

**FROM THE MARSHES TO DEEPWATER, LOUISIANA'S
HYDROCARBON INFRASTRUCTURE IS AT RISK.**

DONALD W. DAVIS, Ph.D.

Administrator

Louisiana Applied and Educational Oil Spill Research and Development Program

Room 258 A Military Science Building

Baton Rouge, Louisiana 70803

Phone: 225-578-3481

Fax: 225-578-0403

e-mail:osradp@attglobal.net

ABSTRACT

Deepwater is America's new energy frontier. This hydrocarbon province is an extension of more than 50 years of offshore activity parallel to Louisiana's coast. Individual wells are producing at record levels. Investment is in the billions. With names like *Auger*, *Neptune*, *Mars*, and *Thunder Horse*, platforms are producing from water depths approaching 3000 m. Field reserves are impressive. There is a new euphoria dominating the industry. The environmental challenges associated with working in deepwater have increased the risk associated with terrorism/security, equipment, onshore infrastructure, oil spill prevention/preparation, pipelines, and response. Even so, the industry and the regulatory agencies have worked carefully through these issues. Superimposed on this environment is the freshwater discharge associated with the Mississippi River. This plume, coupled with hurricanes and coastal erosion issues, adds to the risks associated with hydrocarbon production both on and offshore Louisiana. The policy-making community needs to be aware of these potential risks, as they are real. This paper will address some of these concerns.

THE MISSISSIPPI RIVER'S FRESHWATER PLUME

Since 1990, oil spills such as the *Exxon Valdez*, *New Carissa*, and *Mega Borg*, medical wastes on east coast beaches, red tides in Florida, shellfish bed closures, overfishing, kelp forest destruction, coastal erosion, and wetland loss have been publicized widely. Environmental protection has become the watchword and standard bearer of a new coastal consciousness. Further, with passage of the Coastal Zone Management Act, the coast became an entity of political concern. Any oil spill, regardless of size, is an issue. The *Prestige* spill on the coast of Spain and the *New Carissa* spill on the Oregon coast, and all the ramifications associated with these spill events, are a reminder of what could happen on Louisiana's coast. To the industry's and regulatory community's credit, Louisiana's coast has not been severely impacted by any large offshore spill event. But the potential is always there.

In addition, the environment at risk can be dramatically impacted by the Mississippi's freshwater plume and the associated changes in the fate and effects of oil spilled in the geographic area influenced by the constantly changing plume. A traditional saltwater habitat may, in fact, be freshwater, depending on the discharge from North American's largest river and the sixth largest in the world in terms of discharge.

Draining 41% of the continental United States, the Mississippi discharges freshwater into the northern Gulf of Mexico. Flow, at an average rate of $14,000\text{m}^3/\text{sec}$, through the delta varies by seasons and can affect a considerable area well beyond the Gulf of Mexico's 10-m contour. In

any given day, the Mississippi can carry from .75 to 1.25 million tons of sediments. These sediments are funneled through the basin and channeled off the continental shelf. They are lost to the nearshore sediment budget. As the sediments are dumped into deeper water, the coast is deprived of the material required to build new land at a rate slightly greater than subsidence. Land building by river-flood-flow deposition was effectively terminated with construction of the Mississippi River's engineered levees. As a result, land building has been replaced by extensive and rapid wetland loss at a rate greater than 100 km²/year—on average, one hectare (ha) is lost every 49 minutes, or the equivalent of about 36 ha a day, or 278 m² every minute. In its simplest sense, Louisiana's coastal area is presently out-of-balance with the state's annual marsh loss exceeding 12,000 ha.

In the last 100 years, more than 400,000 ha have been converted to open water, adversely affecting the many interlocking subsystems that make up an estuary's productive habitat. This is crucial, as the estuary represents a transition zone between freshwater and marine ecosystems. Spill contingency plans must change and evolve with the changing natural systems. What was freshwater five years ago could be dramatically different today. The industry and the agencies responsible for decisions concerning spill response must be aware of these changes, as they can affect spill response dramatically.

The power of the Mississippi cannot be underestimated. For example, the 1927 flood, combined with the flood of 1882, submerged 149,184 km²—an area larger than Delaware, Connecticut, Hawaii, Massachusetts, Maryland, New Hampshire, New Jersey, Rhode Island, and Vermont

combined. These floods were benchmark events that transformed how the country manages and controls the Mississippi's discharge/flow. Further, these floods are a reminder, and indicator, of the potential freshwater discharge that can impact the northern Gulf of Mexico. Beyond the coast's "edge" it is imperative the spill response community pay close attention to the Mississippi River's plume. It can impact and change spill response plans. One issue that needs to be addressed is the deployment of dispersants. Since dispersants are approved for offshore use, are they automatically approved for those areas impacted by the freshwater plume that resides off Louisiana's coast?

Satellite-acquired data analyzed by Walker and Rouse (1993), and Walker (1994), revealed that under medium discharge conditions, the plume covers 2200 km² of the continental shelf. Under high discharge conditions, the plume's size doubled and can be detected more than 150 km south and southwest of the delta. The plume extends out to the 1000-m isobath and can spread over more than 13,000 km². Although the plume's freshwater and sediments are generally confined to the continental shelf, substantial cross-shelf and shelf-slope exchanges of plume water can occur. This exchange is most notable during strong wind events, often associated with the passage of winter cold fronts. As a result of altered wind forcing, dramatic changes in plume orientation can develop in a matter of hours (Walker and Rouse, 1993).

Satellite data suggest the proportion of water moving westward increased during winter and possibly under high discharge conditions as well. Consequently, as the industry moves into deepwater, this freshwater flow is a fact that cannot be ignored, since few studies have focused

on the fate of river water once it enters the Gulf of Mexico (Walker 1993). The plume has been observed as far west as Port Aransas, Texas, a distance of 800 km from the Mississippi's delta. Its seasonal discharge, therefore, can play havoc with a wide variety of spill management decisions.

WETLANDS AT RISK?

More than 25% of all oil and gas consumed in this country comes across Louisiana's shore by tanker, barge, or pipeline. It is from this area that energy distribution for the entire eastern and much of the Great Lakes region of the United States begins. As Louisiana's coastline disappears, oil and gas infrastructure along the coast becomes exposed to open Gulf conditions. Wells, pipelines, ports, roads, and levees are more vulnerable and the potential for damaging oil spills increase. As these conditions worsen, the environmental damage from a spill caused by a hurricane or storm increases as well.

Prior to 1940, oil and/or gas were discovered in fields at Caillou Island (1248 wells), Golden Meadow (818 wells), Timbalier Bay (590 wells), Lake Barre (512 wells) and Leeville (445 wells). There are 3613 wells in these fields (International Oil Scouts Association 1994). These wells, and their associated ancillary facilities, were not designed for open Gulf conditions. They are a clear indicator that Louisiana's wetland-oriented hydrocarbon production and distribution networks are vulnerable. Erosion and land loss has removed the protective surfaces so that these fields, and others, are now in open water. A new set of variables are put into play; yet, the

response plans may not address this issue. In short, the landscape may be changing faster than the contingency plans. This is further complicated by Louisiana's plan to implement a number of large siphons and freshwater diversions that will also impact habitats that are currently above the 2 ppt isohaline. Moderately saline environments will become fresh.

More than 40,200 km of pipeline rights-of-way are anchored by Louisiana's barrier islands and marshes (Camire: 2003). Many pipelines that were previously buried beneath the wetlands are no longer buried. Offshore exposed outer continental shelf (OCS) pipelines are required to be reburied. Onshore, the substrate supporting these pipelines has eroded away. Many are now in open water and susceptible to damage from fishing and recreational vessels, barges, and anchors. A 2002 boating incident ruptured a pipeline in Louisiana's marshes and discharged nearly 100,000 gallons. The pipeline was originally laid across the marsh. The accident occurred in open water.

The state's wetland pipeline network is at risk. Many of these pipelines are now in an environment that was not part of the original engineering designs. Lose any part of this pipeline distribution system and two things will occur: 1) fuel prices will almost immediately spiral upward, and 2) cleanup and Natural Resource Damage Assessment expenditures will be affected by the design and implementation of the spill cleanup plan.

The destructive power of a hurricane or tropical storm makes the production, distribution, and storage of "wetland-protected" oil vulnerable to an accidental discharge. The situation is critical.

During the 2002 hurricane season, offshore rigs had to be evacuated during hurricanes *Isidore* and *Lili*. These storms moved onshore within a two-week period and caused considerable direct and indirect damage to the oil and gas industry. In one case, a gas well in southwestern Louisiana's marshes ruptured during hurricane *Isidore* (Farris 2002). A category four storm, hurricane *Lili's* winds and waves exceeded or matched the 100-year design criteria of the oil and gas facilities in her path. Of the 4,000 offshore oil and gas facilities in the Gulf's Federal waters, about 1200 were in the path of Hurricane *Lili* (Congdon *et al.* 2002).

Hurricane damage reports from a range of offshore facilities mentioned no fatalities or injuries to offshore workers. There were, also, no fires or major pollution events caused by *Lili*. The Minerals Management Service (MMS) attributes this in part to: 1) tough design standards; 2) technological advances in damage prevention; and 3) the operator's quick and efficient response to *Lili*. Damage assessment and analysis to offshore facilities from *Lili*, combined with knowledge gained from hurricane *Andrew* in 1992, will provide MMS with an opportunity to evaluate the reliability of current industry standards and MMS regulations in mitigating future hurricane-induced damage to oil and gas facilities (Congdon *et al.* 2002). Considering the quantity of oil produced from offshore, the historical record of oil spilled in the federal waters of the Gulf of Mexico is less than 0.001% of total production (Minerals Management Service 2002). Hurricanes are an issue, but the industry and the MMS has prepared well for these periodic storm events.

In 2003, tropical storm *Bill* was a minimal hurricane, but a dangerous flood threat from rainfall

and storm surge. When the storm made landfall, its maximum sustained winds dropped from 88 km/h to 72 km/h. Even so, *Bill* disrupted power in 200,000 homes and swamped the 27 km road to the main logistic support center for the offshore industry at Port Fourchon—which serves as an all-purpose depot for much of the offshore drilling that takes place in the Gulf of Mexico. Port facilities were inundated with water and closed for seven days. Some feel this closure was one factor in driving up gasoline prices immediately after the storm, as more than 600 offshore platforms are located within a 65-km radius of the Port. To put the problem in perspective, 1000 trucks and 200 ships and boats move through Port Fourchon daily (La 1 Coalition ...: n.d.). Hurricane *Bill* did not result in any oil spilled. If an accident had occurred, road closures would have prohibited response equipment and personnel from getting to the site.

DEEPWATER: AMERICA’S NEW ENERGY FRONTIER

In the late 1980s, new offshore fields were harder to find, and capital costs were slowing exploration and development. Major oil corporations were downsizing and starting to merge their assets with other companies to become what the industry calls “supermajors.” They were abandoning their onshore holdings, while the “Independents” were purchasing these properties and starting to move into deepwater as well. Even so, hydrocarbon exploration and development had declined throughout the region.

This changed in the 1990s. The MMS moved away from targeting specific groups of leases to a policy of area-wide leasing, setting the stage for companies to test new deepwater frontiers. The

industry and the MMS have not been disappointed. The end result is the creation of the United States' most significant oil and gas province. A major milestone was reached in early 2000 when more oil was produced from the Gulf of Mexico's deepwater than from its shallow-water zones. In the new millennium, a growing record of exploration success and rising production in the Gulf's deepwater have made this area a primary focus of global exploration programs. Even with these successes, it should be noted that many of these sites are affected, at least at the surface, by the Mississippi River's freshwater plume. Although perhaps not in the industry's business plans, this plume could have an impact on how one reacts to a spill, or prepares for a MMS unannounced spill drill.

Congress through the Oil Pollution Act of 1990 tasked the MMS with monitoring the response planning capability of offshore oil and gas operators. The MMS's Gulf of Mexico Region initiated the "Unannounced Oil Spill Drill Program" with its announcement in "Notice to Lessees and Operators NTL 92-04." The program was started to test the ability of offshore oil and gas and pipeline operators to contain or mitigate and clean up an oil spill by using the procedures and resources defined in their oil spill response plans. Since June of 1989, MMS has conducted 165 drills, and for the most part the operators have been quite successful in demonstrating their ability to respond to an incident in accordance with their response plan.

There are three types of exercises: table top, mobilization, and mobilization with equipment deployment. During these exercises, an MMS monitoring team presents to the incident commander a scenario involving one or more of the operator's facilities and then observes the

spill management team's simulated or actual response. The program has helped the oil and gas industry improve their capability to respond to actual oil spills, and will continue to focus the drill objectives on issues that impact industry's response capabilities, including alternate counter measures. Current issues also include infrastructure damage from storm events and how that impacts a proper response, and the anticipated effectiveness of dispersant use in the freshwater plume of the Mississippi river. At the conclusion of each drill, the MMS monitoring team discusses with the spill management team the strong and weak areas of the response. MMS requires that a written report be submitted within 15 days documenting completely the exercise, and then prepares a written evaluation of the exercise. Exemplary responses are acknowledged and recommendations/requirements for improvement are given when warranted by MMS. An "Incident of Noncompliance" may be issued for poor performance.

SUMMARY

Because of the Mississippi River's extensive freshwater plume, a significant portion of the country's offshore oil production is conducted, at least seasonally, in a "freshwater" environment. At times, the plume is observable out to the 1000-m isobath and can cover more than 13,000 km². This indicates, at least at the surface, spill response plans will have to include a freshwater component. With the advent of deepwater drilling, and the renewed interest in the Gulf of Mexico's hydrocarbons, these plans may be more important than previously anticipated. How this "freshwater" impacts the response to an oil spill is just now being discussed. One key question is the use of dispersants in these freshwater regions. Since dispersants are approved for the Gulf of Mexico, does this approval include freshwater as well? From the aspect of water

density to the use of alternate counter measures in a high-silt-plume environment, these are also areas of concern and issues that need to be discussed and incorporated in the formal and informal spill drills designed to improve the efficiency of spill response and planning. Freshwater spill events can happen in the Gulf of Mexico, and industry and the regulatory community must keep the freshwater discharge from the country's largest river in their training, planning and response scenarios.

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