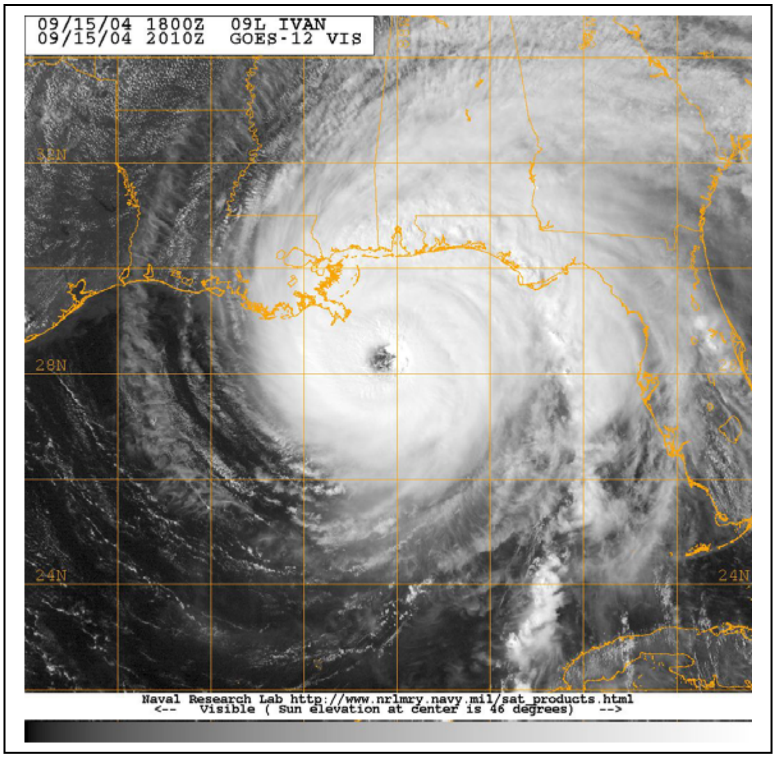
2005 Hurricane Readiness and Recovery Conference

by

E. G. Ward, Offshore Technology Research Center
Robert Gilbert, University of Texas,
Robert Spong, Energo



Final Conference Summary Report
Prepared for the Minerals Management Service
Under the MMS/OTRC Cooperative Research Agreement
1435-01-04-CA-35515
Task Order 39303
Project Number 559

October, 2005

OTRC Library Number: 10/05C155

For more information contact:

Offshore Technology Research Center
Texas A&M University
1200 Mariner Drive
College Station, Texas 77845-3400
(979) 845-6000

or

Offshore Technology Research Center
The University of Texas at Austin
1 University Station C3700
Austin, Texas 78712-0318
(512) 471-6989

A National Science Foundation Graduated Engineering Research Center

TABLE OF CONTENTS

2005 Hurricane Readiness and Recovery Conference Summary Report

Introduction

This report presents a summary of the 2005 Hurricane Readiness and Recovery Conference held on July 26-27 in Houston, Texas. The conference was sponsored by the American Petroleum Institute and co-sponsored by the Mineral management Service, Offshore Operators Committee, US Coast Guard, US Department of Energy, Office of Pipeline Safety, National Ocean Industries Association, and the Offshore Marine Service Association.

Hurricane Ivan had significant impact on the offshore oil and gas infrastructure and thus provided an opportunity for the industry and regulators to investigate, learn and improve. The 2005 Hurricane Readiness and Recovery Conference was developed to provide a forum to discuss learnings and issues from Hurricane Ivan, as well as other recent hurricanes, regarding design and operating practices, technology, and regulations and standards to identify needs and opportunities for improvements.

Day 1 of the Conference was a Plenary Session, and Day 2 consisted of three simultaneous Break-Out Sessions on Drilling, Production, and Pipelines. See Appendix A for the Agenda.

The main objective of this report is to capture and summarize the results from the three Break-Out Sessions, i.e.

Issues and learnings
Major discussion points
Opportunities for improvement

Salient points from presentations made in the Plenary and Break-Out Sessions that provide context and background for these results are also summarized, but the report does not attempt to summarize each presentation. Available presentations are included in Appendices C - F.

The Offshore Technology Research Center facilitated the conference and prepared this Summary Report under the sponsorship of the Minerals Management Service.

Plenary Sessions

Key points from the presentations are summarized below. Available presentations are shown in Appendix B.

This working technical conference was designed to:

- Examine and advance our understanding of metocean conditions for extreme storms like Hurricane Ivan,
- Understand Ivan in a proper historical context with other severe hurricanes,
- Assess the performance of the Gulf of Mexico oil and gas infrastructure (fixed and floating production systems, MODU's, and pipelines) during hurricane Ivan,
- Identify gaps or opportunities to improve design and operational standards to improve the performance of the infrastructure in severe hurricanes.

Hurricane Ivan was an unusually intense hurricane that had a significant impact on the offshore oil and gas drilling and production activities and the infrastructure in the Gulf of Mexico. A number of deepwater floating production systems, mobile offshore drilling units, shallow water production platforms, and pipelines were affected by Ivan. Many facilities were subjected to winds and waves that exceeded design values, and the presence of large waves near the Mississippi River delta caused a number of mudslides.

The assessment of damage to the oil & gas infrastructure due to Ivan as of the date of the Conference is summarized as follows:

Infrastructure	Damage
Mobile Offshore Drilling Units	4 MODUs adrift (broke moorings) 1 MODU damaged (jack up)
Floating Production Systems (deepwater)	drilling rigs moved or lost on 4 FPSs facilities on decks damaged on 10 FPSs
Fixed Jacket Production Systems (shallow water)	7 destroyed facilities on decks damaged on 31 jackets
Oil & Gas Pipelines	>150 pipelines damaged included 12 large (16"or greater) pipelines

The MODU's that went adrift were generally undamaged except for broken mooring systems. The drifting MODU's did not collide with any production facilities, but damage to some of the pipelines is suspected to have been caused by dragging anchors. One MODU was unable to pull its drilling riser and evacuate in advance of Ivan due to a strong loop current and proximity to shallower water, but it successfully rode out Ivan manned with the drilling riser suspended. The experience indicated that loop currents and proximity to shallow water features should be carefully incorporated in developing evacuation plans and updating the plan to reflect present and forecast loop current as the hurricane approaches.

The hulls, moorings, and risers of the deepwater Floating Production Systems (FPSs) - spars, tension leg platforms, semisubmersibles were not damaged significantly, validating the hull, mooring, and riser design technology for these deepwater FPS's that are responsible for an ever-increasing percentage of Gulf of Mexico production. Damage to topsides facilities included deck modules, piping and cables. Such damage is thought to be due to greenwater reaching the deck and winds in excess of design criteria. Drilling rigs were moved on several FPS's, and such movement is thought to be due to rig loads due to high winds (and perhaps FPS motions) exceeding the capacity of rig tie-down fasteners.

Suspected causes of pipeline damage include mudslides, anchor dragging from drifting MODU's, and bottom currents.

Damage to this infrastructure caused a serious disruption in Gulf of Mexico oil and gas production. The percentage of daily Gulf of Mexico oil and gas production that was shut in following Ivan's September 15-16 passage was

	% Shut-in	
Date	Oil	Gas
September 19	85	55
September 27	30	20
October 27	25	12
November 27	12	7
December 27	8	5

The lost production for the 3 months following Ivan was ~ 38 million barrels of oil and ~151 billion cubic feet of gas. Since Gulf of Mexico production is responsible for a large percentage of domestic oil and gas production, this loss had a serious impact on oil and gas prices in the US and world markets. This business impact resulted from the failure of a relatively few parts of the infrastructure, and the industry is initiating steps to improve the reliability and performance of the infrastructure.

With the increased world-wide demand for oil, narrowing supplies and increasing cost of energy, the general public is becoming increasingly aware of the importance of the Gulf of Mexico production and its impact on the nation's economy. This heightened national awareness has increased the public awareness and interest in the offshore oil and gas industry and its regulators, and this will bring increased public scrutiny of the industry.

In addition to testing the oil and gas physical infrastructure, Ivan also provided an opportunity for industry and regulators to confirm the preparation and recovery plans. The industry safely moved 25-30,000 personnel out of the hurricane path without incident. The amount of oil pollution was minimal and validated industry's designs, safety devices, and operational procedures. And as seen from the discussion above, the recovery to pre-storm production rates was accomplished with a speed that was remarkable considering the storm's impact on the infrastructure. This was due to good collaboration by the industry in prioritizing and sharing the use of resources during the post-Ivan recovery period and the responsiveness of government agencies.

The MMS has sponsored 6 research projects to examine the impact of Hurricane Ivan and develop information useful in assessing the adequacy of present standards and regulations:

- Review of MODU Loss of Stationkeeping
- Assess Drilling & Workover Rig Sea Fastener Performance on FPS's (OTRC)
- Assess Fixed Platform Performances (Energo)
- Assessment of Pipeline Damage (DNV)
- Assess Recent & Future Potential for Mudslides (OTRC)
- Mudslide Hazard Mapping (William, Lettis & Associates)

Metocean & Geotechnical Session

Key points from the presentations are summarized below. Available presentations are shown in Appendix C.

Metocean presentations focused the characteristics and severity of Hurricane Ivan, comparisons with other storms, estimated return period, and potential implications on present design practices.

Hurricane Ivan was a Category 3-4 storm as it passed through the offshore oil and gas infrastructure southeast of Louisiana. Hindcast maximum waves were ~96 feet and winds were 92 knots. The hindcast wave heights compared well to measurements from a nearby NDBC buoy and several FPSs, and were generally consistent with elevations of observed damage to FPSs and platforms. There was no evidence of "rogue or freak waves" wave in the data. The wind speeds compared well with available FPS measurements and speeds interpreted from hurricane hunter aircraft. No current measurements were obtained during Hurricane Ivan. There was evidence that a loop current was in the deepwater area affected by Ivan, and the superposition of hurricanes currents and loop currents seem likely to have occurred in these areas.

The wave conditions exceeded the API Recommended Practice 2A design wave height of 72 feet. That wave height is characterized as the maximum height at a random fixed site with a 100-year return period. The maximum wave height in Ivan was significantly higher that the API design value, and corresponds to a return period of 2500 years based on the fixed random site statistics. There was considerable discussion regarding whether the occurrence of a storm such as Ivan should impact the API 100-year design value.

Ivan was actually a Category 5 storm at several points before it weakened to a Category 3 storm as it made landfall. Ivan’s intensity was likely related to the increases in surface temperatures of the southern Atlantic Ocean and the Gulf of Mexico waters in recent years. Both the tropical storm activity and the number and intensity of major hurricanes correlate with surface water temperatures. The seasonal forecast for 2005 indicated a very active year, and is consistent with the number of tropical storms and major hurricanes that had occurred by the time of this Conference. (That forecast was further borne out by events of the remainder of the 2005 season, which included Katrina, Rita, and Wilma.)

The accuracy of real-time hurricane track and intensity forecasting has improved Hurricane forecasting activity in the Atlantic Basin (including the Gulf of Mexico) over the last two decades. This is in part due to the increased surveillance and data from storms via satellite, aircraft, and radar. This increased surveillance, particularly when the hurricanes are far offshore, may partly explain the recent observations of Category 5 hurricanes (Ivan, Katrina, Rita, and Wilma).

A geotechnical presentation focused on natural evolution and building of the Mississippi River delta, and the mechanisms by which large waves can cause mud flows and mudslides on the seafloor near delta. Mudslides have been observed before, and did occur during Hurricane Ivan. Mudslides are responsible for destroying one platform and damaging or moving a number of the pipelines.

References

1. A. Cox, V. Cardone, F. Counillon, and C. Szabo, “Hindcast Study of Winds, Waves and Currents in Northern Gulf of Mexico in Hurricane Ivan”, OTC 17736, Houston Texas, Offshore Technology Conference, May 2005.
2. C. Cooper, J. Stear, J. Heideman, M. Santala, G. Forristall, D. Driver and P. Fourchy, “Implications of Hurricane Ivan on Deepwater Gulf of Mexico Metocean Design Criteria”, OTC 17740, Houston Texas, Offshore Technology Conference, May 2005.

Drilling Break-Out Session

The focus in this session was on the mooring systems for Mobile Offshore Drilling Units (MODUs). A key question discussed was "Does the industry need to revise its standards and recommended practices for MODU mooring systems as contained on API 2SK?"

The main goal of the Break Out Session was to identify and discuss opportunities to improve industry and regulatory practices. Presentations on key topics and panel discussions provided information on observations (learnings and issues). The audience was then engaged in a forum discussion based on these observations.

Presentations Key points from the presentations are summarized below. Available presentations are shown in Appendix D.

The number of mooring failures (defined in this summary as loss of stationkeeping, I.e., rig adrift) in severe hurricanes has increased during the last 10-15 years. Severe hurricanes during this period included Andrew (1992), Lili (2002), and Ivan (2004). The number~~s~~ of MODUs that were set adrift in these hurricanes are:

Andrew - 3
Lili - 1
Ivan - 3

In one instance during hurricane Ivan, a MODU drifted some 70 miles.

Potential consequences of failure we discussed, including the collision with a production structure and severing a pipeline by dragging an anchor. It was recognized that collisions caused by MODUs set adrift during a storm are rare - none have occurred during the last 40 years. Pipelines have been severely damaged and even pierced by drifting MODUs dragging anchors, and such incidents that occurred during Hurricane Ivan and were likely responsible for a portion of the lost production during the post-Ivan recovery.

Present guidelines for mooring system design recommend that metocean conditions associated with a 5-year return period be used for a MODU that is operating far from other permanent structures, and suggest that the return period be increased to 10 years if the MODU will be moored close to a permanent system.

Analyses of the two mooring system failures in Hurricane Ivan indicate that the locations at which the MODU were moored experienced waves that exceeded 100-year return period values, far exceeding the API mooring design conditions. The two mooring systems were estimated to have failed when the waves were between the 50 and 100-year values, thus illustrating that the systems were able to perform well beyond the API design criteria. (A nearby semisubmersible production system had a mooring system that was similar to that used for deepwater MODU's. That system was designed for 100-year criteria, and performed well during the storm and held in seas exceeding the 100-year criteria.). These incidents suggest that the design performance is understood and robust, and the issue is more one of criteria level than uncertainty in design technology.

The potential for a drifting MODU to damage a production structure or pipeline would seem to be increasing with the increasing deepwater infrastructure, and the consequences of such damage (pollution, lost or deferred production, and repair or replacement of infrastructure) could be significant. Such damage to particularly critical structures could impact oil and gas supplies and prices, and heighten public concerns about the nations energy supply.

The industry is developing a JIP to address these issues. Firstly, the study would seek to determine if recent experiences and today's deepwater mooring systems and challenges indicate any needs for change in the API 2SK criteria. Factors that will be considered include

- Recent performance of deepwater mooring systems,
- Increasing water depths,
- Changes in mooring systems configurations (taut and semi-taut systems,)
- New mooring line materials (synthetic ropes),
- Proximity to nearby infrastructure (production structures or pipelines) and potential consequences of damage.

If warranted, the study would then proceed to develop revisions to the criteria to achieve the desired level of performance.

Discussion Table 1 below summarizes the Observations, Discussions, and Recommendations. Note that the discussion period was limited to 1-1/2 hours and thus precluded covering all observations in detail during the session.

Table 1 – Drilling - Observations, Discussions, and Ideas for Improvement								
Observations(Learnings or Issues)		Discussion	Potential Opportunities for Improvements	Type of Improvements			
				Oper. Prac.	Design Prac.	Regs & Stnds	Tech
1	New reality - impact on MODU operations?	Regulators noted the increased importance, visibility, and public interest in deepwater oil & gas production due to • growing importance of domestic production on nation's energy needs • growing percentage of domestic production from the deepwater GOM • the sensitivity in global oil & gas process to actual or potential disruptions in GOM oil & gas production This is causing increased scrutiny by the public on the regulators and industry alike.	These issues can be addressed in the risk and reliability assessment portion of the proposed Mooring JIP study (see discussion for Item 7) by tailoring the consequences of failure to include these concerns.	X	X	X	
2	Standards or regulations?	The regulators pointed out that there are 2 ways to promote safety and protect the public's interest in offshore oil & gas production - 1. up-to-date industry standards, or 2. imposed government regulations The regulators prefer the	Continued support for API's activities to develop industry standards.			X	

Table 1 – Drilling - Observations, Discussions, and Ideas for Improvement							
Observations(Learnings or Issues)		Discussion	Potential Opportunities for Improvements	Type of Improvements			
				Oper. Prac.	Design Prac.	Regs & Stnds	Tech
		industry standards approach because • Such standards are generally developed in a manner that incorporates industry expertise & experience within the framework of regulatory needs • Experience has shown that standard can generally be developed & issued much more quickly than regulations					
3	What are appropriate design criteria for mooring systems?	• The regulators suggested that "No Rigs Adrift" would be an appropriate goal for mooring system criteria in light of – the Ivan experience (3 MODUs adrift & 1 partial MODU mooring failure out of the 7 near the storm track) – mooring failures in other recent hurricanes (Andrew 2, Lili 1) – increased national importance & public awareness of GOM	The proposed JIP will assess the need to change AOI RP's develop and propose any recommendations for needed improvement to the API 2SK subcommittee.		X		

Table 1 – Drilling - Observations, Discussions, and Ideas for Improvement							
Observations(Learnings or Issues)		Discussion	Potential Opportunities for Improvements	Type of Improvements			
				Oper. Prac.	Design Prac.	Regs & Stnds	Tech
		production and operations • Industry pointed out that – Ivan was an usually severe storm (RP> 1000 years) – Drifting rigs have not significantly damaged offshore oil & gas infrastructure to date – An overall cost benefit analysis may not justify an increase in mooring design criteria					
4	What constitutes a mooring failure? • # lines – 1 line – N lines • watch circle • adrift • Consequences of failure • adrift vs infrastructure • others	Mooring failure descriptions to date have considered # lines damaged (broken). Consequences of failure should be recognized in defining mooring failure. It could be reasonable to consider damage descriptions such as • adrift - consequence of damage measured by – potential damage resulting from collision with infrastructure, e.g., ▪ production or	The proposed Mooring JIP can develop meaningful standard definition(s) of failure.	X	X	X	

Table 1 – Drilling - Observations, Discussions, and Ideas for Improvement							
Observations(Learnings or Issues)		**Discussion**	**Potential Opportunities for Improvements**	**Type of Improvements**			
				Oper. Prac.	**Design Prac.**	**Regs & Stnds**	**Tech**
		production gathering structures ▪ pipelines ▪ subsea wells, facilities, & flowlines – potential damage resulting from drilling riser that could not be disconnected and/or pulled • watch circle - consequence of damage measured by potential damage from a connected drilling riser from a larger watch circle due to line failures					
5	Mooring failure and failure rate definitions	Consistent measures of mooring system performance and failures are needed to be able to learn from experiences and performance trends due to system improvements, increasing water depths, and new operating areas. As discussed above, failure definitions for historical incidents range from damaged lines to loss of station keeping. As stated above, the definition of failure should include the	Establish a failure rate measure that recognizes the total MODU exposure and the successes and failures of the mooring systems of the exposed MODU's. .		X	X	

Table 1 – Drilling - Observations, Discussions, and Ideas for Improvement							
Observations(Learnings or Issues)		Discussion	Potential Opportunities for Improvements	Type of Improvements: Oper. Prac.	Design Prac.	Regs & Stnds	Tech
		consequence of failure. Worldwide mooring failure causes include incidents when design values were significantly exceeded as well as failures due to inadequate maintenance or fatigue. Gulf of Mexico failures are largely due to overload, whereas fatigue and maintenance issues are largely responsible for failures in other areas. Failure rate definitions should consider number of MODU's actually exposed to conditions that were near to or exceeding design levels. E.g., MODU's in GOM during a hurricane but that were not exposed to design conditions, i.e., not "tested, should not be considered in determining failure rates.					
6	Need to develop & maintain database on past & future mooring failures & successes in hurricanes to validate design processes & codes	A database of past and future performance should be developed to capture both successes and failures of mooring systems. This database is needed to • study successes and failures to calibrate or	Identify an organization that will develop and maintain the required database.		X	X	

Table 1 – Drilling - Observations, Discussions, and Ideas for Improvement								
Observations(Learnings or Issues)		**Discussion**	**Potential Opportunities for Improvements**	**Type of Improvements**				
				Oper. Prac.	**Design Prac.**	**Regs & Stnds**	**Tech**	
		validate design guidelines & practices • study failures as a basis for possible need to improve design guidelines • understand performance trends E.g., the descriptions of the Nautilus and Jim Thompson MODU mooring system performances during Ivan presented in the Drilling BO Session would provide valuable data for such a database, and can be useful for assessing both MODU and FPS mooring systems design guidelines & practices. Who should develop & maintain the database? • MMS - not in mission • USCG - not in mission • JIP - could analyze a few existing incidents, but not viable for longer term future • Professional society - IADC, SNAME, others						

Table 1 – Drilling - Observations, Discussions, and Ideas for Improvement

Observations(Learnings or Issues)		Discussion	Potential Opportunities for Improvements	Type of Improvements			
				Oper. Prac.	Design Prac.	Regs & Stnds	Tech
7	API 2SK adequate?	Both industry & regulators have asked the question following hurricane Ivan. Two presentations is this BO Session addressed the question - "Standards Review & Update on API 2SK" and 'Proposed JIP on Reliability & Risk Assessment". Issues include • Changes in mooring systems, MODU sizes, & water depths over the last decade since the last API update • Potential increases in risks of damage to the offshore oil & gas infrastructure exposed to nearby MODU's due to increased number of development facilities and the use of MODU's for long term development drilling near FPS's • The increased importance, visibility, and public interest in deepwater oil & gas production Technical issues include	This question will be addressed by the proposed Mooring JIP.			X	

Table 1 – Drilling - Observations, Discussions, and Ideas for Improvement

Observations(Learnings or Issues)		Discussion	Potential Opportunities for Improvements	Type of Improvements			
				Oper. Prac.	Design Prac.	Regs & Stnds	Tech
		• Investigate differences between past & current MODU moorings as part of determining adequacy of existing codes for present mooring systems, e.g., – wind criteria – taut moor & semi-taut vs catenary mooring – synthetic (polyester) vs steel lines – new types of anchors • Are the risks of MODUs operating near infrastructure adequately evaluated?					
10	Inspection schedules for moorings adequate?	Standards are being reviewed by an API Task Group	Revised API 2 I expected to be completed within a year			X	
11	Need forum, consensus body, & funding to continue to improve mooring standards	Recent pressures on industry (downsizing, loss of experienced staff, tight budgets) have hampered the development & updating of standards. Revising API standards to become international ISO standards has drawn on the limited manpower available for standards. Efforts to approach	Industry to continue developing & updating guidelines & standards as needed			X	

Table 1 – Drilling - Observations, Discussions, and Ideas for Improvement							
Observations(Learnings or Issues)		Discussion	Potential Opportunities for Improvements	Type of Improvements			
				Oper. Prac.	Design Prac.	Regs & Stnds	Tech
		standards via JIPs have met with limited success. The financing of standards development & updating by a portion of production royalties was suggested by the industry. MMS stated that industry standards were an industry responsibility. Industry was the prime beneficiary of such standards, and should continue their role in funding the developing & updating standards.					
12	Should the industry focus on API or ISO regulations	Concern was expressed over the slowness of developing regulations through ISO. It was also noted that there are important differences in mooring system needs & experiences between the GOM & areas such as the North Sea & West Africa. E.g., • MODU & FPS's are evacuated during GOM design events (hurricanes) but are manned through design events elsewhere • The ratio of the design event (e.g., RP=100 years)	Participants tended to favor the API processes & timing for developing RPs and guidelines because the process was more generally more focused and responsive to GOM issues & timing, and engaged relevant industry experience more effectively.			X	

Table 1 – Drilling - Observations, Discussions, and Ideas for Improvement							
Observations(Learnings or Issues)		Discussion	Potential Opportunities for Improvements	Type of Improvements			
				Oper. Prac.	Design Prac.	Regs & Stnds	Tech
		to a severe operating environments (e.g., RP=10 years) is much greater in the GOM • Thruster can be used for mooring assist in other areas where MODU's are not evacuated during severe storms					
13	Storm prep & evac procedures adequate (hurricanes, loop currents)? Are operators allowing enough time to prepare?	Transocean presentation on Day 1 pointed out the simultaneous hurricanes and loop currents can impact or reduce options for securing and evacuating a MODU.	Incorporate present & forecast loop currents and proximity to shallow water features in evacuation plans.	X			
15	Storm evac reporting procedures adequate?	Current system is voluntary. Both MMS & USCG urged operators to comply	Support the voluntary reporting system.	X			
16	Recovery equipment availability & sharing?	Not discussed	Not discussed	X			
17	Beacon info to all operators?	Should GPS system information be made available to all operators in order to assess & evaluate threats or damage from drifting MODU's?	Not discussed due to lack of time.	X			
18	Emergency procedures for MODUs adrift	What actions could be taken to prevent drifting MODU's from damaging surface or subsurface infrastructure?	Develop and evaluate ideas, and undertake develop any promising ideas.	X			X

Production Facilities Break-Out Session

The focus in this session was on the damage to facilities and topsides on fixed and floating production structures. The main goal of this Break Out Session was to identify and discuss opportunities to improve industry and regulatory practices related to Production Facilities. Presentations on key topics and panel discussions provided information on observations (learnings and issues). The audience was then engaged in a forum discussion based on these observations.

Presentations

Key points from the presentations are summarized below. Available presentations are shown in Appendix E.

Fixed Platforms A total of 7 fixed platforms were destroyed as a result of hurricane Ivan. One of the seven was toppled by a mudslide, while the other six failures are thought to be attributed to the environmental loads (i.e., wind, wave and current) exceeding the capacity of the structures. Although much of the discussion centered on platforms that were destroyed or heavily damaged, the majority of the facilities in the path of Ivan weathered the storm unscathed or with only minor damage, as shown in the following table.

Fixed Jacket Platforms in Ivan's Path

No Damage	**75%**
Minor Damage	**6%**
Major Damage	**14%**
Destroyed	**6%**

The majority of the platforms that failed or sustained major damage were older platforms that had been designed to earlier standards that had lower environmental criteria. These older platforms generally had lower global strength characteristics (e.g., weaker joints, less robust bracing patterns, etc.) and lower deck elevations than platforms designed to present industry practices. The lower deck height elevations can result in wave loads directly on the deck in severe storms, which can increase the loads on the platforms to well over the platform's ultimate capacity.

Fixed platform damage during Ivan was due to waves in deck, wave loads that exceeded design criteria, and large wind loads. The majority of fixed platforms with damage showed evidence of waves in the deck. Damage included deflected structural members in deck; damage to production equipment, support systems (i.e., piping, cable trays, etc.), and safety systems, particularly in the lower decks; and underwater structural damage to the jacket.

Non-structural topsides damage included damage to equipment (e.g., power controls, generators, etc.) and support systems (i.e., piping, cable trays, etc.) on the lower decks. Displaced or missing grating, handrails and stairs also hampered recovery efforts because they had to be repaired for safety reasons before other equipment damage cold be addressed. Getting the support and safety systems (power, fire water, etc.) up and running and the repair of safety critical items delayed and restricted manning of the facility and required work be done on a day-trip basis. The non-structural damage associated with wave-in-deck resulted in the greatest contributor of downtime for these facilities.

The increased lateral loads due to waves in the deck and the larger waves also caused underwater structural damage to the jacket structure. Observed damage included

- Local buckling on jacket legs
- Parted jacket legs
- Buckled diagonals (global and local at joints)
- Parted diagonals
- Punching shear at brace joints
- Fractured / detached conductor guide framing (first conductor guide framing below waterline)

It is not surprising that some of the older vintage platforms with lower decks that experienced waves in the deck were significantly damaged or lost. The wave inundation resulted in large loads over and above the jacket's design load, causing significant damage to the jackets as the lateral load approached the platform’s capacity. However, no significant damage was observed in the newer vintage platforms that experienced waves in the deck [e.g., Virgo (VK 823), Pompano (VK 989A), Main Pass 252, Petronius (VK 786A)]. This is evidence of the difference between past and present-day designs, and illustrates the improvements in the present design practices and codes.

The observed damage attributed to waves in deck is based on the assumption that the damage resulted from large forces from greenwater (as opposed to spray) impinging on the deck. The maximum elevation of such damage is often interpreted as an indication of the maximum crest elevation of the storm waves. In some instances during Ivan, the observed deck damage indicated crest elevations that were higher than would be expected based on the hindcast significant wave heights. The hindcast methodology has been well verified with data from Ivan and other hurricanes, as has the model to predict crest elevations from the significant wave height. This difference between expectation and observations requires more study.

Two platforms exhibited signs of topside structural failure due to wind loading. One platform included the failure of a light metal skinned structure and the large deformation of a modular building wall. The quarters and heliport toppled over toward the center of another platform

Discussions also included novel inspection techniques to detect damage for jackets (ambient vibrations) and piles (interior inspection by a miniaturized ROV).

Several ways to mitigate the risks of damage to older facilities were discussed, including:

- Removing well conductors (plugging and abandoning inactive wells and removing the conductors that contribute to the lateral loading on the platform)

- Raise the decks
- Install new platforms and/or reinforce the existing platform by providing additional bracing
- Strengthen existing platform (e.g., grouting legs, etc.)
- Platform removal

Floating Production Systems Ten Floating Production Systems (FPSs) were in Ivan's path and experienced severe metocean conditions. Notably, the hulls, moorings, and risers of these deepwater FPSs, which included Spars, Tension Leg Platforms, and a Semisubmersible, were lightly damaged. This lack of damage tends to validate the hull, mooring, and riser design technology for these deepwater FPSs that are responsible for an ever-increasing percentage of Gulf of Mexico production.

Damage to topsides facilities included deck modules, piping and cables. Such damage is thought to be due to greenwater from waves higher than design criteria inundating decks and winds in excess of design criteria. Drilling rigs were moved on several FPSs, and such movements are thought to be due a combination of high winds and FPS motions that created loads that exceeded the capacity of the rig tie-down fasteners. One rig was lost overboard, and the others were damaged and caused collateral damage to other equipment.

Wave damage in the decks of FPSs was not as severe as that observed on the fixed platforms. The damage was generally confined to moved or missing deck grading, hand rails, and equipment braces on the lower decks. Evidence of the wave inundation in the lower decks observed on the fixed facilities was not seen on the floating facilities. Instead the damage may have been caused by wave run-up on the hull structure or other wave interaction with the structure.

Recovery Resources necessary to initiate inspections, conduct repairs, procure equipment, etc. were stretched thin during the recovery effort. Initially onshore housing and transportation were a constraint since many of the damaged offshore facilities could not be immediately manned for safety reasons (damaged safety systems, living quarters, power, etc.). Day-tripping (traveling offshore to facility, working during the day and traveling back to shore base at end of day) was the norm. There were a number of examples showing the cooperation and sharing of resources among companies during the recovery effort.

Discussion Table 2 below summarizes the Observations, Discussions, and Recommendations. Note that the discussion period was limited to 1-1/2 hours and thus precluded covering all observations in detail during the session.

Table 2 – Production Facilities - Observations, Discussions, and Ideas for Improvement

Observations (Learnings or Issues)		Discussions	Potential Ideas for Improvement	Type of Improvement			
				Oper. Prac.	Design Prac.	Regs & Stnds.	Tech.
1	Ivan mudslides caused one platform failure and numerous pipeline failures (Should we install platforms in mudslide areas? – Question posed by Chris Oynes, MMS presentation)	Currently there are approximately 10 existing platforms in mudslide regions. In the case of the one platform failure attributed to mudslides it was indicated during the discussions that this event was more likely an entire slope failure rather than a typical mudslide, (i.e., a very extreme event). These platforms have been through many hurricanes over the years. The general consensus was the installed platforms in mudslide regions are considered acceptable.	None noted.				
2	Non-structural damage (i.e., cable trays, piping, etc.) due to wave inundation at or below lower decks resulted in significant down time at some facilities. (Standards/design hazard assessment)	It was noted that there are no standards currently that directly address this issue. It was noted that there is a committee in API SC14 (14J) on placement of equipment. However it was unclear if this would cover the placement of equipment and its susceptibility to wave/water inundation. It was noted that API 2T may also be standard where this can be addressed.	Performance based design development (to include the evaluation of these non-structural system) Standard that documents what type of systems to evaluate (e.g., safety systems, access, power, control, tie downs)		X		

Table 2 – Production Facilities - Observations, Discussions, and Ideas for Improvement

Observations (Learnings or Issues)		Discussions	Potential Ideas for Improvement	Type of Improvement			
				Oper. Prac.	Design Prac.	Regs & Stnds.	Tech.
3	MODUs adrift during Ivan resulted in potential collision hazard to production facilities. (Should MODU's be removed from the vicinity of high volume facilities prior to a storm event? - Chris Oynes, MMS)	This was not addressed during the Production Facilities Break Out Session.	None noted.				
4	Difficulties plugging and abandoning wells on destroyed fixed platforms (many wells on thee platforms were not active).	The risks associated with finding and plugging and abandoning wells in cases where the platform and associated conductors have sustained severe damage or toppled during the storm is considered to be high when accounting for the amount of saturated dives hours (personnel risks) and other complex underwater activities. In the cases of the destroyed platforms during Ivan many of the wells were inactive for a long period of time but were not plugged and abandoned. It was mentioned that the Offshore Operators Committee (OOC) would be one of the organizations that can get the word out to industry on this issue.	Develop plan to educate industry on risks of keeping inactive wells. It was mentioned that the escrow on abandonment is not used until the entire facility is to be abandon (i.e., facility is not producing any more). It was suggested that consideration be given to providing portions from the escrow for P&A inactive wells (provides incentive to get rid of inactive wells)		X	X	

Table 2 – Production Facilities - Observations, Discussions, and Ideas for Improvement

Observations (Learnings or Issues)		Discussions	Potential Ideas for Improvement	Type of Improvement			
				Oper. Prac.	Design Prac.	Regs & Stnds.	Tech.
5	Platform drilling rig failures result in topside damage (design criteria)	This observation was not discussed in detail during the session. However, a segment of this issue is being addressed as part of the MMS funded study "Assessment of Drilling and Workover Rig Storm Sea Fastenings on Offshore Floating Platforms During Hurricane Ivan", which is being conducted by the Offshore Technology Research Center. The other associated item is the differences in the rig design criteria when compared to the permanent facility design criteria. API 4F presently covers drilling and well servicing structures and would like be mechanism to address design criteria and update design practices based on results of rig fastening study.			X		

Table 2 – Production Facilities - Observations, Discussions, and Ideas for Improvement

Observations (Learnings or Issues)		Discussions	Potential Ideas for Improvement	Type of Improvement			
				Oper. Prac.	Design Prac.	Regs & Stnds.	Tech.
6	Various newer vintage floating and fixed facilities showed signs of wave crests in lower deck elevations (deck height criteria)	Fixed and floating structures need to be address differently. The deck height criteria for fixed structures is dependent on wave height and crest where as for floating structures it is influences by the wave period and associated vessel motions. When comparing the observed fixed platform deck damage and attributed wave height estimates calculated using present design practices to the hindcast wave height estimates there were noted discrepancies. The estimated wave heights based on observed conditions were generally higher than the hindcast estimates. Based on these differences there is still a need, particularly for platforms designer and engineers to understand what was Ivan in relation to present design practices (specifically with regards to wave loading).	Need for interaction between metocean personnel and end users (i.e., platform designers and structural engineers) Mechanism for this is likely API SC2 committee. Recommended practice for covering the development of environmental criteria and methodologies. Guideline for oceanographers to calculate wave heights (currently there is no guidance)		X		X

Table 2 – Production Facilities - Observations, Discussions, and Ideas for Improvement

Observations (Learnings or Issues)		Discussions	Potential Ideas for Improvement	Type of Improvement			
				Oper. Prac.	Design Prac.	Regs & Stnds.	Tech.
7	Metocean database indicates regional environmental differences in GOM (RP2A environmental criteria)	There was general consensus that regional differences in the GOM should be included in design standards and updated in the metocean database. It was noted that the new deepwater facilities have site specific metocean criteria developed. One issue is obtaining funding as well as time from industry personnel to improve industry standards. Joint Industry Project (JIPs), such as the API Structural Integrity Management JIP, have provided alternative avenues to obtain funding and personnel in industry to address needs for updates and development of industry standards.	Update metocean database with Hurricane Ivan Include regional metocean criteria to design standards Mechanism for this is likely API SC2 committee.		X		X
8	Quarters module damage (wind loading and treatment of temporary structures)	Need post Ivan assessment of structural failures to better understand the potential implications to current design practices and whether there is a need for modifications.	MMS funded studies include the assessment of structural failures such as rig fasteners and fixed platform performance but these studies will likely not directly address some of the topside wind damage observations and the treatment of temporary structures (i.e., design criteria).		X		X

Table 2 – Production Facilities - Observations, Discussions, and Ideas for Improvement

Observations (Learnings or Issues)		Discussions	Potential Ideas for Improvement	Type of Improvement			
				Oper. Prac.	Design Prac.	Regs & Stnds.	Tech.
9	Many of the fixed platforms (200-300' WD) that sustained major damage were located near steep deepwater drop off (Is there a shoaling effect influencing the loading?)	There currently is not enough details on whether this is a factor in the failures. Results from the MMS funded project on fixed platforms may provide some insight into this and whether it warrants further study and possibly a look back at past platform hurricane damage patterns to see if there is evidence of this phenomena.	Pending results of MMS funded study on fixed platform performance.				X
10	Development of industry standards instead of development of new regulations (Don Howard) (there are learnings that need to incorporated into industry practices)	This was not covered directly during the discussions. However, as seen in this table most of the ideas for improvement entail the utilization of industry organizations such as API, OOC, etc. to provide the means for addressing the issues and learns from Hurricane Ivan.					
11	GOM is National Resource and will be under greater public scrutiny (need for unified message from industry, we are working as a team to protect the resources and keep America running?)	This was not covered in detail during the session discussions.					

Table 2 – Production Facilities - Observations, Discussions, and Ideas for Improvement

Observations (Learnings or Issues)		Discussions	Potential Ideas for Improvement	Type of Improvement			
				Oper. Prac.	Design Prac.	Regs & Stnds.	Tech.
12	Limited resources (repair, inspection, onshore base housing, etc.) available after hurricane event	This was a common theme in most of the offshore facility recovery efforts. The resources get stretched after a storm while all of the operators work to get there facilities producing again. However, it was evident in the facilities breakout session presentations that there is a lot of cooperation between operators, sharing resources (e.g., workboats, etc.) and communication. This subject was not directly covered in the facilitated discussion.	None noted.				
13	Difficulties in replacing out dated equipment (replacement strategies)	During the presentations it was highlighted that obtaining replacement parts for equipment can be difficult and sometimes requires replacing equipment rather than repairing it. This can impact recovery schedules as well as recovery costs. It was indicated during these presentations that having a replacement strategy in place can help improve recovery aspects.		X			

Table 2 – Production Facilities - Observations, Discussions, and Ideas for Improvement

Observations (Learnings or Issues)		Discussions	Potential Ideas for Improvement	Type of Improvement			
				Oper. Prac.	Design Prac.	Regs & Stnds.	Tech.
14	Environmental monitoring and data gathering during hurricanes (need for more measurements during hurricanes)	A common theme throughout the metocean presentations was the limited measurements collected during the entire duration of Ivan. Keeping the measurement systems operating on offshore facilities it is a significant effort and cost. The level of funding for NOAA measurement buoys was unclear. It was indicated that MMS funding may have been reduced or stopped. On a tangent discussion it was noted that offshore aviation needs accurate weather data as offshore facilities get farther offshore (i.e., into deeper water).	Need to collect more data and make the data accessible (need for data to be shared among industry) Need for more data on motion response of floating structures Need to make a business case to industry and governmental organizations on a global picture (need for more funding for offshore GOM measurements) Install more NOAA buoys in GOM and locate buoys based input from oceanographers for best locations		X		X

Pipeline Break-Out Session

The focus in this session was on the pipeline infrastructure.

The main goal of the Break Out Session was to synthesize information on performance and to identify and discuss opportunities to improve industry and regulatory practices. Presentations on key topics and panel discussions provided information on observations (learnings and issues). The audience was then engaged in a forum discussion based on these observations.

Presentations Key points from the presentations are summarized below. Available presentations are shown in Appendix F.

Pipeline performance during Hurricane Ivan was generally consistent with previous experience in recent hurricanes, such as Andrew and Lili. Most of the pipelines damaged were smaller lines (diameter less than 12 inches), most of the damage was concentrated in the Mississippi delta, and product spills were minimal. However, there were several noteworthy exceptions to previous experience:

- A large variety of failure modes were observed, including mudslides, lateral movements across the sea floor, impact from dragged and displaced objects, and pipeline interaction at a crossing.
- There were several instances where long lengths of pipeline (tens of miles) were displaced significant distances laterally (5,000 to 10,000 feet). These movements were not necessarily caused by mudslides.
- There is evidence that mudslides occurred in deeper water and resulted in greater displacements of the sea floor than previously experienced.

Post-storm assessments of integrity were successful in identifying and correcting problems. Sonar techniques, including side-scan and high resolution, worked well for initial assessments where the pipeline was uncovered. Magnetometer surveys were useful in locating buried pipelines. A piece of excavation equipment that displaces soft sediment with hydraulic circulation was particularly helpful in uncovering buried pipelines. Pressure testing with product at or near operating pressures was successful in either assuring integrity or locating breaks.

The coordinated response of operators and governmental agencies was considered to be successful from the perspective of all parties. Equipment and services were shared, decision-making was streamlined, and corrective action was accomplished as quickly as was technically possible.

The lessons learned from the pipeline experience during and in the aftermath of Hurricane Ivan point to several areas where improvements could be made. First, there is a need to better understand the causes and modes of failure. The existing MMS studies on pipelines and mudslides should help in this regard. In addition, industry is considering supplementing that work with a Joint Industry Project. These studies will however be limited by the quality of data that are currently collected regarding incidents and performance. Therefore, one immediate need is to improve the existing system for incident reporting and documentation. Second, while post-storm integrity assessments were generally successful, there is not a formal program in place to coordinate and guide these efforts. Therefore, industry plans to work to formalize this process, including pre-storm preparation and planning through post-storm response. In this regard, industry would like to expand participation on the API pipeline team to include both smaller and larger operators, both gas and oil representatives, and service providers and designers. Any future needs to change regulations or standards will be identified and coordinated through these ongoing efforts.

Discussion Table 3 below summarizes the Observations, Discussions, and Recommendations. Note that the discussion period was limited to 1-1/2 hours and thus precluded covering all observations in detail during the session.

Table 3 –Pipelines - Observations, Discussions, and Ideas for Improvement

Observations(Learnings or Issues)		Discussion	Potential Opportunities for Improvements	Type of Improvements			
				Oper. Prac.	Design Prac.	Regs & Stnds	Tech
1	Many different modes of failure for pipelines	Failures were ***generally*** not considered abnormal compared to previous experience Modes of failure included: crossing interactions, anchor dragging, displaced objects on sea floor, movement across sea floor, mudslide movement, and loss of bearing capacity. Each mode of failure depends on different factors and there was no predominant mode. This feature of Hurricane Ivan is in contrast to Hurricane Lili, where damage to pipelines was predominantly related to risers. Both newer and older pipelines were damaged. Several instances where adjacent pipelines, even pipelines in the same trench, behaved differently. Failures occurred up to 270 miles west of storm center: possibly due to currents or even Ivan II, although not likely due to low intensity.	Need Joint Industry and Government efforts to collect and carefully analyze the available data on performance – with and possibly in addition to existing MMS efforts. Modes and causes of failure need to be considered carefully in these efforts. Need for improved data collection and incident reporting on failures. Classifications, etc. are wanting.			X	X

Table 3 –Pipelines - Observations, Discussions, and Ideas for Improvement							
Observations(Learnings or Issues)		Discussion	Potential Opportunities for Improvements	Type of Improvements			
				Oper. Prac.	Design Prac.	Regs & Stnds	Tech
2	Not all pipeline movements were necessarily related to mudslides	There were isolated cases of very large movements (5,000 to 10,000 feet of lateral displacement) and significant lengths of pipelines affected (up to 26 miles in length), which are well beyond past experience in the Gulf of Mexico. Unique pipeline movements particularly occurred on the eastern side of the delta in Main Pass area wherein pipelines were carried many thousands of feet seaward by a presently unknown mechanism. Movements probably occurred during Ivan, but may have actually accumulated over time before Ivan. Mudslides in other offshore areas have moved this far, but not in the Gulf of Mexico based on past experience. The mats at the crossing of Nakika and MPOG were not found even though the crossing itself did not move (as it would in a mudslide).	Need more and higher quality data of pipeline movements as a function of time. Need to analyze possibility current-induced movements such as hydroplaning, considering that most currents are parallel to shore. Plots of peak and orbital currents from hindcast data would be helpful.				X

Table 3 –Pipelines - Observations, Discussions, and Ideas for Improvement							
Observations(Learnings or Issues)		Discussion	Potential Opportunities for Improvements	Type of Improvements			
				Oper. Prac.	Design Prac.	Regs & Stnds	Tech
3	Mudslides possibly occurred in deeper water depths and resulted in greater displacements than previously known or expected	The waves in Hurricane Ivan had an unusually long period, meaning that wave pressures would be greater in deeper water. Delta sediment is dynamic, variable and potentially very weak. Data are not yet conclusive about what pipeline failures and movements were due to mudslides. Pipelines perpendicular to mudslide movement apparently did not fare as well as parallel lines. Not all areas of previous slides were apparently affected by Ivan. Burying pipelines deeper (or at all) will likely not help in a mudslide. Existing practice in mudslide areas is to conduct project-specific analyses with recognized experts. These analyses are included in design documents. They are not prescriptive.	Current MMS efforts to better understand mudslide activity in Ivan should help in better understanding what was or wasn't caused by mudslides and why.				X

Table 3 –Pipelines - Observations, Discussions, and Ideas for Improvement							
Observations(Learnings or Issues)		Discussion	Potential Opportunities for Improvements	Type of Improvements			
				Oper. Prac.	Design Prac.	Regs & Stnds	Tech
4	Post-storm integrity assessments were successful in identifying and correcting problems.	Side-scan and 360-degree (high resolution) sonar worked well in assessment where pipeline was uncovered. Magnetometer survey required where pipelines were buried. Rotech equipment worked well in uncovering buried pipelines. Hydrotesting was not used in Ivan assessment of existing pipelines. It would not necessarily have helped in finding leaks, would have been costly, and could have led to additional problems. Pressure testing with contents (product) was conducted at or near operating pressures. Pressure test failures were identified immediately, indicating rupture versus yielding. Pipelines were not first focus in aftermath of storm (unlike topsides).	Need post-storm integrity plan in place before storm (both operators and MMS agree). MMS prefers that this effort be initiated by industry.	X			

Table 3 –Pipelines - Observations, Discussions, and Ideas for Improvement							
Observations(Learnings or Issues)		Discussion	Potential Opportunities for Improvements	Type of Improvements			
				Oper. Prac.	Design Prac.	Regs & Stnds	Tech
5	Coordination of response between companies and agencies was a success	Incremental production losses due to pipeline failures were relatively small compared to facilities. This conclusion is not consistent with public/MMS perception. It may be that other operators had different experiences (approximately 60% of the pipelines affected did not have representation in the breakout session) or that there was a different impact for gas versus oil pipelines. Most of pipelines exposed during Ivan in Main Pass were smaller diameter, so it is reasonable that more, smaller pipelines (and subsequently smaller operators) were affected.	Need to expand make-up of API pipeline team – smaller operators, gas industry, service providers, and designers. MMS may join or there may be a repeat of this workshop in a year or two. Need more pre-storm planning for availability of and collaboration with equipment, personnel, vessels, materials and services. MMS would prefer that this effort be initiated by industry. Need to check condition and certification ahead of time for pieces of repair equipment.	X			

APPENDIX A

Conference Agenda

APPENDIX B

Plenary Session Presentations

APPENDIX C

Metocean & Geotechnical Presentations

APPENDIX D

Drilling Break Out Session Presentations

APPENDIX E

Production Facilities Break Out Session Presentations

APPENDIX F

Pipeline Break Out Session Presentations

APPENDIX A

Conference Agenda

American Petroleum Institute

1220 L Street, NW Washington D.C. 20005-4070
(202) 682-8000 www.api.org

Hurricane Readiness and Recovery Conference Proceedings

July 26-27, 2005
InterContinental Houston Hotel
Houston, Texas

Co-sponsored by:
Minerals Management Service
Offshore Operators Committee
United States Coast Guard
U.S. Department of Energy
Office of Pipeline Safety
National Ocean Industries Association
Offshore Marine Service Association

Endorsed by:
International Association of Drilling Contractors

Tuesday, July 26

8:00 am – 8:15 am	**Welcome and Opening Remarks** *Sandi Fury, Chevron*
8:15 am – 9:00 am	**Grounding - Work Done to Date** *Keynote Speakers:* *Chris Oynes, MMS* *Captain Ron Branch, USCG*
9:00 am – 10:00 am	**Regulatory Perspective** *Don Howard, MMS* *Hector Cintron, USCG*
10:20 am – 11:45 am	**Planning & Response Best Practices: Presentation and Panel Discussion** *Panel: Bob Bemis, Noble Energy Inc.* *Jason Dollar, Shell Pipeline* *Mike Acuff, Transocean*
1:00 pm – 3:30 pm	**Metocean Panel** Wind and Wave Hindcast *Dave Driver, BP*

	Current Hindcast *Jim Stear, Chevron*
	Wind and Wave Measurements *John Heideman, ExxonMobil*
	Ivan from a Historical Perspective *Cort Cooper, Chevron*
	Review of the Ivan Forecasting & Recent Advances in Forecasting Severe Hurricanes *Gene Hafele, Houston/Galveston National Weather Service*
3:50 pm – 4:30 pm	**Soils - Geotechnical Issues Associated with Ivan** *Jim Hooper, Fugro-McClelland Marine Geosciences, Inc.*

Wednesday, July 27

Drilling Break Out Session

8:00 am – 8:20 am	**Introduction** *Craig T. Castille, Dominion E&P* *Mike Conner, MMS*
8:20 am – 8:45 am	**Standards Review and Update on API RP2SK** *Tom Kwan, DTCEL*
8:45 am – 9:10 am	**Deepwater Nautilus Mooring Incident** *Dave Loeb, Shell*
9:10 am – 9:30 am	**Jim Thompson Mooring Incident** *David Petruska, BP*
9:30 am – 10:00 am	**Panel Discussion** *Malcolm Sharples, Consultant* *Noble* *Transocean*
10:20 am – 10:45 am	**Proposed Industry JIP on Reliability & Risk Assessment** *Craig T. Castille, Dominion E&P*
10:45 am – 11:10 am	**Riser Management in Severe Environments** *Darrel Pelley, Transocean*
11:10 am – 11:35 am	**Design & Installation Improvements to Improve Reliability & Mitigate Risk** *Evan Zimmerman, Delmar*
11:35 am – 12:00 pm	**Station Keeping Capabilities of the Development Driller 1&2**

Momem Wishahy, GSF

1:00 pm – 2:30 pm — **Open Forum & Panel Discussion**
Panel: Tom Kwan, David Smith, Dave Loeb, Darrel Pelley, Malcolm Sharples, Mike Conner
Facilitator: Skip Ward

2:50 pm – 3:20 pm — **Plenary Discussion - Air & Marine Vessel Support**
Pat Graves, Air Logistics
Tom Kazusky, Tidewater

Wednesday, July 27

Production Facilities Break Out Session

8:00 am – 8:30 am — **Introduction**
George Rodenbusch, Shell

8:30 am – 12:00 pm — **Facility Impact and Recovery**
Overview of Platform Exposure and Damage
Tommy Laurendine, MMS

VK 823 Virgo
Richard Case, TOTAL

MP 281A
Butch Ventura, Dominion

VK 989 Pompano & MC 657 NaKika
Pat O'Connor, BP

MP 252 & VK 915
Bill Pritchett, Shell

VK 786 Petronius & MP 294 & VK 900
Dave Wisch, Chevron

Some Implications of Consequence Based Design
Dave Wisch, Chevron

Hurricane Ivan Overview
Carl Heinrichs, Apache

1:00 pm – 2:30 pm — **Open Forum & Panel Discussion**
Identify Areas to Improve Industry Practices
Panel: John Heideman, Tommy Laurendine, Pat O'Connor, Griff Lee, Joe Suhayda, Dave Wisch
Facilitator, Robert Spong

2:50 pm – 3:20 pm — **Plenary Discussion - Air & Marine Vessel Support**
Pat Graves, Air Logistics

Tom Kazusky, Tidewater

-

Wednesday, July 27

Pipeline Break Out Session

8:00 am – 8:15 am	**Introduction** *Michael P. Gordon, ExxonMobil*
8:15 am – 9:15 am	**Geotechnical & Facilities Storm Impact** *Kevin Gaudet, Chevron* *Jim Hooper, Fugro-McClelland Marine Geosciences, Inc.*
9:15 am – 10:00 am	**Response Management - Industry Perspective** *Mark Wrzyszczynski, Shell*
10:20 am – 11:30 am	**Recovery (Operations, Assessment, Mitigation)** *Tom Wicklund, BP*
11:30 am – 12:00 pm	**Data Gathering** *Tom Wicklund, BP* *Pipeline breakout summary*
1:00 pm – 2:30 pm	**Open Forum & Panel Discussion** *Panel: Tom Wicklund, Kevin Gaudet, Mark Wrzyszczynski, Jim Hooper, Alex Alvarado, Hector Cintron*
2:50 pm – 3:20 pm	**Plenary Discussion - Air & Marine Vessel Support** *Pat Graves, Air Logistics* *Tom Kazusky, Tidewater*