Angola LNG Integrated Online Transient Simulation Solution for Subsea Pipeline Operations
SOMG – Sociedade de Operações e Manutenção de Gasodutos S.A.
Angola LNG Gas Gathering System
### Challenges for Operations

<table>
<thead>
<tr>
<th>Category</th>
<th>Challenges</th>
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</table>
| Dense Phase Operation | - Varying Compositions  
                       |   - Ensuring Nominations are Met                                          |
| Corrosion           | - Future Presence of Sour Gas and Acid Gas  
                       |   - Difficult to Inspect or Use Corrosion Coupons                         |
|Leaks                | - Large Transport Volumes  
                       |   - Limited Isolation Valves                                              |
| Pigging             | - Subsea Pigging  
                       |   - Infrequent Pigging                                                    |
| Hydrate and Liquids | - Costly to Manage Unanticipated Liquids  
                       |   - Costly to Remediate Hydrates                                           |
Integrated Simulation Solution – Software Packages

- What-If Planning Tool
- Real-Time Monitoring for Multiphase Flow Situations
- Hydrate and Dew Point Monitoring
- Pig Tracking
Integrated Simulation Solution – Pipeline Management System

Field Data
- Pressure
- Temperature
- Flowrates
- Composition

Dedicated Hardware
Redundant Network

Transient Models
- Multiphase
- Compositional

Results
User Inputs
Integrated Simulation Solution – Pipeline Management System

Real-time Mode
- Monitoring
- Composition Tracking

What-If Engineering Tool
- Planning
- Forecasting
- Expansions

Snapshots
Production Scenarios

Models and System
- Data Validation & Calibration
- Engineering
- Model Updates
Dense Phase Operations Solution

- Fully Compositional Model
- Dew Point Monitor
  - Delta T (C)
  - Delta P (Barg)
- Survival Time Calculations
- What-If Tool for Production Scenario Evaluations
Pigging Solution

What-if Engineering Tool
- Simulate Pig Travel Times
- Test Different Flowrates And Pressures

Pigging Monitor
- Predict Arrival Times
- Track Pig Location And Velocity in Real Time
# Pigging Performance

<table>
<thead>
<tr>
<th></th>
<th>Launch Time</th>
<th>Arrival Time</th>
<th>Travel Time</th>
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<tbody>
<tr>
<td>Actual</td>
<td>10:45</td>
<td>17:09</td>
<td>6.4 hrs</td>
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<tr>
<td>Calculated</td>
<td>10:45</td>
<td>17:06</td>
<td>6.35 hrs</td>
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</tbody>
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Distance Traveled: ~ 38 km
Dew Point Monitoring

Profiles
Delta T
Delta P

Flowline Status

Advisor Summary
Hydrate and Liquids Solution

Profiles
Temperature
Hydrate Formation
Pressure
Elevation
H2O

Flowline Status

Advisor Summary
Hydrate and Liquids Solution

Dew Point
- Hydrate – Proximity to Hydrate Curve
- Liquid – Liquid Holdup
- Slugging – Hydrodynamic Slug Flow Regime
- Coverage – All Pipeline Segments and Locations
Hydrate Remediation

Hydrate Formed During Start Up
What-If Engineering Tool Used To Assist With Remediation
Finding Value Through Model Mismatch
System Development and Installation Timeline

- **Development**: 2016
- **Installation and Commissioning**: 2017
- **Plan for Extension and Expansion**: 2018
- **Ongoing Support**: 2019

**System Expansions**

**Future**
Conclusion

**Added Value**
- What-if Tool For Hydrate Remediation And Pigging
- Results Available Anywhere In The Pipeline System
- Data Quality Assessment Through Model Mismatch
- Simple Interface for Operators

**Proven Accuracy**
- Real Time Pig Tracking
- Dew Point And Liquid Prediction

**Risk Management**
- Planning Pigging Operations With What-if-tool
- Gas Composition And Hydrate/Dew Point Monitoring
- 24/7 Availability With Uptime Of Over 99%
Questions?