Accuracy



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Contributory Factors	ISO 17089 example 1 (overly optimistic)	ISO 17089 example 2 (overly pessimistic)	Realistic Example 1	Realistic Example 2
Reproducibility	0.2	0.3	0.25	0.25
Calibration Facility Uncertainty	0.2	0.3	0.23	0.23
Installation influences	0	0.3	0.3	0.3
Calibration data fitting	0	0.3	0.2	0.2
Handling	0.1	0.1	0.1	0.1
Density	0.4	0.6	0.4	0.6
Volume Flow Uncertainty	**0.30**	**0.61**	**0.51**	**0.51**
Mass Flow Uncertainty	**0.50**	**0.85**	**0.65**	**0.78**

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Contributory Factors	API 14.3 example	Alternative Example 1	Alternative Example 2
Discharge Coefficient	0.44	0.5	0.5
Expansion Factor	0.03	0.03	0.03
Orifice Bore	0.05	0.05	0.05
Pipe Diameter	0.25	0.25	0.25
Differential Pressure	0.5	0.6	0.8
Static Pressure	0.5	0.2	0.2
Compression Factor	0.1	0.1	0.1
Temperature	0.25	0.25	0.25
Density	0.6	0.4	0.6
Mass Flow Uncertainty (0.6 beta)	**0.67**	**0.65**	**0.74**

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Contributory Factors	Example 1	Example 2	Example 3
Calibration Facility Uncertainty	0.23	0.23	0.23
Calibration data fitting	0.2	0.2	0.2
Expansion Factor	0.2	0.2	0.2
Differential Pressure	0.6	0.8	1
Static Pressure	0.2	0.2	0.2
Compression Factor	0.1	0.1	0.1
Temperature	0.25	0.25	0.25
Density	0.4	0.6	0.6
Mass Flow Uncertainty	**0.54**	**0.64**	**0.71**

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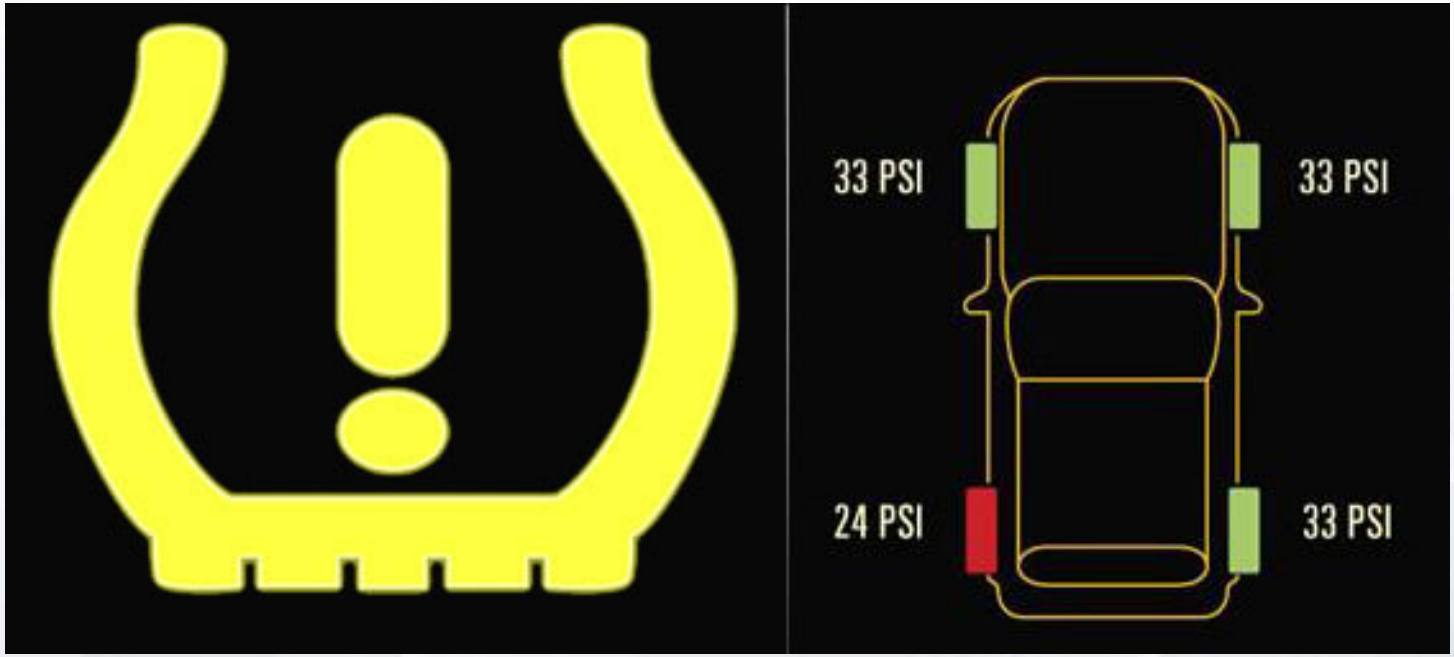
0.8%

Pressure Loss



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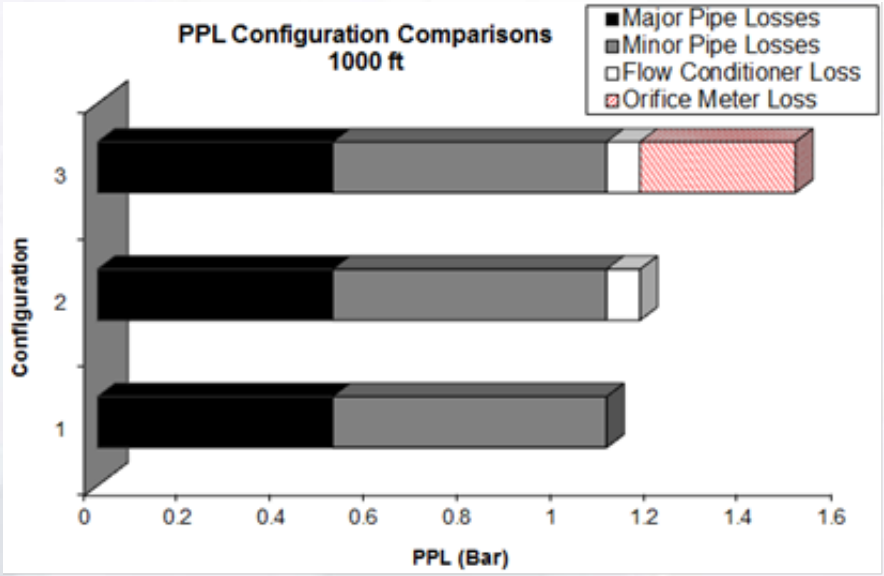

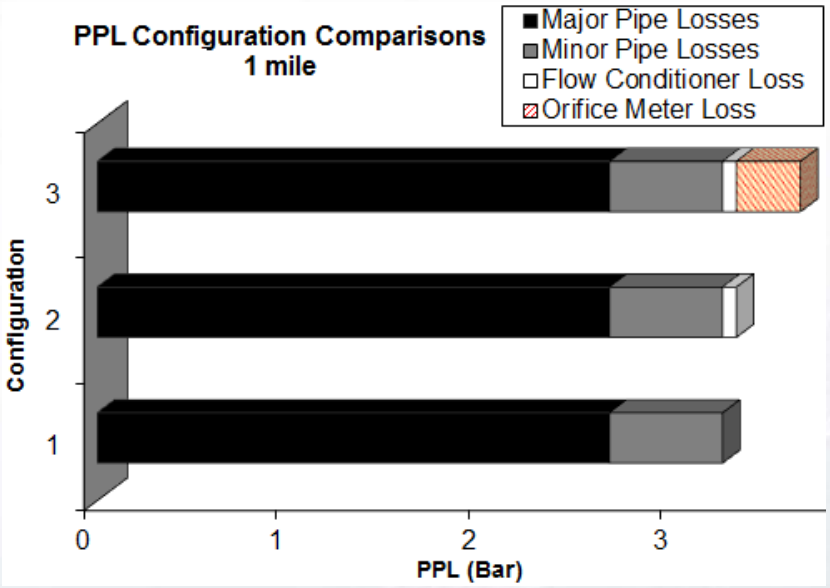

PPL Orifice influence decreases over pipeline length

South Caucasus Pipeline

Location of South Caucasus Pipeline

Location	
Country	Azerbaijan Georgia Turkey
General direction	east–west
From	Baku (Sangachal Terminal), Azerbaijan
Passes through	Tbilisi
To	Erzurum, Turkey
Runs alongside	Baku–Tbilisi–Ceyhan pipeline
General information	
Type	Natural gas
Partners	BP (28.8%) TPAO (19%) SOCAR (16.7%) Petronas (15.5%) Lukoil (10%) Naftiran Intertrade (10%)
Operator	BP
Commissioned	2006
Technical information	
Length	692 km (430 mi)
Maximum discharge	25 billion cubic metres per annum (880×10^9 cu ft/a)
Diameter	42 in (1,067 mm)

Trans-Anatolian Natural Gas Pipeline


Map of Trans-Anatolian Natural Gas Pipeline

Location	
Country	Turkey
General information	
Type	Natural gas
Owner	TANAP project company
Partners	SOCAR (58%) BOTAŞ (30%) BP (12%)
Operator	SOCAR
Construction started	2015
Expected	2018
Technical information	
Length	1,841 km (1,144 mi)
Maximum discharge	16×10^9 m³ (570×10^9 cu ft) per year
Website	http://www.tanap.com/

Wet Gas Performance

ISO/TR 11583:2012

Preview

Measurement of wet gas flow by means of pressure differential devices inserted in circular cross-section conduits

ISO/TR 11583:2012 describes the measurement of wet gas with differential pressure meters. It applies to two-phase flows of gas and liquid in which the flowing fluid mixture consist of gas in the region of 95 % volume fraction or more. ISO/TR 11583:2012 is an extension of ISO 5167. The ranges of gases and liquids from which the equations in ISO/TR 11583:2012 were derived are given. It is possible that the equations do not apply to liquids significantly different from those tested, particularly to highly viscous liquids.

Although the over-reading equations presented in ISO/TR 11583:2012 apply for a wide range of gases and liquids at appropriate gas-liquid density ratios, evaluating gas flow rates depends on information in addition to that required in single-phase flow: a measurement of the pressure loss can be sufficient; measurement of the liquid flow using tracers can be possible; the total mass flow rate may be known (this is more likely in a wet-

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	Paper	English

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ISO/TR 12748:2015

Preview

Natural Gas -- Wet gas flow measurement in natural gas operations

ISO/TR 12748:2015 describes production flow measurement of wet natural gas streams with WGFMs in surface and subsea facilities. Wet natural gas streams are gas-dominated flows with liquids like water and/or hydrocarbon liquids. ISO/TR 12748:2015 defines terms/symbols, explains the various concepts, and describes best practices of wet gas flow meter design and operation. It addresses metering techniques, testing, installation, commissioning, and operation practices such as maintenance, calibration, and verification. It also provides a theoretical background of this comprehensive, challenging and still evolving measurement technology.

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	Paper	English

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Diagnostics

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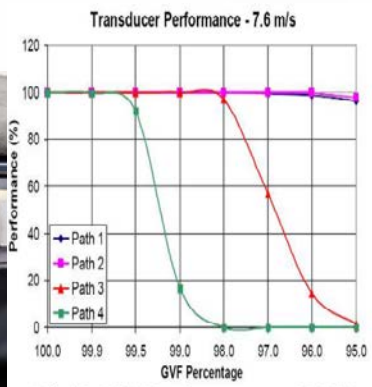


Fig 45. USM Performance vs. GVF%.

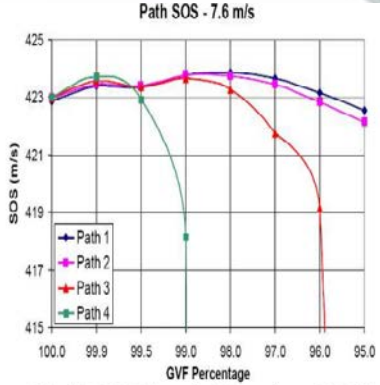


Fig 46. USM Speed of Sound vs. GVF%

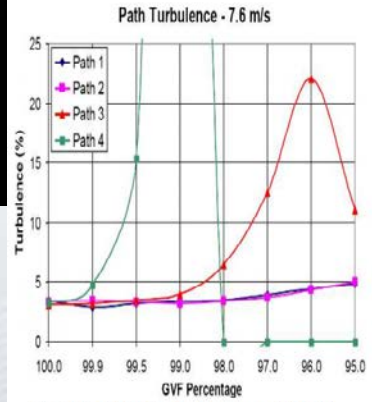


Fig 47. USM Turbulence vs. GVF%.

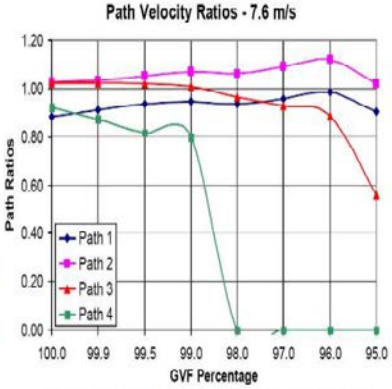
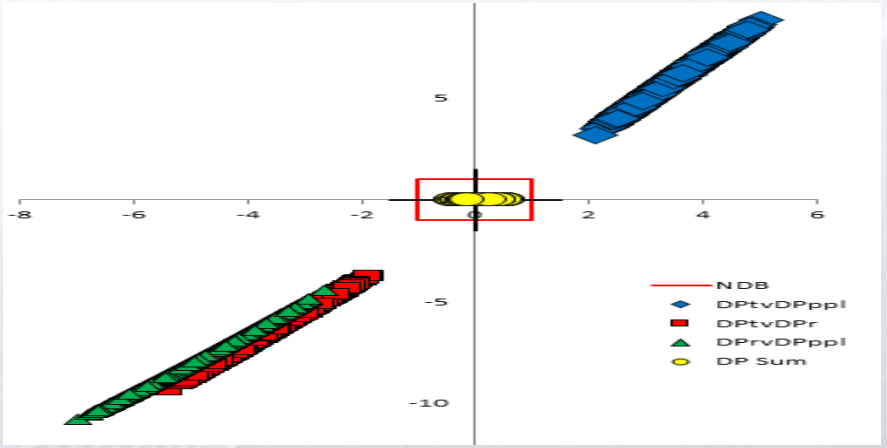
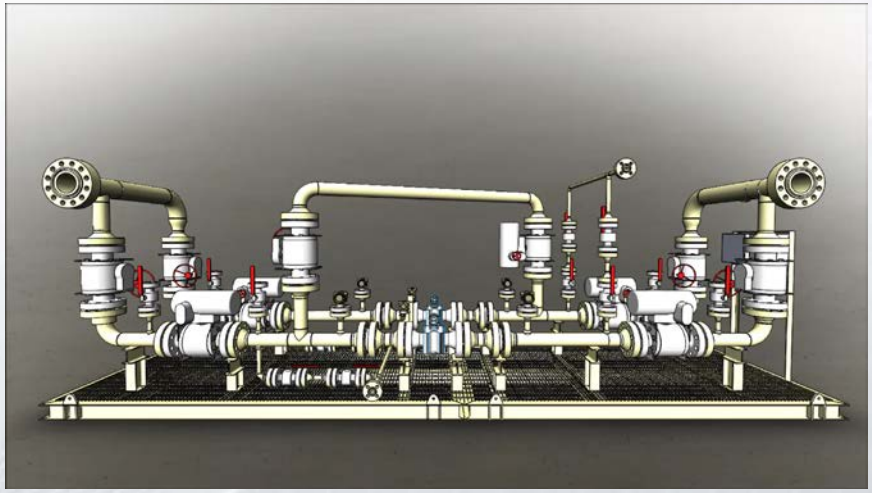


Fig 48. Path Velocity Ratios vs GVF%.

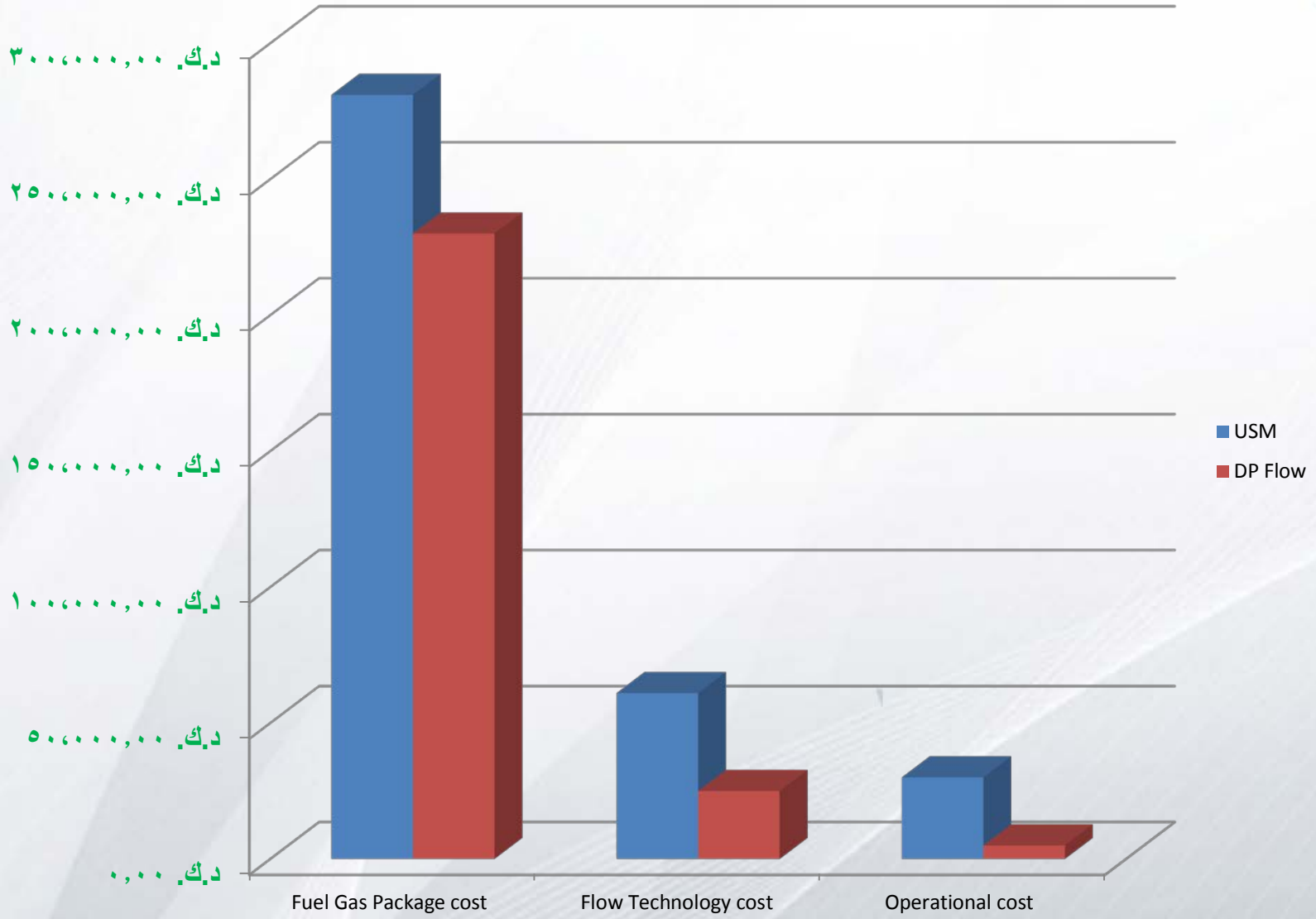

5
-5
-10
-8
-6
-4
-2
0
2
4
6
NDB
DPtvDPppl
DPtvDPr
DPrvDPppl
DP Sum

Opex vs Capex

Opex vs Capex



Opex vs Capex



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Thanks for Attention