It will take a systems approach to offshore drilling safety to reduce the risk of catastrophic explosions and oil spills, according to a new report, *Macondo Well-Deepwater Horizon Blowout: Lessons for Improving Offshore Drilling Safety*. The study was conducted by the National Academy of Engineering and National Research Council, and led by former Navy Secretary Donald Winter, now a professor of engineering at the University of Michigan.

The report’s systems approach for hardware would include better risk assessment, improved design guidelines, more realistic testing and modeling, and an enhanced systems-level understanding of offshore drilling equipment.

On the human resources side, the report calls for

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The analysis of the Macondo Well blowout, which destroyed oversight of safety within a single agency.

The committee drew its recommendations from an analysis of the Macondo Well blowout, which destroyed the Deepwater Horizon drilling rig on April 20, 2010. The accident killed 11 workers and released 5 million barrels of oil into the Gulf of Mexico. The committee estimated that the event cost billions of dollars. Its ecological impact is still being measured.

The Macondo well was difficult to drill. Its total depth was nearly four miles down. Moreover, its highest reservoir pore pressure was very close to the fracture gradients of the formation. In other words, it was primed for a blowout. This became clear during drilling in March and April, when the Deepwater Horizon experienced several “kicks” due to hydrocarbon flows and lost circulation due to formation fracturing.

In April, Deepwater Horizon began to cap the well, sealing it off for future use while BP built the infrastructure needed to transport oil to the shore. The industry typically caps wells by using a combination of cemented liners or casings and additional cement or mechanical plugs. These provide multiple barriers to hydrocarbon flow. The team chose to use a production casing and additional cement or mechanical plugs. These provide multiple barriers to hydrocarbon flow. The team chose to use a production casing and additional cement or mechanical plugs.

The team ran into a number of problems, such as closing the check valves at the bottom of the casing. The crew determined mistakenly that it had cemented the casing in place successfully. It then ran a series of negative pressure tests to check the integrity of the cement job. Every test showed inconclusive and confusing results.

Yet the crew misinterpreted these warning signs, and began capping the well. As it began to displace drilling mud with lighter seawater, hydrocarbons began to flow out of the well. It took more than 50 minutes for the crew to realize it had lost control of the well.

At that point, the crew activated the blowout preventer. This was a tower of valves and rams that sat on top of the well. It was designed to close off any flow of hydrocarbons. Crew members activated the blind shear ram, a last-resort ram designed to crush and sever the drill pipe and seal the well. It failed.

The reliability of shear rams had been questioned well before 2010. Two reports by West Engineering, one in 2002 and the other in 2004, paint a troubling picture. They noted drill pipe have grown larger and their walls thicker as explorers drilled in deeper water. They found that blowout shear rams had difficulty cutting through the new pipes, and also through heavier sections of smaller pipes, such as drill collars and tool joints.

Moreover, shear rams are designed and tested on the surface to cut pipe in tension. When West tested six rams under hydrostatic pressure in compression, only three sheared a test pipe. West did not test whether the ram could actually seal the pipe.

In 2009, Det Norske Veritas, a leading Norwegian maritime risk firm, published a more optimistic study. Even so, it estimated that a blowout preventer using two shear rams would have only a 70 percent chance of successfully sealing a well. The Deepwater Horizon’s blowout preventer had only one shear ram.

A forensic analysis of the Deepwater Horizon explosion by Det Norske Veritas suggested that the pipe, under compression, had moved from the center to the side of the blind shear ram. When called upon, it jammed the ram and prevented it from fully closing. Within minutes of trying to activate the ram, natural gas had surged through the Deepwater Horizon’s derrick. It formed a huge cloud of combustible gas around the vessel that, in the words of the report, “made ignition all but inevitable.”

The crew had other options. It could have used other types of cements or completion styles. Yet economic pressures pushed the crew to complete its work quickly to minimize costs and enable it to move on to another project. While the crew misinterpreted the results of its integrity tests, it had few instruments to help it understand what was happening in the well. When the crew did try to disengage, the blowout preventer failed.

The committee made several recommendations to deal with these issues. Improved design guidelines to protect against all credible risks. It asked for better testing procedures for cemented seals, subject to near-real-time reviews by a competent authority. In addition to more reliable blowout prevention systems, the committee asked for formal maintenance and testing procedures and better operator training.

The panel also called for more instrumentation and computer-based expert decision aids for emergency warnings, as well as autonomous systems to shut down wells in emergencies. It requested better ways to cap and contain blowouts once they have occurred.

On the regulatory side, the committee called for a single government agency to take responsibility for system safety, and formal regulatory review and approval during well construction and abandonment.

Finally, the report recommended expanded safety R&D to improve design, testing, modeling, risk assessment, safety culture, and systems integration. It also supported educating and training personnel to implement system safety.