New Safety Requirements For Munitions
Fuzing System Solutions

54th Annual Fuze Conference
"The Fuzing Evolution – Smaller, Smarter and Safer"

Kansas City, MO - May 11-13, 2010

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Outline

- Safety Issues
- Conventional Requirements
- New Safety Requirements – Trends
- Fuze Safety - Technical Solutions
  - Before safe-separation phase
  - After safe-separation phase
  - Post-conflict phase
- Fuze Technologies
Company Presentation

- A global leader in the field of ammunition fuzes and S&A devices
- Full range of products
- Key competences in
  - Fuzing technologies
  - Micro-technologies
  - Ammunition electronics
Munitions – Safety issues

- The Fuze is the key element to guarantee safety and protection to the crew throughout the logistical and tactical cycles.

- Modern warfare means new safety requirements for munitions.

- This leads to new challenges for the fuze designer, who will have to implement new safety concepts and technical solutions.

... while

- Keeping and enhancing the fuze reliability.
- Dealing with munition constraints as small size and low cost.
Safety: Conventional Requirements

Prior to Safe Separation phase

Firing / Launching Safety

Storage, Transportation & Handling Safety

Then …

Target
Safety: New Requirements

Prior to Safe Separation Phase

Target

Storage, Transportation & Handling Safety

Firing / Launching Safety

Enhanced safety
IM
Two Safety Criteria
Modern weapon severe environment

A Diehl and Thales Company
Safety: New Requirements

Prior to Safe Separation Phase

- Enhanced safety
  - IM
  - Two Safety Criteria

- Modern weapon severe environment

Firing / Launching Safety

Overhead / overflight safety

Mission Abort

Reduce Collateral Damage / Friendly Fires

Flight or Active Phase

Storage, Transportation & Handling Safety
Safety: New Requirements

- Enhanced safety
- Modern weapon severe environment
- Overhead / overflight safety
- Mission Abort
- Reduce Collateral Damage / Friendly Fires
- Increased Reliability for UXO reduction
- Self-Resafing
- Self-Destruct
- Safe / Eco Demilitarization & Disposal
- Overhead / overflight safety

Prior to Safe Separation Phase:
- Storage, Transportation & Handling Safety
- FIring / Launching Safety

Flight or Active Phase:
- Increased Reliability for UXO reduction

Post-conflict Phase:
- Safe / Eco Demilitarization & Disposal

IM
Two Safety Criteria
Safety Requirements: Standards and Trends

- Still usual safety related standards, with continuous improvements, + issue with new technologies
  - e.g STANAG 4187, STANAG 4170, STANAG 4368

- New International agreements and protocols, which lead to obligations or recommendations
  - Mainly related to post-conflict hazards: e.g CCW / CCM UN Protocol
  - Not strictly regulatory but require consideration for any country armies and industry (political issue)
  - Sometimes extended by some governments to other related products

- Media and public opinion pressure
  - Beyond strict regulation
  - Environmentally friendly policy
  - NGO pressure
  - Relevance: sometimes questionnable ?
Fuze Safety Requirement and Solutions (Before Safe Separation)

Main requirements

- Capability to withstand more and more severe firing/launching environments, e.g. with modern howitzer systems or longer carriage time for air-launched munitions
- IM (Insensitive Munition) capability
- Full compliance with STANAG 4187 mainly regarding the 2nd safety feature

Technical solutions

- More G-hardened fuzing solutions
- Implementation of 2nd environment sensor: mechanical or electronic
- IM explosive trains: IM materials, ESAD technology
Fuze Safety Solutions (Before Safe Separation)

- **Hardened design**
  - Design able to withstand harsh environment: 52 cal. gun, Flickramming systems
  - Examples:
    - New generation MOFA fuzes
    - New generation PD fuzes

- **2nd environment sensors**, in particular for non-spinning projectile
  - Mechanical sensor (e.g. relative wind detection)
    - New generation of mortar mechanical fuzes
    - Bomb fuzes

- **Electronic sensors and signal processing**
  - Wind sensors
  - Magnetic sensors
  - Pressure sensors
  - Accelerometers
  - MEMS technology
Fuze Safety Solutions (Before Safe Separation)

- IM explosive train
  - Use of IM energetics material and appropriate safety design
    - Issue for the fuze designer: Need to keep a high energetic power as the munition material is more difficult to initiate!
  - Specific packaging design
  - Relevance of IM single fuze testing vs complete round?
    - Depends on the ammunition type
Fuze Safety Solutions (Before Safe Separation)

- IM Fuze: Use of ESAD / EFI technology
  - Naturally Insensitive solution, in particular with respect to ECM, ESD and shocks
  - In-Line SAU
  - Electronic control of the arming sequence
  - Testing capability
  - Re-safing capability

- Today applied on "high-value" fuzes
  - Air-bomb fuze
  - Missile SAU
Fuze Safety Requirement and Solutions (After Safe Separation)

- **Main requirements**
  - Overhead / overflight safety: no early burst when flying over friendly forces
  - Mission abort: control the fuze or munition status/behaviour during flight when an unexpected event, possibly hazardous, is detected

- **Solutions**
  - Management of the fuze activation and status during flight from safe separation to target vicinity
Fuze Safety Solutions (After Safe Separation)

- Overhead Safety
  - Inhibition of fuze operating in flight (electronic)
  - or
  - Late arming of the SAU, just before intended function on target

- Possible use of environmental sensors providing flight condition information

- Linked to the programming capability, (or remote control) of the fuze:
  - Inhibition or arming time to be set in the fuze control electronics
  - Real-time activity control

- Supposes safe design and architecture, for hardware but also software, incl. data link protocol
Fuze Safety Solutions (After Safe Separation)

- **Mission abort function:**

- **New requirement, now necessary with guided munitions (land or airborne) or with course correction fuzes, when:**
  - Detection of internal operating fault (built-in test)
  - Guidance problem or target identification issue, internally detected or controlled by the weapon system
  - Main issues: Define the appropriate behaviour? What is the safest action? What is a fail-safe design in that case?
  - Fuze functions offer various type of “safe” actions
    - De-activation
    - Self-destruction
    - Self-neutralization or Self-sterilization
  - The relevance of the action to achieve depends on the flight phase or on the specific operational configuration
Fuze Safety Requirement and Solutions (Post-conflict Safety)

- **Main requirements**
  - Preventing hazards after the “military” mission is finished:
    - Enable friendly force manoeuvre in the area where munitions have been used (short term)
    - Keep conflict area safe and cleared for any UXO and ERW prior to civilian population returning (medium/long term)
  - + safe disposal and demilitarization of stockpile

- **Solutions**
  - Best solution: get high reliability of the fuze functions and of the operating on target
  - When difficult to achieve, not because of the fuze function, but due to the target configuration: ➔ safe fuzing backup functions
UXO reduction: Safe backup functions

- **Self-destruct function**
  - Various solutions: pyrotechnical / pyromechanical / electronic
    - Infantry grenade fuze
    - Direct fire fuzes
      - Medium caliber
      - Tank ammunition
      - With and without air-burst function

- PD backup

- **Self Re-safing**

- ... High reliability fuze
New Safety Requirements
Common Needs – Common Technologies

- The new needs and requirements applies to all arms:

Common fuzing technologies and technical solutions can be shared with various applications
Conclusion

- The fuze designer / producer has a key role in the munitions performances and in particular with respect to the reliability and safety requirements.

- Dealing with the new safety requirements, for all arms, suppose the implementation of more complex, but reliable, safety solutions using various technologies,

  ... and always: low cost / small size / low power

- Thanks to its technological leadership JUNGHANS is able to take up technological challenges to provide the user with
  - Safe, reliable and affordable fuzes
  - For current and next generation fuzing systems