

Flow Measurement Institute 2nd Conference

19th & 20th July 2016

Flow Needs Analysis Findings

Muir Porter - NEL



PRIORITIES FOR FLOW MEASUREMENT RESEARCH AND INFRASTRUCTURE 2016 – 2025

CONTRIBUTING REVIEWERS

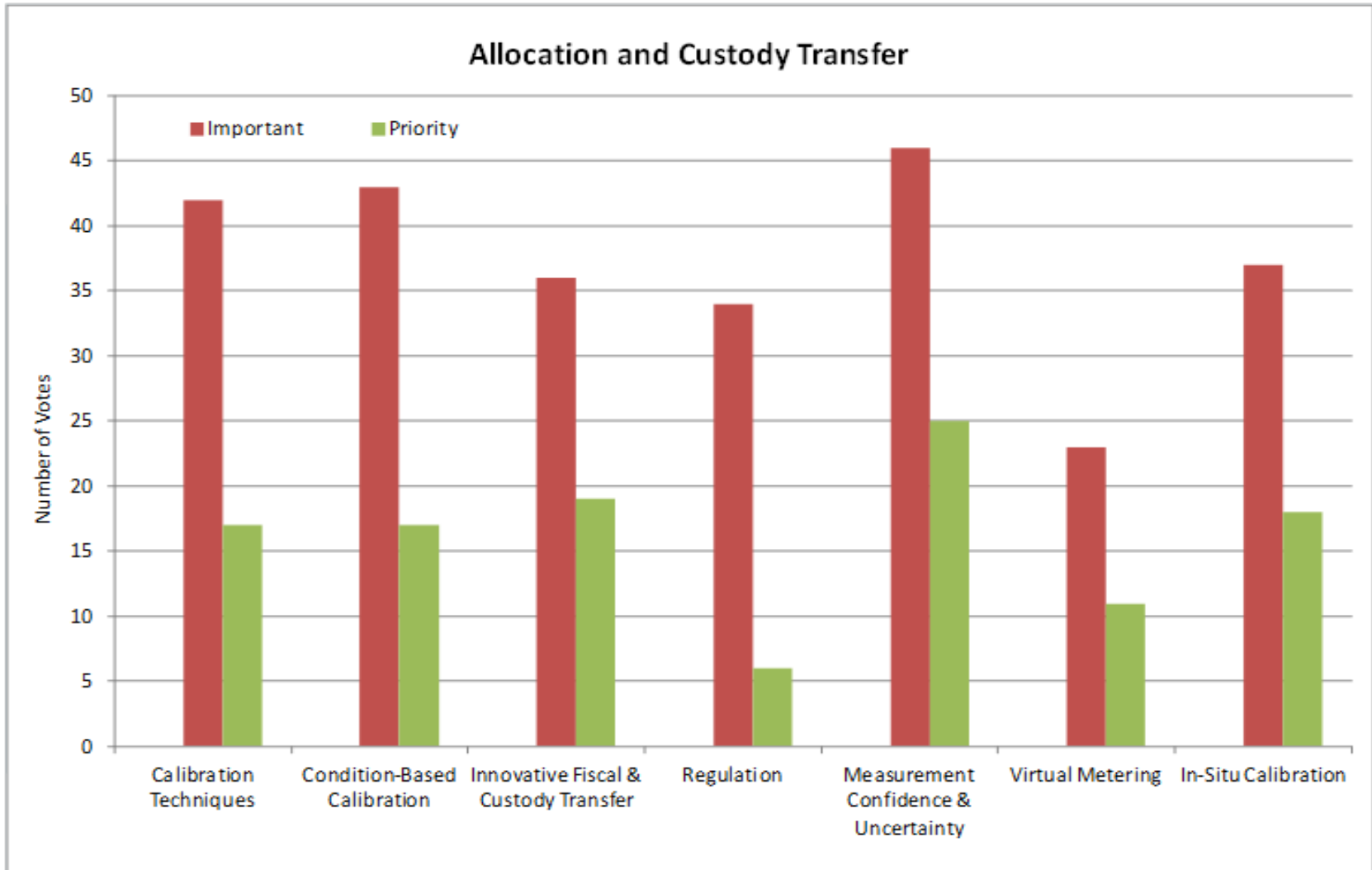
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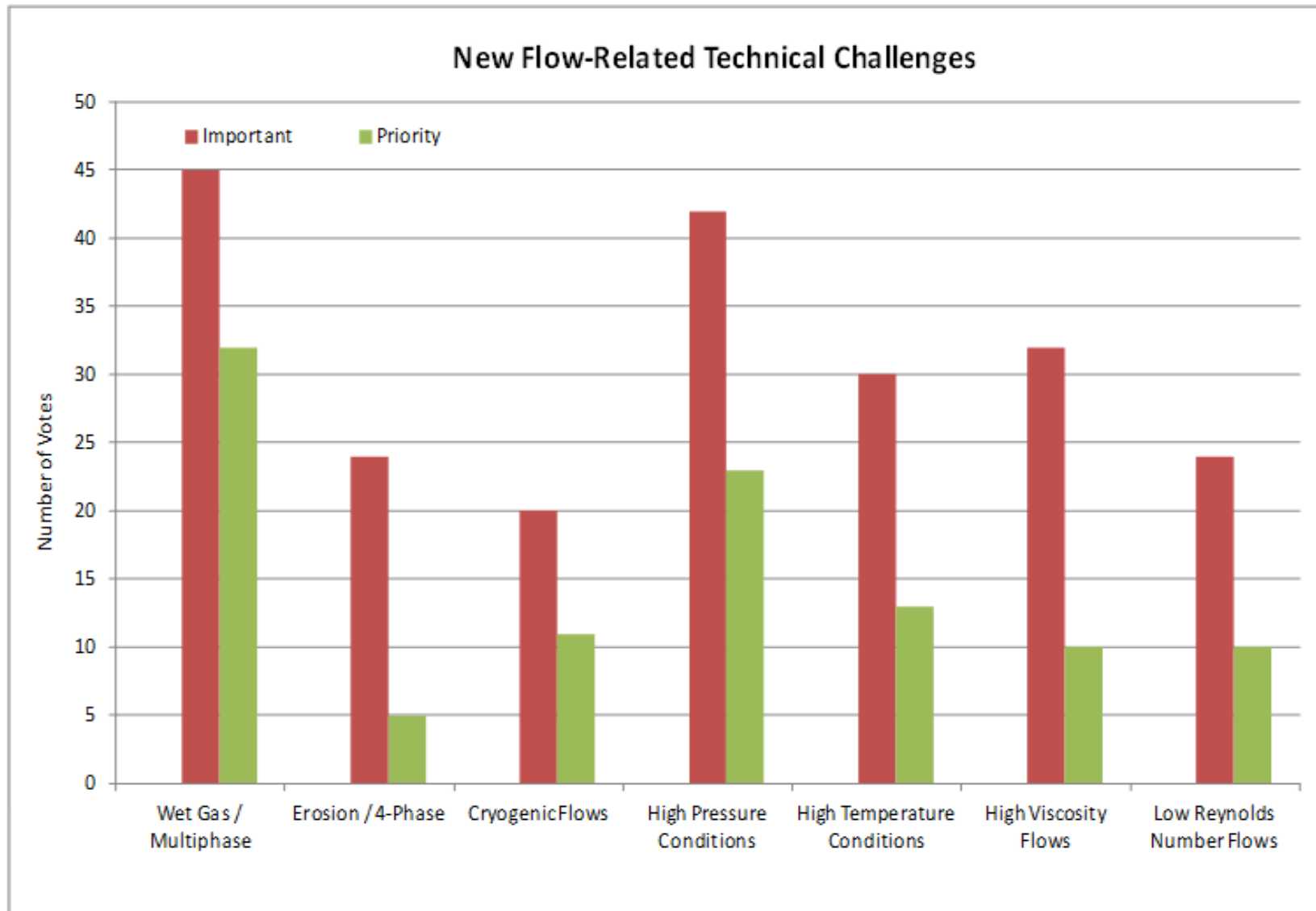
CONTACT

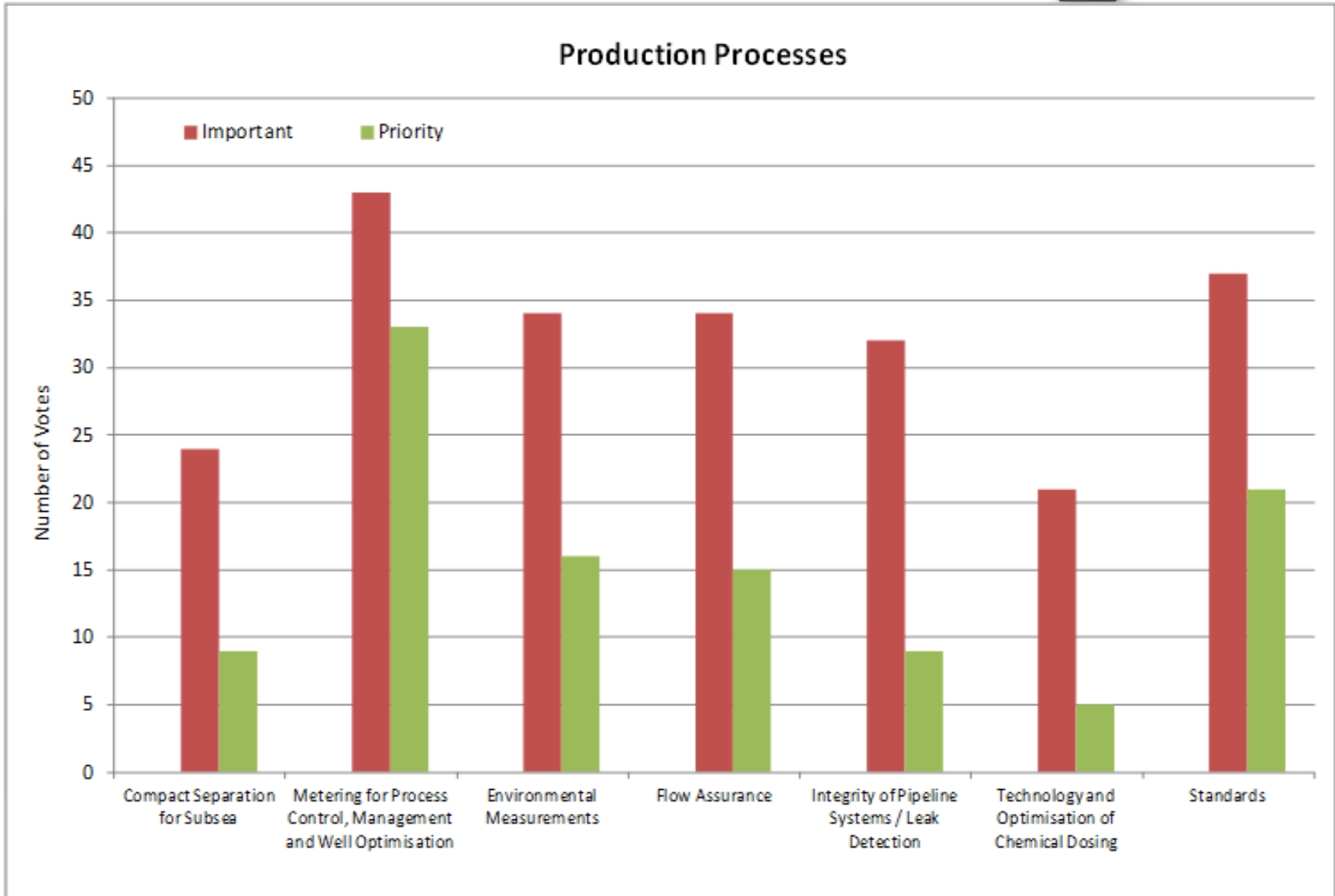
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“It is often perceived that the process of measurement is well understood and developed; this is not the case.”

- Workshops held in London and Aberdeen September 2014: over 60 flow measurement experts
- North Sea Flow Measurement Workshop survey October 2014: oil & gas focus
- Summer 2015 Inaugural FMI conference – gathering of information extended to all key UK industries
- Six month period of FMI Stakeholder meetings and consultation visits
- ‘Priorities for Flow Measurement Research and Infrastructure 2016-2025’: July 2016







- Need for collaboration
- Ever-more demanding production environments
- Scientific understanding
- Research and Infrastructure Funding
- Cost Reduction
- Data capture and analysis
- Standards
- Traceability
- Skills

1. Advance flow measurement accuracy
2. Improve traceability of measurement in the modern industrial environment
3. Support innovation in new sensor and measurement techniques
4. Provide effective flow measurement techniques in challenging environments
5. Improve standards and guidance to industry
6. Support regulation and enable better environmental compliance
7. Tackle data intensive topics
8. Develop new visualisation, simulation and modelling techniques
9. Create better understanding of the impact of fluid properties on flow measurement
10. Deliver measurement-related improvements to flow assurance strategies
11. Support productivity and cost reduction strategies

Categorising Priorities



Summary Themes (Source of Numerical Data: Annexes C to L)	Oil and Gas	Water Supply	Nuclear Power	Food and Drink	Pharmaceuticals	Petrochemical	Aerospace	Agriculture	Conventional Power	Marine
Advancing Flow Measurement Accuracy	6			2	1	1	1		1	1
Improving Flow Measurement Traceability	7	1		1	1					
New Flow Sensors and Techniques	6	2					3		2	
Challenging Process Conditions	5	1	2	1	1	1	3			1
Improving Flow Standards and Industry Guidance	4	4		1	3			1		
Regulation and Environmental Compliance	3	1	1					1		
Flow Measurement Diagnostics and Big Data	2	1		1						
Flow Modelling, Visualisation and Simulation	7	1					1			
Fluid Properties	4									
Flow Assurance	3									
Productivity and Cost Effective Flow Measurement		1								

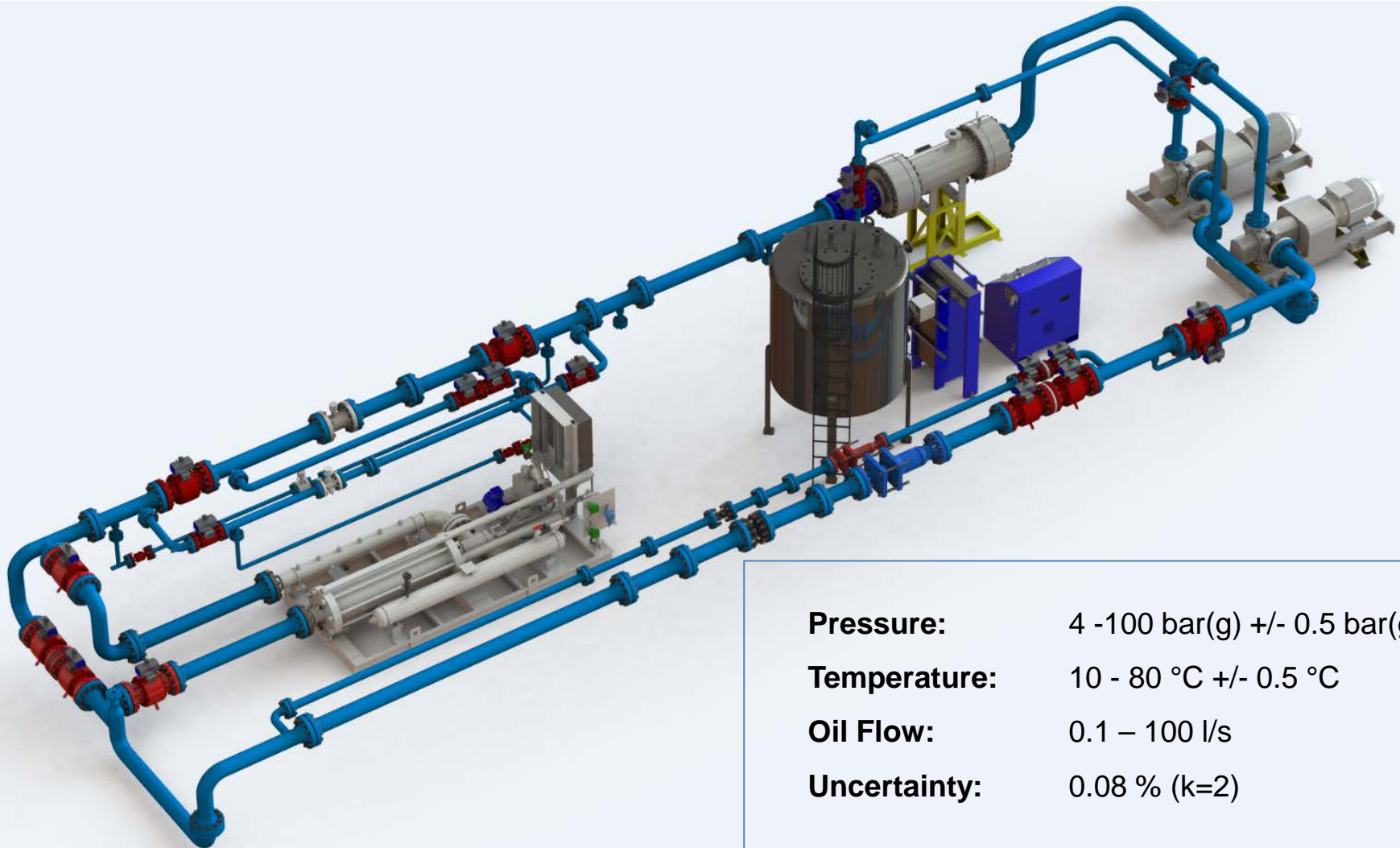
- Aerospace: Estimation of the life of key components within jet engines
- Space: Real-time imaging of propellant within storage tanks / True multiphase mass flow metering
- Petrochemical: An in-depth review of metrology challenges caused by corrosion
- Water: Improving modelling of flood conditions
- Nuclear: Future reprocessing of molten salts
- Food and Drink: Improving the accuracy of multiphase and Non-Newtonian flows.
- Pharmaceuticals: Improving powder flow measurement accuracy and standardisation
- Conventional power Generation: Real-time measurement of biomass

Category 1: Advancing Flow Measurement Accuracy



- C1-003 Determination of the Pressure Effect on Single-Phase Flow Meters
- C4-002 Extending the Composition Range Achievable with On-Line Gas Chromatography
- C6-001 Study of Ultra-Sonic and Coriolis Meter Performance at Low to Medium Reynolds Number
- C6-002 The Use of Multiphase Flow Meters in Heavy Oil Environments
- C7-002 Determination of the Pressure Effect on Coriolis Meter Performance
- F1-002 Steam Flow Measurement Accuracy within Steam Retorts
- I1-004 Improved Thermal Metrology within Jet Engines
- J1-001 Review of Metrology Challenges Caused by Corrosion

C1-003 Determination of the pressure-effect on single-phase flow meters

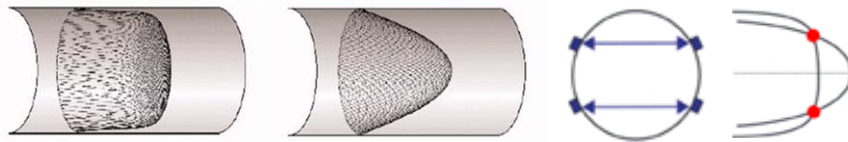


Pressure:	4 - 100 bar(g) +/- 0.5 bar(g)
Temperature:	10 - 80 °C +/- 0.5 °C
Oil Flow:	0.1 – 100 l/s
Uncertainty:	0.08 % (k=2)

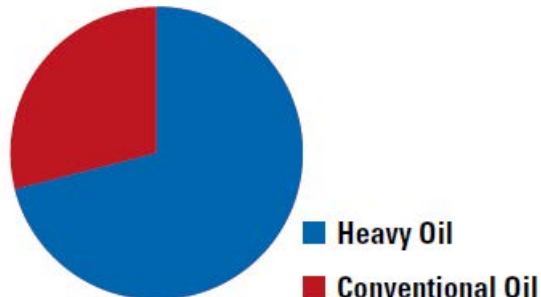
C6-001 Study of Ultra-Sonic and Coriolis Meter Performance at Low to Medium Reynolds Number

Key technical challenges

- Higher viscous friction / boundary layer growth
- Higher pressure losses
- Extreme or varying velocity profiles
- Entrainment of solids or gas



Remaining World Oil Reserves

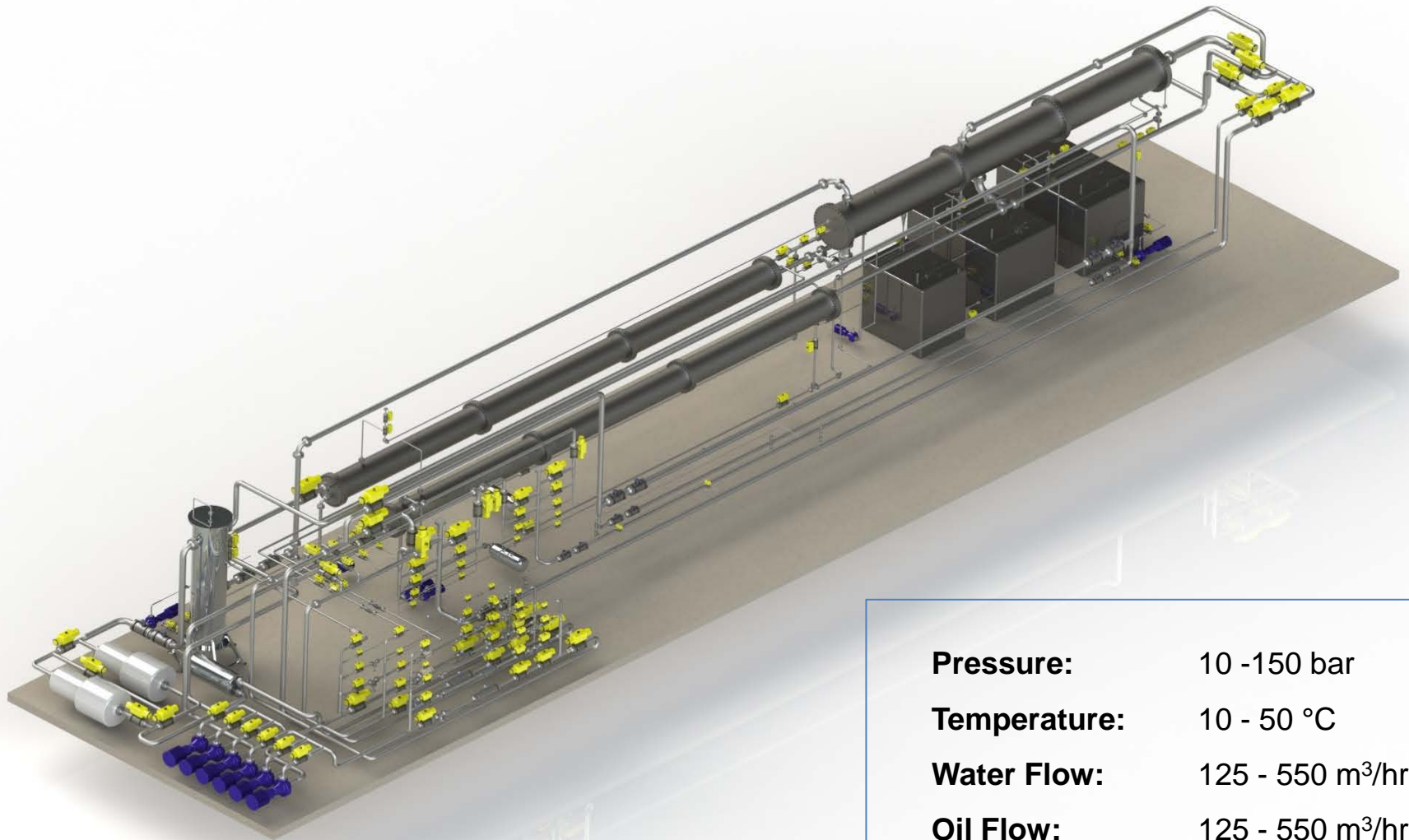


Category 2: Improving Flow Measurement Traceability



- C1-001 Development of a High-Pressure Multiphase Flow National Standard Test Facility
- C7-001 LNG Flow Meter Calibration at -160 Deg C
- C7-004 In-Situ Calibration of Multiphase Flow Meters in Remote Locations
- F1-003 Improving Traceability of Flow Meter Accuracy within Distillation Processes
- G1-004 Improving the Traceability and Accuracy of Input / Output Balance Measurements within Extrusion Processes

New-Era Multiphase Flow Facility



Pressure:	10 - 150 bar
Temperature:	10 - 50 °C
Water Flow:	125 - 550 m ³ /hr
Oil Flow:	125 - 550 m ³ /hr
Gas Flow Rate:	500- 3000m ³ /hr

Category 3: New Flow Sensors and Techniques

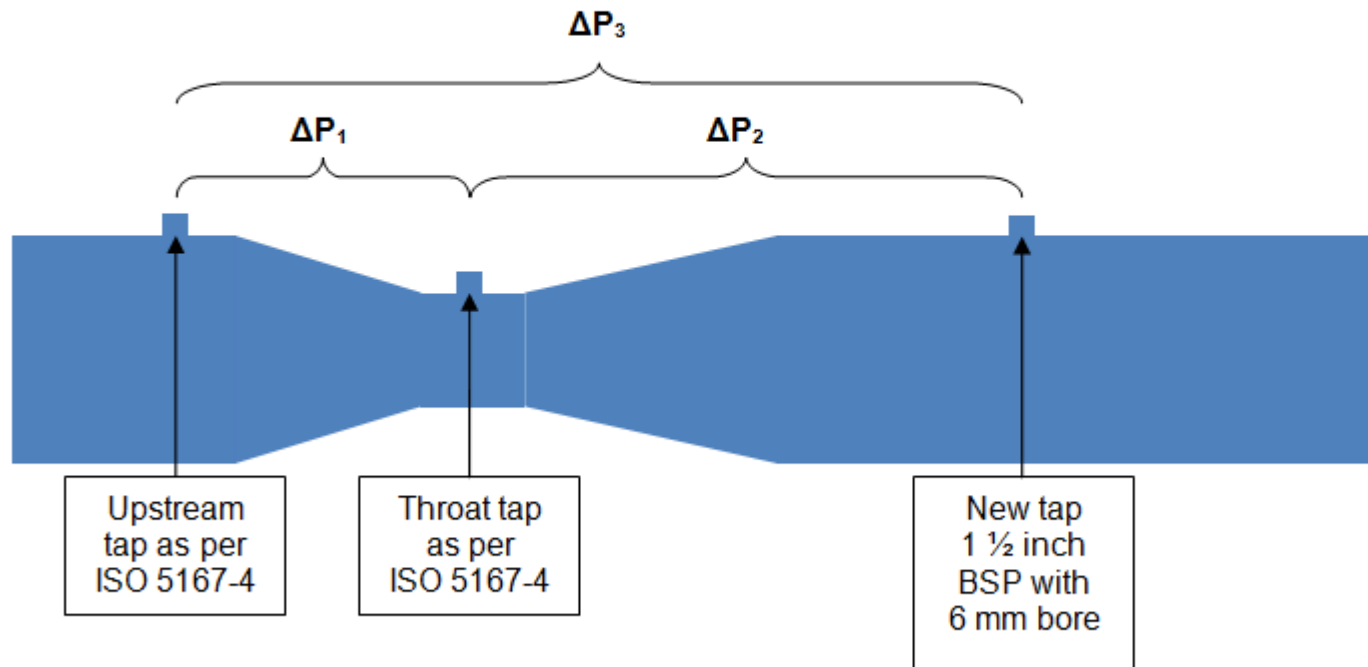


- C5-001 In-Situ Determination of Reynolds Number
- C5-003 Measurement Requirements for Subsea Processing and Control
- D1-002 Development of Flow and Velocity Measurement Technology
- D2-001 Improving Accuracy and Practicality of Doppler Measurement
- H1-002 Real-Time Measurement of Biomass
- I1-001 Real-Time Imaging of Propellant in Storage Tanks
- I1-002 Real-Time Mass Flow Measurement of Propellants in Transfer Processes
- I1-003 Multiphase Flow Measurement in Rocket Motors

C5-001 In-Situ Determination of Reynolds Number

Fundamental Science

By measuring and analysing the pressure profile through an ISO 5167-4:2003 compliant Venturi meter, a better understanding of the fluid dynamics can be achieved.



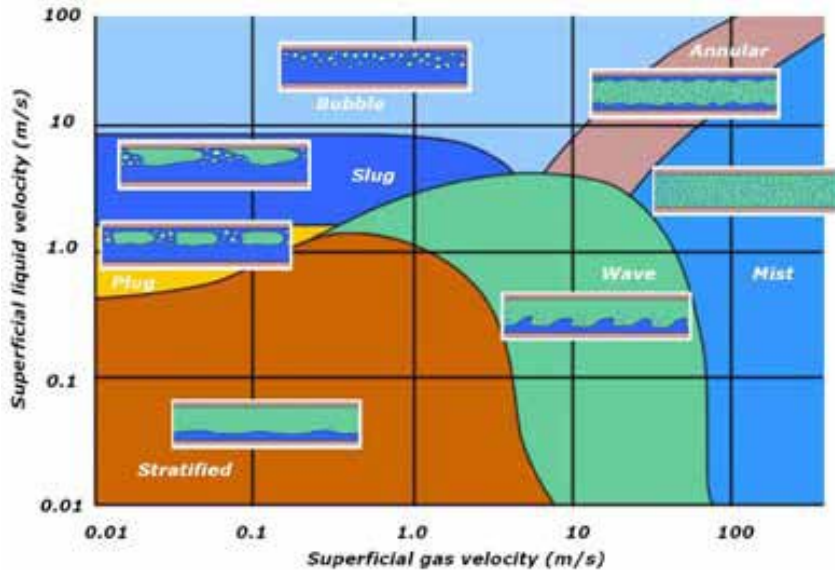
Pressure Loss Ratios (PLRs) can track the changes in Reynolds number and highlight changes in flow dynamics i.e. laminar to transitional to turbulent flow.

Category 4: Challenging Process Conditions

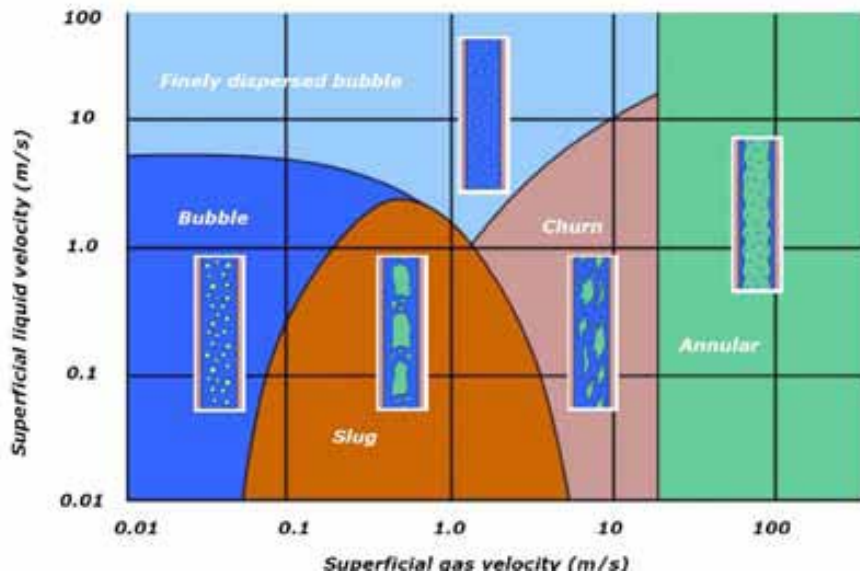


- C1-002 The Structure of Multiphase Flows at High Pressure
- E1-001 Generation IV Cooling Water Process Selection and Testing
- E1-003 Future Reprocessing of Molten Salts and their use with Solar Arrays
- F1-001 Improving the Accuracy of Measurement of Multiphase and Non-Newtonian Flows
- G1-001 Improving Powder Flow Measurement Accuracy and Standardisation
- H1-003 Improve Flow Measurement Accuracy to Reduce Fraud

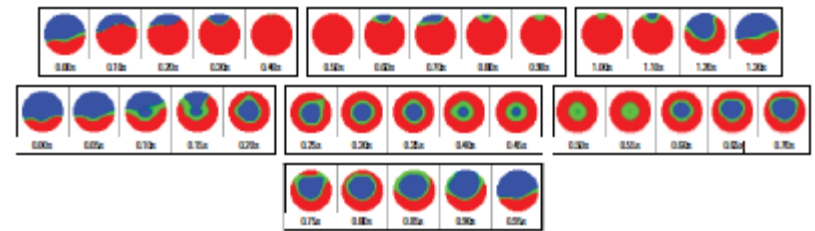
C1-002 The Structure of Multiphase Flows at High Pressure



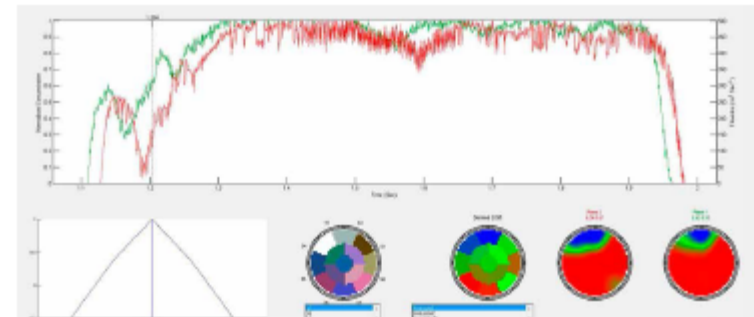
NEL collaboration to develop live-image streaming of complex multiphase flow patterns. This has a massive potential to fundamentally transform the measurement and control of many fluid-handling processes.



Gas-core Slug Flow



Flow Velocity Analysis



Category 5: Improving Flow Standards and Industry Guidance



- C4-003 Extending the Range of the AGA-8 Equation of State
- D2-003 Flow Measurement in Large Diameter Pipes at Low Flow Velocity
- D2-004 Flow Profiling and Uncertainty
- F1-005 Developing Standards on Preventative Maintenance for Flow Instrumentation
- G1-002 Harmonising Regulatory Standardisation for Flow Measurement
- G1-003 Adopting Quality by Design Principles for Flow Measurement

Category 6: Regulation and Environmental Compliance



- C8-001 Metering Techniques for Liquefied Carbon Dioxide
- C8-002 Produced Water Discharge
- C8-003 Measurement for Hydraulic Fracturing
- E1-002 Reprocessing and Separation of Spent Fuel
- K1-001 Improving Flow Measurement Accuracy for Abstraction Measurement

Category 7: Flow Measurement Diagnostics and Big Data



- C5-004 Effective Use of Flow Meter Diagnostics
- D2-002 Smart Networks, Diagnostics and Data Management
- F1-004 Development of Automation and Remote Diagnostics
- C7-003 Steps Towards Condition-Based Calibration



- C2-001 Development of Integrated Non-Contact Electromagnetic Imaging Sensors Suitable for Deep-Water Subsea Application
- C2-002 Modelling Techniques for Phase Velocity Measurements
- C2-003 Advancing Computational Flow Modelling for Multiphase and Wet Gas Flows
- C2-004 Assessment of Virtual Metering
- C5-002 Improved Accuracy of Pressure Loss Correlations
- D1-001 Improved Flood Modelling



- C3-002 Real-Time, and In-Situ, Hydrocarbon Composition Determination
- C4-001 Fundamental Research Programme to Provide Experimental Data to Extend the Range of AGA-8

Category 10: Flow Assurance



- C3-001 In-Situ, Real-Time Multiphase Flow Sampling
- C3-003 Development of New Sensors / Techniques Able to Detect and Measure Dosing Chemicals

Category 11: Productivity and Cost-Effective Flow Measurement



D2-001 Improving Accuracy and Practicality of Doppler Measurement

- Appropriate measurement infrastructure to tackle the underlying traceability issues
- Research to understand the science required to overcome the various challenges
- Development of a strong research community to build and sustain flow measurement knowledge
- Knowledge transfer mechanisms to ensure that new knowledge is applied at all levels in industry to maintain competitive advantage

Summary



Overall there is a compelling case for sustained investment in flow measurement to help meet the challenges facing the whole of industry.



- Do people recognise this picture?
- Next Steps?