Subsea Shuttle, LLC
Production chemicals, delivered subsea as a service™

# Subsea Shuttle, LLC (SSS), Stakeholder update review

FPM – Dave Cercone (US Dept of Energy, NETL project DE-FE-0031859)
BSEE Point person, Minatte Matta
SSS Co-PIs: Jim Chitwood & Art Schroeder

## ENHANCING OFFSHORE RECOVERY BY ENABLING LONGER, SAFER, & CHEAPER SUBSEA WELL TIEBACKS

**2021-12-08; 2-3pm (CDT); participate via below link:**
Meeting ID: meet.google.com/wtw-qstb-tic

Phone Numbers: (US)+1 402-735-0209 PIN: 360 139 181#

Contact: Art Schroeder, CEO & Co-founder
art@SubseaShuttle.com
713-681-1482
https://subseashuttle.com/

# Safety moment & agenda

| | | | |
|---|---|---|---|
| **2:00 PM - 2:10 PM** | 10 | **Introductions,**<br>**Mtg particapnts, affiliation & area of expertise** | Mtg participants |
| **2:10 PM - 2:15 PM** | 5 | **Safety moment & agenda review** | SSS - Art Schroeder |
| **2:15 PM - 2:30 PM** | 15 | **Project overview**<br>o Background & objective<br>o Project schedule, structure & particpants<br>o Progress **- FAT of Process Module complete** | SSS - Art Schroeder |
| **2:30 PM - 2:40 PM** | 10 | **Discussion / Comments**<br>o DOE<br>o BSEE<br>o Others | DOE FPM - Dave Cercone<br>BSEE - Minatte Matta |
| **2:40 PM - 2:50 PM** | 10 | **Next Steps**<br>o Skid Fame & Storage Tank assembly<br>o Systems Integration Test (SIT), 2021Q1<br>o Offshore demonstration, 2022Q3/4 | SSS - Art Schroeder |
| **2:50 PM - 3:00 PM** | 10 | **Discussion / Comments**<br>o DOE<br>o BSEE<br>o Others | open |
| **3:00 PM - 3:00 PM** | 0 | **Adjourn** | All |

Peace & Calm
Fit some into your schedule

# Opportunity

## U.S. BOEM, BSEE Looking at Ways to Boost Gulf of Mexico Oil and Gas Output

OE Staff • *September 23, 2020*

https://www.oedigital.com/news/481878-u-s-boem-bsee-looking-at-ways-to-boost-gulf-of-mexico-oil-and-gas-output?utm_source=AOGDigital-ENews-2020-09-23&utm_medium=email&utm_campaign=OEGDigital-ENews

According to 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 provided some important initial data, and our team will consider the economic parameters used to examine these **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 then have more tools to minimize stranded resources.”

# Benefits

1. **Longer offsets**

2. **Lower development costs** of tie-back opportunities within current technology reach by removing tubes from umbilicals (reducing umbilical costs by up to 80%)

3. **Reduce host platform space and weight requirements** (equipment, chemical and riser load); and hence cost on newbuilds. Free up space on existing brownfield host platform to allow de-bottlenecking, tie-in additional wells, and/or new equipment requirements

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

5. "**Chemical Injection as a Service™**", mimicking successful onshore chemical delivery model; migrate capex of reusable/redeployable equipment to service company and sell chemical by the gallon, where and when required to operator

6. **Design one, then build many**. This approach minimizes spare parts, simplifies inspection, maintenance, repairs, and lowers costs

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

8. Significant step towards 'normally un-attended' operations (or platform 'de-manning')

# Project objectives

## Project Scope

Process module +
PRCM Power Regulator
& Control Module

### Tasks – Phase I (2020-04 through 2022-03)

Task 1 - Project Management Plan (PMP)

Task 2 - Data Management Plan (DMP)

Task 3 – Technology Maturation Plan (TMP)

Task 4 – Design work

Task 5 – Detailed Engineering and Construction of Subassemblies

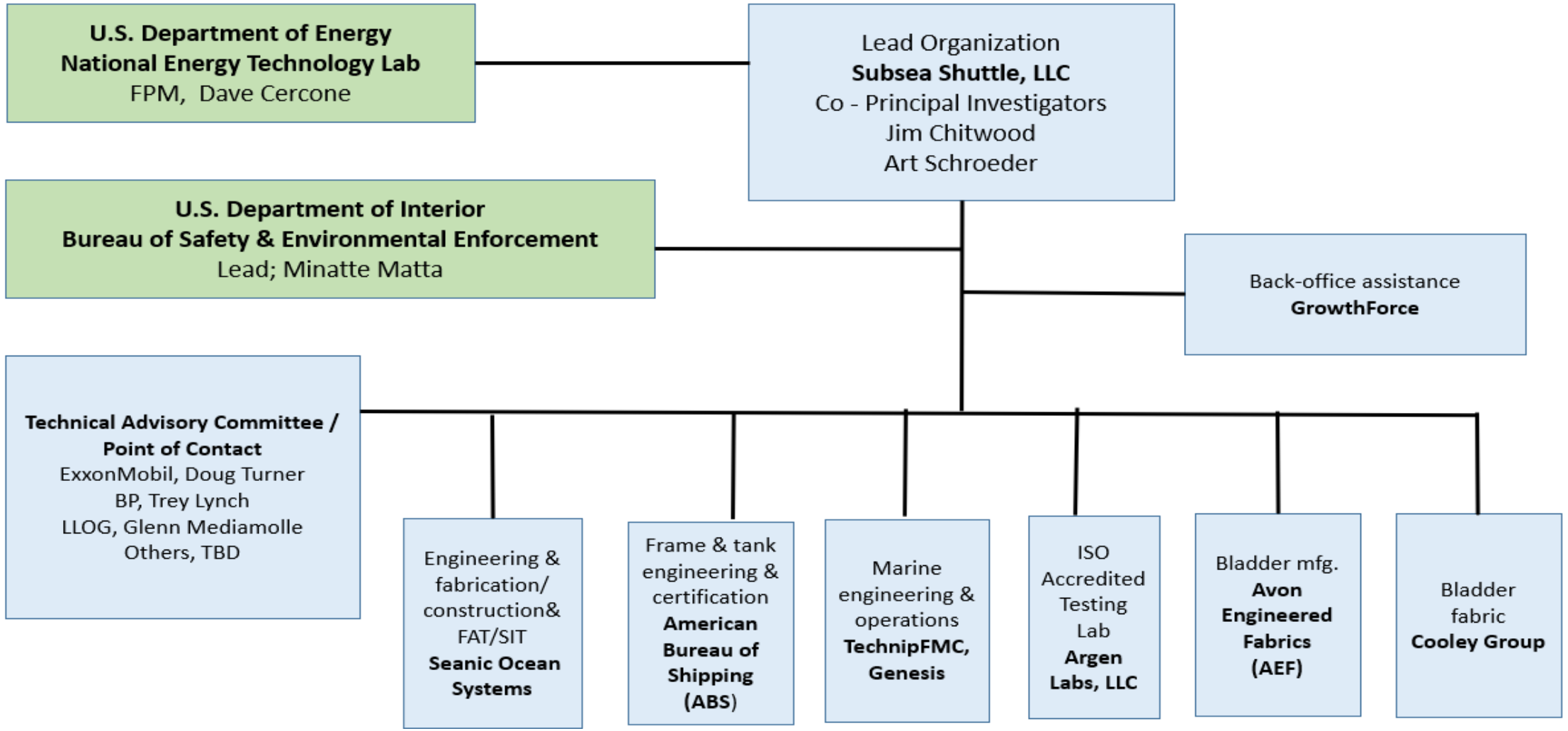
Task 6 – Fabrication and Assembly of Prototype Injection Unit

Task 7 – Prototype Qualification Testing of Assembled System (SIT)

### Tasks – Phase II (2022-03 through 2023-03)

Task 8 – Offshore demonstration

# Participants



# Functional Design Specs

| Component | Description | Reference/standard |
|---|---|---|
| **Overall system** | • 'Touchless' chemical transfer, quayside to subsea & back to quayside<br>• Pat'd dual barrier chemical containment<br>• Qualified to 10,000 fsw / 10-year design life | Meets rqmts of hazardous environment IMDG |
| **Frame** | • 25' x 8' x 8.5'(tall)<br>• Weight: 7 S. Tons tare 30 S. Tons (w/ payload) | API 2 CCU standard<br>IMDG T11, ADR/RID & DOT |
| **Storage tank** | • 100 bbl (w/ 20 bbl reserve)<br>• Working pressure: 4 BAR (58 psi)<br>• External collapse: 10 psi | ASME, Sect VIII Div. 1 |
| **Bladder** | • 120 bbl<br>• Compatible with most std production chemicals | Mil spec MIL-PRF-32233<br>3rd party performance tstg |
| **Pump** | • Proven onshore triplex pump, modified<br>• 84 gpd of chemical @ DP up to 10,000 psi.<br>• Electric driven, variable speed controlled | Custom, base on API RP 14 C |

# Engineered fabric; 1000's of uses over decades

Subsea Shuttle™
Fluids & facilities, delivered and operated as a service





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

# Production chemicals; testing and 3rd party qualification

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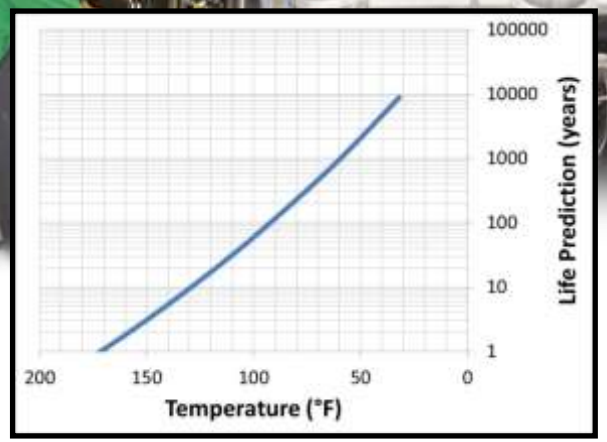
- Long-Term Aging Testing
  - Test Temperature(s): Wide range, 3 temperatures
  - Test Duration: 60 days
  - Test Fluids: Various
  - Test Pressure: 4400 psi
  - Testing: Triplicate + samples

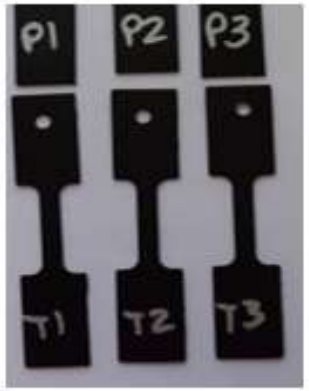
Biaxial Tensile Properties – Proprietary me
Uniaxial Tensile Properties - ASTM D412/D
Mass Change, Volume Swell - ASTM D471
Tearing Resistance - ASTM D1004
Permeation Testing -API 17J

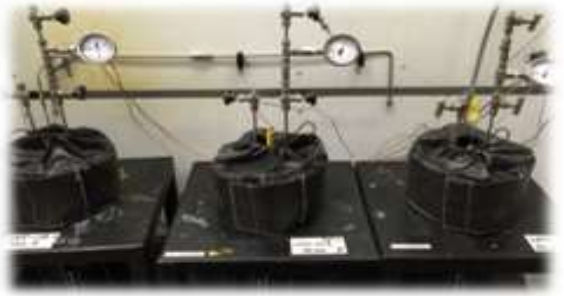
Friction/Wear Testing; Fabric on Fabric and Fabric on Tank Wall




## Logistics of Testing

Prepare Specimens → Age in Fluid → Test Mechanical & Physical Properties



**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

Uniaxial Tensile
Two Orientations
ASTM D1708


Puncture
ASTM D751


Seam (Shear)
Custom Method


Trapezoidal Tear
ASTM D751

# Small scale (500 gal) storage system test and optimize

## 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

# Small scale (500 gal) storage system test and optimize

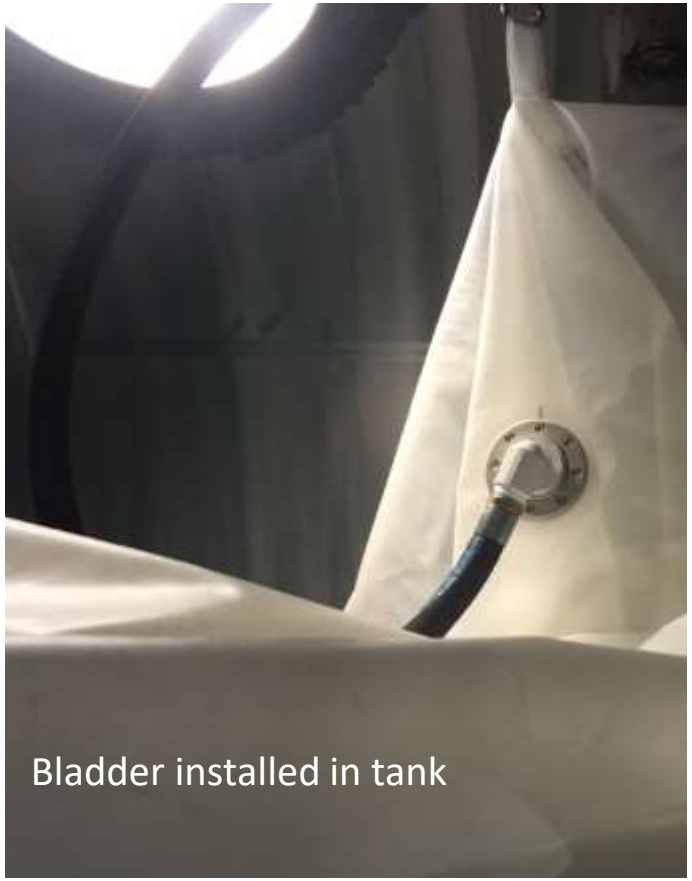
## Testing results

- Bladder behavior was consistent, predictable & repeatable
- Able to achieve very low chemical residuals after pump-down.
- No observed detrimental bladder material behavior.
- SME participants + regulators witnessed model test / demonstration

# Large scale storage system tests & optimization

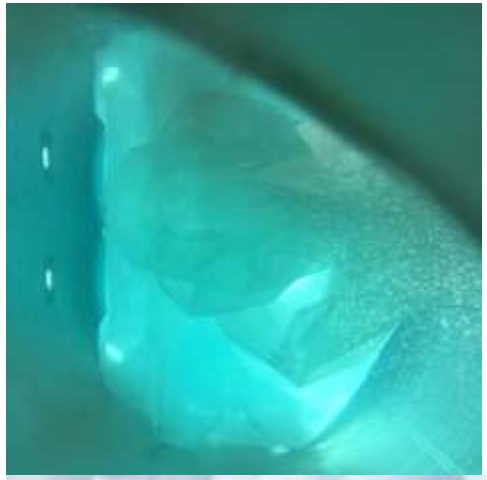

Loading & subsequent testing of large bladder (~600 bbls) bladder/tank interaction

# Prototype (full scale) test tank/bladder performance testing, complete



Bladder installed in tank

Test tank; full scale (100 bbls)



Bladder in tank, filing

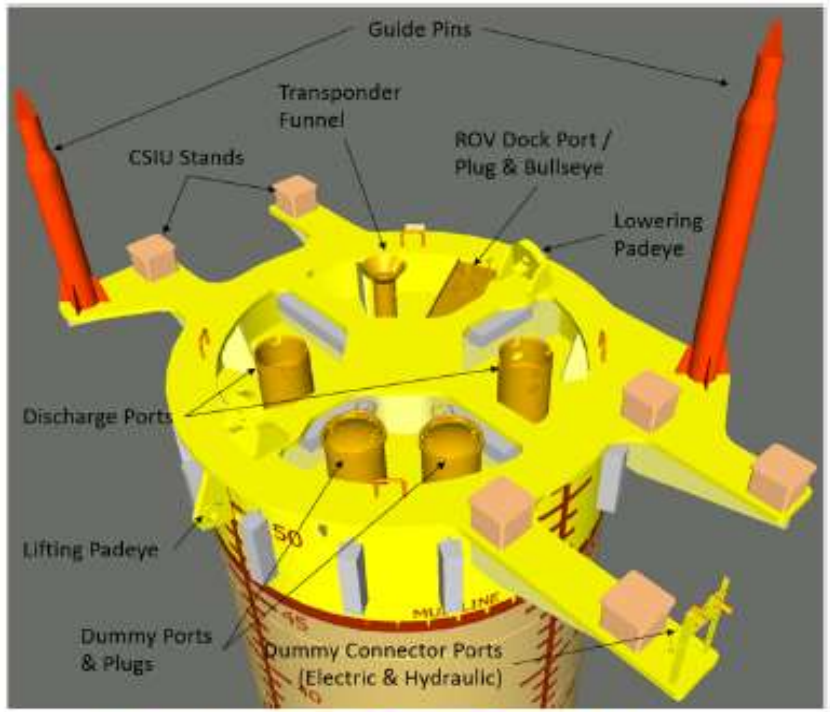

Installing bladder in tank, perfected methodology for installing w/o manned entry

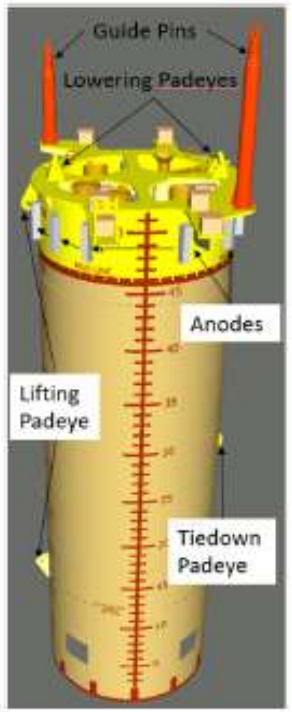
# Geotechnical design report


1. INTRODUCTION
   1.1 Purpose and Scope
2. GEOTECHNICAL DATA
3. MUDMAT AND SUCTION PILE LAYOUT
4. MUDMAT DATA
   4.1 Mudmat Dimensions and Loads
   4.2 Mudmat and Chemical Injection and Storage Unit Self-Weight
   4.3 Seabed Slope and Installation Tolerance
5. MUDMAT DESIGN METHODOLOGY
   5.1 Mudmat Design Methodology and Code
   5.2 Mudmat Bearing Capacity
   5.3 Mudmat Sliding Capacity
   5.4 Skirt Penetration Resistance
6. MUDMAT FOUNDATION ANALYSIS
   6.1 Mudmat Bearing Capacity and Sliding Stability
   6.2 Mudmat Capacity Analysis Results
   6.3 Mudmat Skirt Penetration
7. SUCTION PILE OPTION
   7.1 Shear Strength Profile for Pile Capacity
   7.2 Soil Parameters for Installation and Extraction Analyses
   7.3 Soil Sensitivity and Alpha Factor
   7.4 Pile Data and Loads
   7.5 Geo-hazard Considerations
8. SUCTION PILE DESIGN CRITERIA
   8.1 Factor of Safety
   8.2 Installation Tolerances
9. SUCTION PILE ANALYSIS METHODOLOGY
   9.1 General
   9.2 Suction Pile Capacity
      9.2.1 Limit Equilibrium Approach
10. SUCTION PILE CAPACITY ASSESSMENT RESULTS
11. INSTALLATION AND EXTRACTION OF SUCTION PILE
   11.1 Installation Analysis
   11.2 Soil Plug Heave
   11.3 Extraction Analysis
12. INSTALLATION GUIDELINES
   12.1 Allowable Tolerances
   12.2 Landing Speed and Self-Weight Penetration
   12.3 Minimum Relocation Distance
   12.4 Instrumentation
13. CONCLUSIONS
14. REFERENCES

APPENDIX A – LATERAL LOAD BY SEABED CURRENT
APPENDIX B – MUDMAT CAPACITY CALCULATION SPREADSHEET
APPENDIX C – SUCTION PILE CAPACITY CALCULATIONS FOR SLS CASE

# Foundation design, complete



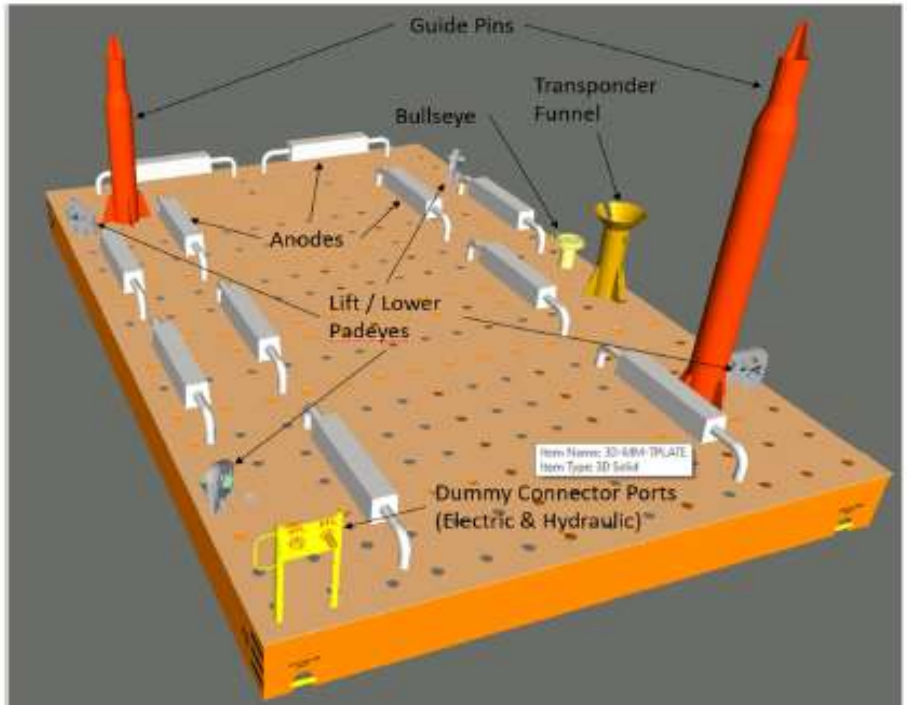




## Suction Pile Details

- 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)



# Chemical Storage & Injection Unit, design complete

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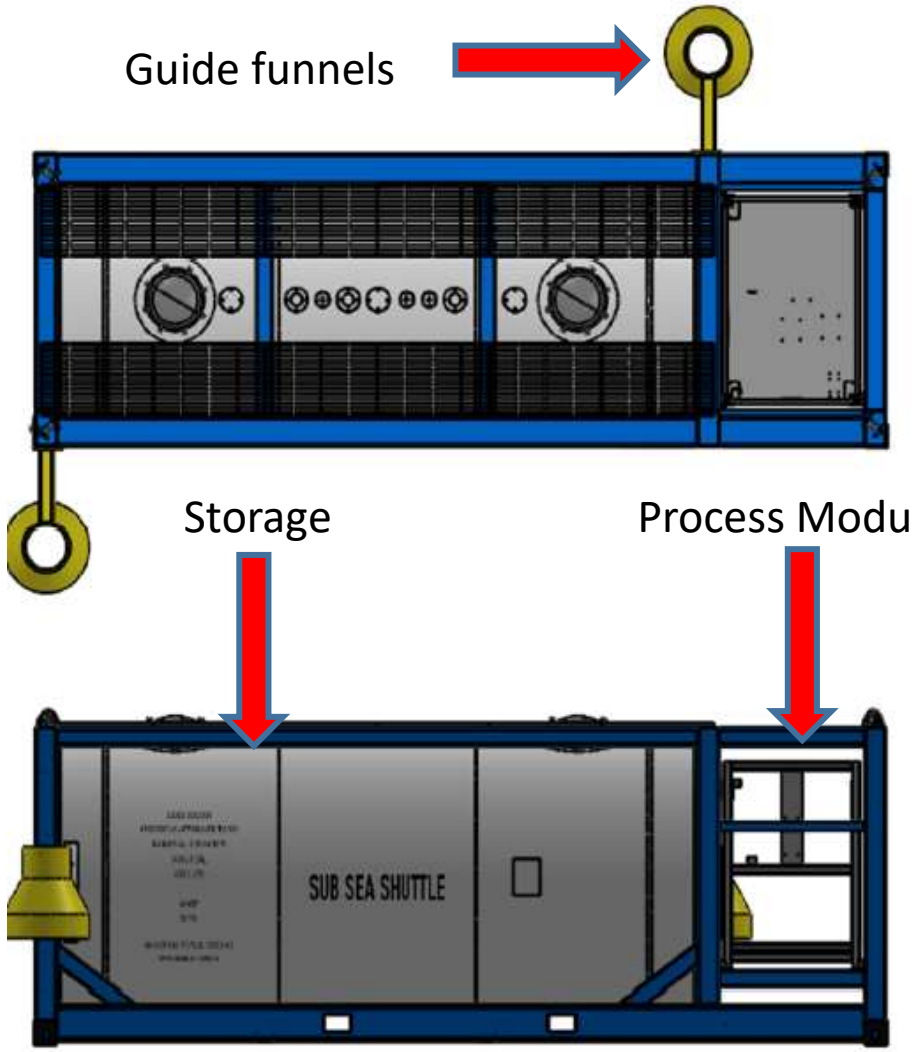
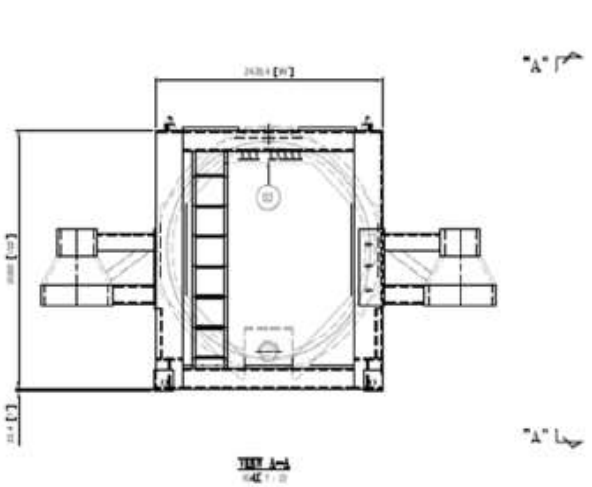
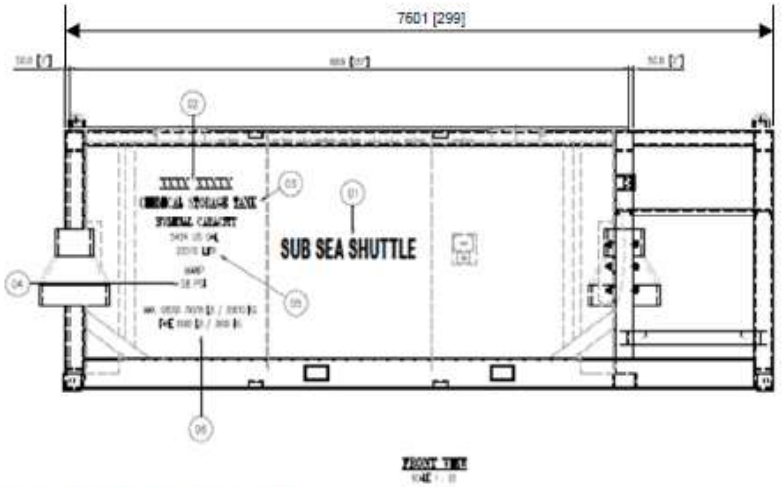
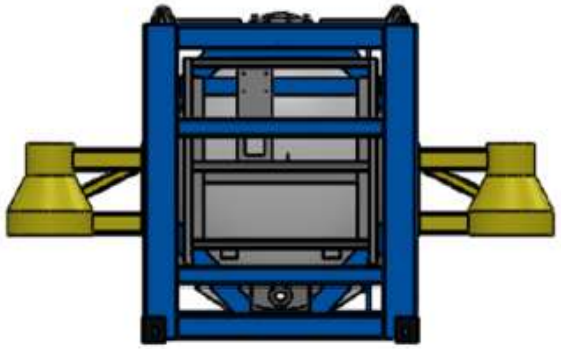




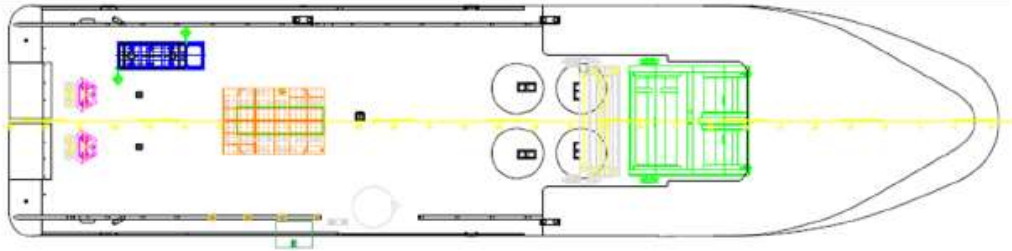
## CSIU Details

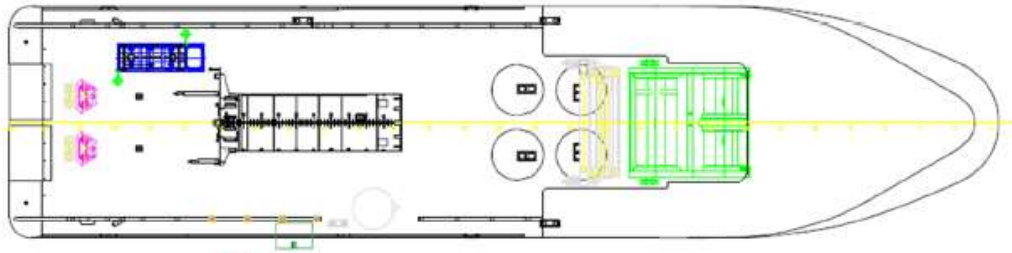
- Length – 25’ 0”
- Width (structure only) – 8’ 0”
- Width (with guide cones) – 16’ 0”
- Height – 8’ 6”
- Height (with padeyes) – 9’ 0”
- Total Weight (air, empty) – 33.7 kips
- Total Weight (air, full) – 79.1 kips (35.9 mt)

# Marine risk analysis & operational assumptions, complete

## Construction Vessel

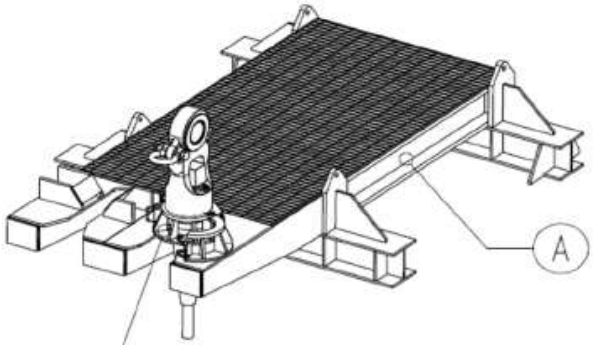
- DP2
- 250 mt crane or A&R lowering system to 3000m
- Either must have active heave compensation or accommodate an inline heave compensator
- WROV with pumpskid
- Positioning / Survey spread



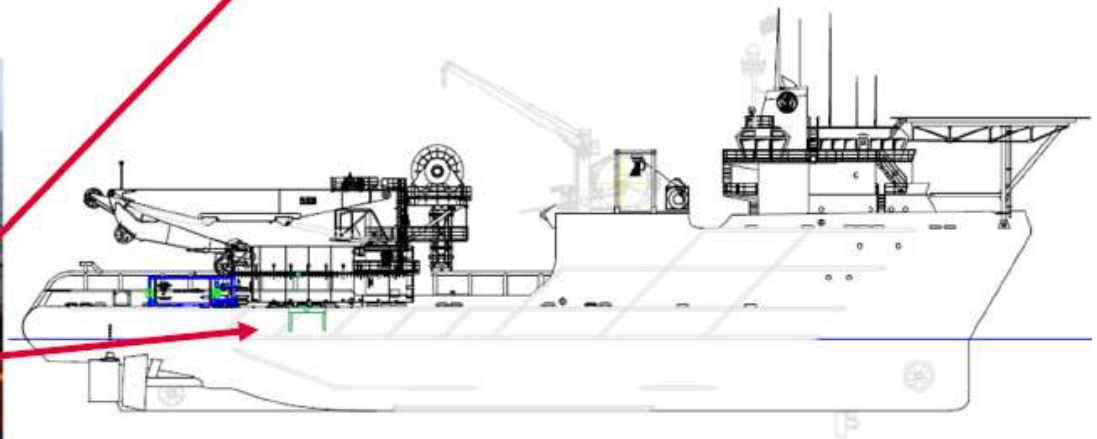


## Environmental Limits

- Wave Height – 1.5m $H_s$ (limited by suction pile launch through splash zone in worst heading)
- Wave Period – Analyzed from 6.5 sec to 10.5 sec.
- Current Speed – 2.0 kts







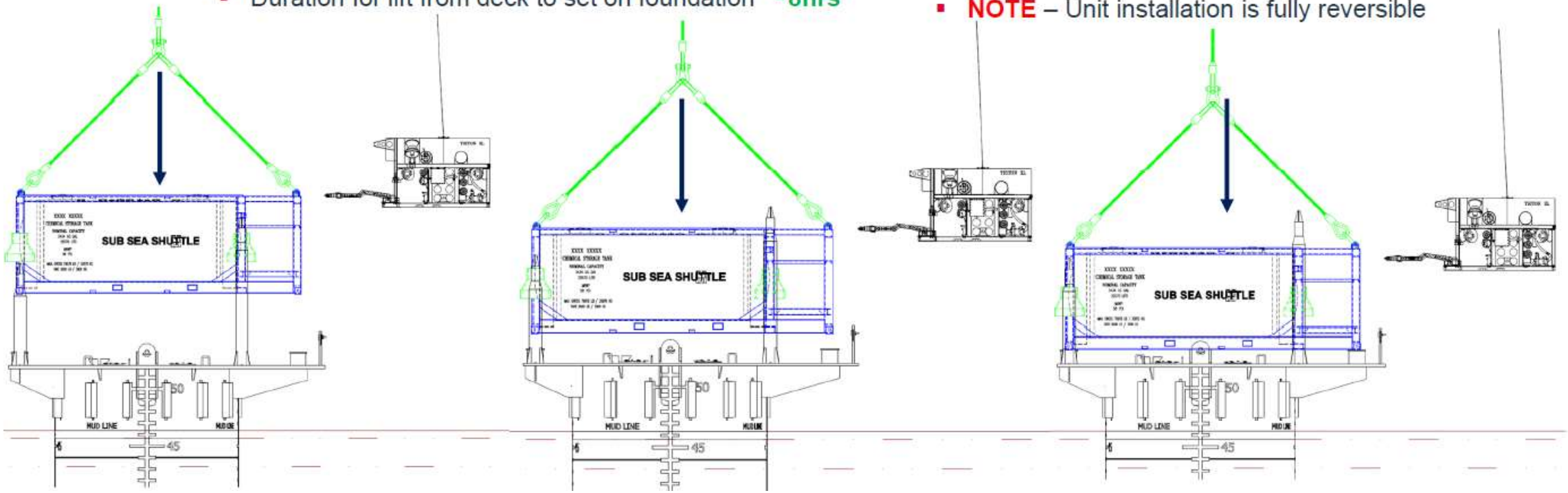
# Marine risk analysis, storyboard- installation

## Unit Set on Pile

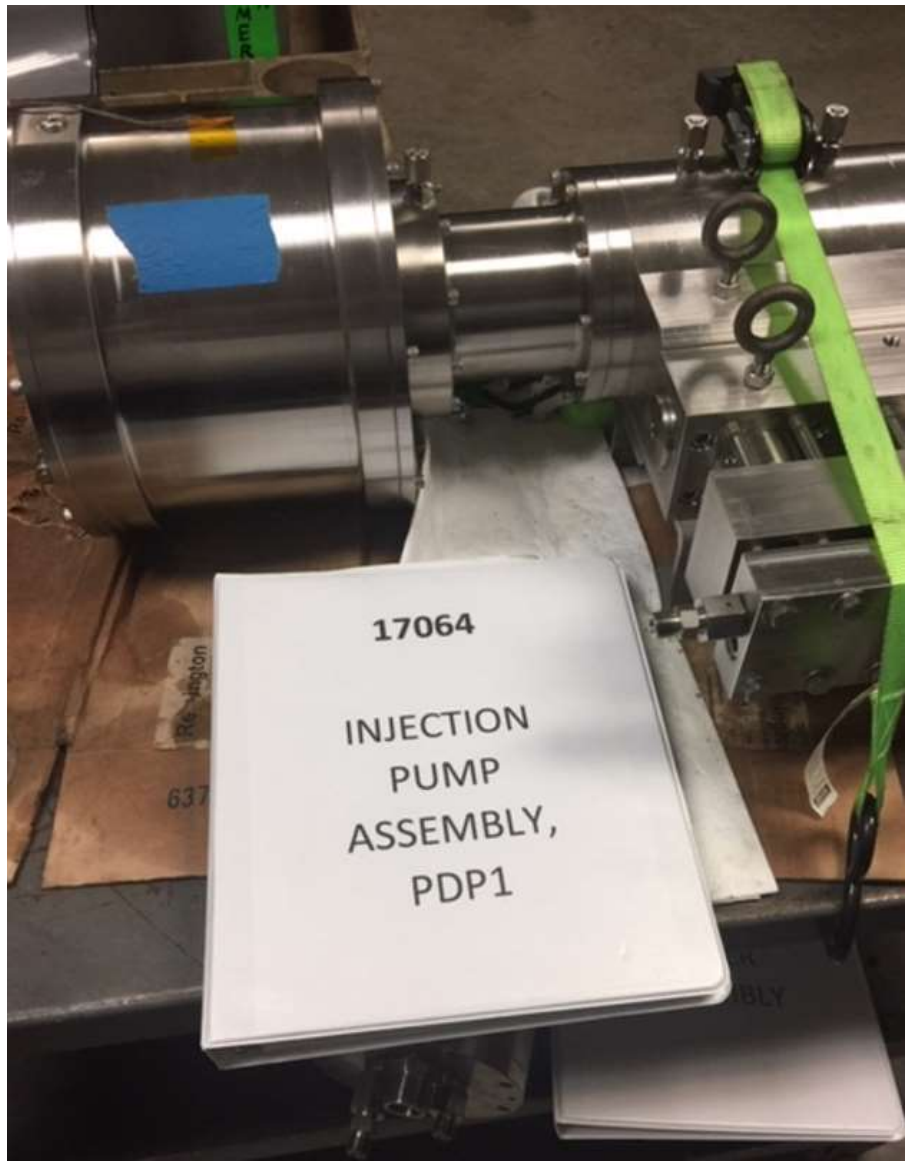
- Unit 1st guide cone engages long guide pin
- Unit 2nd guide cone engages short guide pin
- Unit set on foundation
- Duration for lift from deck to set on foundation ~8hrs

## Securing & Rigging Recover

- Lowering rigging slacked
- ROV engages securing pins
- ROV disconnects ROV shackles on Unit lifting padeyes
- Rigging recovered to surface
- **NOTE** – Unit installation is fully reversible

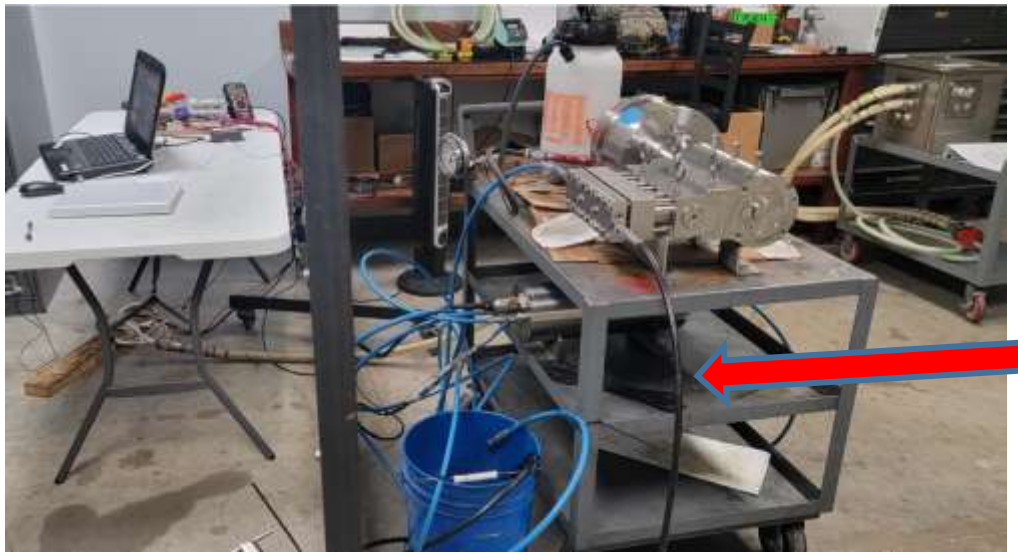


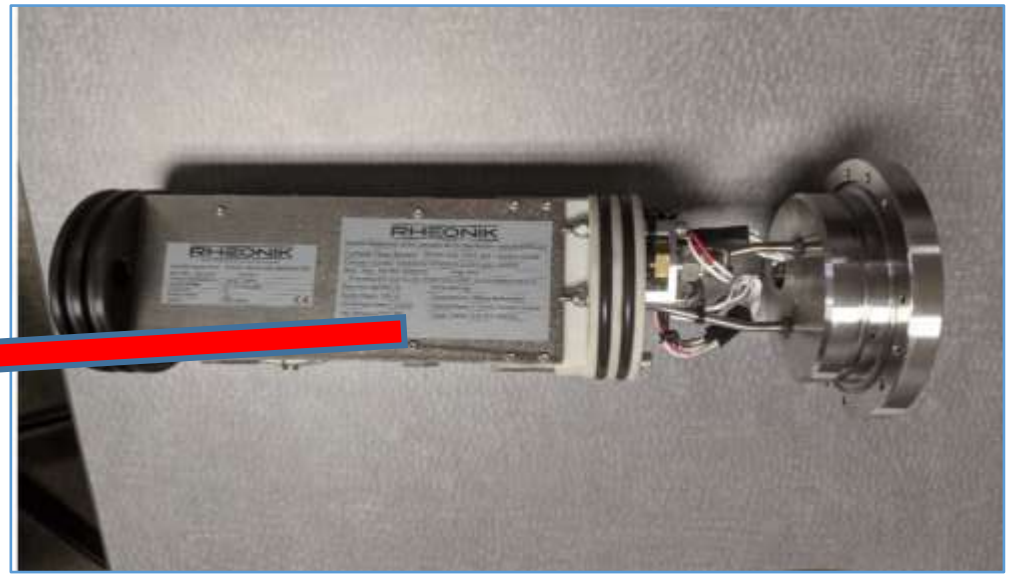
# Subassemblies, built & tested




Injection pump testing

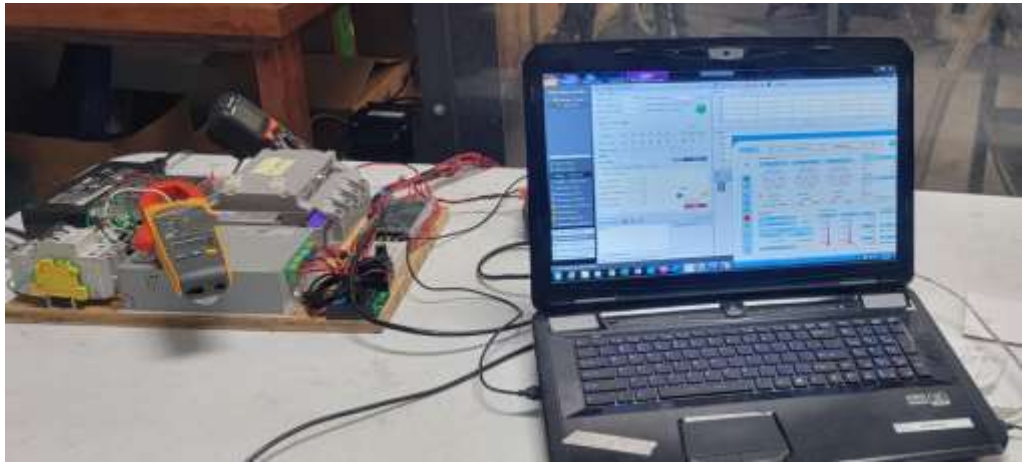
# Subassemblies, built & tested







Coriolis Flow meter assembled and tested (w/ Injection pump)



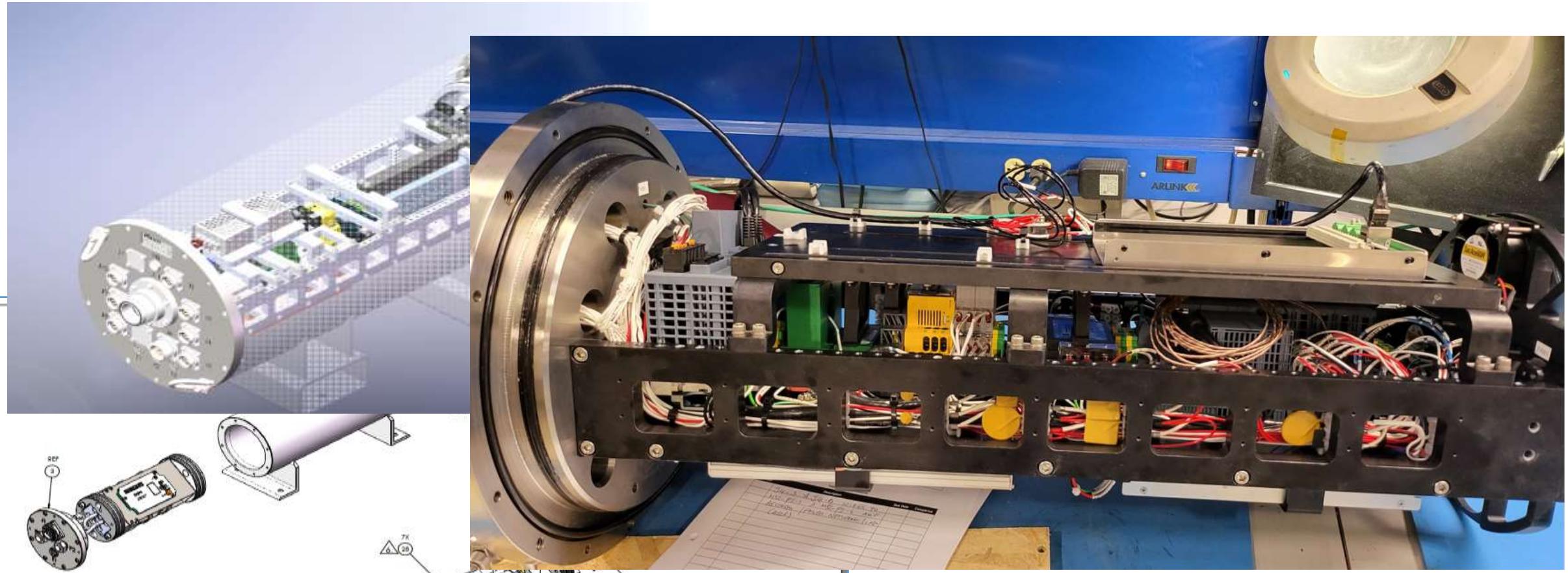
# Subsea electronics assembled, wired & tested

Electric actuator, FAT


Subsea transformer

Tested Pressure balance, oil filled (PBOF) interconnect cables

# Subsea electronics assembled, wired & tested






1 atmosphere cans hold subsea electronics

# Power Regulation & Control Module (PRCM), assembled & tested

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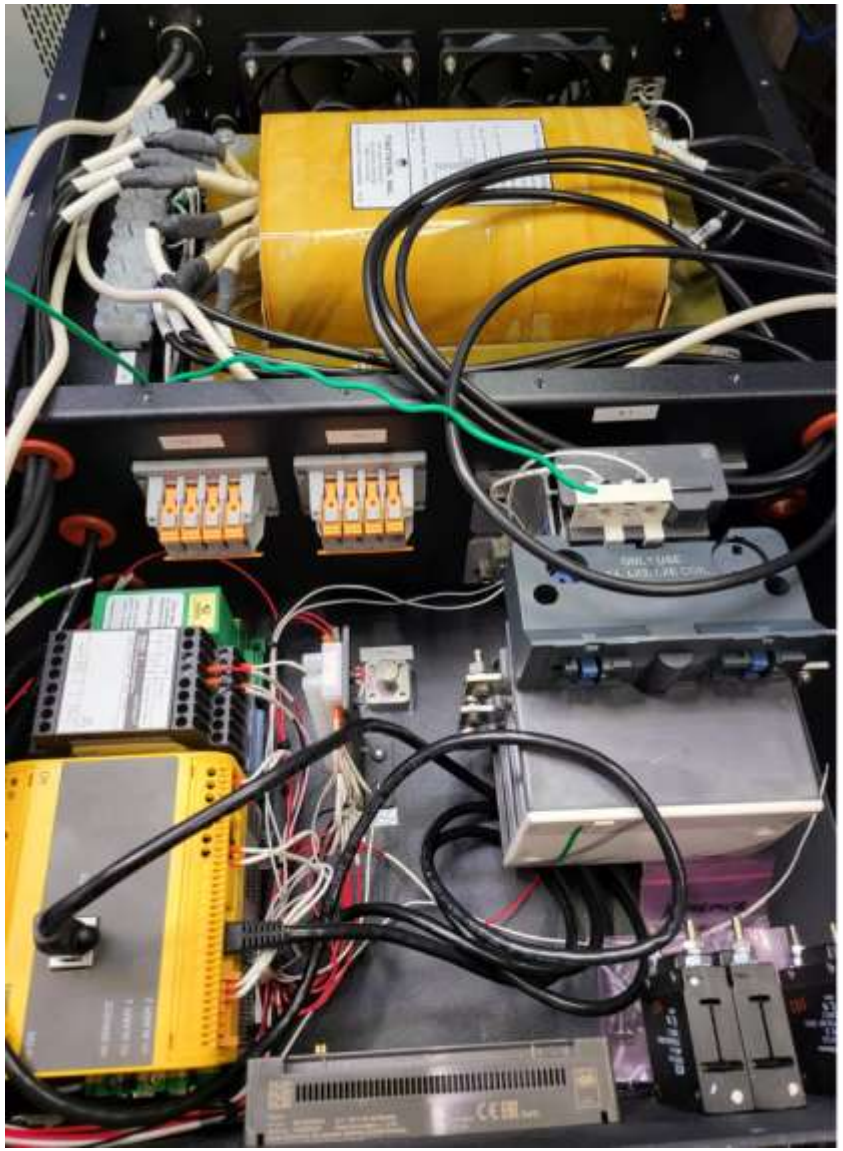
**To be located on host platform**



# Power Regulation & Control Module (PRCM), assembled & tested

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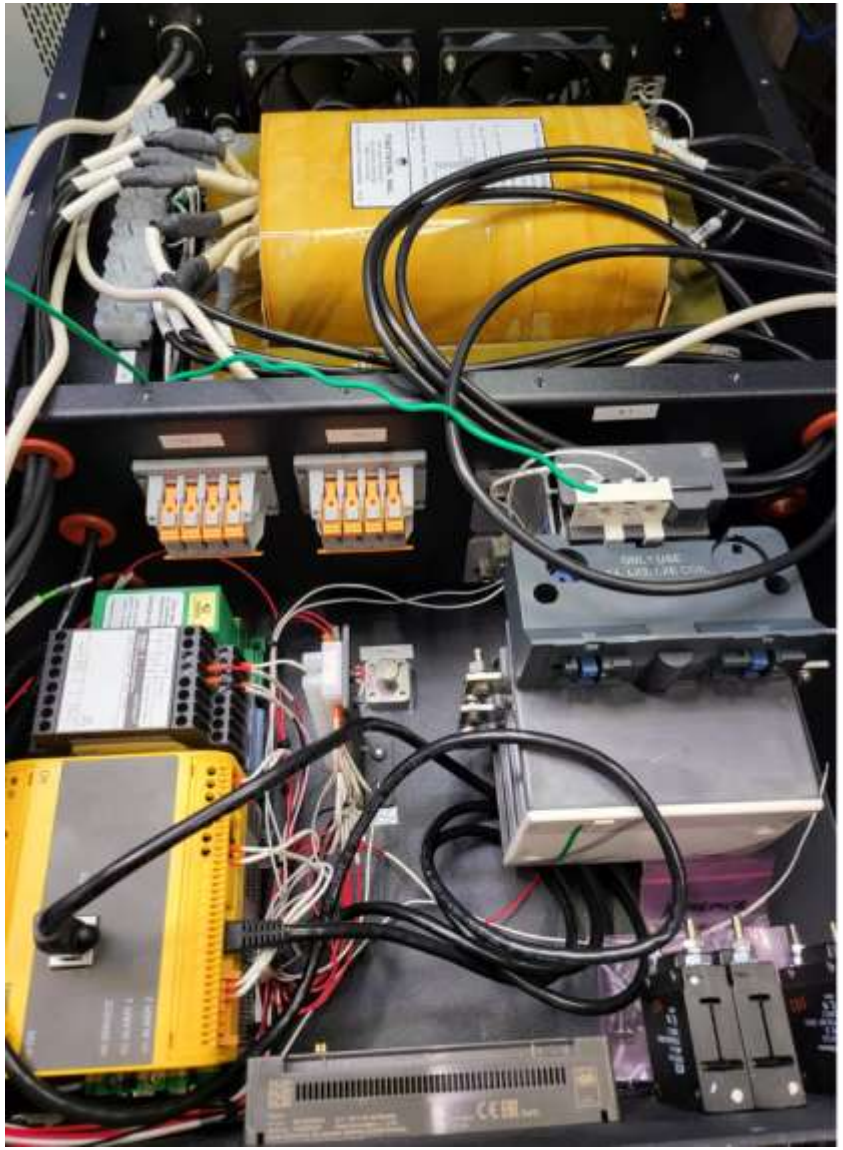
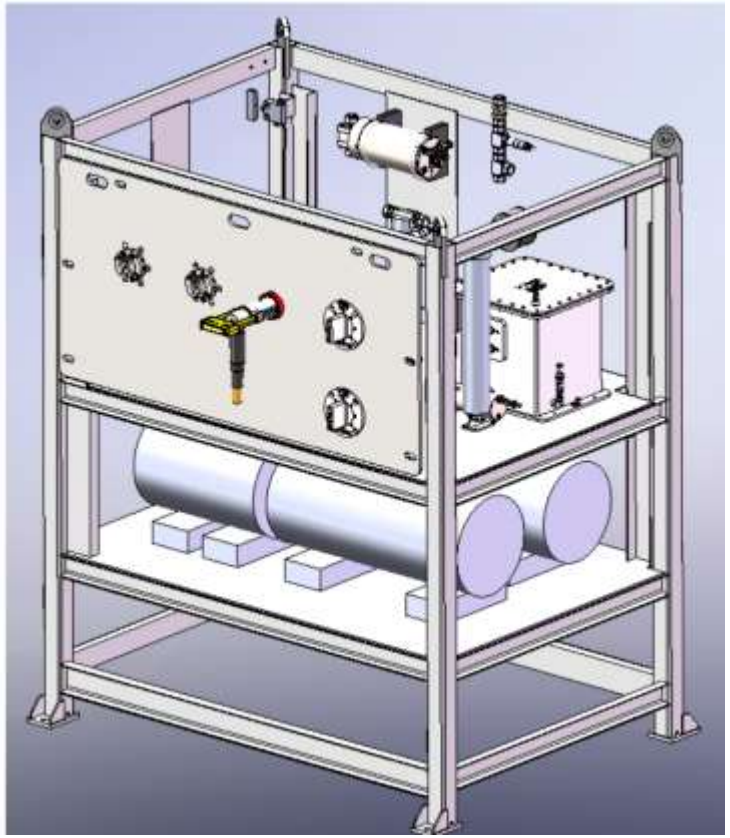
## Power Regulation & Control Module (PRCM)



# Process Module frame , designed, fabricated & tested

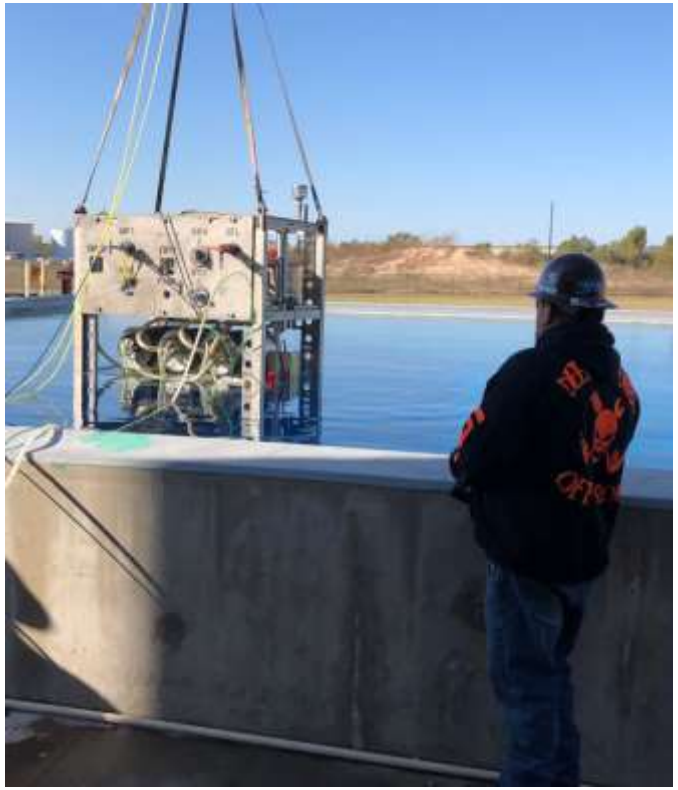
Process skid



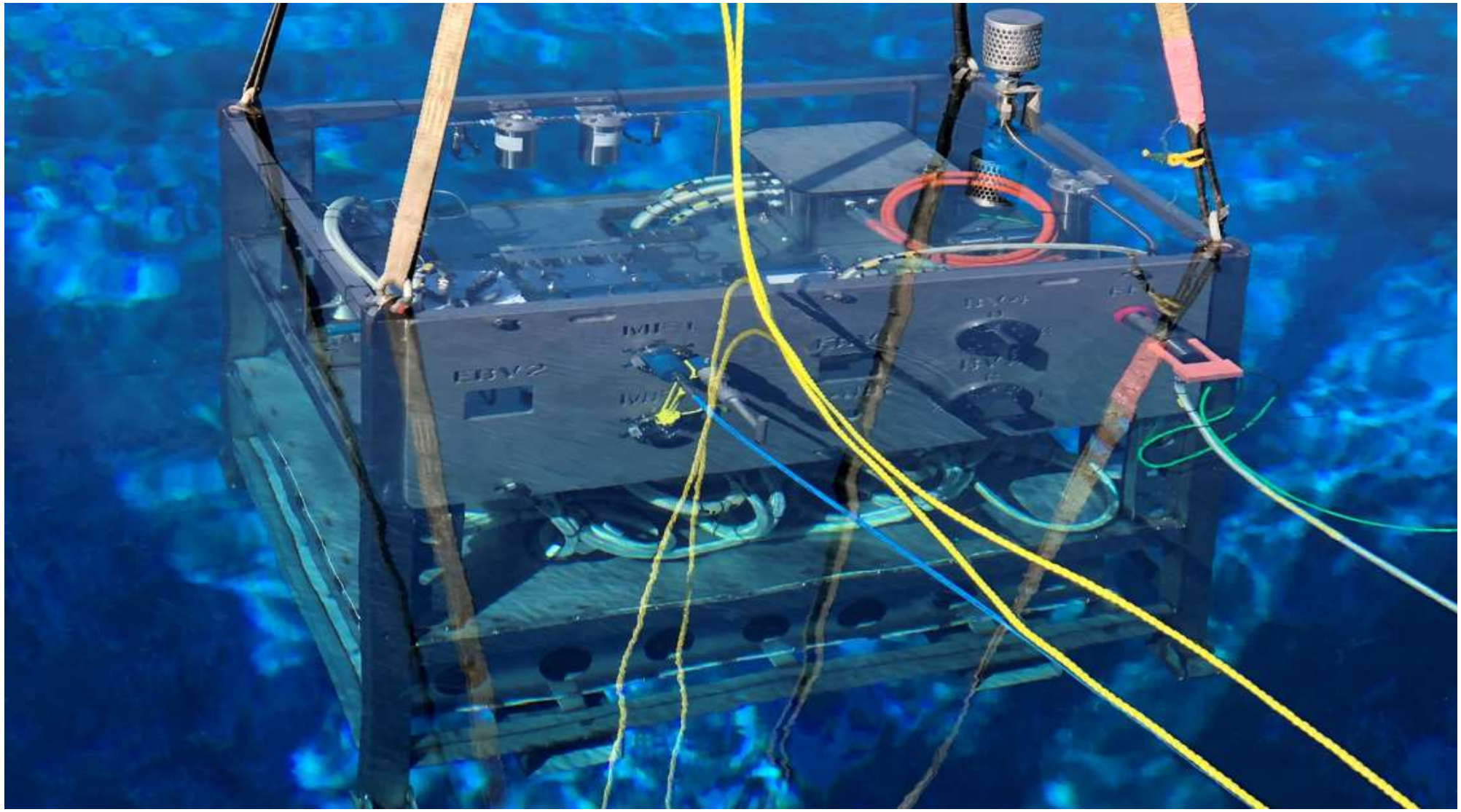
# Process Module, assembled & tested (dry FAT)

# Process Module, assembled & tested (wet FAT)

# Process Module, assembled & tested (wet FAT)

# Process Module, assembled & tested (wet FAT)



# Process Module, assembled & tested (wet FAT)

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Subsea Shuttle™

Subsea Shuttle, LLC

100 BBL Chemical Injection System

Process Module - Factory Acceptance Test

seanic A CENTURION COMPANY

Seanic Document Number: 17064-1539970 Rev. B



## Table of Contents


1 Introduction ..... 6
1.1 Purpose ..... 6
1.2 Acronyms ..... 6
1.3 Terms and Definitions ..... 7
2 References ..... 8
2.1 Industry Standards ..... 8
2.2 Seanic Documents ..... 8
3 Safety ..... 9
3.1 Personnel Health and Safety ..... 9
3.1.1 Personal Protective Equipment ..... 9
3.1.2 Job Safety Analysis ..... 9
3.1.3 Elevated Work ..... 9
3.1.4 Hydraulic Safety ..... 9
3.1.5 Electrical Safety ..... 10
3.2 Environmental Health and Safety ..... 10
3.3 Project Contact Information ..... 10
4 Test Requirements ..... 11
4.1 Tests and Objectives ..... 11
4.2 Test Specification ..... 12
4.3 Required Equipment ..... 13
4.4 Logging ..... 13
5 Control System Test Procedures ..... 14
5.1 Ground Continuity Test ..... 14
5.2 Control System Sensors and Alarms Verification ..... 15
5.2.1 Communication Connections Alarms ..... 20
5.2.2 Insulation Resistance Alarms ..... 22
5.2.3 Process Pressure Reading Alarms ..... 25
5.2.4 Auxiliary Pressure Readings Alarms ..... 28
5.2.5 Voltage Sensor Alarms ..... 32
5.2.6 Current Sensor Alarms ..... 36
5.2.7 Flow Sensor Alarms ..... 40
5.2.9 Fan Control ..... 42
5.2.11 Control System Power Down and Assembly ..... 44
5.3 Umbilical Ground Fault ..... 45
5.4 EBV1 Function Test ..... 48
5.5 EBV2 Function Test ..... 50
5.6 PDP1 Function Test ..... 52





5.7 EBV2 Shutdown Sequence ..... 54
5.8 PDP1 Shutdown Sequence ..... 56
5.9 Interlocks ..... 58
5.9.1 Umbilical Interlock ..... 58
5.9.2 ESD Interlock ..... 61
5.10 Trends and Logging ..... 64
5.11 ESD-Emergency Shut-Down ..... 67
5.11.1 Operator Initiated ESD, PRCM Front Panel ESD Switch ..... 68
5.11.2 Operator Initiated ESD, HMI Terminal ESD Button ..... 70
5.11.3 System Initiated ESD, Loss of COMMS ..... 73
5.11.4 System Initiated ESD, Loss of POWER ..... 75
6 Process Hardware Test Procedures ..... 77
6.1 Compensator Test ..... 77
6.2 Pressure Testing ..... 79
6.2.1 Water Alarm Testing ..... 79
6.2.2 Low Pressure Testing of Process Tubing ..... 82
6.2.3 High Pressure Testing ..... 87
6.3 Function Testing ..... 96
6.3.1 Injection Operation ..... 96
6.3.2 Maximum Operational ESD ..... 99
7 Certification of Factory Acceptance Testing Results ..... 101

# Process Module, assembled & tested (wet FAT)

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### 5.11.2 Operator Initiated ESD, HMI Terminal ESD Button

The following sections triggers the ESD function by pressing the ESD button located in the HMI Screen.

| No. | Task | Complete (Initial) |
|---|---|---|
| | Minimize access to the test area and ensure that all non-essential personnel are outside the designated work/testing area. | BP |
| | Only qualified personnel who have completed and signed the JSA are allowed in the test area. | BP |
| 1. | Ensure that all personnel within the test area have read and signed the required JSA prior to testing. Complete the below information:<br>Test Date (mm/dd/yyyy): 11-9-21<br>Performed by (name/signature): Don Pharr / DPharr<br>Witnessed by (name/signature): Ben Alexander B. Alexander | BP |
| 2. | Verify all electrical connections are made per Interconnect Drawing 17064-1521303. | BP |

### 5.11.4 System Initiated ESD, Loss of POWER

The following sections triggers the ESD function by losing comms from PRCM to Process Module.

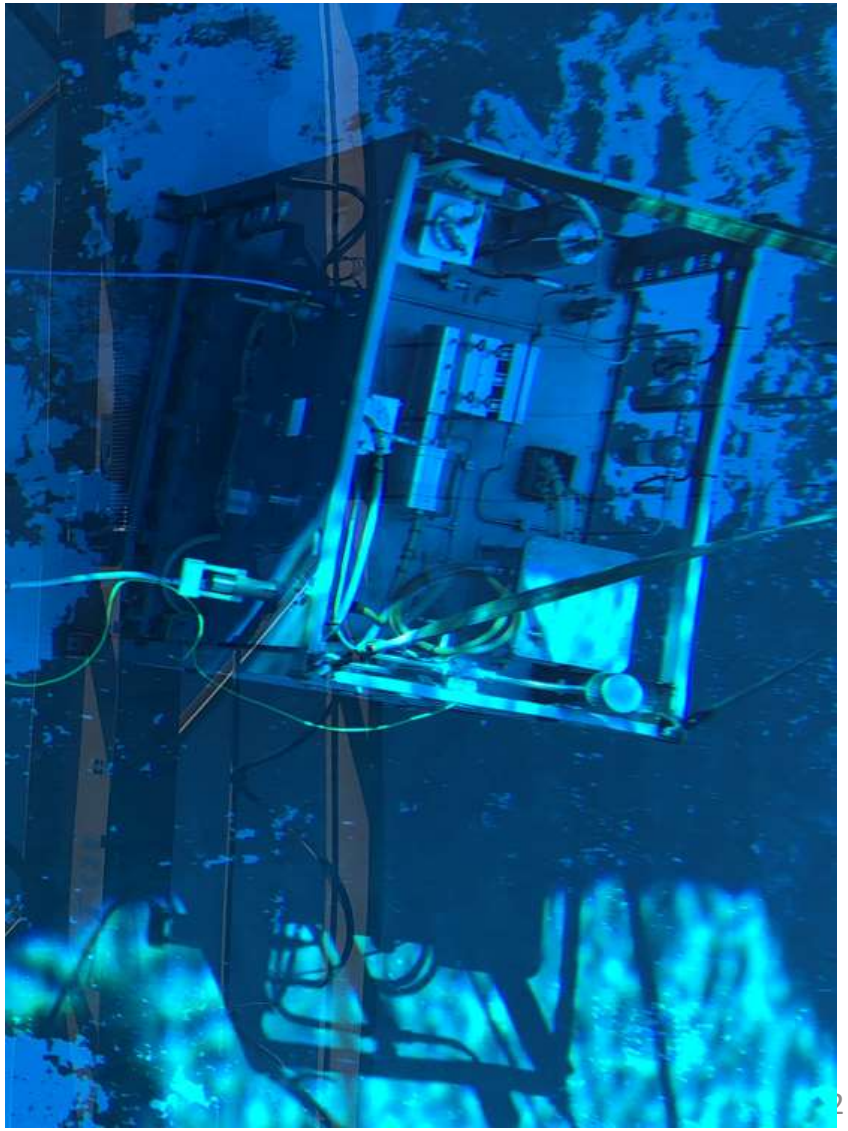
| No. | Task | Complete (Initial) |
|---|---|---|
| | Minimize access to the test area and ensure that all non-essential personnel are outside the designated work/testing area. | BP |
| | Only qualified personnel who have completed and signed the JSA are allowed in the test area. | BP |
| 1. | Ensure that all personnel within the test area have read and signed the required JSA prior to testing. Complete the below information:<br>Test Date (mm/dd/yyyy): 11-10-12<br>Performed by (name/signature): Don Pharr / DPharr<br>Witnessed by (name/signature): Ben Alexander B. Alexander | BP |
| 2. | Verify all electrical connections are made per Interconnect Drawing 17064-1521303. | BP |

**Table 26 - Low Pressure Test for Process Tubing**

| Test | Hold Duration | Start Time | End Time | Start Pressure | End Pressure | Pass/Fail | Name/Date/Signature |
|---|---|---|---|---|---|---|---|
| LP #1 | 3 minutes | 9:55 | 9:58 | 97 PSI | 97 PSI | PASS | Don Pharr 11-16-21 DPharr |
| | 15 minutes | 10:03 | 10:18 | 93 psi | 93 psi | PASS | B. Alexander 11-16-21 B. Alexander |
| LP #2 | 3 minutes | 10:38 | 10:41 | 106 psi | 106 psi | PASS | B. Alexander 11-16-21 |
| | 15 minutes | 10:50 | 11:05 | 99. PSI | 102 PSI | PASS | Don Pharr 11-16-21 |

# Agenda

| | | | |
|---|---|---|---|
| **2:00 PM - 2:10 PM** | 10 | **Introductions,**<br>**Mtg particapnts, affiliation & area of expertise** | Mtg participants |
| **2:10 PM - 2:15 PM** | 5 | **Safety moment & agenda review** | SSS - Art Schroeder |
| **2:15 PM - 2:30 PM** | 15 | **Project overview**<br>o Background & objective<br>o Project schedule, structure & particpants<br>o Progress **- FAT of Process Module complete** | SSS - Art Schroeder |
| **2:30 PM - 2:40 PM** | 10 | **Discussion / Comments**<br>o DOE<br>o BSEE<br>o Others | DOE FPM - Dave Cercone<br>BSEE - Minatte Matta |
| **2:40 PM - 2:50 PM** | 10 | **Next Steps**<br>o Skid Fame & Storage Tank assembly<br>o Systems Integration Test (SIT), 2021Q1<br>o Offshore demonstration, 2022Q3/4 | SSS - Art Schroeder |
| **2:50 PM - 3:00 PM** | 10 | **Discussion / Comments**<br>o DOE<br>o BSEE<br>o Others | open |
| **3:00 PM - 3:00 PM** | 0 | **Adjourn** | All |



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Post OTC 'Customer day' was well attended

# Next steps, fabricate new frame & install existing tank



Post OTC ‘Customer day’ was well attended

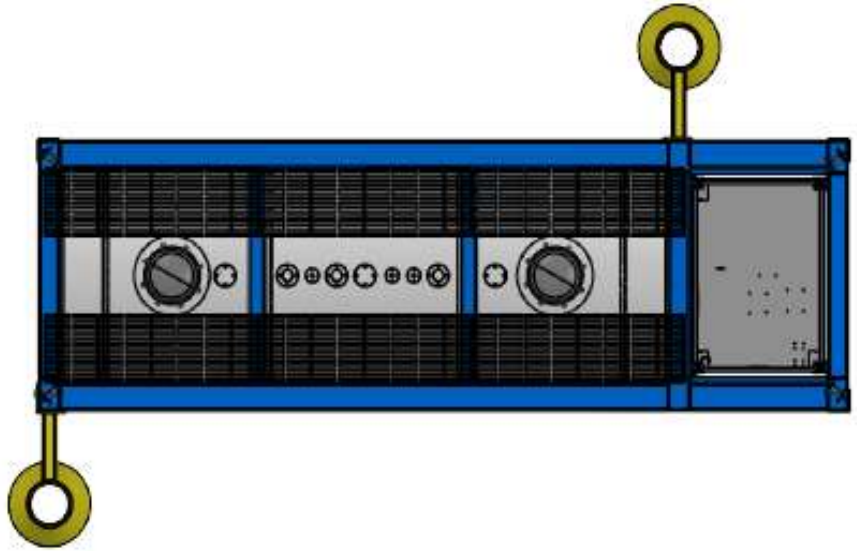
# Next steps, fabricate new frame & install existing tank

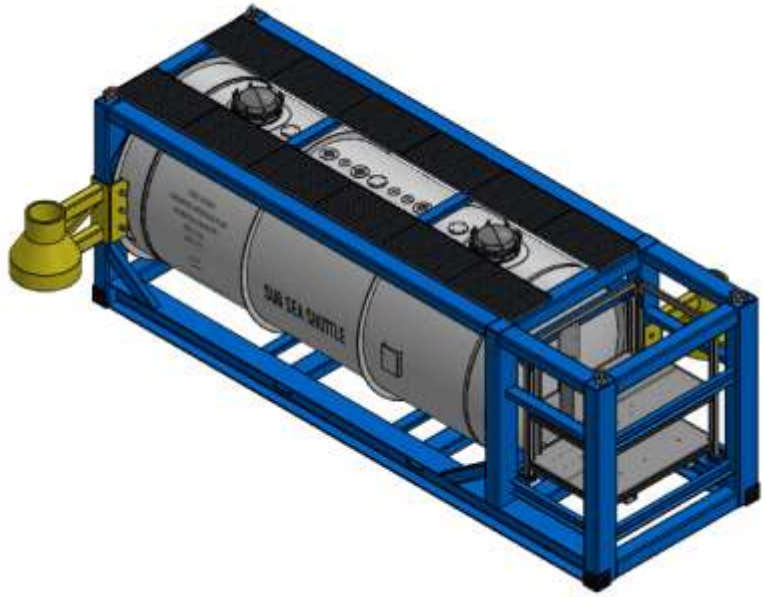


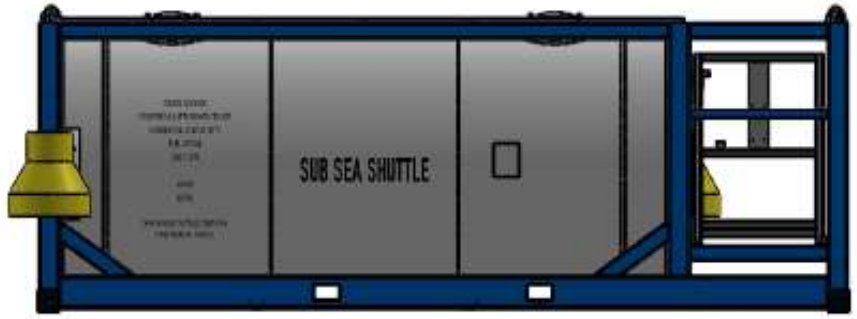
Outer steel shell tank with bladder inside, shown filling anulus with water

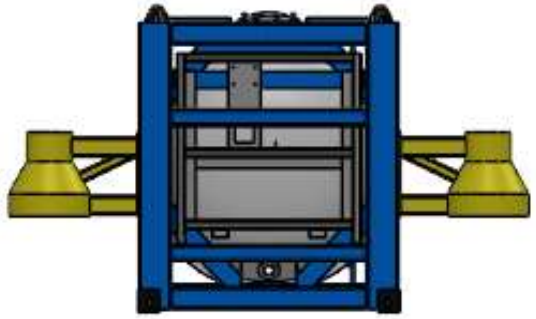
‘Customer review day’ was well attended

# Next steps, fabricate new frame & install existing tank







**FRAME:** API 2 CCU standard + for through water column transit: DNV 2.7-3

**TANK:** IMDG section 6.7.2 (T11)

# Next steps,  System Integration Test (SIT)

Subsea Shuttle, LLC
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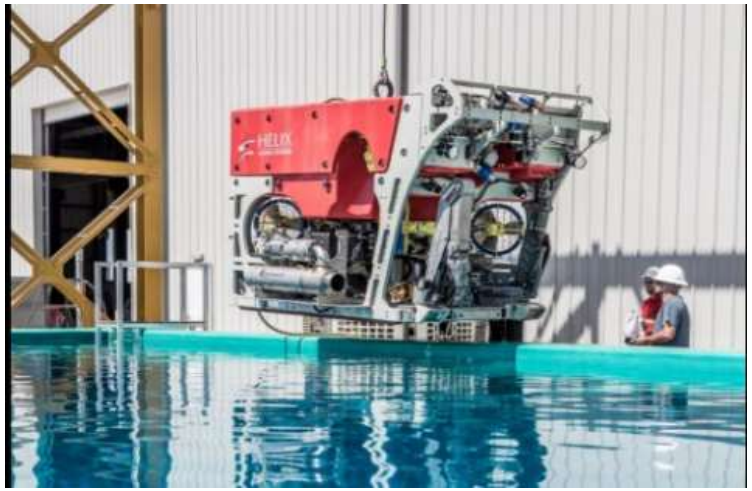
## Test Tank Facilities

- 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



# Offshore demonstration (Phase II)

Subsea Shuttle, LLC
Production chemicals, delivered subsea as a service™

**Subtask 8.1 – Detailed site-specific planning activities**

SSS will plan and coordinate with all stakeholder groups to ensure a safe, regulatory compliant and successful demonstration. Offshore planning activities include:

- Site specific planning including acquisition and fabrication of any site-specific equipment, e.g. seafloor foundation, Umbilical Termination Assembly (UTA), topside (host) power and communication control integration.
- Preparing operational plans regarding specific marine vessel interface requirements, mobilization to quayside, chemical purchase and filling the Integrated Unit, specifying and contracting the marine vessel for installation services,
- Providing oil company with data and information to support the BSEE required Deepwater Operational Plan (DWOP)

**Subtask 8.2 – Acquisition and fabrication of site-specific components**; i.e., the seafloor foundation for the Integrated Unit, flying leads and components for control and power tie-ins to the operator's existing equipment.

**Subtask 8.3 – Offshore deployment, operation and Integrated Unit recovery**

SSS will coordinate efforts among offshore operator, the marine contractor, and BSEE so that deployment and retrieval is conducted safely, and according to regulations.

**Subtask 8.4 – Onshore post-demo inspection and review and Integrated Unit decommissioning**

2-minute animation @
https://www.linkedin.com/posts/artjschroeder_subsea-innovation-offshore-activity-6687433705331544064-g6_V

# Offshore demonstration

- Do you currently have (or anticipate) clogged and/or ‘under-tubed’ umbilicals?
- Are long distance tie-backs part of your future?
- Are you interested in lowering your umbilical costs on greenfields?
- Are you interested in reducing host platform space & weight requirements (equipment, chemical and riser load)?
  - New-builds
  - Brownfield host platform, free up space to allow for additional equipment, de-bottlenecking, tie-in of additional wells
- Eliminating hazardous chemical interaction with personnel on platform by moving to sea floor?

**SSS to provide**:

- Details of Unit specs and onshore testing
- Assist in operator regulatory filings
- Deliver SIT qualified Unit including PRCM (controls unit)
- Foundation design

**Oil company to provide:**

- Fit for purpose review of Unit
- Offshore site for demo
- Load-out, marine transportation, deployment & recovery of Unit & foundation
- Tie-ins, subsea and PRCM in control room

# Agenda

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# 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 ‘de-manning’

- Subject equipment;
  - Cost effective modular design ‘design one, build many’ philosophy
  - Common Off The Shelf (COTS) components where possible
  - Full scale prototype being built
  - SIT 2022Q1
  - Offshore deployment 2022Q3/4