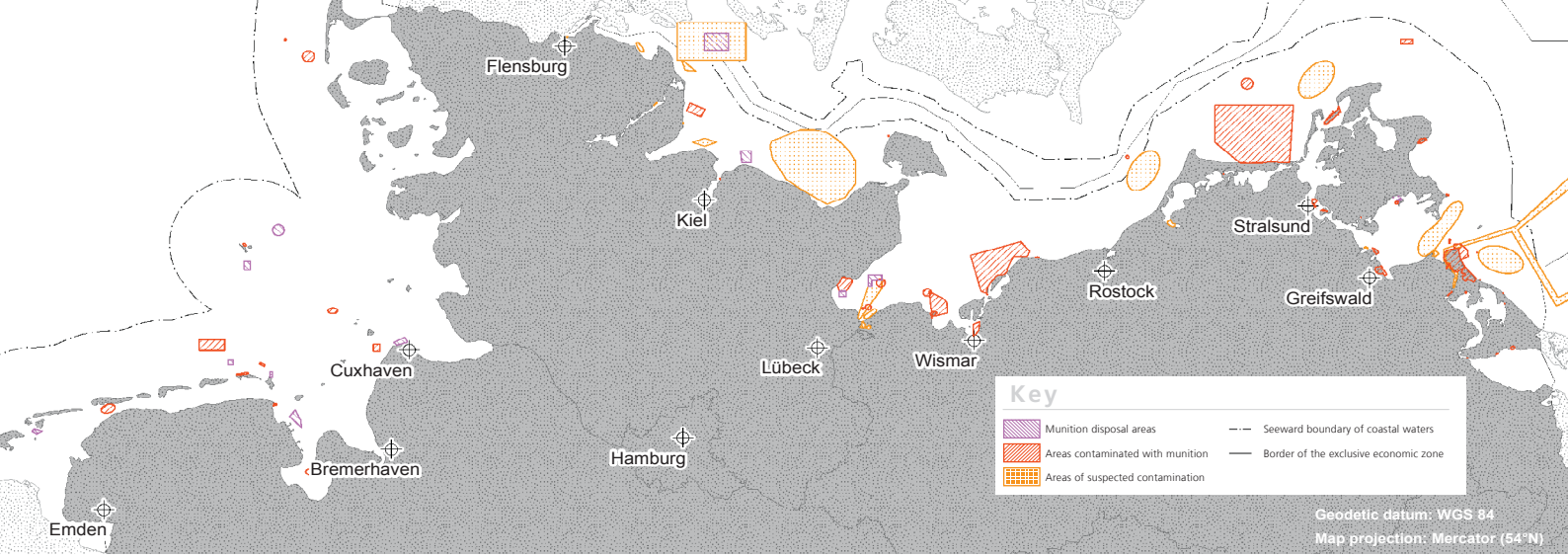
Fraunhofer
ICT

FRAUNHOFER INSTITUTE FOR CHEMICAL TECHNOLOGY ICT

RoBEMM
DEVELOPMENT AND TESTING OF A ROBOTIC UNDERWATER SALVAGE AND DISPOSAL PROCESS

Source: Landeskriminalamt Schleswig Holstein – Kampfmittelräumdienst 2012



AMMUNITION IN THE SEA – EXPLOSIVE LEGACY

According to current estimations there are still 1.6 million tonnes of ammunition in the North and Baltic Sea, most of which result from the demilitarization of Germany after World War II. One problem is that the ships chartered by the allies often disposed of the dangerous materials before arriving in the designated disposal areas. For this reason the exact location of many explosive ordnances is unknown. The ammunition casings are increasingly being carried away or corroded by the effects of currents and the saline environment. A variety of toxic and carcinogenic substances are being released into the water, causing environmental damage.

The poor condition of many marine explosive ordnances and the amounts of explosives contained pose a significant risk to flora and fauna as well as to personnel involved in recovering the materials. As a result, "objects of concern" are generally moved to another location or detonated. The effort involved in this method of disposal and the resulting costs, especially during the construction of offshore wind parks, have increased the demand for alternatives. For this reason, RoBEMM ("Development and testing of a robotic underwater salvage and disposal process, including technology for the disassembly of ammunition in the sea, especially in coastal and shallow waters") aims to develop a viable process and the corresponding technology to expose and thermally destroy the explosive ordnances on site without detonation, leaving only scrap metal which can be returned to land.

For over 60 years, Fraunhofer ICT has been engaged in the characterization and investigation of explosive substances. The knowledge and experience obtained form the basis for a fundamental understanding of safety issues in the field of energetic systems. Within the collaborative R&D project RoBEMM, the institute is therefore working on the safety design of the process chain from the handling of ammunition and explosives through to their disposal. The concepts and parameters for the planned process are based on safety investigations of the historic explosives mixtures. It is also important to determine the composition of the explosive, so that safety risks can be identified.

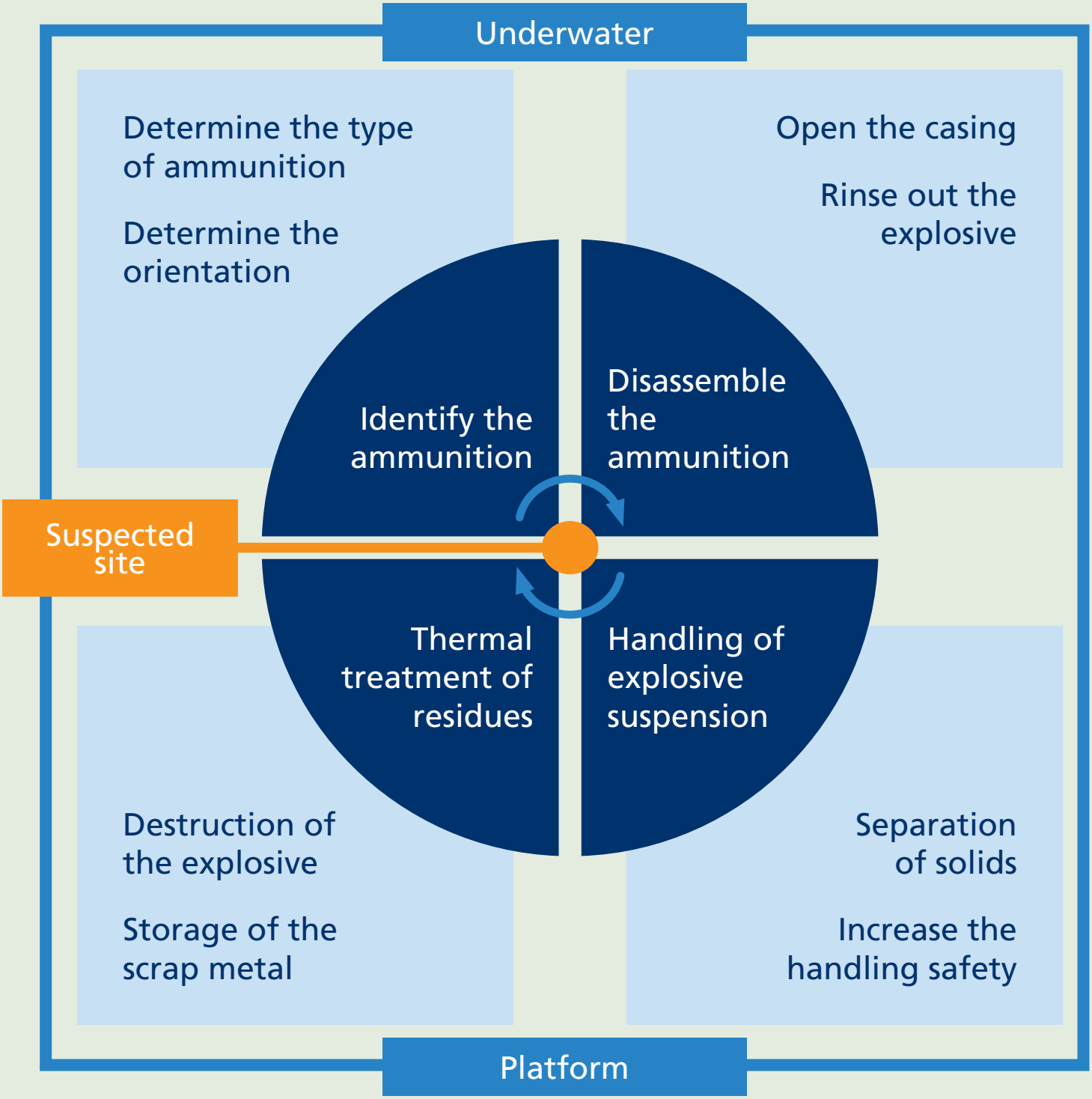
General investigations for the characterization of explosives:

- Measurement of the detonation speed
- Assessment of storage stability
  - Temperature of autoignition
  - Holland test
- Impact and friction sensitivity
- Koenen test to determine sensitivity to temperature increases
- GAP test to measure the initiation pressure
- Differential scanning calorimetry

Methods to measure the composition:

- Gas chromatography
- High-performance liquid chromatography
- Ion chromatography IC
- X-ray diffractometry

Map of the areas contaminated with ammunition in German waters
(MELUND Schleswig Holstein – Bund/Länder-Ausschuss Nord- und Ostsee 2011
URL: http://www.schleswig-holstein.de/DE/UXO/Berichte/PDF/Karten/karte_1.html)



In general substances with an impact sensitivity of less than 40 Nm are considered sensitive, and those with an impact sensitivity of less than 4 Nm are considered especially sensitive. Initial results show that almost all samples of marine explosive ordnances are sensitive to impact.

It follows that in the planned process only equipment (e.g. pumps) with low mechanical stress should be used.

To ensure a holistic assessment of all influencing factors relevant to the project, work safety and environmental protection issues have shaped developments from the beginning.

Emphasis is placed on increasing the handling safety of all explosives involved in the system. This includes desensitizing the explosives with water at the beginning of the disassembly process, and a subsequent fragmentation of the explosive particles in the suspension to a subcritical diameter.

This diameter is a characteristic value for each explosive that defines the threshold after which only parts of the explosive react, and no mass detonations or further reactions occur.

The expected results are:

- Statistical characterization and quantification of the substances in the ammunition
- Selection of suitable equipment
- Identification of whether conventional technologies can be used, and areas where adjustments are needed
- Development of a process and safety concept

PICTURES

Pictures included in the teaching materials of the explosive ordnances disposal team (Kampfmittelräumungsdienst) of Schleswig-Holstein. Left: Moored mine EMA/B. Center: British ground mines. Right: Depth bomb.

Investigation of the impact sensitivity of different samples.

	Impact sensitivity [Nm]
Torpedo heads	25
Moored mines	25
Ground mine, British (Mark IV)	50
Ground mine, British booster charge (Mark IV)	7,5
OS 9 (rinsed out material, non-specified)	6
Pure TNT[2]	15
Lead azide (primary explosive)[2]	2,5 – 4

[2] Köhler J., Meyer R., Homburg A. (2008) Explosivstoffe. 439 pages, Wiley-VCH Verlag GmbH & Co. KGaA; Issue 10, ISBN 978-3527320097


PROJECT PARTNERS

Boskalis Hirdes

- Investigation of explosive ordnances on the seabed
- Recovery of explosive ordnances
- Destruction of explosive ordnances

automatic Klein

- Engineering and automation of testing units
- Planning and construction of measurement, regulation and control units

University of Leipzig

- Environmental management
- Resource management
- Quality control

FUNDING AGENCIES

The project is funded by the Federal Ministry for Economic Affairs and Energy, Grant Agreement No. 03SX403A.

Supported by:

Federal Ministry for Economic Affairs and Energy

on the basis of a decision by the German Bundestag

PICTURES

BAM drop hammer and samples of explosives from a moored mine.

DEVELOPMENT AND TESTING OF A ROBOTIC UNDERWATER SALVAGE AND DISPOSAL PROCESS

Fraunhofer Institute for Chemical Technology ICT

Joseph-von-Fraunhofer-Strasse 7
76327 Pfinztal (Berghausen)
Germany

Director:
Prof. Dr.-Ing. Peter Elsner

Contact

Paul Müller
Phone +49 721 4640-754
paul.mueller@ict.fraunhofer.de

www.ict.fraunhofer.de

V02.0