MODERN SURFACE-TO-AIR MISSILE SYSTEMS – NATIONAL/NORWEGIAN ADVANCED SURFACE-TO-AIR MISSILE SYSTEM (NASAMS)

Maj. instr. sup. Gelu ȚANU*
MG (ret.) Prof. Florian RĂPAN, PhD**

The „air-counterair confrontation" is a defining component of the contemporary war reality. This antagonism determined the continuous transformation of the air-space environment and fueled the constant progress of its main actors: the offensive air platforms, respectively antiaircraft fighting systems. To keep the pace with the rhythm imposed by the air combat means, the surface-to-air missile systems constantly find new solutions to cope with the modern challenges of the constantly evolving battle space. NASAMS offers such a solution which proves to be a successful one and enjoys an increasing popularity, despite the serious competition from this sector.

Keywords: NASAMS; surface-to-air missile system; air threats; air environment.

The constant presence and increasing role played by the Air Power in all modern military conflicts, regardless their nature or origin, entirely prove the necessity to develop this vital component of the Military Power.

The concept of Air Power is the cumulative result of factors and elements which collaborate and condition its relevance in the broader context of the state power equation[1].

Consolidating Air Force, as a central element of the Air Power, requires a consistent and coherent effort which, among others, involves the permanent update and modernization of its weapon and support systems.

In the Air Force, maybe more than in the other categories of armed forces, the level of technological actuality of the weapon systems radically conditions its potential and relevance in the contemporary battlespace.

The ground-based air defense systems represent a vital component of the force structure and decisively contribute to the effort of obtaining a certain degree of control of the airspace above the area of operations, as well as of defending the national sovereignty in the air space.

***"Carol I" National Defense University*
e-mail: *tanu.gelu@yahoo.com*
****"Carol I" National Defense University*
e-mail: *rapan_florian@yahoo.com*

Just due to the role played by this category of systems in the current air fight and the continuous improvement and diversification of the air threats, there is a constant interest in updating and developing the surface-to-air missile systems.

In this context, NASAMS offers a suitable solution to counter a broad category of air threats, mainly the ones operating inside the atmospheric envelope[2].

What sets NASAMS apart from the other modern surface-to-air missile systems is the fact that it uses as main interceptor the air-to-air missile AIM-120 AMRAAM[3], with all the advantages and disadvantages resulting from such an option.

NASAMS is a medium range surface-to-air missile system produced by the Norwegian company Krongsberg Defense and Aerospace, in cooperation with the American one, Raytheon, the last one producing both the radar and the missile used by this system.

NASAMS is also remarkable due to a modern and very flexible C2[4] solution, which facilitates the integration and cooperation with a diverse range of weapon systems, from antiaircraft guns and missiles (L-70, RBS-70, HAWK, PATRIOT), to directed-energy weapons (DEW)[5].

Like the other similar surface-to-air missile systems, NASAMS has been designed to defend the objectives of vital importance or urban areas against the entire spectrum of air breathing threats: combat air platforms, helicopters, cruise missiles and UAVs[6].

The system reached its operational capability in 1994 and was deployed for the first time by RNoAF[7]. In this environment NASAMS was continuously developed and perfected and, in 2003, 4 other systems were purchased and deployed by the Spanish Army[8].

Of particular importance for the development of this system was the implementation of NASAMS II, a consistent update of the initial system, which increased its attractiveness and facilitated new and important contracts. Significant parts of this update were the implementation of Link 16 connectivity and the improved capabilities provided by the radar station, with its perfected variant, AN/MPQ-64F1 Improved Sentinel. Following this update, in December 2006, Netherlands Army signed a contract for a NASAMS II system which was going to use the tri-dimensional surveillance radar EADS TRML-3D. One year later, in 2007, the first NASAMS II system was delivered to RNoAF[9].

The system's capabilities were proved repeatedly through tests and exercises, like the live fire exercise conducted by the Spanish Army in November 2008[10]. Of equal importance for the system's development were the firing exercises conducted by RNoAF in 2011 and 2012, which proved NASAMS's ability to launch different types of missiles produced by Raytheon, like AIM-9X Sidewinder or Evolved Sea Sparrow Missile (ESSM)[11].

The performance displayed by NASAMS during these exercises facilitated the signature of new important contracts, among which it is worth mentioning the one with Finland Ministry of Defense, in 2009, with RNoAF, in 2011 and 2013, as well as the one with Oman Ministry of Defense, in 2014[12].

The success enjoyed by the missile system is demonstrated by the signature, in 2015, of a new agreement between Raytheon and Krongsberg, which extends their partnership in developing NASAMS for another additional ten years, until 2025[13].

A similar missile system was developed, up to a point, in the United States of America by Raytheon, to answer the need created by the HAWK decommission and the increasing focus of PATRIOT toward ballistic defense. The system is named SLAMRAAM[14] and has, in general terms, the same contents as NASAMS. Despite the considerable investments into the development and testing of this system, the program was eventually cancelled, in 2011, due to a combination of factors among which the budgetary cuts and the decreased interest prevailed[15].

The main components of a NASAMS fire unit, at battery level, are the following: the command post (FDC[16]), the 3D radar AN/MPQ64F1 Sentinel, the electro-optical and infrared sensor system and the transport and launch installations, capable of transporting, aiming and launching up to 6 AMRAAM missiles, placed in containers. One of the most appreciated features of NASAM system is its modular construction, which confers flexibility to the fire unit, by allowing the addition of new elements, radars, sensors, launchers, missiles etc.

Currently, a complete NASAMS II battery consists of a tactical control cell (TCC), a fire distribution/control centre, up to 8 radars (AN/MPQ-64 F1 Improved Sentinel), a multi-sensor platform (MPS 500), up to 12 launchers and 72 missiles, offering a considerable fire power capability for this level[17].

The fire distribution centre is the central element of a NASAMS battery and represents an air defense battle management centre (AD BMC4I[18]), which proved its qualities and has already been deployed to several location and different configurations.

FDC is based on a modern fire control system which allows a superior handling of data, increased interoperability and an intuitive and easy to operate man-machine interface, facilitating the real time command of the air defense battle.

The subsystems integrated into the fire distribution center ensure the implementation of essential features which complement the functionality of the missile system, as a whole, such as:

- data link management;
- sensor control;
- air image production;
- track identification and classification;
- protection of own forces and means;
- threat assessment;
- weapon allocation and engagement control;
- mission result assessment.

Attached to the FDC, a mission support instrument (MST[19]) helps and accelerates the decision-making process concerning the deployment planning, system status monitoring and the production of detailed reports and analysis.

Integrating the tactical data links inside FDC involves both handling the relevant messages and implementing the C4I[20] functions to support the achievement of the needed interoperability level in order to maximize the coordination between FDC and the other actors of the battlespace.

The open and modular SW/HW[21] allows the integration of offensive and defensive fire capabilities, through the combination of air defense systems, field artillery means, offensive missiles and dedicated assets for CAS[22] missions, into an efficient „plug & fight" solution. The FDC implements extended connections with the higher echelons, adjacent units, fighting systems, sensors and interceptors, despite the variety of communication and data protocols in use, building a single system, with a high level of integration.

At the same time, FDC provides the users with several tools in support of the decision-making process, starting with the dissemination of a single integrated air picture, the common operational picture, the threat evaluation and weapon allocation. Additionally, each system connected to the FDC can contribute, using its own means, to the consolidation of the information base needed to conduct military operations.

The FDC is placed on the chassis of a Mercedes-Benz G-Class (4×4) light truck propelled by a diesel engine of 2,8 l, generating 120 hp and allowing a road speed limit of 138 km/h and a cruising range of 800 km. Additionally, the special design of the suspension and transmission systems provides a very good cross-country capability[23].

Another important element of NASAMS missile system is AN/MPQ-64F1 Improved Sentinel, a tri-dimensional surveillance radar, of high resolution, designed to discover, track, identify, classify and report all the air threats within its range.

The radar benefitted from a continuous update and improvement program, one of the main development directions aiming at the extension of its surveillance range. Another priority was to increase the ability to process signals, by integrating several computers as well as the latest COTS[24] technologies. This allowed a superior A/D[25] processing capacity, a faster data control and created additional space for future development of the radar.

The update process continued with the development of new X band emitters and receivers, which have several advantages compared to the previous versions. Thus, the emitter uses a single main oscillator to generate frequency, which produces lower clutter and allows a better detection on clutter background. The single channel receiver, also in X band, is designed to pair up with the new emitter. The antenna system was also updated by the introduction of a new controller and a new digital interface for the interconnection with the data processor, giving the operator a superior control of the direction and rotating speed of the antenna.

In order to avoid the fratricide, the radar station benefits from an integrated modern IFF system.

The MPQ-64F1 Improved Sentinel Radar can be put into a battle position in less than 15 minutes and can be switched to the transport mode in less than 10 minutes, while achieving the full operational status does not take longer than a few minutes. A team of 2 soldiers is enough to operate the radar, without any need of additional personnel for the handling or maintenance.

The radar provides targeting data for the FDC ensuring accurate information before the launch and continuous updates during the mid-flight of the AMRAAM missile. The performance offered by the radar station is facilitated by its inherent features like the X band operating frequency, the tri-dimensional pencil beam, the Doppler impulse and the phase and frequency scanning. The antenna is designed to rotate with 20-30 rpm and allows the tracking of targets approaching from any direction and up to a distance of over 120 km[26].

The radar station is mounted and propelled by the same vehicle like the FDC, a Mercedes-Benz G-Class light tactical vehicle, offering the same features and providing a good cross-country mobility for this essential component of the missile system.

The recognition of the performance and features offered by this radar is also demonstrated by its popularity on the international stage, currently, more the 200 radars being ordered, out of which more than 100 have been delivered or are still under production.

Another important element and, to some extent, specific for this missile system, is the sensor system MPS 500, used for the visual identification and evaluation of the air threats.

The multi-sensor platform MPS 500 is a highly stabilized sensor system used during night and day

for the detection, observation and identification of flying objects as well as for the target tracking and engagement control. It consists of a sensor package encompassing a thermal camera, a video camera, a 6 Hz range detector, a video tracker, a vertical sensor and a North sensor.

The system is actively stabilized, equipped with a GPS unit and a North detection unit, and can be remotely operated from FDC. MPS 500 is equipped with its own power generator, and during transport the sensor platform can be lowered inside a special container, for safety reasons.

The sensor system is used for the accomplishment of the following tasks:

- passive mode target engagement;
- passive mode surveillance;
- threat evaluation and fire results assessment;
- higher echelon tracks evaluation;
- target and engagement data acquisition;
- jam emitter assessment.

Similar to the other elements of NASAMS, MPS 500 is using the same type of light tactical vehicle which gives it comparable movement possibilities[27].

Additionally, the compact and light design ensures a high manoeuvrability, flexibility and ease of deployment, allowing the quick integration of MPS 500 into existing missile systems.

The launching stations of NASAMS are used to transport, aim and launch the missiles placed inside sealed containers. As mentioned before, the launchers are able to use several types of missiles, in different combinations, even from the same launching station.

In firing position, the launchers are lowered to the ground level, fixed and automatically levelled using a system of hydraulic jacks and are able to launch all the 6 missiles they carry in only a few seconds.

The launchers are connected to the FDC through a secured wired or radio connection and can be deployed as far as 25 km from the command post.

Depending on the beneficiary, the launch platforms may be powered by different types of vehicles. Thus, the Norwegian systems are towed by Scania 6x6 trucks, the Finnish ones by Sisu trucks, while the Spanish ones by Iveco trucks[28].

After a contract signed in 2011, the Norwegian Army became the first beneficiary of a High Mobility Launcher (HML), developed by Raytheon, consisting of 4 AMRAAM missiles mounted on a HUMVEE tactical vehicle. Integrating this new launching stations into the deployed NASAMS, contributes to the improved mobility of the missile system, as a whole[29].

AMRAAM (AIM-120) is a well-known air-to-air missile used by a broad range of modern combat planes, both American (F-15, F-16, F/A-18, F-22, F-4F) and European (Sea Harrier, Harrier II Plus, Eurofighter, JAS-39 Gripen, JA-37 Viggen and Tornado). The missile used by NASAMS is AIM-120C7, an improved version of AIM-120C, integrating several updates. Compared to its predecessors AIM-120A and B, AMRAAM has smaller control surfaces but a longer range and increased agility to fight against manoeuvring combat aircrafts. Additionally, AIM-120C7 brings an entire range of updates by improving the antenna, the receiver and signal processor, but also by integrating new software algorithms to fight against the new air threats. Also, the miniaturization of the missile's internal components created additional space for the future development and improvement of the missile[30].

The missile allows target interception as far as 33 km and up to a maximum height of 15 km[31].

In order to improve the capabilities offered by NASAMS, Raytheon developed a new missile AMRAAM-ER, which promises an extension of the operational range with up to 50% and of the operational height with up to 70%. Actually, this missile is a combination between AMRAAM and ESSM missiles, both developed by Raytheon, by taking the frontal part of the first and the propellant of the last.

In the flight test of August 31st, 2016, in Norway, the missile proved a perfect compatibility with the NASAMS which launched it, opening the way to a new stage of development for this missile system[32].

All the elements presented above entirely prove the fact that NASAMS is a medium range surface-to-air missile system in continuous development and improvement.

Currently the system is used by 6 nations and enjoys an increasing international appreciation, a fact proved by the recent interest expressed by states like India, Australia, Indonesia and Lithuania[33].

NASAMS offers one of the most modern and flexible air defense solution, capable to answer a broad variety of operational requests.

Among the most valued features of this missile system we can easily identify: the open architecture which guarantees a considerable growth potential, superior mobility due to the reduced dimensions, high fire and engagement capacity, increased stability to electronic counter-countermeasures and many others

To conclude, the medium range surface-to-air missile system NASAMS provides a competitive and adaptive air defense solution due to its capacity to quickly identify, engage and destroy a large array of present and future air threats.

NOTES:

1 Ion Puricel, *Puterea aeriană în mișcare*, "Carol I" National Defense University Publishing House, Bucharest, 2016, p. 15.

2 Air breathing threats.

3 AMRAAM – Advanced Medium-Range Air-to-Air Missile.

4 C2 – Comandă-Control.

5 https://www.armyrecognition.com/norway_norwegian_army_missile_systems_vehicles_uk/nasams_norwegian _advanced_surface_to_air_missile_system.html, accessed at 15.01.2019.

6 UAV – Unmanned Air vehicles.

7 RNoAF – Royal Norwegian Air Force.

8 http://www.defense-aerospace.com/articles-view/release/3/99591/spanish-army-conducts-nasams-live_fire-exercise.html, accessed at 15.01.2019.

9 https://www.airforce-technology.com/projects/national-advanced-surface-to-air-missile-system-nasams/, accessed at 15.01.2019.

10 *Ibidem*.

11 *Ibidem*.

12 https://www.raytheon.com/sites/default/files/capabilities/rtnwcm/groups/public/documents/content/nasams_pdf.pdf, accessed at 18.01.2019.

13 http://missiledefenseadvocacy.org/air-defense/u-s-air-defense/u-s-deployed-air-defense-systems/national-advanced-surface-to-air-missile-system-nasams/, accessed at 19.01.2019.

14 SLAMRAAM – Surface Launched AMRAAM.

15 https://www.strategypage.com/htmw/htada/20110111.aspx, accessed at 20.01.2019.

16 FDC – Fire Distribution Center.

17 https://www.globalsecurity.org/military/world/europe/nasams.htm, accessed at 21.01.2019.

18 AD BMC4I – Air Defence Battle Management Command, Control, Communications, Computers, and Intelligence.

19 MST – Mission Support Tool.

20 C4I – Command, Control, Communications, Computers, and Intelligence.

21 SW/HW – SoftWare/HardWare.

22 CAS – Close Air Support.

23 https://www.armyrecognition.com/norway_norwegian_army_missile_systems_vehicles_uk/fdc_fire_distribution _center_vehicle_nasams_technical_data_sheet_specifications_pictures_video_12712157.html, accessed at 23.01.2019.

24 COTS – Commercial Off-The-Shelf.

25 A/D – Analog-to-Digital.

26 https://www.armyrecognition.com/norway_norwegian_army_missile_systems_vehicles_uk/mpq-64f1_3d_radar_vehicle_nasams_technical_data_sheet_specifications_pictures_video_12712155.html, accessed at 27.01.2019.

27 https://www.armyrecognition.com/norway_norwegian_army_missile_systems_vehicles_uk/electro_optical_eo _sensor_vehicle_nasams_technical_data_sheet_specifications_pictures_video_12712154.html, accessed at 30.01.2019.

28 https://www.armyrecognition.com/norway_norwegian_army_missile_systems_vehicles_uk/nasams_norwegian _advanced_surface_to_air_missile_system.html, accessed at 31.01.2019.

29 https://www.kongsberg.com/en/kog/news/2013/june/ny-kapasitet-i-nasams-luftvernsystem/, accessed at 01.02.2019.

30 https://www.raytheon.com/capabilities/products/amraam, accessed at 01.02.2019.

31 https://www.globalsecurity.org/military/world/europe/nasams.htm, accessed at 01.02.2019.

32 https://www.defensenews.com/digital-show-dailies/ausa/2016/10/04/raytheons-extended-range-amraam-missile-destroys-target-in-first-flight-test/, accessed at 01.02.2019.

33 https://www.kongsberg.com/~/media/KDS/Files/Products/Air%20Defense%20Systems/Brochures/NASAMS_Air%20Defence%20System.ashx?la=en, accessed at 05.02.2019.

BIBLIOGRAPHY

Puricel Ion, *Puterea aeriană în mișcare*, "Carol I" National Defense University Publishing House, Bucharest, 2016.

https://www.armyrecognition.com/norway_norwegian_army_missile_systems_vehicles_uk/nasams_norwegian _advanced_surface_to_air_missile_system.html

http://www.defense-aerospace.com/articles-view/release/3/99591/spanish-army-conducts-nasams-live_fire-exercise.html

https://www.airforce-technology.com/projects/national-advanced-surface-to-air-missile-system-nasams/

https://www.raytheon.com/sites/default/files/capabilities/rtnwcm/groups/public/documents/content/ nasams_pdf.pdf

https://www.strategypage.com/htmw/htada/20110111.aspx

https://www.globalsecurity.org/military/world/europe/nasams.htm

http://missiledefenseadvocacy.org/air-defense/u-s-air-defense/u-s-deployed-air-defense-systems/national-advanced-surface-to-air-missile-system-nasams/

https://www.armyrecognition.com/norway_norwegian_army_missile_systems_vehicles_uk/fdc_fire_distribution _center_vehicle_nasams_technical_data_sheet_ specifications_pictures_video_12712157.html

https://www.armyrecognition.com/norway_norwegian_army_missile_systems_vehicles_uk/mpq-64f1_3d_radar_vehicle_nasams_technical_data_sheet_ specifications_pictures_video_12712155.html

https://www.armyrecognition.com/norway_norwegian_army_missile_systems_vehicles_uk/electro_optical_eo _sensor_vehicle_nasams_technical_data_sheet_ specifications_pictures_video_12712154.html

https://www.armyrecognition.com/norway_norwegian_army_missile_systems_vehicles_uk/nasams_norwegian _advanced_surface_to_air_missile_system.html

https://www.kongsberg.com/en/kog/news/2013/june/ny-kapasitet-i-nasams-luftvernsystem/

https://www.raytheon.com/capabilities/products/amraam

https://www.defensenews.com/digital-show-dailies/ausa/2016/10/04/ raytheons-extended-range-amraam-missile-destroys-target-in-first-flight-test/

https://www.kongsberg.com/~/media/KDS/Files/Products/Air%20Defense

%20Systems/Brochures/ NASAMS_Air%20Defence%20System.ashx?la=en