



SAFETY SERVICES ORGANISATION



Session 6.3

Surveillance & In-Service Proof

Ammunition Safety and Performance Module



Lesson Objectives

By the end of this lesson you should be able to:

- **Explain the concept of ammunition Surveillance**
- **Explain the concept of ammunition In-Service proof**
- **Describe the chemical and environmental degradation effects upon ammunition and explosives**
- **Explain the relatively dangerous aspects of degradation and auto-ignition of propellants in storage and use**



Introduction and Definitions

- **‘Surveillance’** refers to a systematic method of evaluating the properties, characteristics and performance capabilities of ammunition throughout its life cycle in order to assess the reliability, safety and operational effectiveness of stocks and to provide data in support of life reassessment
- **‘Proof’** refers to the functional testing or firing of ammunition and explosives to ensure safety and stability in storage and intended use
- **Service Life**
- **Storage Life**
- **Stability**



Rationale

- **The safety and stability of ammunition and explosives in storage can only be established by a comprehensive ‘ammunition surveillance’ system, specifically to ensure:**
 - The safety and stability of ammunition
 - That ammunition performs reliably
 - The efficient monitoring of environmental conditions

Responsibilities

- The appropriate national technical authority should be responsible for:
 - development and promulgation of an in-service proof and surveillance plan;
 - ensuring the plan is carried out;
 - analysis of results and tests;
 - ensuring ammunition is allocated a condition code;
 - rapid identification of unsafe stocks; and
 - ensuring the disposal of life-expired stocks within an expedient time period.
- The surveillance and proof tasks can be mandated to different entities



Requirements

- **Surveillance and ISP require a range of capabilities to ensure an effective system, including:**
 - An ammunition management plan
 - Trained staff
 - An explosives laboratory
 - Effective sampling mechanisms
 - An efficient accounting system

Requirements

- **Minimum staffing responsibilities are required to ensure an effective system. The following must be considered:**
 - The creation of a plan for each in-service munition and that the plan is carried out
 - The results of analysis and tests are published and acted upon
 - That 'condition codes' are allocated to ammunition
 - The rapid identification of stocks that are unsafe to store or use
 - That the disposal of expired stocks takes place



Ageing, Degradation & Quality Standards

- **Describe how a number of influences can affect the ageing and degradation of munitions such as:**

Energetic Materials may:

- De-bond between material and inert surfaces
- Stabiliser depletion within the energetic material
- Migration of compounds within the energetic material
- Cracking of brittle materials
- Compatibility problems

Ageing, Degradation & Quality Standards

- **Electronics may:**
 - Age and become sub-optimal
 - Suffer shock damage
- **Structural components may:**
 - Fail, e.g. O-rings
 - Suffer from impact, corrosion or vibration damage
- **Environmental conditions such as:**
 - Temperature cycling (hot/cold/hot/cold)
 - High and/or low temperatures
 - Vibration, shock and pressure



Zygi, Cyprus 11 July 2011

- The Evangelos Florakis Naval Base explosion was the worst peacetime military accident ever recorded in Cyprus. The incident occurred on 11 July 2011, when **98 containers of explosives that were being stored for 2½ years in the sun** on the Evangelos Florakis Naval Base near Zygi self-detonated.
- The resulting explosion **killed 13 people**, 12 of them immediately, including Captain Andreas Ioannides, the Commander of the Navy (Cyprus's most senior naval officer), and the base commander, Lambros Lambrou. Also killed were four navy personnel and six firefighters, while a **further 62 people were injured**. The explosion severely damaged hundreds of nearby buildings including the island's largest power station, responsible for supplying over half of Cyprus' electricity. As a result, **much of Cyprus was without power** in the immediate aftermath of the incident and rolling blackouts were initiated in order to conserve supplies.
- As a result of the incident, the Cypriot Defence Minister and the Commander-in-Chief of the Cypriot National Guard both resigned. Angered by the government's failure to dispose of the munitions, which had been seized in 2009, several thousand citizens staged demonstrations in the capital Nicosia and other cities, every day in the week following the accident.



Ageing, Degradation & Quality Standards

Planning Surveillance is significantly enhanced by:

- **Design evaluation**
- **Baseline data**

Climatic impact on degradation of explosives

Ammunition design for specified climatic conditions

Reduction of service life outside these parameters

Design surveillance regime to account for:

- **Weather**
- **Hot/cold temperatures**
- **Direct solar radiation**
- **Diurnal cycling**
- **High humidity**



Ammunition Quality Standards (IATG 07.10)

- National Technical Authority assesses the appropriate quality level required for the national stockpile
 - Surveillance data
 - Accidents
 - Faults

Typical Quality Standards (IATG 07.10)

- Standard Acceptance Limited Quality (SALQ) is the minimum for ammunition accepted into operational service
- Functional Limited Quality level (FLQ) is the minimum quality standard for ammunition that may be used operationally
- Operational Limited Quality level (OLQ) is the minimum quality standard for ammunition to remain in service for either operations or training

Ammunition Type	SALQ	FLQ	OLQ
Small Arms Ammunition (SAA)	99%	96%	92%
High Explosive (HE) Ammunition	97.5%	92%	85%
Ammunition for Training	92.5%	85%	75%



Ammunition Quality Standards (IATG 07.10)

- What would you set as the SALQ, FLQ and OLQ for a shoulder-launched anti-tank rocket?



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High Explosive (HE) Ammunition	97.5%	92%	85%
Ammunition for Training	92.5%	85%	75%

Surveillance

- **This is a process of conducting regular checks on the condition of a nation's stocks against in-service predictions**
- **It is vital to gather all available data on specified munitions before inspecting the stocks**
- **Testing is an important aspect of Surveillance determining the state of munitions. These tests include:**
 - Radiography testing
 - Non-destructive testing
 - Visual inspections

Surveillance

- **An effective Surveillance process should be able to confirm munitions exposed to:**
 - Harsh environmental conditions
 - Physical damage
 - Changes to the physical and chemical characteristics of energetic and non-energetic materials

Selection of Munitions for Surveillance and ISP

- **The selection mechanism for the surveillance of munitions should be included in the in-service proof and surveillance plan, for that particular type of munition.**
 - It should be primarily based on the following criteria:
 - Age
 - Exposure to adverse climatic conditions
 - Length of time held by units and not by specialist ammunition depots
 - Ammunition that has displayed unusual performance during training
 - Number of times handled or transported
 - Number of tests already conducted on the munition



Surveillance

- Effective surveillance and record keeping can prevent explosive accidents in storage or transport
- Munitions recovered from abandoned post-conflict stockpiles should never be used and must be destroyed

In-Service Proof

- **In-Service Proof is:**

- Applied to weapon systems to assess muzzle velocity, chamber pressure and other performance characteristics
- Used to assess fuze time delays and stimuli for grenades and mines
- Assess burning rates and chamber pressures for pyrotechnics and rocket motors

In-Service Proof

- ISP is used to provide the continued assurance of performance and to predict how future performance may degrade.
- This can then be used against expected estimates for the shelf-life of specific munitions and helps with stockpile management.
- This process may also be used to extend the shelf-life of some munitions beyond their predicted useful life
- All such actions are to be properly recorded

Environmental Monitoring

- Effective environmental monitoring should be conducted on munitions during their life-cycle
- This can enable more accurate predictions on a munition's predicted shelf-life and gain better value for money.
- Use of data loggers and temperature gauges are methods by which monitoring may be conducted
- All monitoring results must be recorded within central databases

Chemical Stability of Propellants

- Of all types of chemical degradation, the auto-ignition of nitrate ester-based propellants poses the most dangerous situation
- Safety point: The observation of brown-coloured fumes emanating from propellants indicates that auto-ignition could occur at any moment

Chemical Stability of Propellants

- Single and double based propellants using nitrocellulose and nitroglycerine can decompose even in ideal storage conditions due to autocatalytic decomposition
- The use of chemical stabilisers can help to slow down the above process
- Adverse storage conditions have a critical bearing on the stability of propellants

Chemical Stability of Propellants

- A number of differing tests can be conducted on propellants to analyse and predict the ageing effects
- This assists with gaining knowledge on the safe use of such explosives
- Sampling techniques can be used on propellants to assist with surveillance
- The use of a stability test schedule on National stockpiles is good practice and helps determine explosive safety

Points to note

- Propellants especially, pose a serious danger of nitrocellulose breakdown and spontaneous ignition which requires monitoring
- These Surveillance and In-Service Proof processes increase the cost effectiveness of stockpiles by reducing non-operational stock levels and extending the shelf life of ammunition

Questions

Lesson Objectives

You should now be able to:

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