NEL Flow Test Facilities
(Oil & Gas Sector)
NEL - Background

• Established in East Kilbride, Scotland in 1947 as a UK Government research laboratory

• Privatised in 1995, but remains one of the UK’s National Measurement Institutes

• NEL is a business of the Munich based TÜV SÜD Group

• Over 100 staff with 75% professional engineers

• Largest grouping of flow experts
NEL - Key roles

- Test & Calibration, R&D, Consultancy (private and public sectors)

- NMI – Hold UK National Standards for Flow Measurement (UKAS accredited facilities)

- Manage the UK Government’s flow metrology research programme

- Standards Development - BSI, Euramet, ISO (Chair ISO-TC-30), & HMC-1

- Knowledge Transfer - NSFMW, Oil & Gas Focus Group, Environmental Club, lunch & learns, guest lectures

- Flow metrology training (Including NEL Flow Course)

- Lead collaborative research – JIP’s and EMRP
**Single phase flow**

**Gas**
- Volumetric flowrates: 100 m³/hr to 1400 m³/hr
- Operating Temperature: 20 ± 1°C
- Operating Pressures: 10 to 63 bar
- Uncertainty: 0.35%

**Oil**
- Volumetric flowrates: 0.05 l/s to 200 l/s
- Operating Temperature: 10 to 60 °C
- Viscosity Range: 1.5 to 1500 cSt
- Line Pressure: Up to 7 bar
- Uncertainty Range: 0.03 to 0.08%

**Water**
- Volumetric flowrates: 0.05 l/s to 400 l/s
- Operating Temperature: 10 to 40 °C
- Uncertainty Range: 0.1 to 0.15%

**CURRENT FOCUS**
- HP/HT for subsea installations – NEL’s new oil facility (4 - 100 bar, 20 - 80°C)
- Development of diagnostics – Support new risk-based management approach
Multiphase flow line

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<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Refined Oil</td>
<td>Up to 140 m³/hr (uncertainty &lt; 1%)</td>
</tr>
<tr>
<td>Salt water</td>
<td>Up to 140 m³/hr (uncertainty &lt; 1%)</td>
</tr>
<tr>
<td>Nitrogen gas</td>
<td>Up to 600 m³/hr (uncertainty &lt; 1.5%)</td>
</tr>
<tr>
<td>GVF</td>
<td>0 – 100% Water Cut 0 – 100%</td>
</tr>
<tr>
<td>Line pressure</td>
<td>0 to 15 barg</td>
</tr>
<tr>
<td>Line temperature</td>
<td>5 to 55°C</td>
</tr>
<tr>
<td>Line sizes</td>
<td>1 to 6-inch</td>
</tr>
<tr>
<td>Max test line length</td>
<td><strong>Horizontal</strong>: 60 m (up to 30m test section) <strong>Vertical height</strong>: 10 m</td>
</tr>
</tbody>
</table>

- Multiphase flow meters
- Water cut meters
- Compact separators
- Pumps, valves, jet mixers
- Sampling systems
- Pigs
- Risers
- Tomography systems
- Flow behaviour (slugging)

**CURRENT FOCUS** (Well optimisation & Flow Assurance)
- Subsea metering (reduce Opex/ Capex, well testing)
- Visualisation (flow regime - slugging)
- Heavy oil multiphase
- Emulsions
• **Upper Pressure:** 150 bar
• **Upper Temperature:** 50 °C
• **Water Flow:** 125- 550 m³/hr
• **Oil Flow:** 125- 550 m³/hr
• **Gas Flow Rate:** 500- 3000 m³/hr
### WET GAS FLOW LOOP

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<table>
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<tbody>
<tr>
<td><strong>Gas (Nitrogen)</strong></td>
<td>(100 – 1400) m³/hr</td>
</tr>
<tr>
<td><strong>Liquid (kerosene)</strong></td>
<td>up to 10% by volume (depending on gas flow rate &amp; system resistance)</td>
</tr>
</tbody>
</table>
| **Uncertainties** | Gas mass flowrate: ± 0.3 to ± 0.5%  
                      | Liquid mass flowrate: ± 0.2 to 0.5% |
| **Line temperature** | 20 ± 0.1°C |
| **Line pressure** | 10 to 63 bar gauge (913 psi) |
| **Line sizes** | 2 to 10-inch |

- Flow meters
- Compact separators
- Production equipment
- Wet-gas sampling systems
- Liquid detection monitors
- Flow behaviour

### CURRENT FOCUS
- 3-phase flow (0.5% liquid - 10% error)
- Installation effects (orientations, bends)
NEL Test Facilities - Density

Density Test Facility

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density Range</td>
<td>620 to 920 kg</td>
</tr>
<tr>
<td>Operating Pressures</td>
<td>1 to 100 bar</td>
</tr>
<tr>
<td>Operating Temperatures</td>
<td>10 to 110° C</td>
</tr>
</tbody>
</table>

Allows testing and traceable calibration of densitometers to national standards & research and characterisation of liquids and gases, including complex fluids such as live crude oils and biofuels.
Erosive Flow Test Facility

NEL Erosion Flow Facility

Choke valve severe wear

Cone Flowmeter (CFD V Testing)

• Erosion and Sand Management
• Modelling life extension of assets

(Particle) Erosion Testing Services
• Type Testing
• Endurance Testing
• API 6AV1 Slurry Testing
• Cyclic Valve Testing
• Accelerated Testing

Typical Components Tested
• Hydrocyclones
• Flexible hoses
• Material coatings
• Flow meters
• Flow restrictors
• Choke valves
• Isolation valves
• Piping configurations
• Sand monitors
• Sand screens
• Inhibitors

<table>
<thead>
<tr>
<th>Particle Size</th>
<th>Aperture/ Mesh size microns</th>
<th>Test Fluid</th>
</tr>
</thead>
<tbody>
<tr>
<td>710</td>
<td></td>
<td>- Water/sand</td>
</tr>
<tr>
<td>500</td>
<td></td>
<td>- Water/sand + viscosifier (API slurry)</td>
</tr>
<tr>
<td>355</td>
<td></td>
<td>- Gas/sand</td>
</tr>
<tr>
<td>250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>180</td>
<td></td>
<td></td>
</tr>
<tr>
<td>125</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;125</td>
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</tbody>
</table>
Produced Water Test Facility

- Oil-in-water sampling systems
- Online sensors (replace sampling/reduce reliance on ROVs)
- Produced water treatment techs (advanced purification systems)

Typical test fluids:

- Crudes
- Condensates
- Production control fluids
- Solids (controlled particle size)
Sensors & Physical Properties Testing

- Testing composition sensors
- Evaluation of sampling systems
- Testing of secondary sensors (P, T)
- Fluid behaviour - Physical properties and phase boundaries (e.g. CO₂ & impurities)
- Material Integrity

<table>
<thead>
<tr>
<th><strong>CO₂ Static Test Facility - Specification</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Pressures</td>
</tr>
<tr>
<td>Operating Temperatures</td>
</tr>
<tr>
<td>Temperature Stability</td>
</tr>
<tr>
<td>Circulation Flowrate</td>
</tr>
<tr>
<td>Test Fluid</td>
</tr>
<tr>
<td>Typical Contaminants</td>
</tr>
</tbody>
</table>
Flow & Thermal Modelling - CFD

Flow
- Complex erosion
- Multiphase flow
- Heavy oil multiphase
- Installation effects
- Hydraulic analysis
- Gas dispersion/smoke propagation
- Rotating and turbo-machinery
- Non Newtonian fluids
- Moving and deforming mesh simulations

Thermal
- Conduction
- Forced convection
- Natural convection
- Radiation
- Conjugate heat transfer

*CFD validated against test facilities & archived empirical data*
Physical Property Data Service (PPDS)

- Database of Quality-assured physical property data based on validated measurements
- Thermodynamics calculation suite based on industry codes and established equations-of-state
- Full traceability and measurement uncertainty values returned for all data and calculations
- The ability to add additional user databanks of pure components and binary systems
- Can be tailored to meet specific user needs with customised menus
- Can be integrated into other systems, including commercial software e.g. HYSYS and CFD
Test Facility Research Projects

NMS Research Projects

• Heavy oil multiphase flow
• Visualisation - Tomography for flow patterns (flow laboratory & field tool)
• Wet gas (3-phase and installation effects)
• Pressure effects on densitometers, Coriolis, USM and DP flow meters
• Multiphase flow reference metrology network (EMRP/NMS)

Recently completed JIPs

• Subsea sampling: oil-in-water (2 JIPs)
• Multiphase flow meter evaluation (3 JIPs)
• Densitometer JIP
• Coriolis metering JIP
PRT proposals submitted by NEL

- Underpinning Gas Production Data (shortfalls in AGA-8 from changing compositions)
- Heavy Oil metrology (single & multiphase)
- Metrology for hydrocarbon flow assurance
- Produced Water Treatment & Measurement
- Big Data & analytics for upstream oil and gas
- Upgrading ISO standards 11583: 2012 and 12748: 2015 (3-phase wet gas)
- Harmonising EU multiphase test facilities
Upcoming events

- **NEL Open Day**, East Kilbride – **18 May 2016**
- **NSFMW 2016** – St Andrews, **25 to 28 October 2016**
- **Oil & Gas Focus Group** (OGFG - **Quarterly** in Aberdeen)
- **FMI (Flow Measurement Institute)** – over 70 organisations
- **Produced Water Club**
Thank You

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