Enhancing Offshore Recovery by Enabling Longer, Safer, and Cheaper Subsea Well Tiebacks

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Presentation Outline

• Project Overview
• Technical Status
• Accomplishments to Date
• Lessons Learned
• Project Summary
• Appendix (additional available information)
Per BOEM, about 4 out of 5 deepwater facilities are producing less than 50% of their daily oil production capacity, based on a three-year average of daily production rates.

"Through collaboration, BOEM and BSEE identified contingent resources that exist 30-60 miles away from existing facilities. This research will identify any difficulties that new technological advances may face, that could potentially hinder production and project economics," the two agencies said.

“BSEE has … examined extended-reach subsea tieback projects given the capacity that exists in the region,” said BOEM Acting Director Walter Cruickshank. “Based on that analysis, BSEE could have more tools to minimize stranded resources.”
Project Overview

Goals and Objectives

The **goal** is to develop and demonstrate new technology that can be utilized to help reduce the cost of subsea well tie-backs and extend their reach to unlock stranded resources.

Offshore, ‘enhanced oil recovery’ can be the difference between economically drilling a subsea well and achieving primary and often secondary (usually water injection) recoveries (50/60%) versus leaving the resources in the ground (0% recovery) due to the high cost of dry tree, platform supported wells.

The **objective** is to design, engineer, construct/fabricate, test, and qualify a full-scale prototype subsea chemical storage and injection system for low dosage rate production chemicals to enhance offshore oil production.
Project Overview
Specific Objectives

Phase 1, 2020-04 through 2021-12 key objectives:
• Design, engineer, procure, fabricate subassemblies
• Integration of subassemblies into a complete prototype Integrated Unit.
• Prototype Integrated Unit tests and qualification activities culminating with a System Integration Test (SIT).
• Identify and contract w/ operator to demo Integrated Unit in an offshore field

Phase II, 2022-01 through 2022-12 key objectives:
• Planning & coordination of offshore demonstration of the Integrated Unit, including regulatory reviews
• Acquisition & fabrication of all site specific (offshore field demonstration location) components
• Offshore deployment, operation/demonstration, then recovery
• Onshore post-demo Integrated Unit inspection, review and analysis
• Final technical report
Project Overview

Participants

U.S. Department of Energy
National Energy Technology Lab
FPM, Dave Cercone

U.S. Department of Interior
Bureau of Safety & Environmental Enforcement
Lead; Minatte Matta

Technical Advisory Committee / Point of Contact
ExxonMobil, Doug Turner
BP, Trey Lynch
LLOG, Glenn Mediamolle
Others, TBD

Lead Organization
Subsea Shuttle, LLC
Co-Principal Investigators
Jim Chitwood
Art Schroeder

Back-office assistance
GrowthForce

Engineering & fabrication/construction & FAT/SIT
Seanic Ocean Systems

Frame & tank engineering & certification
American Bureau of Shipping (ABS)

Marine engineering & operations
TechnipFMC, Genesis

ISO Accredited Testing Lab
Argen Labs, LLC

Bladder mfg.
Avon Engineered Fabrics (AEF)

Bladder fabric
Cooley Group
Technical Status

- Engineered fabric; 1000’s of uses over decades

- Abrasion resistant
- Tear resistant
- Tremendous tensile strength
- Wet environment properties
- Material – matched to chemical use
- 10-year + life expectancy in many applications
Technical Status

- Production chemicals, testing and 3rd party qualification

- Long-Term Aging Testing
  - Test Temperature(s): Wide range, 3 temperatures
  - Test Duration: 60 days
  - Test Fluids: Various
  - Test Pressure: 4400 psi
  - Testing: Triplicate + samples
    - Biaxial Tensile Properties – Proprietary method
    - Uniaxial Tensile Properties - ASTM D412/D
    - Mass Change, Volume Swell - ASTM D471
    - Tearing Resistance - ASTM D1004
    - Permeation Testing - API 17J
    - Friction/Wear Testing: Fabric on Fabric and Fabric on Tank Wall

Chemical/fabric qualification:

1. MeOH
2. LDHI
3. Scale Inhibitor
4. Corrosion Inhibitor
5. Asphaltene Inhibitor
6. Dispersant
7. Seawater
8. Process developed to qualify additional chemical
Technical Status

- Scale (500 gallons) storage system test and optimization

Earlier Phase Testing results

- Bladder behavior was consistent, predictable & repeatable
- Able to achieve very low chemical residuals after pump-down.
- No observed detrimental bladder material behavior.

Over 30 SME participants + regulators witnessed model test / demonstration
Technical Status

Full size test tank/bladder performance testing

Bladder in tank, filling

Test tank; full scale but w/o process module

Installing bladder in tank, Subsequently perfected methodology for installing w/o manned entry
Technical Status

- Prototype frame, process and storage system, under construction

Process module

CSIU Details

- Length – 25’ 0”
- Width (structure only) – 8’ 0”
- Width (with guide cones) – 16’ 0”
- Height – 8’ 6”
- Height (with padeyes) – 9’ 0”
- Total Weight (air, empty) – 33.7 kips
- Total Weight (air, full) – 79.1 kips (35.9 mt)
Technical Status

- Process module

- Injection pump testing

- Flow meter

- Subsea electronics (1 atmosphere pressure cans)
Technical Status

• Subsea electronics

One (1) atmospheric ‘cans’ (pressure vessels) hold electronics
Technical Status

- Top-side (host platform) electronics, PRCM, power regulation and control module
Technical Status

• Phase 1 (onshore) test facilities

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
Technical Status

- Foundation design

**Suction Pile Details**
- Pile Outside Diameter – 16’ 0”
- Pile Length – 52’ 0”
- Short Pin Length – 8’ 11”
- Long Pin Length – 12’ 11”
- Pile Steel Weight (air) – 220.4 kips
- Outfitting Weight (air) – 5.1 kips
- Total Weight (air) – 225.5 kips (102.3 mt)

**Mudmat Details**
- Length – 29’ 0”
- Width – 19’ 0”
- Short Pin Length – 8’ 11”
- Long Pin Length – 12’ 11”
- Total Weight (air) – 28.5 kips (12.9 mt)
Technical Status

- Offshore installation planning and analysis
  - Operational assumptions
  - Qualitative Risk Analysis (QRA)
  - Foundation design
  - Vessel loadout
  - Foundation deployment
  - Storage and injection unit deployment
  - Operational hook-up
  - Recovery (reverse)

Vessel Loadout

M/V Holiday

Typical Light Construction Vessel
- Dimensions – 288’ x 66’ x 29.6’ (87.78m x 20.12m x 8.99m)
- Clear Deck – 116’10” x 54’ (35.36m x 16.46m)
Technical Status

- Foundation with Chemical Storage & Injection Unit

Guidepost w/ funnels

Storage system

Process module

Mudmat foundation

Anodes
Lessons Learned

– Impact of COVID wrt,
  • Procurement, longer leads, stocking levels, pricing
  • Personnel, out of office work environment and illness

– Impact of regulations
  • Testing of tank
  • Over-road hauling
Project Summary

– Analysis and testing of sub-assemblies and components proceeding as planned, but with delays.
– Oil company under Letter of Intent wrt demonstration

2-minute animation depicting our solution can be viewed @ https://www.linkedin.com/posts/artjschroeder_subsea-innovation-offshore-activity-6687433705331544064-g6_V
Bibliography

– List peer reviewed publications generated from the project per the format of the examples below.

None to date