

Definition sheet #1

Nomenclature definition of munition removal activities in the sea #1

Introduction

This document defines the central activities for the removal of *munitions in the sea* with the goal of harmonising the used terms between the different involved stakeholders. The document is produced within the effort to develop an assessment of technologies used in the EOD process (Weiher et al., tbp). Hence, the definitions are written from a technical *ordnance* disposal perspective.

The definitions were produced through a process of literature research, expert comments, and iterative discussions among several initiatives investigating *submerged munitions*, including the research consortia of CAMMera, MMinE-SwEEPER and BorDEx, to integrate scientific, operational, legal, and policy viewpoints. The resulting document demonstrates the great variety of definitions for similar activities and terminologies across various guidance documents. Competing definitions were harmonised wherever possible.

Readers are invited and encouraged to provide feedback and comments to the document to further the discussion and development of the definitions. Please find contact data at the end.

Structure of the document

The document provides definitions for central terms related to *munition removal* in the sea, presented in the **Definitions chapter**. The **Technology evaluation framework chapter** briefly introduces the central terms of the technology assessment. The definitions are based on existing terms taken from literature, which are presented in the **Glossary of referenced terms**. Terms contained in the glossary are marked as italic throughout the document. An extensive report with the backgrounds on the discussion is published separately (Weiher et al., 2026).

Scope of the document

This document contains definitions that can be applied to the removal of both *conventional* and *chemical munitions*. The procedures for handling *conventional munitions* in this document refer to the four phases of the *explosive ordnance disposal (EOD)*, as in the quality guideline for offshore EOD (Frey, 2020). While many of the activities for *chemical weapons (CW)* and *chemical warfare agents (CWA)* are similar to the EOD activities, their handling has different requirements regarding safety and exposure risks. In existing EOD guidelines *chemical weapons* are mostly excluded (compare UNMAS, 2014 chapter 4.3.3.).

This document does not cover Mine Countermeasures (MCM) nor does it concern *munitions* in active conflicts and wars. While shipwrecks and inland-waters are within scope, they are not explicitly addressed.

GEOMAR MMinE-SwEEPER CAMMera Clearance Activities for Marine Munition through Efficient Remediation Approaches

Definitions

Each definition starts with the **term** followed by the definition text. Relevant sub-terms of the *munition removal* activities are defined indented below the central definitions. The *munition removal* activities are sorted roughly following the EOD sequence.

Munitions in the sea

Munitions are items designed for military operations or use as a weapon, comprising manufactured or improvised devices containing *explosives*, *propellants*, pyrotechnics, initiating composition, or nuclear, biological or *chemical warfare agents*, or an associated component explosive in nature. *Munition* encompasses *conventional munition* as *explosive ordnance (EO/EXO)*, unused and *unexploded ordnance (UXO/UO) or unexploded bombs (UXB)*, *abandoned explosive ordnance (AXO)*, and *chemical weapons (CW) with chemical warfare agents (CWA)*, next to nuclear and biological weapons.

Dumped munition is *munition* deliberately disposed (see *dumping*, *dumpsite*) at sea or inland waters.

Submerged munition is *munition* located wholly or partly below the water surface in a marine or inland water body, including items lying on or buried within bottom sediments, or contained in submerged wrecks.

Munition in the sea is *submerged munition* that has entered and remains in the marine environment through deployment, combat, training, abandonment, deliberate *dumping*, accidental loss or sinking.

Munition removal activities in the sea

The following definitions concern central activities during removal of *munitions in the sea*.

Munition removal covers all activities related to removing *munitions* from the sea.

Mapping covers all activities related to finding *munitions in the sea* including the data generation (sensing and processing) and interpretation (detection, classification, identification).

> **Technical surveys** are structured missions for the discovery of *munitions in the sea*, including *as-found survey* at the beginning and *as-left survey* at the end of *munition removal* activities.
>
> **Sensing** is the process of measuring the seabed and water column using inspection methods and sensor technologies for data gathering.
>
> **Processing** is the preparation of data for correct interpretation and the creation of usable products.
>
> **Detection** is the process of localising *anomalies* in an area to produce a map or list of potential *munitions*.
>
> **Classification** is the process of categorising *anomalies* to distinguish *munitions* from other *anomalies* of anthropogenic, geogenic, or other origin and select targets for further investigation.
>
> **Identification** is the confirmation of targets as *munition* and specification of the exact type and condition.

Leave-in-place covers all risk containment strategies for *munitions* left in-situ without prompt intervention.

> **Monitored natural recovery** is a sediment remedy relying on natural processes to isolate/destroy/reduce bioavailability or toxicity of contaminants, implemented with long-term monitoring.
>
> **Containment** are methods to isolate single *munitions* from the environment.
>
> **Cover-up** are methods for the physical and chemical isolation of *munitions*, *munition compounds,* or *contaminated sediment* on site, by covering it with external material.

Clearance covers all processes that aim to remove *munitions* and *munition compounds* from the seabed.

Uncovering is the exposure of objects from the sediment for inspection, recovery, or in-situ destruction.

In-situ destruction/blast in place (BIP) is the destruction of *munitions* on seabed or in water, either direct in place or after relocation for safe destruction at a different site.

Depending on the reaction velocity BIP encompasses burning (< 0,01 m s^{-1}) and deflagration (<1000 m s^{-1}) as subsonic, and low-order (LOD) (1.000 – 5.000 m s^{-1}) / high-order detonation (HOD) (5.000 - 10.000 m s^{-1}) as supersonic reactions (Bourne et al., 2020).

Ex-situ destruction is the controlled destruction of *munitions* after relocation to a different environment.

Render-safe procedures is the neutralisation of *munitions* by permanently disrupting its function.

Recovery is the retrieval and lifting of *munitions* from seabed (vertical displacement).

Relocation is the transition of *munitions* to a different site or containment device under water (horizontal displacement).

Storage is the safe deposition of *munitions* for transition under water, at sea surface, or on shore.

Transport is the transition of *munitions* at sea surface or on shore (horizontal displacement).

Residue removal is the elimination of *munition compounds* (MC) from water and sediment.

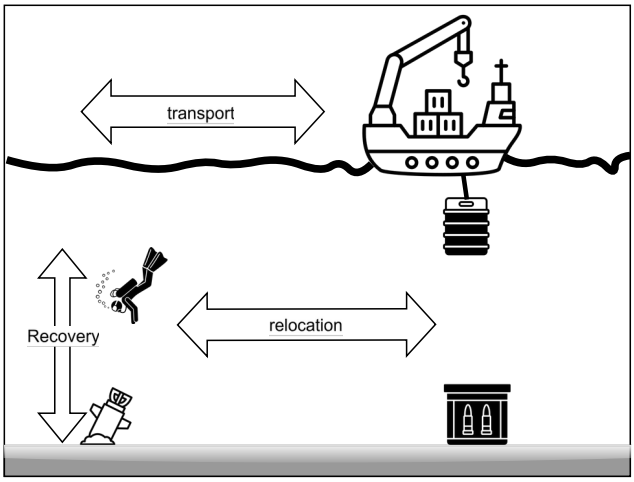


Figure 1: Modes of moving munitions from sea (see credits)

Mitigation is the reduction of negative impacts caused by application of any *munition removal* method.

Disposal covers all activities for neutralisation of recovered *munitions* at a designated facility.

Dismantling is the process of preparing *munitions* for treatment by separating its components.

Treatment is the final conversion of *munition compounds* into an *inert* end-state by thermal, chemical, and mechanical methods.

Contamination assessment covers all activities to determine the contamination of sediment, water, flora and fauna with *munition compounds*.

Monitoring is the tracking of environmental impact factors at specific sites over time, to measure the chemical contaminants/pollutants in the environment.

Rehabilitation covers all activities to re-establish the resilience of the affected ecosystems.

Risk assessment is the analysis of hazards and their probability of occurrence in different risk areas. Risk assessment for remediation of *munitions in the sea* encompasses the identification and evaluation of potential risks for environment, human health, economics, safety, and security related to *munition removal*.

Remediation is the strategic response to risk assessment and covers the evaluation of *munition removal* activities, *risk management, prioritisation* of potential risks, strategies for the prevention of unacceptable risks, and the *mitigation* of negative environmental impacts.

Technology evaluation framework

Remediation of *munitions in the sea* requires objective means for evaluation of different strategies, methods and technologies. The technology evaluation framework (Weiher et al., tbp) is an approach to provide a methodology to assess the suitability of specific technologies and evaluate the associated impacts and risks of remediation.

Technologies & practices refer to the known stage in the development of methods for removal of *munitions in the sea*. **Technologies** encompass hardware and software required for performing *munition removal* activities. **Practices** encompass procedures for the efficient application of the technology and strategies for minimizing associated impacts and risks.

Best Available Techniques (BAT) refer to the most effective and advanced stage in the development of methods for *munition removal*, indicating the practical suitability **for remediation of *munitions in the sea*** with reasonable costs, accessibility,and acceptable impacts and risks.

Techniques are methods containing required technologies and their operationalisation. Depending on the technology category, operationalisation includes procedures for implementation, operation, processing, and quality control. Depending on the task BAT can cover single technologies, or a combination of methods.

Operating Procedures encompass Standard Operating Procedures and Recommended Operating Procedures. **Standard Operating Procedures (SOP)** are controlled, approved and task-specific instructions that prescribe how a recurring operation must be performed, to ensure reliability and safety. They are binding if required by competent authority, law or contract. **Recommended operating procedures (ROP)** are technical guidelines for the implementation and operation of technologies that have been agreed on by a larger community.

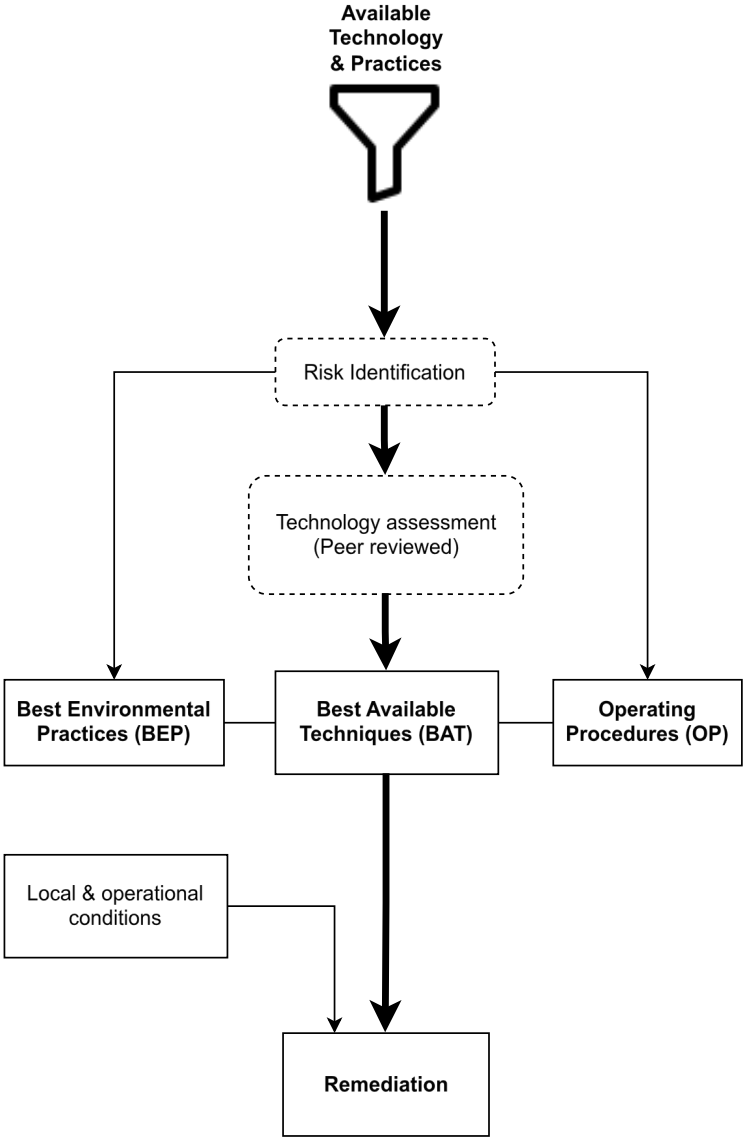


Figure 2: Technology assessment workflow

Following the precautionary principle **BAT for remediation** need to provide sufficient information for the later evaluation of associated environmental impacts and potential risks to environment, human health, economics, safety, and security. Thereby BAT are linked to OP and BEP and consider the local & operative conditions.

While ***Environmental Impact Assessment (EIA)*** is not mandatory for *munition removal* activities, it is a recommended procedure for remediation of *munitions in the sea*.

Best environmental practices (BEP) refers to the application of the most appropriate combination of control measures and strategies to minimize negative environmental impacts in a given context, using Best Available Techniques.

Glossary of referenced terms

The following definitions are referred to specify relevant terms from external documents.

Abandoned explosive ordnance (AXO)
"*Explosive ordnance* that has not been used during an armed conflict, that has been left behind or *dumped* by a party to an armed conflict, and which is no longer under control of the party that left it behind or *dumped* it. Abandoned explosive ordnance may or may not have been primed, fuzed, armed or otherwise prepared for use." (UNMAS, 2003)

Abandoned chemical weapons
"*Chemical weapons*, including old *chemical weapons*, abandoned by a State after 1 January 1925 on the territory of another State without the consent of the latter." (OPCW, 2020)

Ammunition
Synonym for *munition.*

Anomaly
"As used in geophysics, a deviation from an expected background condition that can result from either a real, physical change (e.g. buried metal object) in the subsurface, or various kinds of interference related to the geophysical equipment or external sources. Note: the anomaly is the deviation. It is to be differentiated from the buried metal object or "source" resulting in the anomaly." (ITRC, 2018)

As-found survey [EOD quality guideline]
Technical survey, typically geophysical, executed at the beginning of EOD activities. Defined as the "process of locating and surveying locations at which *UXO* may be present" (Frey, 2020).

As-left survey [EOD quality guideline]
Technical survey of EOD, typically geophysical, executed at the end of EOD activities with similar methods as the as-found survey. Defined as the "process of renewed surveying of locations in which debris or a *UXO* item was found with the aim of detecting other objects corresponding to the *reference object*" (Frey, 2020).

Chemical munition
Synonym for *chemical weapons.*

Chemical warfare agents (CWA)
"Chemical warfare agents (CWAs) are physiologically effective chemicals that are subject to the Chemical Weapons Conventions (CWCs)." (HELCOM, 2025)

"*Chemical warfare materials* include V- and G-series nerve agents or H-series (mustard) and L-series (lewisite) blister agents in other-than-munition configurations; and certain industrial chemicals (e.g., hydrogen cyanide (AC), cyanogen chloride (CK), or carbonyl dichloride (called phosgene or CG)) configured as a military *munition*." (EC, 2022)

Chemical warfare materials (CWM)
Synonym for *chemical weapons*.

Chemical weapons (CW)
The following definitions were summarised from the Chemical Weapons Convention (CWC):

Chemical Weapons are toxic chemicals (see *chemical warfare agents*) and their precursors (except for non-prohibited purposes and in consistent quantities), *munitions*/devices specifically designed to release those chemicals to cause harm, and any equipment specifically designed for such *munitions*/devices.

Precursors are any chemical reactant taking part at any stage in the production of a toxic chemical, including the key component of a binary/multicomponent system.

Key component (of Binary/Multicomponent Systems) – the precursor with the most important role in determining the toxic properties of the final product and reacting rapidly with the other component.

Old chemical weapons are CW produced before 1925, or CW produced between 1925 and 1946 that have deteriorated to a point where they can no longer be used as CW. (OPCW, 2020)

Cluster munition
"Cluster munition refers to a *conventional munition* that is designed to disperse or release explosive submunitions each weighing less than 20 kilograms, and includes those explosive submunitions." (UNMAS, 2003)

Contaminated sediment
"[C]ontaminated sediment is soil, sand, organic matter, or other minerals that accumulate on the bottom of a water body and contain toxic or hazardous materials at levels that may adversely affect human health or the environment." (EPA, 2005)

Conventional munition
"*Munitions* that create damage from kinetic, explosive or incendiary energy. They include small arms, sea and land *mines*, bombs, rockets, missiles and *cluster munitions* that do not have a nuclear or chemical load." (EC, 2022)

Dumping
"Deliberate disposal of waste and other matter from aircraft, vessels or other man-made structures at sea, as well as any disposal at sea of any of these structures." (EC, 2022)

Dumpsite
"Geographical point or area where *munitions* have been *dumped* at sea." (EC, 2022)

Environmental impact assessment (EIA)
Environmental Impact Assessment (EIA), as defined in Directive 2011/92/EU (EU, 2011) and amended by 2014/52/EU (EU, 2014), is the procedural instrument by which, before development consent is granted, public and private projects likely to have significant effects on the environment are systematically evaluated. The assessment is centred around the *protected goods* (a) population and human health, (b) biodiversity, (c) land, soil, water, air and climate, (d) material assets, cultural heritage and the landscape, and (e) the interaction between these factors.

From the *mine action* perspective, IMAS defines EIA as "process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant environmental effects of *mine action* activities prior to decisions being taken and commitments made" (UNMAS, 2003).

Explosive ordnance (EO)
"All *munitions* containing *explosives*, nuclear fission or fusion materials and biological and *chemical [warfare] agents*." (EOD COE, 2017)

Notably, the Protocol on Explosive Remnants of War by the United Nations defines explosive ordnance as "*conventional munitions* containing *explosives*, with the exception of *mines*, booby traps and other devices" (UN, 2003).

IMAS on the other hand defines explosive ordnance as "interpreted as encompassing *mine action*'s response to the following *munitions*:

- *Mines*

- *Cluster Munitions*
- *Unexploded Ordnance [UXO]*
- *Abandoned [explosive] Ordnance [AXO]*
- Booby traps, Improvised Explosive Devices [IED] [...] [and] Other devices [...]" (UNMAS, 2003).

Explosive Ordnance Disposal (EOD)
The EOD quality guideline defines explosive ordnance disposal as the "entire process consisting of the four phases of the *preliminary survey*, the *technical survey*, *investigation of target points*, and clearance and disposal" (Frey, 2020).

The European study defines EOD as the "detection, identification, onsite evaluation, rendering safe, recovery, and final disposal of *unexploded ordnance* and of other *munitions* that have become an imposing danger, for example by damage or deterioration" (EC, 2022).

Explosives
"[A] substance or mixture of substances which, under external influences, is capable of rapidly releasing energy in the form of gases and heat." (UNMAS, 2003)

Inert
"[A] *munition* that contains no *explosive*, pyrotechnic, lachrymatory, radioactive, chemical, biological or other toxic components or substances.

Note: […] The inert state of the *munition* may have resulted from a render safe procedure or other process to remove all hazardous components and substances." (UNMAS, 2003)

Investigation of target points [EOD quality guideline]
As phase of the EOD quality guideline investigation of *target points* is defined as the "entire phase in which the target list prepared during the *technical survey* is used and which serves the purpose of checking of the potential presence of *UXO* as well as the sign-off of *unconfirmed target points*" (Frey, 2020).

Mine [IMAS 04.10]
"*Munition* designed to be placed under, on or near the ground or other surface area and to be exploded by the presence, proximity or contact of a person or a vehicle." (UNMAS, 2003)

Mine action [IMAS 04.10]
"Activities which aim to reduce the social, economic and environmental impact of *explosive ordnance*." (UNMAS, 2003)

Munition [IMAS 04.10]
"[A] complete device charged with *explosives*, *propellants*, pyrotechnics, initiating composition, or nuclear, biological or chemical material for use in military operations, including demolitions." (UNMAS, 2003)

Munition is also defined in this document (see Definitions).

Munition compounds
"A large number of *munition* compounds were used to fulfil a relatively small range of tasks. *Explosives* were designed to provide an extraordinarily high energy release rate to enable detonation. *Propellants*, on the other hand, have a much lower energy release rate and are used to propel missiles, shells, or other payloads towards their targets. Incendiary materials are designed to ignite flammable goods in the target area after a hit or to illuminate. Other payloads were intended to provide artificial fog or smoke. Finally, *chemical warfare agents* (*CWAs*) are physiologically effective chemicals that are subject to the Chemical Weapons Conventions (CWCs)." (HELCOM, 2025)

Munition constituents
Synonym for *munition compounds.*

Munitions in the sea
Munition in the sea is defined in this document (see Definitions).

Munition removal
Munition removal is defined in this document (see Definitions).

Ordnance
“Explosives [see *explosive ordnance*], chemicals [see *chemical weapons*], pyrotechnics, and similar stores (e.g., bombs, guns and *ammunition*, flares, smoke, or napalm).” (EC, 2022)

Preliminary survey [EOD quality guideline]
As phase of the EOD quality guideline preliminary surveys are defined as the “entire phase of the desk-based study, which serves the purpose of creation of a threat assessment and the formulation of recommendations for the subsequent phases of EOD” (Frey, 2020).

Propellant
“[D]eflagrating explosive used for propulsion. [A] substance that is used to move an object by applying a motive force. This may or may not involve some form of chemical reaction. It may be a gas, liquid, or, before the chemical reaction, a solid. Chemical propellants are most usually used to project *ammunition* warheads. [A] substance on its own or in a mixture with other substances that can be used for the chemical generation of gases at the controlled rates required for propulsive purposes.

Protected goods [EIA]
The protected goods (Schutzgüter) – Directive 2011/92/EU (EU, 2011) Article 3(1), as replaced by the 2014 amendment (EU, 2014), requires the *EIA* to "identify, describe and assess in an appropriate manner, in the light of each individual case, the direct and indirect significant effects of a project on the following factors":

- (a) population and human health;
- (b) biodiversity, with particular attention to species and habitats protected under the Habitats Directive 92/43/EEC and the Birds Directive 2009/147/EC;
- (c) land, soil, water, air and climate;
- (d) material assets, cultural heritage and the landscape;
- (e) the interaction between the factors referred to in (a) to (d).

Article 3(2) adds that the effects on those factors shall include the expected effects deriving from the project's vulnerability to major-accident or disaster risks relevant to it. This section is explicitly relevant when dealing with hazardous risks by *UXO* and *chemical munition* in marine environments.

Reference object [EOD quality guideline]
“The smallest object to be detected.” (Frey, 2020)

Risk management
“The process of analysing potential risks and developing measures to mitigate potential impacts. It is not possible to remove all risk but it is possible to mitigate risk to an acceptable level. Stakeholder consultation is a key part of the risk management process.” (UNMAS, 2014)

Submerged munition
Submerged munition is defined in this document (see Definitions).

Target point [EOD quality guideline]
"Location at which, according to the results of data interpretation from the *technical survey*, *UXO* may be present." (Frey, 2020)

Technical survey [EOD quality guideline, IMAS]
As phase of the EOD quality guideline technical surveys are defined as "the entire phase in which the results of the desk-based *preliminary survey* are used and which serves the purpose of the preparation of a target list as well as the sign-off of target-free areas according to the objective" (Frey, 2020).

The IMAS defines technical survey as "collection and analysis of data, using appropriate technical interventions, about the presence, type, distribution and surrounding environment of underwater EO, in order to better define where EO is present, and where it is not, and to support evidencebased prioritisation and decision making processes" (UNMAS, 2014).

Technical survey is also defined in this document (see Definitions).

Unconfirmed target point [EOD quality guideline]
"*Target point* at which no *UXO* was found during its investigation." (Frey, 2020)

Unexploded bomb (UXB)
Synonym for *unexploded ordnance*, sometimes "Unexploded aerial delivered bombs", primarily used in the united kingdoms.

Unexploded ordnance (UXO/UO)
"*Explosive ordnance* that has been primed, fuzed, armed or otherwise prepared for use or used. It may have been fired, dropped, launched or projected yet remains unexploded either through malfunction or design or for any other reason." (UNMAS, 2003)

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Ongoing discussion

The methods and technologies for remediation are item of ongoing scientific discussion, thus all definitions might be subject to change. Comments for the discussion and development of definitions are explicitly welcome.
Please send them to Nils Weiher, Torsten Frey and Jens Greinert from Geomar: nweiher@geomar.de, tfrey@geomar.de and jgreinert@geomar.de

For further information visit "Munitions in the Sea" by JPI Oceans:
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