NORTH ATLANTIC COUNCIL

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NATO ARMY ARMAMENTS GROUP (NAAG)

Proposals from the NAAG groups for sponsoring 2024-cycle NIAG studies

Note by the Secretary

Ref.1: AC/225-DS(2022)0003

1. The NAAG tasked its subordinate groups to submit their proposals (Step-1/2) for the NIAG 2024 cycle studies by 15 May 2023 (Ref.1). The NAAG Secretariat has received six study proposals. They are listed below, and annexed, in the chronological order of their submission dates.

- JCGVL: Modularity as the Key Enabler to Enhance NATO Rotorcraft Capabilities
- JCG SBAMD: Next Generation SBAMD System Requirements and Concept of Employment
- JCBRND CDG: Concept for a Non-Contact Evaporation of Low Vapour Chemical substances (NCE-LVC)
- ICGIF: Future NATO Common Indirect Fire (IF) Round for Maximum Interchangeability (155mm Artillery, 120mm Mortar, 105mm Artillery, 81mm Mortar)
- LCGLE: NATO Medium and Large Caliber Direct Fire Munition Interoperability
- LCGLE: Real-Time Operational Environment Mobility Model (ROEMM)

2. The NIAG procedures require a prioritization of the study proposals by the respective CNAD Groups, and then, by the Main Groups Forum. This will produce the input to the overall CNAD-level prioritization decision.

3. A proposed NAAG prioritization will be formulated during the NAAG Board of Advisors (BOA, ie. NAAG and Capability Groups Chairs) meeting on 20 June 2023, for a final decision at the NAAG meeting on 21-22 June 2023.

***** Releasable to IP when separated from enclosures 1 and 2

4. The delegates are kindly requested to be prepared for any discussion and for the agreement of priorities at the NAAG meeting. The NAAG Groups are invited to review the proposals and identify their potential interest and support to the studies proposed by other groups. Comments and queries should be sent to the NAAG Secretary prior to 15 June, to inform the discussion of the Chairs on 20 June.

(Signed) Osman Tasman

Enclosures: 6

Action Officer: Mr Osman TASMAN, x4300
tasman.osman@hq.nato.int
Original: English

Joint Capability Group on Vertical Lift

NIAG Study Proposal

1. **Title of Proposed Study:** Modularity as the Key Enabler to Enhance NATO Rotorcraft Capabilities.

2. **Brief Description of Proposed Study:** The study will identify, assess, and recommend modularity design features for legacy[1], enduring[2], and the future Next Generation Rotorcraft (NGR)[3] with the objective of identifying a scalable and timely increase in platform capability, interoperability, survivability, and adaptability. The platforms will need to operate together seamlessly, and with other assets (e.g., Long Range Fires), to deliver the desired operational effects. The study will identify, assess, and recommend modularity design features for Next Generation Rotorcraft (NGR), Enduring and Legacy platforms with the objective of identifying scalable hardware and software solutions that can improve platforms capability, interoperability, survivability, and adaptability in a timely manner. The study recognizes the disruptive nature of the Ukrainian conflict and the drive to improve rotorcraft capability in an accelerated and cost-effective method in advance of fielding NGR. Modularity can enhance capability management within available national budgets taking into consideration the rotorcraft related capabilities identified in the NATO Defense Planning Process (NDPP) Capability Codes and Statements. The study will illustrate how modularity can enhance rotorcraft interoperability and survivability when deployed in a high intensity environment against advanced threats.

3. **Background:** In 2016 the NATO Joint Capability Group on Vertical Lift (JCG VL) proposed a NIAG study to address modularity in the design of the next generation rotorcraft. The SG-219 final report was published in May 2018 highlighted the advantages that could be obtained through the application of modularity at the system level. Follow-on JCG VL sponsored NIAG studies built on this foundation in SG-227 on Rotorcraft Manned and Unmanned Teaming, SG-239 on Integrated Sustainability for Next Generation Rotorcraft, SG-246 on Innovative Military Aviation Acquisition, and SG-266 on Joint-Domain Rotorcraft. Interoperability and Survivability. Each of these studies highlighted the benefits of modularity and the adaptability of the NATO rotorcraft fleet to meet a mix of mission requirements and take advantage of Conditioned Based Operations (CBO).

[1] Epoch 1 – Legacy represents the current day, notionally until 2030, with the 'legacy' referring to existing rotorcraft platforms that are characterized as largely analogue and considered at the end of their evolutionary lifecycle and therefore subject to only marginal capability enhancements via the partial integration of new equipment.

[2] Epoch 2 - Enduring is notionally the 10 years between 2030 and 2040, though it is envisaged that Enduring platforms will continue to feature in many nations beyond 2040 due to budgetary pressures and operational need. These are aircraft characterized by digitally enhanced versions of legacy airframes and a generation of designs that date from the late 20th and early 21st centuries. 'Evolved legacy' are characterized by far greater digital architectures and connectivity, enabling more sophisticated DAS and TTPs to be employed without further extensive redesign or recapitalization.

[3] Epoch 3 - Next Generation. The characteristics of Next Generation Rotorcraft (NGR) are still not defined as formal Requirements setting has not been completed. NGR will also exhibit enhanced Air Vehicle performance, enabling evolved TTPs which will be essential to platform survivability. Such design features will include high-speed/low level flight, enhanced vehicle control and maneuverability, high-altitude efficient cruise.

"Rotorcraft modularity" and the associated interfaces will need to be clearly defined at the C2, platform, system, hardware, and software levels to ensure interoperability between different types (e.g., Attack, Reconnaissance, Utility, Cargo, and Maritime Helicopters) of Modernized Enduring and Next Generation platforms, and associated Land, Air and Maritime component elements (e.g., Ground Troops, UAS, and ISTAR assets). The study will inform nations considering the modernization of their current enduring fleets to a Modernized Enduring standard, acquiring new equipment, or the potential acquisition of future next generation capabilities such as NGR.

4. Objectives of the Study:

a. What is the Objective of the study in terms of what is to be carried out, why and with what purpose? The objective of the study is to address legacy, enduring and NGR rotorcraft modularity at the hardware and software interface level and to identify the advantages and increased capability to be achieved in the areas of interoperability and survivability resulting from common interfaces and mission equipment. The application of common interfaces and qualification standards will enable the adaption of mission specific modules enhancing the fleet capabilities to address multiple missions. Common interfaces will also enhance platform supportability and system availability.

b. What is/are the operational scenarios to be considered? The study is not expected to require the development or use of new operational scenarios. The study will utilize the information contained in the SG-266 developed Concept of Employment (CONEMP) which was published as a standalone NATO document[4].

c. What is the scope of the study to be, as appropriate? The study will address rotorcraft hardware and software modularity and identify the importance for establishing common interfaces and qualification standards to enhance platform capabilities between legacy, enduring and evolving NGR rotorcraft. Modularity can be implemented and accomplished in a phased approach to be scaled for ship compatibility, troop movement, artillery movement, resupply (OPV), Naval surveillance/ASW, recon/light attack, heavy attack/missile truck, drone carriage (air and USV, USSv), counter IADS/SEAD, CSAR. Whereby legacy aircraft modules add additional capabilities, enduring aircraft modularity can rearchitect with open systems to increase interoperability between legacy and enduring classes of rotorcraft with the NGR. Commonality between modular components fitted to each epoch (see footnote 1, 2, and 3) of aircraft ensures enhanced interoperability and availability.

d. What is the study to address – specific issues, technologies, documentation, potential follow-on demonstrations or testing, etc.?

i. The study will identify a set of rotorcraft modules and interfaces, i.e., structures, propulsion, avionics, electronics, and weapons, with the objective to identify common hardware and software interface requirements and qualification standards that would facilitate the exchange of mission and weapon system components between nations rotorcraft fleets. This may

[4] Concept of Employment (CONEMP) for NATO Rotorcraft Operating in Peer Nation Threat Environment, AC/225(VL)(2022)0002(INV), Dated 22 July 2022.

range from a basic installation to a fully integrated capability – the objective being to enhance capability and platform availability while requiring minimal invasive modifications (power, provision & mounting interface). This will define the required minimum level of interoperability achievable between legacy, enduring and NGR platforms.

ii. Command and Control Communications (C3) is a critical platform capability involving Platform-to-Platform, Ground-to-Air, and Air-to-Ground information integration, interoperability (e.g., Land, Air and Maritime Components), and connectivity in all environments. C3 modularity, integration, and interoperability between legacy, enduring and NGR platforms shall be addressed, with the best option for assured communications between them recommended.

iii. Architect the concept of a family of connectors (power and data/signals) for different types of rotorcraft components and subsystems. Identify and outline the technical requirements to be addressed in the development of a STANAG for a common family of rotorcraft module interface connectors.

iv. Identify digital platform architectures, software communication protocols and data models for legacy, enduring and next generation platforms. Define the impacts of module/black box condition monitoring on platform readiness and availability. Define the Modular Open System Approach (MOSA) minimum level of compatibility required to support advanced cross-domain operations of legacy, enduring and NGR platforms when operating as an integrated operational fleet.

v. Propose rotorcraft mechanical, vibration, thermal, and electromechanical environment standards applicable to legacy, enduring and NGR.

vi. Review current NATO rotorcraft STANAGs and identify those standards that need to be updated/revised or eliminated. Propose new standards as applicable.

e. What is the required output of the study, that is what information and recommendations is the study to deliver in the final report? Fully address the questions above and document the analysis and rational for the conclusions reached and the recommendations contained in the final report. It is anticipated the study will recommend the development of new STANAGs.

5. Please indicate whether you would like to be presented with alternative solution options, taking into consideration that exploring various options may reduce the depth of the study scope: Yes. Modularity may identify multiple approaches and not a single approach or answer. Alternative methods to obtain the end objective of enhanced mission interoperability, survivability, and adaptability, need to be explored and defined. Addressing outlying alternatives will be controlled to not adversely increase the scope of the study.

6. What are the active companies in the sponsor entity that have proper expertise in the field of this study request and that could be invited to participate in this study? Please

list POC details. There are extensive major aerospace prime contractors and small and medium size enterprises (component and system suppliers in the first, second and third tier of the supply chain), located in the NATO and listed Partner nations having the technology and capability to make a positive contribution to this study. The listing of individual companies identified by the Sponsor would not be all inclusive. The NIAG national heads of delegation have the list of companies in their nation authorized to participate in NIAG studies. This list may or may not include the company point(s) of contact. Many of these companies have participated in prior NIAG rotorcraft related studies.

7. **NATO Priority**: The emerging rotorcraft Lessons Learned from event in Ukraine is an area of increased importance to ensure maximum capability and survivability of NATO and nation's existing legacy and enduring assets and the planning for NGR. The study results will provide important information to the recently initiated NGRC Concept Phase MOU nations, as well as to those nations interested in inserting capabilities into their current fleets to ensure interoperability with NGRC. The study report will also provide Allied Command Operations and Allied Command Transformation with insights as they periodically update their plans and NDPP Capability Codes and Statements.

8. **Intended Follow on to the Study:** The results of the study will provide nations with timely information to enhance the capabilities, interoperability and survivability of their current fleets, as well as those nations interested in the acquisition of advanced rotorcraft capability. The study results may also support the Emerging Disruptive Technology activities evolving within NATO Headquarters through the identification of critical materials and technologies. The study final report will contribute to NATO's vision on modularity and interoperability. A follow-on study is anticipated building on the evolving Lessons Learned from events in Ukraine, and the evolution of NGR.

9. **Other NATO Bodies Involved in the Related Area of Work:** There are several NATO organizations and agencies involved or interested in this topic, to include ACO, ACT, IMS, AIRCOM, DI (Multinational Programs), and NSPA (NGRC Project Management/Contracting). The study results will inform nations and national industrial supplier to assist in focusing their research, development, and products to support modular NATO rotorcraft systems.

10. **Current Industrial Involvement with the Sponsor Group:** Sponsor's past NIAG studies over several years have consistently attracted 12 to 25 companies from 10 to 15 nations. This study is expected to see the same level of interest and participation.

11. **Proposed Start Date:** February / March 2024.

12. **Desired Completion Date:** June 2026.

13. **Study Classification:** Not to exceed NATO Restricted.

14. **Study Open to Partner industries:** NATO Only plus Sweden, and Switzerland.

15. **Final report releasable to:** NATO plus Finland, Sweden, and Switzerland.

16. **Sponsoring Group Point and IS Point of Contact:**
Sponsor: Mr. Lars Ericsson, Chairman, JCG VL

Staff Advisor: Mr. Alexander DeFazio, DI.

Joint Capability Group on Surface Based Air & Missile Defense

NIAG Study Proposal

1 Title of Proposed Study: Next Generation SBAMD System Requirements and Concept of Employment.

2 Brief Description of Proposed Study: The Surface Based Air and Missile Defense (SBAMD) systems deployed by NATO nations today were designed and developed ten to twenty years ago. In the intervening period there have been significant enhancements in several associated technologies. Peer adversaries have taken advantage of these technological developments to enhance the offensive capability of their threat systems. However, during this same period, only limited system enhancements and upgrades have been applied to NATO SBAMD systems due to the associated cost and the fact these systems had seen very limited operational employment. The one exception is in the area of Counter-Unmanned Aerial Systems (C-UAS). State and non-state adversaries have employed UAS systems extensively as low-cost surveillance and attack platforms. Recent events in Ukraine have demonstrated the importance of a multi-tiered SBAMD capability. The conflict has also highlighted shortcomings associated with those systems sent to Ukraine. The next generation SBAMD capability (post-2035) must be designed to take advantage of the lessons learned from Ukraine's engagement with a peer state. In addition, advanced sensor, effector and communications technologies must be leveraged to support the design and development of an integrated, interoperable and survivable SBAMD capability. The design and development of the next generation SBAMD capability provides a unique opportunity to rethink SBAMD organizations, tactics, techniques, and procedures as reflected in the Concept of Employment (CONEMP) developed as part of the study.

3 Background:

a. JCG SBAMD has sponsored a series of NIAG studies addressing air and missile capabilities[1] which provide important historical and technical background information in support of this study.
b. The rapid technical and operational advances made by potential hostile peer states in offensive air operations, to include cyber and EW has reinforced the immediate need to identify future SBAMD system requirements. Requirements that provide a system-of-systems approach to create a truly integrated, interoperable and survivable SBAMD capability within the Alliance.
c. Recent events in Ukraine against a peer-state adversary has identified shortcomings that must be addressed and considered in the design and development of a next generation capability.
d. The critical integration enabler to achieve the required level of interoperable resides in the areas command and control communications (C3).

4 Objectives of the Study:

[1] SG-148, SG-160, SG-170, SG-188, SG-200, SG-220, SG-238, SG-265.

a. What is the Objective of the study in terms of what is to be carried out, why and with what purpose? The objective of the study is to identify the system operational requirements for a next generation SBAMD capability (post-2035) taking into consideration advances in technology and lessons learned from the on-going events in the Ukraine.

b. **What is/are the operational scenarios to be considered?** The scenarios required to support this study were developed during the conduct of several prior JCG SBAMD sponsored NIAG studies. Unique vignettes based on the earlier scenarios and tailored to real-world events may be developed during the study.

c. What is the scope of the study to be, as appropriate? The study will define SBAMD system-of-system requirements for a post-2035 fielded capability. Specifically, sensors, effectors, command and control communications and a proposed organizational construct that takes advantage of the technologies embedded in the system will be addressed.

d. What is the study to address – specific issues, technologies, documentation, potential follow-on demonstrations or testing, etc.?

i. The study will update the evolving threat, to include hypervelocity threats now being deployed.

ii. The system construct will be identified and supported by an appropriate mix of sensors, whose technical characteristics will be described, and an assessment made as to the TRL levels achieveable in 2035.

iii. The system construct will also be supported by a mix of effector capabilities that can be employed in the time period of interest. The effector TRL will be identified and assessed.

iv. The communication, command and control architecture will be defined internal and external to an SBAMD battalion/regiment, to include the interface protocols required to integrate current and evolving SBAMD command and control activities to CAOC level. The study will address fixed base, manoeuvre elements and interface with maritime forces for both real-time engagement operations and force operations, as well as space-link requirements.

v. The study will develop an SBAMD battalion and battery (to section level) organizational block diagram that takes advantage of the proposed technical system requirements and communications architecture. System elements (sensors, effectors, C3) will be allocated to the appropriate organizational elements.

vi. An SBAMD Concept of Employment (CONEMP) will be developed explaining the employment and operation of the next generation proposed SBAMD system-of-systems capabilities (post-2035). The CONEMP will take into consideration the requirement to defend fixed site, mobile land operations and interact with maritime forces, as well as airbase defense.

e. What is the required output of the study, that is what information and recommendations is the study to deliver in the final report?

i. Fully address the above questions and document the analysis and rational leading to the conclusions and recommendations reached in the first-year interim report and final report.
ii. Provide a detailed CONEMP describing the proposed employment of the next generation system capability enabled by the proposed system requirements.
iii. Identify an organizational structure (Battalion down to battery section) based on the next generation system requirements and the CONEMP.
iv. The identification of specific integration, interoperability, and survivability issues (technical, legal, regulatory), together with mitigation measures that would preclude the development and fielding of a fully integrated SBAMD systems-of-systems capability across the Alliance.

5 **Please indicate whether you would like to be presented with alternative solution options, taking into consideration that exploring various options may reduce the depth of the study scope:** Yes. There are several alternative options composed of different sensors and effectors mixes that could perform the mission. The study is to identify the best option to counter the threat with the minimum number of unique sensors and effector types.

6 **What are the active companies in the sponsor entity that have proper expertise in the field of this study request and that could be invited to participate in this study? Please list POC details.** There are several major aerospace companies and small and medium enterprises located in NATO and Partner nations having the technology and capability to make a positive contribution to this study. The listing of all individual companies to be identified by the Sponsor is unknown and would not all inclusive. The NIAG national Heads of Delegation have the list of companies in their nation that they have been authorized to participate in NIAG studies. This list may or may not include the company point(s) of contact.

7 **NATO Priority**: The NATO Surface Based Air and Missile Defense program of work and associated air defense related programs are currently designed by NATO as a high priority area of interest within the Alliance.

8 **Intended Follow on to the Study:** The results of the study will support nations in the acquisition of advanced SBAMD capability, as well as supporting the NATO community in the identification of enhanced force protection technology development and integration. The study results are expected to be available in support of the NATO sponsored Modular GBAD Concept Phase MOU program, as well as the Emerging Disruptive Technology activities within NATO Headquarters. A follow-on study may be required to provide in-depth analysis of specific technical areas developed during the execution of this study.

9 **Other NATO Bodies Involved in the Related Area of Work:** There are several NATO organizations and agencies involved or interested in the topic, to include ACO, ACT, IMS, AIRCOM, DI (Multinational Programs), and NSPA (Project Management/Contracting) for the Modular GBAD Concept Phase MOU. This study will provide important current and out-year data to support the ACO Force Generation Process and the ACT NATO Defense Planning Process.

10 **Current Industrial Involvement with the Sponsor Group:** The Sponsor's past NIAG studies conducted over several years have consistently attracted 25 to 50 companies from 10

to 18 nations. This study is expected to obtain the same level of interest and participation.

11 Proposed Start Date: March/April 2024.

12 Desired Completion Date: June 2026.

13 Study Classification: Up to and including NATO Restricted.

14 Study Open to Partner industries: Study is open to Sweden and Switzerland only. Participation by other nations will be considered by the Sponsor prior to the NIAG study group Exploratory Group meeting.

15 Final report releasable to: NATO plus Sweden, and Switzerland. Release of the report to other nations will be determined by the content of the final report. Release of the report to other nations will require written authorization from the sponsor, JCG SBAMD.

16 Sponsoring Group Point and IS Point of Contact:

Sponsor: Dr. Leigh Moore, Chairman, JCG SBAMD.
Staff Advisor: Mr. Henning Anderson, DI.

Joint Chemical, Biological, Radiological, and Nuclear Defence Capability Development Group

NIAG Study Proposal

1 Title of Proposed Study:

Concept for a Non-Contact Evaporation of Low Vapour Chemical substances (NCE-LVC)

2 Brief Description of Proposed Study:

The objectives of the proposed study are to (1) identify technologies for the evaporation of persistent chemical substances with low vapour pressure from various surfaces and (2) develop a concept for an apparatus for the evaporation of these substances which can be coupled to the inlet of an ion mobility spectrometer (IMS).

3 Background:

In order to prevent NATO forces from entering areas which are contaminated by hazardous chemical substances, a timely detection and identification of those hazardous substances is required. With regard to this capability, the detection of persistent chemical substances with low vapour pressure represents a considerable technological challenge because established technologies for the detection of hazardous chemical substances, such as IMS, are based on the analysis of the gas phase. Due to their low vapour pressure, persistent chemical substances do not pass into the gas phase at usual environmental temperatures. Thus, the commonly used chemical detectors are hardly capable of detecting persistent chemical substances. A widely discussed solution to this challenge is to use specific heated accessories for low vapour chemical analyte mobilization that work in tandem with a suitable chemical gas detector. Worldwide, research groups have investigated various technological approaches for the evaporation of sessile chemical substances (e.g. laser evaporation or plasma evaporation) in laboratory studies.

4 Objectives of the Study:

a. What is the Objective of the study in terms of what is to be carried out, why and with what purpose?

i) To identify technologies for the evaporation of persistent chemical substances with low vapour pressure. The purpose is to provide an overview and an evaluation of available technologies with regard to their field-ready use.

ii) To develop technical and practical concepts, and cost-effective solutions for an apparatus for the evaporation of persistent chemical substances with low vapour

pressure based on the most promising technologies identified in the first phase of the study. It should be possible to couple the apparatus to the inlet of an IMS.

b. What is/are the operational scenarios to be considered?

i) Detection of contaminations after a terrorist attack by persistent hazardous chemical substances with low vapour pressure.
ii) Determination of the extent of the contaminated area as part of the hazard management during recovery from a terrorist attack.
iii) Detection of contaminated areas as part of military operations.
iv) Determination and marking of the contaminated areas in the context of military operations.
v) Checking military equipment for contamination by persistent hazardous chemical substances.

c. What is the scope of the study to be, as appropriate?

- Identification of technologies for the contactless evaporation of persistent chemical substances from surfaces.
  - Brief description of the state-of-the-art regarding technologies capable of evaporating these substances, including performance data and known limitations.
  - Assessment of technologies with regard to their use in the above-mentioned scenarios.
  - Selection of the most promising technologies in terms of performance data, technological maturity and implementation risk.
- Development of two technological concepts.
  - Investigation of the technical possibilities of combining the selected technologies with an IMS.
  - Estimation of performance data and possible limitations.
  - Assessment of usability for the interception of terrorist attacks.
  - Assessment of usability in military operations.
  - Assessment of the realization risks and the time to industrial product development.

d. What is the study to address – specific issues, technologies, documentation, potential follow-on demonstrations or testing, etc. ?

- Technologies for the contactless evaporation of persistent chemical substances with low vapour pressure.
  - Laser evaporation
  - Plasma evaporation
  - Thermal evaporation
- To provide procurement solutions for future detection systems capable of detecting persistent chemical substances to NATO and partner nations.
- To provide solutions for technical improvement of the existing chemical detector systems.
- To provide basic input to the revision of NATO operational and materiel detection, identification and monitoring standards.
- It is the intention of the sponsor, that the developed concept shall be evaluated by a technology demonstrator in a follow-on study. The technology demonstrator should enable the experimental proof-of-concept and determination of performance data.

e. What is the required output of the study, that is what information and recommendations is the study to deliver in the final report?

The main expected result of the study is an emphatic concept for a system for contactless detection and identification of persistent hazardous chemical substances with low vapour pressure. The study should also include information on the technological maturity of the technologies considered and the risk of implementation. The outcome of the study should enable NATO and partner nations to initiate necessary procurement processes in a timely manner.

5 Please indicate whether you would like to be presented with alternative solution options, taking into consideration that exploring various options may reduce the depth of the study scope:

The main objective of the study is to provide the previously described information. The identification and evaluation of alternative technologies and technical solutions are part of the study task.

6 What are the active companies in the sponsor entity that have proper expertise in the field of this study request and that could be invited to participate in this study? Please list POC details.

AIRSENSE Analytics GmbH

POC: Wolf Münchmeyer
Hagenower Straße 73, 19061 Schwerin, Germany
phone: +49 385 3993-280
email: muenchmeyer@airsense.com

BREITFUSS MESSTECHNIK GmbH

POC: Ulli Breitfuss
Danziger Str. 20, 27243 Harpstedt, Germany
phone: +49 4244 9679-13
email: u.breitfuss@breitfuss.de

BRUKER Optics GmbH & Co. KG

POC: Ralf Burgartz
Permoserstrasse 19, 04318 Leipzig, Germany
Phone: +49 341 2431-501
Email: Ralf.Burgartz@bruker.com

HEYL Chemisch-pharmazeutische Fabrik GmbH & Co KG Berlin

POC: Alexander Heyl
Kurfürstendamm 178 – 179, D-10707 Berlin, Germany
phone: +49 816-9611
email: alexander.heyl@heylgroup.com

7 NATO Priority:

No priority has yet been given but it is anticipated to be HIGH as the detection capability for persistent chemical substances with low vapour pressure is a prioritized planning area.

8 Intended Follow on to the Study:

It is the intention of the sponsor, that the developed concept shall be evaluated by a technology demonstrator in a follow-on study.

9 Other NATO Bodies Involved in the Related Area of Work:

i) The JCBRND-CDG as the main sponsor the study.
ii) The JCBRN Defence COE
iii) Arms Control, Disarmament, and WMD Non-Proliferation Centre as Capability Area Facilitator (CAF) for CBRN Defence and the Chief of Nuclear and CBRN Defence Policy Branch as Co-CAF for CBRN Defence
iv) STO Human Factors and Medicine (HFM) Panel

10 Current Industrial Involvement with the Sponsor Group:

None known

11 Proposed Start Date:

February 2024.

12 Desired Completion Date:

December 2024.

13 Study Classification:

NATO UNCLASSIFIED

14 Study Open to Partner industries:

Yes, the study is open to industry from NATO nations, NATO IP partner nations and ISRAEL

15 Final report releasable to:

NATO IP and ISRAEL

16 Sponsoring Group Point and IS Point of Contact:

Dr. Frank SABATH
Chair JCBRND-CDG
Email: FrankSabath@bundeswehr.org
Phone: +49(0)5192 136 200/201

1 **Title of Proposed Study:**

Future NATO Common Indirect Fire (IF) Round for Maximum Interchangeability (155mm Artillery, 120mm Mortar, 105mm Artillery, 81mm Mortar)

2 Brief Description of Proposed Study:

- Identify the best approach for exchange of information between government to share technical data on each others existing munitions of interest.
- Consider the focus on information exchange between government to supply the information. Ex: NATO? FMS case? MoU? Other means?
- Highlight Industry perspective on efforts needed to to re-tool or invest in order to produce a common projectile (based on outcome of NATO existing suite of projectiles or a future projectile)
- Propose a list of NATO options for a standirzed complete round for future implementation for maximum interoperability.
- Identify the main characteristics and parameters for common unified complete rounds[1] that would be usable by the main indirect firing platforms and producable by the main ammunition manufacturers
- Consider the trade-offs in key performance parameters such as range, lethality, cost, logistics & storage, manufacturability, to include consideration of the capacity of manufacturers etc.
- Consider ease of disposal
- State potential limitations for interchangeability across main IF platforms
- Consider the ability to be certified by national armaments authorities
- Consider an improved process required for certification by nations

3 Background:

The war of aggression against Ukraine brought the insufficiency of munitions interchangeability up to the spotlight. The munitions interchangeability has been a concern even before the war, as expressed by the field commanders during the NAAG's visits to the enhanced Forward Presence (eFP) battlegroups headquarters. Indeed, NATO the military planners are now taking the subject as of a highest priority.

The Indirect Fire (both artillery and mortar) munitions interchangeability remains on the paramount of this focus. At the expert community meetings (ICGIF), nations expressed interest in potential development of a future NATO Common Indirect Fire Round (Projectile, Propeller, Initiation System, Fuze) for Maximum Interchangeability. Interchangeable rounds would ideally be able to, within a designed system or concept, maintain the maximum firing range of the NATO platforms without significant barrel wear or conditions that would result in an unsafe configuration.

The study will be conducted in conjunction with NATO-NAAG efforts to establish interchangeability through common testing, and sharing of information regarding national certifications. These efforts will inform each other.

The Industrial perspective of the feasibility of such a solution will be instrumental to shape the discussions and potentially lead into NATO standards defining a common round.

4 Objectives of the Study:

[1] **Per NATO Term complete round (for 155mm: primer, propellant and charge system, projectile, fuze)**

a. What is the Objective of the study in terms of what is to be carried out, why and with what purpose?

Per background

b. What is/are the operational scenarios to be considered?

- Lessons from UKR warHigh intensity conflictForward deploymentsPotential emerging challenges
- Training

c. What is the scope of the study to be, as appropriate?

Provide a report to address the.. as minimum…

To achieve the scope of the study, there needs to be an understanding on how information should best be exchanged within NATO.

The scope of the study is to identify what current round(s) would be of interest to NATO. If none exist, leverage on industry to propose a common round that can be manufactured to a "NATO standardized round" where any countries weapon can reliably fire the common round.Additionally, this study should consider aspects of 155mm howitzer interaction between a common propelling charge, projectile and the chambers of allied howitzer platforms.

Furthermore, the study should highlight differences and possible compatibility of 81mm and 120mm mortar barrels and rounds fielded across NATO. For the 105mm Rounds, the focus should address a common round that can achieve ranges in excess of 11.3km in existing NATO country platforms. Lastly, the study should identify a standarsdized common fuze setter interface to allow NATO platforms to set each other's advanced munitions (BONUS / Excalibur / Vulcano / electronically set fuzes), and common rocket motor plug technology, to enable future upgrades to automated platforms to address the Armies of the Future.

d. What is the study to address – specific issues, technologies, documentation, potential follow-on demonstrations or testing, etc. ?

- Gaps in interchangeabilityProposals to improve and update AOP-29
- Assessment of NATO fleet (weapon and complete round) that is currently in use.
- In 155mm howitzers, with various chamber geometries used, the study needs to highlight the interaction of a proposed common projectile and propellant. Particuraly the challenge of a charge system that would allow fine tailoring across different weapon systems.
- In 105mm consideration should be given to a common round that can achieve ranges in excess of 11.3km. The 11.3km rounds in standard use would require additional work to utilize, but should be excluded from this study.

e. What is the required output of the study, that is what information and recommendations is the study to deliver in the final report ?

- Information exchange between government for current products (weapon, complete rounds)
- Standardization-related recommendations for future NATO complete rounds
- Key parameters for interchangeability
- Analytical framework to maximize interchangeability (process to utilize to help design)
- Proposals to aid and improve evaluation procedures and tools used for certification/recertification
- Define the information needed for Firing Tables Development.
- Update to AOP29

5 Please indicate whether you would like to be presented with alternative solution options, taking into consideration that exploring various options may reduce the depth of the study scope:

Yes…

6 What are the active companies in the sponsor entity that have proper expertise in the field of this study request and that could be invited to participate in this study? Please list POC details. *(in random order)*

- Nexter (FR), Rheinmetall (GE)
- KONSTRUKTA Defence, ZVS (SK)
- MKE (TU)
- General Dynamics (Ordnance and Tactical Systems), American Ordnance, Day & Zimmerman, Action, Amtech, Armtec, BAE OSI, Nammo (US)
- Expal (ES),
- Nammo (NO)
- BAE Systems (UK)
- Thales-LAS (FR)
- Eurenco (FR), etc…..

7 NATO Priority:
top

8 Intended Follow on to the Study:

- Consider a common, sharable NATO-owned munition design
- Consider interchangeable PGM
- Consider the Innovative Munitions Study (SG282) input
- Consider emerging technologies for fuzes (cameras, target recognition, terrain scanning, fire appreciation, BDA, etc..)
- Consider two rounds that have ballistic similitude: An HE unitary and a cargo projectile that can carry multiple hetero or homogeneous payloads.
- Consider universal propelling charge that can address multiple chamber sizes better than the current state of the art systems that can maintain range across the alliance within a single family design.

9 Other NATO Bodies Involved in the Related Area of Work:
STO, CASG, NNAG

10 Current Industrial Involvement with the Sponsor Group:
ICGIF

11 Proposed Start Date: ASAP

12 Desired Completion Date: ASAP

13 Study Classification:
NU

14 Study Open to Partner industries:
Yes.

15 Final report releasable to:
IP

16 Sponsoring Group Point and IS Point of Contact:
Jean-Philippe Simon (ICGIF, Future Capabilities Panel Vice-Chairman)
Osman Tasman (ICGIF Staff Advisor)

1 Title of Proposed Study:

NATO Medium and Large Caliber Direct Fire Munition Interoperability

2 Brief Description of Proposed Study:

Assess, characterize, and differentiate the interoperability of the current and future NATO medium and large caliber direct fire munitions (≥20mm, non-artillery/non-indirect fire), their production sources and their respective compatibility with the various medium and large caliber guns/cannons mounted on the entire fleet of NATO land tracked and wheeled platforms. This study will serve as a tool for Allied Commanders to have confidence in the use of ally-sourced ammunition in their medium and large caliber weapons systems and serve as a tool for allied munition producers to understand what they must modify in their munitions to maximize compatibility and interoperability across the NATO Alliance.

3 Background:

The Russian War of Aggression in Ukraine presented and unprecedented opportunity for the NATO Alliance to demonstrates its relevance and necessifty in the collective defense of Europe. NATO has risen to that challenge and delivered unwavering materiel support to Ukraine in terms or weapons systems, ammunition, and technical support. In providing this unprecedented support, munition interoperability and compatibility has emerged as a concern that needs attention.

NATO as an alliance has introduced new, diverse, and higher performing weapon systems across its land vehicle fleet. While this diverse collection of weapons systems has created unrivalled performance and capability, it has also created new challenges in understanding which weapon systems are compatible with which ammunitions systems. This challenge became evident when weapon systems and munitions were provided to Ukraine with uncertain confidence that the munitions provided from one Allied nation were compatible with a weapons system from another Allied nation. This study aims to bring renewed confidence in the compatibility and interoperability of NATO munitions and provide a list of opportunities where interoperability and compatibility can be enhanced.

4 Objectives of the Study:

a. What is the Objective of the study in terms of what is to be carried out, why and with what purpose?

Identify all medium and large caliber munition (M&LC) sources for the NATO alliance; assess and characterize the interoperability and compatibility factors of the M&LC munitions produced by those sources; and differentiate what M&LC weapon systems throughout the Alliance are compatible with those M&LC munitions to build confidence in allied M&LC munition interoperatbility and identify opportunities to enhance M&LC munition interoperability.

b. What is/are the operational scenarios to be considered?

NATO Commanders in each of the 31 member nations are presented with mixed M&LC munition lots from each of the 31-member nation munition sources. How can the NATO Commander have confidence a provided munition from an ally will safely and effectively function in their respective medium and large caliber weapons systems?

c. What is the scope of the study to be, as appropriate?

Assess, characterize, and differentiate each NATO M&LC Weapon System’s compatibility and interoperatbility with each NATO M&LC munition source and type.

M&LC Munitions include but are not limited to the following:
20 x 102mm -HEI, AP, TP, TP-T
20 x 110mm - HEI, TP, TP-T, HEIT-SD
20 x 128mm - HEI, TP, TP-T, HEIT-D
25 x 137mm - TP-T, APFSDS-T, HEI-T
30 x 113mm - TP, TP-T, API, HEI-SD
30 x 173mm - APFSDS-T, TP-T
35 x 228mm - TP-T, HEI, HEI-T
40 x 53mm - HE, TP, TP-T, HE-T
40mm - HEI, HE-T, AP, TP-T
57mm - HE, TP-T
76mm - Naval: HE, TP, HE-PD
90mm - HE-T, HEAT, HESH
100mm - HEAT, APDS; Naval: HE, TP
105mm - Tank: HE, HEAT, HEP, HESH, APFSDS
120mm - Tank: HE, HEAT, APFSDS
125mm - Tank: HE, HEAT, APFSDS, Practice
127mm - Naval: HE, TP, Full Charge, Reduced
130mm - HE-FRAG

d. What is the study to address – specific issues, technologies, documentation, potential follow-on demonstrations or testing, etc.?

The study should address all critical munition-weapon system interoperability and compatibility factors including but not limited to weapon system and munition component dimension and tolerances (overall length, diameter, etc) headspace, timing, charge pressure, and other factors.

Follow-on studies could take this analysis to the next level in understanding the performance of the different M&LC munitions in the various M&LC weapons systems in terms of range, accuracy, reliability, and other factors of interest.

e. What is the required output of the study, that is what information and recommendations is the study to deliver in the final report?

At minimum, the report should provide a compatibility and interoperability matrix of NATO M&LC Weapons Systems vs. NATO M&LC Munitions. The matrix at minimum should show the specific M&LC munition's source nation, manufacturer, and type, and whether it can be safely and effectively fired in a respective and corresponding weapon system. The report should also identify what factors or concerns prevent a munition from being safely and effectively fired in a corresponding NATO ML&C weapon system.

5 Please indicate whether you would like to be presented with alternative solution options, taking into consideration that exploring various options may reduce the depth of the study scope:

Yes.

6 What are the active companies in the sponsor entity that have proper expertise in the field of this study request and that could be invited to participate in this study? Please list POC details.

General Dynamics Corporation Ordnance and Tactical Systems, BAE Systems, Rheinmetall Defence, Nexter Systems KNDS, RUAG Holding A.G., Fiocchi Munizioni S.p.A., Prvi Partizan A.D., Companhia Brasileira De Cartuchos (CBC), Northrop Grumman, Orbital ATK, NAMMO, Elbit System, Rafael Systems, Kongsberg Gruppen,

7 NATO Priority: High

8 Intended Follow on to the Study:
Performance of the different M&LC munitions in the various M&LC weapons systems in terms of range, accuracy, reliability, and other factors of interest.

9 Other NATO Bodies Involved in the Related Area of Work: NNAG

10 Current Industrial Involvement with the Sponsor Group: N/A

11 **Proposed Start Date:** 01SEP2023

12 Desired Completion Date: 31MAR2023

13 Study Classification: NATO Unclassified

14 Study Open to Partner industries: Yes

15 **Final report releasable to:** NATO Interoperability Platform

16 Sponsoring Group Point and IS Point of Contact:

Primary:
Joseph P. Cannon, PhD
Chairman, LCG LE
NATO Army Armaments Group (NAAG)
+1.586.219.7092
joseph.p.cannon.civ@army.mil

Alternate:
Osman Tasman
NATO Land Armaments Coordinator
Defence Investment Division
NATO HQ, L8.2071
+32(2) 707 4300
tasman.osman@hq.nato.int

1 Title of Proposed Study:
Real-Time Operational Environment Mobility Model (ROEMM)

2 Brief Description of Proposed Study:
Valid soil strength information is the foundation for accurate mobility assessment of both manned and unmanned ground vehicles. To be accurate, simplified terramechanics mobility prediction models such as the NATO Reference Mobility Model (NRMM) require timely in situ soil strength information. Remotely sensed soil strength data obtained from both drone and satellite-based sensors require ground truth information of actual soil conditions to improve accuracy.

The ROEMM process looks to insert onboard vehicle localization, terrain interaction and preview sensing information to the mobility assessment process. The goal is to fused remotely sensed data with real time acquired performance data of ground vehicles in the operational environment (OE). This enhancement alone will create geospatially precise, empirically informed Modified Combined Operations Overlays (MCOO). Continual validation combined with actively learned assessment will further enhance MCOOs enabling ground force commanders to have real time mobility knowledge from which to base their manoeuvres and counter manoeuvre plans. Standardization of the ROEMM process will enhance cooperation with other international actors looking to improve the security of ground forces by improving distribution of mobility information.

3 Background:
UGV/UAVs are uniquely suited to be equipped with modular sensor payloads that can be tailored to sense and measure desired attributes of the operational environment (OE) such as terrain topography and soil capacity for ground vehicle traverse. Currently, remotely obtained earth observation data collected from UGVs, UAVs, and satellites is merged with existing high-fidelity geospatial data and processed through mobility models such as the NRMM. The mobility model pits these data inputs against known/quantified vehicle mobility characteristics to make informed assessments on where a given vehicle can effectively manoeuvre and where it cannot. This information is then aggregated into a vehicle specific, geospatially reference mobility information map that is used to assess the general mobility of unit assets at echelon to aid in their mission planning. This capability can also be used to maintain enhanced situational awareness of route trafficability in lower intensity operations. The accuracy of the assessment, however, is highly dependent upon real time ground truth conditions and onboard vehicle processing of this data is currently not available. To be of use, the remotely sensed data must first be back hauled to processing centres with the capacity to fuse the remotely sensed data. It is then validated using sporadically available ground truth data and converted into mobility relevant information for distribution at some time later.

ROEMM looks to enhance this process at the operations level through the insertion of a vehicle borne terrain sensor suite that will provide locally observed data for real time assessment of what the vehicle is going to experience. Then

the remotely sensed assessment is enhanced by using vehicle operation response data that is geospatially synchronized to vehicle sensor suite to further inform, “train” the remote sensor-based mobility assessment of future vehicle operations in that OE. For this study, both of these efforts, as well as the remote sensor data, will be routinely validated at a test site that is relevant to the particular OE. Initially, a series of test sites will be set up to represent the different terrain and soil conditions prevalent in the region. As the remotely sensed assessment is trained for a particular OE through follow on operations, the need for continual validation will subside.

4 Objectives of the Study:

a. What is the Objective of the study in terms of what is to be carried out, why and with what purpose?

The ROEMM study will demonstrate the innovative merger of remotely sensed (Lidar, Radar, Hyperspectral, High Resolution Photography) soil strength, type and moisture content terrain data to similar on vehicle preview sensed data enhanced by real time localization and vehicle performance data. The empirically improved remote sensor data will be further refined by image training to obtain enhanced remote estimations of terrain capacity for ground vehicle traverse.

As a by-product, the project will establish a purchase description that defines necessary equipment, sensor, model and process efficacy, affordability, and fidelity required to conduct the ROEMM process. This process and the tools necessary to conduct will be presented and proposed to NATO as a Standardization Proposal to harmonize and characterize how the alliance quantifies military mobility.

b. What is/are the operational scenarios to be considered?

- Intelligence Preparation of Battlefield
- Real-time situational understanding of OE and LOC trafficability
- Capability/limitations/opportunities for manoeuvre plans
- Interoperability and standardized ways and means to quantify mobility.

c. What is the scope of the study to be, as appropriate?

Through the State Partner Program Innovation Network (SPPIN) the Michigan National Guard (MING) and the Latvian Armed Forces (LAF) have partnered with respective national academic institutions with demonstrated competency in mobility prediction modelling and remote sensing development in support of NATO security operations in the Baltic region. If the ROEMM study suitably funded, this SPPIN partnership will demonstrate the innovative merger of remotely sensed (Lidar, Radar, Hyperspectral, High Resolution Photography) soil strength, type and moisture content terrain data to similar on vehicle preview sensed data enhanced by real time localization and vehicle performance data. The empirically improved remote sensor data will be further refined by image training to obtain enhanced remote estimations of terrain capacity for ground vehicle traverse.

To support the ROEMM study, platforms from the LAF and MING, outfitted with sensors from Latvian and Michigan industry, will be used to collected relevant OE data. Collected data will be processed through established mobility models to quantify OE mobility. Once refined and proven, this process will be applied and demonstrated with units conducting training at NADWC (JENS 24-25, ONS 24-25) and DEFENDER 24-25. Capability will be demonstrated in all seasons, with tactical and non-tactical vehicles to show model fidelity and utility.

d. What is the study to address – specific issues, technologies, documentation, potential follow-on demonstrations or testing, etc. ?

The ROEMM study will demonstrate operational capability that:

- *Informs Intelligence Preparation of Battlefield*
- *Maintain Real-time situational understanding of OE and LOC trafficability*
- *Informs commander of the capability/limitations/opportunities for manoeuvre plans*
- *Establish a standard approach to employ ROEMM Process within NATO*
- *Creates interoperability and standardized ways and means to quantify mobility.*

e. What is the required output of the study, that is what information and recommendations is the study to deliver in the final report ?

The ROEMM study will prove and deliver a process that can be applied to achieve the outcomes described above. As a by-product, the project will establish a purchase description that defines necessary equipment, sensor, model and process efficacy, affordability, and fidelity required to conduct the ROEMM process. This process and the tools necessary to conduct will be presented and proposed to NATO as a Standardization Proposal to harmonize and characterize how the alliance quantifies military mobility.

As the initial output, the proposed ROEMM study will set up the collection ground truth data to validate remote earth observation methods. Geotechnical researchers from a relevant OE such as the Baltic region will lead the initial test site selection from which terrain characterization and trafficability testing will be conducted. Soil samples will be collected from the test site for standard laboratory-based soil testing. In situ soil strength measurements that can be input into a recognized ground vehicle mobility model will also be taken. In situ measurements collected during this task will be then processed into the mobility modelling parameters and will represent the first terramechanics data set to be used to validate remote earth observations for the test site made by Geomatics researchers.

After gathering data and laboratory testing, the laboratory test data t will be linked to the in-situ data obtained. The research will establish a relationship between shear strength and the water content of the soil based on critical state soil mechanics theory. This data will be further correlated with mobility performance data for a specific vehicle cross the same terrain. Existing mobility

models will be examined to find the best fit. A Material Point Method simulation of a problem related to the investigated issues, linking vehicle and soil data will also be made. The established correlations will be the basis for publication

Remotely obtained earth observation data collected from UGVs, UAVs, and satellites will be merged with the high-fidelity geospatial soil and vehicle performance data and processed through mobility models to refined the model predictions. The output will be a process that can be used to further train the remote earth observations to accurately report ground vehicle mobility data obtained from future observations.

5 Please indicate whether you would like to be presented with alternative solution options, taking into consideration that exploring various options may reduce the depth of the study scope:

Yes

6 What are the active companies in the sponsor entity that have proper expertise in the field of this study request and that could be invited to participate in this study? Please list POC details.

Michigan Technological University (MTU) and its Keweenaw Research Center (KRC) has participated extensively in the development and refinement of the NATO Reference Mobility Model (NRMM) and mobility assessment tools for ground vehicles under NATO Applied Vehicle Technology (AVT) Groups 248, 308, and 341.

Riga Technical University (RTU) has extensive knowledge of off-road mobility in the Baltic region augmented by work with the Latvian geospatial information agency, commercial forestry and agriculture industries.

Aalto University is the leading technical university in Finland and one of the best in the world, well known for soil and vehicle trafficability modelling in the Baltic region.

7 NATO Priority: High

8 Intended Follow on to the Study: Implementation and optimization of the ROEMM process and toolsets for promulgation into NATO as a standard or enhancement to the existing NRMM.

9 Other NATO Bodies Involved in the Related Area of Work: NAAG CBRN-D; similar process and tools could be used for CBRN Reconnaissance.

10 Current Industrial Involvement with the Sponsor Group:

Michigan Technological University (MTU) and its Keweenaw Research Center (KRC) has participated extensively in the development and refinement of the NATO Reference Mobility Model (NRMM) and mobility assessment tools for ground vehicles under NATO Applied Vehicle Technology (AVT) Groups 248, 308, and 341.

Riga Technical University (RTU) has extensive knowledge of off-road mobility in the Baltic region augmented by work with the Latvian geospatial information agency, commercial forestry, and agriculture industries.

11 **Proposed Start Date:** 01 OCTOBER 2023

12 Desired Completion Date: 30 SEPTEMBER 2024

13 Study Classification:
NATO Unclassified

14 Study Open to Partner industries: Yes

15 Final report releasable to: NATO Interoperability Platform

16 Sponsoring Group Point and IS Point of Contact:

Primary:
Joseph P. Cannon, PhD
Chairman, LCG LE
NATO Army Armaments Group (NAAG)
+1.586.219.7092
joseph.p.cannon.civ@army.mil

Alternate:
Osman Tasman
NATO Land Armaments Coordinator
Defence Investment Division
NATO HQ, L8.2071
+32(2) 707 4300
tasman.osman@hq.nato.int