2025-01-0041

A Digital Approach to Safer Munition Storage and Streamlined Permitting Process

Author, co-author (Do NOT enter this information. It will be pulled from participant tab in MyTechZone)
Affiliation (Do NOT enter this information. It will be pulled from participant tab in MyTechZone)

Abstract

In an era of a renewed focus on strategic resilience, nations face increased pressure to adapt and expand their munition storage infrastructure for stockpile readiness.

Ensuring the interior and exterior safety of munition depots while enabling interoperability across borders has become a critical operational and (geo)political requirement. At the same time, many countries struggle to reconcile the urgency of defense expansion with the complexity and length of environmental permitting processes, which are often not adapted to military realities.

To address this dual challenge, we have launched the development of a web-based version of an Explosive Safety Site Planning (ESSP) tool. Its primary goal is to harmonize safety calculations and hence facilitate cross-border interoperability through a standardized framework. As a secondary goal, this harmonization may help streamline and accelerate environmental permitting procedures, often a bottleneck in national and multinational infrastructure projects.

Based on a validated MS Excel-based method used in training and dedicated projects, the platform introduces a modular digital architecture to automate and standardize safety calculations internationally.

The ESSP tool ensures compliance with NATO's Explosives Safety and Risk Management (ESMRM) Policy [1] by embedding technical nuances and risk-based principles from a thorough application of AASTP-1's Quantity Distance (QD) tables [2]. It supports planners in identifying compliant layouts, calculating safety distances, and simulating risk reduction scenarios.

By enabling joint storage planning and embedding safety and environmental compliance early in capability development, the ESSP tool enhances nations' ability to conduct multinational operations with safe, scalable, and efficient logistics. Its digital backbone helps retain institutional knowledge and reduces reliance on fragmented legacy expertise, increasing organizational efficiency and resilience.

This article will outline the ESSP tool's concept, its development roadmap, and its expected impact on safety governance and interoperability.

Context

In the wake of Russia's invasion of Ukraine, NATO has been forced to rediscover the critical role of ammunition in collective defense. As Osman Tasman [3] highlights, the Alliance faces unprecedented challenges in ensuring that ammunition provided by different nations can be used safely and effectively in joint operations. Ammunition interchangeability has re-emerged as a force multiplier, but it is also constrained by fragmented certification practices, limited testing capacity, and diverging national regulations.

These operational realities underline a broader renaissance of ammunition. For decades, European nations reduced stockpiles, sold or abandoned depots, and neglected investment in logistics infrastructure. While demilitarization dominated the agenda, forward-looking stockpile management, transport, and storage were largely ignored. Today, the political reflex is to allocate budgets to rebuild stocks, often expressed in "days of supply." Yet acquisition is only the first part of the puzzle.

The harder question is where and how to store these munitions safely and compliantly. Modern depots must operate within NATO safety standards while also meeting increasingly strict environmental permitting processes, many of which were not designed with defense in mind. Exemptions for military applications that once existed have disappeared, leaving ministries of defense to navigate long, complex approval cycles even as operational urgency grows.

A harmonized Explosive Safety Site Planning (ESSP) framework is a critical enabler of NATO's ammunition logistics. By embedding AASTP-1 safety principles into a digital, NATO-interoperable tool, ESSP provides not only technical compliance but also procedural alignment and a shared understanding of risk tolerability .

In interoperability terms [4], the ESSP tool will help nations to move from Level 1 "deconflicted", where Forces merely avoid interfering with one another, towards Level 2 "compatible" and ultimately Level 3 "integrated", where Forces operate together effectively without technical, procedural or human barriers. The latter level is characterized by common networks, capabilities, procedures and language.

This tool will therefore directly support the Multinational Ammunition Warehousing Initiative (MAWI) [5], which depends on nations being able to apply storage safety criteria consistently across shared depots.

Why?

Primary goal

The primary goal of the ESSP tool is to harmonize safety calculations and facilitate cross-border interoperability through a standardized framework.

At first glance, the Quantity Distance (QD) method may appear mathematically straightforward, being essentially a matter of drawing circles around a Potential Explosion Site (PES) to determine safe distances to an Exposed Site (ES). For a single PES–ES combination this holds true. However, real depots rarely involve a single pair. Even in relatively simple site plans, hundreds of PES–ES combinations must be evaluated iteratively, each requiring consistent application of rules and conditional modifiers.

Moreover, the QD method is often misconceived as a purely "consequence-based" tool. In reality, it embeds numerous risk principles. These derive from decades of empirical data and expert judgement, reflecting unforeseeable reactions of munitions that may occur outside their intended operational scenarios and in many different packaging types and storage infrastructures.

Secondary goal

Beyond harmonizing safety calculations, the ESSP tool may also contribute to a more transparent and therefore faster environmental permitting process, a well-known bottleneck in both national and multinational ammunition infrastructure projects.

On the one hand, compliance with NATO Quantity-Distance (QD) criteria remains the benchmark for explosive safety. Meeting these criteria demonstrates that the residual risk is acceptable within Alliance standards. On the other hand, if a site does not meet QD requirements, a more detailed risk assessment in line with AASTP-4 [6] [7] and ESMRM becomes mandatory. This involves identifying hazards, quantifying their likelihood and potential consequences, and documenting the chosen risk treatment measures together with the decision on whether the remaining risk can be accepted.

Besides, the environmental legislations would impose their own permitting processes, often requiring impact studies, consultation procedures, and alignment with eg. EU SEVESO Directive-type obligations.

Military depots must prepare both an internal storage license and an environmental permit application, even though strategic or classified aspects may limit the public release of information.

Different approaches

Across NATO nations on the European continent, four broad approaches can be observed:

Full civilian regime

Defense must fully comply with civilian environmental and safety legislation, with no exemptions. NATO QD rules (AASTP-1) may serve as guidance, but the legal framework is entirely civilian. This often results in lengthy and complex procedures with little adaptation to military realities.

Example: Luxembourg (Waldhof depot), where QD compliance had to be reconciled with SEVESO-type regional environmental legislation.

Defense-specific exemption with equivalent framework

Civilian SEVESO-style rules formally do not apply, but Defense must adhere to a dedicated military regime considered equivalent in terms of risk control.

Example: United Kingdom, where the MACR (Major Accident Control Regulations) [8] provides a defense-specific alternative to SEVESO obligations.

Grey zone / partial exemption

Defense is exempt from parts of the civilian framework, but without a clearly defined equivalent. Military standards (AASTP-1) are formally applied internally, yet their legal status vis-à-vis regional environmental authorities remains ambiguous.

Example: Belgium, where AASTP-1 serves as the reference for Defense, but environmental permitting is still required under regional legislation, often creating friction or duplication.

NATO framework integrated into civilian regime

Civilian law explicitly incorporates NATO standards, making AASTP-1 the legally binding benchmark. This creates clarity and legal certainty: once QD compliance is demonstrated, approval follows.

Example: The Netherlands, where AASTP-1 is directly referenced in civilian legislation [9].

Partial conclusion

By embedding QD compliance in a digital tool that produces transparent, standardized safety documentation, the ESSP tool will help reduce these discrepancies. It provides a common denominator for both defense authorities and civilian regulators, bridging gaps between regimes, avoiding duplication, and accelerating permitting decisions.

Ultimately, a harmonized ESSP tool offers a minimum condition for credibility in national discussions. It will create the leverage to evolve towards the so-called "Dutch system," where the civilian framework is fully aligned with NATO standards.

Importantly, all relevant expertise is concentrated within NATO's AC/326 Sub-Group C, the body responsible for developing AASTP-1 and its QD methodology. Since all NATO decisions are consensus-based, the tool will reflect common intent, shared best practice, and will incorporate worldwide expert input.

Solution

The new tool will be designed as a layered and modular system that brings together data entry, automated safety calculations, and clear reporting into one coherent environment. This ensures that users can work with standardized inputs and receive transparent outputs, whether the tool is used nationally as a stand-alone application or hosted at NATO level as a shared service. Its structure also allows for future enhancements, such as more advanced risk assessments, optimized layout proposals, or links to geospatial (planning) platforms.

A key lesson from previous NATO digital initiatives is that long-term sustainability must be built in from the start. The ESSP tool will therefore require continuous updates to keep pace with new editions of AASTP-1 and evolving NATO digital policy, as well as regular security checks and resilient hosting arrangements. Equally important is the establishment of a clear governance model, giving nations confidence that the tool will remain reliable, secure, and properly maintained throughout its lifetime. Cost-sharing, trust funds, or tiered licensing models can all provide mechanisms for sustaining this effort.

Experience also shows that digital tools in the defense domain need a strong framework for quality and resilience. Every new version of the ESSP tool will therefore be carefully tested and reviewed before being released, with security built in from the start. Information will be strictly controlled and backed up, weaknesses will be monitored and corrected, and continuity plans will ensure the tool remains available even under adverse conditions. In this way, it will remain trustworthy, compliant with NATO rules, and fit for long-term use in sensitive defense environments.

Development will follow a dual track. On the one hand, a NATO-compliant version will be created as the common reference for interoperability, ensuring that all calculations are accepted and recognized across the Alliance. On the other hand, national versions can be adapted to local needs, for example to support environmental permitting or to integrate with country-specific procedures. What remains crucial, however, is that the technical core of the tool evolves in lockstep with AASTP-1. This guarantees that NATO and national users always work with the same backbone, ensuring consistency in safety assessments while allowing flexibility in application.

Roadmap

Development will proceed in stages. It begins with a joint analysis of requirements, bringing together stakeholders from NATO and partner nations and consolidating more than a decade of lessons from training and field projects. This will lead to the creation of a prototype, which combines data entry, safety calculations, and visualization of depot layouts.

The first working version for NATO, the so-called Minimum Viable Product, is planned to enter development at the end of 2026. This version will include the essential functions and will be tested with lead nations under the scrutiny of NATO's expert community before being made available more widely. From there, the tool will be refined and expanded, incorporating lessons learned and feedback from operational use.

Once validated, the tool will move towards full operationalization: ownership and intellectual property will be secured, licensing arrangements defined, and long-term hosting and support organized. Training, user assistance, and regular updates will ensure that the tool is not only launched but also sustained.

Conclusion

In conclusion, the ESSP tool's concept represents more than a technical upgrade of the existing MS Excel-based method.

By combining a NATO-compliant core with national flexibility, and by ensuring continuous alignment with AASTP-1, the tool will help streamline safety governance and environmental permitting alike.

The roadmap starting at the end of 2026 provides a clear path from concept to operational use of a tool with a clear view on its life cycle management with a high security standard.

Ultimately, this initiative will reinforce NATO's ability to store and manage ammunition safely, efficiently, and in full interoperability across borders.

References

1. STANAG 2617: ALP-16: EXPLOSIVES SAFETY AND MUNITIONS RISK MANAGEMENT (ESMRM) IN NATO PLANNING, TRAINING, AND OPERATIONS; Edition A, Version 2 FEBRUARY 2023
2. STANAG 4440: AASTP-1: NATO GUIDELINES FOR THE STORAGE OF MILITARY AMMUNITION AND EXPLOSIVES; Edition C, Version 1 MARCH 2023
3. Tasman Osman, "The NATO Ammunition Interchangeability Challenge in the Land Domain". DECEMBER 2025
4. STANAG 2437: AJP-01; ALLIED JOINT DOCTRINE Edition F Version 1 DECEMBER 2022
5. Multinational Ammunition Warehousing Initiative (MAWI) https://www.nato.int/nato_static_fl2014/assets/pdf/2021/6/pdf/2106-factsheet-mawi.pdf; FEBRUARY 2022
6. STANAG 4442: EXPLOSIVES SAFETY RISK ANALYSIS - GUIDELINES FOR RISK-BASED DECISIONS - AASTP-04 VOL I EDITION B; NOVEMBER 2024
7. STANAG 4802: EXPLOSIVES SAFETY RISK ANALYSIS - TECHNICAL BACKGROUND - AASTP-04 VOL II EDITION B; NOVEMBER 2024
8. DSA 03.OME part 4: Major Accident Control Regulations (MACR)
9. MP 40-21: "Voorschrift Opslag en Behandeling Ontplofbare Stoffen en Voorwerpen Defensie"

Contact Information

Mail: Info@sentadvice.be

Tel: +32(0)476599266