Subsea Shuttle ®

Fluids & facilities, delivered and operated as a service

Subsea Shuttle, LLC

Overview of technology and progress

PoC: Art Schroeder; Art@SubseaShuttle.com



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.”

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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')

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New solution for subsea well chemical delivery

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Old school - umbilical

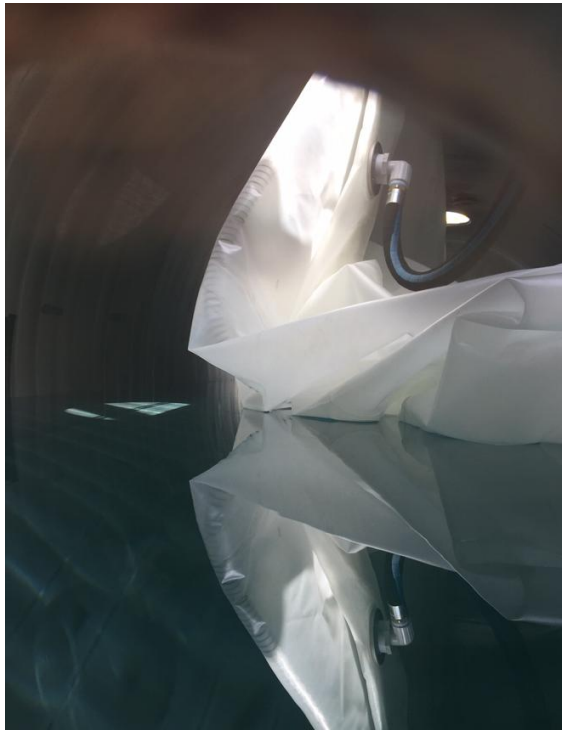
- Logistical issues, high-cost, long lead
- Chemical stored on platform (PPE concerns)
- Umbilical tubes - subject to plugging, corrosion, crimping, etc.
- **Costly recovery at end of field life**



SSS solution

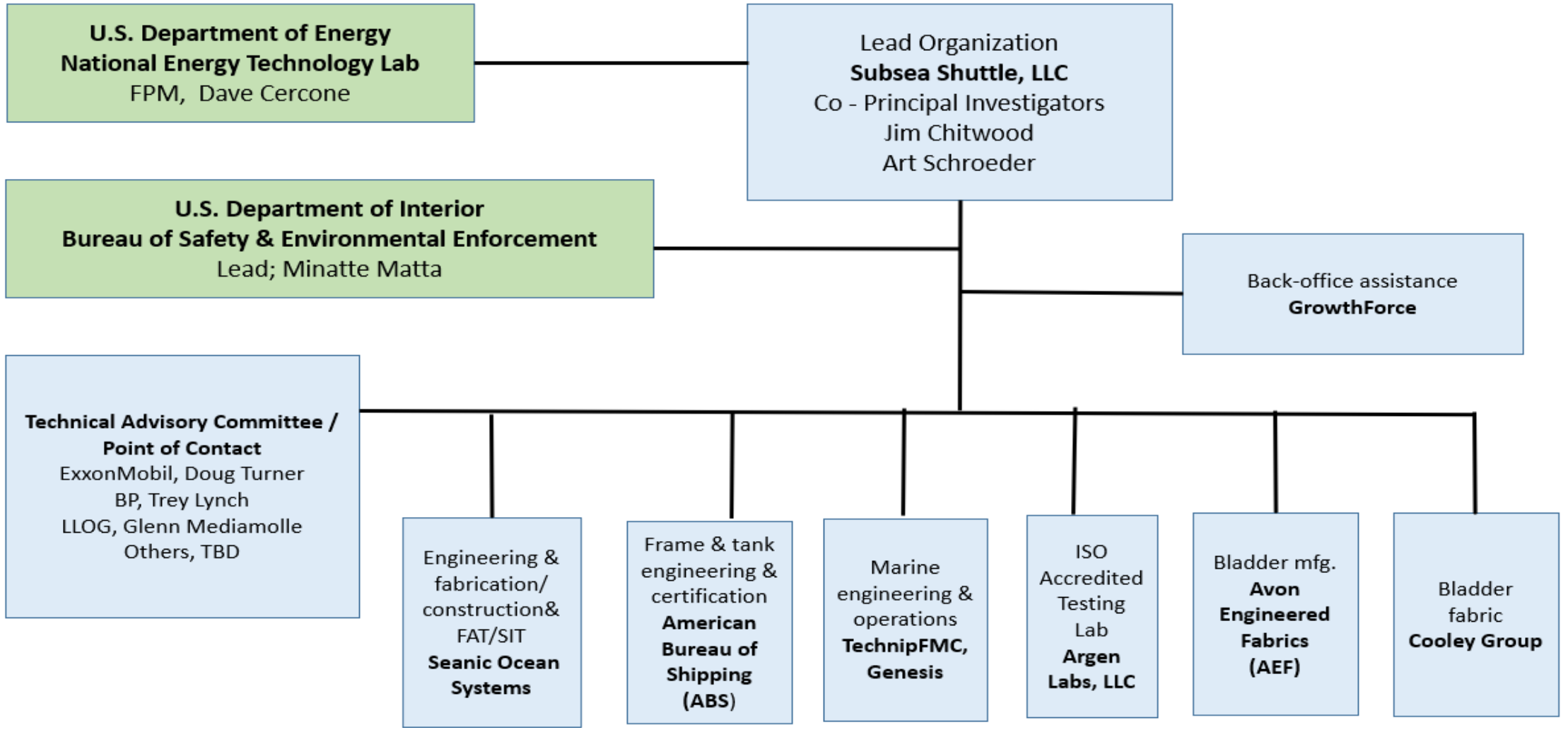
- Enables long-distance subsea tie-backs
- Enhances (cut costs)
- Removes host personnel exposure to chemicals
- Standard marine ops, deploy & exchange-out
- Over the road 'truck-able' ISO frame
- **Production chemicals - delivered to oil company as a service** (vs. oil company capex)





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Participants



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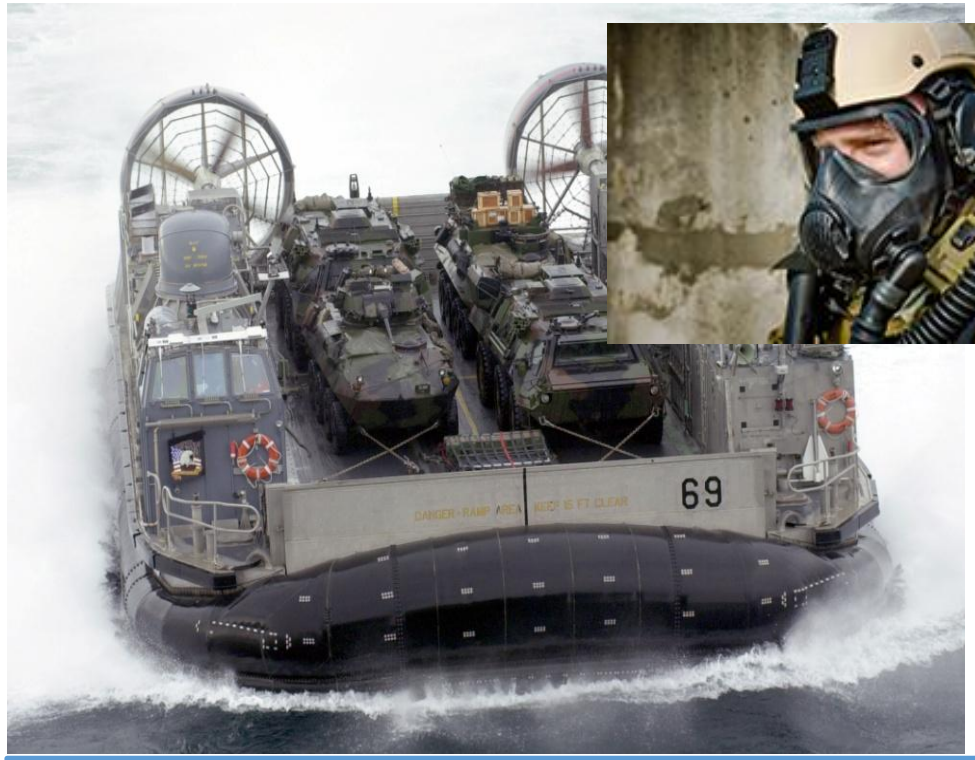
Functional Design Specs

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Component	Description	Reference/standard
Overall system	• Pat'd dual barrier chemical containment • Qualified to 10,000 fsw / 10-year design life	Meets rqmts of hazardous environment IMDG
Frame	• 25' x 8' x 8.5'(tall) • Weight: 7 S. Tons tare 30 S. Tons (w/ payload)	API 2 CCU standard IMDG T11, ADR/RID & DOT DnV 2.7-3 hydro-dynamic
Storage tank	• 120 bbl • Working pressure: 4 BAR (58 psi) • External collapse: 10 psi	ASME, Sect VIII Div. 1
Bladder	• 120 bbl • Compatible with most std production chemicals	Mil spec MIL-PRF-32233 3rd party performance tstg
Pump	• Proven onshore triplex pump, modified • 84 gpd of chemical @ DP up to 15,000 psi. • Electric driven, variable speed controlled	Custom, base on API RP 14 C
Valves & actuators	• Electric motor valve actuators, w/ battery back-up. • Smart Batteries for fail-to-close position	Safety Integrity Level (SIL)2 per IEC 61508
Controls & sensor	• Electronics; 1 Atmosphere cans (3)	API RP 17 F compliant & various IEEE
Piping	• Various sizes, SS w/ Swagelok fittings • Flexible flying leads, rated to 20ksi	API RP-1111 section 2.1.7 (c) Welding: API Specification 17D

Engineered fabric; 1000's of uses over decades

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

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Production chemicals; testing and 3rd party qualification

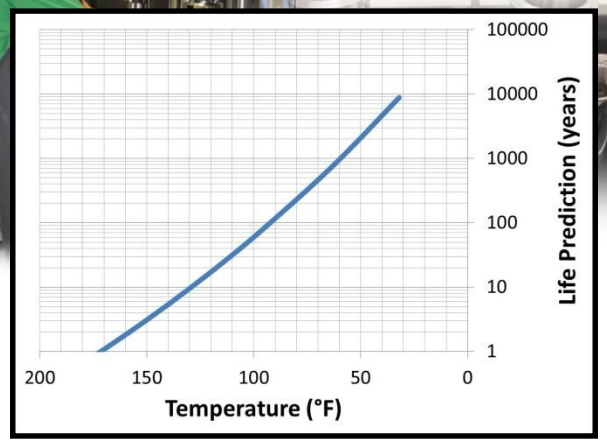
Subsea Shuttle®
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- Long-Term Aging Testing
  - Test Temperature(s): Wide range, 3 temperatures
  - Test Duration: 60 days
  - Test Fluids: Various
  - Test Pressure: 4400 psi
  - Testing: Triplicate + samples

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



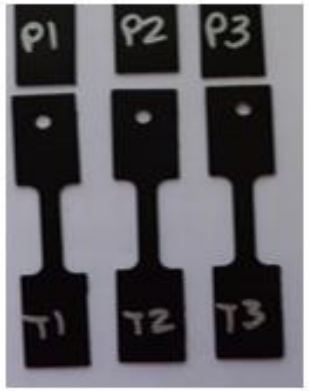


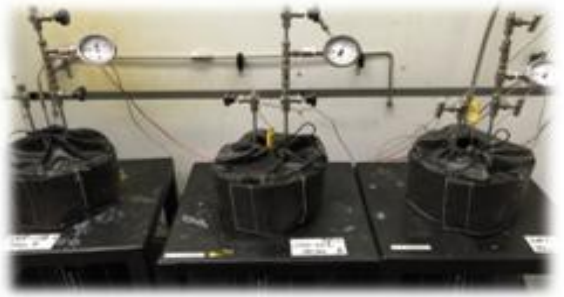
Chemical/fabric qualification:

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

Logistics of Testing

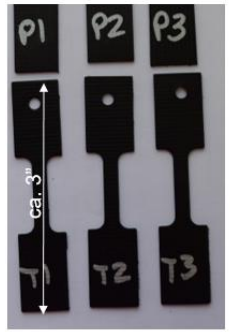
Prepare Specimens → Age in Fluid → Test Mechanical & Physical Properties



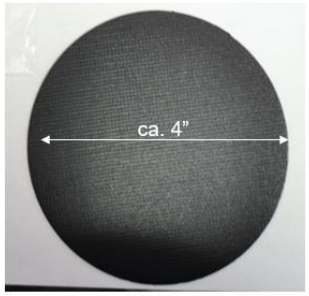




Uniaxial Tensile
Two Orientations
ASTM D1708



Puncture
ASTM D751



Seam (Shear)
Custom Method



Trapezoidal Tear
ASTM D751



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Scale storage system test and optimize





Earlier test results

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

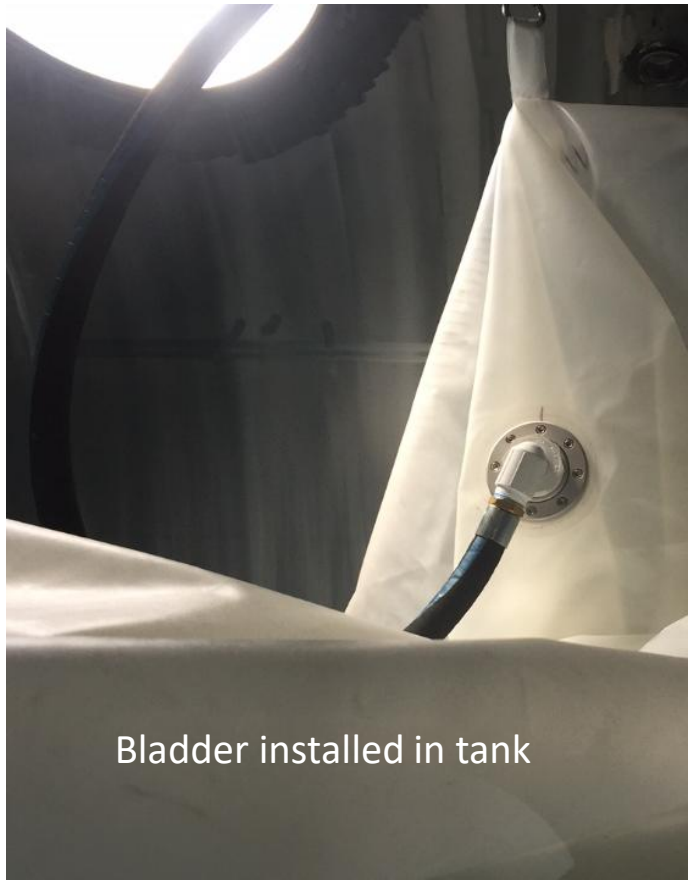




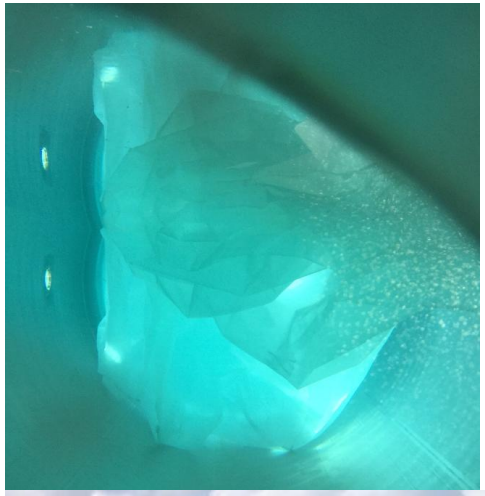
Over 30 SME participants + regulators witnessed model test / demonstration

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Tank/bladder performance testing



Bladder installed in tank



Bladder in tank, filing



Test tank; full scale but w/o process module

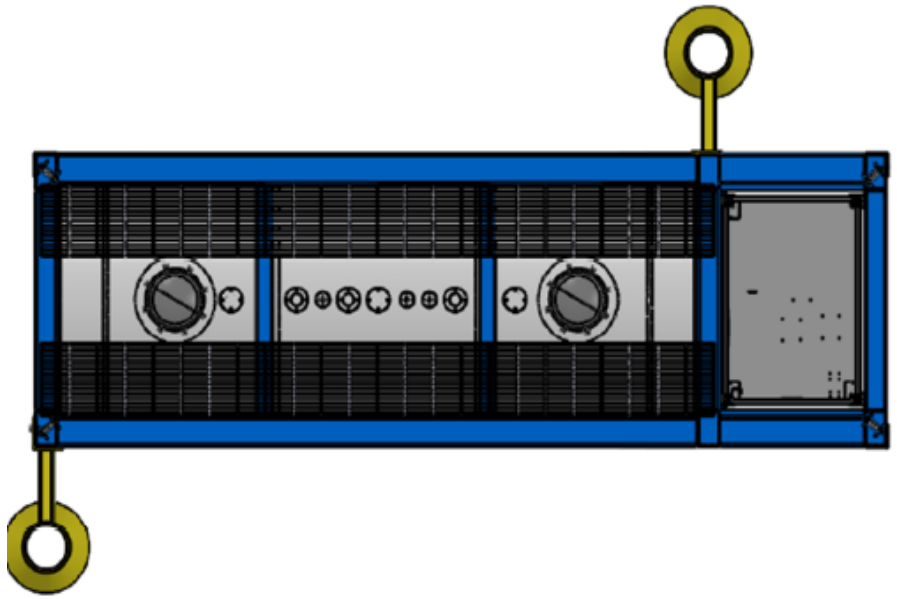


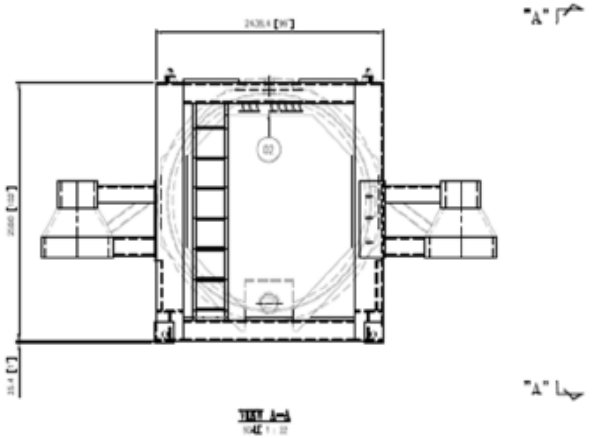
Installing bladder in tank,
Subsequently perfected methodology fo installing w/o manned entry

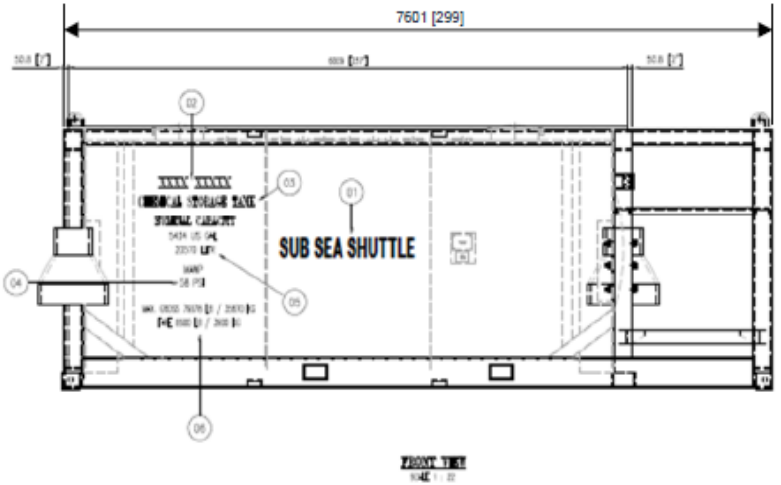
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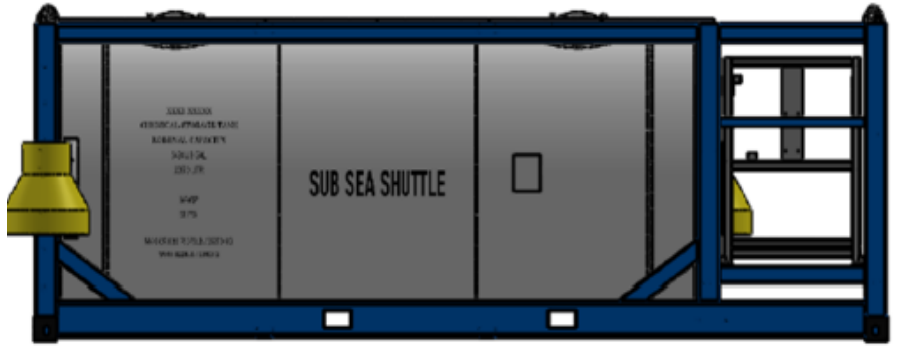
Chemical Storage & Injection Unit

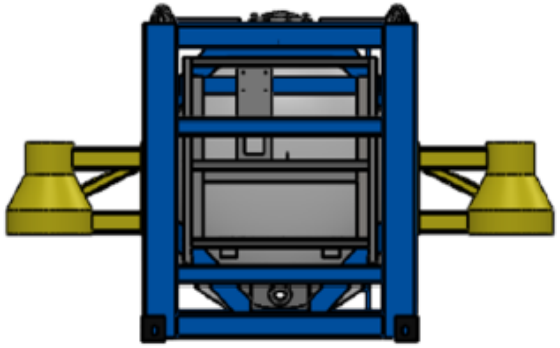
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CSIU Details

- 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)

Technical approach, qualification process – Inspection & Test Quality Plan (ITP)

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Project Name:	100 BBL Chemical Injection	**Project Number (PN):**	19-17064	**Customer:**	SSS
Seanic Document No:	17064-1513068	**Revision:**	AA	**Project / P.O. Number:**	Contract
Customer Doc No:	N/A	**Revision:**	N/A	**P.O. Issue Date:**	April 20, 2020
Manufacturer Name:	Seanic Ocean Systems	**Description:**	System Level Inspection & Test Plan		

Activity	Description	Quality Related Activity	Reference Document	Acceptance Criteria	Verifying Document	Activity Requirements		
						Supplier	Seanic	SSS
1.	Design Verification	Design Review	General Assembly Drawings	API 2 CCU FDS	Preliminary Conceptual Drawings & Functional Design Specifications	N/A	A, H, V, R	A, AR, R, H
2.	Design Analysis / Calculation Package	Submission of Design Analysis Package	FDS	API 2 CCU ASME BPVC Section VIII Div. 1	Structural Analysis ABSG-SG20-SSS-PM-RPT-0001 ABSG-SG20-SSS-PM-RPT-0002 Process Module Calculations 17064-1517467 ABS Class Approval	DR	DR	AR, V
3.	Factory Acceptance Test Procedure (FAT)	Submission of Factory Acceptance Test Procedure	FAT's	FAT Procedure	Signed FAT's	N/A	A, DR	R, AR
4.	System Integration Test Procedure	Submission of System Integration Test Procedure	SIT's	SIT Procedure	Signed SIT	N/A	A, DR	R, AR
5.	Material Acquisition	Verification of Materials Against Certification	MTR's	Seanic Country of Origin List Detail Drawings	Approved MTR's	AR, H, R, T/C,	AR, DR, R	M

Activity Codes:	**AR:** Approval Required	**R**: Review of documentation	**H:** Hold Point	**M**: Monitor	**T/C:** Test Certificate Required	**W**: Witness Inspection
	DR: Documentation Required	**N/A** Not Applicable	**P:** Procedure Review	**V:** Verify	**A:** Activity Required	**S:** Surveillance

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Control system - actuator

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Functional Specs

- Based on API 17H Class 2 torque tool
- 10,000 fsw
- 250 FT-LBS torque
- ‘Spring-less’ w/’smart battery back-up for specified fail to safe position positioning & monitoring

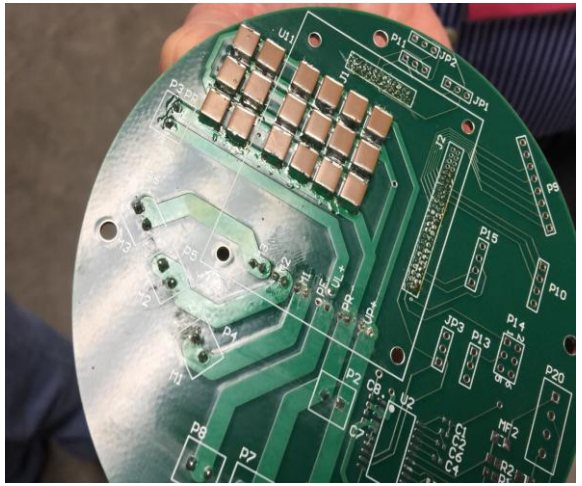
Motor and Gearbox specs:

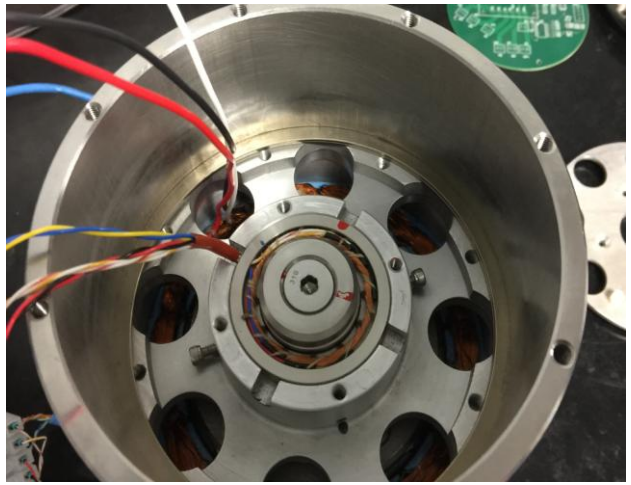
- 3 phase brushless DC motor
- 10 RPM max speed at torque
- 48,640 points/revolution

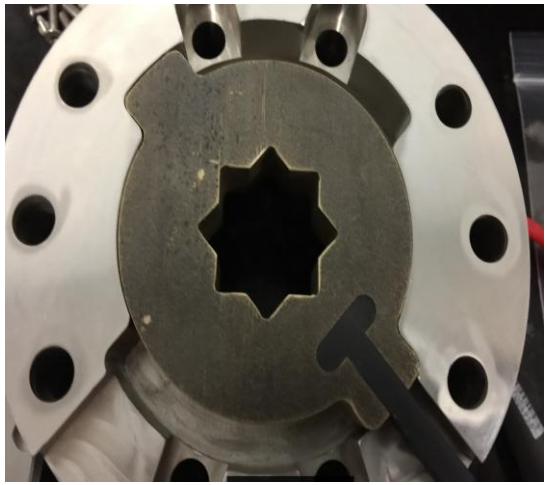
Motor controller:

- Serial communications
- Water alarm
- Position limiting
- Torque profiling (valve health & functionality monitoring)
- Ramping functions









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Control system - actuator

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Qualification testing

- Full FMECA process
- Comprehensive Functional Design Specs
- 8 step full function test
- 2,000,000 revolutions
- Hyperbaric testing of assembly w/valve
- Full documentation



Test #	Test	Objective
1.	Measure torque output of actuator at different current levels.	Verify actuator is capable of achieving torque required to open ball valve.[1]
2.	Actuate motor in 15 degree increments one full revolution in CW and CCW directions.	Verify motor is capable of moving to a commanded position as would be required in a multi turn valve.[2]
3.	Spin actuator motor 500,000 revolutions CW and CCW in water.	Verify motor is capable of minimum 1,000,000 total revolutions with no appreciable wear. Verify no short circuits in electrical system or heat issues.[2]
4.	Actuate motor against hard stops 200 times at peak torque for 3 seconds CW and CCW in water.	Verify mechanical assembly and motor are capable of repeating peak hold torque with no loss in output or mechanical degradation. Verify no short circuits in electrical system or heat issues.[3]
5.	Spin actuator motor 500,000 revolutions CW and CCW under 5,000 psi external water pressure (10,000 fsw equivalent).	Verify motor is capable of minimum 1,000,000 total revolutions with no appreciable wear while under external water pressure. Verify no short circuits in electrical system or heat issues.[2]
6.	Actuate motor against hard stops 200 times at peak torque for 3 seconds CW and CCW under 5,000 psi external water pressure (10,000 fsw equivalent).	Verify mechanical assembly and motor are capable of repeating peak hold torque with no loss in output or mechanical degradation while under external water pressure. Verify no short circuits in electrical system or heat issues.[3]
7.	Interface actuator with 1.5" AE MP Subsea Ball Valve and rotate under differential valve pressure.	Verify actuator is capable of interfacing with and rotating ball valve with 10,000 psi differential across ball.[14]
8.	Measure torque output of actuator at different current levels.	Verify actuator is capable of achieving torque within 5% of Test #1.[1]

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Chemical injection pump, FMECA

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FMECA tool used to drive ITP (Inspection, Test & Qualification Plan

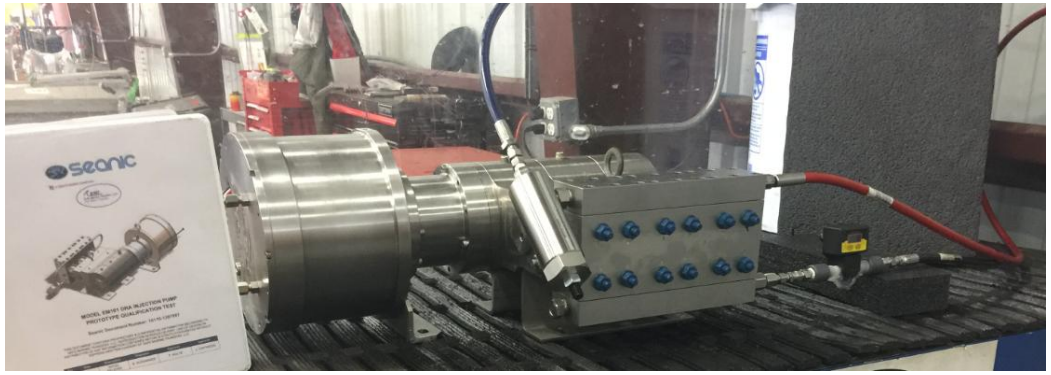
	A-Unlikely	B-Remote	C - Occasional	D-Frequent	E - Very Frequent
1 - Minor	0	0	0	0	0
2 - Low	0	1	0	0	0
3 - Moderate	34	2	2	0	0
4 - High	32	14	8	0	0
5 - Very High	94	10	6	0	0

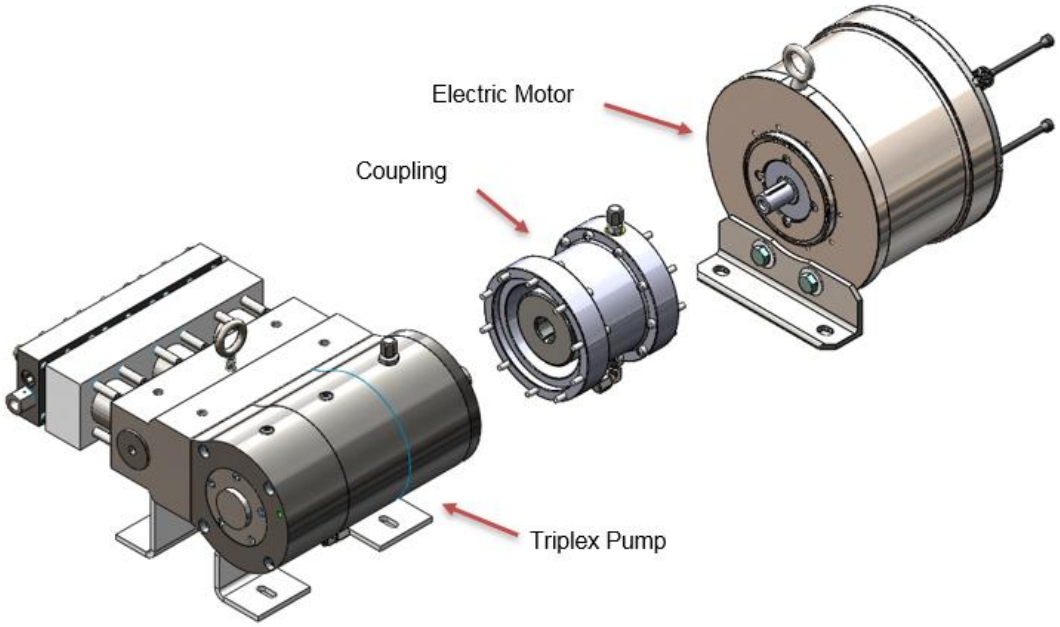
The starting premise for the Pump and Drive Assembly is that the design cycle has included and resolved common (individual) pump and drive related issues at the separate manufacturers. This includes, material compatibility,

Identifier		Potential Failure Mode (error state)	Potential Effect(s) of Failure	Potential Cause(s) of Failure	Current Design		Criticality (FMECA		
					Current Design Controls (Prevention)	Current Design Controls (Detection)	Consequence / Severity	Probability / Frequency	Risk Category
1.00	Marinized CheckPoint plunger-type pump with variable speed drive								
1.10	See item 1.00	Flow paths blocked	Feedback information to user limited	Monitoring system fails, resulting in degraded understanding of remaining pump life	1. Use of high TRL subsea instrumentation and connectors 2. Specification of equipment appropriately rated to conditions	1. Hyperbaric pump test to evaluate pump, motors and controls as a working system 2. Underwater pump test at low hydrostatic pressure to test for pump life	3	B	3B
1.11	See item 1.00	Test and Measure Performance Curves for pump, drive and control assembly	Determine and document the turndown and max rates of pump assembly	Establish baseline operations for pump assembly against which future performance may be trended.	Validate the pump assembly meets the functional and performance specifications	Modify the assembly design or change its functional spec to meet the overall performance objectives.	2	B	2B
2.00	Marinized CheckPoint plunger-type pump with variable speed drive								

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Chemical injection system, testing





Injection Pump Qualification Test

32-page qualification document & 7 different test procedures;

1) Pump valve test – 29 step

2) Hydrostatic proof test – 17 step

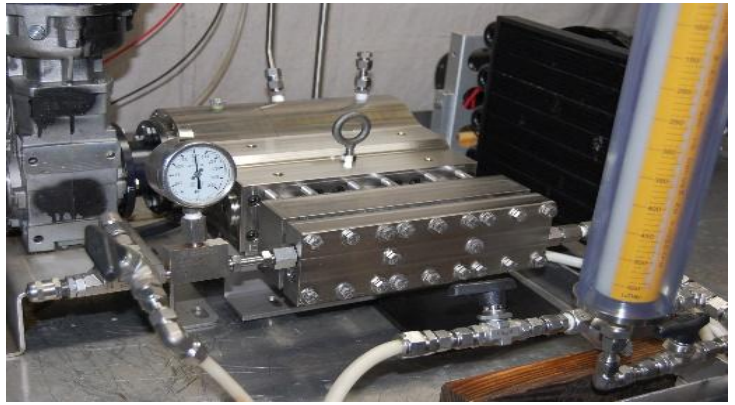
3) Chemical end valves – 16 step

4) Pump wear test – 23 step (100k cycle test/inspect)

5) Pump suction test

6) Test post-wear - 18 step

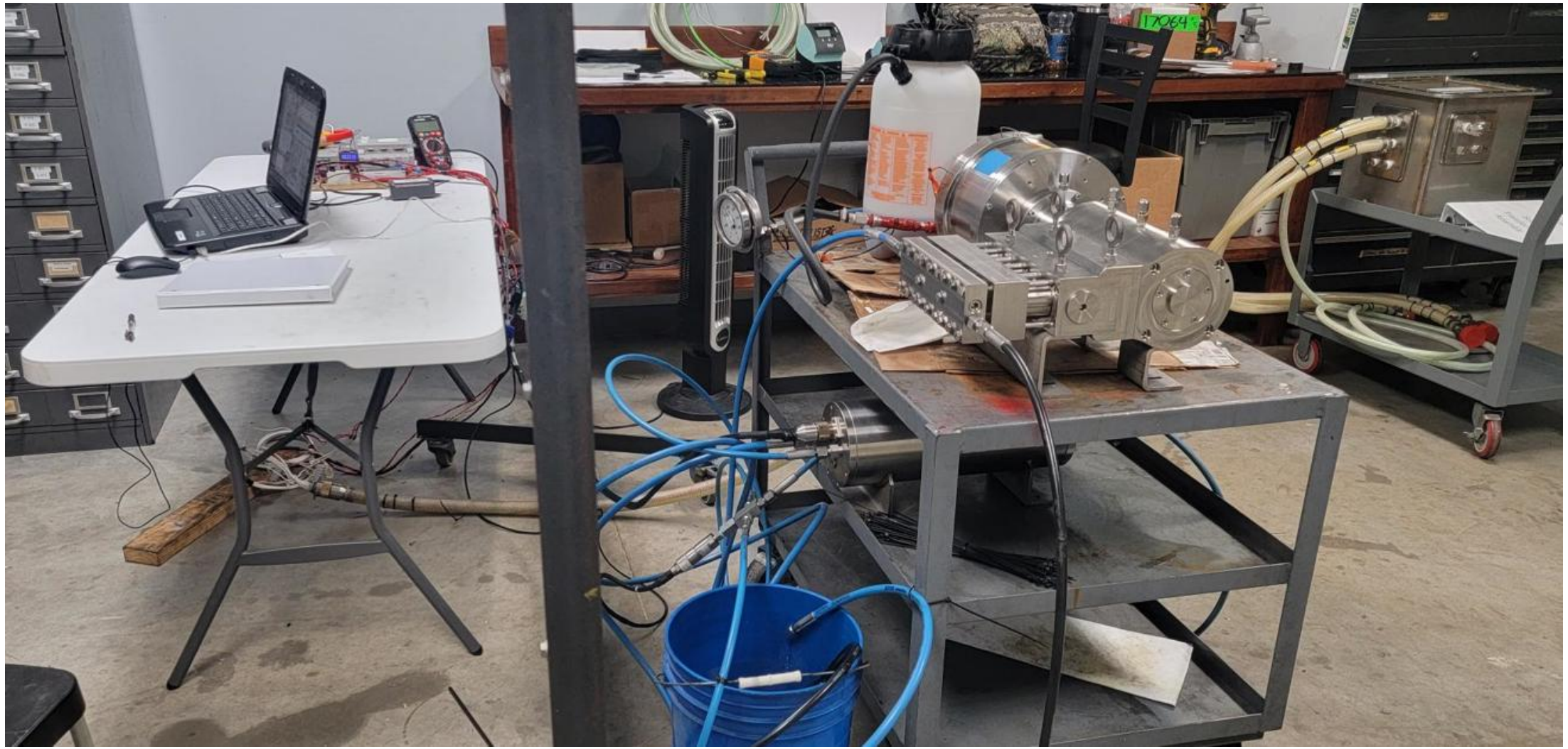
7) Assemble test to 1 m revs



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FAT, pump and meter

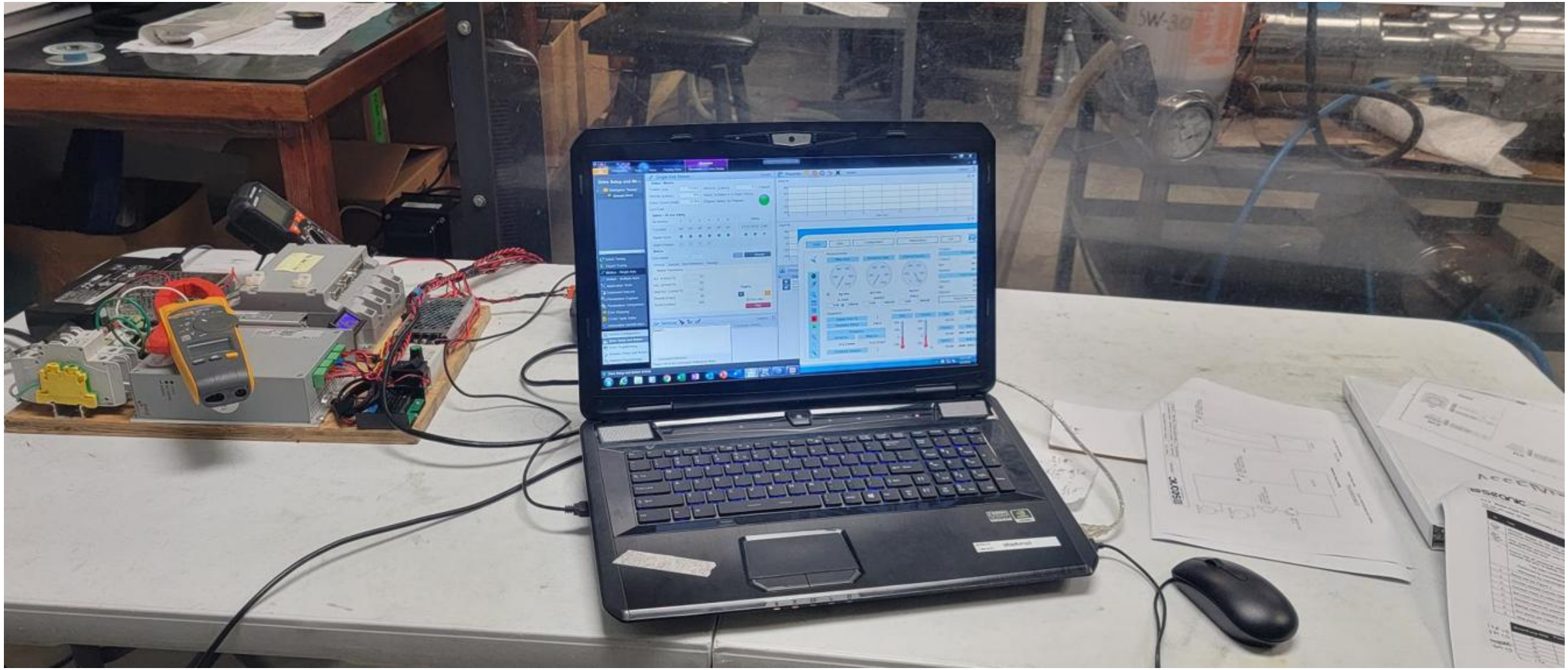
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FAT, pump and meter

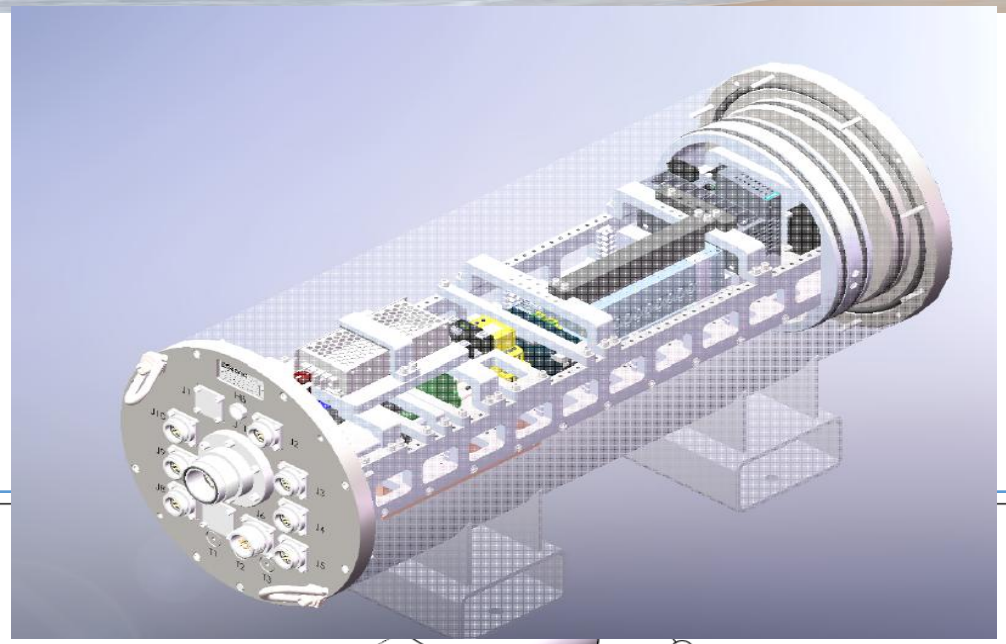
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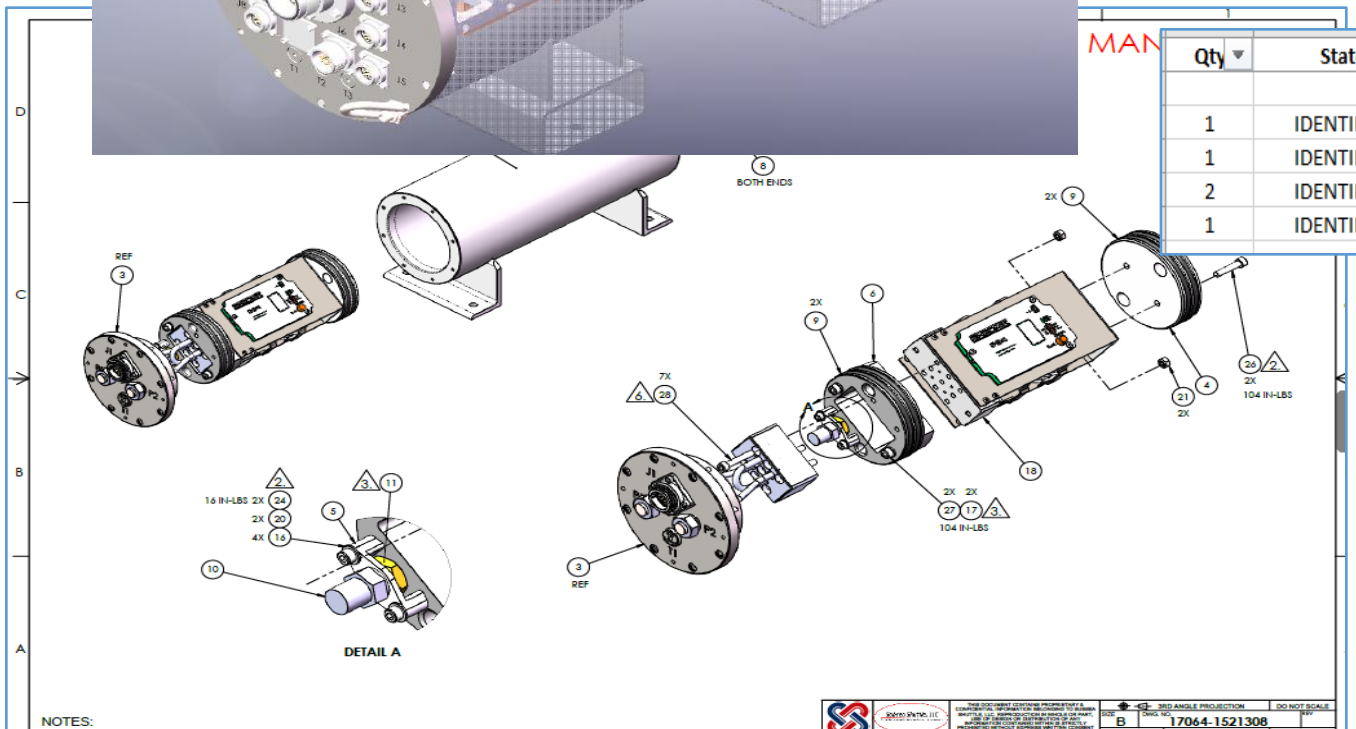
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Subsea electronics assembly

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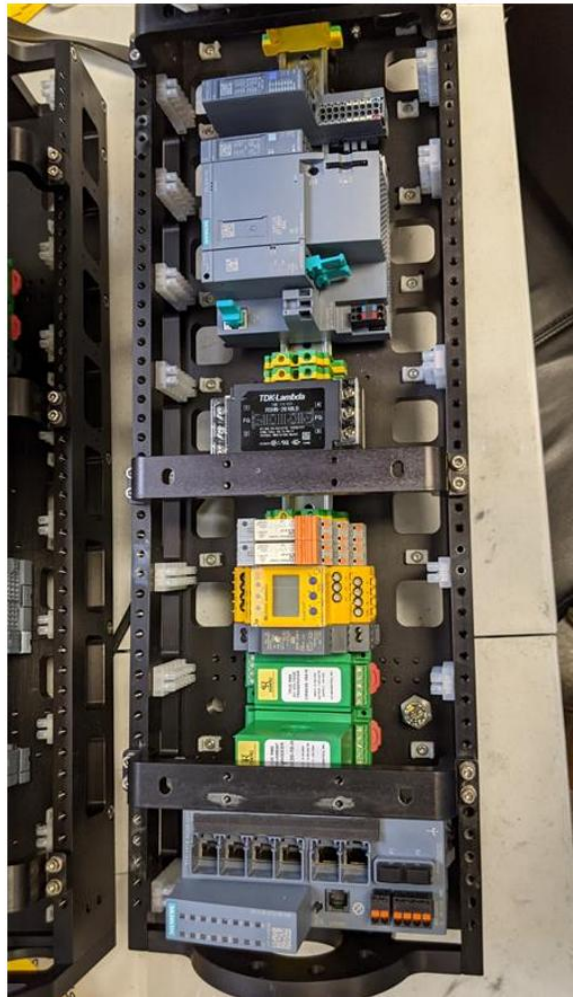
Qty	State	Item	Manufacturer	Part Number	Lead
		MOTOR RTU			
1	PENDING NRE	Endcap(Front)	Machine Shop	17064-1523157	
1	PENDING NRE	Endcap(Back)	Machine Shop	17064-	
1	PENDING NRE	Vessel Housing	Machine Shop	17064-1523144	
1	IDENTIFIED	MSSM4#8FCRPBOFHV,2M 3000V PIGTAILS POTTED	Seacon	TBD	
7	IDENTIFIED	MINM12FCRLPBOF-HP POTTED W/2M FT TAILS	Seacon	TBD	
1	IDENTIFIED	MINO16B(4#10,12#22)CCPL-PBHP	Seacon	MINO16CCPL-C01	
	PENDING NRE	PLC Components(CPU, Switch. Modules)	Siemens	na	
1	IDENTIFIED	MOTOR POWER SUPPLY	Elmo	ELP-30/120VAC-1P	5 weeks
1	IDENTIFIED	Subsea battery module	SWE	Subsea Direct	12 weeks
1	IDENTIFIED	135VDC Power Supply (PS4)	SynQor	MCOTS-C-28-135-HZ-F-S	10 weeks



Qty	State	Item	Manufacturer	Part Number
		TRANSFORMER HOUSING		
1	IDENTIFIED	Subsea Transformer	Tinitron	MAD-5727-001
1	IDENTIFIED	MINM12(4#16,8#20)CCPL-PBOF-HP	Seacon	MINM12CCPLPBHP
2	IDENTIFIED	MSSCCP,M,4,#8,PBOF, HV 1.00" TUBE OD	Seacon	MSSM4CCPPBOFHV
1	IDENTIFIED	ODI ROV WETMATE	ODI	04ROV-RMP00

1 atmosphere cans hold subsea electronics

Subsea electronics assembly



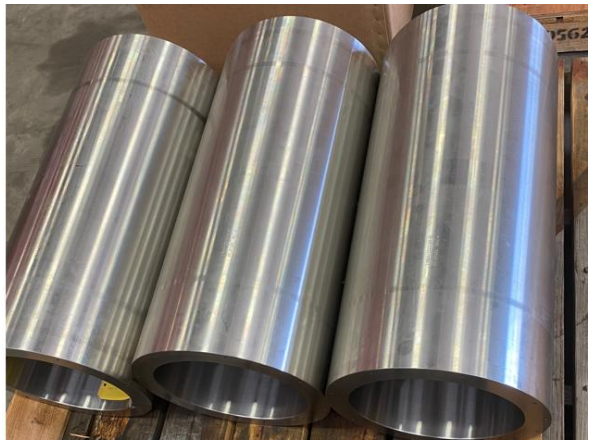


Subsea electronics, currently being wired & tested



Subsea Transformer assembly



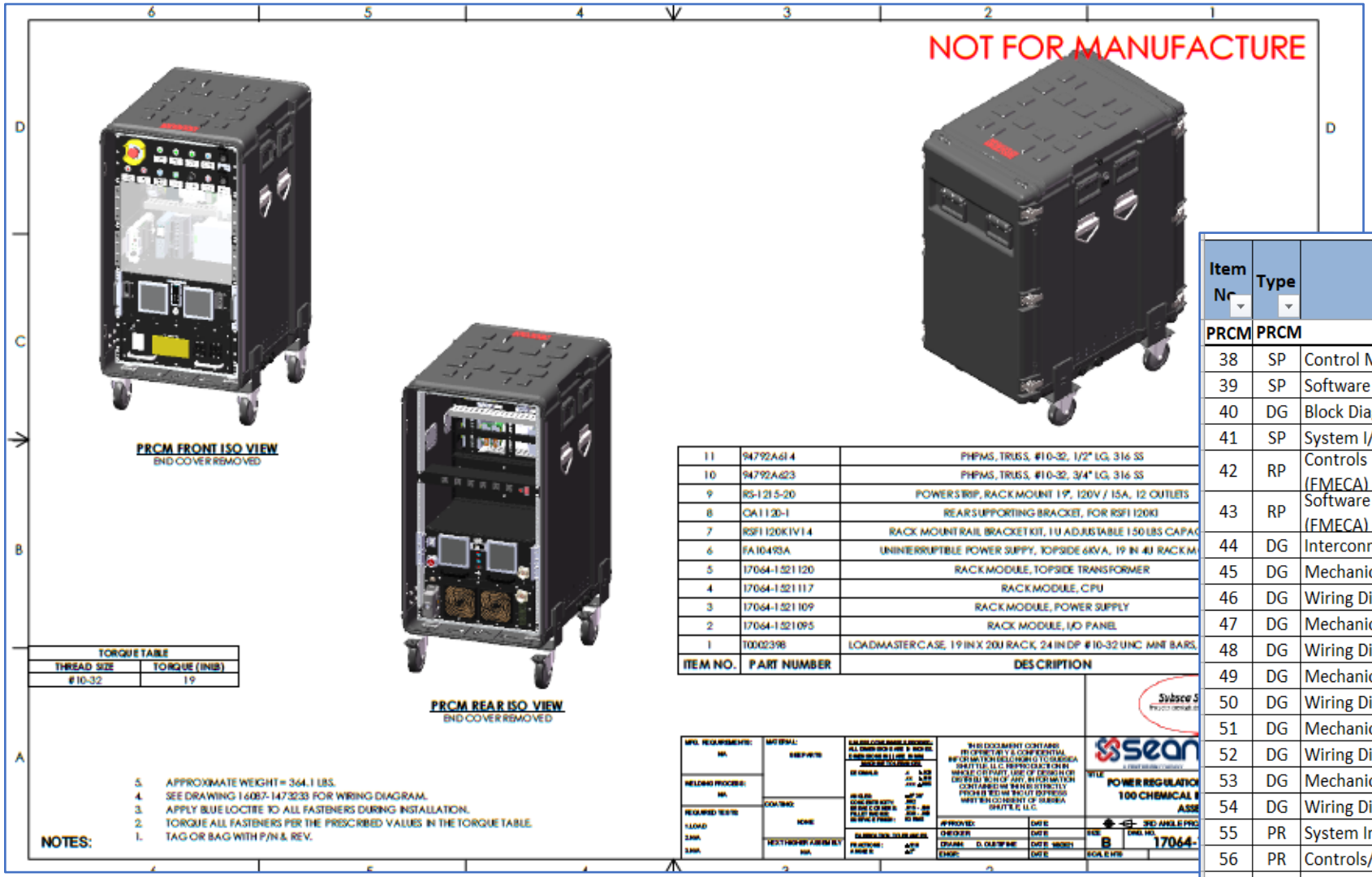


1 atmosphere cans hold subsea electronics

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Next steps, Power Regulation and Control Module (PRCM)

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To be located on host platform

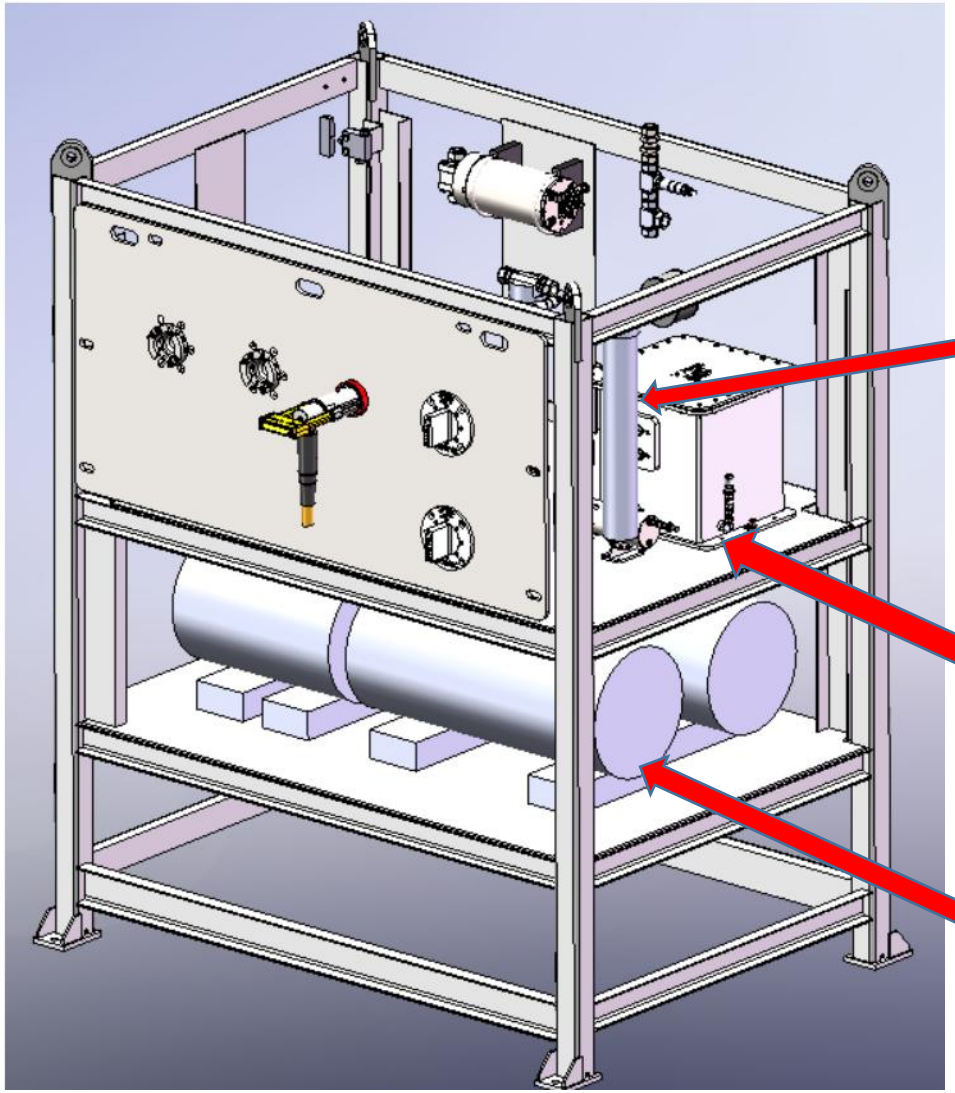
Item No	Type	Description	Seanic Doc #	% Complete
PRCM	PRCM			
38	SP	Control Module Functional Design Specification (FDS)	TBD	95
39	SP	Software Functional Design Specification (FDS)	TBD	90
40	DG	Block Diagram	17064-1521313	95
41	SP	System I/O List	TBD	95
42	RP	Controls Failure Mode, Effects, and Critical Analysis (FMECA)	TBD	95
43	RP	Software Failure Mode, Effects, and Critical Analysis (FMECA)	TBD	95
44	DG	Interconnect Drawing	17064-1521303	95
45	DG	Mechanical Assembly - PRCM	17064-1520870	95
46	DG	Wiring Diagram - PRCM	17064-1520818	95
47	DG	Mechanical Assembly - SCM	17064-1522001	95
48	DG	Wiring Diagram - SCM	17064-1523100	95
49	DG	Mechanical Assembly - I/O RTU	17064-1521557	95
50	DG	Wiring Diagram - I/O RTU	17064-1521543	95
51	DG	Mechanical Assembly - Motor RTU	17064-1523126	95
52	DG	Wiring Diagram - Motor RTU	17064-1523756	95
53	DG	Mechanical Assembly - Subsea Transformer Housing	17064-1520633	95
54	DG	Wiring Diagram - Subsea Transformer Housing	17064-1520802	95
55	PR	System Integration Test (SIT)	TBD	0
56	PR	Controls/Software Operations & Maintenance Manual	TBD	0
57	PR	Control Actions for Operations	17064-1495093	80
58	DG	PRCM General Arrangement Drawing	17064-1520870	95

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Next steps, process equipment assembly

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Process skid





Injection pump testing

Flow meter



Subsea electronics (1 atmosphere pressure cans)

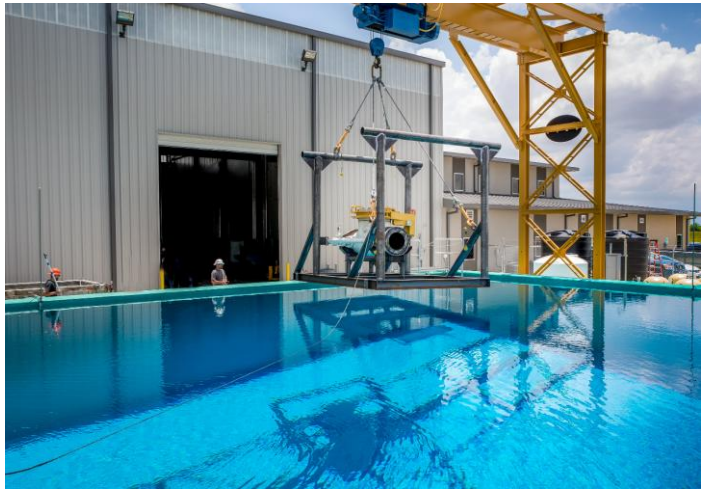
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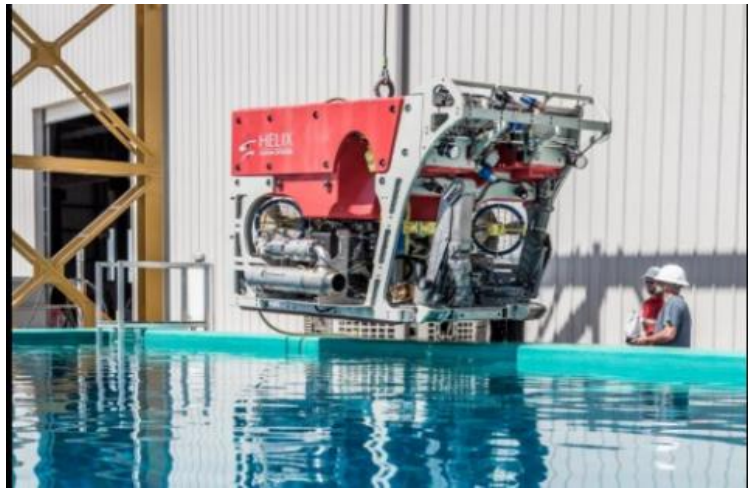
Technical approach, qualification process – System Integration Test (SIT)

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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





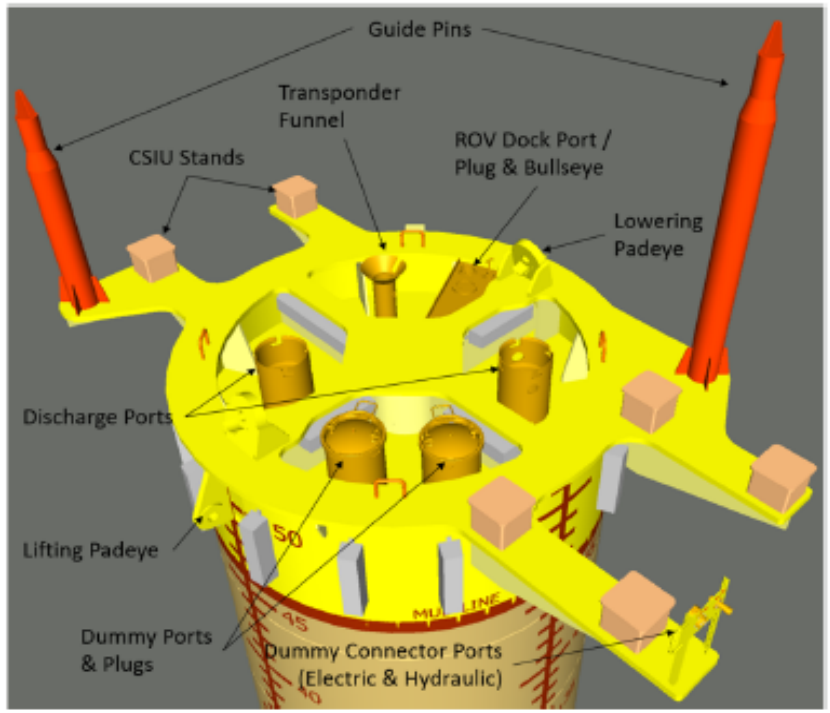


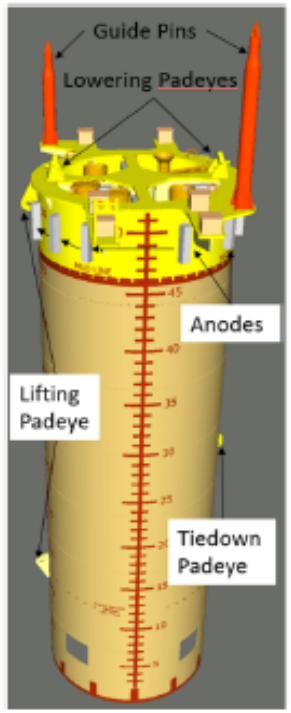


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Progress, foundation design

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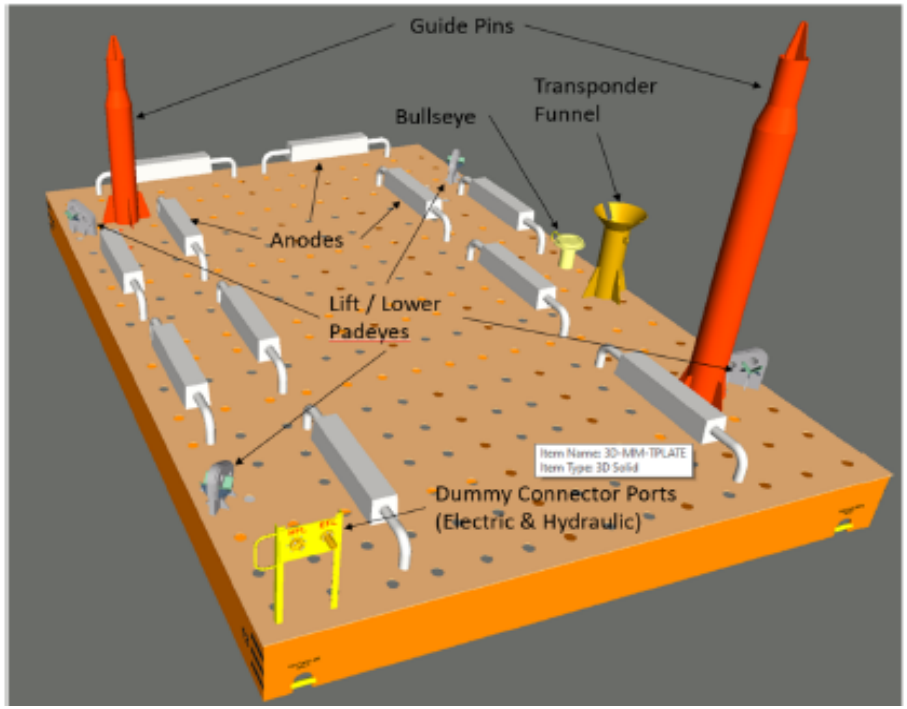


Suction Pile Details

- 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)

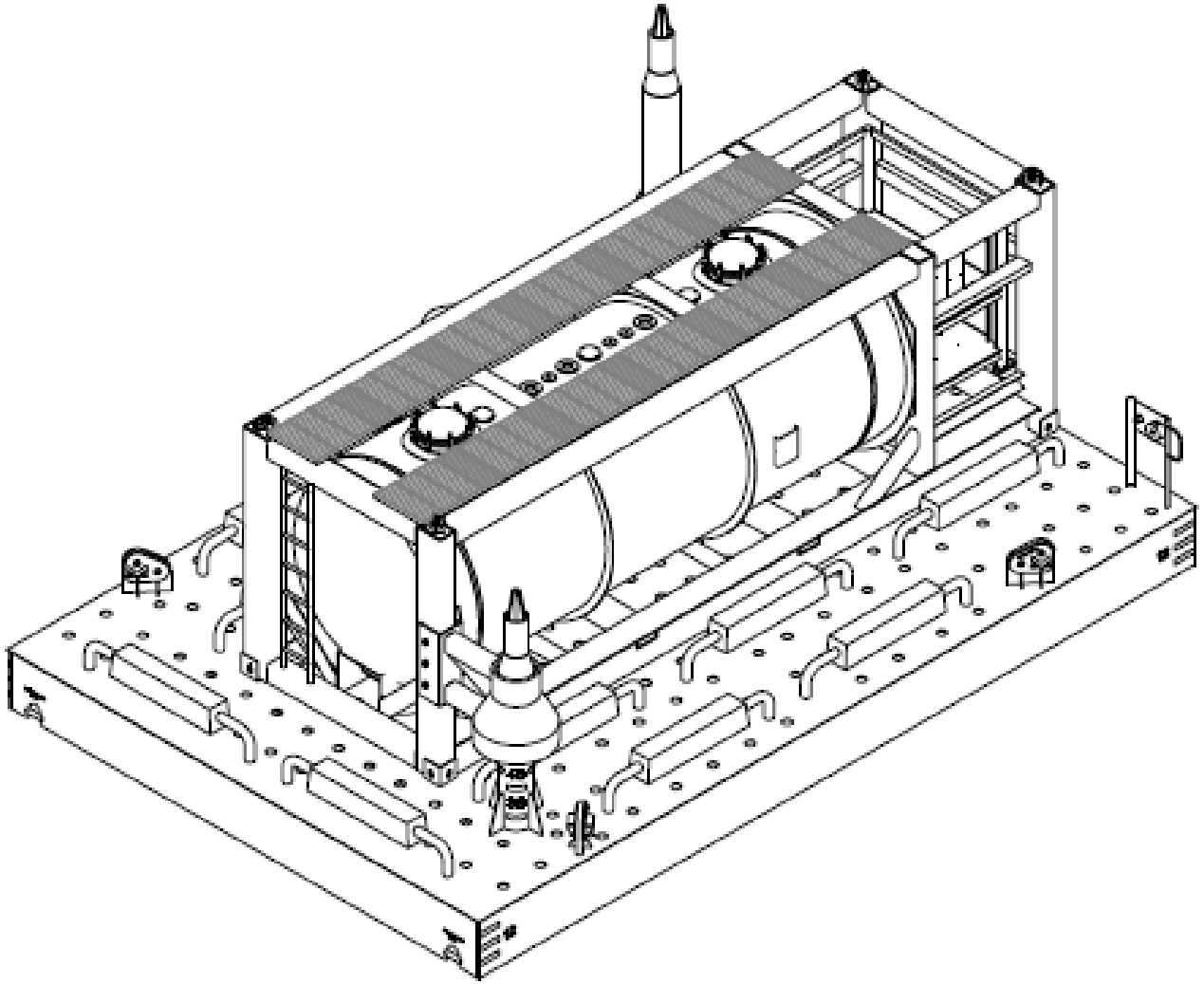
Mudmat Details

- 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)



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Progress, foundation design



DRAWING LIST	
DRAWING NUMBER	DRAWING TITLE
100253C001-000-DW-5251-0101	GENERAL NOTES AND DRAWING LIST
100253C001-000-DW-5251-0102	GENERAL ARRANGEMENT
100253C001-000-DW-5251-0103	FRAMING AND DETAILS - SHEET 1 OF 3
100253C001-000-DW-5251-0104	FRAMING AND DETAILS - SHEET 2 OF 3
100253C001-000-DW-5251-0105	FRAMING AND DETAILS - SHEET 3 OF 3
100253C001-000-DW-5251-0106	MISCELLANEOUS DETAILS - SHEET 1 OF 2
100253C001-000-DW-5251-0107	MISCELLANEOUS DETAILS - SHEET 2 OF 2
100253C001-000-DW-5251-0108	ANODE ARRANGEMENT AND DETAILS
100253C001-000-DW-5251-0109	PAINTING AND MARKING ARRANGEMENT

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Geotechnical design report

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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

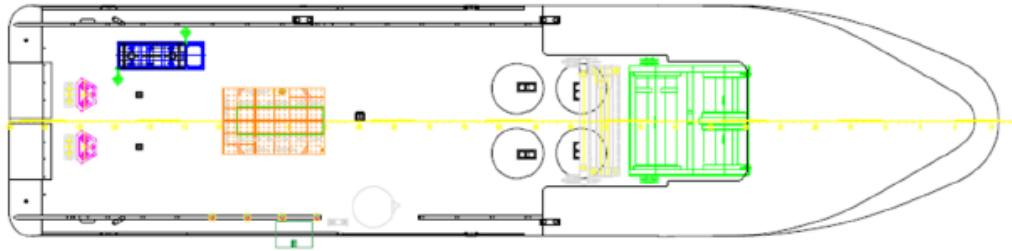
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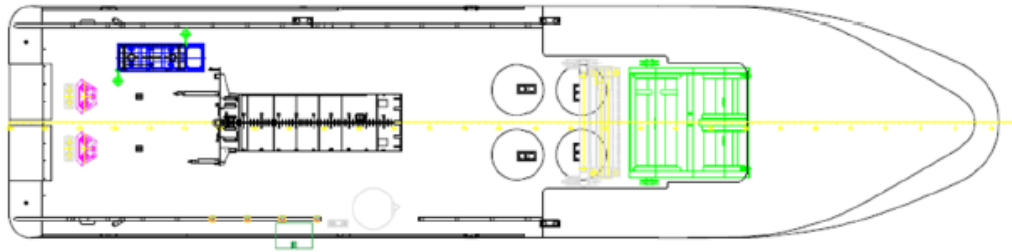
Marine risk analysis, operational assumptions

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Construction Vessel

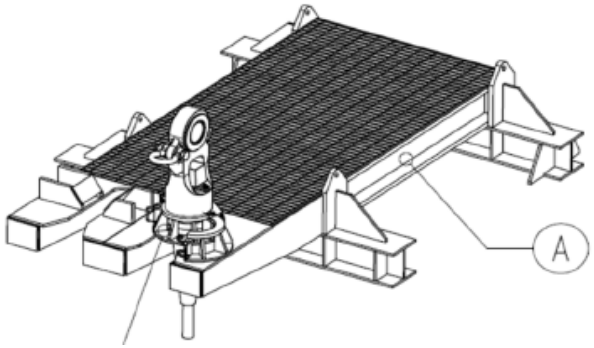
- DP2
- 250 mt crane or A&R lowering system to 3000m
- Either must have active heave compensation or accommodate an inline heave compensator
- WROV with pumpskid
- Positioning / Survey spread

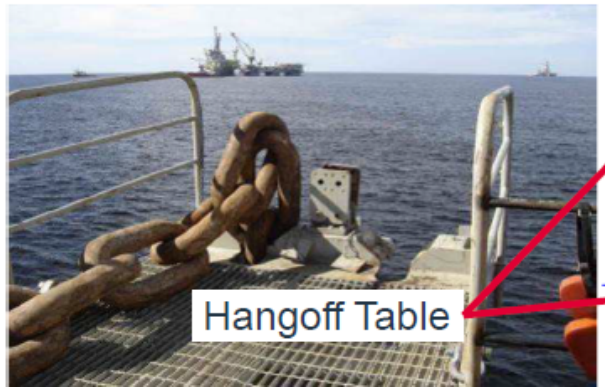


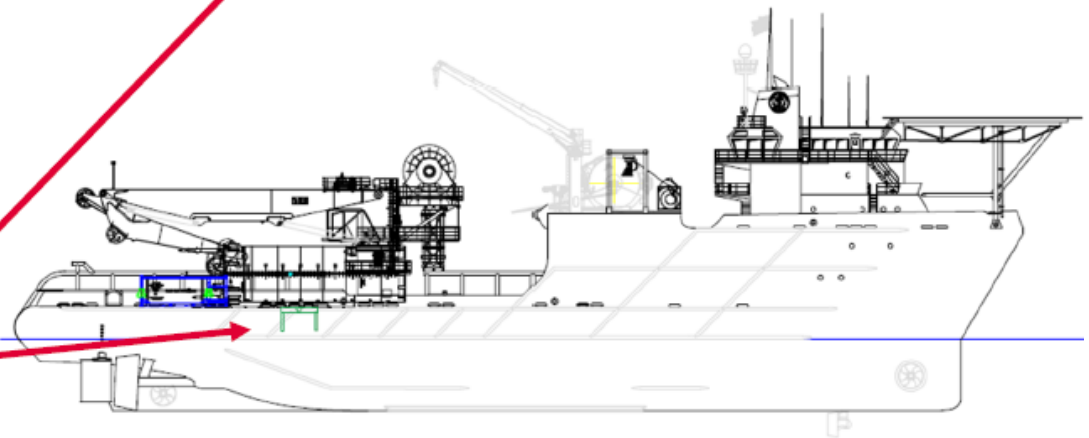


Environmental Limits

- 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







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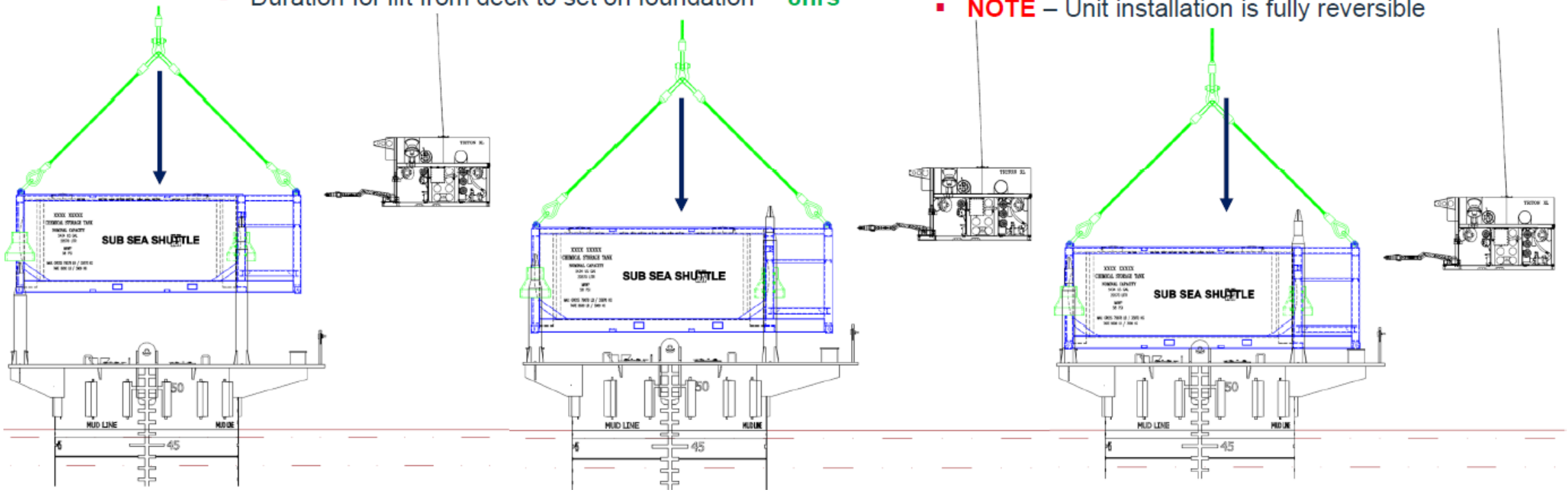
Marine risk analysis, storyboard- installation

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



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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?
- 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

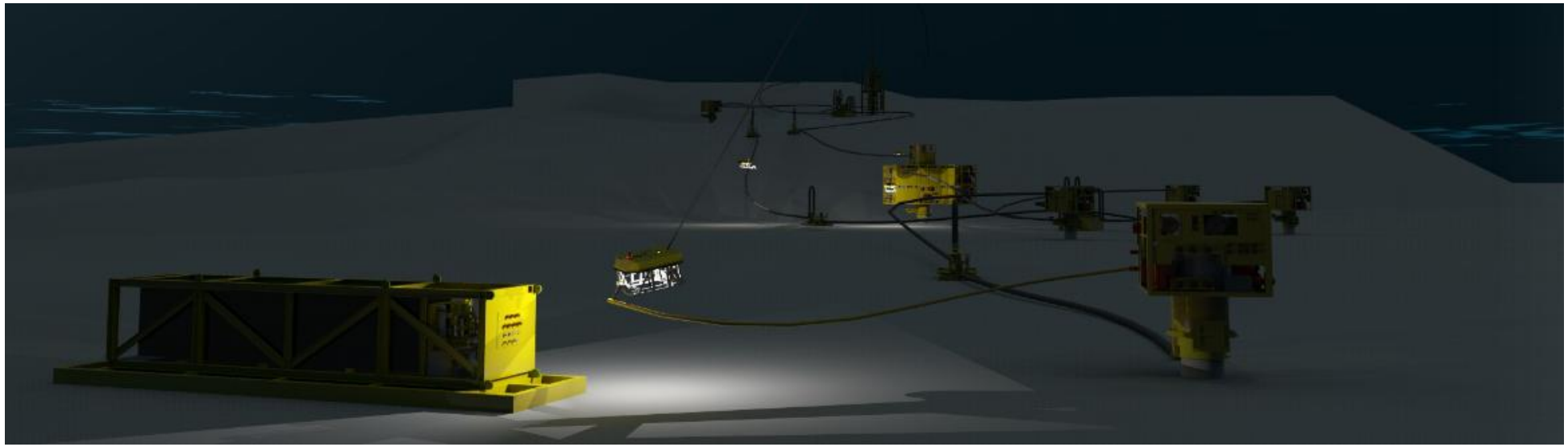
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Summary

- 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 ‘design one, build many’ philosophy
  - Common Off The Shelf (COTS) components where possible
  - Full scale prototype being built
  - SIT 2022Q1
  - Offshore deployment 2022Q2-4



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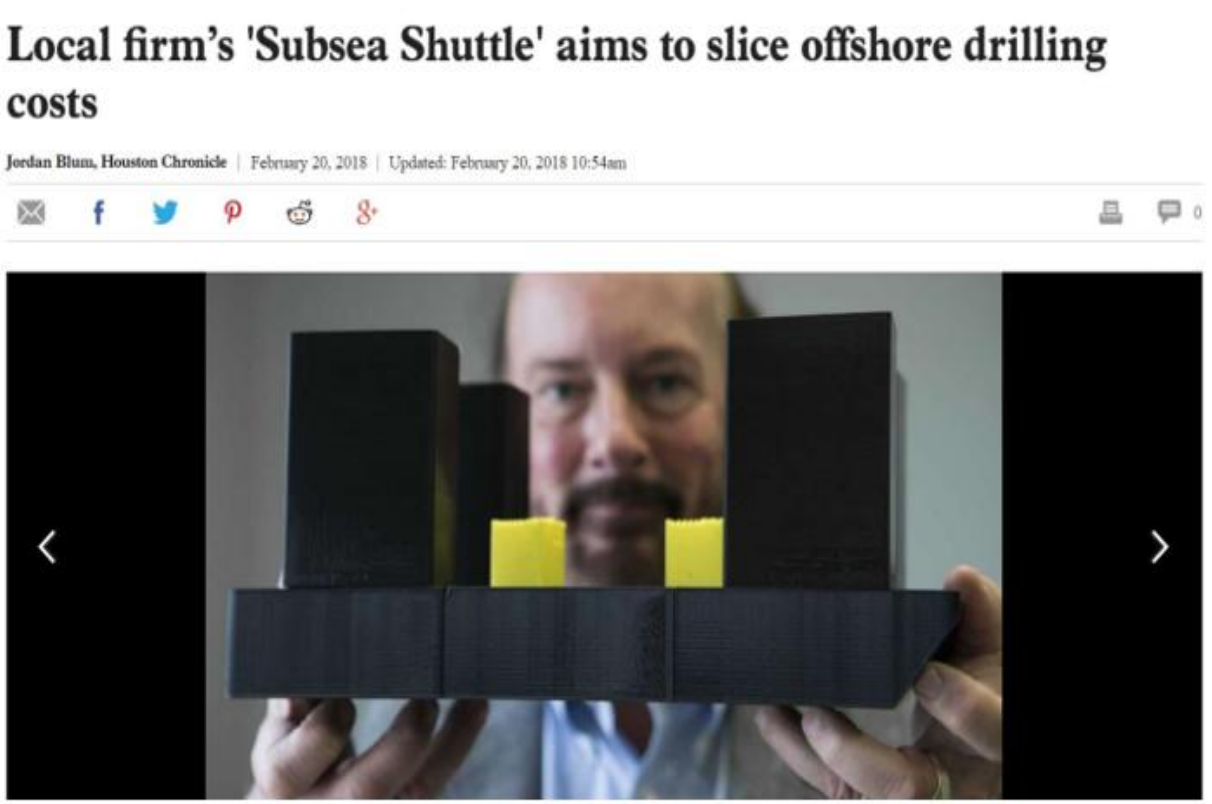
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Potential 2nd business line that would complement the SCSIU business. The Subsea Shuttle™, a tool (or service) utilizing patent (pending and issued) technology and trade secrets developed in conjunction with a Strategic Alliance w/ Trelleborg for subsea 'build-out'.

- Alternative to heavy-lift derrick barge deployment/recovery of integrated subsea equipment packages;
  - Brownfield EOR (Low-salinity saltwater injection, et al)
  - Switchgear, motor controllers, pumps, compressors, separators, etc.

- Enable inexpensive transfer of equipment requiring periodic IRM to/from sea-surface/sea-floor

4.4.4 Houston Chronical – lead story



Local firm's 'Subsea Shuttle' aims to slice offshore drilling costs

Jordan Blum, Houston Chronicle | February 20, 2018 | Updated: February 20, 2018 10:54am

"Punch above weight class with smaller/cheaper vessels"

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Best Deepwater Technology Award

- RAR Plus™ – Delmar Systems, Inc.
- Linear eActuators – Schlumberger OneSubsea
- DEEPFRAC™ Deepwater Multistage Fracturing Servi
- AFGlobal, Active Control Device (ACD) – AFGlobal Co
- Light Weight Compact Tree – Baker Hughes, a GE co
- Subsea Shuttle™ – Safe Marine Transfer, LLC
- Imperium™ Intelligent Completion Platform – Halli
- Rotating Buoyancy Modules – Trelleborg Offshore



Take away:

Move production equipment from host platform to seafloor

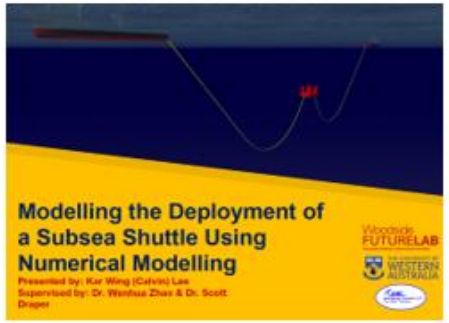
- Reduces space & weight loads on platform & Minimize PPE
- Initial integration, testing and commissioning quayside, plus subsequent IRM
- Eliminate need for expensive heavy lift vessel

Shuttle capable of handling 600+ tons payload:

- Chemical & fuel storage (liquids) and pumps, compressors, separators, etc.

Offshore demonstration (Woodside & UWA)

- Fugro
- Technip
- Saipem
- Subsea7
- McDermott
- DOF subsea
- Regional marine ops



Offshore validation & numerical Modelling (Woodside & UWA)

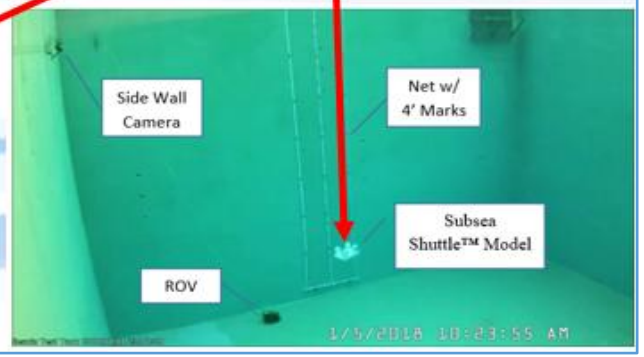


Test tank validation of CFD & simulation (Woodside)









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Earlier phase of DoE project
Technology development and regulatory review

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Operator, regulator, and contractor input & review:

- Testing
- Storage
- Transport
- Deployment & connection
- Operation
- Surface refill
- IRM
- Recovery



DeepStar™ BAKER HUGHES FUGRO UNIVERSITY OF HOUSTON SMT Advisory Committee AIRE INDUSTRIAL ARGEN POLYMER AVON Avon Rubber p.l.c. U.S. DEPARTMENT OF ENERGY NETL
STRESS ENGINEERING SERVICES INC. Alan C. McClure Associates, Inc. HELIX CANYON OFFSHORE DSA DYNAMIC SYSTEMS ANALYSIS SMT SIMULATIONS INC. Seaman Corporation TRELLEBORG OceanWorks International

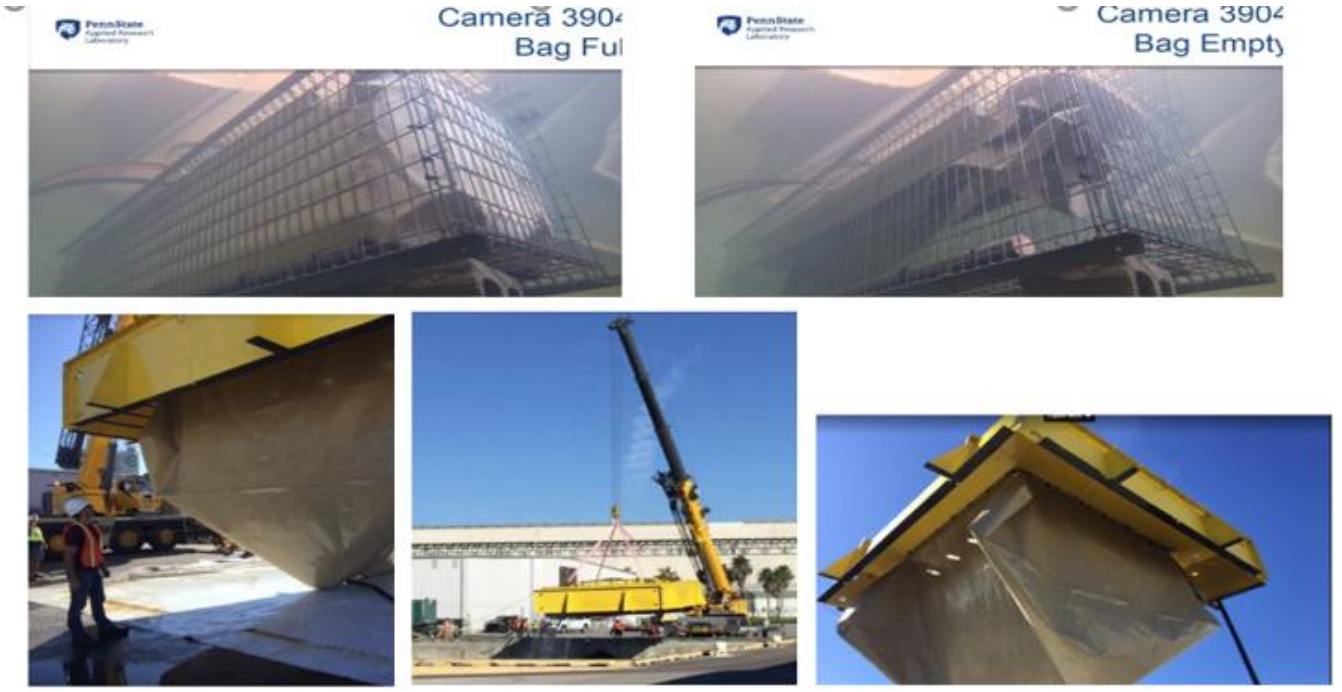
Earlier phase:

- US DOE , major funding
- Costshare & work for hire
- 3 years & $10m invested
- 50+ SMEs; input & review
  - Concept, design, engineering; complete
  - Testing & validation; components sub-assemblies & scale models; done
  - Data, drawings, reports & technical details – available
  - Patents issued (6), numerous pending + significant Trade Secrets

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Penn State's ARL earns Navy research contract worth as much as $2.1 billion

Posted Thu 1 Mar 2018

https://news.psu.edu/story/508126/2018/03/01/research/penn-states-arl-earns-navy-research-contract-worth-much-21-billion

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Relevant published work

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79. Qualification and Case Studies Subsea Chemical Storage and Injection Unit
Art J. Schroeder. Jr., James E. Chitwood, Tom A. Gay, Safe Marine Transfer
Matt York, Ben Alexander, Todd Holtz, Seanic Ocean System
Offshore Technology Conference; OTC-29307-MS, May 2019

78. Subsea Smart Electric Control Unit for Building Smarter and Cheaper Subsea Hardware.
Art J. Schroeder. Jr., James E. Chitwood, Tom A. Gay, Safe Marine Transfer
Matt York, Ben Alexander, Todd Holtz, Seanic Ocean System
Offshore Technology Conference; OTC-29639-MS, May 2019

77. Deepwater Technologies Potentially Improve Safety and Lower Costs in Shallow Water
Tom A. Gay, Art J. Schroeder. Jr., James E. Chitwood, Safe Marine Transfer
American Oil and Gas Report Article; Feature article. 2019-Feb issue

76. Innovative Installation Technology Potentially 'Punches above its Weight-class'
Art J. Schroeder. Jr. Safe Marine Transfer, LLC, Collin Gaskill, Trelleborg, Scott Draper, UWA, RiverLab
World Oil, Feature article, November 2018;

75. Making Deepwater Development Profitable Again
Art J. Schroeder. Jr. Safe Marine Transfer, LLC, Antony Croston, Collin Gaskill, Trelleborg Flow Control, October 2018

73. Enabling Longer, Cheaper Subsea Tie-backs Utilizing Local Subsea Chemical Storage & Injection
Art J. Schroeder, Jr., James E. Chitwood, Tom A. Gay, Safe Marine Transfer, LLC, Jeffrey Bahr, Argen Polymer LLC., Kevin Brennan, Canyon Offshore, Matt York, Seanic Ocean Systems, Inc.
Offshore Technology Conference; OTC-28775-MS, May 2018

70. Deepwater Permanent Subsea Pressure Compensated Chemical Reservoir and Injection System
Art J. Schroeder Jr., and James E. Chitwood, Safe Marine Transfer, LLC.
Research Partnership to Secure Energy for America (RPSEA) UDW Conference; Galveston, Tx. August 31, 2016

69. Game-changing Technology Enabler for Ultra-Long Tieback Systems and Subsea Processing
Art J. Schroeder Jr., and James E. Chitwood, Safe Marine Transfer, LLC
IEA Gas & Oil Technology Collaboration Program; London, England June 13, 2016

68. Development & Qualification of a Subsea 3,000 Barrel Pressure Compensated Chemical Storage and Injection System
Art J. Schroeder Jr., and James E. Chitwood, Safe Marine Transfer, LLC.; Tim Krasin, Brian Lee, Canyon Offshore; Dan Krohn, Menno Huizinga, and Alex Paramonoff, OceanWorks International, Inc.; Charlotte Schroeder, Energy Valley, Inc.; Tom A. Gay, Consultant; David Cercone, National Energy Technology Laboratory (NETL, a unit of U.S. DOE); and James Pappas, Research Partnership to Secure Energy for America (RPSEA)
Offshore Technology Conference OTC-26966-MS; Houston, Tx. May 2016

67. A New Subsea Large Load Deployment System
J. Chitwood, A. Schroeder, Safe Marine Transfer, Inc.; T. Krasin, B. Lee, P. Newlin, K. Brennan, Canyon Offshore; R. Nicoll, C. Wilson, Dynamic Systems Analysis Ltd.; N. Noseworthy, GRI Simulations; T. Gay, Consultant; D. Cercone, National Energy Technology Laboratory (NETL, a unit of U.S. DOE); and J. M. Pappas, Research Partnership to Secure Energy for America (RPSEA)
Offshore Technology Conference OTC -26904-MS; Houston, Tx. May 2016

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About Subsea Shuttle (SSS)

Texas based Limited Liability Company (LLC)

- Ownership; Mngt & LSPI (https://www.liquidpower.com/)
- 100+ issued patents with numerous pending and trade secrets

Management

- Worked closely for two decades; engineering & project management; 100+ projects ranging from $250k to $5m
- Individually, participated/managed numerous projects in 8 to 9 figure level
- Customers included;
  - NOCs, IOCs, independents
  - Governmental agencies;
    - International; IEA, IFP, NOFO,
    - US DoE, DoI, DoD, DoC
  - Consortiums; DeepStar®, RPSEA, OSRL, CCC
  - Manufacturers, large and small
  - Startups; support and consultation with dozens; built and sold several.

Art J. Schroeder, Jr. - Co-founder & CEO
https://www.linkedin.com/in/artjschroeder/



James E. Chitwood – Co-founder & CTO
https://www.subseashuttle.com/#about



Tom A. Gay – Sr. Advisor
https://www.linkedin.com/in/tomagay/



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Papers, Report-outs, & Awards

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Global Awards 2022 NETL finalist

Celebrating chemical engineering excellence

The IChemE Global Awards celebrate chemical, process and biochemical engineering excellence and are widely considered as the world's most prestigious chemical engineering awards.

Now in their 29th year, the IChemE Global Awards 2022 are open for entries. With 19 categories, the awards recognise chemical engineering's best people, projects and companies. They are free to enter and both IChemE members and non-members can submit an entry.

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Value proposition

Vision: The industry leader enabling, Subsea tie-backs; Longer. Cheaper. Better™

Value proposition (operator):

- Enable long-distance subsea tie-backs
- Cut costs by;
  - Eliminating chemical and hydraulic tubes in umbilical
  - Reducing platform space and weight requirements
  - Eliminate hazardous chemical interaction with platform personnel
- Increased Host platform 'optionality' / profitability (keeping it full)
- "Chemical Injection as a Service" (mimicking successful onshore delivery model)
  - Design one, build many; enables lower costs
  - Better match with changing reservoir conditions
- Significant step towards platform 'de-manning'

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