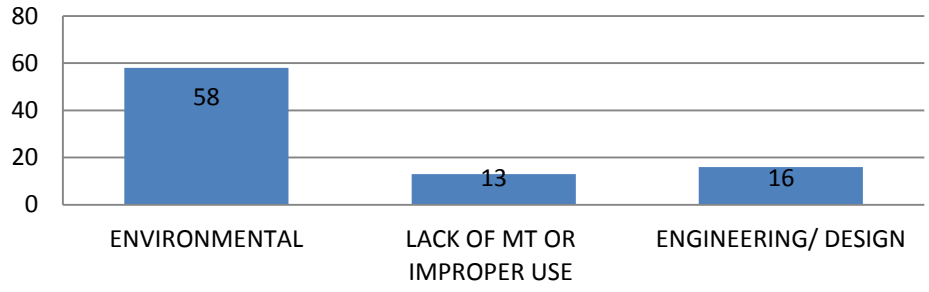
Safety and Cost benefits of working with dive companies when planning construction, modifications and maintenance in the nuclear industry.

NRC Generic Letter 89-13: The intake structure should be visually inspected, once per refueling cycle, for macroscopic biological fouling organisms, sediment, and corrosion. Inspections should be performed either by scuba divers or dewatering the intake structure or other comparable methods. Any fouling accumulation should be removed.

A concern shared by many in the power generating industry has been the increased vulnerability of some plants or plants' systems to micro and macro fouling. This is due in great part, to environmental factors such as: lowering water levels; shifts in weather patterns and changes in biodiversity of the lakes, seas, and rivers which supply cooling water. As evidenced by the graph of the study of 70 cooling water or intake events in nuclear power plants around the world.[1]

2001-2012
70 INTAKE/COOLING WATER EVENTS:
CAUSES*



Topping the list of mitigation defenses to these issues is thorough cleaning and systematic inspections and repairs. Moreover, many maintenance and cleaning activities already being regularly performed are being reevaluated and modified to meet changing regulations, and in some places systems and components themselves may have to be modified. Here enters the question of having some of this work be performed by divers, because a crew of divers can often complete these tasks without needing a proper unit shut down (depending on system configuration). Even during an outage, they can do the work without draining the system; and many systems simply can't be drained due to design configuration or because of the constraints of shorter outage durations.

When considering underwater work, safety and cost play major roles in the decision making process. If the plant is not familiar or knowledgeable of diving, it may shy away from performing maintenance or modifications using divers and opt for a more time consuming and costly process.

[1] Event information collected from INPO OE database.

SAFETY

Safety can be enforced by following a heavily scripted work order to the letter under an exacting, highly regulated, and oversight driven process. But since those processes are culture based and cultures can shift over time, safety can truly best be attained and maintained by planning tasks with awareness and knowledge of the limitations and challenges a worker may face when performing underwater work. It can be even more successful when new construction or modifications are carefully thought out and planned with the requirements of the inevitable future maintenance in mind. In addition, safety consciousness is also best reflected when a company takes steps to involve those experienced, in this case in underwater work, early on. Such experienced individuals will be able to assist engineers with the best approach to underwater entry and work from the start, thus providing a safer process in the end (see the NRC note below). What may seem simple or practical to an engineer or construction design company, can prove near impossible and/or hazardous when applied to an underwater world where visibility can end up being nil and conditions less than favorable. Lastly, safety is all but assured when the people involved, such as plant supervision, are well informed of the risks and limitations of underwater work and can thus can plan defenses and mitigate hazards early on.

The common practice of using pressure washers or hydroblasting when cleaning debris in screens, bays and other cooling water system components and structures has inherent dangers. One of which is the capability of water to inject itself in the skin of a person, causing injury and risking infection. When debating doing it in the dry or underwater, consider this: This hazard remains for divers, but is greatly reduced by three factors: One, the protective equipment for a diver (wet suit or dry suit, neoprene gloves, metal helmet) is in itself a better protective barrier than overalls. Two, the water atmosphere greatly reduces the force of the jet with less distance. And, three, less people are present in the vicinity of such work, since divers do not work close to each other, and at most, there will likely be no more than two divers in a team in the area, versus a whole crew of people cleaning a drained bay.

Another example from my experiences as a diver, and later as a supervisor: An underwater fish deterrent system was previously installed where the manifolds for the individual projector assembly cables were located in an area which initially looked logical on a drawing, but turned out to be nearly inaccessible when it came time to plug in the cables underwater. Visibility at the time of year when this recurring task had to take place was often no more than a few inches, and the average water temperature was 45 degrees or less, so the diver had to wear very thick gloves while performing this task. It was difficult for a diver to fit his gloved hand in the space provided to plug the cable in, and in addition, the dive hat reduced the field of vision even further because it did not fit in the small area where the manifold was located. Thus the diver was practically working blind and unable to properly reach and manipulate the cables and the manifold during yearly installation and troubleshooting. A few years later this system was modified, and the divers worked closely with the engineers to improve the design and location of the manifolds. This time they were placed where a diver could easily walk up to it and, wearing a camera on his dive hat, allow supervisors on the surface to see the condition of the installation and even verify placement of plugs for testing the operability of the system.

I firmly believe that underwater work challenges the perspective of a lot of people who are not familiar or aware of what it is like to work in that environment. For example, during a common weld job: A manager may view the task the same way s/he would approach any other weld job, and consequently be surprised when it begins to take longer to complete than expected. It is hard for someone to imagine

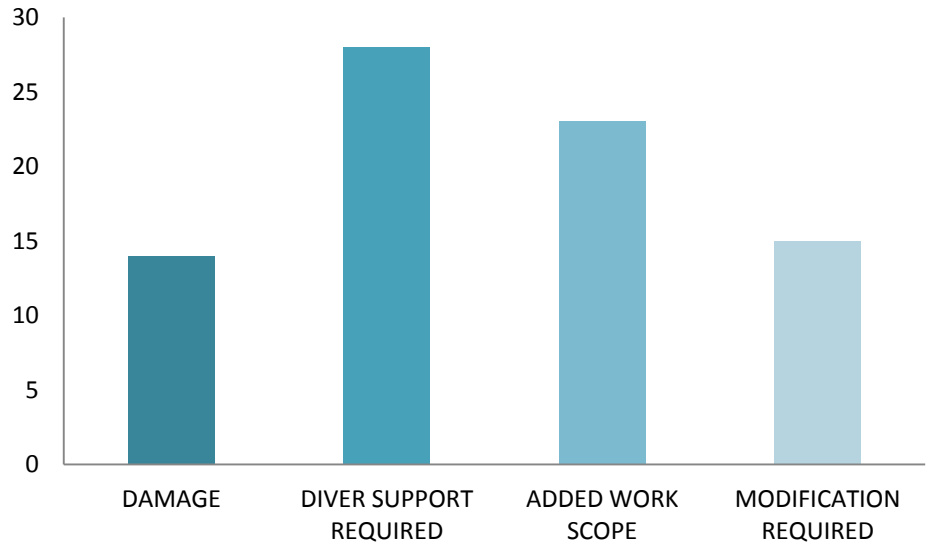
that the underwater welder may very likely have to be positioned upside down in order to reach the area he needs to weld, all while also dealing with bad visibility, temperature extremes and water currents, while wearing bulky dive gear and a +20lb dive helmet.

The situations noted above are only a few examples of why it can be invaluable in time and money saved in the long run by ensuring the appropriate discipline is involved early on with the planning or the project.

NRC 10 CFR Appendix A to Part 50: Criterion 45—Inspection of cooling water system. The cooling water system shall be designed to permit appropriate periodic inspection of important components, such as heat exchangers and piping, to assure the integrity and capability of the system.

COST

Designing water intakes to allow for proper underwater access by placement of entry points, trash racks, stop logs, netting, and even the design of travelling water screens, can save money in the long run when divers are able to easily and safely access an area to clean or repair components in a timely manner without the need to drain or go off line. OE exists where a plant had algae problems because in order to inject the chemical needed to inhibit algae growth, the cooling tower basin required isolating for at least 24 hours at a time when this was not doable without going offline. At another plant, inspections have to be planned at a time of the year when isolating the intakes does not affect the cooling needed to maintain 100% power. And at many sites, divers have often been pinned to trash racks or had their umbilicals sucked and even severed by pumps which can't be isolated. The graph below further dissects the 70 reviewed events and depicts the costly results. Many of the events resulted in all 4 (damage, require diver support to fix, and/or modify and resulted in added work scope to fix or prevent recurrence).



Section 316(b) of the Clean Water Act requires that the location, design, construction and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact.

Design of entry points for underwater work is crucial to the continued safety of a job. An example and OE comes from the plant I work in. Six years ago we replaced our traveling water screens with a newer design. This is one of the best implementations of forethought I have witnessed. Not only did this modification prove commitment to the system safety function of cooling water, but it greatly improved the conditions divers had to face each time they worked in the forebay. Prior to the replacement, the only way into the essential service water pump bay was by way of the traveling water screen itself. A support crew of mechanics had to remove individual screens in order to allow the diver entry to the other side of the bay and the diver had to secure the gears to prevent movement or shifting of the screens. This meant not only the added time and cost of support groups, the added risks of pinch points and passing under a load (the traveling water screen) but most importantly the loss of near direct access to the diver. Not to mention this was time consuming at a time when resources are sorely needed for other tasks during a refueling outage. The new screens were designed and installed with a hatch on either side of the screen. Now the forebay can be safely accessed from either side of the traveling water screen depending on the task. Permanent ladders were also installed, thus reducing the clutter of scaffolding or temporary ladders and increasing room to maneuver a fully dressed out diver with a bail-out bottle on his back.

These are examples of how improved design or modification (a capital expenditure) results in improved efficiency of O&M personnel and thus indirectly reduces labor costs and downtime. The capital cost of technologically improved designs and equipment, such as the traveling water screens in our plant, may be higher than standard assets (or having replaced the older traveling water screens with like-for-like) but they reduce O&M and life cycle costs. Cost reduction is also achieved when a recurrent task can be performed safely with less resources and when the duration of the job can be streamlined due to the efficiency of design and planning factor and not the avoidance factor (see below). And finally, when task completion time is reduced, a crew is freed up to perform other work during a busy refueling outage.

NUMARC 93-01: Monitoring of structures, like systems and components, should be predictive in nature and provide early warning of degradation. The baseline condition of plant structures should be established to facilitate condition monitoring activities.

I believe that in most plants, a direct avoidance of this fact of "power generation plant life" (underwater maintenance) will have and can have negative repercussions. Work will not be performed, and then failure of a system or component will force the work to be performed in an emergent fashion, thus increasing risk to the worker, and to the system and plant as well. After all, circulating water systems and ultimate heat sinks fall under non-safety related structures, systems, or components whose failure could prevent safety-related structures, systems, and components from fulfilling their safety-related function

(10 CFR 50.65). Planning safety and human error reduction into our work, is one of our safety guiding principles, and this begins with proper design, planning and execution of a job, understanding who will be performing it, when and where. And the best way to understand that is by directly involving those knowledgeable and experienced in that unique field and discipline.