MMS OCEAN SCIENCE

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MMS *OCEAN SCIENCE* is published quarterly by the Minerals Management Service to communicate recent ocean science and technological information and issues of interest related to offshore mineral recovery, ocean stewardship, and mineral revenues.

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ABOUT THE COVER

Top Left: A juvenile scamp, *Mycteroperca phenax*, on a deep patch reef at West Flower Garden Bank. Photo courtesy of NOAA.

Top Center: A satellite image shows hurricane Floyd just off the Florida coast on September 14, 1999. Photo courtesy of NOAA.

Top Right: A sperm whale surfaces near BP's *Horn Mountain* spar and Heerema's construction vessel *Balder.*

Main Photo: BP's Thunder Horse, a moored semi-submersible PDQ (Modularized Production, Integrated Drilling and Quarters).

Back Page: Background platform image by Gregory S. Boland

All photos courtesy of Minerals Management Service unless otherwise noted.

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25th Anniversary
Minerals Management Service
1982-2007

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www.mms.gov

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An MMS inspector witnesses testing of a safety device at an instrumentation panel.

ADAPTING TO CHANGE . . . SAFELY

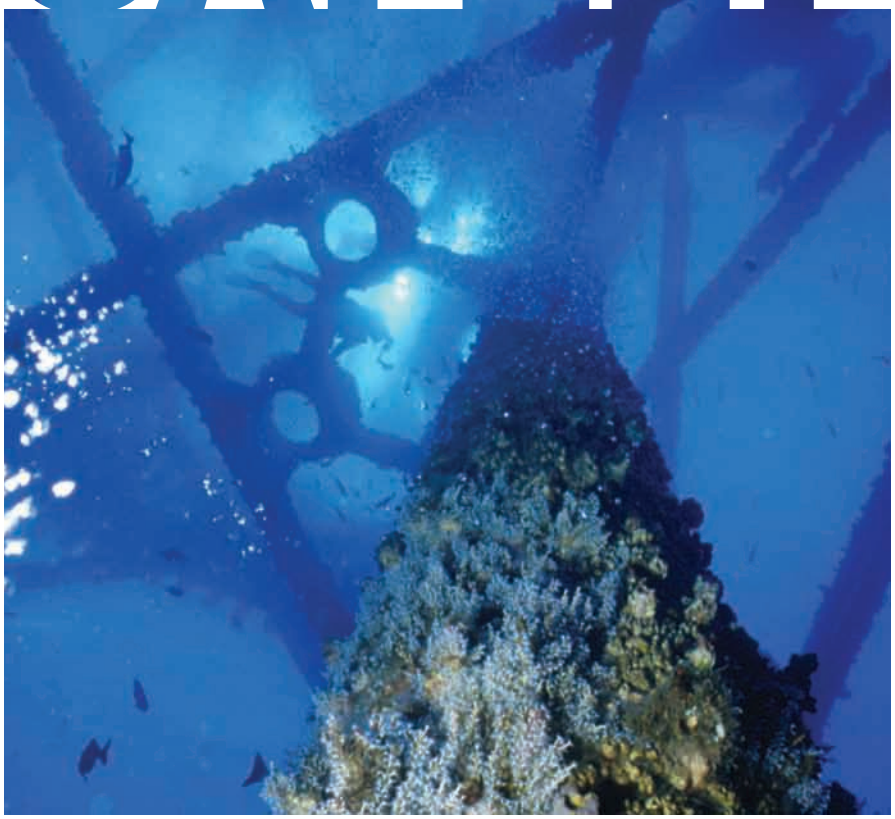
As the Nation's need for energy grows, oil and gas operators on the Outer Continental Shelf (OCS) are learning to find energy resources more quickly, extract them more cleanly, transport them safely, and do it all in adverse weather and ocean conditions...while minimizing disturbance to its living neighbors. That is a tall order, but the Minerals Management Service (MMS) and its industry partners are doing it every day.

Winds and waves buffet exploration and production equipment and can cost millions of dollars in equipment fatigue and wear. Scientists and engineers have researched new equipment designs capable of moving with the winds and waves. Compliant towers that can literally sway with the winds are being installed! Scientists are also working to learn more about powerful currents such as the Loop Current and design ways to work with or counteract this natural force.

Safety is another ongoing issue that demands continuous attention from industry partners. One of these issues is the pressure of oil and gas pockets that could cause blowouts in wells. Blowout preventers are being constantly improved and upgraded to ensure that valuable resources are not lost and worker safety is enhanced.

And then there are hurricanes! Lessons learned after Hurricanes Ivan, Katrina, and Rita are ensuring that plans are in place to mitigate or prevent damage to equipment and the environment.

While there is a strong interest in providing oil and gas supplies from the OCS to the consumer as fast and as economically as possible, MMS is making sure that it is done cleanly, safely, and responsibly. Through adaptive management strategies, MMS is anticipating and responding to changes in technologies, assimilating new information from its ongoing studies, and implementing flexible management approach as it responds to new ideas, new situations, and new knowledge...every day.



Divers swimming under a platform.

ADAPTIVE MANAGEMENT: FURTHERING THE MMS MISSION

Above: At the Flower Garden Banks, the giant anemone *(Condylactis gigantea)* is found only in the deeper areas, not on the reef crest. Photo courtesy of NOAA.

In a perfect world, decision-making would be as easy as retrieving a crystal ball from its designated place on the shelf and gazing into it to foresee the consequences of a particular action. In the real world, however, no one can predict with absolute certainty exactly what will happen when choosing one option over another. Acknowledging this uncertainty is just part of a new Department of the Interior (DOI) policy directive to incorporate a process called "adaptive management" (AM) whenever possible. What is adaptive management and how does the Minerals Management Service (MMS) use it?

Simply put, adaptive management is a systematic, planned approach to improving resource management even in the face of uncertainty, and gaining experience and knowledge that will improve future management decisions. While the concept may sound elementary, it actually encompasses many processes already in place at MMS.

Judy Wilson, Chief, Environmental Compliance Unit at MMS, explains. "AM is likely carried out differently based on mission and responsibilities. The resource mandate for the Fish & Wildlife Service (F&WS), for example, is to protect and further the conservation of wildlife. MMS, however, is a regulatory agency for energy exploration, development and production on the Outer Continental Shelf (OCS) so we have a different focus and responsibility. Adaptive management for the F&WS may emphasize testing a hypothesis to determine what management strategies may be most effective or which sampling methodology is statistically most appropriate for a particular species. With a regulatory agency, we have to come up with specific answers. How will a decision or activity impact marine, human, and/or coastal environments? How will we protect those resources from harm? How will mitigations work and how can we evaluate their effectiveness?"

Wilson clarifies how adaptive management comes into play when considering, for example, the best methods for decommissioning offshore structures. "We require operators to clear the seafloor of obstructions at the end of the lease or after structures are no longer useable.

In adaptive management, comparing actual outcomes against predicted outcomes promotes improved understanding of not only which actions work and which do not, but also **why.**

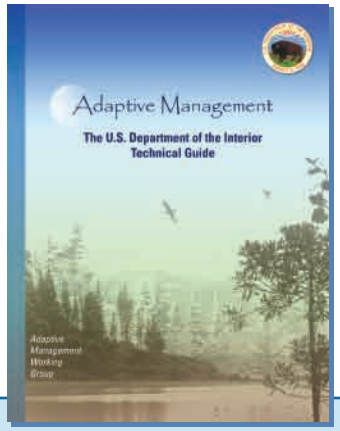
Many times, they use explosives to remove bottom-founded structures at least 5 meters below the mudline, but those explosives might impact marine life. In the case of sea turtles or sperm whales, for example, MMS consults with agencies that manage those resources, and we must know how decommissioning activities affect each species. We didn't have all of the answers—there were areas of uncertainty."

Wilson says adaptive management is extremely helpful in such cases. For decommissioning, MMS funded studies and research to understand the various explosive and non-explosive removal techniques; forecast the characteristics of future explosive removals; compare *in-situ*, engineered and bulk explosive charges; and model shock wave and sound propagation to aid in calculating the protected species impact zones during explosive removals. "This helps us establish a protected zone so as not to negatively impact marine mammals, sea turtles, or fish. Other efforts looked at how past removals with protective measures in place were carried out and their effects. Combining socioeconomic studies, engineering studies, predictive modeling studies, and monitoring programs helps us decide the best way for operators to decommission retired structures while protecting the marine environment."

In adaptive management, comparing actual outcomes against predicted outcomes promotes improved understanding of not only which actions work and which do not, but also *why*. This key part of the process involves careful monitoring of outcomes that advance scientific understanding and may lead to policy or operational adjustments as part of an iterative learning process.

With any mitigation measure, like those for decommissioning, MMS checks to see if operators carry out the measures and if the outcome is as predicted. That evaluation was a big part of structure removal discussions with MMS, industry, and the National Marine Fisheries Service. Those discussions help MMS decide whether to continue requiring the same measures. If outcomes are not as predicted, the new information is assessed and management decisions are adjusted. "We require industry to implement mitigations and we monitor them to see if they are effective and appropriate," says Wilson. "It is a continuous learning cycle."

Adaptive management extends beyond compliance and into many MMS field operations. Currently, activities in the Arctic have been limited to exploration, and so far no development facilities exist on Federal lands. Under the OCS Lands Act, MMS is required to collect information about the environment in order to make assessments of the potential environmental impacts from activities associated with the resource recovery. One key issue raised is the potential impact on endangered species, particularly the bowhead whale. The whales migrate in the spring and fall from their winter feeding grounds in the Bering Sea to their summer breeding area east



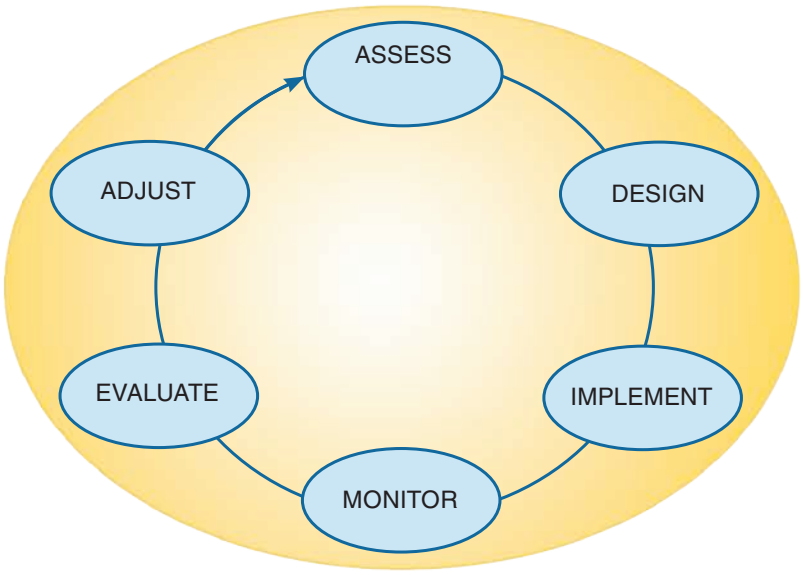
Adaptive Management Guidebook

Adaptive management [is a decision process that] promotes flexible decision making that can be adjusted ***in the face of uncertainties as outcomes*** *from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an* ***iterative learning process****. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a 'trial and error' process, but rather emphasizes learning while doing.* ***Adaptive management does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits.*** *Its true measure is in how well it helps meet environmental, social, and economic goals, increases scientific knowledge, and reduces tensions among stakeholders.*

of the Beaufort Sea. During the fall migration, the whales are hunted by subsistence whalers that reside along the coast of the Beaufort Sea.

When the program first started, little was known about bowhead whales beyond the traditional knowledge of the Iñupiat. The impacts from the activities were unknown and the factors that influenced where the whales migrated were also unknown. Addressing the issues of bowhead whale migration and subsistence whaling has involved numerous scientific projects over the years. Two projects specifically include monitoring. The objective of the first project was to address the concerns of native subsistence whalers regarding the impacts of offshore oil exploration, and production activities on the migratory path of bowhead whales. Aerial surveys of migrating whales were initiated in 1979 to evaluate the effects of exploratory activities on the migratory pathway. During most of the years, exploration activities were occurring, but some surveys were taken during years when no activity occurred.

A second project was initiated in 2000 to address the direct concerns raised by residents of the Village of Nuiqsut, who hunt whales near Cross Island in the Beaufort Sea, which is close to the first offshore platform in the Arctic. Noise from an offshore oil production facility is perceived to cause the bowhead whales to migrate farther from land, thus making whaling efforts more difficult, dangerous, and possibly unsuccessful. In an effort to understand and define these concerns, the second project was funded to monitor the subsistence whaling effort and assist in management strategies.



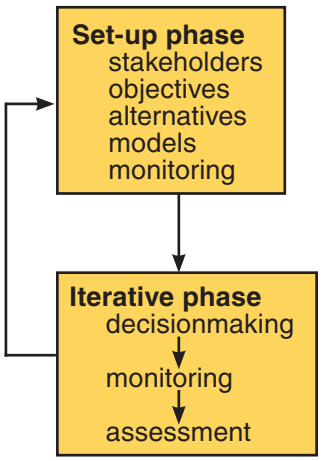
Bowhead whales in the Gulf of Alaska. Photo courtesy of NOAA.

Another adaptive management strategy used by MMS can also be recognized in the Gulf of Mexico (GOM). As industry began planning for operations in the GOM in the early 1970s, MMS began writing environmental impact statements for lease sales and initiated environmental studies to support analyses. Studies documented, among other things, thriving coral reef communities at the unique Flower Garden Banks (FGB) in the northwestern GOM. Recognizing the need to ensure the protection of these reefs in the face of uncertain impacts, MMS sponsored the first "multiple-use" meeting in 1973, which brought together the oil and gas industry, the general public, academia, and private contractors. This and numerous other meetings and public hearings culminated in several mutually agreeable concepts to protect the reef communities, including stipulations for monitoring and adaptive environmental management.

The MMS stipulations specified the protective measures, and the stipulations became a part of the lease document. The stipulation for the FGB established a No Activity

Zone and a 4-mile "shunt" zone. The No Activity Zone, where no activities can take place, protects the banks' biota from mechanical damage due to drilling, platform and pipeline emplacement, and anchors. The shunt zone, in which all effluent from the drilling process must be shunted to near the seafloor, was designed to prevent drilling discharge from reaching the banks' unique biota. As part of the stipulation, lessees had to monitor environmental conditions at production sites and at the banks themselves under strict MMS guidelines.

As more was learned about the banks through the studies program and monitoring, the stipulation was modified to reflect the best possible information, and the provisions of the latest stipulation was applied to appropriate blocks regardless of the older stipulation in the lease. After several years and numerous monitoring reports, MMS knew no damage was being done to the banks or the coral habitat. The MMS showed great flexibility at this time in reducing the stipulation for compliance monitoring at production sites. At the same time, MMS recognized the need to continue to monitor the condition of living reefs. It became clear that the banks were being severely damaged from sports fishing and commercial vessels anchoring on the shallow coral reefs. The MMS assisted with the installation of anchor moorings at the banks so vessels could tie up easily and not drop anchor.



Two-phase learning in adaptive management. Technical learning involves an iterative sequence of decisionmaking, monitoring, and assessment. Process and institutional learning involves periodic reconsideration of the adaptive management set-up elements.

Wilson says that a continuous process of flexible decisionmaking and careful monitoring of outcomes isn't simply a mandate for MMS. "Even though it's DOI policy that we try to incorporate adaptive management into our proposed actions, we're doing it because it makes sense. It furthers our mission to avoid or reduce the likelihood of impact on the environment by improving our management and improving how industry manages its activities. I think we have always practiced adaptive management but it may not have been so well defined."

Adaptive Management Operational Steps

Set-up phase

Step 1 - stakeholder involvement:
Ensure stakeholder commitment to adaptively manage the enterprise for its duration.

Step 2 - objectives:
Identify clear, measurable, and agreed-upon management objectives to guide decisionmaking and evaluate management effectiveness over time.

Step 3 - management actions:
Identify a set of potential management actions for decisionmaking.

Step 4 - models:
Identify models that characterize different ideas (hypotheses) about how the system works.

Step 5 - monitoring plans:
Design and implement a monitoring plan to track resource status and other key resource attributes.

Iterative phase

Step 6 - decisionmaking:
Select management actions based on management objectives, resource conditions, and enhanced understanding.

Step 7 - Followup monitoring:
Use monitoring to track system responses to management actions.

Step 8 - assessment:
Improve understanding of resource dynamics by comparing predicted vs. observed change in resource status.

Step 9 - iteration:
Cycle back to Steps 1 and 6.

3-D IMAGES ALLOW SCIENTISTS TO "SEE" THE FUTURE

New 3-D imaging technology being used in deepwater exploration is making it possible for scientists to "see" beneath the earth's surface. Scientists are using the technology to discover pathways through which fluids such as oil may flow, as well as formations that may be barriers to that flow. Operators can use this information to place exploratory wells more precisely, which reduces costs and risks and aids the recovery of a greater amount of the oil resource discovered.

Many oil and gas companies are using advanced visualization technology to take advantage of the new imaging capability. Advanced visualization technology allows scientists to "immerse" themselves in the data using large-scale, 3-D, high-resolution displays. The display allows greater collaboration, faster, more accurate evaluation and interpretation of the data, and improved exploration success rates.

The Minerals Management Service (MMS) is acquiring an immersive visualization center that will allow 3-D data to be shown on multiple projection walls or room theaters. The computers used in the center interpret an enormous array of geological, petrophysical, geophysical, and palentological data to create the 3-D "picture" of the area being studied.

Although the image presented is far more complete than in the past, it is not without gaps. Smaller and thinner reservoirs and fractures cannot be located with any certainty by the new technology. In addition, the data cannot distinguish between fluids – water or oil may appear the same. As the new technology is refined, however, these gaps in the information may be filled in and a more complete picture of what is below the surface may appear, allowing oil and gas companies to concentrate their resources in areas where the largest potential is "seen."

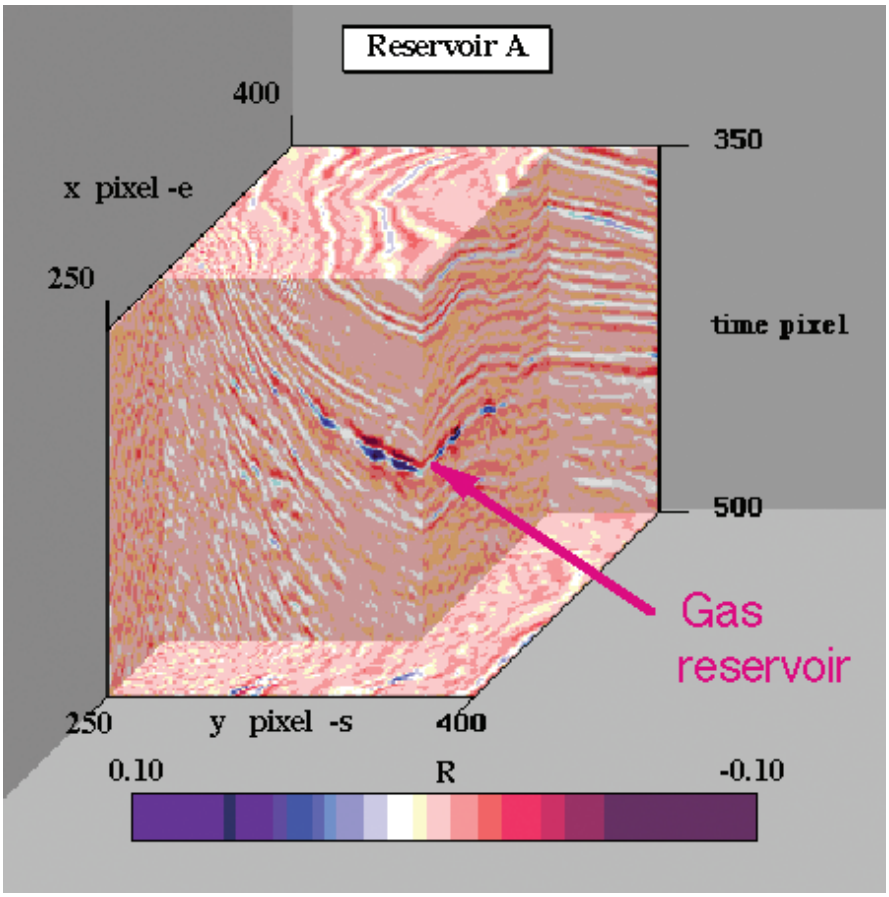


Figure at left: 3-D seismic data cube of gas found in the Gulf of Mexico at about 1.5 kilometer depth. Strata dip up to the left toward a salt dome. Gas trapped in a porous sandstone layer shows up as a brightly colored layer of red over blue - a low impedance layer. Image courtesy of www.ig.utexas.edu.

FOR MORE INFORMATION:

Digital Seismic Profile Data

Website: www.mms.gov/sandandgravel/PDF/MMSFinal.pdf

Finding Oil and Gas

Website: www.ig.utexas.edu/people/staff/backus/res.a.htm?PHPSESSID=def1b9

SACRIFICIAL ANODES

MANAGING AGING PIPELINES

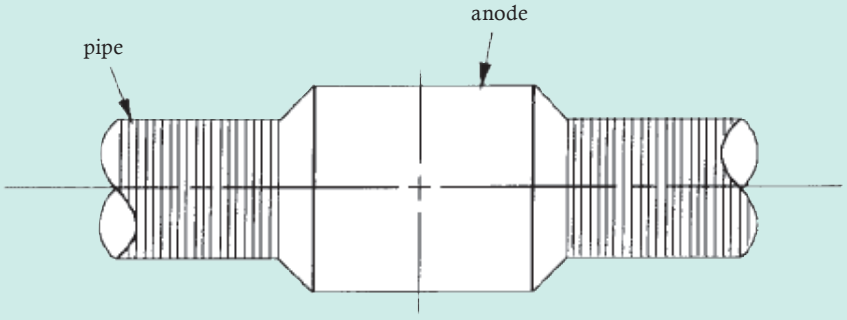
As the steward of the Nation's energy and mineral resources on the Outer Continental Shelf (OCS), the Minerals Management Service (MMS) has become concerned in the last decade with a process that has the potential to create an environmental impact: pipeline corrosion. Pipelines are the safest means of transportation for oil and gas from the source to onshore and offshore storage facilities on the OCS. But even the safest means can fall short when equipment is damaged or fails as a result of corrosion. The consequences of pipeline failure can be oil spills, repair expense, interruption of oil and gas supplies, pollution, and subsequent litigation.

The most common corrosion protection system in use today is the installation of a sacrificial anode on the pipeline. The sacrificial anode (positive) is a piece of corrodible metal (generally alloys of zinc, magnesium, and aluminum) attached by an electrically conductive solid or liquid to the steel pipeline that serves as the cathode (negative). Polarization from the electrical current flow between the anode and the cathode causes the steel to become more negative, which protects the surface from corrosion. The anode corrodes first (it is *sacrificed*) and generally will nearly completely dissolve before the protected pipeline will corrode.

Sacrificial anode on a steel underground storage tank. Photo courtesy of www.epa.gov.

According to a study by Florida Atlantic University and funded by MMS, it is estimated that 55 percent of pipeline incidents in the GOM before 2004 were a direct result of corrosion. In the Pacific Region, 44 percent of the pipeline failures in the last 12 years were corrosion-related. Many oil and gas pipelines in the shallow waters of State and Federal OCS waters have been in service for 40-50 years. The sacrificial anode systems meant to protect them from corrosion were only designed to last 25 years. Because the existing pipelines are aging and more pipelines are being added, the need to address this issue is a priority.

The increased impacts of corrosion and the possibility of leakage has prompted MMS and its academic and industry partners to study new ways to retrofit old pipelines. In addition, a standardized procedure is being formulated for checking for internal and external corrosion, reporting that corrosion, repairing the same, and retrofitting new corrosion prevention systems. These consistent procedures are going to be especially important as pipelines venture farther into deep water, where the difficulty of repair and oversight will increase.



Schematic illustration of an offshore pipeline galvanic anode.

FOR MORE INFORMATION:

Preventing Oil Spills

Website: www.mms.gov/tarprojects/242.htm

Website: www.mms.gov/tarprojects/496/FinalReport.%20FAU.06.20.05.pdf

HELPING TO MAKE THE OCS SAFER THROUGH TAR

J-lay pipeline welding and weld inspection operations.

Data compiled by the Technology Assessment and Research (TAR) Program can be vital to understanding and reacting to natural disasters. As an integral part of the Minerals Management Service (MMS) Regulatory Program, the TAR program is designed to support research associated with operational safety parameters and pollution prevention. Established in the 1970s, TAR was tasked with ensuring that industry functions on the Outer Continental Shelf (OCS) incorporated current operational standards as outlined in the Outer Continental Standards Land Act (OCSLA) of 1978.

Through the use of its two functional research programs, Operational Safety and Engineering Research (OS&ER) and Oil Spill Research (OSR), TAR is designed to address technological issues associated with all degrees of operational functions. It is through the combined use of these two programs that OCS issues may be determined, evaluated, and incorporated into future plans.

There are four principal objectives for TAR:

- ☑ Technical Support (the evaluation of MMS-lead operational proposals)
- ☑ Technology Assessment (the review of industrial applications)
- ☑ Research Catalyst (a vehicle for research initiatives)
- ☑ International Regulatory (working through international cooperation for research and development).

It is through these highly focused areas that TAR works to provide the best possible knowledge base for safe and responsible operations in the OCS.

Of recent concern to MMS is the devastation brought on by hurricanes such as Katrina and Rita. With one of the Nation's largest sources of oil and gas production concentrated in the Gulf of Mexico, such overwhelming forces can cause unprecedented damage and destruction. Through a 4-week period in the months of August and September 2005, substantial damage was inflicted throughout offshore oil platforms in the region. Although the path of destruction left by both hurricanes (which registered as Category 5 storms) resulted in the greatest natural disasters to oil and gas development in the history of the Gulf of Mexico, there was no loss of life, no energy related long-lasting environmental impact, and most structures performed adequately. These impressive facts are a tribute to the safety protocols and requirements developed previously by industry, MMS, and their partners.

Following these recent hurricane disasters, TAR was charged through MMS to study these powerful events to even better prepare and protect the U.S. energy supply from future storms. The directives given to TAR included in-depth study of wave crests and their impact, data collection on wind and wave development, and pipeline damage assessment. The ultimate goal of these initiatives was a qualitative and quantitative evaluation of fixed offshore platform performance. In addition, damage to structures was assessed and the effectiveness of current design standards and pollution prevention systems were determined.

The MMS is constantly assessing and evaluating methods by which the OCS can better be prepared for, and withstand, natural disasters. TAR is a valuable program that assists MMS in keeping with its mission as an ocean steward.

FOR MORE INFORMATION:

Pipeline Research

Website: www.mms.gov/tarprojectcategories/pipeline.htm

PREVENTING BLOWOUTS

BOP-ING THE GUSHER

Blowout preventer.

When many people think of oil wells, they think of a plume of oil shooting high into the sky and covering the wildcatters below in black liquid as they celebrate hitting the "Big One." Beneath this romanticized version of oil exploration lies the real truth – gushers or blowouts were costly and dangerous. That danger and loss of revenue led to the invention of the blowout preventer (BOP), which has proved invaluable to the oil and gas industry.

The BOP is a large valve that surrounds or encompasses the top of an oil and gas well. This valve can be closed (usually remotely) if the pressure from oil and gas fluids backs up and threatens to explode out of the drill pipe and put the rig at risk. The valve can be reopened when the pressure has been controlled and the danger is past.

There are many types and sizes of BOPs encompassing many pressure ratings. Some BOPs seal around drill pipes or casings in the well, while others close over the top of the open wellbore. Still others can cut through the drill pipe to seal the top. A ram BOP, invented by James Smither Abercrombie and Harry S. Cameron in 1922, can literally "ram" the drill string shut with two opposing hydraulic rams. The annular BOP, invented by Granville Slone Knox in 1944, is a common preventer. The annular BOP uses a rubber "ring" reinforced with steel to squeeze the well closed.

No matter which type of BOP is used, a regular maintenance schedule is essential because of the critical nature of the equipment. Test schedules can range from daily checks for critical wells to 14-day intervals for wells with little history or probability of pressure buildup.

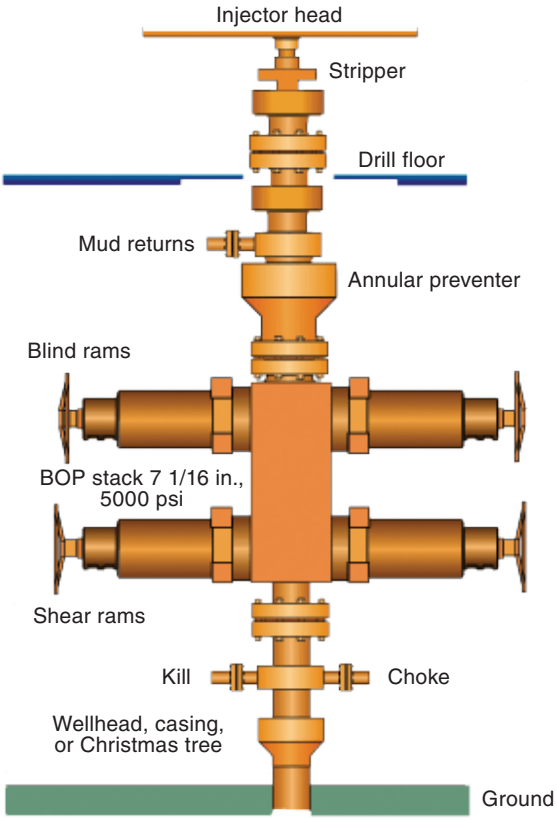


Diagram of a blowout preventer. Graphic copyright Schlumberger, Ltd., used with permission.

The Minerals Management Service (MMS) monitors the test results as well as new developments and strategies in BOP design, development, and testing. A reliable BOP able to withstand the higher pressures of deepwater wells with larger drilling diameters is of special importance to industry. The MMS and its industry partners are initiating studies to stay ahead of the issue, create new technical standards, and ensure that any existing or upgraded equipment will protect personnel, equipment, and the environment that surrounds them.

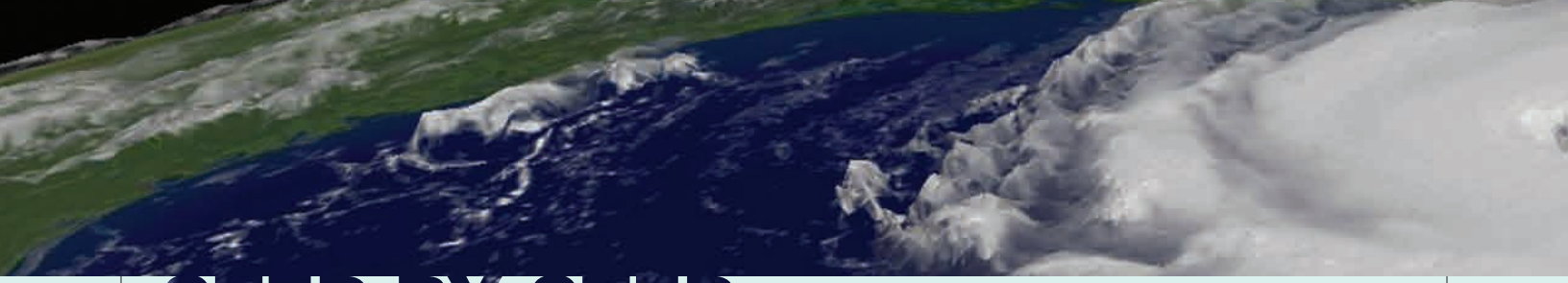
FOR MORE INFORMATION:

Blowout Preventers

Website: www.glossary.oilfield.slb.com/Display.cfm?Term=blowout+preventer

Website: www.mms.gov/tarprojects/008.htm

Website: www.mms.gov/tarprojects/566.htm



STEP BY STEP
DEALING WITH HURRICANES IN THE OCS

Lessons learned as a result of Hurricanes Katrina and Rita have underlined the ***importance of preparation.***

After Hurricanes Katrina and Rita, the Minerals Management Service (MMS), oil and gas exploration and production operators, and State and local officials recognized the need for an updated Hurricane Operations Plan and recovery procedures that could deal with the next "100-year storm." Hurricane Operations Plans are filed by each operator and outline their evacuation methods, measures for "shutting-in" the oil and gas production, and start-up procedures for post-storm recovery. The Hurricane Operations Plans are complicated, but operators develop, test, and refine their plans frequently so that facilities are ready to implement the plans immediately when hurricane season begins.

The most important priority for MMS and oil and gas operators is to ensure there is no injury or loss of life. As soon as it is projected that a tropical storm or hurricane will enter the Gulf of Mexico (GOM), non-essential personnel will usually begin evacuation. Nearly 20,000-30,000 employees work in the GOM, so the process of evacuation takes time and coordination. Service helicopters and boats will take personnel to safe facilities onshore. Those employees necessary to "shut-in" the facility and protect the company's assets will remain until that process is completed.

Protecting the Nation's supply of oil and gas from production and transportation disruption and protecting the environment from oil spills are the next priorities for MMS. Operators also prioritize protection of their company's oil and gas production and transportation equipment. All wells on the Outer Continental Shelf (OCS) must be equipped with downhole safety valves, which shut off the flow of oil in the event of an emergency. When a hurricane is forecast, the valves are closed and the oil flow is stopped to prevent spills should the platform be damaged. They remain shut until MMS gives the go-ahead for restart.

All oil and gas operators are required to report shut-in production statistics to MMS. These statistics include the platform name, daily oil production, cumulative oil shut-in, daily natural gas production, cumulative natural gas shut-in, anticipated production return time, and the reason production was shut-in. At the height of Hurricane Katrina, 95 percent of oil production and 83 percent of gas production in the OCS was shut-in.

As soon as the hurricane passes, operators return to inspect for damage to their platforms, rigs, and equipment both above and below water. If the initial underwater inspection detects significant structural damage, more detailed underwater inspections must be conducted. A complete inspection of pipelines must also be completed before start-up. A visual inspection is conducted by divers or remotely operated vehicles. A check for flow, leaks, or other damage that cannot be readily seen by the initial visual inspection is also required.

Before production can resume on a platform or rig, operators and lessees must provide their initial start-up plans to MMS, who will review them for safety concerns. The MMS will then allow start-up to continue, making certain resuming production is accomplished as rapidly as possible while still ensuring the protection of human lives and ocean ecosystems. Operators continue to provide updated status reports each month as the start-up process continues.

In a 2006 joint press conference with the Department of Energy and the American Petroleum Institute, MMS announced

the implementation of several improvements to their oversight system. The improvements include

1. Extensive pre-season planning with the Department of Energy and the U.S. Coast Guard (USCG) to facilitate communications during storms;
2. Coordination with industry to improve safety, specifically through mobile offshore drilling unit (MODU) improvements, jack-up site assessment guidelines, risk assessment tools, and platform upgrades;
3. Inviting a representative of the U.S. Coast Guard to join the MMS Continuity of Operations Plan (COOP) team to improve and enhance communication regarding damage to facilities and subsequent warnings to mariners by the USCG; and
4. Improvements to electronic hurricane reporting systems to better improve communications between industry and MMS.

Lessons learned as a result of Hurricanes Katrina and Rita have underlined the importance of preparation. The struggle to quickly obtain repair and replacement equipment, add additional personnel, and obtain the basic necessities for recovery have emphasized the need for a broader plan to deal with potential disasters. At the same time, offshore operations were able to maintain a record of no loss of life and no significant environmental damage from wells on the OCS during both storms. The MMS and industry representatives will continue to refine and implement Hurricane Operations Plans that emphasize the safety of personnel, equipment, and marine environments, while ensuring minimal disruption of oil and gas production in the GOM.

HURRICANE OPERATIONS PLAN

- ✓ Notification is received that a hurricane will be entering the Gulf.
- ✓ All non-essential personnel are removed to shore by ship or helicopter. Personnel with "shut-in" responsibilities remain on platform.
- ✓ To prevent spills should the platform be damaged, valves "shut-in" the oil flow until it can be safely restarted.
- ✓ All remaining personnel are evacuated before the storm hits.
- ✓ Operators report shut-in statistics daily to MMS. These statistics include the platform name, daily oil production, cumulative oil shut-in, daily natural gas production, cumulative natural gas shut-in, anticipated production return time, and the reason production was shut-in.
- ✓ After the storm passes, operators return to inspect for damage to their platforms, rigs, and equipment. They inspect for damage above and underwater.
- ✓ Repairs are carried out both above and below water.
- ✓ A complete inspection of pipelines must also be completed before start-up. A visual inspection is conducted by divers or remotely operated vehicles. A check for flow, leaks, or other damage that cannot be readily seen by the initial visual inspection is also required.
- ✓ After repairs, operators and lessees provide their initial start-up plans to MMS, who will review them for any safety concerns.
- ✓ Operators provide updated status reports each month as the start-up process continues.
- ✓ When the inspections and repairs are completed, environmental safety is assured, the start-up process is finished and production resumes.

FOR MORE INFORMATION:

Hurricane Preparedness

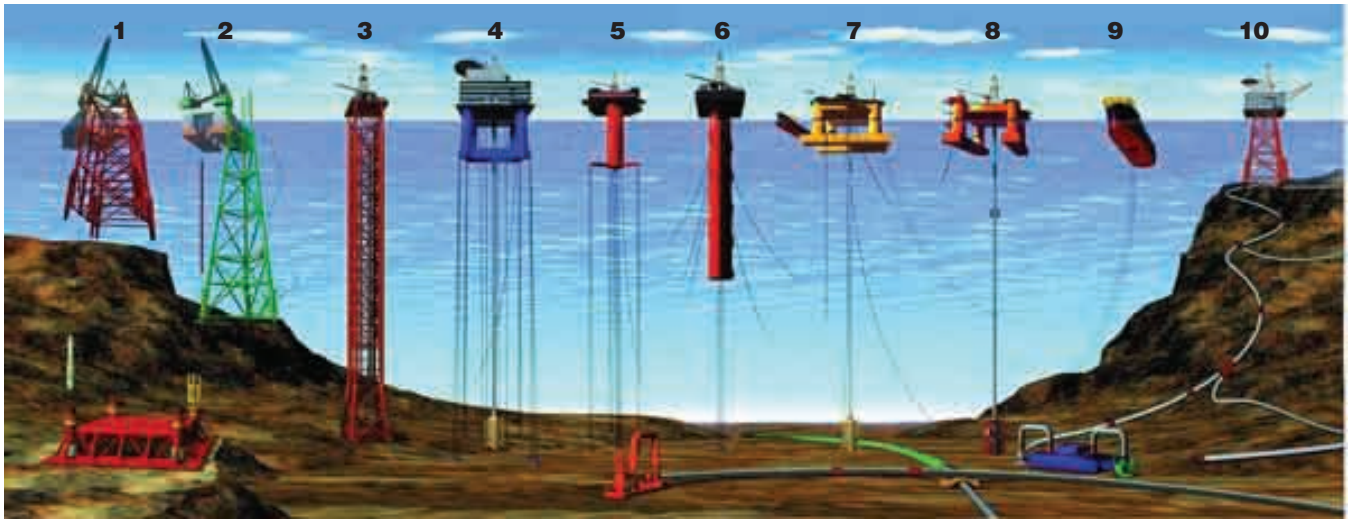
Website: www.mms.gov/tarprojects/559.htm

Website: www.mms.gov/tarprojects/559/AB-4c_Planning_Resposne-Acuf-Transocean.pdf

Website: www.nws.noaa.gov/om/brochures/hurr.pdf

STABILITY THROUGH FLEXIBILITY

COMPLIANT TOWERS



Much like the earthquake-resistant structures that are being built in areas such as California, a flexible, swaying offshore platform tower is an advantage in the Gulf of Mexico (GOM). When hurricanes or other severe storms hit, waves, wind, and currents pound tower structures and create resonance and amplification by their energy. This amplification causes vibrations in the structure that can create excessive stress on the construction and decrease endurance. Compliant or flexible towers are created to yield to wind and water movement rather than to resist them.

During hurricanes, natural wave intervals are about 13 seconds long.

Definitions

Resonance:
The prolongation of sound or reverberation.

Natural Wave Interval:
The average timeframe between waves.

Sway Period:
How long a structure is forced into a non-vertical position.

Compliant towers can typically achieve natural sway periods of 30-33 seconds. This difference in wave rates significantly reduces the resonance and amplification of winds and waves. The towers are secured to the seafloor with piles, but the structure has flex legs or axial tubes that help control the mass or weight and stiffness of the tower, making it less sensitive to the vibration frequencies of wind and waves.

Compliant towers are in their third generation and have advanced significantly in technology since they were introduced in the GOM in the early 1990s. But though the technology has advanced, they have remained simple to construct using commonly available equipment and parts, which reduces the cost and construction time of the tower. The updated design has reduced the structural weight, but the tower remains very stable.

Owned by ChevronTexaco, Petronius is the tallest compliant tower installed in the GOM to date. The 2,001-foot tower is standing in 1,700+ feet of water and is arguably the tallest free-standing structure in the world. The entire structure weighs around 43,000 tons and can deflect or sway within a 25-foot envelope.

Above: Types of offshore oil and gas structures.
1,2) Conventional fixed platforms
3) Compliant tower
4,5) Vertically moored tension leg and mini-tension leg platform
6) Spar
7,8) Semisubmersibles
9) Floating production, storage, and offloading facility
10) Subsea completion and tie-back to host facility (all records from 2005 data).
Courtesy of NOAA.

As exploration and production move deeper and deeper, compliant towers will make it easier and less costly to construct platforms in the GOM. And as the natural sway response of these towers is improved and refined, they may prove a boon to protecting oil and gas interests in the Gulf.

FOR MORE INFORMATION:

Compliant Towers

Website: www.offshore-technology.com/projects/baldpate/

Website: www.mms.gov/tarprojects/052/052AA.pdf

Website: www.mms.gov/tarprojects/052/052AD.pdf

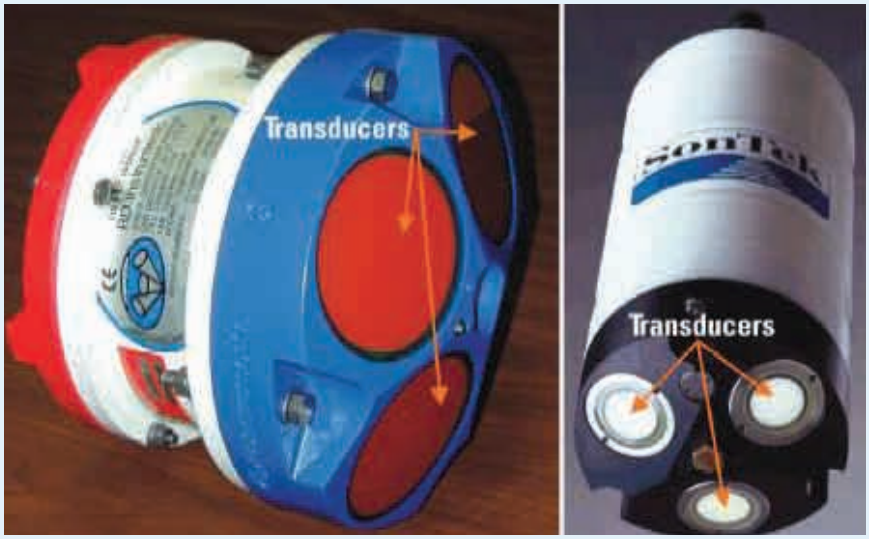
Website: https://portal.mustangeng.com/pls/portal30/docs/folder/mustangeng/technical_articles_content/June1999.pdf

BETTER DATA MEANS LESS STRESS

As oil and gas exploration and production move farther into deeper waters of the Gulf of Mexico (GOM), the challenges, too, grow more difficult and costly. Equipment at great depths faces stress from high pressure, cold temperatures, and the movement of strong currents such as the Loop Current. The strain on equipment, especially during installation, and the resulting damage and expense caused by vibrations from currents is a source of concern both to operators and the Minerals Management Service (MMS).

The Loop Current is a horseshoe-shaped phenomenon that streams up from the tropical waters of the Caribbean, moves across the GOM, and exits at the Florida Straits near Cuba. Periodically, this current will squeeze off deep, warm eddies, which travel across the GOM until they eventually dissipate, usually in the western Gulf. Some eddies are so large they have their own names and can be hundreds of miles wide. The Loop Current travels at approximately 4 knots, or the equivalent of a 60-mile-per hour gale-force wind.

When strong currents such as the Loop Current flow around platform pipes, they create a vortex or eddy as they pass. When this eddy breaks away from the pipe or riser, it creates vibrations that travel up the pipe, greatly reducing the life of the equipment. To ensure drilling equipment is manufactured to safely withstand those vibrations, MMS has adopted tough standards from the American Petroleum Institute (API). These standards are being incorporated into regulations governing postlease safety and pollution prevention.



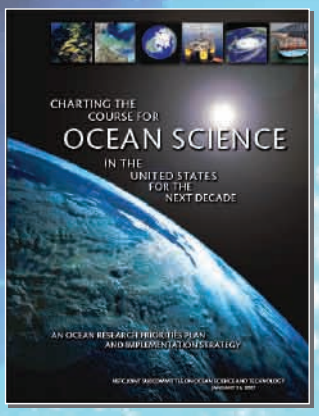
Two Acoustic Doppler Current Profilers commonly used by the U.S. Geological Survey. Photos courtesy of USGS.

This effort was cited in President Bush's U.S. Ocean Action Plan as an excellent example of the partnership between government and industry in support of the Integrated Ocean Observing System (IOOS).

Although scientists know the path of the Loop Current historically, it has always been capricious. Operators have used models to try to accurately predict where this current might be at a given time – with little success. Results have been limited to where the current might be in days or weeks. In an effort to predict currents with greater accuracy, MMS issued a Notice to Lessees and Operators (NTL 2005-G05) in April 2005, requiring oil companies in the GOM to report current velocity information from Acoustic Doppler Current Profilers (ADCPs) based on oil platforms. The ADCPs measure current velocity at 20- to 30-minute intervals, covering areas of the Outer Continental Shelf with total water depths between 1,300 and 7,900 feet. This effort was cited in President Bush's U.S. Ocean Action Plan as an excellent example of the partnership between government and industry in support of the Integrated Ocean Observing System (IOOS).

The availability of this information will enable scientists to form a large three-dimensional picture of ocean movements. They will be able to better understand the Loop Current and its eddies, as well as newly discovered deepwater currents. This understanding will enable operators to avoid installing equipment during periods of greater current activity, saving money and system stress, and ultimately providing a safer structure.

MMS
A steward of the ocean environment



Ocean Research Priorities Plan and Implementation Strategy.

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Charting the Course for Ocean Science in the United States for the Next Decade: An Ocean Research Priorities Plan and Implementation Strategy describes national ocean research efforts that must be pursued over the next 10 years. Developed with extensive ocean community involvement, this document represents the first national effort to identify research priorities that address key interactions between society and the ocean. This document will serve to guide research efforts for the ocean community, including Federal agencies, for the next decade.

Integral to the successful pursuit of these research efforts is the participation of the many sectors of the ocean community. No one group or sector, including Federal agencies, is expected to address the priorities alone, thus, engagement of multiple entities and partnerships between them is a critical component of the implementation strategy. These efforts will also help ensure that national priorities are appropriately addressed at a variety of scales (global to local) and tailored to account for differences in geographic regions, as well as different ocean uses, interactions, and phenomena within these areas. The research efforts outlined in this document will help ensure the health and sustainability of our ocean ecosystem for years to come.

Electronic copies of the *Ocean Research Priorities Plan and Implementation Strategy* are available at http://ocean.ceq.gov/about/docs/orppfinal.pdf. Hard copies of the document may be obtained by contacting the National Ocean Partnership Program at

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