Welcome and Objectives

Sandi Fury, Chevron
Conference Sponsors

- **Co Sponsors:**
  - American Petroleum Institute
  - Offshore Operators Committee
  - Minerals Management Service
  - United States Coast Guard
  - United States Department of Energy
  - Office of Pipeline Safety
  - National Ocean Industries Association
  - Offshore Marine Service Association

- **Endorsed by:**
  - International Association of Drilling Contractors

Conference Expectations

- This is a working technical conference designed to:
  - Advance our understanding of the metocean conditions possible from extreme storm events like Hurricane Ivan
  - Put Ivan into a historical context with regard to resulting environmental forces
  - Assess the performance of Gulf of Mexico infrastructure to Ivan: MODUs, platform rigs, production platforms and pipelines
  - Identify gaps or opportunities for improvements to current design or operational standards that could improve the reliability and performance of infrastructure on the OCS to hurricane events

- We don’t expect to have the answers to all of the questions by the end of the conference

- We do expect to leave the conference with a path forward to complete the performance assessment and answer the question “are the current design standards adequate?”
Industry Assessment

- Industry performance during Ivan was not atypical to historical hurricane performance, despite Ivan’s severity.
- Minimal release of oil to the environment is a testimony to the performance of safety devices/factors considered in design as well as prudent operational procedures.
- Industry demonstrated the ability to move significant numbers of people from harms way through a timely and efficient evacuation.
- Good collaboration by Industry in prioritizing use of resources in responding to exposure post Ivan.
- Agency responsiveness to industry needs and requests facilitated return to normal operations.
Industry Assessment

- Business Impact from Ivan was significant but generally resulted from the failure of a few pieces of infrastructure.

- Opportunities have been identified for further consideration to improve reliability and performance of producing assets in the GOM to hurricane conditions.

Opportunities for Further Consideration

**Metocean**

- Closer look at metocean conditions in shallow water
- Re-evaluate 100 yr and other return period wave heights
- Evaluate platform damage versus hindcasted waves
- Further validate deepwater currents
Opportunities for Further Consideration

**Structural**
- Sponsor a workshop to discuss structural damage caused by Ivan
- Consider need for additional guidance in RPs regarding securing of equipment on platform decks and topsides
- Consider air gap criteria for platform design and assessment
- Review guidance on identification of mudslide prone areas

**Drilling**
- Consider establishment of reliability basis for GOM, including hurricane season
- Consider enhancements to API RP 4F to address loading issues and tie-downs associated with drilling structures
Opportunities for Further Consideration

- **Pipeline**
  - Better understand the factors contributing to pipeline performance during Ivan
    - Consider geo-technical issues (mudslides, silting, seafloor mapping)
  - Update industry recommended practices based on research findings

Collaboration of Industry and Government technical experts
- To better understand performance issues and high-grade opportunities for further review
- Further discussion of JIPs / studies as appropriate to address areas of concern or value added research opportunities

Actively share derived information throughout industry
Today’s Agenda

- Background
  - Work in progress – how did we get where we are?

- Perspective of the regulators
  - Performance of the Industry
  - Opportunities for improvement

- Grounding on the environmental conditions seen during Ivan
  - Metocean conditions and the relevance to current design standards
  - Advances in hurricane forecasting
  - Geotechnical issues associated with Ivan
2005 Offshore Hurricane Readiness and Recovery Conference
July 26-27, 2005
Chris Oynes
MMS Regional Director
Gulf of Mexico Region

Topics

- The setting - GOM as an asset
- Why are we here - effects of hurricanes
- What is MMS doing
- Challenges - do we need to do more
The Setting - Gulf of Mexico as an Asset

Leases in the Gulf 20 Years

- 1985: 1,205
- 1995: 1,947
- 2005: 7,414
Gulf of Mexico Deep Water Oil Production

- Millions of Barrels Per Year

Gulf of Mexico Deep Water Gas Production

- Billions of Cubic Feet (BCF) Per Year

Minerals Management Service

As of 5/6/05
Future of the Gulf

**Total Gas Production**

- 1995: 13.09 BCF/day
- 2002: 12.44 BCF/day
- 2011: 13.24 BCF/day

Future of the Gulf

**Oil Production is Exploding**

- 1995: 0.947 Million barrels/day
- 2004: 1.562 Million barrels/day
- 2011: 2.248 Million barrels/day
GOM OCS Deepwater Production
(Percentage of total Gulf of Mexico)

- Oil: 77%
- Gas: 26%

Year:

Minerals Management Service

WHY ARE WE HERE?
Damage from Hurricane Ivan

- Mobile Offshore Drilling Units
  - 5 adrift
- Platforms
  - 7 fixed platforms were destroyed
  - 31 platforms with serious damage
- Platform rigs
  - 1 leaning platform rig from Spar
  - 1 missing platform rig from Spar

Reported Pipeline Damage

<table>
<thead>
<tr>
<th>Storm</th>
<th>No. of Reported Pipelines Damaged</th>
<th>Pipelines 16” or Greater in Diameter</th>
<th>No. of Pipelines w/Damage Caused by Mudslides</th>
<th>No. of pipelines w/Damage Caused by Mooring Drag</th>
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<td>Hurricane Ivan</td>
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<td>12</td>
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</tbody>
</table>
Before Hurricane Lili

After Hurricane Lili

Interpretation based on ROV survey
After Hurricane Lili

Before Hurricane Lili
After Hurricane Lili

Storm Comparison: Serious Damage

- Platforms
- Rigs
- Pipelines

Minerals Management Service
WHAT IS MMS DOING?

MMS Studies

- Awarded 6 contracts totaling over $600,000
- Studies will examine the impact of Hurricane Ivan on the Gulf of Mexico oil and gas infrastructure
- Will be used in assessing the adequacy of current design standards and regulations
NTL No. 2005-G06

- Hurricane and Tropical Storm Evacuation and Production Curtailment Statistics NTL effective May 26, 2005
- Requires operators to submit statistics regarding evacuation of personnel and curtailment of production because of hurricanes, tropical storms, or other natural disasters
- Submittal of MMS Form MMS-132

MMS Form 132

- Submitted daily by operators who have any shut-in production or evacuation of any facility or rig
- Form is either emailed or faxed
- Required to be submitted by 11 a.m.
Previous Studies

- MMS is reviewing study results on Hurricane Lili – Stress Engineering report on pipelines
- MMS is reviewing previous studies on Hurricane Andrew

Challenges for Industry and MMS – Do We Need to Do More??
Platforms

WHAT CAN WE DO TO MINIMIZE DAMAGE?
- Is API RP 2A 21st Edition adequate?
- Is the 100 year storm criteria sufficient?
- Should we install platforms in mudslide areas?
- How do we make platform rigs more secure?
- Should MODU’s be removed from the vicinity of high volume facilities prior to a storm event?
- How do you secure your facilities in environmentally sensitive areas?
- Are synthetic mooring systems used on floating facilities adequate?

MODU’s

RIGS ADRIFT ARE NOT ACCEPTABLE!
- Is the API RP 2SK Mooring Designs standard adequate?
- What are the assumptions used in performing risk analysis for mooring near infrastructure? Are they sufficient??
- Are the current standards for anchors and synthetic mooring systems adequate?
- Are the current storm preparation and evacuation procedures adequate? Are operators allowing enough time to properly secure and prepare?
- Are the recommended inspection schedules for mooring systems adequate?
Pipelines

- Are the current design standards adequate?
- Are the storm preparation procedures adequate?
- Should we lay pipelines in mudslide areas?
- Should pipelines be laid only perpendicular to mudslide areas?
- Do we need redundancy built into the major pipeline systems?
- Should lines be hydro-tested tested prior to returning pipelines to service?
- Should all pipelines be buried?

Future Efforts

- Continue working closely with industry and other federal agencies
- Continue to assess the effectiveness of current design standards and regulations
- MMS expects to act before and after studies completed
Big Picture – New Reality

- Rising production
- More infrastructure exposure
- Country’s growing dependence on Gulf of Mexico
- Gulf of Mexico is one driver of the markets – press scrutiny is intense

2005 HURRICANE SEASON
(To Date)
RESPONSE & RECOVERY FROM IVAN IN THE EIGHTH CG DISTRICT

Captain Ronald Branch
Chief, Marine Safety
Helo Flights by CG Marine Inspectors

- CG Marine Inspectors fly offshore daily to conduct Annual Safety Inspections, Hull Exams, Deficiency Checks, New Construction Oversights, & MTSA Verifications on Floating Offshore Installations & MODUs
- Also, inspectors conduct Initial Safety Exams of Fixed Platforms
- CG Marine Inspectors average approx 300 flights per year
Lightering Zones

• 4 Designated Lightering Zones used by single-hulled tankers thru 2015
• 6 Traditional Lightering Areas used by double-hulled tankers (VLCCs/ULCCs)
• Largest & busiest in U.S.; receives 30% of the nation’s crude oil

Deepwater Ports – Oil & LNG

Louisiana Offshore Oil Port (LOOP)
- 18 mi offshore / 110’ water depth
- 3 Mooring Buoys
- Up to 1.2M BOPD

Gulf Gateway Energy Bridge (LNG)
- 116 mi offshore/298’ water depth
- Submerged Turret Loading
- 270M cubic ft per day
Channel Surveys

- Coast Guard works closely with other Federal agencies such as Army Corps of Engineers and the National Oceanic and Atmospheric Administration
- Coast Guard partners with pilots associations and industry groups

To open ports in as safe and efficient manner as possible.
Flooding and minor damage to CG facilities

Station/ANT Pensacola
Station Destin
Station Panama City
Station Station Venice
Dauphin Island
Group Mobile
SUPPORT TO OTHER AGENCIES

• FEMA Region 4 (Atlanta) two CG reps for post-hurricane operations at Regional Response Coordination Center.

• FL, AL, MS & LA state Emergency Operations Centers all with CG reps assigned.
Voluntary Reporting of Evacuation Initiative
2005 Offshore Hurricane Readiness and Recovery Conference
Regulatory Perspective

Don Howard
MMS Field Operations
Regional Supervisor
Ivan Entering the GOM

Platform Evacuations Due to Hurricane Ivan
Rig Evacuations Due to Hurricane Ivan

Ivan Storm Track
Ivan and Deepwater Facilities

Main Pass 293 A
Year Installed 1969

Main Pass 305 C
Year Installed 1969

Main Pass 306 E
Year Installed 1969

Mississippi Canyon 20 A
Year Installed 1984

Destroyed by Hurricane Ivan
Floater Damage

MC 538

HK 786

MC 471

Hurricane Ivan GOM Structure Damage

- MODUs
  - 4 adrift with 1 leaning at 3 degrees
- Platforms
  - 7 fixed were destroyed
- Platform rigs
  - 1 leaning platform rig from Spar
  - 1 missing platform rig from Spar
Hurricane Ivan GOM Pipeline Damage
(Updated 7/18/05)

- Reported Pipeline Failures: 169
- Pipelines with Multiple Failures: 5
- Pipelines with Failures due to Mudslides: 21

Percentage of GOM Daily Production Shut-in due to Hurricane Ivan
## GOM Production Lost due to Hurricane Ivan

- **Total Daily Lost Production (As of January 3, 2005)**
  - 148,228 BOPD (Approx. 8.72% of Normal GOM Daily Production)
  - 593.69 MMCFD (Approx. 4.83% of Normal GOM Daily Production)

- **Total Cumulative Lost Production from 9/11/04 to 1/3/05**
  - 38,357,900 BBLS of Oil (Approx. 6.34% of Normal GOM Annual Production)
  - 151,736 MMCF of Gas (Approx. 3.41% of Normal GOM Annual Production)

- **For perspective, current Daily Lost Production is equal to approximately:**
  - .99% of Average Daily US Consumption of Oil
  - .75% of Average Daily US Consumption of Gas

## Mudslide Area
**Hurricane Ivan Research**

1. Review Mobile Offshore Drilling Unit (MODU) loss of station keeping ability

2. Assess Drilling and Workover Rig Storm Sea Fasteners on Offshore Floating Platforms During Hurricane Ivan

3. Assess Fixed Offshore Platforms in Hurricanes Ivan, Andrew and Lili

4. Assess Pipeline damages

5. Examine and review the mudflow/mudslide areas in the Gulf of Mexico caused by Hurricane Ivan

6. Develop a database of ocean currents

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**Review Mobile Drilling Unit (MODU) Loss of Stationkeeping Ability**

**OBJECTIVES**

- Study MODU failures
- Review the mooring criteria
- Determine if new criteria would have helped

Dr. Malcolm Sharples

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MMS Securing Ocean Energy & Economic Value for America
Assess Drilling and Workover Rig Storm Sea Fasteners on Offshore Floating Platforms During Hurricane Ivan

Objectives:
- Assess the drilling rig fastener system
- Review rig tie-down criteria on floating production platforms

Assess Fixed Offshore Platforms in Hurricane Ivan, Andrew and Lili

Objectives:
- Assess the effectiveness of structural design standards
- Recommend new standards
Pipeline Damage Assessment from Hurricane Ivan

Objectives:
- ID root causes of damage.
- Compare design and installation methods.
- ID techniques to mitigate future PL damage.
- Recommend best practices and code changes.

A Pilot Study for Regionally-Consistent Hazard Susceptibility Mapping of GOM Submarine Mudslides

Objectives:
- Develop criteria for mapping slope susceptibility to mudslides.
- Evaluate effectiveness of mudslide susceptibility mapping by comparing against pre-Hurricane Ivan mudslide data.
Mudslides During Hurricane Ivan and an Assessment of the Potential for Future Mudslides in the GOM

Objectives:
- Review mudslide areas resulting from Hurricane Ivan.
- Perform numerical analyses and numerical modeling of mudslide data.
- Map areas of high risk and/or where further evaluation is needed.

Path Forward
- New Standards?
- New Regulations?
U.S. Coast Guard
Marine Safety Office – New Orleans

OFFSHORE HURRICANE READINESS

July 26-27, 2005

Topics

• NIMS
• Hurricane IVAN
  - Widespread Damage to Infrastructure
  - Multiple Responses to Protect Environmentally Sensitive Areas
  - Lessons Learned
National Incident Management System (NIMS)

Overview


Directed Secretary, DHS to develop and administer:

- **National Incident Management System** (NIMS)
  Core set of concepts, principles and terminology for incident command and multiagency coordination

- **National Response Plan** (NRP)
  All-discipline, all-hazards plan
NIMS and NRP

National Incident Management System (NIMS)

Used for all events

Local Response

State Response or Support

Federal Response or Support

NIMS aligns command, control, organization structure, terminology, communication protocols, resources and resource typing for synchronization of response efforts at all echelons of government.

Incident

DHS integrates and applies Federal resources both pre and post incident.

Resources, knowledge, and abilities from Federal departments & agencies.

National Response Plan (NRP)

Activated for incidents of national significance.

Command and Management

Incident Command System

Concepts and Principles

- Most incidents are managed locally
- Modular and scalable
- Interactive management components
- Enables diverse organizations to work together
  - Common terminology
  - Common standards
  - Common procedures
- Measurable objectives
- Minimal disruption to existing systems and processes
- User friendly and applicable across spectrum of emergency response and incident management disciplines
Command and Management
ICS Organization and Operations
Command and General Staff

- Command
- Operations
- Planning
- Logistics
- Finance/Administration

NIMS Information

- http://www.nimsonline.com/
- http://www.fema.gov/nims/nims.shtm
Lessons Learned
Questions?
Hurricane Preparedness

- NEI Implements a Five-Phase Hurricane Preparedness Plan

- Phase One
  - Guidelines for Continual Readiness
    - June 1 thru November 30
    - Update Severe Weather Notification List
    - Review Hurricane Evacuation Procedures
    - Review Emergency Response Procedures
Hurricane Preparedness

- **Phase Two**
  - Receive Weather Alert or Storm Notification
    - Review Operations Forecast
    - Communication with Air and Marine Transportation
    - Review Hurricane Evacuation/Safety Procedures
    - Perform Safety System Checks

- **Phase Three**
  - Evacuation Preparedness
    - Secure Equipment and Function Test NAV Aids
    - Hold Pre-Evacuation Safety and Procedures Meeting
    - Evacuation Of Non-Essential Personnel

- **Phase Four**
  - Shut-Down And Evacuation
    - Pump Liquid Hydrocarbons into Pipeline
    - Shut-In Wells and Subsurface Safety Valves
    - Close Incoming and Exit Pipelines
    - Shut-Down Operating Systems
    - Evacuate
Hurricane Preparedness

- Phase Five
  - Reboarding
    - Visual Inspection of Affected Area
    - Pre-Boarding Safety Meeting
    - Damage Assessment
    - Equipment Integrity Verification
    - Safety System Function Test
    - Facility Startup

Emergency Management System

- Goal
  - Develop a Proactive Response System Utilizing an Integrated Management System

- Objective
  - Establish a Command System to Manage Emergency Response and Crisis Operations

- Structure
  - Noble Energy Utilizes the Incident Command System That Was Adopted by The U.S. Coast Guard for Use in Oil Spills
    - ICS is now known as the National Incident Management System (NIMS) – its use is now mandated under the new National Response Plan approved in November, 2004
Incident Management Organization Chart

Incident Management Structure

- Incident Command
  - Incident Commander and Staff to Manage The Event
- Operations
  - Organize and Manage Tactical Response Operations
- Source Control
  - Control and Stabilize the Source
  - Shoreline Protection Strategies
  - Site Specific Waste Management
- Planning
  - Incident Action Plan Development
  - Safety Security and Environment
  - Long View Strategy
Incident Management Structure

- Logistics
  - Support Of Personnel and Equipment
  - Communications
- Safety
  - Site Safety Plans
  - Site Security Plans
- Liaison
  - Regulatory / Media Communications
- Finance
  - Accounting
  - Contracting
  - Insurance
  - Procurement

Response Levels

- Noble has a Three Tier Level of Response Based On The Size and Scope of The Incident

- Tier One
  - Short Small Scale Incident With Minor Damage That Can Be Handled With Facility Personnel
  - Facility Personnel Engaged, IMT Members are Notified But Not Assembled

- Tier Two
  - Medium Scale Incident, Major Injury and or Limited Damage To Facility
  - Facility Personnel Engaged, IMT Members Assembled

- Tier Three
  - Major Incident, Aviation Emergency, Major Fire, Ivan
  - All IMT Members Assembled and External Response Organizations Activated
Gulf of Mexico

Hurricane Ivan
Main Pass 306 Field
MP 305, 306 & 293

Hurricane Ivan

- Fixed Wing Reconnaissance Reported Missing Platforms, No Pollution
- Confirmed Status By Two Helicopter Flights Reported Sheening From Standing Platforms
- Activated Emergency Response Team
- Activated Oil Spill Response Team
- Established Houston Command Post
- Agency Notifications
- Set up Venice Command Post
Planning Cycle

- NEI Segmented Planning into Two Functional Groups
  - Operation Planning Group
    - Focus on the Current Incident
    - Assist on Logistic Setup
    - Support Incident Command
  - “Long View” Planning Group
    - Focus On Long Range Strategy
    - Establish Goals and Objectives
    - Define Best Management Practices

Planning Stages

- Stage I – Stabilize Pollution and Safety
- Stage II – Damage Assessment
  - Existing Platforms
    - Structural Integrity
  - Lost Platforms
    - Site Survey
- Stage III – Structural Stabilization
  - Assessment
  - Planning
  - Execution
Planning Stages

- Stage IV – Operational Planning
  - Salvage/P&A
  - RTP – (Return to Production)
  - Reserve Analysis

- Stage V – Execution
  - Salvage/P&A
  - RTP
  - Reserve Recovery

Planning Considerations

- Safety
  - Diver Safety
  - Personnel

- Pollution
  - Well Bore
  - Submerged Equipment
  - Support Vessels & Surface Equipment

- Weather
  - Seasonal Weather
  - Storms
Planning Considerations

- Operational
  - Equipment Availability
  - Operational Efficiency
  - Learning Curve
  - Communication

- Financial
  - Insurance
  - Accounting

Lessons Learned

- Early Reconnaissance
- Experienced Emergency Team
  - Periodic Emergency Drills
  - Strong Alternate Support

- Agency Alliances
  - MMS
  - US Coast Guard
  - State Agencies
  - US Customs
Lessons Learned

- Industry Alliances
  - Shared Resources
    - Transportation
    - Dive Vessels
    - Pollution Control Equipment
    - Emergency Response Peer Contacts
  - Contracting Issues
    - Operator to Operator
    - Operator to Vendor

- Planning Phase
  - Transitioning from Emergency Phase
    - Avoid Reactive Response
  - Source Industry, Environmental & Regulatory Experts
  - Target “Fit for Purpose” and “Best in Class”
Offshore Hurricane Readiness & Recovery Conference

Pipeline Planning & Response

July 26, 2005
Houston, Texas

Pipeline Planning & Response

- Preparation for a Storm
- Monitoring During a Storm
- Recovery Efforts
Typical Phases of Storm Preparation/Response

Storm/Hurricane Planning Prior to the Season

Monitoring Storm to Determine Evacuation Plan

Securing Facilities & Installations

Evacuation

Monitoring

Assess Damage

Recovery Efforts

Restart

Advance Storm/Hurricane Planning

- Identify members of the Incident Command System & establish protocol for daily storm updates & evacuation planning.

- Establish requirements for evacuation and restart with producers.
  - Contact Control Center before evacuation.
  - Closing meter readings
  - Inform Control Center of any damage upon return
  - Obtain clearance prior to restart

- Place response vessels on standby as appropriate.
Repair Equipment Inventory - Shelf

- ROV operated concrete removal tool, diamond wire saw, flooded member detector, lift frames, etc.
- ROV operated end connectors with upward looking hubs & collet connectors 12” through 20”
Securing Pipelines & Related Facilities

- Confirm adequate inventory in tanks to maintain weight.
- Secure any loose items.
- Pump down the platform sump.
- Leave appropriate generator(s) running
- Establish communication procedures with drill rigs near any pipelines.
- Daily teleconferences with SPLC staff.

Monitoring During Storm

- Plot storm track, scope of wind, waves, etc. with respect to pipelines.
- Monitor pipeline pressures during storm via Control Center in Houston.
- Receive status updates on drill rig positions for those near pipelines.
- Communicate with staff to determine personal impacts.
Recovery Efforts

Reconnaissance Flights.

- Recon flights with fixed wing and large helicopters as soon as weather and sea conditions allow.
- Report any findings back to Pipeline Incident Commander.
- If lost communication at some platforms, these will be the first to re-man to read actual pressures on the system and restore remote communications.

Recovery Efforts

Standup Tests.

- Test only during daylight hours with aircraft monitoring line during test.
- Pressurize pipelines slowly. Calculate the number of barrels required to raise to the test pressure in advance.
- Hold test pressure for two hours while flying line to observe for any signs of oil.
Recovery Efforts

Release Investigations & Repair.

• Plot coordinates of any sheens observed with respect to pipelines using in-house software.

• If wind, current, and sheen location indicate that a pipeline is suspected to have a leak, mobilize boat to location to investigate.

• Develop response and repair plan for MMS, DOT, and USCG review/approval.
PHILOSOPHY

To have a predetermined, communicated plan that defines the procedures to conduct an orderly and safe evacuation of the company’s drilling vessels when required.

The four main objectives:
- Protect personnel
- Protect the environment - secure the well properly
- Protect the asset - secure the rig properly
- Resume operations safely and efficiently
**PLAN PHASES AND ALERT ZONES**

**Phase I: Preparation (June 1 – November 30)**
- Review Hurricane Evacuation Plan (HEP) by all personnel annually
- Document revisions and confirm with management by June 1
- Monitor weather conditions inside/outside the GOM

**Phase II: Warning Time**
- Declared when a severe tropical disturbance originates around GOM or Caribbean Sea (Yellow Alert Zone)
- Continuous (24-hour) weather updates through third-party vendor

**Phase III: Hurricane Alert**
- Declared when a named storm with potential for hurricane force winds approaches within 72 hours of location or 24 hours outside of Red Alert Zone
- “Red Alert Zone” is when the time to secure/evacuate equals the hurricane travel time over the calculated distance

**Phase IV: Secure/Evacuate**
- Declared when a potential hurricane approaches within 24-36 hours of location or enters into calculated Red Alert Zone
  - Aid client with MMS notification for evacuation statistics

**Phase V: Return to Work**
- Declared when hurricane has passed
Hurricane Ivan - Deepwater Horizon

- Waited on current with displaced riser from Sept 9 until disconnect on Sept 11:
  - Time at disconnect was 81 hours including 36 hours of transit time away.
  - Ivan on projected straight line path to location would have TS level winds within 90 hours.

- Rig experienced high currents > 3.5 knots due to migration of Ulysses Western Front current across location.

- Performed disconnect with 3.3 knots surface current reading.
Hurricane Ivan - Deepwater Horizon

- Planned to move to SW/S to find lower currents to pull riser
  - Current field to SW extended 40 miles – 2.6 knots of current
  - Unable to drift with current to the NE due to proximity of escarpment - 2300’
    elevation within 2 miles
  - Unwilling to go SE or E due to high currents and approaching path of storm
  - Due to the high current and ability to only move at .3 knots (split SDC ring),
    rig remained in high currents
- 44 personnel remained with the rig through storm

Effects of Hurricane Ivan on Horizon

- Closest proximity of eye to the rig was 110 miles
- Rig experienced 35’+ seas and 52+ knots wind
- Spider jumped out of gimbal once
- Highest current = 3.9 knots
- Post Hurricane Ivan, the rig had to move to SE to find lower currents of 1.3 knots
Lessons Learned – Ivan/Deepwater Horizon

- Lessons Learned
  - High capacity rigs can successfully operate in extreme current events > 3.5 knots as outlined in high current operating guidelines
  - Appreciate impact of directionality of loop current and near seabed topography on ability to drift and pull riser to escape hurricane’s path
  - Utilize current info from support vessel (if available) and account for slow transit speed (.3 knots if SDC ring split) to determine extended transit times with loop current present
  - Required extension of T-Times to account for current, hurricanes and bathymetry

Hurricane Ivan - Deepwater Nautilus

- Progressive failure of pre-laid mooring system after encounter with metocean conditions which exceeded the design criteria for MODU’s temporary moorings causing the rig to drift for 71 miles

- Action Items from Lessons Learned
  - Internal mooring strength reliability engineering study ongoing to quantify failure probabilities in order to quantifying risk
  - Installed Rig Tracker to continually monitor the location of the rig from shore during storm
  - Installed secure netting around communication equipment