ENHANCING OFFSHORE RECOVERY BY ENABLING LONGER, SAFER, AND LOWER COST SUBSEA TIEBACKS

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“...developing subsea tie-backs.... We are going to fill those (hubs) with tie-backs” Starlee Sykes, BP, VP Global projects

“If we can keep every one of those facilities (hubs) full.... That’s our strategy...fast-paced tiebacks fit in really nice.” David O’Conner; BP – Head of Global projects
Industry need, longer tie-backs

Subsea chemical storage & injection will **enable** longer tie-backs

How great would it be to ‘expand the radius of opportunity’ from your existing hub? And cut up to 80% of costs!
Advantages of subsea chemical storage & injection

**Old school - umbilical**
- Logistical nightmare & high-cost
- Chemical stored on platform (PPE concerns)
- Umbilical tubes - subject to plugging, corrosion, etc.
- Recovery costs at end of field life

**Subsea storage solution**
- Pressure comp’d & dual barrier (pat’d)
- Design & engineer one; build many
- Eliminate umbilical tubes

Business model: *chemical delivery as a service*

- Enables long-distance tie-backs
- Cut significant (80%) costs
- Standard marine operations
Solution integration

Subsea landscape

- Host facility
- Mooring lines & risers
- Chemical storage & injection unit (Subsea Shuttle solution)
- ROV
- Flowlines
- Umbilical - Power - Comms - Chemical tubes
- Subsea wells
Built on earlier successes

Pressure compensated steel tank (secondary)

All electric valve actuator

10 ksi (initial) variable speed electric injection pump

Chemical/fabric qualified storage bladder (primary)

US Pat. 9,656,801

Subsea Shuttle
Fluids & facilities, delivered and operated as a service
## Functional Design Specs

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
<th>Reference/standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall system</td>
<td>• ‘Touchless’ chemical transfer, from mnfr to subsea&lt;br&gt;• Pat’d dual barrier chemical containment&lt;br&gt;• Qualified to 10,000 fsw / 10-year design life</td>
<td>Meets rqmts of hazardous environment IMDG</td>
</tr>
<tr>
<td>Frame</td>
<td>• 20’ x 8’ x 10’(tall)&lt;br&gt;• Weight: 7 S. Tons tare 30 S. Tons (w/ payload)</td>
<td>API 2 CCU standard&lt;br&gt;IMDG T11, ADR/RID &amp; DOT</td>
</tr>
<tr>
<td>Storage tank</td>
<td>• 100 bbl (w/ 20 bbl reserve)&lt;br&gt;• Working pressure: 4 BAR (58 psi)&lt;br&gt;• External collapse: 10 psi</td>
<td>ASME, Sect VIII Div. 1</td>
</tr>
<tr>
<td>Bladder</td>
<td>• 120 bbl&lt;br&gt;• Compatible with most std production chemicals</td>
<td>Mil spec MIL-PRF-32233&lt;br&gt;3rd party performance tstg</td>
</tr>
<tr>
<td>Pump</td>
<td>• Stock onshore triplex pump, modified&lt;br&gt;• 84 gpd of chemical @ DP up to 10,000 psi.&lt;br&gt;• Electric driven, variable speed controlled</td>
<td>Custom, base on API RP 14 C</td>
</tr>
<tr>
<td>Valves &amp; actuators</td>
<td>• Electric motor valve actuators, w/ battery back-up.&lt;br&gt;• Smart Batteries for fail-to-close position</td>
<td>Safety Integrity Level (SIL)2 per IEC 61508</td>
</tr>
<tr>
<td>Controls &amp; sensor</td>
<td>• Electronics; 1 Atmosphere cans (3)</td>
<td>API RP 17 F compliant &amp; various IEEE</td>
</tr>
<tr>
<td>Piping</td>
<td>• Various sizes, SS w/ Swagelok fittings&lt;br&gt;• Flexible flying leads, rated to 20ksi</td>
<td>API RP-1111 section 2.1.7 (c)&lt;br&gt;Welding: API Specification 17D</td>
</tr>
</tbody>
</table>
Qualification process – System Integration Test (SIT)

Test Tank Facilities

- 50’ x 50’ x 30’ (deep)
- 560,000 gallons
- 2000 lbs./sf loading
- 10 T overhead crane
- HD video & LED lighting
- Remote monitoring
- ROV operations
- Oil Spill Collection System
Subsea Shuttle team

Art J. Schroeder, Jr.
Co-founder & CEO

Jim Chitwood
Co-founder & CTO

Dr. Tom Gay
Board member
& Sr. Advisor

Previous to Subsea Shuttle, Art worked in upstream operations, engineering and construction for major operators. Schroeder also has served on numerous professional, corporate and civic boards, and is the recipient of numerous awards, including the Offshore Technology Conference’s Special Citation and SPE’s Management and Information Award. He holds several patents and a B.S and an M.S. in chemical engineering from the Georgia Institute of Technology, and an M.B.A. in finance and international business from the University of Houston.

Chitwood has 48 years of industry experience in offshore engineering and research and development, working both domestically and internationally. His principal project from 1991 to 2014 was the Chevron-led DeepStar Project, where he managed joint industry R&D undertakings. Chitwood has worked for various engineering, manufacturing and production companies both as an employee and as a consultant throughout his career. He holds 14 patents and has an M.S. in mechanical engineering from Texas A&M University.

Dr. Gay has 40 years of industry experience, including 31 years with ExxonMobil in upstream roles in research, project engineering, commercial and facility integrity. Gay served as BG Group’s technical authority for floating production systems and represented BG in several DeepStar projects. His experience includes assignments in the United States, Norway, the United Kingdom and France. Gay holds a B.S. in mechanical engineering from Oklahoma State University and an M.S. and Ph.D. in mechanical engineering from the University of Texas at Austin.
U.S. Department of Energy funds three EOR tech concepts

Secretary of Energy, Dan Brouillette

The U.S. Department of Energy’s (DOE) Office of Fossil Energy has selected three projects to receive around $9 million in federal funding for cost-shared research and development projects.

DOE said on Tuesday that the projects aim to enhance the potential of enhanced oil recovery (EOR) in offshore wells by advancing promising proof-of-concept technologies.

According to the Department of Energy, the concepts could reduce subsea facility complexity, increase control and monitoring, and enable greater tieback distances to production facilities.

The second is for “Enhancing Offshore Recovery by Enabling Longer, Safer, and Cheaper Subsea Well Tiebacks” by Subsea Shuttle. The project aims to deliver a safe, effective, low-cost solution to assist with the monetization of economically stranded resources via subsea wells tied back to existing host facilities.
Lead Organization: Subsea Shuttle, LLC

Project Partners:
- US Dept. of Energy
- US Dept. of Interior, BSEE
- Oil company subject matter experts
  - ExxonMobil Doug Turner
  - BP Trey Lynch
  - LLOG Glenn Mediamolle
  - Equinor Anish Simon
  - Others TBD

Contractors:
- Seanic Ocean Systems
- TechnipFMC, Genesis
- Argen Labs, LLC
- AEF, LLC
- Trelleborg
- ABS
Subsea Shuttle, LLC is under contract to provide guidance and review.
Use-cases and value-adds

1. Longer tie-backs

2. **Lower costs** (reducing umbilical costs by up to 80%)

3. Reduce host platform space and weight requirements

4. **Eliminate hazardous chemical interaction** with personnel

5. “**Chemical Injection as a Service**”, mimicking successful onshore chemical delivery model

6. **Engineered for modular industrial fabrication**; minimizes spare parts, simplifies inspection, maintenance, and repairs, and lowers costs, & facilitates compliance with global ‘local content’ requirements

7. **Better match chemical** with changing reservoir conditions

8. Significant step towards ‘**normally un-attended**’ operations & **subsea separation systems**
Subsea Shuttle, LLC is seeking

1. Oil company operators,
   a) Offshore demonstration solving immediate needs;
      • Replace clogged and / or ‘under tubed’ umbilicals
      • Supplement / additional chemical treatment
   b) Longer term needs;
      • Reduce development costs
      • Extend tie-back lengths

2. Oil Field Services company to provide;
   a) Deployment, recovery, & IMR

3. Chemical companies interested in establishing leadership / exclusive position in subsea;
   a) Production chemicals
   b) Specialty fluids (e.g. hydraulic control)
Summary

- Subsea tie-backs will dominate deepwater;
  - Cost effective exploitation of smaller pockets
  - Keep existing hubs full, reduce costs on a per bbl basis

- Subsea chemical storage and injection;
  - Enable longer tie-backs
  - Lower costs
  - Facilitate development of additional resources
  - Helps facilitate normally unattended platform development / ‘de-manning’

- Subject equipment;
  - Engineered for modular industrial fabrication
  - Common Off The Shelf (COTS) components where possible
  - Suite of 30+ patents issued and pending
  - Full scale prototype being built
  - SIT 2021-Q3
  - Offshore deployment 2022-Q2