ULTRA-DEEPWATER ADVISORY COMMITTEE (UDAC)

SEPTEMBER 17, 2013
TWENTY-THIRD MEETING

MEETING MINUTES

A Federal Advisory Committee to the U.S. Secretary of Energy

I hereby certify that this transcript constitutes an accurate record of the Ultra-Deepwater Advisory Committee meeting held on September 17, 2013.

Elena Melchert
Acting Designated Federal Officer

9-23-13
Date

ULTRA-DEEPWATER ADVISORY COMMITTEE
23RD MEETING; SEPTEMBER 17, 2013; WEB MEETING

ATTENDEES:

Committee Members
Mary Jane Wilson, Chair
Doug Foster, Vice Chair
George Cooper
Hartley Downs
James Litton
Stephen Pye
Lesli Wood

RPSEA
James Pappas, Vice President
Bob Siegfried, President

U.S. Department of Energy
Elena Melchert,
Acting Designated Federal Officer
Erica Folio, Committee Manager
Roy Long, Technology Manager,
National Energy Technology Laboratory
Dasari V. Rao, Division Leader,
Los Alamos National Laboratory
Michelle Rathbun, Meeting Recorder, IBM
Kelly Rose, Technology Coordinator,
National Energy Technology Laboratory

DISCUSSION:

Committee Business

- The meeting was opened at 1:00 p.m. EST by the Acting Designated Federal Officer, Elena Melchert.
- Ms. Melchert took roll call and announced that a quorum was present; 7 of 8 committee members were in attendance.
- Ms. Melchert gave opening remarks about DOE's Office of Fossil Energy.

Ultra-Deepwater Research Portfolio Presentations

- Mr. Pappas presented RPSEA Administered Cost-Share Research Overview (Attachment 4).
- Ms. Rose presented NETL ORD's EPAct Complementary Program (Attachment 5).
- Dr. Rao presented LANL Ultra-Deepwater Risk Assessment (Attachment 6).

Overview of the DRAFT 2014 Annual Plan

- Ms. Melchert explained the contents of the draft plan and the process for UDAC to review the portfolio, discuss general thoughts, and to make subcommittees (Attachment 3).
- The Committee discussed themes from the research portfolio.

Establishment of Subcommittees

- Committee members established two Subcommittees.
  - Sunset Subcommittee: George Cooper (Chair), Hartley Downs, Mary Jane Wilson, Lesli Wood
  - Program Subcommittee: Doug Foster (Chair), Quenton Dokken, Jim Litton, Stephen Pye
- Ms. Melchert reviewed the process and next steps.
- There were no public comments.
- The Committee Chair, Mary Jane Wilson, adjourned the meeting at 4:41 p.m.

ATTACHMENTS:

Number	Description
Attachment 1	Delegation of Acting Designated Federal Officer
Attachment 2	Meeting Agenda
Attachment 3	UDAC Overview
Attachment 4	RPSEA Administered Cost-Share Research Overview
Attachment 5	NETL ORD's EPAct Complementary Research
Attachment 6	Ultra-Deepwater Risk Assessment

Attachment 1

Department of Energy
Washington, DC 20585

MEMORANDUM FOR FILE

TO: ULTRA-DEEPWATER ADVISORY COMMITTEE

FROM: GUIDO DEHORATIIS
DESIGNATED FEDERAL OFFICER
UNCONVENTIONAL RESOURCES TECHNOLOGY ADVISORY COMMITTEE

SUBJECT: **Acting Designated Federal Officer**

I hereby designate Elena Melchert, Division Director, Oil and Gas Safety and Environmental Sustainability, to serve as the Acting Designated Federal Officer for all remaining meetings of the Ultra-Deepwater Advisory Committee.

Attachment 2

Department of Energy
Washington, DC 20585

23rd Meeting of the Ultra-Deepwater Advisory Committee
Tuesday, September 17, 2013

Online Meeting: https://usdoe.webex.com/usdoe/mc
Meeting Number: 999 672 456
Meeting Password: password
Call-in toll number (US/Canada): 1-650-479-3208
Access code: 999 672 456

Agenda

12:45 pm	*Registration* Member Login; Speaker Login
1:00	Call to Order, Member Roll Call, Welcome Administrative topics
	Opening Remarks by the Designated Federal Officer
1:15	Overview of the Oil and Gas Ultra-Deepwater Research Program -DOE-RPSEA portfolio -NETL portfolio -LANL Risk Assessment
2:45	Overview of the *DRAFT 2014 Annual Plan*
3:45	Establishment of ad hoc Review Subcommittees and Chairs
4:45	Public Comments, if any Next Steps
5:00 pm	Adjourn

Approved:

Elena Melchert
Acting Designated Federal Officer

9-6-13
Date

Attachment 3

Ultra-Deepwater Advisory Committee

Elena Melchert

Acting Designated Federal Officer

Ultra-Deepwater Advisory Committee

September 17, 2013

U.S. DEPARTMENT OF ENERGY | Fossil Energy

2014 Annual Plan Review Process

- September 17, 2013; Web Meeting
  - Overview of DOE Research Program
  - Establish subcommittees
- October 8, 2013; Web Meeting
  - Subcommittees present their reports to UDAC
  - UDAC develops *final* findings and recommendations on the *2014 Annual Plan*
  - Chair appoints Editing Subcommittee to develop UDAC's written report
    - Editing Subcommittee may not change the letter or spirit of the UDAC findings or recommendations
  - Editing Subcommittee begins meeting immediately after the UDAC meeting adjourns

2014 Annual Plan Review Process

- Conference Call Meeting on November TBD
  - UDAC meets via conference call to vote on the Editing Subcommittee report
  - Chair delivers the UDAC final recommendations to the Secretary of Energy via the Designated Federal Officer (DFO)

Next Steps

- **September 17, 2013**: Begin review
- **October 8, 2013**: Deliberate on recommendations
- **November TBD**: Vote on Editing Subcommittee report

Attachment 4

RPSEA Administered Cost Share Research Overview: Ultra-Deepwater Program

James Pappas, P.E.

Vice President, Ultra-Deepwater Programs

jpappas@rpsea.org

(281) 690-5511

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

Outline

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

Attachment 4

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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Research Partnership to Secure Energy for America

Attachment 4

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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Attachment 4

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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Attachment 4

Technical Accomplishments FY 2013

Projects Completed in FY 2013

Attachment 4

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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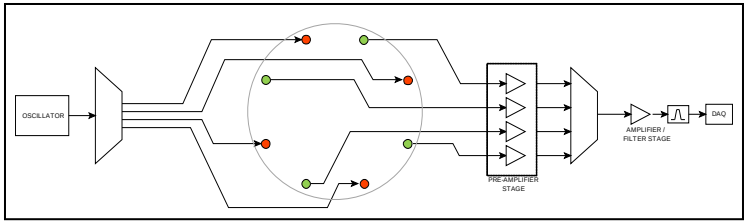
Safety & Environmental Sustainability: Drilling, Completions & Interventions

Attachment 4

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

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

Significant Findings

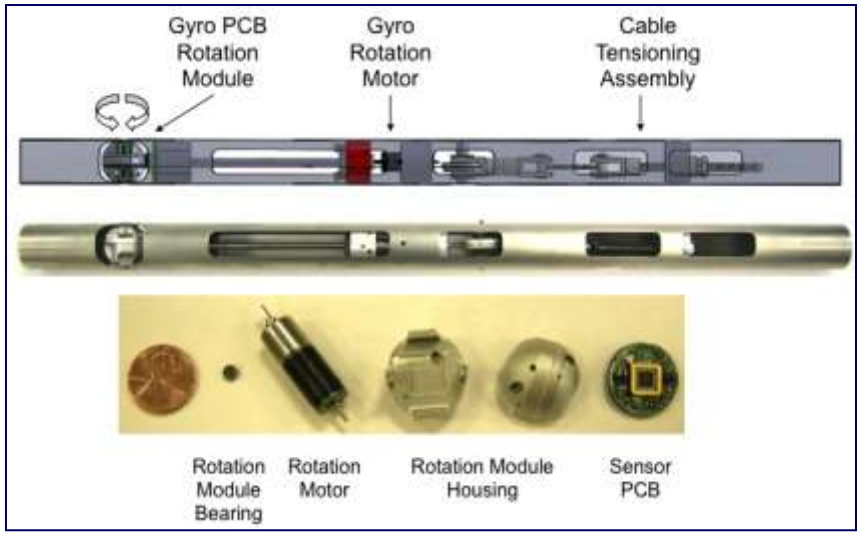
- Full ID flow control system was created & developed that can be placed in wellbore laterals requiring less than 1 Watt of power to open or close sleeves.
- Wireless power transfer concept was determined to be feasible at much higher efficiencies than originally conceived and at much longer distances 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

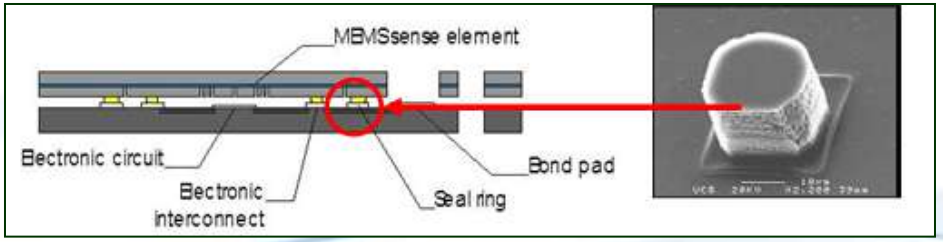
- *At source transmission of pressure, temperature, flow meter & fluid Identification data.*
- *Real time transmission or reception of data and orders – immediate control and feedback!*
- *Useful in multilaterals.*
- *Can be used as an additional safety barrier.*

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

Attachment 4

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.*

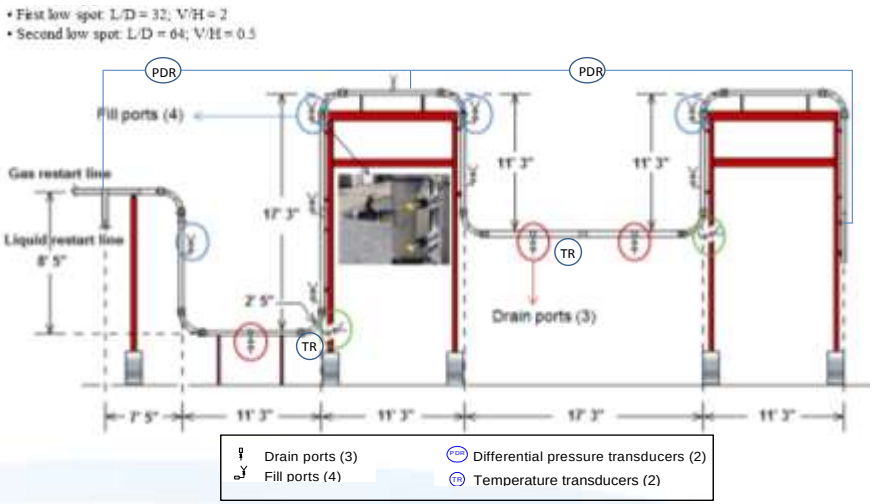
Safety & Environmental Sustainability: Stabilized Flow & Flow Assurance

Attachment 4

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

Attachment 4

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.*

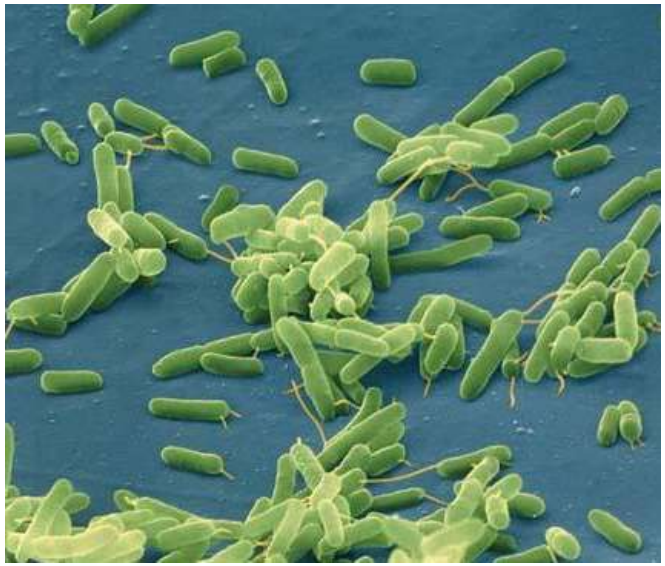
Safety & Environmental Sustainability: Safety & Environmental Systems

Attachment 4

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

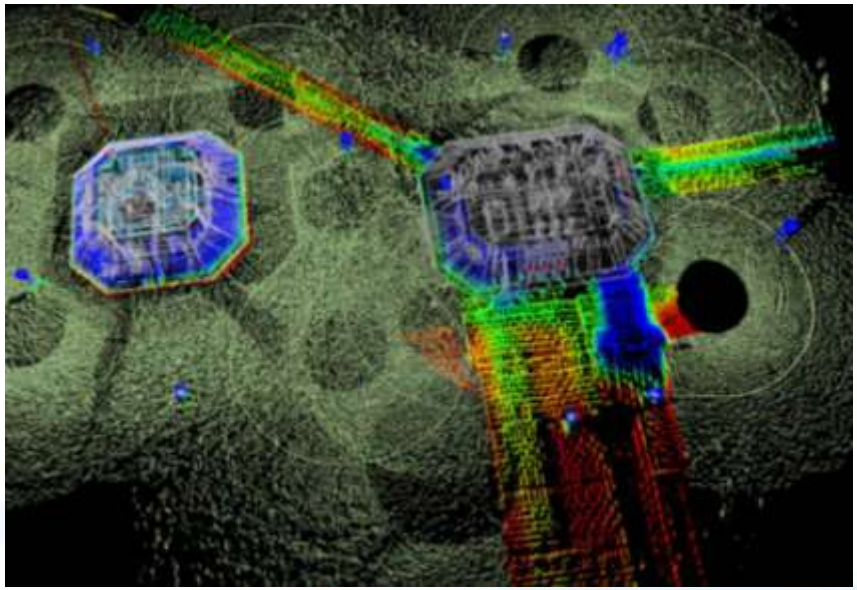
- Simplified optical system by reducing the 9 lasers in the LLNL system to only 2 in production version with corresponding decrease laser alignment complexity.
- Feasibility of high data rate comms using RF conduction through saltwater as a communications mechanism proven with a sea trial demonstrating 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.

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).*

Attachment 4

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

Attachment 4

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

RPSEA
Research Partnership to Secure Energy for America

Attachment 4

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

RPSEA
Research Partnership to Secure Energy for America

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

Attachment 4

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

Attachment 4

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**

Attachment 4

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…

Research Partnership to Secure Energy for America

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)

Attachment 4

RPSEA Administered Cost Share Research Overview: Ultra-Deepwater Program

James Pappas, P.E.

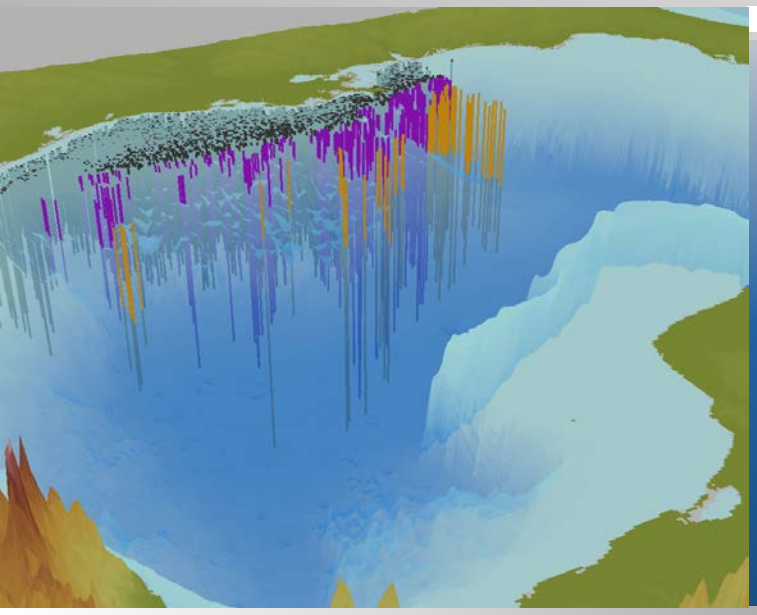
Vice President, Ultra-Deepwater Programs

jpappas@rpsea.org

(281) 690-5511

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

Attachment 5



UDW Portfolio Update

NETL ORD's EPAct Complementary Research

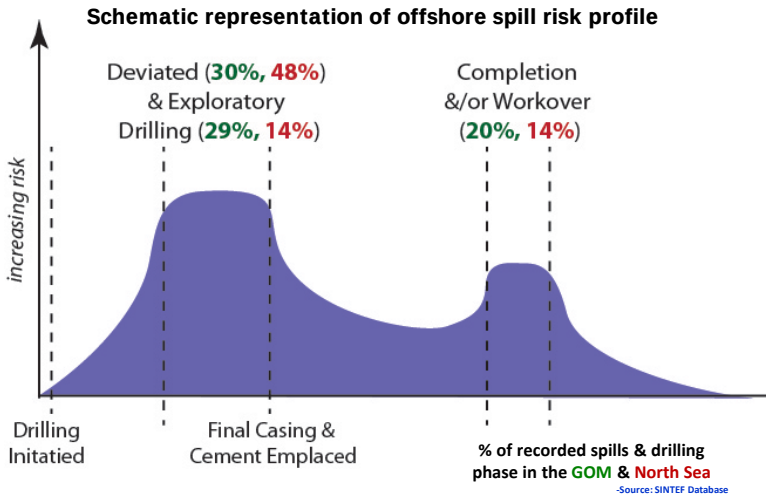
Reducing risks associated with ultra-deepwater hydrocarbon systems

Kelly Rose, Ultra-Deepwater Technical Coordinator

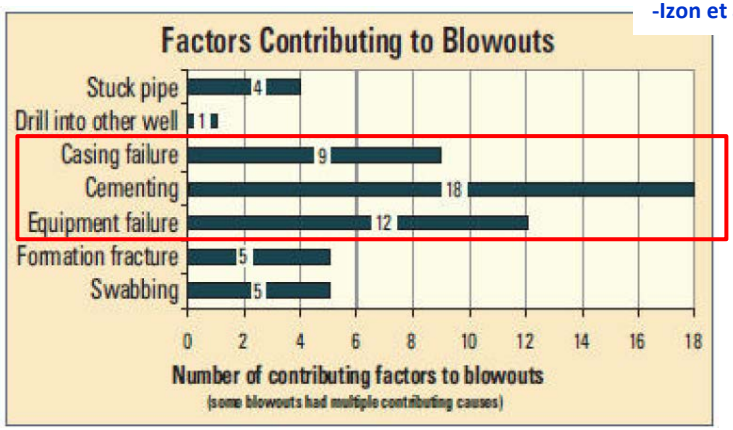
September 17th, 2013

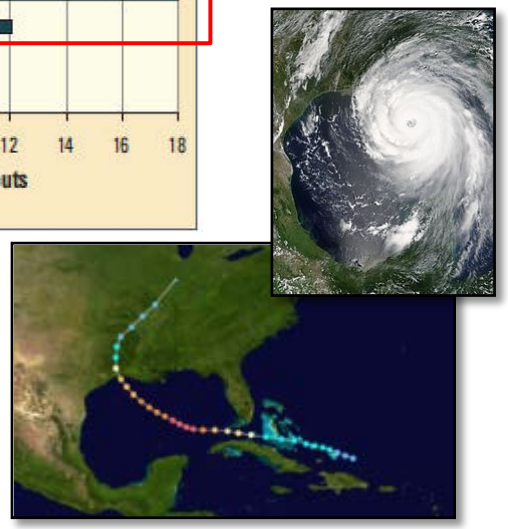
Drivers NETL's Complementary UDW R&D Program Targets Top Offshore Spill Risks

Attachment 5



-Izon et al. 2007





- **Cementing Failures**
- **Equipment & Casing Failures**
- **Higher risk targets, "exploratory" systems**

- Recent offshore events, such as Katrina/Rita (2005) & Deepwater Horizon spill (2010)
- 2010 Executive Order 13547, Interagency Ocean Policy Task Force (IOPTF)
  - Executive agencies (including DOE) challenged to enhance national stewardship of the ocean, coasts, &Great Lakes
- 2012 Challenges Identified by DOI's OESAC Spill Prevention Subcommittee

  Deep water and offshore frontier areas face production risks that are fundamentally distinct from onshore operations:
  - Drilling phase identified as having highest number of risks and uncertainties
  - Concerns about fracturing the formation can have a big impact on well design, lost circulation, and loss of well control
  - Well design incorporating multiple barriers are essential to safety.

Complementary Program Portfolio Attachment 5
Ultra-Deepwater (UDW)

Improved Science Base for Materials and Wellbore Integrity

- Characterizing the Behavior of Metal-Based Systems Used for Control Devices in Extreme Environments *[Lead: Jeff Hawk] 2010 to present*
- Improving Science-Base for Wellbore Integrity, Foam Cements *[Lead: Barbara Kutchko] 2010 to present*
  - *FY13 merit review, Excellent rating*
- Evaluation of Lithology:Cement:Casing Barrier Integrity under UDW Subsurface Conditions *[Leads: Margaret Ziomek-Moroz and Barbara Kutchko]* ***NEW***

Reducing Risks & Mitigating Impacts Associated with Extreme Offshore Conditions

- Quantifying Complex Fluid-Phase Properties at High Pressure/High Temperature (HPHT) *[Lead: Isaac Gamwo] 2010 to present*
- Assessing Risks and the Potential for Environmental Impacts for Deepwater and Ultra-Deepwater GOM Resources *[Lead: Kelly Rose] 2010 to present*
  - *FY13 merit review, Very Good rating*

Improving Safety through Rapid Detection and *In Situ* Characterization

- Improving Deepwater Drilling Safety through Enhanced Understanding of Multiphase Flow Dynamics of Hydrocarbon Mixtures *[Leads: Bob Warzinski and Frank Shaffer] 2010 to present*
  - *FY13 merit review, Very Good rating*
- Risk Reduction at the Drill Bit - Adaptation of Existing Technology to Reduce Risks Associated with Deep and Ultra-Deep Drilling *[Lead: Kelly Rose] 2013 to present*

UDW Tech Transfer to Date:

Attachment 5

www.edx.netl.doe.gov/udw

47 Conference Presentations

20 Published Articles & Reports

- Additional manuscripts undergoing internal and external peer review

12 Datasets released via EDX

2 Data-driven tool/app via EDX

NOW UPDATED WITH FY13 Q3 PUBS, PRESENTATIONS, TOOLS, ETC

Complementary Program Portfolio Attachment 5
Ultra-Deepwater (UDW)

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- Improving Science-Base for Wellbore Integrity, Foam Cements *[Lead: Barbara Kutchko]*
- ***NEW*** Evaluation of Lithology:Cement:Casing Barrier Integrity under UDW Subsurface Conditions *[Leads: Margaret Ziomek-Moroz and Barbara Kutchko]*

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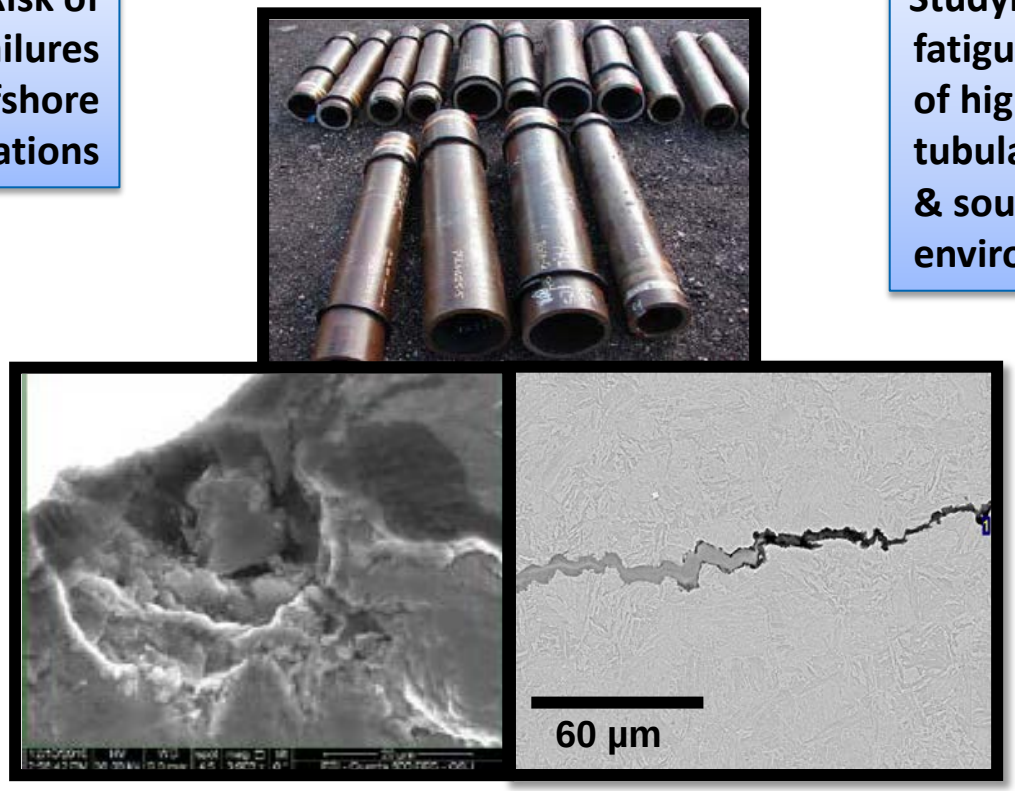
Characterizing the Behavior of Metal-Based Systems Used for Control Devices in Extreme Environments (Lead: *Hawk)*

Attachment 5

Reducing Risk of Material Failures During Offshore Operations



Studying corrosion & fatigue performance of high-strength tubulars in seawater & sour brine environments

Improving understanding of how conventional alloys & advanced alloys and surface treatments may allow for safe and reliable use of metallic components in extreme wellbore conditions

Characterizing the Behavior of Metal-Based Systems Used for Control Devices in Extreme Environments (Lead: *Hawk)*

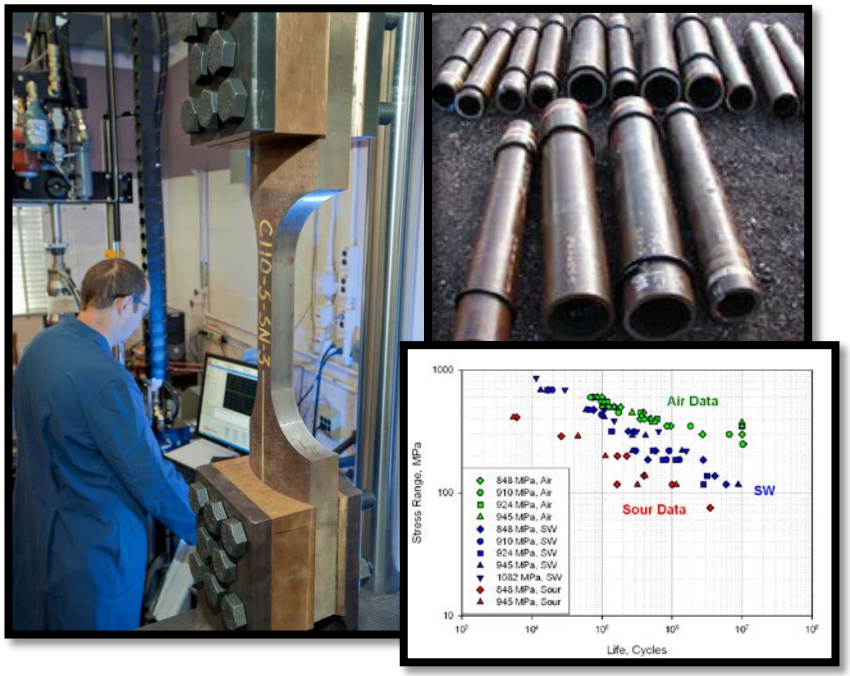
Attachment 5

Driver: Lack of data on key safety-performance metrics for metallic components at extreme conditions

Project Goal: Expand the science base on the performance of new HPHT alloys and surface treatments designed for use in extreme conditions

pre-FY13 Status: ORD strength/ corrosion experiments of common **UDW** alloys to date found:

- No evidence one alloy is superior to another
- Best materials for conventional drilling do not translate to extreme conditions
- Prior seawater and air tests not relevant for HPHT or sour systems
- Identified preferential locations for pit and fatigue crack development = point of weakness in HPHT/UDW



FY13 R&D Focus: On corrosion & fatigue performance at HPHT conditions of advanced metallic surface treatments & metallic welds

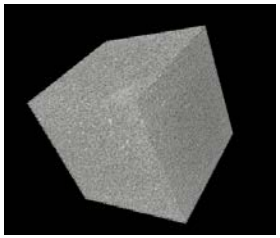
Anticipated FY13 Products:

- Report characterizing the behavior of "welded" metal-based systems used for piping and control devices in extreme conditions
- Report summarizing evaulation of surface treatments on corrosion & fatigue behavior at HPHT
  - Hammer peening vs. Low Plasticity Burnishing (LPB)

Improving Science-base for Wellbore Integrity of Foamed Cements
(Lead: Kutchko)

Attachment 5

API RP10-B at room P,T



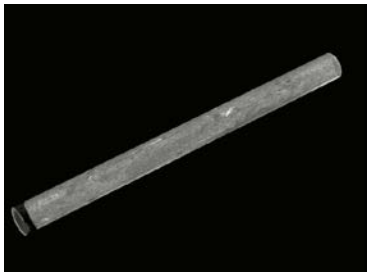
Development of imaging and analysis protocols

Lab-based Pressure Vessel (on loan from Schlumberger)

Reducing Risk of Cement-Related Failures During Offshore Operations

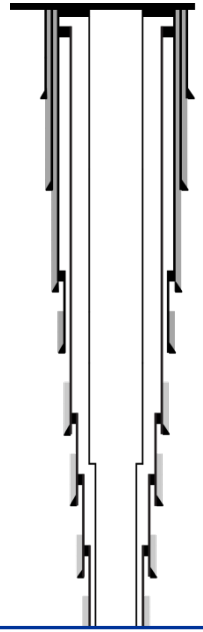
Evaluation over range of mix-design parameters

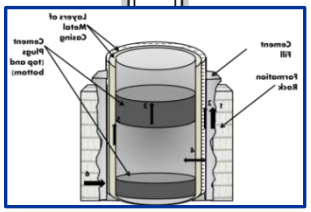
Slip Stream at Wellhead (with BP & Schlumberger)



Evaluation of mix designs under field conditions

***In situ* Conditions**





CFD to simulate mesostructure

Improving Science-base for Wellbore Integrity of Foamed Cements
(Lead: Kutchko)

Driver: Unknown properties of foamed cements under downhole conditions (high P, T). Need to know strength & permeability.

Project Goals:

- Database of foamed cement properties—mesostructure (e.g., gas distribution), strength, permeability for various mix designs.
- Predictive relationship for properties as function of mesostructure.
- Predictive relationship for mesostructure based on mix design, placement conditions, etc.

pre-FY13 Status:

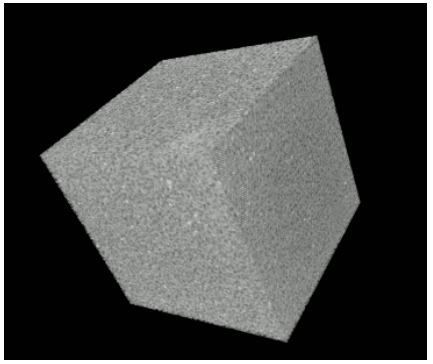
- Completed gap assessment (NETL-TRS-003-2012)
- Developed imaging & analysis techniques (NETL-TRS-2-2013)
- Analyzed first field sample (slip-stream) using CT (TRS under develop.)

FY13 Focus:

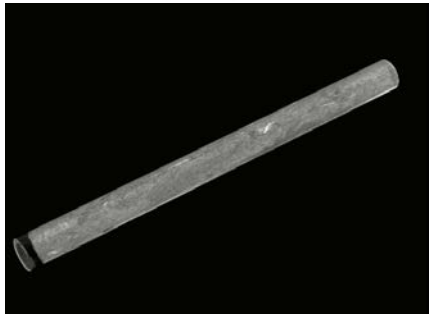
- Characterize multiple slip-stream samples from 3 major service companies
- Characterize lab-based samples for different foaming agents, stabilizers, and foam qualities at two pressures (500 psi, 1000 psi)

Anticipated FY13 Products:

- TRS describing imaging & analysis data on slip-stream samples
- TRS describing data on variation in physical properties as function of mix design



3D CT Scan of a 10.4 mm^3 digital subsection of 10% foam quality cement



3D CT Scan of field-generated foamed cement. Foam quality 47.8%; collected at a pressure of ~290 psi

NEW Evaluation of Lithology:Cement:Casing Barrier Integrity under UDW Subsurface Conditions

(Leads: Ziomek-Moroz & Kutchko)

Driver: Changes in pressure and temperature cycles or corrosion can cause the development of microannuli (potential flow paths) in offshore cement barriers. This is especially significant in ultra-deepwater wells, which are large heat exchangers and are drilled in extreme HP/HT environments.

Project Goal: Study the interactions between wellbore materials that may lead to catastrophic failure of the well over time

pre-FY13 Status: This is a new project

FY13 Focus:

- Complete a knowledge/gap analysis study to constrain key research concerns.
- Use the results of the gap analysis to drive initial FY13 experiments.

Anticipated FY13 Products:

- Report summarizing findings of scoping and gap study
- Results from initial experiments to determine potential flow paths in HP/HT environments

Complementary Program Portfolio Attachment 5
Ultra-Deepwater (UDW)

Improved Science Base for Materials and Wellbore Integrity

- Characterizing the Behavior of Metal-Based Systems Used for Control Devices in Extreme Environments *[Lead: Jeff Hawk]*
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- ***NEW*** Evaluation of Lithology:Cement:Casing Barrier Integrity under UDW Subsurface Conditions *[Leads: Margaret Ziomek-Moroz and Barbara Kutchko]*

Reducing Risks & Mitigating Impacts Associated with Extreme Offshore Conditions

- Quantifying Complex Fluid-Phase Properties at High Pressure/High Temperature (HPHT) *[Lead: Isaac Gamwo]*
- Assessing Risks and the Potential for Environmental Impacts for Deepwater and Ultra-Deepwater GOM Resources *[Lead: Kelly Rose]*

Improving Safety through Rapid Detection and *In Situ* Characterization

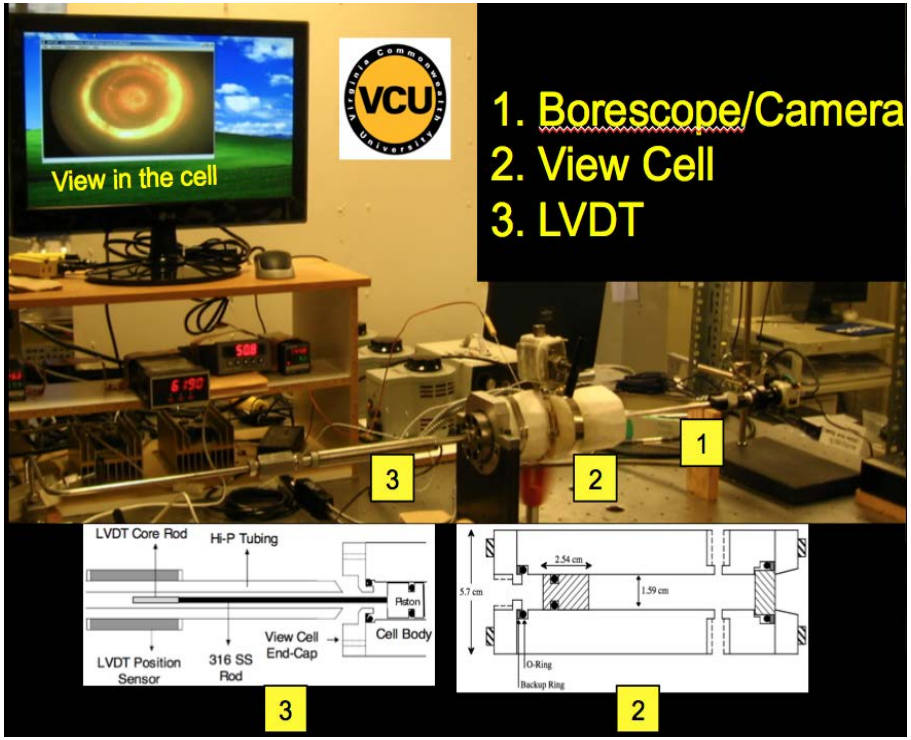
- Improving Deepwater Drilling Safety through Enhanced Understanding of Multiphase Flow Dynamics of Hydrocarbon Mixtures *[Leads: Bob Warzinski and Frank Shaffer]*
- Risk Reduction at the Drill Bit - Adaptation of Existing Technology to Reduce Risks Associated with Deep and Ultra-Deep Drilling *[Lead: Kelly Rose]*

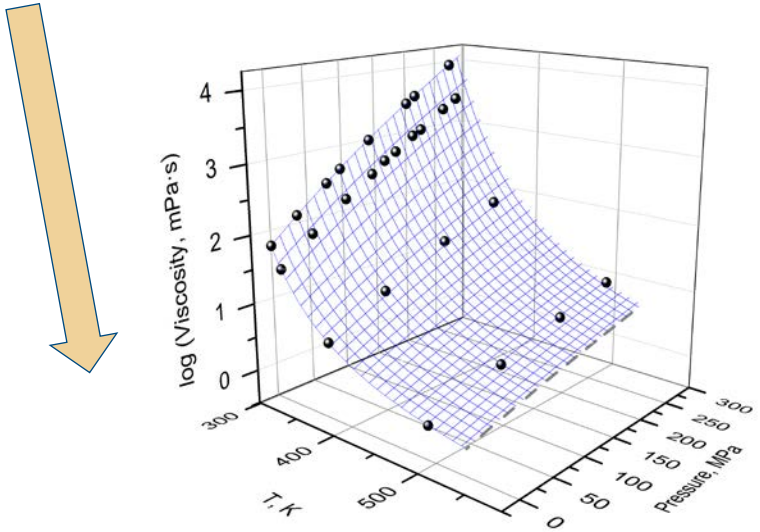
Quantifying Complex Fluid-Phase Properties at High Pressure/High Temperature

Attachment 5

[Project Lead: Gamwo]

Expand data on density & viscosity to 40 kpsi, 500 °F (pure compounds, mixtures, crude)





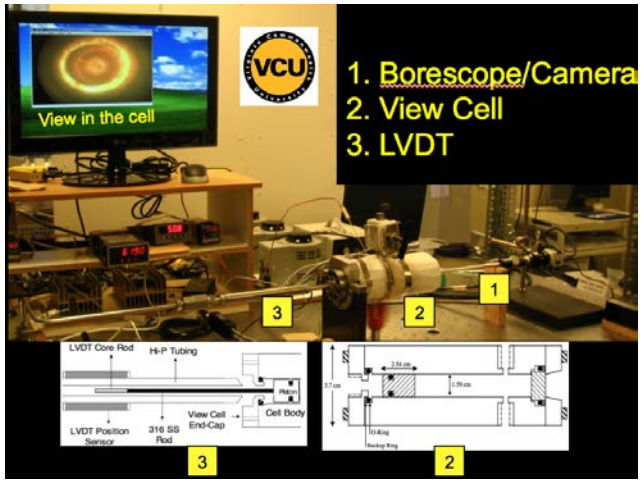
Develop higher accuracy equations of state

Quantifying Complex Fluid-Phase Properties at High Pressure/High Temperature

Attachment 5

[Project Lead: Gamwo]

Driver: Limited availability of hydrocarbon fluid properties at high PT associated with deepwater wells

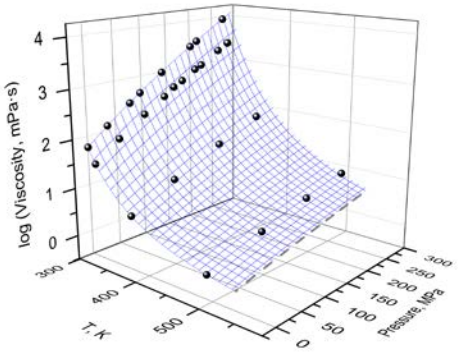


Project Goals:

1) Expand database on hydrocarbons to 40kpsi & 500 °F
2) Develop higher accuracy equations of state for high PT
3) Develop standards for high PT property measurement

pre-FY13 Status:

- Built apparatuses for density & viscosity measurement
- Characterized pure compounds: densities (19), viscosities (4)
- Characterized density of binary mixture (C3+C10)
- Developed higher accuracy EOS for pure compounds
- Identified/characterized viscosity standard



FY13 Focus:

- Characterize binary mixtures: densities & viscosities
- Characterize crude oil: density
- Extend EOS to real oil mixtures; develop EOS tool

Anticipated FY13 Products:

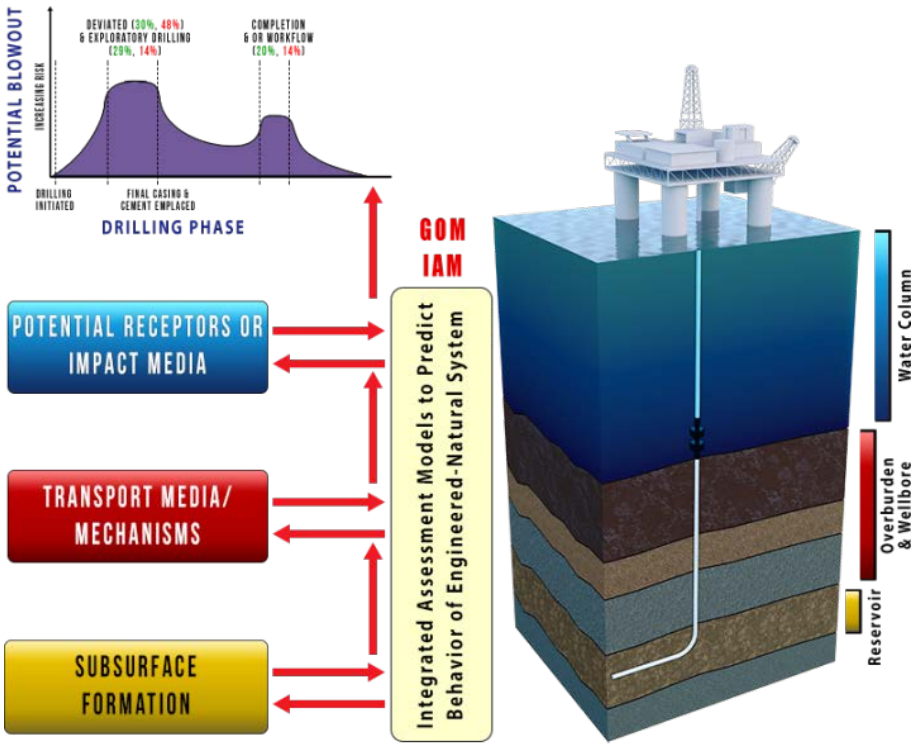
- TRS detailing density datasets on binary mixtures
- Web-based, user-friendly program for density EOS

Assessing Risks and the Potential for Environmental Impacts for Deep & Ultra-Deepwater GOM

Attachment 5

[Project Lead: Rose]

Developing tools and information to evaluate and predict what happens in extreme offshore hydrocarbon systems

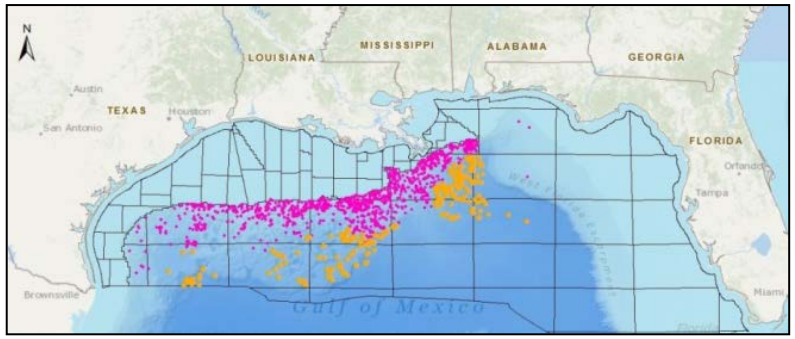


NETL Gulf of Mexico IAM

1st coordinated platform to allow for:

- **independent,**
- **rapid-response,**
- **science based prediction**

of UDW hydrocarbon production risks and environmental impacts



BLOSOM + EDX Energy Data eXchange + GEO CUBE + VGM TOOL

Coordinated data:simulation system for oil spill impact & risk evaluation

Assessing Risks and the Potential for Environmental Impacts for Deep & Ultra-Deepwater GOM

[Project Lead: Rose]

Driver: Need for a cohesive suite of tools and data to support independent, rapid science-based prediction of UDW hydrocarbon risks and assessment of spills

Project Goal: Reducing risks and environmental impacts from extreme offshore hydrocarbon production

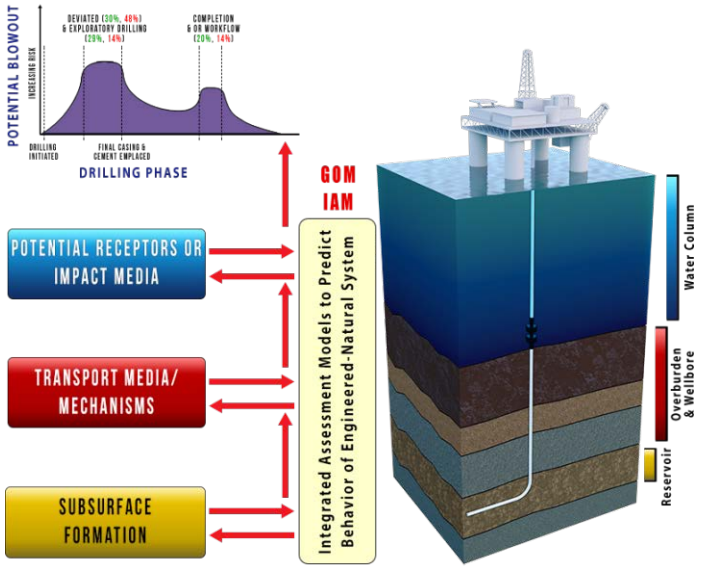
pre-FY13 Status:

- Released GOM Geocube, online map based tool containing key spatial data for the GOM
- TRS summarizing key GOM impact receptor analysis
- Completed beta water column component model, BLOSOM
- Continued development of GOM subsurface database

FY13 Focus:

- Complete beta GOM subsurface database
- Complete beta development of cumulative risk tool
- Complete integration of 3 IAM component models
- Shakedown BLOSOM, run in API oil spill modeling study

Anticipated FY13 Products: Beta integrated platform to allow for independent, rapid-response, & science based prediction of UDW hydrocarbon production risks and environmental impacts



BLOSOM + EDX Energy Data eXchange + GEO CUBE + VGM TOOL

Coordinated data:simulation system for oil spill impact & risk evaluation

Complementary Program Portfolio Attachment 5
Ultra-Deepwater (UDW)

Improved Science Base for Materials and Wellbore Integrity

- Characterizing the Behavior of Metal-Based Systems Used for Control Devices in Extreme Environments *[Lead: Jeff Hawk]*
- Improving Science-Base for Wellbore Integrity, Foam Cements *[Lead: Barbara Kutchko]*
- ***NEW*** Evaluation of Lithology:Cement:Casing Barrier Integrity under UDW Subsurface Conditions *[Leads: Margaret Ziomek-Moroz and Barbara Kutchko]*

Reducing Risks & Mitigating Impacts Associated with Extreme Offshore Conditions

- Quantifying Complex Fluid-Phase Properties at High Pressure/High Temperature (HPHT) *[Lead: Isaac Gamwo]*
- Assessing Risks and the Potential for Environmental Impacts for Deepwater and Ultra-Deepwater GOM Resources *[Lead: Kelly Rose]*

Improving Safety through Rapid Detection and *In Situ* Characterization

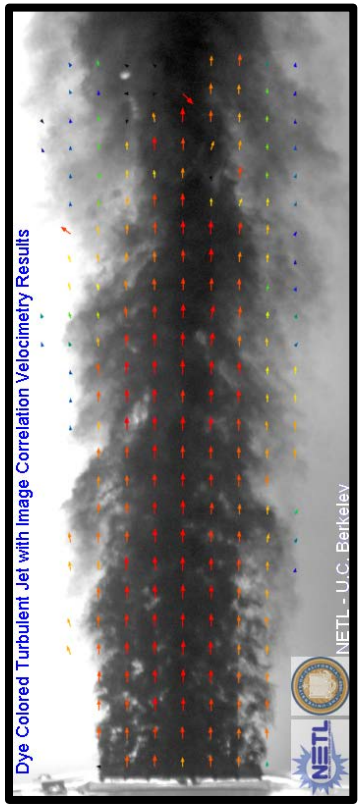
- Improving Deepwater Drilling Safety through Enhanced Understanding of Multiphase Flow Dynamics of Hydrocarbon Mixtures *[Leads: Bob Warzinski and Frank Shaffer]*
- Risk Reduction at the Drill Bit - Adaptation of Existing Technology to Reduce Risks Associated with Deep and Ultra-Deep Drilling *[Lead: Kelly Rose]*

Improving Deepwater Drilling Safety through Enhanced Understanding of Multiphase Flow Dynamics of Hydrocarbon Mixtures

Attachment 5

[Project Lead: Warzinski]

Develop software to quantify flow accurately using high speed video from ROV



4” turbulent dyed water jet studied at UCB

CH_4 bubble w/ hydrate shell

Develop science base to predict hydrate formation & hydrocarbon compositions & volumes in water column plumes

Improving Deepwater Drilling Safety through Enhanced Understanding of Multiphase Flow Dynamics of Hydrocarbon Mixtures

Attachment 5

[Project Lead: Warzinski]

Driver: Quantification of gas/oil flows using high-speed video from ROVs

Project Goals: Develop video-analysis tool for accurate quantification of oil/gas plume rates; incorporate hydrate formation in quantification tool

pre-FY13 Status:

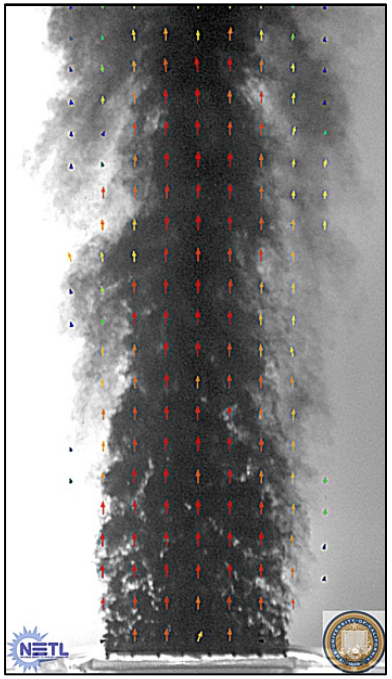
- Completed scoping for appropriate surrogate multi-phase conditions for validation
- Completed data collection for water-water and air-water plumes (UC-B facility).
- Completed data collection for Type I/II hydrates (methane, ethane, propane) (NETL facility)

FY13 Focus:

- [Perform oil-water(-gas) experiments at OHMSETT (funded by BSEE)]
- Validate video-analysis tool using datasets on air-water, water-water, and oil-water
- Complete analysis of experimental data on Type I/II hydrates
- Initiate incorporation of hydrates into video-analysis tool

Anticipated FY13 Products:

- Video-analysis tool (prototype) for quantifying plume rates using high speed images from ROV



4” turbulent dyed water jet studied at UCB

CH_4 bubble w/ hydrate shell

Risk Reduction at the Drill Bit - Adaptation of Existing Technology to Reduce Risks Associated with Deep and Ultra-Deep Drilling

[Project Lead: Rose]

Driver: Significant concerns have been raised about how to safely develop UDW resources and ensure domestic supply. Detecting in a timely, efficient manner when there is a kick is a significant challenge in deepwater systems.

Project Goal:

To develop a low cost means for detecting kicks when they happen at the bit, utilizing largely existing wellbore data

pre-FY13 Status:

- Initiated scoping and feasibility study
- Filed "report of invention" in preparation for NETL patent review process

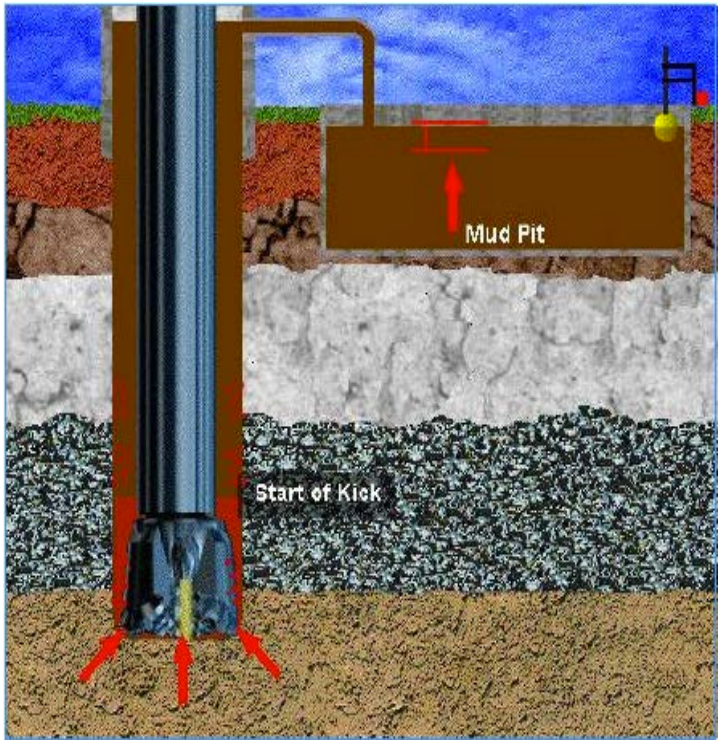
FY13 Focus:

- Complete scoping and approach feasibility study
- Initiate numerical and experimental efforts to validate and implement approach for supporting early kick detection

Anticipated FY13 Products:

- Preliminary tool/approach for early kick detection

Early Detection is Critical



- **Maintain control of well**
- **Reduce environmental, human, and economic impacts**

UDW Tech Transfer to Date:

Attachment 5

www.edx.netl.doe.gov/udw

47 Conference Presentations

20 Published Articles & Reports

- Additional manuscripts undergoing internal and external peer review

12 Datasets released via EDX

2 Data-driven tool/app via EDX

NOW UPDATED WITH FY13 Q3 PUBS, PRESENTATIONS, TOOLS, ETC

Attachment 6

70 YEARS OF CREATING TOMORROW

Los Alamos NATIONAL LABORATORY

Ultra-deep Water Risk Assessment

DV Rao

September 17, 2013

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Operated by Los Alamos National Security, LLC for the U.S. Department of Energy's NNSA

NNSA National Nuclear Security Administration

Attachment 6

Summary of Phase-I (1st-yr) Analyses

Risk-ranking of candidate technologies

Model Baseline and Data

- Generic ultra-deep water drilling operation in GoM with MODU
- Overpressure Drilling consistent with IADC and API guidance.
- Class VII BOP with 1 BSR and 1 CSR (BOP Controls API-RP 53).
- End-to-end probabilistic risk assessment (APET and FT)
- Well dynamics modeling for blowout time scales and flow rates
- Reliability data from 3rd Party (SINTEF) and from JIP efforts

OTC Abstract submitted summarizing results

Ranked list of technologies

1. Real-time data from the bottom-hole
2. VSP (see also No. 9 below)
3. Automated kick detect (with 1 above)
4. Human performance improvement:
   - MWD alerts during swabbing, fishing, etc.
   - Rotating control device
   - 'quick-response' BHP control (closed cycle)
5. Inline DP BOP/Check-valve
6. Reliable LMRP & Emergency Containment
7. Improved BOP
   - Casing, Collar and DP locator
   - Larger choke/vent lines and higher capacity mud-separator
8. Sub-salt 3-D seismic after setting shoe
9. Well dynamics modeling (1-d ➔ 3-d)

Attachment 6

Summary of Phase-II (2nd-yr) Analyses

Driver: How can we achieve orders of magnitude improvement?

Project goal: Identify risk-important technologies and their TRL for Ultra-deep Paleogene

Technical Approach: Systems and risk modeling to estimate risk management

Uncertainties and Knowledge-Gaps

- Peleogene Wilcox formations in ultra-deep-waters of GoM
- Dynamics of salt movement
- Drilling window is small and very high uncertainty (fewer off-set wells)
- Increased probability of ballooning, mud losses and well-control issues.
- Multiple sands
- High Pressures and potentially High Temperatures
- Ocean dynamics (RPSEA-1402 Data)

Model Baseline and Data

- Generic well in GoM[1]
- Lithology data from multiple sources [2-3]
- Closed Loop Drilling[4-6] (or Managed Pressure Drilling)
- MWD suite of sensors[6] + Coriolis flow meter

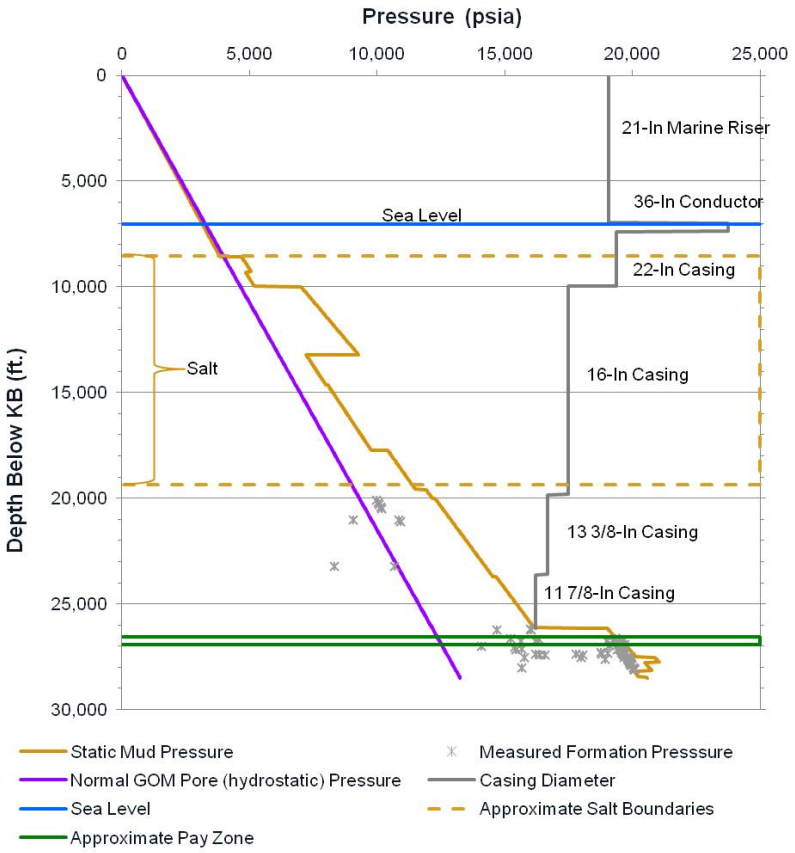
References

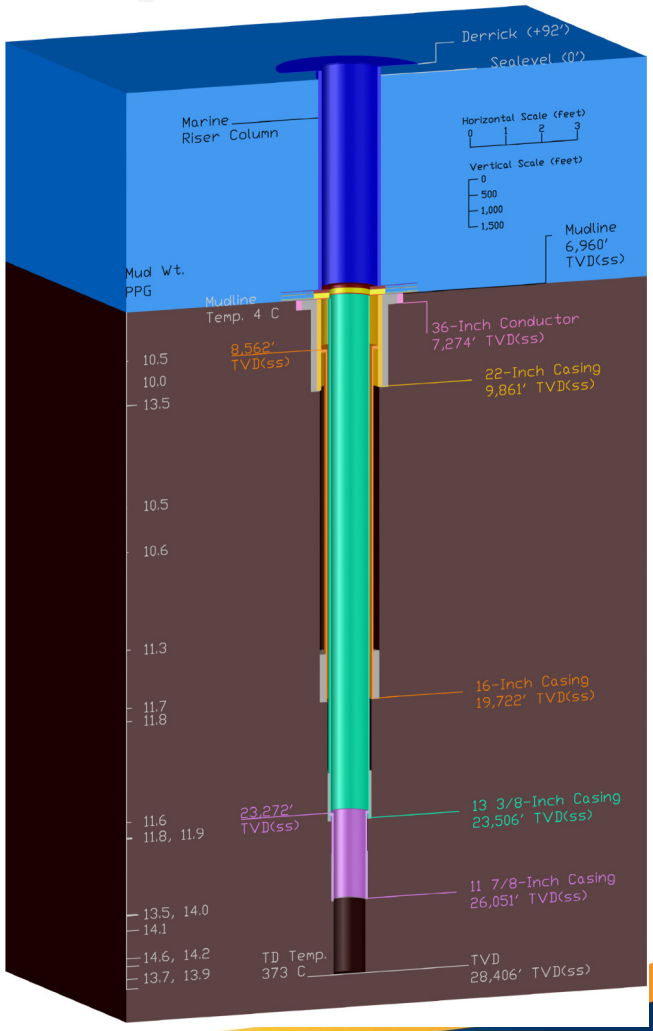
[1]IHS database
[2] Dessenberger et al;
[3] RPSEA 2501-12 Knowledge Reservoir
[4]JPT Survey.
[5] D. Hennegan, Weatherford (OTC-24097)
[6] Bob Judge, GE Oil & Gas
[7]See Slides 6 and backup slides.

Attachment 6

Generic Well Model for Simulations

Variations from the base-case will be considered





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Candidate MWD Technologies for Simulations

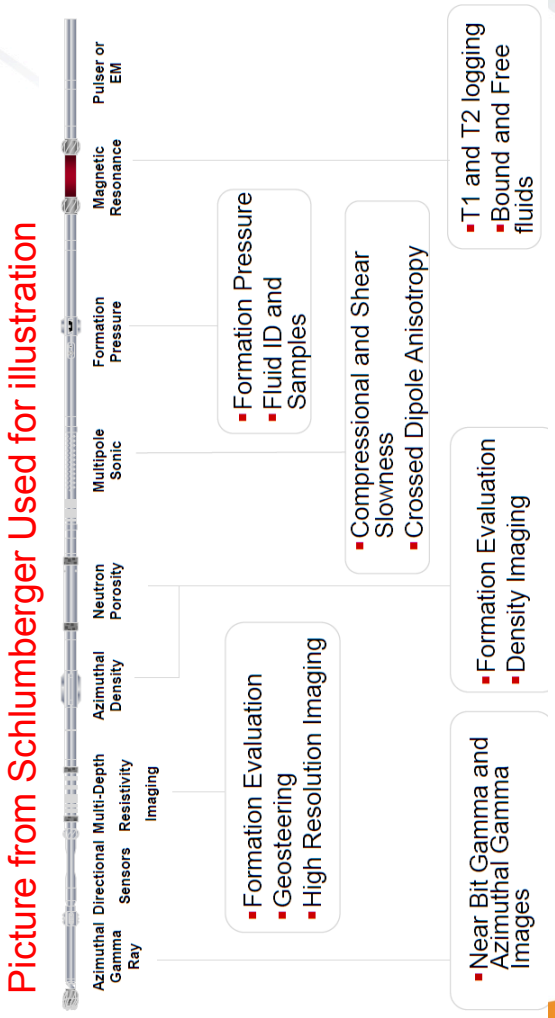
Information using Bayesian Inferencing

- Vertical Seismic Profile (S_1)
- Coriolis Mud Flow Meter (S_2)
- Annular Pressure & Temperature (S_3, S_4)
- Resistivity At The Bit + Gamma Ray (S_5, S_6)
- Sonic (S_7)
- Rate of Penetration (S_8)
- Shock & Vibration at the bit (S_9)

$$p(E \mid S) = \frac{p(E) \times p(s \mid E)}{p(E) \times p(S \mid E) + p(NE) \times p(S \mid NE)}$$

$$p(S \mid E) = p(S_1, S_2, S_3, S_4 \mid E)$$

$$\cong p(S_1 \mid E) \times p(S_2 \mid E) \times p(S_3, S_4 \mid E)$$

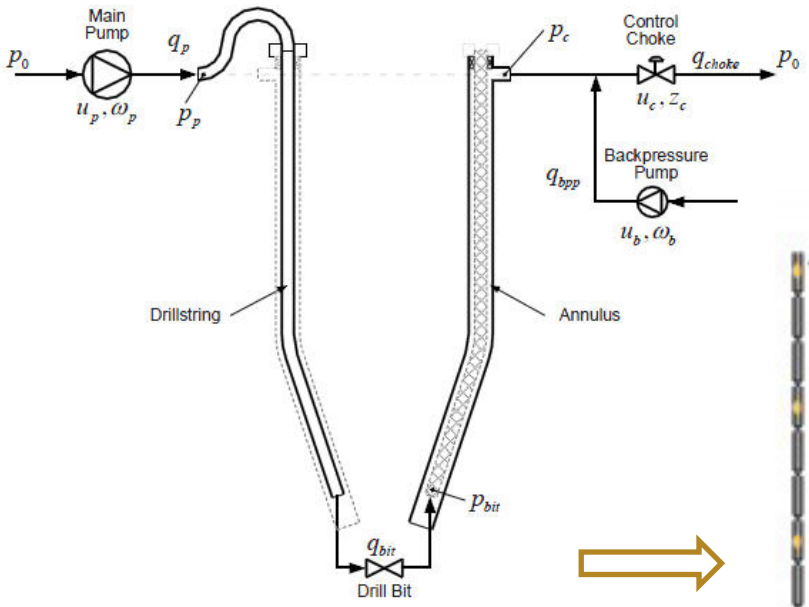


Human performance assessed based on p(E|S).
NRC/FAA Data.

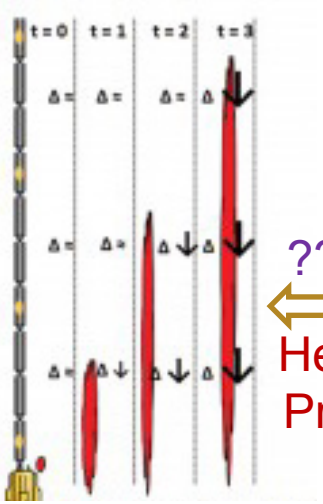
Attachment 6

Computational Well-Dynamics Model

To provide data on false negatives and false-positives?



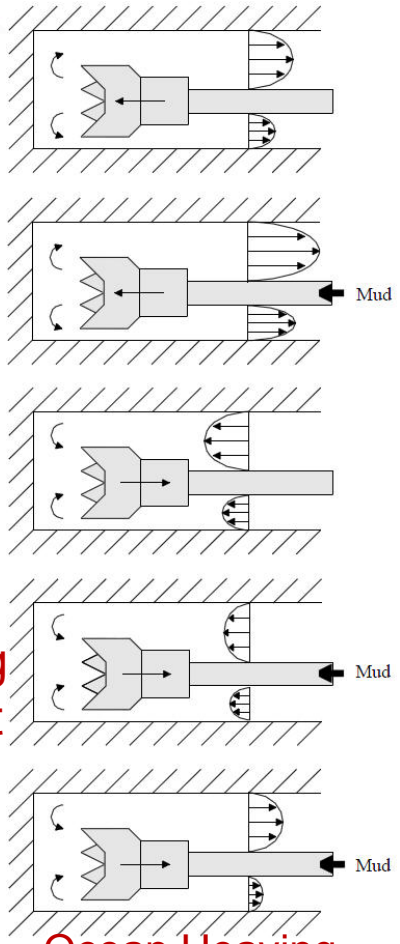
Heaving Isolated



Kick Progression

????

Heaving Present



Ocean Heaving

Picture from Chin and Zhuang, Stratamagnetic Software used for illustration of Swab-Surge Modeling

- Multi-phase CFD Model
- Closed Loop System
- Uncertainty Analysis

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Anticipated Results

- Technical Report Summarizing Risk Assessment.
- Brief to Industry and Stakeholders

Attachment 6

BACKUP SLIDES

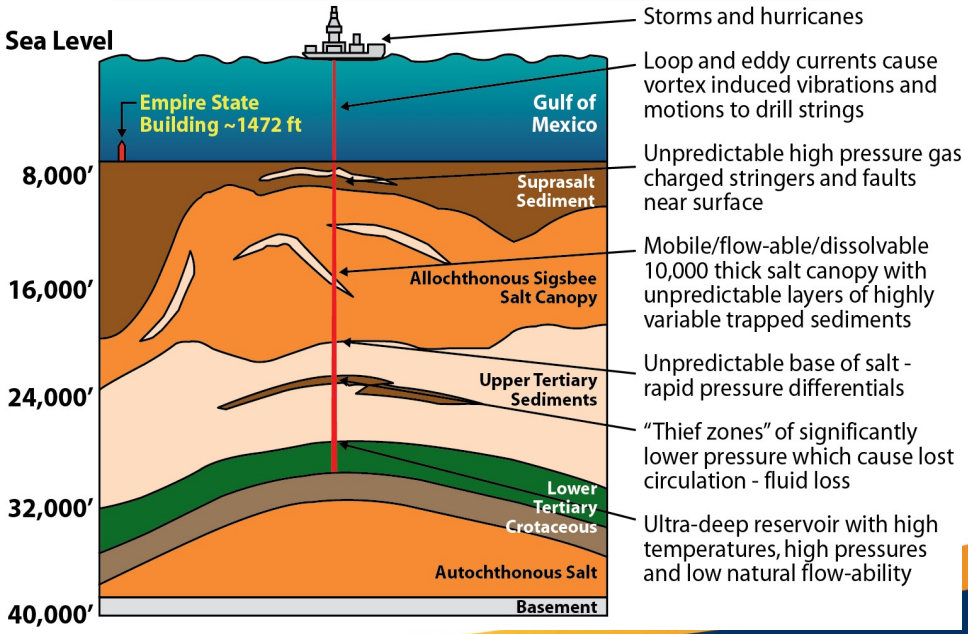
Attachment 6

Stratigraphy and Heterogeneity impact on UDW Drilling

- Ultra-deep water plays have unique characteristics different from the past history.
  - Reservoirs are often at greater subsea depths and have HPHT (>15,000 psi & >180°F)
  - Seismic imaging of subsalt reservoirs is often poor
  - Reservoirs are consolidated, cemented and have low rock compressibility. They often have lower porosity and permeability but with local seismic fault regions that could have very high permeability
  - Lower overburden significantly lowers window between pore pressure and formation fracture pressure in the target region; some times window less than ½ pound-per-gallon (or 200 – 300 psi)

Parameter	Units	Upper Tertiary	Lower Tertiary
Total Vertical Depth	ft	16, 500	27, 500
Water Depth	ft	4, 200	7, 800
Reservoir Thickness	ft	35	210
Porosity	%	28	17
Water Saturation (Sw)	%	25	30
Permeability	mD	500	16
Rock Compressibility	µsips	12	3
Reservoir Pressure	psia	11, 000	19, 500
Reservoir Temperature	F	186	230
Saturation Pressure	psia	5, 000	1200
API Density	API	32.0	29.0
Gas-to-Oil Ratio	Scf/stb	1, 000	300
Oil FVF	Rb/stb	1.61	1.14
Oil Viscosity	cp	1.5-2.0	3-4
Absolute Open Flow Potential	Stb/d	33, 000	6, 500
Peak Oil Rate	Stb/d	6, 000	6, 000

Phenomenological description of the challenges (Chevron)



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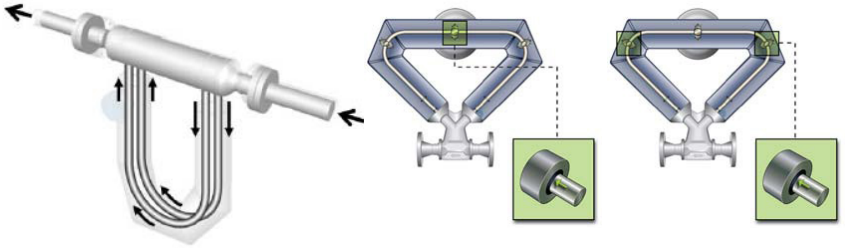
Attachment 6

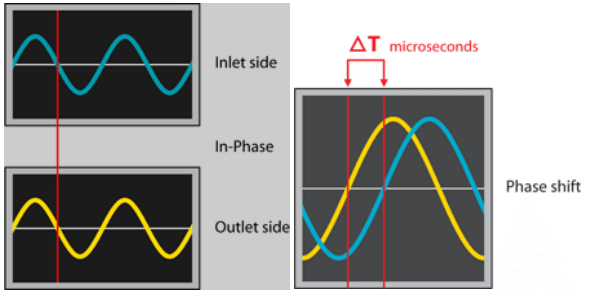
Coriolis Mud Flow Meter

Excess mud flow out of the well = Kick

Coriolis sensors are classified as a ultivariable sensor, as they provide a measurement of mass and volume flow rate, density and temperature. The mass flow rate accuracy is 0.05 to 0.1% of rate. The sensor consists of a manifold which splits the fluid flow in two, and directs it through each of the two flow tubes and back out the outlet side of the manifold

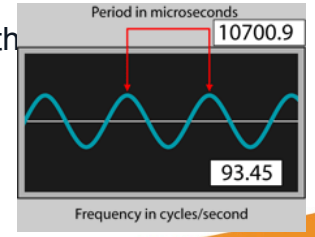


A drive coil is mounted at the center of the two flow tubes geometry to vibrate the process fluid and tubes at a natural harmonic frequency. A magnet and a pickoff coil are located on the inlet and outlet side of the flow tubes and provide the means for measuring the Coriolis effect.
Because of the vibration, the coil moves through the magnetic field and generates a sine wave proportional to that motion.



When the tubes are full of process fluid and at a zero flow condition, the sine waves from the inlet and outlet pickoff coils are in phase. Under flowing conditions, the tubes twist due to the Coriolis effect and the two sine waves shift apart. The time differential between the two signals is directly proportional to mass flow rate.

Measuring the frequency of the tube vibration provides a direct measure of the density of the fluid. The fluid volume flow rate at operating conditions is determined by dividing the mass rate by the measured density. An RTD measures temperature of the flow tubes.



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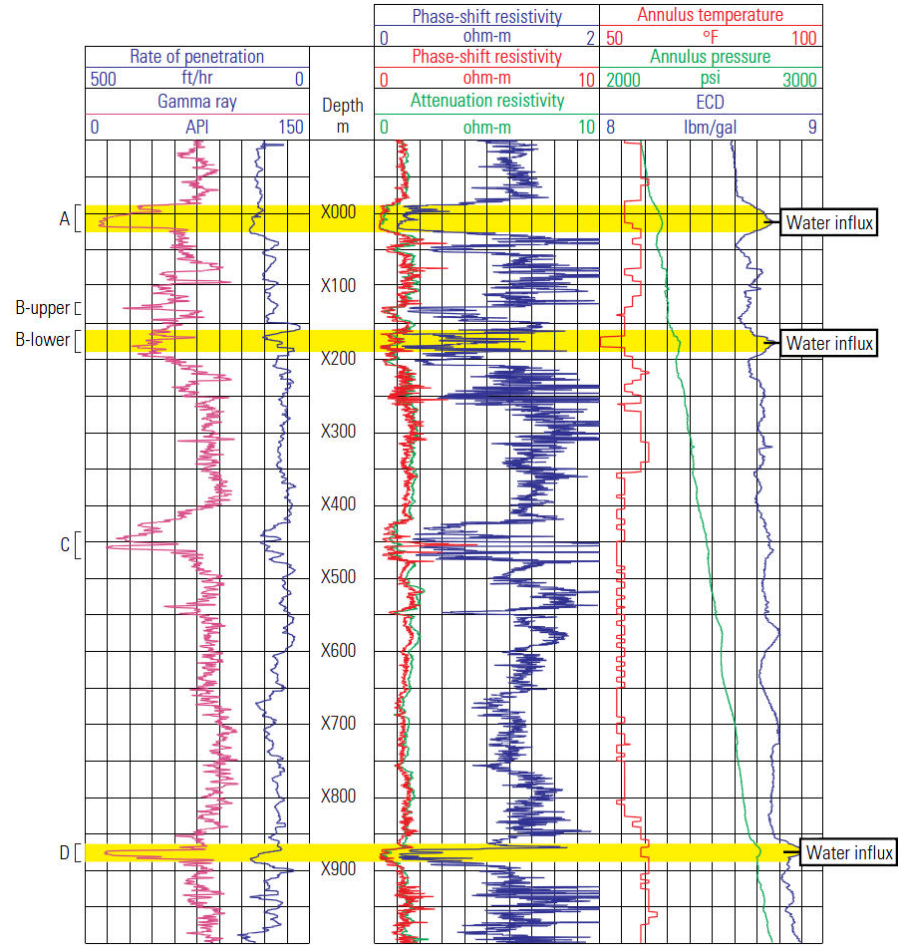
Annular Pressure & Temperature



Annular Pressure & Temperature measurements distributed up the drill string provide real-time data that can monitor the progress of an expanding kick volume in the annulus.