About the MMS

- Bureau of the Department of the Interior

- Manage the mineral resources located on the Nation's Outer Continental Shelf (OCS)
Gulf of Mexico OCS

- 30% of the Nation’s oil production
  (≈ 570 million bbls./year)

- 21% of the Nation’s natural gas production
  (≈ 5 trillion cu. ft./year)
Gulf of Mexico Infrastructure

Pipelines on the OCS

- 23,313 miles of ACTIVE pipelines
- 12,298 miles of ACTIVE DOT pipelines
Overview

- On-bottom Stability
- Recent events
- Case Studies
- Further Research
Pipeline On-Bottom Stability
Design, Inspection, Maintenance

- 100 yr storm or 5x design
- Wave and current forces
- Spanning
- Liquefaction
- Slope failure (mudslide)
Historic On-bottom Stability Cases

Mud Slides

West Delta Area

South Pass Area
Mudslides
Pipeline Stability During Recent Storm Events

- Large pipe displacements
- Large quantities of pipe affected
- Large pipe diameters
- Non-mudslide events
- High specific gravities
Hurricane Ivan

- **Landfall:** Gulf Shores, AL September 16, 2004
- **GOM OCS on September 14, 2004**
  - as Category 4, 140 mph
- **Significant Wave Height of 59 ft. on OCS**
- **Maximum Wave Height of 91 ft. on OCS**
Hurricane Ivan

- 10,000 miles of pipelines were in the direct path.
- 78% (1.3 million BBL/D) of OCS oil production was shut-in during the storm.
- 49% (6 BCF/D) of OCS gas production was shut-in during the storm.
Hurricane Ivan
18-inch Oil Pipeline
Hurricane Ivan
18-inch Oil Pipeline

14 miles
3000 feet
Platform
Hurricane Ivan
18-inch Oil Pipeline

Observations

- Pipeline is un-buried
- Relatively deep water
- Pipe Specific Gravity: >1.6
  - S.G. is product dependent
- Southward movement
Hurricane Ivan
18-inch Oil Pipeline

Possible Causes

- Storm surge recession
  (post storm)

- Soil liquefaction
Post-inspection revealed:
- No leaks
- Integrity maintained

Minor cover damage at pipeline crossings

Hurricane Ivan
18-inch Oil Pipeline
Hurricane Katrina

- Landfall: Buras, LA
  August 29, 2005

- In GOM OCS on
  August 28
  as Category 5, 175
  mph

- Significant Wave
  Height of 55 ft. on OCS
Hurricane Rita

- Landfall: Sabine Pass, TX September 24, 2005
- In GOM OCS on September 22 as Category 4, 147 mph
- Significant Wave Height of 38 ft. on OCS
Hurricanes Katrina and Rita

- 100% (1.5 million BBL/ D) of OCS oil production was shut-in during both storms
- 94% (10 BCF/ D) of OCS gas production was shut-in during both storms
- 22,000 miles of pipelines were in the direct path of both storms
Hurricane Katrina
26-inch Gas Pipeline

- Ship Shoal Area
- Length: 22 miles (Federal OCS)
- Water Depth: 50 ft

Pipeline Location
Hurricane Katrina
26-inch Gas Pipeline

Damage

- Over 9 miles of pipe displaced

- Maximum Displacement: 4000 ft out of right of way (north)
Hurricane Katrina
26-inch Gas Pipeline

Observations

- Buried
  - Relatively shallow water
  - Pipe Specific Gravity 1.4
  - 20-inch SSTI did restrain movement
  - Small SSTIs allowed unimpeded movement
Hurricane Katrina
26-inch Gas Pipeline

Possible Causes

- Long period storm waves
- “Un-zipping” effect
- Hydrodynamic Lift
Hurricane Katrina
26-inch Gas Pipeline

Repair / Remediation

- Decommissioned by removal

- Replacement of entire pipeline scheduled for Summer 2007
West Cameron Area
Length: 4 miles
Water Depth: 50 feet

Hurricane Rita
10-inch Gas Pipeline

Pipeline Location
Hurricane Rita
10-inch Gas Pipeline

Severed end found 4000 feet from riser

Maximum Displacement 5000 ft (south)
Observations

- Buried
- Failed pipeline, riser, and riser clamps at platform
- Pipeline crossings provided minimal to no impedance to movement
- Pipeline displaced neutral to slightly upslope
Hurricane Rita
10-inch Gas Pipeline

Possible Causes

- High pipe
- Scour
- Liquefaction
- Hydrodynamic Lift
- Storm surge recession (post-storm)
Hurricane Rita
10-inch Gas Pipeline

Repair / Remediation

- Decommissioned by removal
- Entire pipeline has been replaced
Further Research

➢ Why these pipelines?
➢ Storm trajectories
➢ Geotechnical / Geophysical
  - Soil conditions
  - Seafloor topography
  - Man-made features
  - Water Depth
  - Pipeline orientation
Further Research

- Design assumptions
- Inspection
- Maintenance
- Operation
Further Research

- Determine risk to existing pipelines
- Design standards
- Mitigation