Gulf hurricanes: how prepared are you?

With the 2009 hurricane season upon them, Gulf of Mexico operators are hoping that this year is much calmer than the last. 2H Offshore Inc's Himanshu Maheshwari, Peter Falconer and Mark Cerkovnik discuss how a well-designed integrity management plan offers the tools to help operators survive the season intact.

Although hurricanes Gustav and Ike barely measured Category 2 at landfall, the 2008 storms left a trail of destruction in the Gulf of Mexico, destroying 60 offshore platforms, damaging over 100 more, and shutting in a significant amount of the region's oil and natural gas production. Some of the destroyed platforms were of modern design, as little as seven years old.

The number of platforms destroyed by hurricanes in 2008 should be a wakeup call to the industry reminding us that, despite all the technology brought to bear, hurricane conditions represent a significant risk offshore. Of the platforms in the hurricane-affected zone, about 3% were destroyed, despite the fact that those platforms were supposed to be designed to handle that size storm.

To-date, no comprehensive study has been made to explain why so many facilities were damaged in 2008, but it is likely that such a study will find numerous factors contributed. In the meantime, it is the industry's responsibility to take the rational steps necessary to prepare itself for the 2009 hurricane season, which runs from June through the end of November. Certainly the failures of 2008 prove that Gulf of Mexico operators should take the approach that their offshore structures are not immune to hurricanes, and further effort needs to be expended to manage this risk.

Damaged facilities can take months to repair. With the size of the capital investment in offshore systems, the cost of lost production, repairs and inspection following a shutdown during a hurricane can have severe financial impact on operators in the present market. Maintaining production with minimal downtime is critical to investors.

Regulations in the Gulf of Mexico may sometimes require an operator to conduct post-hurricane inspections on both topsides and subsea components prior to startup and to delay production until those inspections are reported. However, if the operator has a well-designed integrity management (IM) plan in place, and the ability to show by way of

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monitored loads and verified analysis that damage was unlikely, then the operator can present an argument with a sound engineering basis that production can safely begin without delay.

Even more important, a well-designed IM program may identify weaknesses in the facility early on so they may be addressed before a hurricane strikes.

Task force

It is clear that hurricane season carries with it a number of tasks a responsible operator needs to prepare for. Examining those tasks will show that the activities for hurricane preparation line up well with the tools available in a well-designed IM program. Some of the elements of a comprehensive IM program that relate to hurricane preparedness and response are:

- emergency planning for both pre-hurricane preparation and post-hurricane response;
- operational phase verification of design;
- verification of the facility with respect to new environmental load requirements;
- management of change processes;
- inspection and monitoring to verify condition with respect to structural integrity;
- maintenance of records relating to structural integrity and documentation of configuration; and
- maintenance of analytical models for quick evaluation of the structures and the risks.

Pre-hurricane response plans are written plans that detail what will be done in the range of plausible hurricane scenarios. Operators should ask: are those plans up-to-date and are the teams trained and ready to execute the plans? Do the plans correlate with the design assumptions for the facility? Are the plans coordinated?

Design verification of dynamic structures is another important task. Offshore floating platforms, together with their risers and moorings, are dynamic systems. As such they represent a greater design challenge, with greater uncertainties compared with static structures. Most dynamic structures such as automobiles and airplanes undergo extensive prototype testing prior to production and regular in-service inspection. Large offshore systems are generally one of a kind, and testing prior to deployment is not a viable option. However, once the structure is installed, monitoring the response of the hull, risers, and mooring system to verify that the system works as designed makes good engineering and business sense. Whether this post-installation verification is done under the umbrella of the design project team or through the operational IM program will depend on the operator's philosophy; however, as evidenced by the 60 failed structures in 2008, there is much more to be learned about designing offshore systems. In addition to validating the design, the response evaluation exercise may detect component problems stemming from installation or fabrication not picked up during the commissioning process.

After Katrina and Rita in 2005, the industry revised upwards its predictions of maximum wave heights for a 100-year return period hurricane in the central Gulf of Mexico. The hurricanes of 2008 could result in another upward revision of the design waves for some regions. In addition to the size of the waves, the duration of the storm prediction may also need revision. Operators have an obligation to understand what margins of safety they have against the latest predictions of environmental loads and to take steps to mitigate the risks if those margins are too low. In some cases, the company that designed the platform may no longer exist or if it does, the design team that worked on it may have long since disbanded. Re-certification of the facility to new design loads may set off a hurried and unpleasant exercise in documentation recovery. Operators who diligently maintain the design information as required by regulation will find re-certification less onerous.

It is also important to note if a platform has been modified since its original design. Typical modifications include the addition of process equipment or the tieback of additional risers. These changes affect the ability of the platform to withstand hurricane loads, and it is important to verify that sufficient margins of safety exist after the changes. Change management is a key part of maintaining integrity.

Change is not always by design: over time, degradation processes like corrosion and fatigue may affect the condition of a platform and its risers. A good IM program will identify the high-risk structure and impose a plan of inspection to verify the condition of key areas. While inspection is often an inadequate tool to check for fatigue cracks, especially in risers and moorings, an IM program that includes monitoring of key loads and responses can indicate if component risk of fatigue loading is higher than anticipated in design. Likewise, a well-planned and faithfully executed corrosion control program can mean the difference between survival and failure of an offshore platform under the extreme loads of a hurricane.

Beneath the surface

Once the hurricane has passed, an inspection of the topsides structure is generally in order. To facilitate this, pre-written inspection plans should be in place. But it is also important to remember that the offshore production infrastructure is analogous to an iceberg: the equipment seen on the surface is only a fraction of the extent of the development subsea. Underwater offshore damage in 2005 and 2008 included impairment to structures, risers and flex-joints connecting pipelines to the platforms, along with major deformation to pipelines carrying hydrocarbons to shore. While the subsea architecture in deepwater is generally shielded from the effects of hurricanes, it is not immune. Large movements by floating platforms can impart load to wellheads, risers and pipelines. The incidence of dropped objects increases in the rush to prepare for abandonment as well as during the storm. And nearer shore, currents can initiate mudslides and scour. As part of the hurricane preparations, inspection plans covering the affected subsea facility can be written that detail any inspection work anticipated. Preparing these plans in advance can expedite the execution of the inspections following a hurricane.

A hurricane's effect on an offshore

structure depends on a variety of parameters: wind speed and direction; current speed; depth and direction; wave height and direction; and, of course, the effect of all in combination. Design analysis will have explored the worst-case design scenarios but may not address the particular combination of effects in a given storm. More and more, operators of offshore platforms are seeing the value of maintaining finite element analysis (FEA) models of the vessel or structure and the mooring and riser systems so that after a hurricane they can quickly conduct a simulation that indicates where the highest stresses occurred and whether they represent sufficient risk to require detailed inspection. It is natural to manage this activity with a comprehensive IM program since the information generated is used to provide more accurate risk assessment and determine the need for inspection.

Health check

Managing integrity has become increasingly important from cradle to grave. A carefully designed IM program has benefits beyond hurricane preparedness as well. It will provide a periodic health check on the asset and a record of the asset integrity, which enhances the value to potential buyers. It furnishes documentation of compliance with regulations, as well as a basis for extending the utility of an asset beyond its original design life. The IM program can provide a rational basis to justify rapid start-up after an environmental event like a hurricane, minimize unplanned downtime, and access to data to make informed decisions regarding integrity. Inspection and monitoring can be targeted – and therefore less expensive – and the preservation of data over the life of the asset minimizes the impact of staffing changes. Finally, a comprehensive IM program provides a mechanism to review operational practices with respect to integrity, to track and close out anomalies and integrity issues, to track staff competencies against job requirements and to coordinate the asset's preparation for hurricanes.

Whether the IM program is seen as a cutting edge approach to asset management or just an organized way to do traditional facility engineering, and whether the tasks are outsourced or done by permanent staff, taking care of business on a day-to-day basis is the key to avoiding surprises when the next hurricane roars through the Gulf. OE