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Stockpile Management: Surveillance and Proof[1]

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Overview

Surveillance and proof are essential to ensuring the safety, reliability, and operational effectiveness of conventional ammunition. This chapter summarizes the requirement for the in-service proof and surveillance of ammunition within national stockpiles.[2] It stresses that many states suffer a deficit of technical expertise in ammunition management. The importance of surveillance and proof in these cases is often poorly understood, leading to failings in ammunition safety and stability.

Surveillance and proof

Surveillance is a systematic method of evaluating the properties, characteristics, and performance capabilities of ammunition throughout its life cycle. It is used to assess the reliability, safety, and operational effectiveness of stocks. Proof is the functional testing or firing of ammunition and explosives to ensure safety and stability in storage and intended use.

In-service proof and the surveillance of ammunition are undertaken to ensure that the ammunition continues to meet the required quality standards throughout its life. Quality, from this perspective, includes the performance of ammunition during use and its safety and stability during storage. The chemical, electrical, and mechanical properties of ammunition change and degrade with time, leading to a finite serviceable life for each munition. The accurate assessment of munition life is of paramount importance in terms of safety and cost.

Although the life of an item of ammunition is often determined by safety considerations related to energetic materials, this may not always be the case. The deterioration, due to ageing, of non-energetic components such as rubber seals, electronic components, and structural materials can also limit the safe life of the ammunition by affecting safety or performance parameters. It is important that the whole system is considered when assessing life-limiting factors for ammunition, not just the propellant or other energetics.

States often initially use the fact that shelf life has expired to try and justify the use of donor resources to fund stockpile destruction. This justification is technically inaccurate, as shelf life only provides an indication of the performance of ammunition, and not necessarily of its safety and stability in storage.

Rationale for surveillance and proof

The safety and stability of ammunition and explosives in storage can only be established by a comprehensive ammunition surveillance system that uses a methodology of both physical inspection by trained personnel and chemical analysis. Surveillance is carried out systematically by evaluating the characteristics and properties that the ammunition type possesses and measuring how the ammunition performs throughout its entire life cycle. This will, in turn, allow assessment of the safety, reliability, and operational effectiveness of the ammunition. Only then can safety in storage be properly assessed. The use of ammunition surveillance can then be used to extend shelf life, if appropriate. Shelf life extension may provide significant financial savings, as there will be no need to procure new ammunition.

Ammunition is subjected to technical surveillance and in-service proof for a wide range of reasons. It is a vitally important component of responsible ammunition stockpile management, and is the only way that the safety and stability of ammunition stockpiles can be properly addressed. Major reasons include:

- ensuring the safety and stability of ammunition in storage;
- ensuring the safety, reliability, and performance of ammunition during use;
- predicting, and therefore preventing, ammunition failures that are inherent in their design or are the result of ageing;

- monitoring the environmental conditions that the ammunition has been stored in;
- ensuring that the first point of detection of catastrophic failure is not the user;
- predicting failure and degraded performance in order to support effective ammunition procurement cycles;
- predicting future performance, service life, and limitations; and
- identifying and monitoring critical characteristics of the ammunition that change with age and exposure to the environment.

Degradation and service life

Each ammunition type will age slightly differently from every other, and within ammunition types there are many complicating factors that will affect how they age. In addition, there will always remain the risk of a random, unforeseen event (such as from an error in manufacture) that can cause an individual item, within an otherwise homogeneous group, to fail over time. For most ammunition, one or two of the degradation mechanisms will limit its available life. Some of the more common failure mechanisms include (but are not limited to):

Energetic materials:

- de-bonding between the material and inert surfaces;
- stabilizer depletion within the energetic material;
- migration of the mobile species within the energetic material;
- cracking of brittle materials; and/or
- compatibility problems.

Electronics:

- component ageing; and/or
- component shock damage.

Structure:

- O-ring failure;
- mechanical damage (impact, corrosion); and/or
- vibration.

In addition to the physical damage caused by shocks and vibration, ammunition also degrades chemically. The energetic items that cause the explosive effect are invariably of organic chemical composition, and, in common with all other chemical compositions, they break down, migrate, or change over time. This change is normally accelerated with increased temperatures. Degradation may also be hastened by large variations in temperature (i.e. cycling from hot to cold), low temperatures, high or low humidity, vibration, shock, and pressure.

In order to assess the rate at which these factors may develop, ammunition is tested during its introduction to service, and a service life is assigned to it. The service life is based on the expected in-service usage of the ammunition and the amount of time its chemical components are expected to remain within performance limits and safe for use. As this is an inexact science, and to ensure that the service life prediction remains valid, worst-case assumptions are traditionally made regarding the environment that the ammunition will experience. Thus, when the end of service life is approaching, a life-extension programme should be formally sought. This will inevitably require non-destructive testing or live firing to determine the condition and performance of the ammunition. If this condition is better than predicted, extra life may be approved.

Progress to date

In many post-conflict and developing countries there is no residual technical expertise in ammunition management and often no understanding within the wider military as to the importance of surveillance and proof in terms of ammunition safety and stability. This can result in a range of consequences. First, ammunition can be unsafe in storage, with the subsequent likelihood of undesirable explosive events leading to fatalities (CHAPTER 13) and major unexploded ordnance clearance requirements. Second, individuals within the military may be unnecessarily placed at risk while working in ammunition storage areas. Third, it may cause unnecessary accidents during training, leading to fatalities and injury. Finally, the poor performance of ammunition during operations can result in misfires and stoppages,

leading to a breakdown in the morale of troops as they lose confidence in the ammunition.

Effective ammunition management, including surveillance and proof, requires a systems-based approach implemented by appropriately trained and qualified personnel (CHAPTER 8). Training of ammunition technical specialists is a long-term process. For example, the North Atlantic Treaty Organization course for ammunition technical officers is now over 15 months long. Even basic ammunition management training takes months, not weeks, and is often overlooked by state security forces in post-conflict or developing countries during security sector reform.

Conclusion

Ammunition is required to function correctly and predictably, despite having to withstand exposure to a wide range of environmental conditions. In addition, it must remain safe during handling, storage, transport, use, and disposal. The level of degradation of its components determines the safety and suitability for use of a particular ammunition type, whether through being subjected to a normal service environment or after exposure to extreme conditions (such as shock damage, heat, humidity, rough handling, etc.).

The accurate assessment of ammunition life is therefore of paramount importance in terms of safety, performance, and cost. Historically, this lifespan has been calculated based on worst-case assumptions and generic environmental storage conditions, but the introduction of ammunition life assessment is now refining this process to ensure the best use of resources.

Many countries do not have the technical expertise to conduct effective ammunition surveillance and proof. As a result, ammunition deteriorates, becomes unsafe and unstable, and poses a risk to military assets and the public. While some donors provide technical assistance and training to countries that lack ammunition management expertise, many more national stockpiles remain at risk from a combination of inadequate ammunition management and ignorance as to the vital role of surveillance and proof.

Notes

1 This is now developing into a wider-ranging concept of munitions life assessment as part of an integrated test, evaluation, procurement, management, and disposal process.

2 The chapter does not cover the testing, evaluation, and proof of ammunition during development and acceptance into service. Nor is it designed to provide information on the wide range of proof or surveillance techniques available.

3 The references are only available from NATO or the UKMoD on formal request.

Further reading[3]

NATO (North Atlantic Treaty Organization). 2001. *STANAG 4170: Principles and Methodology for the Qualification of Explosive Materials for Military Use*. Brussels: NATO. 16 February.

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UKMoD (United Kingdom Ministry of Defence). 2005. *Defence Standard 05.101, Part 1: Proof of Ordnance, Munitions, Armour and Explosives*. London: UKMoD. 20 May.