Ensuring the sustainability of crucial underwater pipeline infrastructure

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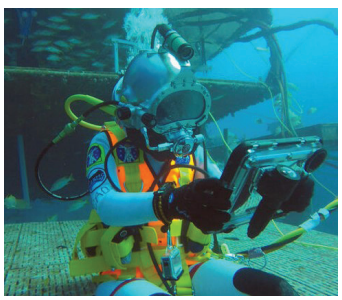
Over 190,000 miles of liquid petroleum pipelines exist within the US, 40,000 miles of which rest beneath bodies of water. These submerged pipelines are impacted by punishing elements, salt, waves and marine traffic, all of which test their resilience. Pipelines that live in the harsh underwater environment must be maintained differently from pipelines on land. Materials that may last for decades on the surface can deteriorate underwater in just a few years. Ensuring their structural integrity is paramount to avoiding catastrophic environmental, safety and economic consequences.

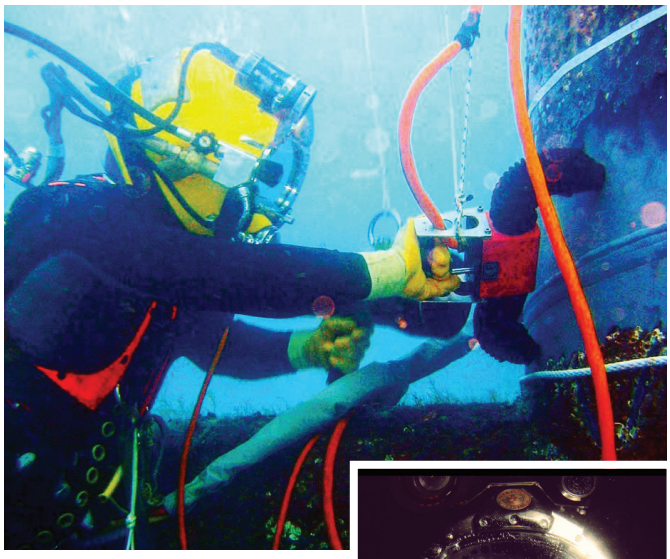
Regular inspection and monitoring by skilled underwater experts are a crucial requirement for maintaining the structural health of this vital infrastructure. Non-destructive testing (NDT) is the most common form of specialised inspection technique for accomplishing this. For pipe structures that transport materials from the sea floor to the ocean's surface, which do not accommodate the use of internal pipe inspection gauges (PIGs) for in-line-inspection (ILI), must be manually inspected. Ultrasonic Testing (UT) methods and techniques are the most commonly used forms of manual NDT. As such, it would be reasonable to expect that the qualifications prioritised for inspectors would be highly sophisticated. In fact, such skills as industrial rope climbing and commercial diving capabilities are now emphasised over crucial NDT expertise, a discrepancy that must be addressed.

Disparity in personnel certification

When it comes to deploying inspection personnel to test pipelines, regardless of their locations on elevated offshore platforms or the ocean bed, there often is an overemphasis on certifications in rope access or commercial diving. This focus on physical capabilities over specialised training is problematic, if not dangerous.

Historically, the commercial diving industry would equip divers to undertake a variety of underwater tasks, including inspection, construction, welding, jetting and salvage. The industry, however, has yet to universally recognise the importance of assigning these tasks only to highly certified and experienced inspection personnel.





NDT methods necessitate substantial training and experience, especially when inspections occur underwater, in confined spaces, and in poor visibility conditions. It's clear that merely having an NDT technician looking over the shoulder of a diver or ROV operator through a video system is an inadequate approach. A more proactive and engaged role for NDT technicians is imperative.

Diving deeper into NDT

Non-destructive testing is essential for maintaining offshore infrastructure. Specifically, ultrasonic testing (UT) methods are extensively used for pipe structures both above and below the ocean surface. UT has been a particularly reliable practice since the inception of the offshore industry.

The construction of offshore oil and gas installations began in the late 1940s. At the time, inspections were implemented at the discretion of the owner or operator. Regulations and requirements were not imposed until 1970 when the Occupational Safety and Health Administration (OHSA) acquired statutory authority to conduct and require inspection of structures in US waters. Since then, few amendments have been made to inspection requirements. Industrial applications of UT thickness techniques in

underwater environments were not developed or deployed until the mid-1980s. While such industrial applications of UT in underwater environments were only pioneered 40 years ago, multiple UT techniques have evolved with the advancement of technology.

Today, UT techniques include ultrasonic thickness testing (UTT), flooded member detection (FMD), ultrasonic angle beam, time of flight diffraction, guided wave, acoustic emission and 3D sonar Imaging. These sophisticated methods are instrumental in identifying structural thickness, corrosion, welds, crack detection and sizing discontinuities.

The rapid pace of technological advancement points toward an expected boom in UT underwater techniques in the future. With every new testing method, however, comes the need for additional specialised knowledge and training.

One example proves the point – ultrasonic thickness testing (UTT) was the pioneering method for gathering simple thickness measurements in underwater steel structures, a technique now used on a variety of pipeline materials.

UTT generates a mechanical waveform that provides a fundamental understanding of the integrity of the pipe. Remaining wall thickness is critical to know for accurately assessing structural integrity, as well as for pressure burst calculations. Although UTT is traditionally a manual, operator-driven technique, similar to applications on infrastructure above the water, it has been incorporated into a semi-automated process known as automated ultrasonic testing (AUT).

In the AUT method, a probe is secured onto a manipulator arm in a robotic system that can scan the exterior of the structure within the outlined scan parameters of a specific part. This methodology enables a faster and more reliable acquisition of data.

By incorporating a method that plots the information in a two-dimensional representation of the material, referred to as a C-scan, it becomes possible to detect, size and visualise corrosion or flaws in an efficient manner.

Another innovation, guided wave UT systems, are frequently used for above-ground pipeline inspection. Increasingly, they are being adapted for underwater use. In guided wave inspection, the transducers are set into a ring that matches the outside diameter (OD) of a pipe, and a torsional wave is sent out through the pipe wall to detect issues such as corrosion or cracking.

All of this rapid progression in ultrasound technology points to why ever-evolving applications require ever-enhanced capabilities and certification. As technology advances, the industry could see a dramatic increase in UT underwater techniques. With the advent of these testing methods, specialised knowledge and training must keep pace to ensure the effective collection and interpretation of inspection data.

The need for NDT expertise

Adding to the challenge of rapid technological advancements, many pipelines are now located in hard-to-reach areas. This makes it even more crucial for inspection teams to have proper NDT training, certifications and hands-on experience before undertaking their duties. Employing an engineer or NDT technician who first and foremost has all the necessary technological training and certification, and secondarily training them in rope access, or commercial diving, would result in a far more competent talent pool capable of conducting high quality inspections.

Conversely, training a commercial diver to become a certified NDT technician may not yield the same level of expertise.

For some commercial diving companies, establishing a fully qualified NDT program, developing an approved written practice and inspection procedures, employing an ASNT NDT Level III for each method, and adequately training, testing and certifying their divers as NDT technicians, may not be cost-effective. Moreover, the minimum "on-the-job" experience hours required for each method or technique may add to the challenge.

This difficulty is compounded as newer and more advanced technologies enter the industry, requiring a more specialised technician to master them. Rather than going it alone, these companies need a more widely accepted standard.

The need for global NDT standards

The absence of universally recognised minimum standards for NDT inspection personnel is a glaring issue. Companies such as Chevron, Shell, Exxon Mobile and BP have a responsibility to accept consistent industry recommendations.

Now is the time for such industry leaders to signal their willingness to accept industry-wide and global standards and certifications developed jointly by such organisations as ASNT, ISO, API and others for on the surface and underwater assessments.

The International Organization for Standardization (ISO) and the American Society for Nondestructive Testing (ASNT) currently offer standards and recommendations for inspection training and certification of personnel.

As online education courses gain momentum, more industry professionals can achieve their basic training accreditations virtually, providing companies access to a larger pool of suitably educated technicians, ready for hands-on training and certification.

AI and machine learning

The late 20th and early 21st centuries witnessed a seismic shift in NDT technologies, transitioning from analogue to digital. This digitisation altered the certification needs and requirements for inspection personnel.

The rise of artificial intelligence and automation has ushered in software that can analyse, interpret and report on data more swiftly and accurately than even highly trained technicians.

Despite these advancements, however, the need for certified and experienced technicians and subject matter experts remains crucial. They not only ensure proper implementation of predictive maintenance and inspection tools, but also validate the results. The lack of standard inspection regulations, coupled with financial pressures, could compromise safety and risk management practices.

In conclusion, to prevent catastrophic events from occurring due to defects in underwater pipelines, industry leaders must re-evaluate the certification prerequisites of inspection personnel. It is clear that operational continuity of these structures relies heavily on meticulous, regular inspections conducted by qualified and certified professionals. Those professionals employ NDT methods as the structural backbone of maintaining and safeguarding offshore infrastructure.

A well-trained and NDT-certified workforce is the key to safeguarding the structural integrity of underwater infrastructure. The necessity for a reorientation of hiring perspectives is needed to focus primarily on NDT expertise to ensure the sustainability and safety of the invaluable underwater infrastructure over other types of qualifications.

The shift in hiring priorities is clear: 'use the right tool for the job'. Rope access and commercial diving are simply vehicles to transport the qualified technician to the location that requires inspection.

We need to prioritise NDT training and experience. Industry leaders must recognise that their greatest asset is a qualified workforce and urge the adoption of standards set forth by ISO and ASNT. Only then can we ensure the continued structural integrity of our underwater infrastructure and avert disasters.

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