The Central Research institute
of the Armed Forces of Ukraine

Military Science. Vol. 3 No. 1 (2025)

The specifics of applying the capability-based assessment method to address the tasks of protecting Ukraine's critical infrastructure from air attacks

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Abstract. The relevance of the issue being studied stems from the adaptation of the capability-based assessment method for developing the armed forces to address tasks related to the protection of Ukraine's critical infrastructure from air attacks. In this context, alongside military forces and assets, security forces and civilian resources are also employed. Consequently, it becomes necessary to account for the specific characteristics of the tasks, their execution conditions, and the properties of the protected objects to ensure their continuous operation and restoration in the event of damage. As the article focuses on exploring the use of the capability-based assessment method for critical infrastructure protection in Ukraine, its aim is to outline the specific features of this method. The basis of the proposed method embraces the difference in requirements for capability indicators of forces and assets tasked with protecting objects and creating operational effects (achieving results), alongside current indicators, to identify the necessary measures for modifying the basic components (elements) of capabilities. The aim is to align current capability indicators with the required standards. These measures are then used to calculate the required resources, their costs, and the time needed to select a contractor. The article highlights the key features of applying the method to address the set task, explaining their content and examining their impact on the intermediate and final research results. It also justifies the characteristics of the indicators used to develop forces and assets for protecting critical objects to achieve the assigned tasks.

The article materials offer practical value for units in ministries, agencies, and educational institutions. The experience of adapting the well-known method may prove useful not only for addressing military tasks but also for other applications.

Keywords: Ukraine's critical infrastructure, critical infrastructure facility, capability of a resource to create an operational effect (achieve a result), capability, protection objective, task list, task execution conditions, task performance success indicator.

Introduction

In the Armed Forces of Ukraine (AFU), the transition to defensive planning based on a capabilities-based assessment method (the ability of a military formation to achieve assigned tasks under specified conditions) is ongoing. With the onset of large-scale aggression by the russian Federation (RF) against Ukraine, it became clear that to destroy Ukraine, it was sufficient to target the facilities ensuring the functioning of the state, its economy, housing stock, and enterprises. These facilities are now classified as critical infrastructure, the

protection of which from aerial attack is primarily the responsibility of the Air Force of the Armed Forces of Ukraine. AFU scientists have developed and substantiated recommendations for implementing the principles and rules used by NATO member states, grounded in the capabilities-based assessment method. The Institute for Mathematical Machines and Systems Problems of the National Academy of Sciences of Ukraine has also proposed using this method to determine tasks for protecting critical infrastructure in Ukraine from aerial attack. The article's relevance stems from the need to study the adaptation of this method to address the protection of critical infrastructure in the context of repelling large-scale aggression by the russian federation, with the aim of ensuring the resilience of the state's functioning. In light of this, the article aims to highlight the specifics of using the capabilities-based assessment method to tackle the protection of critical infrastructure in Ukraine from aerial attack.

Literature Review

To regulate defensive planning in the Armed Forces of Ukraine, the following documents have been developed: Recommendations on Defensive Planning Based on Capabilities (Recommendations, 2017), Regulations on Medium- and Short-Term Defensive Planning (Regulations, 2016), and Recommendations on the Organisation of Capability Assessments (Recommendations, 2017). These documents outline the key principles of capabilities-based planning within the Ministry of Defence and the General Staff of the Armed Forces of Ukraine, detailing processes, procedures, characteristics, and indicators.

To further elaborate on these key principles, military scientists from the Central Scientific Research Institute of the Armed Forces of Ukraine have analysed Ukraine's experience in defensive planning and its application in the practice of planning within structural units (Djeniezhkin, 2020; Romantsenko, 2022; Havryliuk, 2020). The National Defence University of Ukraine has developed a methodological framework for conducting defence reviews within the Ministry of Defence and the Armed Forces of Ukraine (Snitsarenko, 2019), alongside capability assessments within functional capability groups (Krykun, 2019).

At scientific and practical conferences, the implementation of capabilities-based planning methods in practice has been discussed (Dryniv, 2021), along with the experience of the Armed Forces of Ukraine in repelling large-scale aggression by the russian federation against Ukraine (Bieleskov, 2021).

This demonstrates that the Armed Forces have established a solid methodological foundation, enabling the application of capabilities-based methods in defensive planning, particularly for addressing the protection of Ukraine's critical infrastructure from aerial attacks..

Methodological Framework

The method currently employed by most NATO member states in defence planning is based on the fundamental principles of military capability development. Defence planning (DP) in these countries encompasses:

Defensive dominance (force and resource planning);

Operational planning (OP) – planning the deployment of forces.

In simple terms, defence planning involves detailing decisions and executing military-political directives to enable the Defence Forces (such as the Armed Forces of Ukraine) to develop the ability to operate effectively within a defined operational environment while performing tasks to achieve strategic objectives in war (or armed conflict). The core of the method used to define the system of indicators for the future Armed Forces of Ukraine lies in a tool that compares the current state of a military formation's capability (measured by seven groups of indicators) with the

requirements for achieving the necessary operational effects in specific military (combat) operations. If the indicators align, the military formation is capable of generating the required operational effects during task execution; if discrepancies exist, it is not capable (see figure 1).

Eliminating or maximising the minimisation of discrepancies in indicators (to align current indicators with requirements) is achieved by altering the basic components (elements) of capabilities, the modification of which defines the directions and tasks for military formation development, as well as the primary resource requirements. Resource management eliminates or minimises the deficit (the difference between current capability indicators and the required ones for creating operational effects) as much as possible. The removal or minimisation of the capability deficit to generate effects (perform tasks) indicates that the military formation is capable of completing the assigned task, enabling the transition to planning military formation development.

1st stage: Defining the requirements and actual numerical values for the capability indicator that enables a military formation to generate operational effects while performing tasks under specified conditions.

2nd stage: Capability assessment.

3rd stage: Defining the measures required to modify the basic components of capabilities and their associated costs.

Picture 1 shows data collection stages for development planning of the Armed Forces of Ukraine based on capability assessment, which are:

4th stage: Selecting the option from the list of measures where the capability deficit has been either eliminated or minimised. Based on this, a decision is made on planning military formation development (its capabilities – the ability to accomplish assigned tasks) (see figure 2).

The adaptation of the method for addressing the protection of Ukraine's critical infrastructure objects (Objects) has specific features at the data preparation stages for planning the development of air defence (AD) and anti-missile defence (AMD) forces and resources, which take into account the characteristics of the Objects (Resolution, 2022; Collection, 2018; Bobro, 2019; Kuleshov, 2020). These features, which should be considered during research, include:

the resilience of critical infrastructure refers to its ability to function reliably under normal conditions, adapt to constantly changing circumstances, withstand and quickly recover from accidents, technical failures, malicious actions, natural disasters, and hazardous natural phenomena. It is also important to note that the term "security," as used in the definition of "critical infrastructure protection," encompasses physical security (physical protection), operational security, and functional security (Green Paper, 2015);

the protection of Objects is entrusted both to the Armed Forces of Ukraine (Law, 2021) and the relevant sectors of the economy, which have control over these Objects. Currently, to enhance security and ensure the resilience of national Objects, a new security provision philosophy is being developed, based on the joint efforts of the state, society, citizens, and business. This philosophy underpins the first strategic goal of the policy for critical infrastructure protection – the development of a security partnership (Green Paper, 2015);

the large number of Objects, exceeding 1,000, as defined by the resolutions of the Cabinet of Ministers of Ukraine (Resolution, 2000), with each being unique in terms of its protection level.

According to the Law of Ukraine on "Critical Infrastructure" (Law, 2021), Objects in Ukraine are classified into four categories of criticality based on the potential consequences of disruptions to their functioning:

Category 1 – includes particularly important objects with national significance, the disruption of which would lead to a state-level crisis;

Category 2 – covers vital objects, whose disruption would cause a regional crisis;

Category 3 – pertains to important objects, the failure of which would lead to a local crisis;

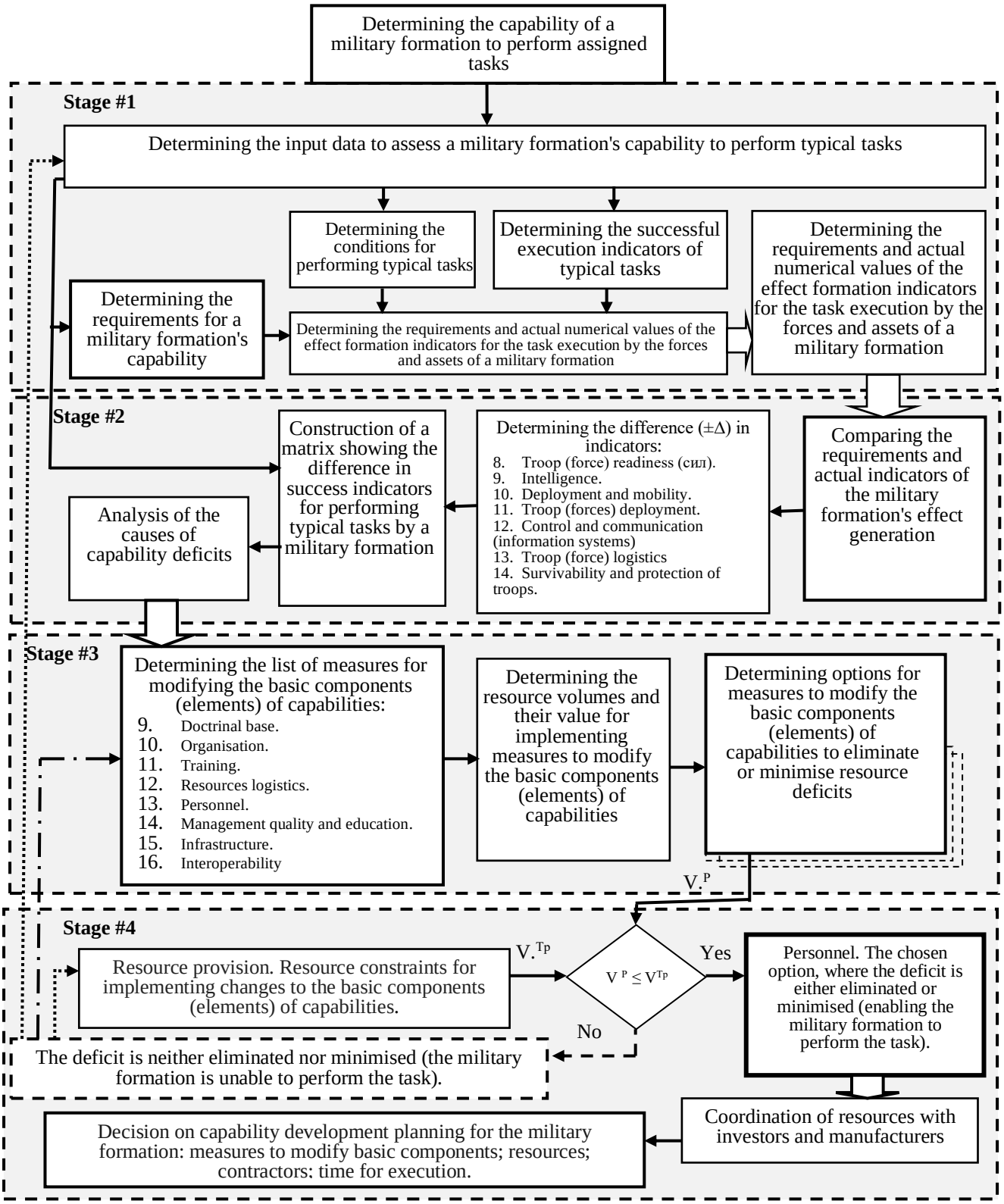


Figure 1. The systematic illustration of the identification flow of the development indicators within the AFU through the capabilities assessment

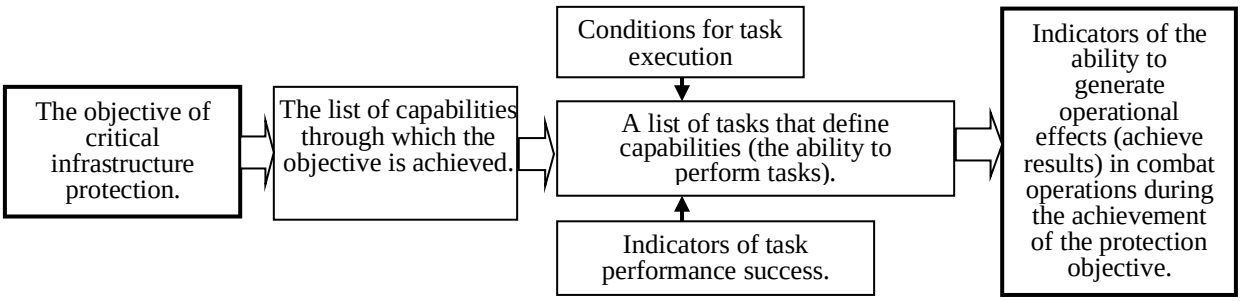


Figure 2. Simplified representation of the scheme for determining the indicators that characterise the achievement of the critical infrastructure protection objective.

Category 4 – involves essential objects, the disruption of which would result in a local-level crisis;

The failure of any facility affects the operational conditions of other facilities and the functioning of the economy, transport, and housing services;

Leading countries worldwide recognise the need to protect critical infrastructure (CI) from all types of threats (all-hazards approach): cyber threats; threats from precision strike weapons; drone attack threats; internal (insider) threats; chemical, biological, and radiological threats; electromagnetic pulse threats; natural threats; accidents and technical threats; hybrid threats (Directive, 2008);

The Air Force of the Armed Forces of Ukraine protects facilities by covering them from airstrike attacks using an object-zone method, with designated forces and assets, as determined by the commander's decision (Law, 1992);

Facility protection is carried out within the established system for safeguarding the state's critical infrastructure (CI), in coordination with departmental and private forces and assets, as well as those from other components of the Security Forces and Defence Forces of Ukraine (Green Book, 2015; Directive, 2008);

The foundation of the modern russian method of waging war against Ukraine is the destruction of critical infrastructure facilities to force the Armed Forces of Ukraine (AFU) to lay down their arms and stop resisting (Report No. 8-1, Report No. 8-2, Bielsikov, 2021).

The aforementioned features should be taken into account when determining the initial data for obtaining performance indicators of the Air Defence (AD) and Anti-Missile Defence (AMD) forces and assets of the Armed Forces of Ukraine, as well as other components involved in protecting facilities from air attacks:

1. At the first stage, when determining the requirements and actual numerical values of a military formation's capability indicator, it is advisable to create operational effects during the execution of tasks under specified conditions:

– the goal of protecting (rather than covering) facilities from air attacks should be defined as "preventing destruction or irreparable damage, halting the functioning of, or losing control over facilities due to airstrike means of a military nature, or their combination with actions of a technogenic, natural, or socio-political nature, such as strikes using air defence and anti-missile defence systems, drone attacks, strike aviation, and other airstrike means, by intercepting them on their flight trajectory or diverting them off course away from the critical infrastructure facility";

– among the commonly known tasks for air defence and anti-missile defence forces and assets in achieving defined capabilities within a multi-domain protection environment, the inclusion of space-based systems for early warning regarding the employment and deployment of strike assets

is advisable. This also encompasses Electronic Warfare (EW), cyber protection, cyber attacks, and the alerting of forces and assets about the onset of attack preparation (Fig. 3);

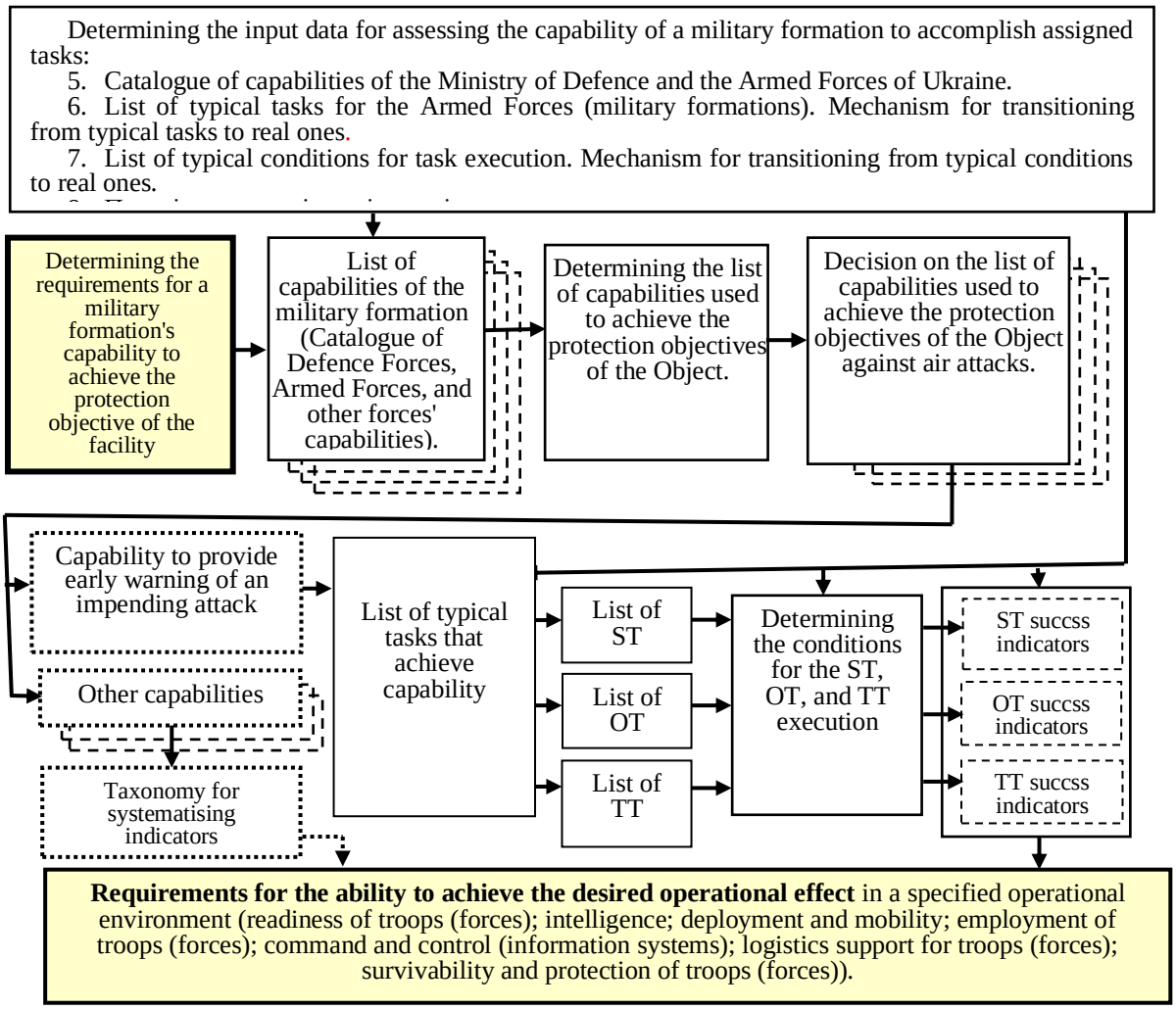


Figure 3. Schematic representation of the sequence for determining the requirements for a military formation's capability to perform typical tasks

– given the criticality of the facilities, success criteria for task performance should be set higher to ensure guaranteed defence against attack and facilitate the restoration of functionality;

– when considering conditions for task execution, the degree of physical protection of the facility and the availability of departmental and private protection means should be taken into account;

– among the requirements for the air defence system to protect facilities from attack, it should be noted that an increase in participants (forces and assets in a multi-domain protection environment) demands enhanced capacity and the ability of the command system to perform all necessary functions for managing forces and assets.

– facilities are classified into four criticality categories based on the potential consequences of their disruption, allowing the establishment of four typical calculation methods for planning air defence, anti-missile defence, and other protection measures. These methods should then be applied to each facility, considering the unique protection characteristics of each in accordance with the

relevant categories.

2. At the second stage, "Capability Assessment," when determining the deficit (or surplus) of the ability of available forces and assets to protect facilities from air attacks, it is advisable to:

– it is essential to measure not only the difference in capability indicators for creating effects in combat actions (operations) by the Air Defence (AD) and Anti-Missile Defence (AMD) systems of the Armed Forces of Ukraine, but also other means for protecting facilities, control elements (C2), and logistics (particularly material and technical support for a diverse range of protection measures);

– to determine the causes of capability deficits and, based on this, develop measures to modify the core components (elements) of capabilities, capability matrices are constructed for each military formation task (specifically, the military formation, the capability bearer) to align existing capability indicators with required standards:

– epending on the analysis task, the number and relevance of such matrices may vary: from a matrix for a single capability bearer to the total number of capability bearers across one or several military formations as a whole;

– when analysing the causes of a deficit (or surplus) in the ability to complete a given task, it is advisable to use not only the analysis of defined capability indicators for creating operational effects but also additional indicators that characterise the facility protection process (particularly when determining the effectiveness of decisions made under various conditions) (Fig. 4).

№	Difference in capability indicators for creating effects in operations (actions)	Doctrines	Organisation	Training	Material logistics	Management quality	Personnel	IInfrastructure	Notes
1	±Δ Preparedness								
2	±Δ Surveillance								
3	±Δ Deployment and mobility								
4	±Δ Employment effectivity								
5	±Δ Control and communication								
6	±Δ Troops logistics								
7	±Δ Forces' survivability and communication								
Total measures for modifying the basic components of capabilities		Measures	Measures	Measures	Measures	Measures	Measures	Measures	Analysis results
Required resources for implementing measures		Resources	Resources	Resources	Resources	Resources	Resources	Resources	Analysis results
Responsible executor		Executor	Executor.	Executor	Executor	Executor	Executor	Executor	Analysis results
Time required for execution		Time	Time	Time	Time	Time	Time	Time	Analysis results

Figure 4. Capability matrices for creating operational effects and the basic components (elements) of capabilities

3. At the third stage, "Determining the options for a list of measures to change the basic components (elements) of capabilities to eliminate or minimise resource deficits," it is advisable to:

– consider that a deficit in the ability to complete a given task should focus on forming the necessary resource volumes to eliminate or minimise it as much as possible. This determination begins with analysing the formulation of the acquired capability, the content and number of tasks, and the pre-defined impact of the basic components on changes in operational capability indicators. The identified measures are generally regulatory, so resource volumes are determined using the same method – the regulatory method;

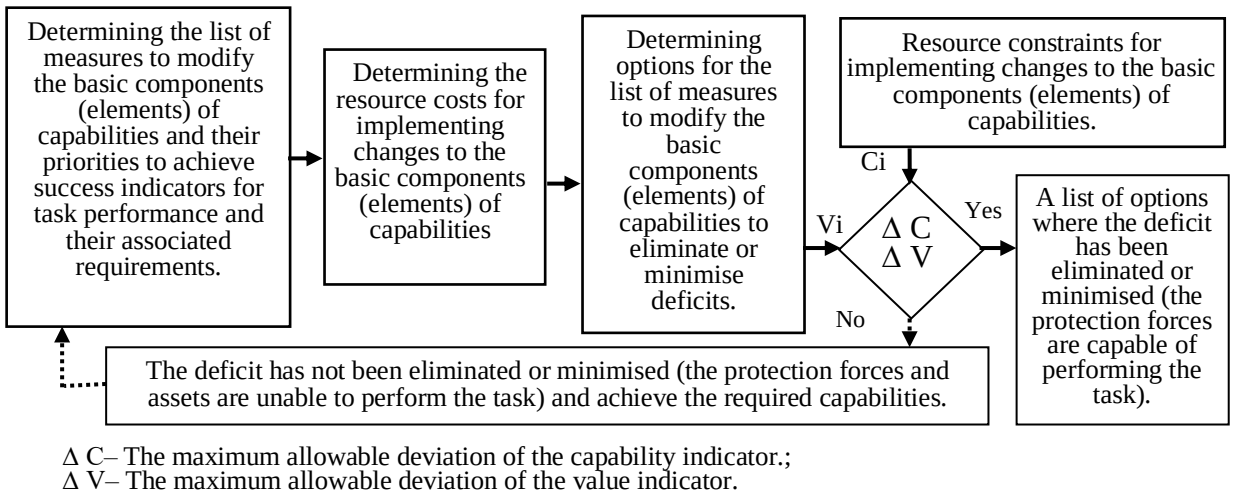
– the identified measures are then used to develop actions for adapting the military formation to operations in the relevant protection environment (operational environment), alongside tasks and measures for its development.

4. At the fourth stage, "Selecting the option for a list of measures where the capability deficit has been either eliminated or minimised," a decision is made on planning the military formation's development (its capabilities – the ability to perform assigned tasks). As a result, it is advisable to:

– form the process for selecting options to modify the basic components and resource expenditure for their implementation, based on the fundamental (initial) capability matrices, defined priorities, resource coordination results (between defence product manufacturers and investors), and limitations set by military-political directives;

– develop 3–4 options for constructing forces and assets to protect 4 typical critical infrastructure facilities, and, based on these, create 3–4 potential lists of measures to achieve the defined capabilities, which should be used during project funding discussions (Fig. 5);

– after selecting and approving the chosen combination that meets task performance capability requirements and remains within resource constraints, a decision is made to approve the future armed forces indicators and initiate planning for their development.



Δ C– The maximum allowable deviation of the capability indicator.;
Δ V– The maximum allowable deviation of the value indicator.

Figure 5. Schematic representation of selecting the option that combines task performance capability and the value of measures to modify the basic components (elements) of capabilities.

Results

The method based on capability assessment for protecting Ukraine's critical infrastructure from air attacks includes the following key characteristics:

The nature of critical infrastructure and the requirements for its protection (in the context of

russia’s large-scale aggression against Ukraine, among other factors);

Defining objectives, the list of protection tasks, conditions for protection in a multi-domain operational environment, and establishing indicators for successful task performance;

The need to manage not only the forces and assets of the Defence Forces of Ukraine and the Armed Forces of Ukraine, but also those of the State Emergency Service, the private sector, and international forces and assets, which determines the specific requirements for the protection management system;

The application of methods to assess the causes of capability deficits, determine measures to calculate the resources needed to eliminate or minimise the deficit, and establish priorities for implementing these measures;

The selection of measures to modify the basic components (elements) of capabilities to meet task performance requirements and remain within allocated resources;

Conditions necessary for transitioning to the planning phase for the development of Ukraine’s Armed Forces.

In its current form, the planning method for defining and developing forces and assets to protect Ukraine's critical infrastructure from air attacks is, in the view of the authors, capable of achieving the intended objectives. It is fully aligned with its core principles and supports the improvement of the protection system.

Discussions

Dieniezhkin (2023) and Serediuk (2020) discuss in their publications the methodological support for applying the planning development method to the Armed Forces of Ukraine and other defence force components, based on capability assessment. The authors (Havryliuk (2023), Sahanuk (2021) focus their work on the adaptation of the capability-based planning method and capability development management, specifically in relation to the Armed Forces of Ukrain, to address their development needs. Dryonov (2021) examines the prerequisites and prospects of implementing the capability-based planning method (the Method) within Ukraine's security and defence sector. Dieniezhkin (2023) explores the military-political aspects of defence management and the potential risks involved in developing and implementing the Joint Operational Concept for the Defence Forces – 2035.

The aforementioned authors, whose list could be extended, have centred their publications and conference or seminar presentations on issues related to the components of the Defence Forces and the Armed Forces of Ukraine. Research on the application of the Method in other areas of state governance, outside the defence sector, is currently absent, highlighting the necessity and timeliness of the authors' attempt to adapt this method for managing the protection of Ukraine’s critical infrastructure.

Conclusion

Thus, the capability-based assessment method allows for resolving issues related to bringing existing forces and resources for protecting Ukraine's critical infrastructure into a state that ensures reliable protection against air attacks.

Recommendations

The proposed features of the capability-based assessment method may prove useful for automating management processes in tasks ensuring the operation of Ukraine's critical infrastructure during both wartime and post-war periods (code: "Protection"). Given the specific characteristics of its application, this method could also be applied to address protection tasks for other facility types.

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