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DEALING WITH UXO (UNEXPLODED ORDNANCE): DETECTION, IDENTIFICATION, DISPOSAL AND AWARENESS

ABSTRACT

UXO are munitions that did not explode when they were employed and still pose a risk of detonation. All over the world dredgers have encountered UXO during their operations. Consequently, awareness has been increasing about the prevalence of the presence of UXO and the extreme safety risk they cause which should and must be taken into account during the preparations of dredging operations. Detection, identification and disposal are the three key words here.

Although the majority of incidents only lead to delays, in some cases major damage to property has indeed occurred. Sometimes the presence of UXO comes as a genuine, unpleasant surprise and the impact on the safety and security of the crew is significant.

To avoid unexpected encounters with UXO a thorough and professional investigation of the given area is recommended. This can involve historical research of maps and archives, followed by detection and identification on site with specialised equipment.

All in all, to reduce risks and achieve the higher levels of safety, the detection and removal of UXO should be performed by professionals, who have been specially trained to handle and dispose of UXO. Should crew members discover UXO, expert help should immediately be sought.

INTRODUCTION

UXO (unexploded ordnance) present a tremendous risk during day-to-day seabed intervention operations all over the world. Warfare, military exercises and dumping of munitions on a large scale have left us with an incredibly large number of unexploded bombs, shells, naval mines, torpedoes and grenades, dating back to the 1800s.

Dredging and other seabed interventions such as cable and pipeline installations and piling works often encounter UXO. When pumping sand, for instance, munitions can get stuck in the pump. The majority of incidents only lead to delays. However, in some cases major damage to property has indeed been incurred. In any event, the impact is always significant:

Above: Dredging vessels work all over the world and wherever they work UXO (unexploded ordnance) present a safety risk to dredging operations. To prevent unnecessary accidents, detection, followed by identification and disposal by EOD (explosive ordnance disposal) professionals are imperative.

Consider the feelings of insecurity amongst the crew.

Amongst people in the maritime sector awareness is growing that the risk of encountering UXO in their daily work is no longer acceptable. More and more the possible prevalence of UXO is part of the preparation and risk assessment of dredging projects. To avoid unexpected encounters with UXO, a thorough and professional investigation of the given area is recommended. This can involve historical research of maps and archives, followed by detection and identification on site with specialised equipment. The final step is disposal.

The detection, identification and disposal of UXO are carried out with high-tech equipment, surrounded by safety regulations for the people involved and protective measures for the environment. But still, surprises can lurk. This is why caution and awareness remain the highest priority. Think about it: All munitions are designed to kill people and/or destroy assets. If there is an explosion, no one is an exception. No one is safe.

WHAT IS UXO?

UXO is short-hand for "unexploded ordnance", which are explosive devices

(military munitions such as bombs, rockets, missiles, naval warfare, grenades, and sea and land mines) that were deployed but did not detonate as intended. These munitions were prepared for action – primed, fused or armed – and deployed in a manner to pose a risk to operations, installations or people, yet they remain unexploded. They can be unexploded for various reasons such as a malfunction or design. Even after decades of dormancy, UXO present a tremendous risk to day-to-day operations in a given area.

UXO exist worldwide and poses a potentially lethal threat in any area in which they are present. The inherent dangers associated with UXO can largely be attributed to the deterioration of the detonator and main charge, which makes these already volatile components more sensitive to disturbance such as heat, shock and/or friction. Munitions that were once deemed "duds" (unexploded ordnance with all safeties off) and discarded can pose a potent threat because of their volatile natures.

PREVALENCE

The risk presented by UXO is rivaled only by its prevalence. Dating as far back as the late 1800s, UXO are encountered domestically and abroad in nearly every industrialised country, in former combat areas or former defense sites such as coastal defense firing ranges and testing sites.

Particularly heavy concentrations of UXO exist in regions that have encountered substantial bombing during past wars, such as Germany, France, Belgium, the Netherlands, the United Kingdom, the Middle East, Japan and Laos. The imminent threat of UXO-related casualties or property damage is however not restricted to heavily-bombed or war-torn countries; coastal waters of the United States and Canada are also heavily affected (Figure 1).

CAUSES

Besides actual warfare, other causes have led to the presence of UXO. The most important one is the dumping of munition. Take for instance the Second World War: After the end of the war in 1945 large amounts of ammunition were dumped at sea. In general these were not primed and therefore not as dangerous as "duds" – munitions that did not explode. The quantity of discarded munitions was, however, enormous – more than 1.3 million tonnes (1,300,000,000 kg) of conventional ammunition was dumped in the German sector of the North Sea alone.

In addition, enormous numbers of English and German mines had been laid in both the North Sea and the Baltic Sea during the war. And that is only in European waters. Military exercises in many parts of the world are a root cause of the presence of munition in expected, and unexpected, places.

RISKS

The risk of any UXO is that it will explode when being disturbed. The corrosive effects of seawater over the course of years and decades are unpredictable. This makes Explosive Ordnance Disposal (EOD) work complex, but it is precisely why the role of EOD professionals is so vital. Sometimes shells are found that explode as soon as they come into contact with air. Lives really are at risk.

Over the years, a great number of incidents have been reported regarding munitions being discovered. The majority of incidents only lead to delays, but major damage to property has indeed occurred. In any event, the impact is always significant: Consider for example the feelings of insecurity amongst the crew. When munitions are present, the situation is never entirely safe. But the sooner – and more effectively – the crew are made aware of potential risks, the smaller the chance of unpleasant surprises. For that reason it is important for management and crews to ask, "Could there be UXO in the area where we will be working?"

This question should be part of the preparation for every dredging and offshore project. Inexperienced people should not handle UXO. Professionals should be called in at the earliest possible stage, preferably as early as the (pre) tendering phase, so they have time to provide a thorough advice on the local situation and to

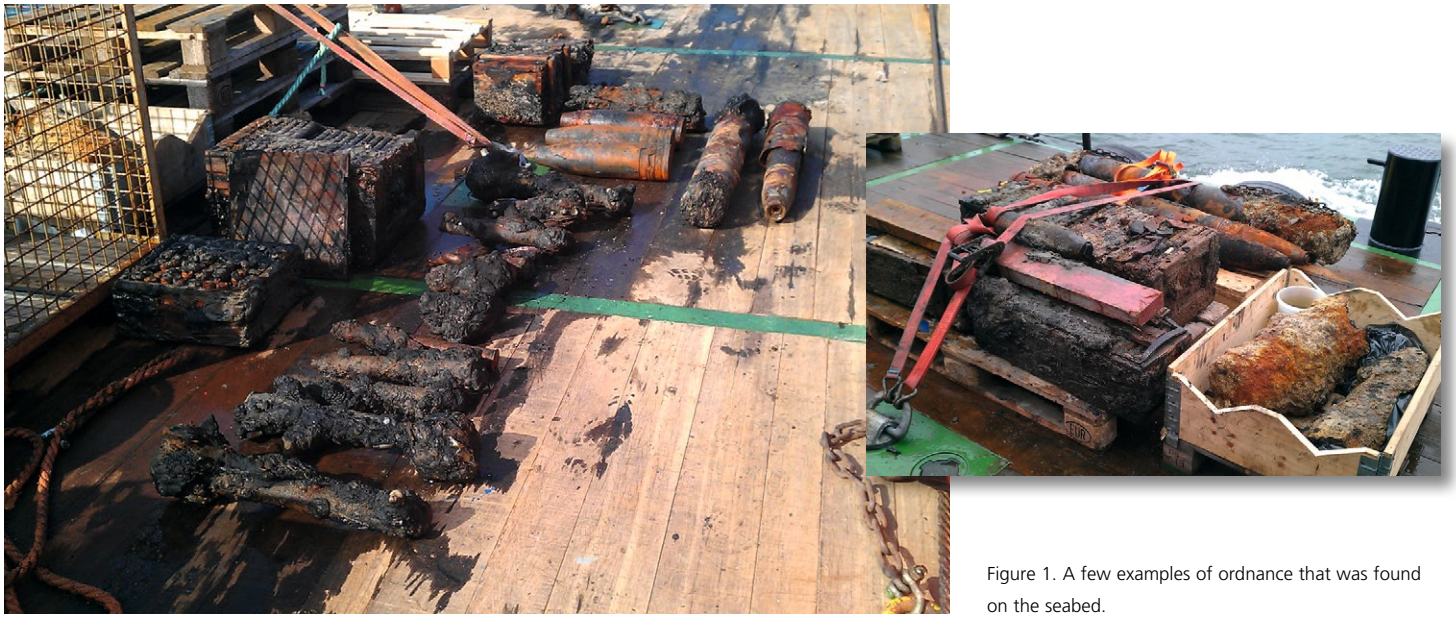

Figure 1. A few examples of ordnance that was found on the seabed.

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address the presence of UXO if necessary. This approach also has commercial benefits: If a contractor can present a customer with an overview of possible UXO, the issue has been turned into a shared problem.

HISTORICAL RESEARCH

EOD work often starts in (inter)national archives. As military actions at sea, like battle activities, military practice and the placement of mines are often documented, a great deal of information can be found here.

In the Second World War bombing raids were meticulously administered. After air raids, photographs were taken to show where bombs had landed, making it possible to determine the number of duds. However, sometimes the execution of an air strike went differently than had been planned. For example, a ship that was ordered to dump ammunition sometimes started doing this before reaching the actual dumpsite. To get a complete picture of the location of the ordnance, the logbooks of the fleet and particular ships have to be consulted.

Using the systems available now, EOD experts have been able to locate and map out quite a number of UXO at sea and on land (Figure 2). For instance, by comparing archival photographs from the Imperial War Museum in London with photographs of newly built houses and offices, one can determine where ordnance was dropped. With this information and the development of advanced detection systems, unexploded bombs have been successfully removed from residential areas.

DETECTION & IDENTIFICATION

Detecting, identifying and disposing of munitions at sea requires specialised high-tech equipment that can easily detect a crown cap at large depth under the seabed.

In many cases, the seabed is mapped out using magnetometers installed on survey vessels working in both deep and shallow waters. The magnetometers can also be used in combination with Remotely Operated Vehicles (ROVs). This is a reliable, but expensive, approach because it requires Dynamic Positioned (DP) vessels. In waters down to

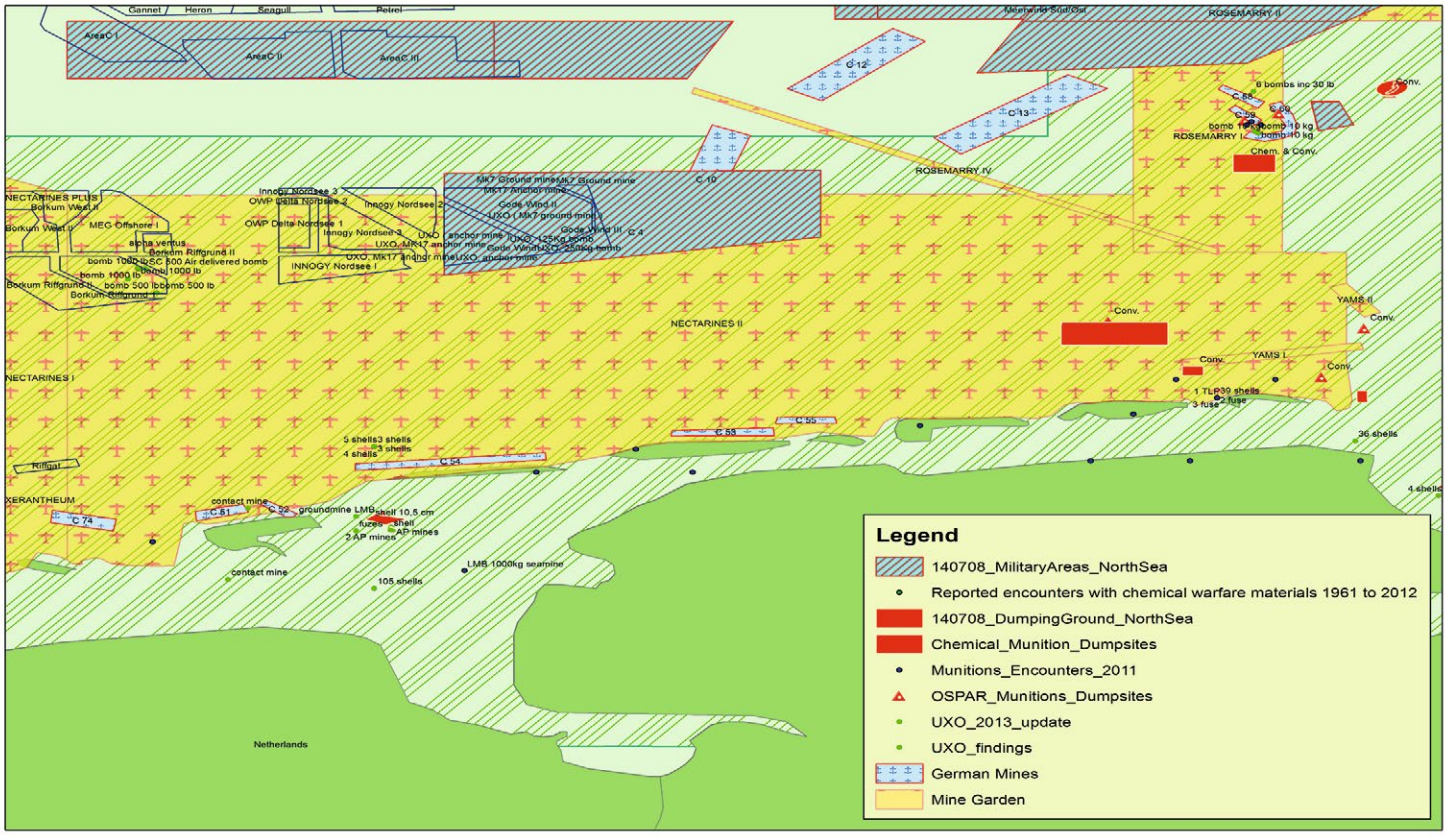

Figure 2. An overview of UXO in the coastal area of the Netherlands and Germany.

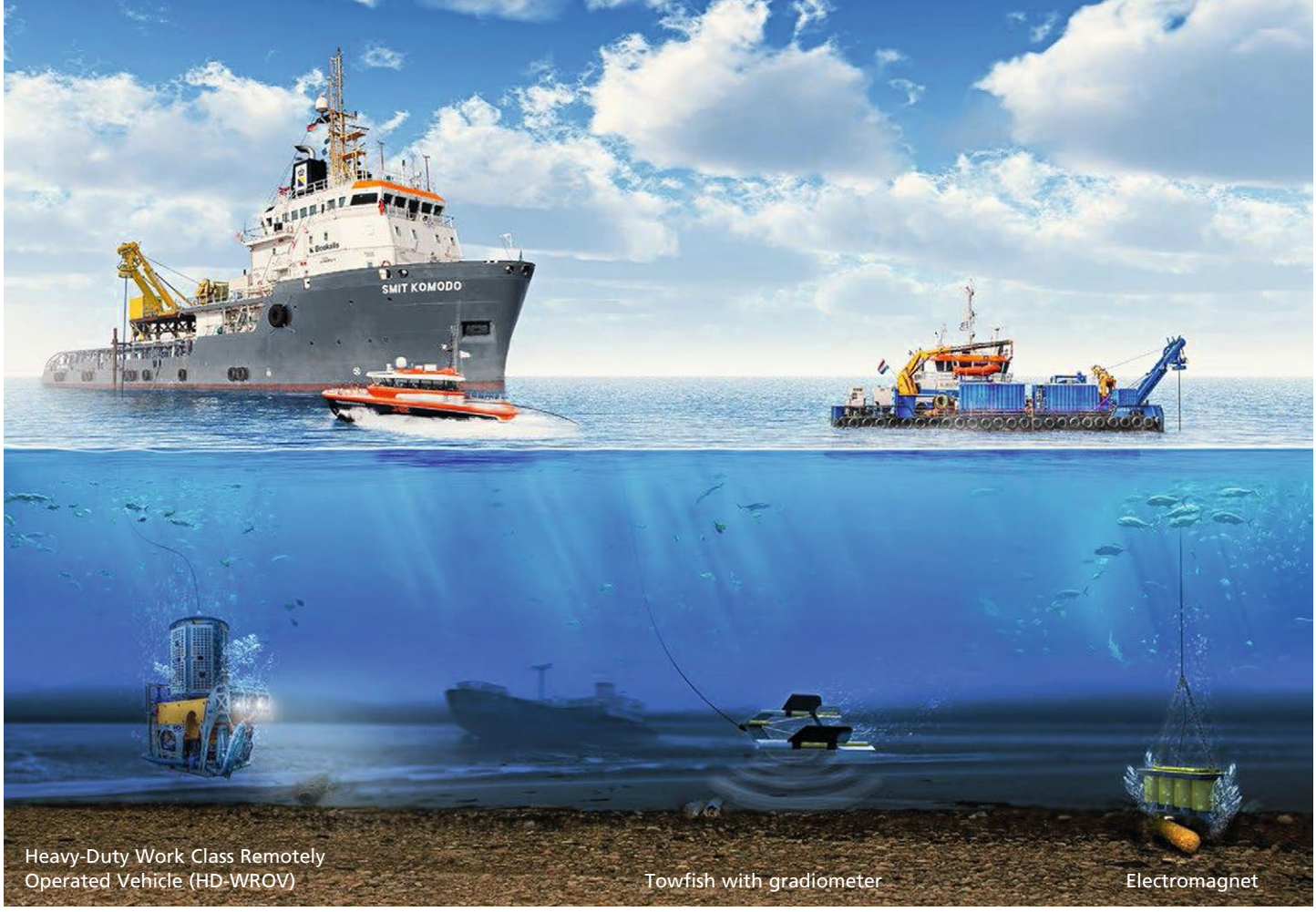

Figure 3. Left, a Heavy-Duty Work Class Remotely Operated Vehicle (HD-WROV) used to locate and salvage ammunition. Middle, a towfish with gradiometer to locate ammunition. Right, an electromagnet for salvaging ammunition.

depths of 100 metres, Remotely Operated Towed Vehicles (ROTVs) are often deployed. An ROTV is towed over the seabed behind a survey vessel. Gradiometers can also be used in deeper waters. These are precise measuring instruments in an arrow-shaped structure, which is towed by a survey boat (Figure 3).

One of the latest detection methods uses an Autonomous Underwater Vehicle (AUV). This can be described as a "robotic fish" that scans the seabed by itself using sonar technology. Anything it finds is literally mapped out using special software.
In any given area, thousands of UXO-suspected anomalies may be present, but it is not always possible to see the difference between a gas bottle and a bomb dropped by a plane. So the next phase involves identifying all UXO-suspected finds. In the past this work was executed by divers, but ROVs are much safer and more cost efficient. Nowadays UXO can be identified even in zero-visibility conditions, using acoustic camera systems.

DISPOSAL

After the identification phase, the next question is: Can the ordnance be (re)moved safely? Most duds like ground mines, naval mines and torpedoes must never be moved; they have to be rendered harmless on location.

One of the methods used to detonate a bomb is a Cobra-type shape charge, which is put into place immediately alongside the dud using an ROV. The Cobra is aimed at the detonator mechanism of the dud by laser. Experts then set off the Cobra from a safe distance, rendering the dud harmless. Ordnance that is deemed safe to transport is then picked up using specially developed electromagnets or robotic arms (manipulators) on an ROV that can bring bombs weighing up to 300 kilograms to the surface (Figure 4).

Subsea cranes are used for heavier ordnance. The munitions are then passed on to the relevant government authority for final disposal.

THE ENVIRONMENT

Countries can have strict environmental and other regulations regarding the detonation of duds at sea. A primary environmental concern is the protection of marine life and various methods have been developed to ensure their safety.

Before exploding any ordnance, a range of approaches are used to keep marine life at a distance. Technologies such as electronic seal scarers and pingers, acoustic devices for chasing seals and other marine mammals away can be uitilised.

Immediately prior to the actual detonation, all fish in the area are chased away by a series of small explosions. Also, to reduce the impact of the actual explosion, an air bubble curtain can be installed: This is an ingenious system that uses pumps and perforated air hoses to produce large amounts of bubbles. Bubble curtains were originally developed to reduce sound waves generated by piling work below the surface, but they also damp down the pressure wave generated by an underwater explosion.

The procedures mentioned above are time consuming and labour intensive, which makes detonating a single bomb an expensive

operation. To reduce some of these costs, specialists are presently investigating possibilities to tailor the bubble curtain technology specifically to ordnance detonation.

SAFETY OF EOD PROFESSIONALS

Ensuring the safety of EOD professionals themselves is, of course, another important subject. Being aware of the risks of UXO, as well as being well informed, is crucial. Working safely in the detection and disposal of UXO all comes down to good preparation and careful implementation. Only trained personnel with an understanding of munitions should be allowed to work out the data for a magnetometer survey, because based on certain characteristics they are able to indicate a strong suspicion on whether or not an object is likely to be an UXO.

Time is a major factor for being able to work carefully, both in terms of safety for crews, vessels and the environment. This can include the placement of blast screens to break pressure waves and protect against fragments on board dredging vessels. Various procedures and technical solutions have been developed to ensure safety of the people at work. For instance, when munitions are discovered, they are temporarily stored in a specially designed subsea basket, which is then marked so that it can easily be found again later with a transponder. In this way the UXO can be brought on board the vessel at the last moment, thus minimising the risks.

And finally, the use of divers should be minimised because of the risks involved in the processes of detection and disposal. Working with ROVs is far safer and should be done as much as possible during the identification and clean-up of objects.

AWARENESS AND KNOWLEDGE

Locating and removing UXO yourself was once considered simply to be part of being a professional dredger. Nowadays contractors realise the risks this entails and no longer accept those risks.

The growing awareness about the dangers of UXO has manifested itself in the attention spent to the prevalence of UXO in any given area during tenders and preparations of dredging operations. Sometimes an UXO survey is handed out together with the tender. However, people do not always have the knowledge to judge the information they have received at its true value.

For instance, if a mine field has been swept, one could assume that the area is clean and safe. In fact, minesweeping simply means that the anchor chain has been cut and the mines have been detonated by shooting at them. Unfortunately, this process only results in the detonation of about 10% of the mines and consequently most of them drop to the seabed. Although an area that has been mine-swept in this way may be safe for shipping vessels, it is not safe for anyone like dredging crews working on the seabed to

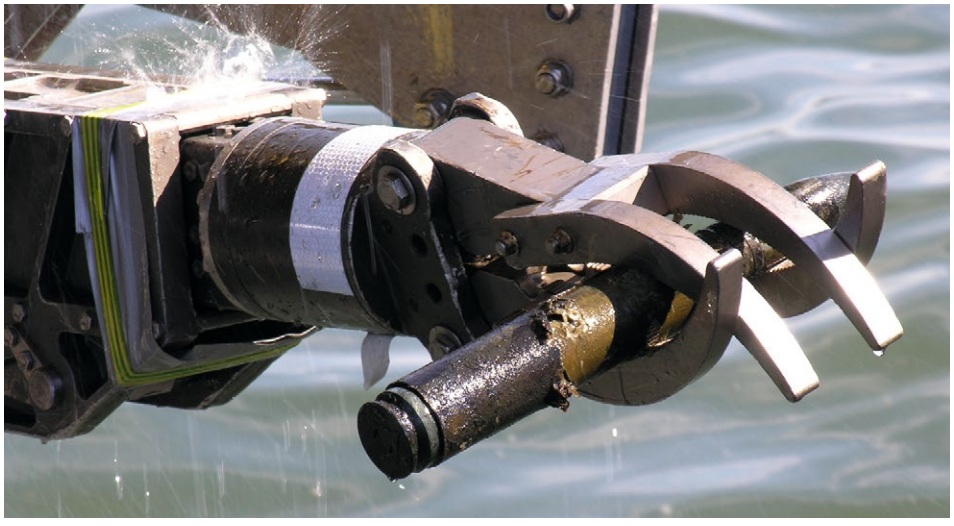

Figure 4. A grenade picked up by an ROV manipulator.

In addition, different types of munitions require different types of approaches. Sometimes detection and disposal measures are being taken, but they are not adapted to the actual risks. This creates a false sense of security and is perhaps even more dangerous than the risk itself. To avoid taking unnecessary risks, all plans should be checked by EOD experts.

Finally, despite precautions and preparations, surprises can still lurk beneath the waters, even in known "bomb areas". Incidents involving plastic anti-tank mines and aluminium sea-mines have occurred. These are undetectable with standard magnetometers, with grenades found in mine-swept areas and with unexpected ordnance in supposedly safe sand. This is why caution remains the main focus and standing orders like "no personnel in the pump room when dredging" are imperative. All munitions are designed to kill people – if there is an explosion, no one is an exception, no one is immune to injury.

CONCLUSIONS

The continued presence of UXO in various parts of the world cannot be underestimated. These can and do present a threat to the safety of the dredging projects, including crews and other workers as well as vessels. Therefore, taking proper precautions before a project starts is crucial.

Professionals should be called in at the earliest possible stage, preferably as early as the (pre)tendering phase. The overwhelming majority of UXO-related incidents can be avoided if handled by properly trained EOD professionals working with modern inspection and disposal technologies.

For this reason, the universal recommendation is that UXO should never be touched or handled by unqualified persons. Only properly trained professionals can assess the risks and safely neutralise the threat posed by discarded munitions.