DAIMON Toolbox Fact Sheets:

Methods to Study the Impact of Dumped Munitions on Marine Biota

Assessment category: Munitions detection and identification

Toolbox component: Munitions identification

Fact Sheet 1.3: Munitions identification via Neutron Activation Analysis (NAA)

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What is it?

The use of Elemental Analysis System (EAS) allows identification of individual munition. Provided that there is additional information available,the condition of munitions can be assessed as well. The chemical analysis of sediment and/or water samples can provide a warning that the general vicinity contains chemical weapons, but identification of individual munition from multiple objects or clusters is difficult. An EAS instrument can be mounted on a remotely operated vehicle, provided it can deliver the required power (2kW) It can also be used as diver-operated equipment. Measurements can be performed without touching the object, thus, minimizing the risk of release of toxic munitions compounds.

What does it tell you?

EAS can provide the following information to the user:

- Elemental composition of the unknown munition
- Indication of the specific payload and munition type if an adequate spectrum library is available.
- Give estimate on corrosion level and leakage amount
  - requires information on munition dimensions and mass via sonar/magnetic.
  - library of known munition spectrums
  - Previous NAA surveys on the same object.
- Information if munitions payload material has leaked to the surrounding sediment or if the payload elements are located inside the munition shell.
  - requires the use of a compton camera imaging detector module.

EAS takes advantage of a method called Neutron Activation Analysis (NAA). A small particle accelerator is used to generate a neutron beam which is directed at the unknown munition in the seabed. Elemental composition of the object is defined by measuring the resulting gamma

spectrum from the object. Identification is possible as spectral fingerprint for different munition types and payloads is distinct because different payloads contain different elements.
It is possible to draw conclusions about munition condition such as corrosion level, or if the payload has leaked already or if it is inside the munition shell.

How to measure it?

Once individual munition is located,a remotely operated vehicle (ROV) equipped with a EAS Module can be sent to inspect the object. The ROV needs to deliver the EAS neutron source and detector package as close to the munition as possible, at least within 500 cm from the munition.The ROV should be equipped with a sediment- penetrating near sonar in order to correctly position the instrument relative to munitions buried in sediment. Sonar and magnetic data can be used to give an estimate on the size and mass of the object.

Measurement time varies strongly as a function of distance. The closer the measurement can be done to the object the faster it is. Identification of elements that are present is relatively fast, within 5-20 min. Getting sufficiently accurate measurements to give good estimates of corrosion and leakage level requires 1-5 h of measurement time.

Due to long measurement time and cost of ship time, it is recommended that ROV and EAS is based on buoy and operated remotely via a satellite link.

***Equipment*:**

- Distance from munition to the instrument should be less than 500 cm.
- Any vessel able to deliver the instrument
- ROV or divers to deliver and position the EAS instrument near the munition
- Sediment penetrating sonar if the munition is buried inside the sediment used for positioning, size/caliber estimation and geometry corrections on data.

How to analyse and assess the data?

The instrument provides information on what elements have been detected and on elemental ratios. Ratios of different elements tell us what payload the object under measurement likely contains.

The mass of the measured elements can be estimated, provided that pilot signal material can be inserted near the munition. Thus, shell material mass / payload mass (S/P ratio) can be measured.

If the imaging detector module is used, also ratios of shell inside / outside (I/O ratio) payload elements can be measured.

The S/P ratio, elemental data and optionally I/O ratio is recorded in the AMUCAD database.

The database library, containing library of measured spectrums and known elemental ratios, can be used to cross reference and identify the unknown munitions.

If release of compounds from the munitions has not happened, I/O ratio is large. If the I/O ratio is small, a release of payload is occurring at the moment.

From historical records, we can deduce what the S/P ratio should be in an object of a measured size/caliber and payload. If S/P ratio is much lower than expected, payload might have leaked out or the munition identification is not correct. If S/P ratio is higher than expected, the shell might be corroding, but considerable release of payload has not happened yet.

If regular surveys are performed, changes in measured information can be used to draw conclusions on leakage and corrosion.

References

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