FFI-RAPPORT

21/01139

Modular Lightweight Minesweeping II

— deliverable DE 0.7 executive summary

EDA Contract No B-1475-ESM1-GP

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Summary

The main purpose of the European Defence Agency (EDA) project Modular Lightweight Minesweeping II (MLM II) is to improve the technology of the demonstrators for unmanned light-weight modular minesweeping system used in the EDA project MLM, and to develop new sources in order to achieve the prototype stage of those systems. This will be done through theoretical studies, numerical modelling, development and integration of sources, and verifications by sea trials.

This document is the Executive Summary of the project. It describes the participants, the objective, the time line, the work packages, the systems involved, the sea trial, the results achieved, the lessons learned and the recommendations.

This report is unclassified and can be freely distributed to other participating member states of the European Defence Agency.

Sammendrag

Hovedmålet med European Defence Agency-prosjektet Modular Lightweight Minesweeping II (MLM II) er å forbedre teknologien til de ubemannede lettvekstsystemene i det tidligere European Defence Agency-prosjektet MLM, og utvikle dem til prototypestadium. Dette gjøres gjennom teoretiske studier, numerisk modellering, utvikling og integrasjon av kilder og verifisering gjennom sjøprøver.

Denne rapporten er en oversikt over prosjektet. Den beskriver deltagerne, målsettingene, tidslinjen, arbeidspakkene, de involverte systemene, sjøprøven, resultatene, erfaringer og anbefalinger.

Rapporten er ugradert og kan distribueres fritt til andre deltagende medlemsland i European Defence Agency.

Content

1 Introduction

This report is the Executive Summary of the EDA project “Modular Lightweight Minesweeping II”. It describes the participants, the objective, the time line, the work packages, the systems involved, the sea trial, the results achieved, the lessons learned and the recommendations.

This report is unclassified, and can be freely distributed to other participating Member States of the European Defence Agency.

2 Participants

Five companies and research institutes from four different countries collaborated in the EDA MLM II project.

CTM – Poland: does research, development, design and experimental work to develop and implement modern solutions in the field of naval technologies as well as other technologies related to national security and defence.

FFI – Norway: the Norwegian Defence Research Establishment (FFI) has the primary responsibility for defence-related research in Norway.

Patria – Finland: is a defence and aerospace group with international operations delivering competitive solutions based on its own specialist know-how and partnerships. Patria Systems BU has operated in underwater acoustic line of business since the ‘80s.

Thales Norway: is one of the largest industrial centres of expertise for development of mission critical systems and solutions in Norway.

WTD 71 – Germany: supports the German Navy in matters concerning the entire range of naval defence technology during all phases of the defence acquisition cycle.

3 Objective

The main purpose of the European Defence Agency (EDA) project Modular Lightweight Minesweeping II (MLM II) is to improve the technology of the demonstrators for unmanned light-weight modular minesweeping system used in the EDA project MLM, and to develop new sources in order to achieve the prototype stage of those systems. This will be done through theoretical studies, numerical modelling, development and integration of sources, and verifications by sea trials.

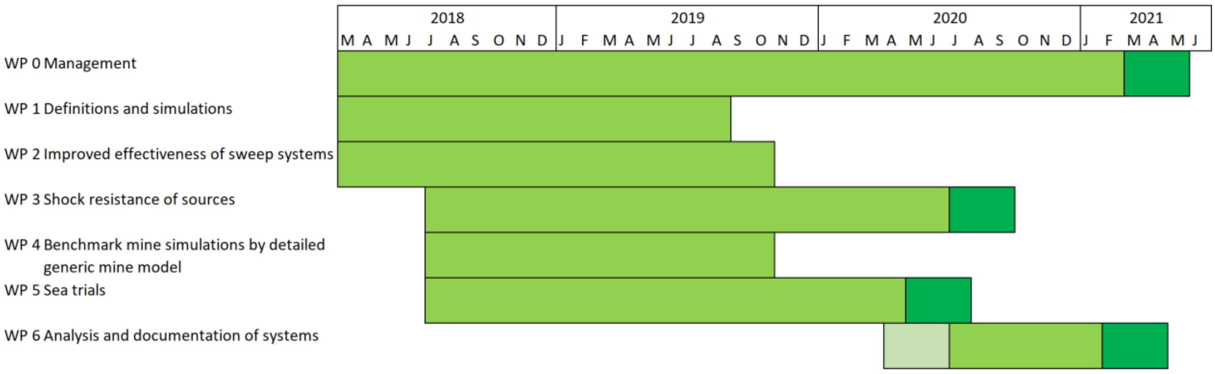
4 Work packages

The work in the project was divided into 6 work packages, each consisting of two or more tasks. Below the work packages and the responsible entities are shown.

WP0 Management (FFI)
WP1 Definitions and simulations (FFI)
WP2 More efficient sources (CTM)
WP3 Shock resistance of sources and USVs (WTD 71)
WP4 Benchmark mine simulations by generic mine model (WTD 71)
WP5 Sea trials (WTD 71)
WP6 Analysis (FFI)

5 Time line

The contract was signed March 14th 2018. This point in time is called T0. Originally the project duration was supposed to be 3 years (until March 2021). However, due to the world wide COVID-19 pandemic, the sea trials in Aschau had to be postponed by 3 months. Therefore, the project was extended by 3 months and last until June 2021. This was done by way of Amendment 1 to the contract, signed in July 2020. At the closing meeting in June 2021 the project was completed.



Project Management Group (PMG) meetings were held every six months, usually preceded by technical meetings. PMG members were welcome to join these technical meetings.

6 Systems involved

6.1 EEG/S improved system

The CTM system is a towed influence minesweeping system, consisting of three modified Elementary Electromagnetic Generators surface modules (EEG/S. Each module consist of a set of coils to generate both static and alternating magnetic fields. In addition, each EEG/S has two electrodes to generate electric fields. The EEG/S require electrical power from the towing vessel. The electrical current in each coil and electrode can be set independently, enabling the generation of complex magnetic and electric signatures. The distance between the EEG/S can be varied using cables with different lengths.

6.2 EEG/V with depressor

The EEG/V prototype is a new submersible version of EEG. This completely new design is more streamlined and hydrodynamically stable. It contains two coils (horizontal and vertical) to generate the static magnetic field. The module is slightly buoyant and is kept at a predefined depth using a specially designed depressor.

6.3 Acoustic source AC-15 (working title)

The acoustic LF source used in this project consists of two components:

- Dry end: Communication and control box
- Wet end: LF source AC-15

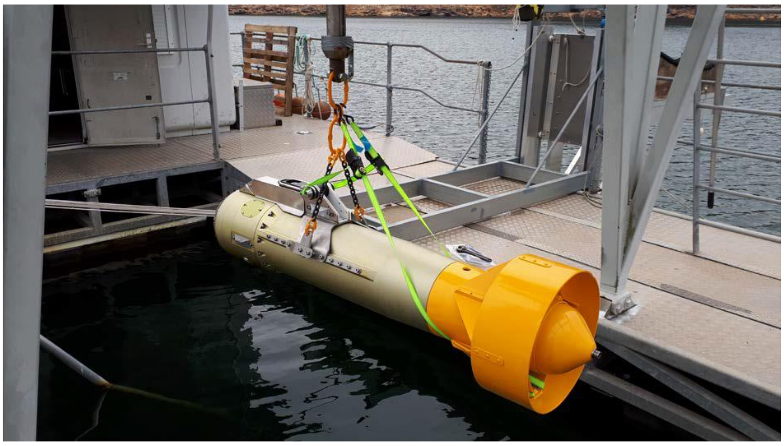
The communication and control box controls the settings of the LF source. During the trials it was positioned on the float above the LF source and connected to the source by a cable. In the future product (ACS) the data transfer does not need WiFi-connection and the electronics will be inside the wet end. Settings were changed using a wireless connection from aboard the towing vessel. The LF source consists of two lateral pistons, each with a diameter of 30 cm, able to produce ship like noise in the frequency band from 10 to about 100 Hz with programmable tonals. The source has a weight of 350 kg in air and 100 kg in water.

The acoustic HF source with transducers was located in the separate tow body due to the divided test plan. The HF source in this test has a weight of 50 kg in air and the outer diameter was 20 cm. The HF source had 7 individual transducers covering bands: 80 to 200 Hz, 200 to 500 Hz, 500 to 1000Hz, 1 to 4 kHz, 4 to 10 kHz, 10 to 16 kHz and 16 to 30 kHz. Each element can transmit broad band noise including programmable tonals.

6.4 ETMA USV

The ETMA (Erprobungsträger Minenabwehr – Testing vessel for mine countermeasures) has catamaran-like hull made from GFRP. It is manufactured by Atlas Elektronik UK and commercially available as the ARCIMS USV. It is 11.2 m long and 3.4 m wide. It weighs roughly 7.000 kg, which means that it is possible to lift it by crane and transport it on a low-bed truck. ETMA's propulsion system consists of two independent systems. A Yanmar V8-Diesel engine that produces up to 272kW (370hp) powers each of those systems. The propulsion itself comes from two Hamilton waterjets. Together the two propulsion systems accelerate the ETMA up to 30kn (55km/h), if the hulls are clean.

6.5 CP-AAG



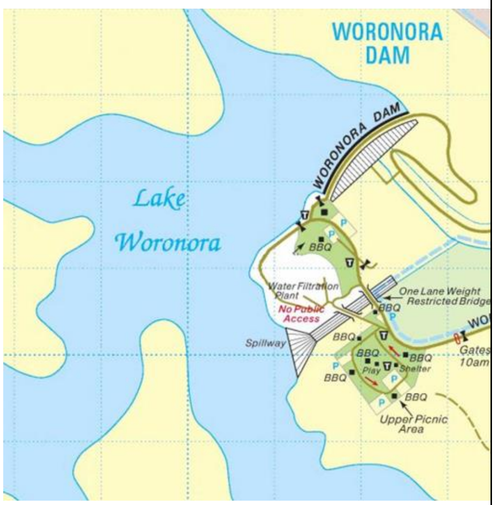
The CP-AAG (Cable Powered Advanced Acoustic Generator) is an acoustic noise source designed for sweeping acoustically activated sea mines. CP-AAG was developed by Thales Australia and is based on the operational system Advanced Acoustic Generator (AAG). The main difference is that the CP-AAG utilizes 3-phase power supply from the towing vessel in order to derive all internal power required for operation instead of a turbine driven by the speed through water as used in the AAG.

The acoustic signature is generated by a piston located in the front of the source. The piston is driven by a three phase motor that circulates hydraulic oil through a rotating disk with a slot-system that defines the piston frequency. The CP-AAG can operate using the 3 or 7 slot spool valve. The 3-slot spool valve allows the acoustic piston to operate at frequencies between 5 Hz and 107 Hz. The 7-slot spool valve allows the acoustic piston to operate at frequencies between 10 Hz and 250 Hz. Frequencies above these are generated by harmonics.

7 Sea trials

Two sea trials were held. The first was in November 2018 and May 2019 at Woronora Dam in Australia. Here the CP-AAG from Thales Australia was tested. The second test was in August 2020 in Aschau in Germany. Here the other systems were tested.

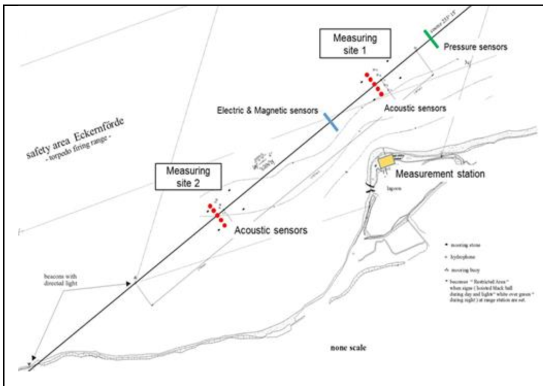
7.1 Woronora Dam



The acoustic measurement trial was conducted at Woronora Dam in November 2018 and May 2019. Two separate trials were necessary to gather measurements of the entire frequency range of the CP-AAG. A fault was identified with the CP-AAG during the first trial limiting the output frequency range. The fault was repaired and allowing full operation and measurements to be conducted in May 2019. The trials were conducted by Thales Australia and DSTG (Defence Science and Technology Group).

Woronora Dam is located approximately 60 km south of Sydney NSW and consists of a main lake area approximately 1000 by 400 metres. The Woronora Acoustics Research Facility consists of a floating pontoon structure and a small number of containers on shore (storage and office space). The pontoon is permanently moored on the lake. The heavy lift pontoon is used to lower and rotate items weighting up to two tonnes in order to calibrate and evaluate underwater acoustic properties using a variety of sensors and systems.

7.2 Aschau



The Aschau range is located in the Eckernförde bay near the city of Eckernförde in Germany. Aschau is a multi-influence range consisting of acoustic, magnetic, electric and pressure field sensors. The range depth is approximately 21 meters. The range is secured as a military restricted area. The main objective of the range is to determine underwater signatures as function of all relevant ship parameters, like speed and diving depth with sufficient signal to noise ratio.

During the trials three ranges were be used: two acoustic ranges (MP1 and MP2) and one electromagnetic range (EMMS). The first acoustic range consists of 5 sensors, 40 m apart, the second acoustic range consists of 4 sensors, 40 m apart. Stationary acoustic tests were carried out on the second acoustic range. The EMMS consists of 7 sensor platforms, 10 m apart.

Of the 11 days that were available, 8 days resulted in useful measurements. During the remaining days no tests could be carried out due to technical problems and bad weather.

Test and source	Days
Dynamic acoustic measurements with the acoustic LF source	1
Static acoustic measurements with the acoustic HF source	1
Electromagnetic measurements with variable depth EEG/V	1
Electromagnetic measurements with 3 EEG/S electromagnetic sources	4
Electromagnetic and acoustic measurements with 3 EEG/S and the LF acoustic source	1

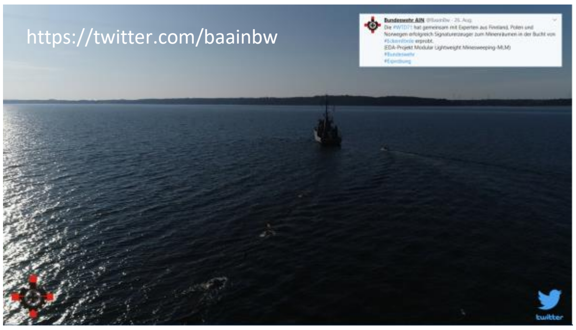
8 Results achieved

The prototype systems in this project had different levels of technological readiness. Besides the HF acoustic source all of them were towed successfully over the measurements range and their signals were measured in a realistic scenario. The signals proved to be ship like, even though the source levels of the signals produced were not yet high enough.

The highlight was when 3 EEG/S modules and the LF acoustic source were towed together over the sensor ranges producing a realistic acoustic, magnetic and electric signature.

The signatures to be produced were simulated beforehand using various national calculation tools. Additionally a generic mine model was used to simulate the detonations against modelled target ships. The analysis of the sea trials shows that the systems are able to produce the expected signatures and do so repeatedly.

9 Lessons learned



During a sea trial the support must be flexible, experienced and decisive, to fix problems and find solutions, because unexpected problems (such as changing weather and failing technology) will happen. Handling different prototype systems that have to work together at sea requires extensive experience and know-how, especially because no established handling procedures exist for these systems.

During the sea trials in Aschau, WTD71 provided such excellent support. Without their flexibility, know-how, motivation and problem solving abilities the sea trials could not have been executed.

10 Recommendations

The MLM and MLM-II projects have proven the feasibility of the MLM concept, but there is still much work to be done in order to operationalize such systems. There are still no fully developed operational MCM systems based on USVs with lightweight sources.
It is therefore recommended to continue this successful line of research. The systems should be further developed in order to achieve an advanced prototype stage. The advanced systems should be tested with an operational focus using underwater multi-influence ranges. In addition to the technology of the systems, also the following subjects need to be addressed:

- Operational procedures
- Command and Control
- Planning & Evaluation
- Concept of operations
- System requirements

About FFI

The Norwegian Defence Research Establishment (FFI) was founded 11th of April 1946. It is organised as an administrative agency subordinate to the Ministry of Defence.

FFI's MISSION

FFI is the prime institution responsible for defence related research in Norway. Its principal mission is to carry out research and development to meet the requirements of the Armed Forces. FFI has the role of chief adviser to the political and military leadership. In particular, the institute shall focus on aspects of the development in science and technology that can influence our security policy or defence planning.

FFI's VISION

FFI turns knowledge and ideas into an efficient defence.

FFI's CHARACTERISTICS

Creative, daring, broad-minded and responsible.

Om FFI

Forsvarets forskningsinstitutt ble etablert 11. april 1946. Instituttet er organisert som et forvaltningsorgan med særskilte fullmakter underlagt Forsvarsdepartementet.

FFIs FORMÅL

Forsvarets forskningsinstitutt er Forsvarets sentrale forskningsinstitusjon og har som formål å drive forskning og utvikling for Forsvarets behov. Videre er FFI rådgiver overfor Forsvarets strategiske ledelse. Spesielt skal instituttet følge opp trekk ved vitenskapelig og militærteknisk utvikling som kan påvirke forutsetningene for sikkerhetspolitikken eller forsvarsplanleggingen.

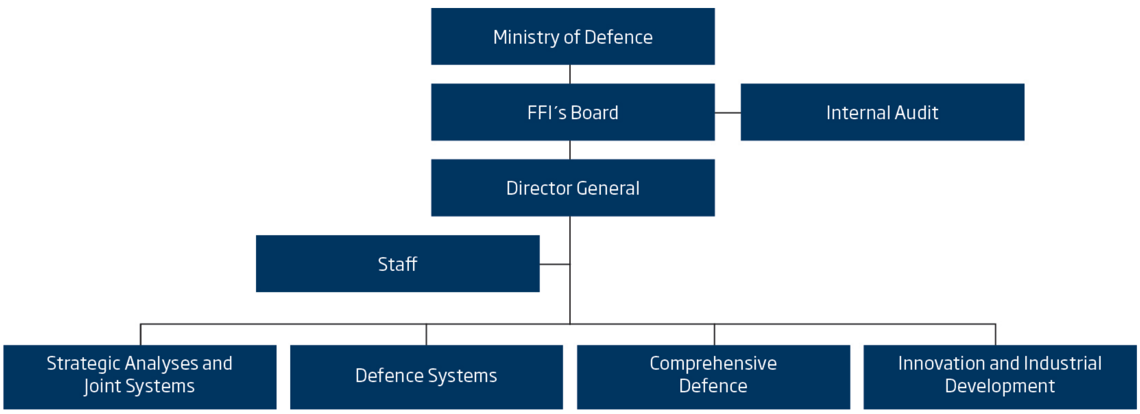
FFIs VISJON

FFI gjør kunnskap og ideer til et effektivt forsvar.

FFIs VERDIER

Skapende, drivende, vidsynt og ansvarlig.

FFI's organisation



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