Research Partnership to Secure Energy for America

Technical Forum
July 22, 2010
9:00 – 4:00

Research and Technology Needs for Deepwater Development
Addressing Oil Recovery and Effective Cleanup of Oil Spills

Breakout Sessions

Detailed Research Ideas
(to be included into a summary white paper)

Preventive Technologies

- More research to determine what additional conditions we have on Ultra Deep drilling vs. shallow drilling. Traditional drilling methods may not be the best for ultra deep/drilling subsea.
- Survey/Evaluation/Database of All? possible release scenarios and potential solutions
- Training/software tools to allow regulatory agencies to quickly evaluate release risk
- Benchmarking to increase awareness and standards for a safe culture with regard to decision making, risk tolerance and safety
- Better Cementing – downhole tools and sensors for better cement evaluation and real-time mitigation of gas influx, lost circulation, channeling and other problems of cement integrity. Also better cement formulations
- <u>Minimize Well Control Incidents</u>
  Lost Circulation
  Prevention + Mitigation
  · while drilling (kick prevention)
  ·· running casing
  ··· cementing – proper zonal isolation
  <u>Prevention</u>
  Wellbore strengthening materials + methods
  <u>Mitigation</u>
  Improved LCM for severe losses
- As we recommend "Automation" we need software engineering processes to U & U tls software
- Can BOP equipment be the tertiary control device?
- Automated well control
- Establish a database of well control kick incidents & how it was managed – lessons learnt opportunity + training
- Better BOPE – BOPE performance testing under high pressure, high flow rates and highly erosive flows
- Methods to measure & monitor annular pressures on subsea wellheads
- Upgraded sensor package to have much improved data on downhole events – connected by higher bandwidth to surface to allow control.

- More real-time data for well control – More use of downhole sensors during drilling to provide real-time evaluation of well-control related parameters & faster, ore reliable identification of well control events
    - Wired drillpipe
    - MEMS-based, low power sensors in "couplings"
    - DTS (Distributed Temperature Sensors) behind casing for cement placement evaluations
- Re-evaluate the engineering of installed steel catenary riser using:
    - Actual installed response of vessel
    - Severe weather conditions
    - Gradual (and potential) souring of well fluid
    - A degree of operation error (e.g. failure to implement remedial work on time)
- Expand Managed Pressure Drilling to develop wellhead and downhole sensors for flow, temperature, pressure and others to monitor fluids in drill pipe and the cased hole to detect imbalance of fluid in/out of hole
- We need automation standards for drilling control systems and all rig software
- Use of SIL certified systems and software practices as found in other process industries. Global standards exist – apply them
- Improved
    - ROV tech
    - BOP tech
    - Behavior training among integrated companies
- Use shape memory alloys in deepwater applications
- Early detection of gas influx into wellbore by more accurately measure mud flow in and out of the well system
- Enhance capabilities of ROVs. More precise capabilities to intervene at 10,000 ft.
  BOP redundancy + spacing to allow predetermined capping connectors
- Consider more research to define the behavior of methane hydrates under drilling & well completion conditions.
- Casing lockdown technology improvements
- Improve the ability of rigs to disconnect their riser equipment both at seabed, surface. Also consider near surface BOP that can be backed with subsea isolation device for additional safety.
- Database/knowledge base of G.O.M. deepwater wells & reservoir does exist + is kept current + maintained by Knowledge Reservoir. This could be augmented to incorporate additional information, analogs, best practices, etc.
- Ability to rotate casing while cementing using subsea BOPs
- Develop technology to detect and measure hole conditions that are unacceptable for cementing and indicate corrective action.
- For control systems, you don't need to use nuclear or aeronautical practices. Use existing international practices applied on production platforms and on-shore process industry.
- Deal with unknown pore pressure
    - Pore pressure ahead of the drill bit
    - Reservoir model verification
    - Automatic choke control
    - Seismic while drilling
    - Return of check shot requirement (MMMS)
- Enhance geology + geosciences capabilities to better predict formation pressures in path ahead of drill bit

- Ongoing industry wide technology development forum focusing on specific areas of industry concern and providing ideas that are available to all
- Research into developing technologies capable of measuring pressures real time behind liners across reservoirs once installed for positive indication of well control post installation of casing and onwards.
- "Cold eyes" review by non-industry experts (Nuclear w.r.t. risk assessment, NASA, Secretary Chu National Labs)
- Improved remote sensing and measurement technologies for subsea production facilities (structural integrity management) to detect small failures before they become big ones
    - Sense small hydrocarbon leak
    - Sense structural degradation (pipelines/flowlines/risers)
    - Sense unplanned movement of structures

Risk Assessment

- We should pursue methods that minimize the personnel requirements on location – i.e. remove some of the human risk factor. Both the risk of human loss and the risk of human error.
- We need to
    - Baseline current practice against which we can judge new/proposed solutions
    - Define failure, i.e.
        - Failure req maintenance (critical – stop ops, deferred)
        - Failure resulting in an HC release
- Knowledge Management
    - Record date
    - Capture lessons learned
    - Dissemination of knowledge

  Lead to predictive analytics using metadata
- Have to quantify risk and uncertainty. Can't wait for the government to define it!
- Apply Probabilistic Risk Assessment methods, as used in nuclear industry to characterize low frequency – high consequence events using system level models of drilling operations and geological uncertainties and human factors
    - Risk significant modes
    - Risk-informed practices and regulation
- Proactive RCA with planned results communication with aim toward technology not legal
- Probabilistic well design via collaborative well loading data sharing

  Reliability-based design for well designs integrated into BOEM standards
- Proposal made to Congressman Brady: Integrated risk assessment: present and future inferences

Response Technologies

(1 vote) Surveillance

- Develop AUVs with advanced subsea surveillance capabilities for plume tracking
- Understand key species to monitor based on location + season of event
- Clamp-on flow measurement of pipeline, flowline, wellhead, riser, etc. ROV – deployable
- Develop improved hydrocarbon detection/measurement sensors for subsea plume sensing

- Better way to distinguish chemically dispersed vs. physically dispersed oil at depth in blowouts. Big problem right now.
- Integrity management – monitor health/status of subsea equipment ot detect trends before problem occurs and results after HC detected.
- (6 votes): Technology for localization and quantification of deepwater wellhead or pipeline leak.
    - Identify, track
    - ROV or onboard placement
    - Optical, acoustic, other
- Need better means of measuring dispersed oil plumes than use of CDOM fluorometers
- ☆ Equipment or models to understand flow properties as well as fluid composition in the subsea environment.
- (1 vote): Surface tracking of subsurface plumes via controlled source electro-magnetic methods
- Cheap, small, highly accurate oi-in-water sensors for low conc. of oil. Deploy as sensor cloud along shoreline or floating
- (1 vote) development of better technology for tracking subsurface plumes – acoustic technology – vessel mounted ADCPs? SIDE scan?
- (1 vote): Source (need res. fluid composition known), Plume tracking w/new Navy forward looking sonar
- (1 vote) Investigate effectiveness of existing acoustic Doppler current profiers/ability to track subsurface plume
- (1 vote) JIP to own & deploy pre-made, stand-alone seafloor "observatories" to monitor both blowout flow and all seafloor equipment activities (x,y,z locations w/central coordination of same)
- (1 vote): Research as baseline of current conditions + impacts that occur due to current spill
- Some automatic system that kicks in immediately after a blow-out is detected that begins monitoring where flow is going → immediate communication back to shore/operators to help mobilize resources focused to most efficiently respond. This could include sensors with information on fluid density/GOR, etc.

(10 votes) Flow Rate Measurement

- Lessons learned from remote sensing
- (2 votes): Hydrate prevention in Top Hat configuration
    - Mitigation (MEG, Meth, Other)
    - Flow as a slurry
        - Minimize drop size
        - Form dry hydrates

Other/Overall

- (2 votes): Map Decision Tree
    - Top Kill yes/no
    - When to use/not use dispersants
    - When to deploy booms/skimmers

  Objective: Improve understanding of constraints: well size, fluids, metocean flow rates
  Direct measurement (T/P) drill bit, previous csg string all the way to surface
  <of exploratory wells>

Onshore Remediation & Cleanup

- Better way s to deliver nutrients subsurface to enhance bioremediation
- More effective sand beach cleaning technology
- Large scale application of oil eating microbes to spill area

- Offshore or Onshore: Improved understanding of fate + effects of oil with dispersants applied at depth
- (2 votes): Research in technologies to efficiently clear contaminated shores, i.e. sand, beach remediation
- (1 vote): Investigate all types of remedial technologies and resulting impacts
- (1 vote): Joint industry effort associated with better understanding of dispersants
    - Impact large volumes
    - Best types
    - Better eco-friendly
- (2 votes): How best to bioremediate oiled wetlands
- (1 vote) Enzymes or oxygen-delivery compounds that can be packaged with dispersants and hasten biodegradation.
- (1 vote) Blend microbes and nutrients into dispersants and surfactants
- Biological dispersants
- Issue: Dispersant Toxicity: Develop new low toxic/non-toxic dispersants for deployment

Collection & Containment

- (1 vote): containment and separation at source (sea floor): underwater separators
- Containment/collection
    - How good are skimmers?
      Can they be made better?
    - Can green dispersants be developed?
- (1 vote) Technology (chemical or other) to keep surface oil together so it can be easily skimmed
- Ways to direct oil from blowout to minimal area on surface so it can be skimmed more easily
- (2 votes): Reducing barriers to use of new clean-up technologies
- Temporary oil/gas storage at mudline in deepwater w/portable vessels. Maybe similar to Arco's pyramids for seeps in California
    - Can be deployed anyway
    - Allows 5-10 days temp storage till ships return
    - Leverages water pressure to keep flow volume smaller
- Design in contingency components to flow path equipment to enable fast, safe connection of containment equipment.
- Submerged plume cleanup – use riserless mudlift pumps to accurately recover submerged oil plumes and treat at surface.
- Make containment/collection equipment part of the recovery plan so that the right equipment is available to interface properly for the eventuality.
- (1 vote): Containing oil with an extensive debris field
- (5 votes): Define containment and collection capacity requirements
    - Subsea BOP stack failure mode (Macando)
    - Near mudline casing failure
    - Intermediate subsurface depth failure (cratering)
    - Subsea flowline failure

  What collection & containment capacity is needed for a response system

Barrier Removal

- (3 votes): Prevention from reaching shore: Development of floating plasma technology recycling skimming vessels: PEM technology
- (1 vote): Oil-water separators as mobile units brought to beaches, coasts, etc. to recover water (& therefore separate oil)

- (1 vote): Technology to separate oil from water and then dumping water back to sea
- (2 votes): Surface oil skimmer (vertical vs. horizontal) (not A Whale)
- (2 votes): Improved skimmer capacity – new technology: Review oil/water separation systems
- (1 vote) vessel skimming improvements
- (1 vote): Low power, portable oil/water separators to improve skimming efficiency
- (1 vote): Understand how bottom-injected dispersant affects volume of surface and subsurface oil
- Need a system to allow skimmers etc. to be brought nationwide to site of a large spill
- Sustaining flow in risers to surface while minimizing back pressure on well.
- Management of spilled oil that occurs prior to industry spill response containment systems.
- (3 votes): Blowout Containment Structure for Deepwater (Cap over BOP)
    - Use current suction pile technology for rapid deployment
    - Include instrumentation for monitoring well pressures
    - Can be pre-fabricated in advance and deployed on seabed next to well.
- We need to find out how long the hydrocarbons that are suspended/dissolved reside in the GOM before being carried out to the Atlantic in order to estimate long term ecological effects in GOM. That includes effects of biochemistry and other chemical interactions.
- Research into simple tar removal equipment/machine for beaches
- (1 vote): Research into failure modes during drilling and production phases. Outcome to develop containment cones, oil "production" risers, vessel requirements, design criteria.
- (1 vote): ☆ Rapid well intervention/containment standby equipment
    - ☆ Integrated "subitems" of response
        - "containment" may or may not be exclusive of "intervention"
- With all spill response companies, annual spill drills → How does the US not have a response vessel similar to the "A Whale"? As operators fund spill response companies – why not use some of the money on a "A Whale" and hope we never have to use it?
- Develop tool to allow unified command to evaluate trade-offs between dispersant (bottom-injected), subsurface and surface oil volumes
- Improved methods of applying dispersants
- Improved portable oil/water separation technology for use with skimmers
- Enhanced portable skimming and separation equipment
- Determine which methods work in current disaster and concentrate on those for potential future use

Well Control Intervention

- Cofferdam large enough to not be affected by hydrates, then filled with heavy weight mud to bury the well (Kill it like Chernobyyl – bury it)
- Better ways to assess well casing integrity (remote?)
- Develop enhanced ROV/AUV capabilities for better crisis response capabilities (e.g. autonomous operation of BOP override from long standoff distance)
- Modeling WC events and scenarios to predict what may happen during w/c events and analyze what is happening. Then what will happen with one response vs. another.
- (9 votes): Combine containment/collection with intervention – need to look at what equipment and methods to be used.
- (7 votes): Develop in wellbore tool for wellbore isolation – remote or hydraulic activated – part of casing or drillstring.
- (2 votes): Well control intervention – diverter plug decie for (GERD) open flow

- (1 vote): Research into multi-task vessel for well intervention and oil spill recovery and/or dispersant application
- Study ways to form a blockage in a flowing well or flowlie such as:
    - Purposely forming a hydrate
    - Use electromagnetic field to increase viscosity
    - ?????????

Capping of Damaged Wellheads in Deepwater

- Have preparation to drill relief wells before original well drilled beyond certain depth.
- (2 votes): Increased ability to accurately plan for blowout control in contingency plans: AFE's, equipment needed or if even possible.
- Development of universal access points (non-branded) to BOP/wellbore to enable intervention/kill by multiple resources
- (1 vote) dual BOP
- (1 vote): New products technologies that can be positioned over the source and then transfer oil to containment tanks research using controlled spills or a replicable event.
- Remote monitoring and diagnostics of well to prevent blowouts as well as be training tool for operators, design people, engineers
- (3 votes): Establish a JIP to collectively own the special equipment that will be deployed subsea to cap/contain a blowout
- (3 votes): Improved Top Kill
    - Improved models to simulate process
    - Improved mud inj. geom. and proves to effect a top kill
    - Improved understanding of counter current flow of multiphase mixtures.

Ecosystems

- Establishment of a well integrity standards applicable to different phases of a well drilling, completion and production life
- Need to study effects on coastal environment (plant and animal) both short and long time
- Research to identify aspects of the ecosystem that add to its overall value (hatcheries, migrations, seasonal behaviors) and focus on sensitivities to outside activities and how those affects can be mitigated, protected against.
- Quantification of habitat type
- Valuation study of ecosystem services associated with water column in G.O.M.
- Understand deepwater ecology and the potential impacts of massive hydrocarbon releases at depth
- (1 vote): <u>Ecology:</u> Investigate deepwater ecosystem with emphasis on oil and gas seepage
- (3 votes): How to create stronger integration of ecosystem services valuation with ecological sciences
- (3 votes): Establish an ecosystem benefits analysis to quantify impacts of ecosystem disruption
- (1 vote): Toxicity to key environmental receptors from weathered oil to which dispersant has been applied.
- (2 votes): Understanding of linkages between habitat types – watershed to abyssal plains.
- (1 vote): Develop an ecological index to determine more sensitive and impacted systems and most important systems that could cause large scale impacts

- (2 votes): Early warning – high density (area, depth, time) monitoring of local hydrocarbon concentration and drop size. Determine value to all players. Requires accuracy (uncertainty)! Are there game changing options? i.e. citizen empowerment and engagement over monitoring.
- (3 votes): The question – what is needed to understand the movement of marine life/wildlife? Research need: what are the key environmental species which are indicators of ecosystem health and function.
- Clamp-on measurement of flow, pressure, temperature & fluid composition for flowline, pipeline, riser, wellhead, etc. ROV deployable and/or readable
- (1 vote): Early Warning Issues:
    1. Political pressure
    2. Liability
    3. Transparency
    4. Wikipedia – type collection and interpretation
- Environmental Modeling – Advance coupled modeling (Bio – Ocen Physis-Ocen Chem-Geo) at 10 – 100 km scales
- Effects on human quality of life
- (1 vote): Research for "rapid" response solutions for ecosystems understanding that rapid may have a unique definition in nature.
- Valuation studies of impacts of alternative response options
- Tech Gaps
    1. Low cost
    2. Array based
    3. Wireless/GPS
    4. Hands Off

  Oil/water sensors
- Develop integrated, open access GOM ecosystem data
- Fund enhanced ecosystem recover research
- Understand tradeoffs between use of offshore response options such as dispersants, and near/onshore options
- R&D to determine + prioritize Gulf Coast ecosystem gaps, to use to further develop a plan.