ORM Was In Motion During USS Monitor Expedition 2001

By HTC(SW/DV) William Turner, Naval Safety Center with Dr. John Broadwater, National Oceanic and Atmospheric Administration

We in the Navy too frequently seem to base our lessons learned on some terrible mishap or unfortunate chain of events. In the diving community, we often hear our "rules are written in blood." In many cases, this is true! If the principles of operational risk management had been applied in most of these instances, I'm sure many lives and thousands of dollars in equipment costs would have been saved. In this article, I am going to give you a new example on which to base your lessons learned. This is an example of how ORM will work, and will work superbly, when used correctly.

Last year's diving expedition on the USS *Monitor* off the coast of North Carolina was undoubtedly one of the most hazardous, but successful, peacetime salvage operations ever undertaken by the Navy. Working with the National Oceanic and Atmospheric Association, or NOAA, the salvage operation was to recover *Monitor's* steam engine from deeper than 230 feet of salt water in an area known as the "Graveyard of the Atlantic."

I want to emphasize ORM is not a program; it's a process. When used correctly, the process provides us with a means to identify and minimize risks encountered in almost any situation.

There are three levels in the ORM process: time critical, deliberate and in-depth.

Along with the three levels, are four principles.

- Accept risk when benefits outweigh the cost.
- Accept no unnecessary risks.
- Anticipate and manage risk by planning.
- Make risk decisions at the right level.

Finally, there are the five steps in the ORM process.

- Identify hazards.
- Assess hazards.
- Make risk decisions (on the hazards identified and assessed in steps one and two).
- Implement controls to minimize identified hazards.
- Supervise (watch for change).

There you have it–ORM in a nutshell. Sounds easy enough, right? Well, when I asked Mobile Diving and Salvage Unit Two's commanding officer, Cdr. Bobbie Scholley, how she and her Navy salvage team–and NOAA scientists–did it, she indicated members of the expedition definitely incorporated ORM into the operation, although perhaps not everyone was calling it ORM.

Cdr. Scholley and her team used all operational risk management levels, principles, and steps when planning for the year 2001 expedition began in November, 2000. Those planning this expedition were organized into teams. Within the teams, smaller groups were formed to tackle the many tasks and minute details to be worked out before the first dive; to name a few, they included engineering, logistics, diving procedures, manning, and training.

For the first time ever, Navy divers would operate from a civilian saturation-diving system owned by Global Diving Industries. This presented a whole new set of problems: getting the system on the barge, assembling a team and training its members, locating gas supplies and support equip-

Navy photo by PHC(DV/SW) Andrew McKaskle, CinCLantFlt Det. Combat Camera Atlantic

A surface-supplied Navy diver descends to the *Monitor* wreck site on a diver's stage, to prepare to salvage the main engine and other artifacts during Monitor Expedition 2001.

Navy photo by PH2(DV) Eric Lippmann, CinCLantFlt Det. Combat Camera Atlantic

ENCS(DV) Bill Staples uses a hammer and chisel to free deck plating from the wreck of the *Monitor*'s hull to gain access to the ironclad's side-lever steam engine and bring it to the surface for examination and restoration.

Navy photo by PH2(DV) Eric Lippmann, CinCLantFlt Det. Combat Camera Atlantic

BMC(DV/SW) Ruben Finger with Mobile Diving and Salvage Unit Two (left) taps ENCS(MDV) Lyle G. Becker—also with Mobile Diving and Salvage Unit Two —to inform him he is ready to monitor the recompression chamber so Senior Chief Becker can run diving operations to the *Monitor* wreck site.

ment, and some other problems. This lengthy planning phase also identified many hazards the salvors might face.

In 235 feet of salt water, depth became a serious concern. The divers would be breathing a mixture of helium and oxygen to avoid nitrogen-narcosis problems, and they would decompress in a chamber on deck to help protect them from ever-changing currents on the edge of the Gulf Stream.

Supervisors used special umbilical-management procedures to prevent paying out excess hose over the side in the strong current. They developed emergency procedures for the surface-supplied divers to use in conjunction with the saturation diving bell. These are only a few of the unique challenges the Navy salvors would face during this several-month-long mission.

The USS *Grapple* departed the Little Creek Naval Amphibious Base on April 21, 2001, to officially bring the Navy into Phase I of the *Monitor* salvage expedition. *Grapple*'s primary mission was to install additional lifting equipment and to position the engine-lifting frame directly over the ironclad's engine to prepare for the second phase of the operation: recovering the engine.

After completing the four-point moor to position the ship directly over the wreck, *Grapple*'s divers set about their task of installing the heavy hydraulic rams, chains, and cables necessary to raise *Monitor*'s engine. After losing several days to storms and high winds, the divers were able to again go over the side to continue their work.

They discovered aluminum blocks inadvertently had been installed on the old vessel's steel ram assemblies. When aluminum and steel are placed in salt water, they develop an electrical potential that results in rapid deterioration of the aluminum components. With no way to replace the aluminum parts underwater, the rams had to be retrieved for repair ashore.

Once the rams had been recovered, divers removed and replaced the large lifting chains between the spreader and the engine-lifting frame. With the weather again deteriorating, *Grapple* departed the Monitor National Marine Sanctuary to return to Little Creek, but not before completing 32 dives for more than 30 hours of bottom time.

Phase II of the expedition was carried out aboard the Manson Gulf barge *Wontan.* This immense barge had a 500-ton crane and became home for more than 150 Navy divers and support personnel from 27 commands; they all rotated through the operation, as did dozens of civilians from numerous other participating organizations.

The three-week load-out, and preparing the barge in Houma, La., presented their own special safety concerns. Hundreds of thousands of pounds of equipment and supplies were rigged and loaded onto the barge and secured for the trip. Extra berthing modules were loaded to support the large expedition crew complement needed to sustain around-the-clock diving operations. Finally, the barge load-out was completed, and the barge departed for the *Monitor*'s grave.

During the 14-day transit, which included a stop in Morehead City, N.C. (thanks to tropical storm Allison) final diver preparations were made, and divers received training to familiarize them with the Global Diving Industries saturation diving system.

While the commercial diving industry frequently uses saturation diving, the Navy does so sparingly. Saturation diving enables divers to work for hours at extreme depths, compared to the limited 30-40 minutes of bottom time Navy divers have when using their surface-supplied, mixed-gas system.

Meanwhile, after reaching the *Monitor* site on June 17, and after establishing an eight-point moor over the wreck, it was time for the teams of divers to go to work. Both the saturation and surface-supplied divers were divided into two 12-hour shifts that would work around-the-clock, seven days a week. Capt. Chris Murray, the Navy's on-scene commander, and Dr. John Broadwater (NOAA's Chief Expedition scientist) would head the day shift. Mobile Diving and Salvage Unit Two's C.O., Cdr. Scholley, and Jeff Johnson (NOAA's historian), would lead the night shift.

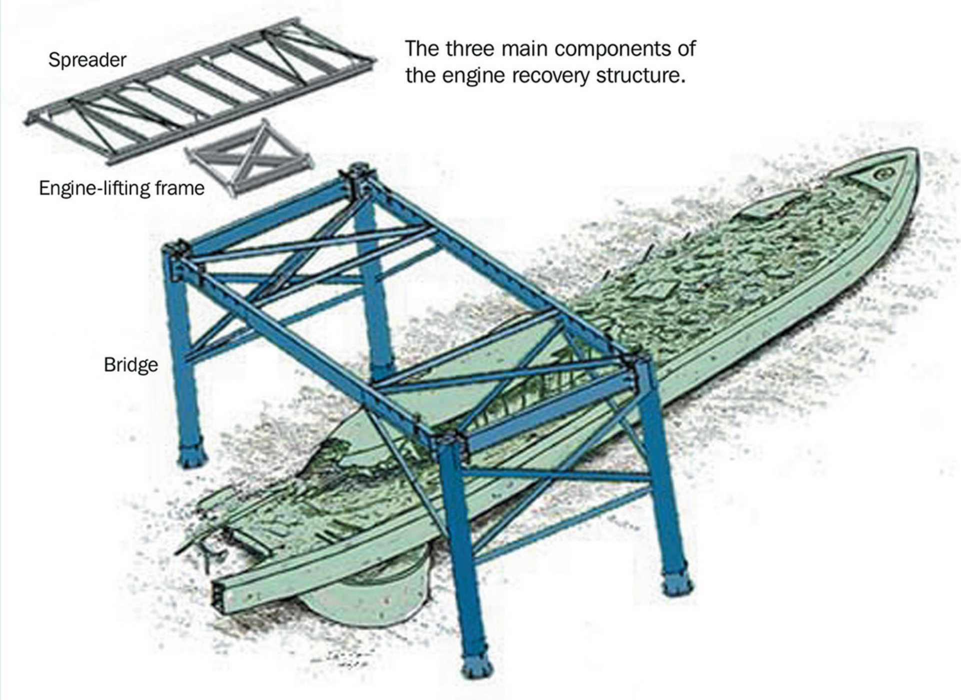
The surface-supplied dive teams then began installing hydraulic-lifting rams and continued working on the engine-recovery structure, while saturation-dive teams worked to evaluate the saturation-diving system. On Tuesday, June 18, the evaluation dive successfully was completed when four divers were pressurized to 180 feet of salt water. This was the first time Navy divers had used a civilian saturation-diving system during official operations. In addition to the surface-supplied and saturation-dive teams, the Navy's remotely-operated vehicle, MR-2, was on-scene to provide video and still-image documentation.

"During the first couple of weeks, we seemed to have some sort of an emergency procedure [non-life threatening] on almost every dive." said Cdr. Scholley. "All were handled flawlessly, providing an invaluable amount of real-time training for supervisory and dive-station personnel. These problems are things you can not anticipate, they fall under time-critical ORM and involve all four ORM principles. Training can, and will prepare you for these circumstances. But, when someone's life could depend on the decision you make, it's nice to have a tool like ORM in your toolbox."

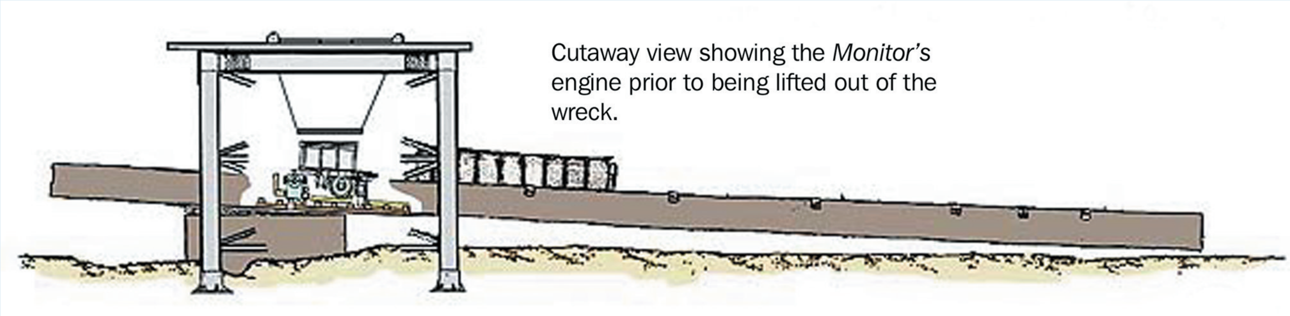
With the weather cooperating, both surface-supplied and saturation divers worked to remove the lower-engine hull plating and marine growth that had formed on the wreck for nearly a century and a half.

After divers used a variety of hydraulic tools, underwater cutting torches, hydro-blasters, scrapers, and even hammers and chisels, the engine finally was ready for rigging after nearly four weeks of around-the-clock shift work. With an unusual period of calm weather predicted for Monday, July 16, divers rushed to complete the intricate rigging necessary to lift the engine from its long-time resting place.

With the weather holding and the final rigging inspection completed, the order was given to raise



The three main components of the engine recovery structure.



Cutaway view showing the *Monitor's* engine prior to being lifted out of the wreck.

the engine. The engine initially was lifted only two feet so heavy cargo nets and additional straps could be placed around it to support its various components and linkages and to help secure it to the engine-lifting frame. The engine was then raised another four feet and everything reinspected. Finally, the steel lifting cables were attached to the engine-recovery structure and the entire assembly, an estimated 120 tons, was lifted to the surface and placed onto a waiting barge.

With the engine-recovery structure and the steam engine safely on its way to the Mariners Museum in Newport News, Va., surface-supplied divers continued working to recover the steam engine's condenser. Saturation divers began disassembling a section of the armor belt over the turret in preparation for next year's expedition to recover the *Monitor*'s revolutionary revolving gun turret and its two, 11-inch Dahlgren cannons.

On Monday, July 22, USNS *Apache* came alongside and loaded the cradle that would hold *Monitor*'s steam engine, the condenser which had been successfully recovered by the surface-supplied dive teams, and a large salvage basket containing numerous steam-engine parts and other artifacts recovered by both dive teams.

With all major goals completed and the weather deteriorating, the expedition ended on July 24, and the huge barge carrying the historical remains from the sunken ironclad began its slow journey to Morehead City, N.C. for offload.

During the historic dive mission, surface-supplied divers completed 412 mixed-gas dives for 198 hours of bottom time, having used the Navy's Flyaway Mixed Gas System III. Saturation divers accumulated 467 hours of bottom time and spent 211 man-days in saturation while using the civilian saturation-dive system.

By applying operational risk management during the many months of planning and during the entire operation, this historic expedition was completed without a significant incident, which was a tremendous accomplishment by all involved. It is particularly noteworthy when considering the size and complexity of this unique operation.

(Author's note: Thanks to Mobile Diving and Salvage Unit Two for inviting me to participate in the expedition, and thanks to Jeff Johnston of NOAA.)

One hundred and twenty-nine years after *Monitor* sank in the Graveyard of the Atlantic off the North Carolina coast, the ship's steam engine is brought out of the water for transportation to the Mariner's Museum in Newport News, Va., where the engine will be examined and restored.

Navy photo by JO1(DV) Robert Palomares, USNR, CinCLantFlt Det. 520 Combat Camera Atlantic

How Do Mixed-Gas, Surfaced-Supplied Diving and Saturation Diving Differ?

By HTC(SW/DV) William Turner, Naval Safety Center

Mixed-gas Surface-supplied Diving

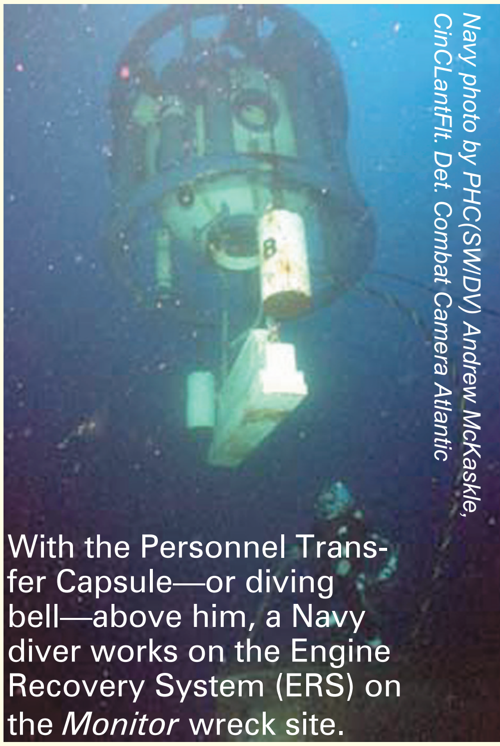
Mixed-gas, surface-supplied diving is conducted with a mixture of helium and oxygen supplied from the surface by an "umbilical," or flexible hose, to a normal operational depth limit of 300 feet of sea water, referred to in the diving profession as 300 FSW. It is used because when diving deeper than 100 FSW, some divers experience a euphoric feeling resulting from nitrogen narcosis. This affects a diver's judgement or skill and tends to produce lack of concern for one's own safety. To counter the effects associated with deep air diving, helium and oxygen are supplied. This mixture is especially suited for diving below the depth limits of regular air (oxygen) diving, but falls short of the depths and times required for saturation diving.

For the *Monitor* expedition, bottom times were limited to 30-40 minutes, but because of descent time and time required to get to the work site, the actual available working time per dive was as little as 15-20 minutes. However, decompression at the end of some dives lasted for up to three hours.

Saturation Diving

Saturation diving is used for deep salvage or recovery, and uses equipment designed to support divers at depths to 1000 FSW. The divers are pressurized to a planned depth in a chamber, or "complex," on the surface and remain pressurized throughout the length of the job. They eat, sleep and live in the chamber under constant pressure equivalent to their diving depth; they are lowered to the dive site by a diving bell which attaches to the chamber that is their living quarters. The divers, connected by an umbilical to the bell, exit the bell to go to work. At the end of the dive, the divers re-enter the diving bell and are raised back to their pressurized surface chamber, remaining under constant pressure the entire time.

The primary advantage of this system is it greatly increases the time divers can spend on the bottom. During the *Monitor* expedition, the diving bell transferred saturation divers between their surface chamber and the site of the Civil War ironclad, some 240 FSW below. Four saturation divers remained under pressure for a week or more, with each diver spending cumulatively up to four hours daily working on the *Monitor.*



With the Personnel Transfer Capsule—or diving bell—above him, a Navy diver works on the Engine Recovery System (ERS) on the *Monitor* wreck site.

Compare those four hours to the daily 30-40 minute bottom-time limits of surface-supplied, mixed-gas diving used on previous expeditions; bottom time is greatly increased with saturation diving. At the end of their week, or "work period," saturation-divers spend several days slowly decompressing in their surface chamber.

BMC(DSW/SW/SG) John B. Staford from the Naval Diving and Salvage Training Center climbs through the deck decompression chamber where he and other divers lived for two weeks during the monitor salvage expedition.