Reservoir compaction and seafloor subsidence continue to be a significant concern for the oil and gas industry. Subsidence near oil and gas reservoirs is usually caused by a high production rate from multiple wells over many years. Production from hydrocarbon reservoirs decreases fluid pressure in the pore space and increases the stress on the rock formation. Depending on the rock strength, the increased stress could induce significant compaction of the reservoir. Typical deepwater Gulf of Mexico reservoirs consist of loose turbidite sands that carry the potential for considerable compaction, especially if significant depletion occurs during the productive life of the reservoir. Compaction can then transfer to seafloor subsidence, with significant displacements occurring over time, in some cases.

Direct results of seafloor subsidence are the increase in water depth and the corresponding reduction in the air gap between the average sea level and the base of a platform structure. This resulting loss of air gap and the potential impacts on platform safety are a major concern for operators. The wave force generated from hurricane winds presents one of the greatest risks for physical damage to offshore platforms; therefore, deck height is one of the most important characteristics in determining platform safety. All offshore platforms are built with the assumption that the deck is high enough to avoid being struck by waves. As subsidence causes a platform to sink over time, it increases the potential for inundation of the deck in extreme storm conditions, putting the platform at greater risk for structural failure and premature shut-in of production.

Gulf of Mexico

Versabar has developed a solution to prolong the life of platforms affected by seafloor subsidence and threatened by potential storm conditions. A raise in platform height is performed using hydraulic rams to increase the air gap between the cellar deck and the expected maximum wave height. This deck-raising technology was developed in 2006, after two Devon Energy platforms experienced considerable storm damage during two major hurricanes in 2005: Katrina (August) and Rita (September). Each platform was successfully raised 14ft using 32 synchronously controlled hydraulic cylinders, with 260 tons capacity each. (Photo below left: before the lift, Photo below right: after)

A key design element of Versabar’s deck-raising technology is the inclusion of split sleeves placed around the platform’s existing legs. The sleeves contain the deck legs during cutting, provide lateral stability for the topsides during jacking, and become permanent leg extension sections to support the topside at the new elevation. Another crucial element is the use of a pin connection to keep the platforms
storm safe during the cutting and welding process. (A leg pin being installed after jacking can be seen in the photo at right.)

Custom-engineered hydraulic power units (HPUs) were built to operate the rams. They were designed with redundancy (two engines, two fuel tanks) so that in the event of one total engine failure, they would still be able to safely operate.

The deck-raising system was designed with two different control modes, synchronous and manual. Synchronous is the primary mode and utilizes a computer system to send signals to the flow-control valves for all of the rams. Computer monitors are used to observe all aspects of the raising procedure including leg displacements, cylinder pressures, and hydraulic oil temperatures. When in manual mode, operators adjust the flow control valves for each leg.

Versabar’s deck raising technology can be used on multi-platform complexes in a simultaneous and synchronized process.

Southeast Asia Project
Versabar has provided engineering and equipment for the raising of a multi-platform bridge-linked complex (diagram above) in Southeast Asia to counteract the subsidence that has occurred at the field over time. Synchronized rams will raise three platforms and their connecting bridges approximately 4m in order to restore a safe air gap. Because the current air gap does not provide enough clearance for installation of rams long enough to perform the entire lift (photo at right), the process needed to be broken down into multiple stages.
Two types of rams were custom-engineered for the job. The first set of rams will raise the platforms 38.5in. After the legs are pinned off, a second set of rams will be installed and will raise the platforms to 106 inches. After pinning off once again, the dual-rod rams (seen at left) will continue to raise the platforms to 159.5in.

Project experience verifies the Versabar deck raising system is scalable to over 20,000 metric ton platform weights. In addition, use of multiple split sleeve extensions and dual-rod rams allows the raising of these large platforms with a high level of operational efficiency and safety.

As the probability of extreme waves entering the deck increases with further subsidence, modifications to facilities should be considered to minimize future adverse effects of compaction and subsidence. Versabar’s deck raising technology provides operators with a cost and schedule attractive option to return air gaps to original levels, or higher if new wave data requires. For additional information go to www.vbar.com.