RPSEA Administered Cost Share Research Overview: Ultra-Deepwater Program

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NETL Office, Sugar Land, TX
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Outline

- Current UDW Program Status
- Technical Accomplishments FY 2013
  - Accomplishments
  - Significant Findings
  - Safety & Environment Impact
- Plan Forward
  - 2012 Solicitation – Selection Progress
  - Current Schedule

Current UDW Program Status

Selected Project Totals

	2007	2008	2009	2010	2011	Total
Universities	5	4	1	3	0	13 (19%)
For Profits	9*	10	9	15	7	50 (74%)
Non Profits	3	0	0	1	0	4 (6%)
National Labs	0	0	1	0	0	1 (1%)
TOTAL SELECTED	**17***	**14**	**11**	**19**	**7****	**68**

* 17 selected, 16 awarded
** 7 selected, 5 in negotiation, 1 awarded

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Completed Project Totals

	2007	2008	2009	2010	2011	Total
Universities	5	2	1	0	0	8 (23%)
For Profits	7	8	7	0	0	22 (65%)
Non Profits	3	0	0	0	0	3 (9%)
National Labs	0	0	1	0	0	1 (3%)
TOTAL SELECTED	**15**	**10**	**9**	**0**	**0**	**34**

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Committed Funds through 2011 Program*

($MM)	RPSEA Funds	Cost Share	Total Costs
2007	$15.2	$ 4.5	$19.7
2008	$11.1	$ 3.0	$14.1
2009	$10.7	$ 6.0	$16.7
2010	$29.8	$ 9.3	$39.1
2011*	$ 2.0	$ 0.5	$ 2.5
Totals	**$68.8 (75%)**	**$23.3**	**$92.1**
Remaining Funds	**$47.8****		

* Only 1 2011 project awarded thus far. If all awarded RPSEA = $11.5MM RPSEA, $3.9MM CS.
** Assumes 8% sequestered funds for 2013 & 2014.
May be reduced to ~ $38.3MM if all 2011 projects are awarded.

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Technical Accomplishments FY 2013

Projects Completed in FY 2013

RPSEA Contract Number	Project Name	Company	Principal Investigator	Period of Performance Start Date	Period of Performance End Date	Total Project Cost	RPSEA Cost Budget	Cost Share Total	% Cost Share
09121-3300-02	Displacement & Mixing in Subsea Jumpers – Experimental Data and CFD Simulations	University of Tulsa	Michael Volk, Jr.	12/14/10	12/14/12	$337,792	$250,400	$87,392	25.9%
09121-3500-01	Intelligent Production System for Ultra Deepwater with Short Hop Wireless Power and Wireless Data Transfer for Lateral Production Control and Optimization	Tubel, LLC	Paulo Tubel	01/28/11	03/28/13	$1,423,587	$1,102,098	$321,489	22.6%
08121-2902-06 COMPLETE	Enumerating Bacteria in Deepwater Pipelines in Real-Time at a Negligible Marginal Cost Per Analysis: A Proof of Concept Study	Livermore Instruments Inc.	Dr. David P. Fergenson	01/25/10	03/30/13	$348,177	$201,060	$147,117	42.3%
07121-2001	Geophysical Modeling Methods	SEAM Corporation	Peter Pangman	06/15/09	06/30/13	$3,291,705	$2,633,364	$658,341	20.0%
09121-3300-08	Sensors and Processing for Pipe, Riser, Structure, and Equipment Inspection to Provide Detailed Measurements, Corrosion Detection, Leak Detection, and/or Detection of Heat Plumes from Degraded Pipeline Insulation	Blueview Technologies	Lee Thompson	12/14/10	06/30/13	$585,600	$468,463	$117,137	20.0%
09121-3500-10	Gyroscope Guidance Sensor for Ultra-Deepwater Applications	Laserlith	Chopin Hua	01/24/11	07/24/13	$619,346	$489,346	$130,000	21.0%
10121-4407-01	Deepwater Direct Offloading Systems, Phase 1	Remora Technology	Kim Diederichsen	08/16/12	08/15/13	$1,054,471	$843,471	$211,000	20.0%
	SUBTOTALS					**$7,660,678**	**$5,988,202**	**$1,672,476**	**21.8%**

7 Completed projects

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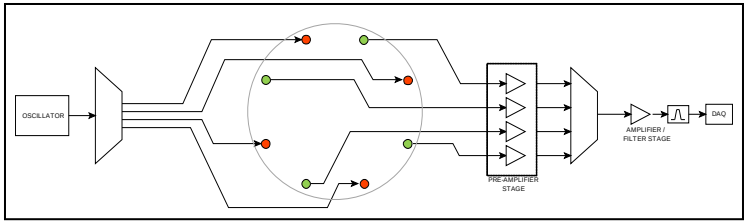
Safety & Environmental Sustainability: Drilling, Completions & Interventions

Intelligent Production System for Ultra Deepwater with Short Hop Wireless Power and Wireless Data Transfer for Lateral Production Control and Optimization

Accomplishments

- Designed remotely operated downhole flow control module for wellbore laterals for real time reservoir to wellbore flow control.
- Production sensor requirements were finalized .
- System was proven to provide power from main bore into laterals without the need of a cable
- Highly efficient engineering module capable of operation with a small battery pack was developed.
- Developed sensor technology that allows for a pressure, temperature, flow meter & fluid Identification package to be placed in the laterals for real time data gathering.
- Working prototype of the low power flow control and data acquisition-transmission system was developed & lab tested, followed by flow loop tests.
- System was ruggedized & tested in the field.



Schematic for fluid identification tool electrodes
Red – Transmitter electrodes and
White – receiver electrodes

Design of sensor package for lateral applications

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Intelligent Production System for Ultra Deepwater with Short Hop Wireless Power and Wireless Data Transfer for Lateral Production Control and Optimization

Significant Findings

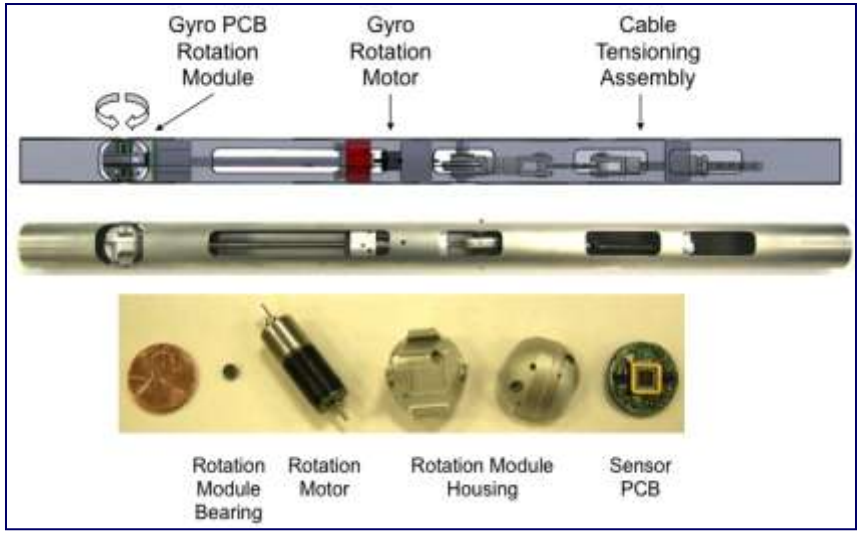
- Full ID flow control system was created & developed that can be placed in wellbore laterals requiring less than 1 Watt of power to open or close sleeves.
- Wireless power transfer concept was determined to be feasible at much higher efficiencies than originally conceived and at much longer distances than anticipated.
- The downhole wireless communications system was also shown to be reliable, capable of 2-way data and command transfer, and immune to the downhole environment.
- The complete package was developed and tested to a TRL of 7 (ready for commercialization).

Safety & Environmental Emphasis

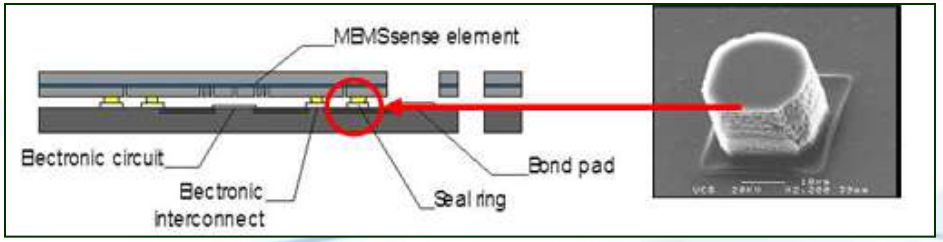
- *At source transmission of pressure, temperature, flow meter & fluid Identification data.*
- *Real time transmission or reception of data and orders – immediate control and feedback!*
- *Useful in multilaterals.*
- *Can be used as an additional safety barrier.*

Gyroscope Guidance Sensor for Ultra-Deepwater Applications

- **Accomplishments**
  - MEMS mechanical sensing element was designed and fabricated.
    - Meets requirements for directional drilling applications.
  - Sensor was successfully operated without failure at 140 C inside a vacuum test chamber.
  - Electronics circuit that accompanies the sensor was developed.
    - Independently verified to properly function at elevated temperatures of 200 C inside an oven.
  - MEMS mechanical sensing element & high temperature electronics were integrated into sensor module prototype.
  - The sensor module prototype was successfully demonstrated in a lab.



Design and components of the Gyroscope module



Side view of microbump interconnected sensor: The process enables a 'divide and conquer'

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Gyroscope Guidance Sensor for Ultra-Deepwater Applications

- **Significant Findings**
  - Design revisions to the gyroscope system to further improve performance.
    - Tolerance to manufacturing variations.
    - Additional optimizations to the quadrature combs, proof mass suspension beams, and resonance modes.
  - Improvements to the gyro sensor electronics to further reduce electrical noise.
  - The gyro drive circuit to be made more sensitive and responsive.
    - A drive amplitude limiter to be added to prevent the proof mass from crashing.
  - Reduce size of control electronics & continue to improve noise filtering.
  - Design of complete sensor for downhole testing.
  - Evaluate alternate gyro designs such as tuning fork gyros.
- **Safety & Environmental Emphasis**
  - *Enables this inertial guidance system to be positioned next to the drill bit.*
  - *Shortened reaction reduces drilling time & lead to more reservoir contact, improving personnel safety & reducing environmental impact.*

Safety & Environmental Sustainability: Appraisal & Development – Geosciences & Reservoir Engineering

Geophysical Modeling Methods

- **Accomplishments**
  - Pre-existing numerical model extended for the additional simulations.
    - Model is unique in its structural and stratigraphic complexity & in the approach taken.
  - "Absorbing upper surface" acoustic seismic simulation recorded over central portion of the model to aid in de-multiple research:
    - Contains no sea surface multiple reverberations.
    - Can be used in conjunction with the pre-existing SEAM free surface simulation to provide a target dataset against which to compare the effectiveness of new de-multiple processing algorithms.
  - Comprehensive CSEM simulation recorded.
    - Provides test dataset to demonstrate effectiveness at direct detection of contrasts between salt & HC reservoirs at both post & pre-salt interfaces.
    - Can be used for research into joint inversion approaches.
  - Large anisotropic acoustic seismic simulation ("TTI acoustic") to provide industry standard dataset to verify accuracy of evolving anisotropic imaging algorithms.

Geophysical Modeling Methods

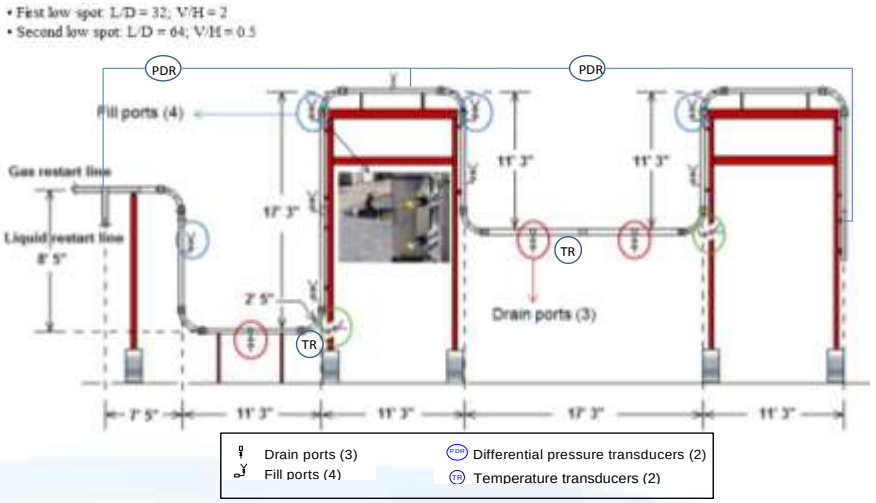
- **Significant Findings**
  - Several simulations demonstrated that very few entities (including commercial vendors, university affiliated research institutes, and U.S. national laboratories) currently have capability to cost effectively create large volume simulation software.
  - Results presented at SEG workshop in 2013 demonstrated high interest in researching both methodology of data processing and effectiveness of integrated interpretation where the exact geologic boundaries are known.
  - The data cubes will be THE industry standard for many years of research.
- **Safety & Environment**
  - *Project will enable better understanding seismic attributes, which will lead to higher incidence of E&P drilling success.*
    - *Fewer wells will be required, leading to less exposure to safety or environmental issues.*
  - *Databases and their use may be transferrable to other seismic related industries, providing them with more precise and accurate tools for fault and fissure detection, especially deep-seated events.*

Safety & Environmental Sustainability: Stabilized Flow & Flow Assurance

Displacement & Mixing in Subsea Jumpers – Experimental Data and CFD Simulations

Accomplishments

- Experimental data for THIs (MEG & MeOH) used to validate 1D, 2D, & 3D jumper configuration models.
  - 1D transient multiphase flow simulator OLGA ® simulations predicted thermodynamic inhibitor dispersion.
  - Comparisons between 2D CFD simulations performed with commercial software FLUENT® 6.3.26 and experimental data from full fresh water loading jumper displacement tests with MEG & MeOH curvilinear grids.



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Displacement & Mixing in Subsea Jumpers – Experimental Data and CFD Simulations

Significant Findings

- Large discrepancies between OLGA simulation results and experimental data found for low injection rate cases.
- CFD simulations helped optimize chemical additive amounts & flow rates required, as well as to optimize the locations of the injection ports.
- Both 2D and 3D CFD simulations provided reasonable prediction for THI distribution along jumper after displacement tests in most cases.
  - Neither model correctly reproduced MeOH overriding the water phase at both low spots.
  - Results obtained by Star-CCM+ 3D generally gave better agreement with the results from the experiment.

Safety & Environmental Emphasis

- *Subsea jumper and downstream plugging/ burst reduction*
- *Optimize (possibly reduce) required inhibitor chemical volumes*

Safety & Environmental Sustainability: Floating Facilities & Risers

Deepwater Direct Offloading Systems, Phase 1

- **Accomplishments**
  - Ongoing work towards deepwater fields in Brazil have confirmed that implementation of a future generation HiLoad DP offloading vessel will:
    - Increase overall offloading availability.
    - Significantly improve day-to-day operations.
    - Increase safety in comparison to existing offloading solutions currently available on the market.

Deepwater Direct Offloading Systems, Phase 1

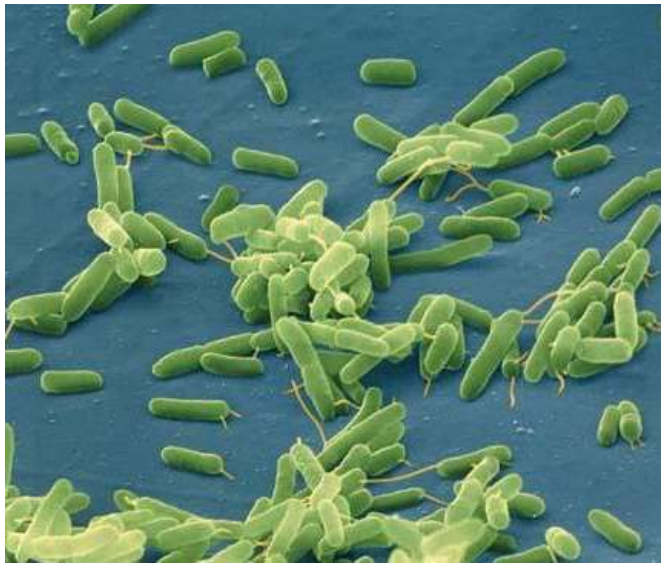
- **Significant Findings**
  - Vessel is capable of use in GOM.
  - Moving vessel may require tender vessel according to DnV study and concurred by Working Project Group.
  - Vessel should move to a safe port upon notification of approaching tropical storm.
  - The next phase of this project is to release findings to industry and regulatory authorities.
  - Interested operators should conduct detailed design and engineering of a HiLoad DP GOM vessel to enable bidding and construction as desired for individual needs.
- **Safety & Environmental Impact**
  - *Safer offloading with less chance of spill than current methods.*

Safety & Environmental Sustainability: Safety & Environmental Systems

BACKGROUND: Replacing Chemical Biocides with Targeted Bacteriophages in Deepwater Pipelines and Reservoirs

Accomplishments

- Diversity of bacteria in samples was determined using next generation sequencing approach.
  - Individual SRB monocultures were isolated & cultured from separate samples.
  - Naturally occurring phages were found, isolated, & determined to be effective first against co-cultures & then against bacterial concentrates.
- Individual phage were found to not only markedly inhibit SRB growth by 6 orders of magnitude or better, but ,unlike chemicals biocides, the test vials have remained clear for months, indicating that the inhibition is long lasting and active.



BACKGROUND: Replacing Chemical Biocides with Targeted Bacteriophages in Deepwater Pipelines and Reservoirs

Significant Findings

- Phage have similar inhibitory effects on active SRB cultures as do currently used chemical biocides.
- Since phage treatments proved to control SRB levels for long periods of time, it thus holds promise as a bio-pesticide for use in the petroleum industry to reduce the need for chemical biocides.
- Additional work is needed to identify or develop phage with expanded host ranges and to study any possible side effects.

Safety & Environment Impact

- *Phage biocontrol treatments are naturally "green."*
- *Phage have a longer lasting inhibitory effect, implying that phage based biocontrol can provide a better treatment option for the petroleum industry to counter microbially influenced corrosion.*
- *The chance to reduce or eliminate H2S gas, turning sour wells into sweet wells can be an economic wonder, eliminating high corrosion common in sour service equipment.*

Enumerating Bacteria in Deepwater Pipelines in Real-Time at a Negligible Marginal Cost Per Analysis: A Proof of Concept Study

- **Accomplishments**
  - Simplified optical system by reducing the 9 lasers in the LLNL system to only 2 in production version with corresponding decrease laser alignment complexity.
  - Feasibility of high data rate comms using RF conduction through saltwater as a communications mechanism proven with a sea trial demonstrating a data rate of ~5 Mbps over a 10 cm distance.
  - Physics based models developed & verified for the signal propagation and further simulation & analysis predicted channel capacities near 50 Mbps, depending on transmission power.

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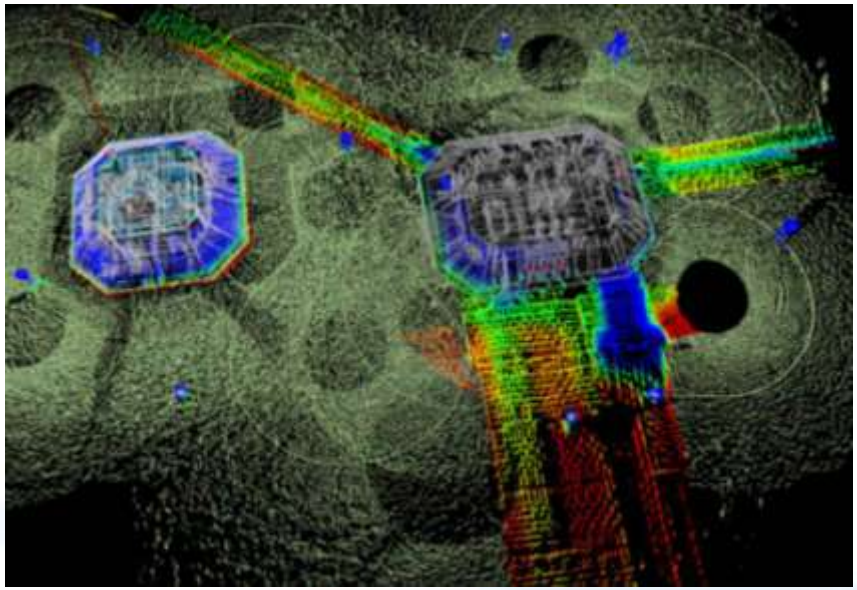
Enumerating Bacteria in Deepwater Pipelines in Real-Time at a Negligible Marginal Cost Per Analysis: A Proof of Concept Study

- **Significant Findings**
  - Instrument (SPAMS) can discern different microorganisms with minimal preparation.
  - Mass spectra of individual microorganisms acquired from multiple cultures of the same strain or species were indistinguishable while those from different genera were clearly distinct.
  - Operated successfully under the highest concentrations of microorganisms applied, up to roughly 109 organisms/ml.
- **Safety & Environment Impact**
  - *Tool provides accurate information faster and at lower cost than currently available tools.*
  - *Able to distinguish between genera for specific bacteriological targeting.*
  - *To develop method of dramatically further streamlining manufacture of the SPAMS & increasing its field ruggedness.*
  - *Future experiments to broaden the organisms to which the system can be applied .*
  - *Future engineering will prepare the instrument for mass deployment.*

Sensors and Processing for Pipe, Riser, Structure, and Equipment Inspection to Provide Detailed Measurements, Corrosion Detection, Leak Detection, and/or Detection of Heat Plumes from Degraded Pipeline Insulation

- **Accomplishments**
  - Leverage DoD-fueled high fidelity acoustic sensing technology.
  - Developed ROV-based acoustic metrology & inspection sensor capabilities for underwater structures.
    - Detailed physical measurements of underwater structures.
    - Detect & identified external corrosion, pitting, and biologic fouling.
    - Detected & quantified petroleum product leaks.
    - Detected heat plumes resulting from cracked or degraded pipeline insulation.



Sensors and Processing for Pipe, Riser, Structure, and Equipment Inspection to Provide Detailed Measurements, Corrosion Detection, Leak Detection, and/or Detection of Heat Plumes from Degraded Pipeline Insulation

- **Significant Findings**
  - Advanced spool piece metrology to commercial acceptance and use.
  - Wide area search and detection of gas and liquid leak in open water.
  - Heat leak detection and mapping during offshore pipeline inspection.
  - Independent of water clarity.

- **Safety & Environment Impact**
  - *Can be used for maintenance inspection to detect corrosion or pitting for underwater structures such as pipelines, risers, platforms, and other subsea equipment .*
  - *Fast deployment in emergencies . Limitation is in ROV ability to deploy.*
  - *Able to detect plumes or leaks even in cloudy or oily water. Resistant to subsea environmental issues (turbidity, fouling, multipath).*

Projects In Progress thru FY 2014

RPSEA Contract Number	Project Name	Company	Period of Performance Start Date	Period of Performance End Date	Total Project Cost	RPSEA Cost Budget	Cost Share Total	% Cost Share
09121-3300-06	High Resolution 3D Laser Imaging for Inspection, Maintenance, Repair, and Operations	3D at Depth	01/13/11	11/19/13	$3,517,738	$2,214,828	$1,302,910	37.0%
08121-2901-01	Ultra-Reliable Deepwater Electrical Power Distribution System and Power Components	GE Global Research	11/24/09	11/23/13	$6,249,959	$4,999,967	$1,249,992	20.0%
10121-4405-02	Ultra-deepwater Dry Tree System for Drilling and Production in the Gulf of Mexico, Phase 2	Det Norse Veritas	09/27/12	12/26/13	$2,982,822	$2,134,395	$848,427	28.4%
10121-4504-01	Intelligent Casing-Intelligent Formation Telemetry System	University of Oklahoma	07/31/12	12/30/13	$594,935	$474,935	$120,000	20.2%
10121-4406-01	Effects of Fiber Rope - Seabed Contact on Subsequent Rope Integrity, Phases 2/2	Stress Engineering	08/21/12	01/21/14	$2,823,411	$1,813,411	$1,010,000	35.8%
09121-3700-02	A 1,000 Level Drill Pipe Deployed Fiber Optic 3C Receiver Array for Deep Boreholes	Paulsson, Inc.	02/16/11	02/15/14	$3,502,608	$2,494,329	$1,008,279	28.8%
08121-2801-02	GOMEX 3-D Operational Ocean Forecast System Pilot Project	Portland State University	03/11/10	03/01/14	$1,560,000	$1,248,000	$312,000	20.0%
09121-3300-10	Development of Carbon Nanotube Composite Cables for Ultra-Deepwater Oil and Gas Fields	Los Alamos National Laboratory	04/25/11	04/25/14	$2,433,090	$1,342,526	$1,090,564	44.8%
08121-2701-03	Ultra-Deepwater Resources to Reserves Development and Acceleration Through Appraisal	The University of Texas at Austin	01/28/10	05/31/14	$351,548	$280,643	$70,905	20.2%
07121-1401	Composite Riser for Ultra Deepwater High Pressure Wells	Lincoln Composites Inc.	12/05/08	06/03/14	$3,208,070	$2,071,507	$1,136,563	35.4%
10121-4502-01	Deepwater Reverse-Circulation Primary Cementing, 2 phases	CSI Technologies, LLC	06/22/12	06/21/14	$1,066,507	$798,507	$268,000	25.1%
10121-4903-02	Autonomous Underwater Inspection Using a 3D Laser, phases 1-4/4	Lockheed Martin	07/18/12	06/30/14	$2,055,271	$1,642,446	$412,825	20.1%
08121-2201-02	Heavy Viscous Oil PVT	Schlumberger	07/27/11	07/27/14	$666,658	$502,961	$163,697	24.6%
10121-4202-01	Hydrate Modeling & Flow Loop Experiments for Water Continuous & Dispersed Systems, Phases 1&2/2	Colorado School of Mines	08/02/12	08/01/14	$881,003	$701,354	$179,649	20.4%
10121-4505-01	Coil Tubing Drilling and Intervention System Using Cost Effective Vessel ~~Phase 1~~ **ALL PHASES**	Nautilus International LLC	07/09/12	08/05/14	$1,838,773	$1,306,739	$532,034	28.9%

15 Projects

Projects In Progress thru FY 2015 or 2016

RPSEA Contract Number	Project Name	Company	Period of Performance Start Date	Period of Performance End Date	Total Project Cost	RPSEA Cost Budget	Cost Share Total	% Cost Share
10121-4801-01	Synthetic Hurricane Risk Model for the Gulf of Mexico	Applied Research Associates	06/10/13	12/09/14	$1,070,808	$856,414	$214,394	20.0%
10121-4306-01	All Electric Subsea Autonomous High Integrity Pressure Protection System (HIPPS) Architecture	GE Global Research	12/17/12	02/16/15	$950,000	$760,000	$190,000	20.0%
10121-4304-01	More Improvements to Deepwater Subsea Measurement	Letton-Hall Group, LLC	07/03/12	07/02/15	$4,057,391	$3,245,910	$811,481	20.0%
10121-4802-01	Effect of Climate Variability and Change in Hurricane Activity in the North Atlantic	University Corporation for Atmospheric Research	07/03/12	07/02/15	$1,800,000	$1,440,000	$360,000	20.0%
10121-4302-01	Ultra-High Conductivity Umbilicals: Polymer Nanotube Umbilicals	NanoRidge Materials, Inc.	08/03/12	08/02/15	$3,217,318	$2,573,854	$643,464	20.0%
10121-4501-01	Smart Cementing Materials and Drilling Muds for Real Time Monitoring of Deepwater Wellbore Enhancement	University of Houston	08/17/12	08/16/15	$3,765,287	$2,580,401	$1,184,886	31.5%
10121-4401-02	Ultra-Deepwater Riser Concepts for High Motion Vessels	Stress Engineering	08/21/12	08/20/15	$499,968	$399,968	$100,000	20.0%
10121-4204-01	Corrosion and Scale at Extreme Temperature and Pressure	Brine Chemistry Solutions, LLC	08/30/12	08/29/15	$4,563,835	$3,651,068	$912,767	20.0%
10121-4402-01	Qualification of Flexible Fiber-Reinforced Pipe for 10,000-Foot Water Depths	GE Global Research	08/06/12	08/05/16	$1,299,869	$1,039,876	$259,993	20.0%
11121-5101-01	Human Factors Evaluation of Deepwater Drilling, including Literature Review, Phase 1 only	Pacific Science & Engineering Group	08/22/13	08/21/16	$2,536,721	$2,029,376	$507,345	20.0%
10121-4402-02	Qualification of Flexible Fiber-Reinforced Pipe for 10,000-Foot Water Depths	DeepFlex	10/08/12	10/07/16	$3,117,957	$2,346,677	$771,280	24.7%

11 Projects

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New 2011 Projects – Negotiating Contracts

RPSEA Contract Number	Project Name	Company	Period of Performance Start Date	Period of Performance End Date	Total Project Cost	RPSEA Cost Budget	Cost Share Total	% Cost Share
11121-5503-01	Instrumented BOP Ram: Drill Collar/Tool Joint Locator	GE Global Research	Negotiating	32 mos	$1,395,476	$1,116,382	$279,094	20.0%
11121-5302-01	Construction and Testing of Deepwater Permanent Subsea Pressure Compensated Chemical Reservoir	Safe Marine Transfer, Inc.	Negotiating	36 mos	$4,748,126	$3,628,794	$1,119,332	23.6%
11121-5402-01	Riser Lifecycle Monitoring System for Integrity Management	GE Global Research	Negotiating	24 mos	$2,000,000	$1,600,000	$400,000	20.0%
11121-5404-03	VIM Study for Deep Draft Column Stabilized Floaters	Houston Offshore Engineering	Negotiating	18 mos	$2,984,891	$2,133,383	$851,508	28.5%
11121-5801-01	Hi-Res Environmental Data for Enhanced UDW Operations Safety	Fugro Global Environmental & Ocean Sciences, Inc.	Negotiating	<48 mos	$1,768,839	$1,038,335	$730,504	41.3%

5 Projects, RPSEA Funds = $9.5MM

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2012 DOE Annual Plan – UDW Program Goal

- Ensure that understanding of UDW operations risks keeps pace with industry developed technologies to tap increasingly challenging reserves.
- Assess and mitigate risk in offshore production activities related to controls, safeguards, and environmental impact mitigation procedures in place during drilling and production operations.
- Research topics are expected to include:
  - Development of *improved well control and wild well intervention* techniques;
  - Evaluation of appropriate *safeguards for blowout preventers, cementing and casing*;
  - Evaluation *of instrumentation and monitoring*;
  - Improvement of *flow assurance*;
  - Expediting the *completion of relief wells*; and
  - *Other topics* associated with ultra-deepwater operations.

2012 DOE Annual Plan - UDW Program Topics - 1

Improved understanding of risks

- Improve understanding of *complex fluid phase behaviors that occur under conditions of extreme pressure and temperature*, and develop advanced models of hydrocarbon behavior.
- Assess and quantify the *risks of environmental impacts from deepwater oil and gas exploration, drilling, and production activity*, to include modeling and evaluation of industry systems, based on newly developed technologies.
- Improve *reservoir characterization* which results in lower dependence on new field developments and new wells, thus *reducing the physical and environmental footprint*.

2012 DOE Annual Plan - UDW Program Topics - 2

Reduce risk through real-time information

- Improve subsea ultra-deepwater *measurement and monitoring instrumentation*, including technologies for "seeing" through the casing via downhole tools to gauge the cement top and in-situ cement characteristics (thickness, channeling, density (gas or liquid pockets), etc.) to better determine potential failure pathways.
- Research *sensors, instrumentation, command electronics, and advanced data interpretation technologies*.

2012 DOE Annual Plan - UDW Program Topics - 3

Reduce risk through advanced technology

- Improve *well control technologies and techniques* to reduce risk.
- Improve *well design and construction* to reduce risks for ultra-deepwater wells.
- Improve *flow assurance*, thereby expediting the completion of well control efforts, and reducing the risk of environmental impacts from potential hydrate plugging related ruptures during producing operations.
- Continue *research, development, and demonstration of advanced technologies* to reduce risk.

2014 DOE Draft Annual Plan - UDW Program Solicitations Influence

Topics to **quantify risk** associated with *HPHT* drilling & fluids, wellbore *Integrity.* & *well control*.

Specific topics may include:

- *Reservoir characterization*, including bounding strata to ensure hydrocarbon containment within the geologic and engineered system.
- Research *sensors, instrumentation, command electronics, & advanced data interpretation* technologies & alert systems.
- Studies of *human behavior* as related to UDW drilling & production operations high risk conditions, with emphasis on the "human-machine" interface.
- Advanced *well & vessel design* to reduce risks of operations in areas of harsh storms.
- *Hardware and novel D&C techniques* that prevent loss of *well control*.

2012 Approved Project Solicitations – Round 1

TAI	Title	Phases	Duration (mos)	RPSEA Funds	Total Cost ($MM)
6001	Marine Sources for Air-gun Substitution	1	24	$ 1.1	$ 1.4
6101	Using Small-Scale Sensing Technologies for In-line Pipeline Monitoring and Preliminary Inspection	1	15	$ 0.2	$ 0.3
6301	Subsea Produced Water Sensor Development	2	24	$ 3.7	$ 4.6
6302	Development and Qualification of a Subsea Produced Water Treatment System for Ultra-Deepwater Re-injection or Subsea Discharge	3	36	$ 2.5	$ 3.1
6501	Extreme Reach, Multilateral Drilling, Completion, and Production in Offshore Arctic Environments to Reduce Footprint and Improve Safety	3	30	$ 2.1	$ 2.6
6502	Reliability of Annular Pressure Buildup (APB) Mitigation Technologies	3	12	$ 0.8	$ 1.0
6504	BOP Shearing Device Technology Development	3	24	$ 1.0	$ 1.2
6701	Dynamic Appraisal with Significant Reduced Environmental Impact on Drilling or Completions	2	24	$ 1.4	$ 2.1
TOTAL				**$12.8 (79%)**	**$16.3**

2012 Approved Project Solicitations – Round 2

TAI	Title	Phases	Duration (mos)	RPSEA Funds	Total Cost ($MM)
6002	Pressure Prediction and Hazard Avoidance through Improved Seismic Imaging	2	24	$ 1.6	$ 2.0
6303	Development and Qualification of a Subsea Produced Water Treatment System for Ultra-Deepwater Re-injection or Subsea Discharge	2	24	$ 3.7	$ 4.6
6401	Real-time Acoustic Oil-Water Separation in Oil Production	2	24	$ 1.2	$ 1.5
6402	Methodology and Algorithm Development for the Evaluation of Ultra-Deepwater or Arctic Floating Platform Performance under Hazardous Sea Conditions	2	20	$ 0.2	$ 0.3
6403	Development of Advanced CFD Tools for the Enhanced Prediction of Explosion Pressure Development in Early Project Phase and Deflagration to Detonation Transition Risk on US GOM Drilling and Production Facilities	2	24	$ 2.9	$ 3.6
6404	Composite or Carbon-Fiber Reinforced Riser for Dry Tree Drilling or Production of High Pressure Wells	2	36	$10.1	$16.0
6503	Development of Best Practices and Risk Mitigation Measures for Deepwater Cementing in SBM and OBM	2	24	$ 2.5	$ 3.2
6505	Early Kick Detection Technology and Demonstration	2	30	$ 2.2	$ 3.0
6801	Ultra-deep In-situ Spectrographic and Multiple Physical Sample Capture System for Autonomous Underwater Vehicles	1	21	$ 1.4	$ 1.7
TOTAL				**$25.8 (72%)**	**$35.9**

UDW Program Timeline

PROGRAM	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
2009	Project Executions											
2010	Project Executions											
2011	Evaluate Bids			NETL Reviews		DOE Approvals		Project Contracting			Commence Projects	Project Executions
2012	RFP Creations		NETL Reviews				DOE Approvals		Bid TAIs		Evaluate Bids	

PROGRAM	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14
2009	Project Executions						Project Closeouts/ Transfers to DOE					
2010	Project Executions						Project Closeouts/ Transfers to DOE					
2011	Project Executions						Project Closeouts/ Transfers to DOE					
2012	NETL Reviews	DOE Approvals	Project Contracting					Commence Projects	Project Executions	Project Closeouts/ Transfers to DOE		

IF Program is extended …

PROGRAM	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15
2009	Project Executions											
2010	Project Executions											
2011	Project Executions											
2012	Project Executions											
2013	Solicit CTRs		Review CTRs			RFP Creations		NETL Reviews				DOE Approvals…

UDW Completed Project Success Stories (through Aug 2013)

Commercialized

- *Knowledge Reservoir:* DW reservoir characterization DB (07121-1701)
- *SEG:* Geophysical models (07121-2001)
- *Stratamagnetic Software:* MPD model and simulation (08121-2502-01)
- *Ecolyse:* Bacterio-phages (08121-2902-04)
- *Livermore Instruments:* Bacteria measurement instrumentation (08121-2902-06)
- *Lockheed Martin:* DW AUV (09121-3300-05)
- *Teledyne Blueview:* Subsea acoustic sensors for DW inspections (09121-3300-08)
- *Tubel LLC:* Short-hop wireless power & data transfer (09121-3500-01)

Implemented in Others' Commercial Products/Portfolios

- *Schlumberger SPT; Emerson Roxar, Framo, Kongsberg, FMC:* Erosion tables and Virtual flow meter test results (07121-1301)
- *Schlumberger SPT, Kongsberg:* Flow assurance test results (07121-1603a, b, 09121-3300-02)
- *Naval Research Lab, National Hurricane Center, NOAA:* Storm prediction DB and models (07121-1801)

RPSEA Administered Cost Share Research Overview: Ultra-Deepwater Program

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23rd Ultra-Deepwater Advisory Committee Meeting
NETL Office, Sugar Land, TX
Tuesday, September 17, 2013