Update for QT-1300™ Developed to Extend Coiled Tubing Operating Envelopes

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Agenda

• Background
• Field Uses
• Equipment Compatibility Testing
• Sizes and Lengths Produced
• Welding
• Sour Gas Corrosion Testing
• Fatigue Testing
Background

- NOV Quality Tubing has developed QT-1300™ with a minimum yield strength of 130,000 psi (~896 MPa).
- Background on this development was initially shared presented at the Roundtable in 2010.
- Higher strength tubing can expand the operating envelope for coiled tubing.
  - Higher pressures
  - Higher axial loads
Coiled Tubing Then and Now

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<tr>
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<th>1997¹</th>
<th>2009 and Beyond…</th>
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<tbody>
<tr>
<td>Maximum Pressure</td>
<td>5000 psi</td>
<td>Occasionally reaching/exceeding 10,000 psi</td>
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<tr>
<td>Maximum Length</td>
<td>15,000 feet</td>
<td>Exceeding 20,000 feet with long laterals</td>
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<tr>
<td>Required yield strength</td>
<td>70 – 90 ksi</td>
<td>100 and 110 ksi available</td>
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<tr>
<td></td>
<td>Could you go higher?</td>
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QT-1300™ is our newest offering in response to current demands
Field Successes

• OFFSHORE
  – North Sea (SPE 143079): TCP runs; guns retrieved instead of being dropped into a “rat hole”. Work has been ongoing since 2010
  – Gulf of Mexico: Intervention operations for shallow water in GoM
  – Contingency strings for Operators
Field Uses

• **ONSHORE**
  – Marcellus Shale in Northeastern USA. Tubing was used to 60+% of fatigue life and retired.
  – Bakken, Rockies and Eagleford in the USA. Coiled Tubing Service company has used 12 strings of QT-1300™ in various shale plays in the USA.
    • Successful operation with CT unit
    • Successful chemical cutting (behavior reported as similar to other CT grades) upon becoming stuck
Sizes and Lengths Produced

• Historically:
  – 1.750”OD & 2.000”OD
  – Wall Thickness from 0.134” to 0.203”

• New Offerings:
  – 2.375”OD
  – Wall Thickness up to 0.236”

• Lengths Produced:
  – In excess of 800,000 feet milled to date
  – 39 Strings produced to date
CT Equipment Testing

• Shear Testing
  – Successfully performed on 2.000”OD x 0.203”WT
  – Prior testing on SPE 143152

• Connector Testing
  – Customer connectors have been tested
  – Field trials have utilized connectors

• Injector Testing
  – Performed by HydraRig and presented in SPE 143152
Sour Gas Corrosion Testing

• Performance in sour gas is expected to be similar to CT-100 or CT-110 grades
• Testing is being performed by a development partner.
  – Results will be published as an SPE Paper
  – In general, the tubing has been successfully utilized in sour wells with inhibitors and scavengers
Tube-to-Tube Welding

• Tube-to-tube welding procedure has been developed for QT-1300™.
• Regionally based welders will be qualified by the end of the 2013.
  – Houston
  – Western Canada
  – North Sea (Aberdeen)
  – Middle East (U.A.E)
• Fatigue testing is ongoing, initial results indicate that tube-to-tube weld performance is similar to predictive results for QT-1000.
Bias Welding

• This grade was described as “high strength coiled tubing” in 2010.
• Refinements to the bias welding procedure have been made to create a weld capable of meeting strength expectations for QT-1300™.
Fatigue Performance Evaluation (2010)

• Fatigue testing on Standard Fatigue test Machine
  – In excess of 350 samples tested over 72” radius
  – 36 samples tested over 48” radius
• Standard set of ASTM E606 strain controlled fatigue tests
• Used to develop algorithm for Flexor and commercially-available fatigue modeling
Fatigue Performance Evaluation (2013)

- Newer set of fatigue testing will be performed using T-Bird Fatigue Machine
  - Both bias weld coupons and parent tubing
- Data will be incorporated into commercially-available and proprietary customer fatigue modeling software
- Expected completion by end of Q1 2014
- Implementation in commercially-available fatigue modeling software in 2014
Thank You For Your Attention