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On the Guard of World Peace. Scientific and Research Organizations in NATO Structures 1952-2022. Problem Outline

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Abstract- Scientific research organizations have a long-standing tradition in NATO's history, testifying to the great role that Alliance decision-makers attach to scientific research. Thanks to comprehensive scientific development, the existence of specialized scientific institutions and cooperation with research units of member states, it was and is possible to develop and grow NATO's power. Thanks to scientists, the Alliance has for many years been a world leader in the development and application of modern military technology. The assembly and cooperation of leading representatives of the scientific and technological world of the member countries has made it possible to develop and implement many innovations in the field of defence. With the passage of years, it has become necessary to develop specialized scientific and research institutions, conducting new research and addressing further challenges facing the defence policy of the Alliance.

NATO's first scientific research organization was AGARD, dedicated to aerospace research and the development of scientific cooperation. The goal of the DRG, established in 1967, was to promote technical cooperation among allied countries in research and new technologies, leading to the development of defence equipment. From the merger of AGARD and DRG, the RTO was formed, operating in the field of defence research and technology. Since 2012, STO has been operating to meet the scientific and technological needs of the Alliance. In 1996, NM&S was founded, developing Alliance approaches to simulation to improve operations. NATO has also created specialized maritime scientific research organizations. SACLANTCEN, NURC and CMRE were active between 1959 and 2022, conducting research in anti-submarine warfare, underwater acoustic phenomena and their application in surveillance, detection, oceanography and port security. NATO's scientific research organizations make a significant contribution to strengthening the Alliance's security and defence forces.

Keywords: NATO, science, AGARD, DRG, RTO, STO, SPS, SACLANTCEN, NURC, CMRE.

I. INTRODUCTION

Scientific and research development is the main driving force behind societies and modern civilization. Since the beginning of the scientific and technological revolution (the third industrial revolution) initiated in the 1950s, there has been a rapid

development of science and technology in highly civilized societies. This was an international trend, the result of the Cold War arms race and, at the same time, the activities of large corporations operating in oligopoly conditions and competing with each other in the field of new products. During the Cold War, seeing the need to develop the Alliance, its leaders realized the need to undertake scientific research aimed at strengthening the pact's forces. The establishment and development of NATO's scientific research institutions was a response to these demands.

Analysing the activities of these institutions, it should be stated impartially that it has brought a significant impact on the increase in combat readiness of the Alliance forces. Its distinctive feature is the great reduction in the duration of the process from the inception of an innovation to its implementation. Many cutting-edge technologies were developed and incorporated, including information processing, environmental protection, new equipment and hardware. It was important to create platforms for cooperation between scientists from Alliance member countries, so that the flow of ideas and experience became possible. Today, research focuses on defence issues on land, sea, air and space.

The presented text aims to present the history and present day of the activities of NATO's scientific and research institutions. For its purposes, a research hypothesis was formulated: the development of NATO's scientific and research institutions has made a significant contribution to the work of strengthening the defence of the Alliance. The questions posed were: how did the various organizations contribute to the realization of NATO's tasks, and how did the Alliance's policy on the development of these organizations change. The text consists of subsections showing the activities of individual scientific research organizations, presented in a chronological context.

II. METHODOLOGY

The basic research material (source materials) was information obtained from official NATO documents, published on websites. They concern, among other things, the activities of individual organizations and reports of the Alliance. These materials are fully reliable

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and show as fairly as possible the activities of the organizations discussed in the text. In addition, book items were used in several places. Critical analysis of these materials made it possible to compile the text and formulate answers to the questions posed.

III. RESULTS

a) AGARD

NATO's first scientific research institution, the Advisory Group for Aerospace Research and Development (AGARD), was established in 1952. It had four sections (cooperation, aeronautics, flight test and instrumentation, and wind tunnel and model tests). The task was to promote and improve the exchange of information on aeronautical and space research work and development among NATO countries. AGARD also provided scientific and technical advice and assistance to the NATO Military Committee in the field of aerospace research and development, with particular emphasis on military applications. The number of scientists grew from 100, to 200 in 1960 and more than 500 in the 1990s. AGARD's highest authority was the National Council of Delegates, consisting of appointed representatives from each member country (Van J. A. 2001). The organization aimed to bring together leading scientists of NATO countries in the fields of science and technology related to aerospace in the following topics:

- Recommending effective ways for member countries to use their research and development capabilities for the mutual benefit of NATO,
- Providing scientific and technical advice and assistance to the military,
- To stimulate progress in aeronautical science related to defence strengthening,
- Improving cooperation among member countries in aerospace research and development,
- Exchanging scientific and technical information,
- Providing assistance to member countries to enhance their scientific and technical capabilities.

Participation in the sections generally lasted three years, although it could be extended. The specific areas of interest of each section changed relatively quickly with the passage of time and technological advances. Each section determined the research and publication program in its specialty, within the general AGARD guidelines set by the Board of Directors. The result of the work was, among other things, the publication of 70-90 scientific papers per year.

As document analysis testifies, during its existence AGARD organized the exchange of scientific information of military significance. Their goal was to strengthen NATO's defence forces and enhance the scientific capabilities of member states. The organization evolved over the years and consisted of a Council of Delegates, reporting to the NATO Military

Committee, and thematic sections. The Council of Delegates provided guidance to the sections and approved their work program. In January 1998, AGARD and DRG merged.

b) DRG

NATO's second science and technology organization, the Defence Research Group (DRG), was established in 1967. It was realized that, despite the end of the Cold War, the development of research contributes to the defence of the Alliance's forces. The main emphasis was intended to be placed on the development of international cooperation. This idea was very correct, as it allowed for increased exchange of scholars and a wider and faster flow of information.

Unlike AGARD, which focused on research, the DRG's main objective was to foster technical cooperation between NATO countries on research and new technologies. The DRG consisted of some 500 outstanding specialists from each Alliance country. They specialized in defence research and development. They worked within the framework of eight sections and two special expert groups. Scientific and research issues included:

- Physics and electronics,
- Optics and infra,
- Operations research,
- Human and biomedical sciences,
- Electronic warfare,
- Air warfare,
- Information processing technology,
- Camouflage,
- Combat engineering technology (AGARD, RTO and STO History, 2020).

An analysis of the source materials reveals that during the 1990s, there was a growing recognition within NATO that there was unnecessary duplication of effort between the DRG and AGARD. There was also some concern about the number of people involved, which had grown to more than 1,000 scientists, engineers and administrators. As a result, NATO Secretary General Javier Solana disbanded the DRG and AGARD in April 1997 as part of a restructuring of defence research and technology. The NATO Research and Technology Organization (RTO) was established, taking over the responsibilities of its predecessors (Daniel, Caraher, 1-6).

c) RTO

The RTO began operations in January 1998, with the NATO Research and Technology Agency (RTA) as its executive body. The RTO was NATO's main defence science and technology organization. It promoted and conducted research and information exchange, developed and maintained the Alliance's long-term research and technology strategy. It was also

involved in advising NATO members on research and technology issues. The organization promoted cooperation between Alliance bodies and NATO member and partner countries to maximize the effective use of modelling and simulation (Proceedings of the 1st NATO Research and Technology Organization (RTO), Human Factors and Medical Panel Symposium, 2006; Tolk, 2006)).

The RTO had a Research and Technology Council, a technical section and technical teams. It was supported in its work by the RTA. About 140 research works were carried out annually in the technical teams. The most important body in the RTO was the Research and Technology Board (RTB). Its purpose was to direct and/or coordinate defence research and technology. Its board consisted of three defence research and technology specialists from each NATO country (NATO Research and Technology Organisation, 2017). The purpose of RTB was to conduct and promote joint research and information exchange. The task was to promote the development and effective use of national defence research and technology to meet the military needs of the Alliance, maintain technological superiority and provide advice to NATO. The RTO carried out its mission with the support of an extensive network of member country experts. It also ensured effective coordination with other NATO bodies involved in defence technology-related scientific and research activities (Curtis et al., 2013).

The research used to carry out the RTO's tasks was:

- Developing and maintaining a coordinated long-term strategy for NATO defence research and technology,
- Ensuring coordination and harmonization of work programs within NATO structures,
- Coordinating research and technology programs and activities between Alliance countries, as well as within NATO,
- Providing advice on research and technology issues to NATO's higher bodies,
- Financing joint studies and research projects,
- Conducting and promoting joint research activities, including tests and practical work,
- Promoting and facilitating the exchange of information on research and technology among NATO member states,
- Providing assistance to member states to enhance their scientific and technological capabilities.

These tasks were carried out in sections created for specific issues for a specific period of time. They were staffed by the most prominent scientists from member countries. Workshops, symposia, field trials, lecture series and training courses were organized. Their important function was to ensure the continuity of specialists, in addition to formulating long-term plans

and research. Cooperation with Central and Eastern European countries was undertaken within the framework of the Partnership for Peace program. The RTO attached particular importance to this activity, as research cooperation was one of the more promising areas for initial cooperation (Curtis et al., 2013).

The RTA was the executive arm of the RTO, organizing a wide range of research, workshops and symposia through which scientists met and exchanged knowledge. The RTA had a rotating staff of about 30 civilian employees and 20 military personnel from member countries (NATO Research & Technology Organization Publications: NATO Collection, 2012). Its activities were carried out by six technical sections covering a broad spectrum of scientific and research activities:

- Vehicle Technology Panel (AVT),
- Human Factors and Medicine (HFM) Panel,
- Information Technology Panel (IST),
- Systems Analysis and Studies Panel (SAS),
- Systems Concepts and Integration Panel (SCI),
- Sensors and Electronics Technology Panel (SET),
- NATO Modelling and Simulation Group (NMSG),
- Information Management Committee (IMC)(NATO Structures: Research & Technology Organisation (RTO, 1997).

During its existence, the RTO was the sole centre of NATO's defence research and technology activities. Its mission was to promote and conduct joint research and information exchange. The goal was to promote the development and effective use of national defence research and technology to meet the military needs of the Alliance, maintain technological superiority and provide advice to decision-makers from NATO and Allied countries.

d) STO

The NATO Science & Technology Organization (STO) has been in operation since July 1, 2012, continuing the achievements of AGARD (1952-1996), DRG (1967-1996) and RTO (1998-2012). It was established to meet the scientific and technological needs of the Alliance. Its mission is to generate, share and disseminate advanced scientific knowledge, technological advances and innovations resulting from activities under the Collaborative Program of Work (CPoW). The STO acts as a forum through which representatives of Alliance member and partner countries have the opportunity to jointly define research needs, conduct research and promote its results, exchange knowledge, experience and information.

The executive bodies of the STO are:

- Office of the Chief Scientist (OCS), supporting the NATO Chief Scientist in his role as Chairman of the Science and Technology Board (STB) and Senior

Scientific Advisor to NATO Senior Management (Science & Technology Board and Office of the Chief Scientist, 2013).

- Collaboration Support Office (CSO) providing executive and administrative support for activities under the collaborative business model (Collaboration Support Office (CSO), 2023).
- The Centre for Maritime Research and Experimentation (CMRE), which organizes and conducts scientific research and technology development, providing innovative and tested scientific and technical solutions to meet the Alliance's defence and security needs. Its tasks focus on maritime affairs, but can extrapolate to other domains to meet current needs (About the NATO Science & Technology Organization, 2015).

The STB's responsibilities include:

- Providing strategic guidance for science and technology in NATO by issuing the NATO S&T (Science & Technology) Strategy and NATO S&T Priorities.
- Directing and leading the STO Work Program.
- Providing science and technology advice in NATO decision-making processes.

There are seven sections within the STO:

- Applied Vehicle Technology (AVT).
- Human Factors and Medicine (HFM).
- Information Systems Technology (IST).
- Systems Analysis (System Analysis & Studies, SAS).
- Systems concepts and integration (Systems Concepts & Integration, SCI).
- Electronics and sensors (Sensors & Electronics Technology, SET).
- Modelling and Simulation (NATO Modelling and Simulation Group, NMSG). (Pages - Panel/Group Page, 2015).

Each year, more than 6,000 scientists and engineers from NATO and partner countries work on some 300 research projects. This results in the publication of highly regarded scientific literature published by STO: Technical Reports (TR), Educational Notes (EN) and Meeting Proceedings (MP). Research results are also published in specialized peer-reviewed journals (Nato.int., Collaboration Support Office (CSO), 2015).

e) NM&S

Within the STO is the NATO Modelling and Simulation Group (NM&S) (Mscoc.org., 2023). In November 1996, the Conference of National Armaments Directors (CNAD) established the NATO Simulation Policy and Applications Steering Group to develop the Alliance's approach to simulation for improving operations (including defence planning, training,

exercises, support). CNAD recommended identifying recommended technical standards to support interoperability and use of simulation through the Modelling & Simulation Master Plan (MSMP). CNAD and the Military Committee (MC) approved it in November 1998. Two organizational structures were established: The NATO Modelling & Simulation Group (NMSG) and the Modelling & Simulation Co-ordination Office (MSCO) providing scientific, executive and administrative support to the NMSG (AGARD, RTO and STO History, 2020). The purpose of the MSMP is to promote cooperation among Alliance bodies, its member states and partner countries to maximize the effective use of modelling and simulation (M&S). The institution has three permanent subgroups:

- Military Operational Requirements Subgroup (M&S Subgroup).
- M&S Standards Subgroup (M&S Standards Subgroup).
- Planning and Programs Committee (Planning and Programs Committee) (Mscoc.org., 2023).

f) SPS

In 1958, the NATO Science Program was implemented to promote the training of scientists in Alliance countries and the position of Scientific Advisor to the NATO Secretary was created. On November 6, 1969, the Committee on the Challenges of Modern Society (CCMS) was established to combine research conducted in the various NATO countries and to create a common base for sharing experiences. Alliance members were increasingly aware of widespread environmental problems that could threaten the well-being and progress of their societies. There was already serious concern about the state of the environment and its degradation due to civilization. The potential offered by the development of technology and the possibility of its application for environmental protection was recognized. In the first decades of the Committee's activity, some 1,500 projects were funded, resulting from the cooperation of more than 6,000 scientists from Alliance countries. 650 scientific books and several thousand peer-reviewed scientific articles were published. More than 60,000 scholars took part in NATO-funded projects of so-called "Advanced Research," 12,000 were awarded NATO scientific fellowships (Science for Peace and Security (SPS) Programme, 2020). Scientific and research cooperation has also been established with the countries of the Mediterranean Dialogue (SPS News. 50 years. 1958-2008, 2008).

On January 1, 2003, the Committee received new regulations, the NATO Science and Environmental Protection Division was liquidated, and the Science Committee and its program were transferred to the newly established Public Diplomacy Division (PDD). On

January 1, 2004, the NATO Program for Security Through Science was established. Research for safety has become a priority. In 2006, after the merger of the Scientific Committee and the Committee on the Challenges of Contemporary Society, the SPS (NATO Committee on Science for Peace and Security) was established.²⁰ On November 1, 2010 (SPS News. N. 75 (3), 2006-2007). SPS was transferred from the PDD Division to the Emerging Security Division Challenges Division, ESCD) (New NATO division to deal with Emerging Security Challenges, 2020).

The SPS promotes dialogue and practical cooperation between NATO member states and partner countries based on scientific research, technological innovation and knowledge exchange. It offers financing, expert advice and support for tailored security activities that meet NATO's strategic objectives. It connects the scientific community with NATO through collaborative science that addresses emerging security challenges. Through SPS activities, researchers, scientists and experts play an important role in helping the Alliance identify, understand and respond to vulnerabilities and threats (Science for Peace and Security, 2020). Research includes: counterterrorism, energy security, cyber defence, defence against chemical, biological, radiological and nuclear (CBRN) agents and environmental security. The aim is to increase support for NATO-led operations and missions and increase awareness of security developments, including through early warning, to prevent crises (SPS - Key Priorities, 2020).

In 2013, the program was revised to focus SPS on larger-scale strategic activities beyond purely scientific cooperation. The SPS program is managed by NATO's Political and Partnerships Committee, which includes representatives of the countries involved in the cooperation. The evaluation of proposals submitted to the SPS program is carried out by a NATO body established for this purpose (Independent Scientific Evaluation Group, ISEG).

Since its establishment, STO has continued NATO's policy of conducting scientific and research work. An analysis of its activities allows us to conclude that its activities aim to best meet the collective needs of the Alliance and partner countries in science and technology. It conducts its activities by generating, sharing and disseminating advanced scientific knowledge, technological developments and innovations resulting from the many activities carried out in the security and environmental fields. It provides information and technology to meet the needs of the Alliance in an ever-changing security environment. What is noteworthy is that at present STO brings together the world's largest security and defence research network. It brings together scientists from member countries, engineers and analysts, industry and academia. STO's activities ensure that NATO maintains its military and

technological edge to meet current and future security challenges.

g) *Maritime Scientific and Research Institutions*

The purpose of NATO's maritime scientific and research institutions was and is to continuously improve the efficiency of the operational activities of the Alliance's naval forces, test and implement innovative technologies, develop international cooperation in the scientific sphere of the Alliance member states, and protect the marine environment.

IV. SACLANTCEN

On May 2, 1959, the SACLANT ASW Research Centre (SACLANT AWS Research Centre, SACLANTCEN) was established. On October 20, 1962, the Centre came under the direction of the Supreme Allied Commander Atlantic (SACLANT). The scientific council that advised SACLANT in the early years evolved into the Scientific Committee of National Representatives (SCNR).

Initially, the scientific program mainly covered underwater acoustics, oceanography, evaluation of submarine warfare systems concepts and methods. Scientific groups were organized according to research criteria. The Underwater Acoustic Research Group conducted theoretical analysis, computer modelling and experiments at sea. The Oceanographic Research Group (The Oceanographic Research Group) built on this work by studying the marine environment and the interactions between the atmosphere and the sea. The groups were supported by the Technical Support Department. It carried out digital calculations, engaged in electronic and acoustic engineering. The research ships "Aragonnese", "Maria Paolina G." and "Manning" were used.

Until the mid-1970s, the Centre's research focused mainly on the open seas, a potential battlefield against Soviet submarine forces. Research in these bodies of water resulted in a number of scientific papers and implementations of new technologies. Some were among the innovative, including work on electromagnetic and surface effects at extremely low frequencies. There was a focus on acoustics and the use of sonar. Spatial frequency interference patterns of continuous waves, Frequency modulation (FM) techniques of sonar were developed. FM sonar was the most successful, and digital FM technique is still part of active sonar. The Reliable Acoustic Path project resulted in the construction of a "Deep Panoramic Sonar" based on a multiple array system known as MEDUSA (Mediterranean Experimental Deep Underwater Sonar Apparatus). This was the first active sonar developed at SACLANTCEN, and was used in experiments until 1973. In the mid-1970s, SACLANTCEN pioneered the use of underwater links to hydrophone buoys, resulting in a

significant increase in data recording efficiency (Twenty Years Of Research At The Saclant, 1979).

In 1975, SACLANTCEN's scientific division was reorganized into two main divisions: the Environmental and Systems Research Division and the Operational and Analytical Research Division. The former had four working groups: deep-sea research, shallow water research, applied oceanography and signal processing, while the latter had three: effectiveness research, tactical research and theoretical studies. The focus was on littoral water research, oceanography and acoustics. In the late 1970s, work began on towed arrays, and testing of the first experimental linear hydrophone array began.

In 1988, a state-of-the-art NRV "Alliance" research and development unit with very low noise levels was put into service. To date, it is considered one of the quietest in the world. It spends an average of 170 days a year at sea on scientific research missions. Research on submarine detection and reconnaissance continued. In the early 1980s, work began on Low Frequency Activated Sonar (LFAS), from the Active Adjunct Project, using a passive towed sonar array and a high-power, low- to mid-frequency emitter. The goal of the Deployable Undersea Program Surveillance Systems (DUSS) program was to develop a static system for use in shallow waters. The project began in the early 1990s with conceptual studies, followed by initial sonar system development and at-sea testing. Improvements to the prototype resulted in DEMUS (Deployable Experimental Multistate Undersea System), delivered 2003.

In 1999, the Sound Ocean Living Marine Resources (SOLMAR) program was launched. This was a multinational, multidisciplinary project aimed at developing tools and/or procedures with which to ensure that there are no marine mammals in the vicinity of the sonar before and during its use. To achieve the research plans, a series of SIRENA sea trials were conducted between 1999 and 2003. Oceanographic measurements were conducted, including temperature, salinity, nutrients, fluorescence and phytoplankton. Sea surface temperature, surface currents and real-time wave action were also studied using satellite remote sensing (Ryan, 2008, 39). In 2002 SOLMAR was transformed into the Marine Mammal Risk Mitigation (MMRM) project. The passive acoustic sonars implemented in the instrument suite were the result of evolving methods and technologies used in subsequent research cruises under the SIRENA program. In addition, the impact of sonar on human factors was studied in all programs, including the work of divers (NATO Undersea Research Centre, 2006-2008, 1-21).

In 1986, a five-year survey of the Greenland, Iceland and Norwegian Seas (GIN) began. Advanced high seas Military Oceanography (MILOC) surveys continued. The goal was to detect and combat submarines and protect maritime communication routes. New technologies were implemented to improve

sonar and underwater detection systems. With MILOC, oceanographic and acoustic databases supporting modelling were created, resulting in better use of operational sensors.

On November 16, 2009, the coastal CRV "Leonardo" was put into service. The 29-meter-long vessel is equipped with a variety of scientific and on-board facilities, in addition to having a very quiet propulsion system.

The number of scientists at SACLANTCEN, employed on temporary contracts, was up to 50. They were supported by administrative and technical teams, mainly the Engineering Department (ED), which provided the means to conduct experiments to develop or verify scientific theories. The Centre had a facility unique in Europe, the Oceanography Calibration Laboratory, which had been in operation since the early 1980s, supporting the activities of SACLANTCEN and NATO's naval and research laboratories. The Centre's scientific output was particularly valuable to member countries with less scientific and research capacity, helping to bridge the gap between their institutions and scientists in the US and UK. The organization was transformed into NURC in 2012.

An analysis of source materials shows that the establishment of SACLANTCEN was the result of the Cold War situation that had prevailed in the world since the 1950s. It was well realized that the Alliance's maritime security was of utmost importance. The main threat was Soviet submarine forces. In the first period of its activity, the organization's scientific program focused mainly on problems related to underwater acoustics, oceanography, evaluation of the concept of anti-submarine warfare systems and methods. Significant successes were achieved in the field of research and application of modern sonar. In the mid-1970s, moreover, SACLANTCEN pioneered the use of underwater links to hydrophone buoys. In 1988, the modern NRV research vessel "Alliance" was put into service, and in 2009, another for offshore research, "Leonardo." Particularly noteworthy is the launch of work on marine environmental protection, including the SIRENA program.

a) NURC

The NATO Undersea Research Centre (NURC) conducted world-class maritime research to support NATO's operational and transformational requirements. Emphasis was placed on the underwater area and solving maritime security problems. Subjects included research in underwater acoustic phenomena and their application to surveillance, detection, oceanography and port security (Barbagelata, Guerrini, Troiano, 2008, 24-33).

NURC's notable achievements include the development of a rapid detection algorithm for autonomous mine countermeasures, the

implementation of a real-time multistate ASW simulation centre, a performance indicator for next-generation underwater surveillance networks, and numerical modelling of wave-current interactions at sea. NURC has a broad set of equipment for conducting experiments at sea: a fleet of AUVs (Autonomous Underwater Vehicle), ROVs (Remotely Operated Vehicle) and seabed survey platforms. NURC has developed research programs whose technologies have been adapted to underwater monitoring. Several projects used for military and civilian purposes have been developed, including the design and implementation of advanced environmental monitoring systems (BARNY, SEEP, SEPTR), which are used by many scientific centres around the world conducting oceanographic research.

The continuation and development of SACLANTCEN's research became NURC. The cited text shows that the previous scientific research work was continued and enriched with modern underwater warfare technologies and, importantly, continued to address issues related to monitoring of the marine environment. It should be noted here that the latter work is also used by civilian institutions.

b) CMRE

The Centre for Maritime Research and Experiments (Centre for Maritime Research and Experiments, CMRE) was established by the North Atlantic Council (NAC) on July 1, 2012, becoming the successor to NURC. It is the hardware organ of STO. CMRE's task is to organize scientific research and development of maritime-related technologies, providing innovative and field-proven technologies to meet the defence and security needs of the Alliance.

CMRE conducts cutting-edge research and experiments from concept development to prototype demonstration in a maritime operational environment. The centre employs specialists in, among others: oceanography, modelling and simulation, and acoustics. It has experienced engineering staff (ED) ensuring quick implementation of conceptual prototypes for trials and experiments. The centre has developed and tested at sea a large number of naval prototypes for anti-submarine warfare, mine countermeasures, maritime and port security and environmental monitoring.

CMRE provides advisory support on maritime defence and security issues to allied countries. It is equipped with a fleet of AUVs and a world-class marine sensor system. It is conducting deep advanced work on multi-static active sonar for searching and tracking a new generation of silent submarines (CMRE - Littoral ISR, 2023). The research project was also "Maritime Security-Port and Ship Protection"(CMRE - Port & Ship Protection, 2020).In turn, the Maritime Surveillance System (Maritime Situational Awareness, MSA) uses

information from the Automatic Identification System (AIS). It applies anomaly detection algorithms and filters to provide NATO maritime surveillance forces with information about unusual situations, such as unexpected ship stops or radical course changes (CMRE - Maritime Situational Awareness, 2020). CMRE develops an annual research and development plan. His current scope of work includes research problems such as artificial intelligence, big data analytics, underwater acoustics, oceanography and autonomous systems (Science and Technology Organization Centre for Maritime Research and Experimentation, 2020).

In 2012, CMRE was established to replace NURC. As can be seen from the presented material, since its establishment it has been one of the world's leading institutions dealing with issues related to the development of maritime research and technologies. Scientific and research work is carried out in nine thematic areas and brings together the most outstanding scientists from the Alliance member countries.

V. CONCLUSION

The presented material, based on official NATO documents, shows the development of the Alliance's scientific and research institutions. They have played an extremely important role in strengthening NATO's defence potential and contributed to the significant development of technology and international cooperation. It should also be emphasized that thanks to them, the Alliance has become one of the leaders in programs and implementations related to environmental security.

Throughout its history, NATO has always attached great importance to conducting scientific and research work. S&T activities include scientific research, technology development, testing, field applications, experiments and a range of related scientific activities including systems engineering, operational research and analysis, synthesis, integration and validation of knowledge obtained through the scientific method. Thanks to NATO's policy, its scientific and research agendas are considered world-leading. It should be emphasized once again that the development of NATO's scientific and research institutions has made a significant contribution to strengthening the Alliance's defence and ensuring international security.

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