NEW FUZING SOLUTIONS FOR IMPROVED SAFETY AND OPERATIONAL CAPABILITIES

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JUNGHANS Defence
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- Challenges and Solutions For New Safety Requirements
- Challenges and Solutions For New Operational Capabilities
JUNGHANS Defence – The Fuze Company

Complete Range of Fuzing Systems

- Fuzes for all types of munitions
- Safety & Arming Devices and Fuzing Modules for Missiles and Complex Weapons

Key competences in Fuzing technologies, Micro-technologies and Ammunition electronics

Two Centers of Competences located in Germany and France
Safety Requirements - Trends

Legacy Safety Requirements

New Safety Requirements

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Safety Requirements - Trends

New Safety Requirements

- Extended safe separation distance
- STANAG 4187 Compliance – all munition fuzes
- STANAG 4368 Compliance (Rocket Motor)
- IM features
- New Weapons Systems (automatic loading / ramming, extended range, new propulsion...)
- Enhanced overflight inhibition/safety
- New Guided Munitions requirements (mission abort, arming control)
- Post-conflict "Safety" (UXO, hazardous duds, Return to safe status, ...)

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Operational Capabilities / Terminal Effect - Trends

Target Detection
Terminal Effect Optimization

- Multi-function
- Scalable effects

Operating Modes

- Point Detonating (Impact)
- Time
- HoB
- Proximity
- Air - defence
- Impact Delay

- Graze Impact
- Soft ground operation
- Time accuracy
- Direct fire / programmable airburst
- Easy integration of Fuze Setter
- HoB accuracy / type of surface
- HoB selection
- Implementation on new munitions

"Tricky targets":
- UAV
- Sea-skimmer missiles
- Fast Inshore Attack Craft
- Hard Target Fuzing
- for A-G weapon, Tank ammo, rocket and missile
SOLUTIONS FOR NEW SAFETY REQUIREMENTS
STANAG 4187 Compliance – Dual Safety Features

- Now required for all new munitions
- Still challenging to the fuze designer

Flight environment detection
in particular for non-spin or low-spin munitions

Relative wind measurement
- Wind-wheel (for mechanical fuzes)
- Wind generator (for electronic fuzes)
- Pressure / airflow sensors

Other flight characteristics measurement
- Low spin sensing (mechanical or electronic)
- Accelerometers / Signal processing
- Magnetic sensors

Space requirements for medium caliber fuzes

Small size / Miniaturization of S&A Devices and Firing trains

DM111S PD Fuze for Mortar Ammunition

Dual Safe Fuze for Air-to-Ground Rocket (THALES 68mm)

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**STANAG 4368 Compliance – Motor Ignition Systems**

- Ignition Safety Devices now required for all new generation rocket and missile motor ignition
  - Comparable to safety requirements for warhead S&A units
  - Capability to revert back to "non-armed" status

**Interrupted train solutions (pyrotechnic)**
- Electromechanical ISD

**In-line solutions EFI/LEEFI-based**
- Use of EFI (Exploding Foil Initiator) or LEEFI (Low Energy EFI)
- Possibility of multi-pulse ignition (dual stage motor)
- Adaptation to various form factors

**Laser ignition**
- Optical interrupted train
- Electromechanical ISD (optical switch)

**Fully electronic ISD**

LEEFI-Based ISD with TBI

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With TBI (Through Bulkhead Initiator)
or
Direct ignition of propellant
**New weapons systems – Fuze Design and Safety Requirements**

- New generation of weapon systems generate more severe firing environments
- This has an impact on fuze design, in particular regarding safety features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Impact</th>
<th>Requirement</th>
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<tbody>
<tr>
<td>Automatic loading systems for howitzer</td>
<td>High shock prior to firing</td>
<td>Robust design of SAD and battery activation system</td>
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<tr>
<td>(flick-ramming)</td>
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<tr>
<td>Automatic loading systems for mortar</td>
<td>No man-in-the-loop -&gt; Removable Safety pin issue</td>
<td>2nd safety feature – fully autonomous (flight detection)</td>
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<tr>
<td>Extended range artillery (artillery fuzes)</td>
<td>High muzzle velocity</td>
<td>Reinforced fuze design / specific materials</td>
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<td>Long carriage flight time (aircraft bombs)</td>
<td>Long flight time: body heating issue</td>
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<td></td>
<td>Severe vibrations environment</td>
<td>Fully electronic design (Electronic SAD based on EFI/LEEFI)</td>
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New Guided/Smart Munitions - New Safety Requirements

- New generation of munitions, as guided and "smart" munitions, provide new functionalities for new operational capabilities
  - These new functionalities lead to new requirements regarding safety management (+ possible impact on reliability)

- **Overflight Safety**
- **Control of arming delay**
- **Mission abort**
- **End-of-Mission Safety**

**Flexibility and full control of the safety and arming function**

**Safe datalink protocol between weapon and S&A function**

**"Safe" action definition?**
- De-activation, Self-destruction
- Self-neutralization, Self-sterilization, ...

**Electronically controlled S&A Device**

**Electromechanical S&A Device**

**Electronic S&A Device "in-line" technology (EFI/LEEFI)**

**Fail-safe design (hardware and software)**

**Use of safety signals provided by the weapon + use of environmental sensors providing flight condition information**

**Fuze can achieve such actions: issue is to define the relevant action (system issue)**
SOLUTIONS FOR NEW OPERATIONAL CAPABILITIES
Optimizing Burst Position at Target – Proximity fuzing

- Objective: provide optimum terminal effect at target, with fully autonomous fuze

- Implementation of proximity function in new munitions
- Incorporate Proximity Module in available space, with environmental issues
- Proximity Module with flexible design and adaptable form-factor

- Air-defence, Naval and littoral warfare
  Attack of "tricky targets"
- Ability to detect a variety of targets, in difficult environment
- New State-of-the-Art FMCW sensor with digital signal processing

- Achieve proximity function for Land Combat / Urban Warfare weapons
- Ability to detect a variety of targets, not very well characterized, in a very tricky environment
- Still very challenging!
  Alternative option: programmable airburst

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Optimizing Burst Position At Target – Airburst Fuzing (Programmable Time)

- Objective: provide optimum terminal effect at target by airburst operation, controlled with programmed time
  - Achieving "proximity" operation when proximity is difficult or not possible
  - e.g. land combat / urban warfare

Limitation of integration issues

Program the fuze without requiring substantial change of the weapon system for fuze setting integration

Achieve fuze setting at muzzle exit or in-flight

Time accuracy / Correction of deviations

Ability to
- measure relevant flight parameter deviations (e.g. $V_0$)
- Correct the set time

Autonomous solutions: on-board correction with "cooperative" system or fully autonomous

System controlled solutions: Measurement $V_0$ + corrected order sent by the system
**Multi-function Fuze Issue**

- Objective: to improve operational flexibility with fuzes able to achieve all operational missions, whatever the requested and relevant operating mode
  - Optimized value for money, from an overall mission perspective
  - Obvious benefits but possible trade-offs and challenges for the fuze designer

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"One-fits-all" but not with discounted performances

- Ability to achieve the required function with the same performances than a single dedicated fuze

- Now possible with the implementation of state-of-the-art electronics, sensors and signal processing

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Keep interoperability and independence to the weapon

- No substantial change to the weapon system. Possibility to use on different weapon systems

- • Autonomous fuze, capable of automatic mode selection
  - • Fuze setting devices not "intrusive" with the system (e.g. in-flight prog.)
Conclusion

- Fuzes and fuzing systems are fundamental contributors to safety and operational capabilities of munitions and missiles
  - Modern fuzes have to deal with new requirements in terms of operational effectiveness and safety features
- New technologies in micro-mechanical systems, electronics and sensors lead to significant improvements in new generation fuzes, providing solutions to meet these new requirements
- As a dedicated Fuze Company JUNGHANS Defence is able to
  - leverage and share such solutions for the benefit of various fuze applications
  - take up technological challenges to provide the war-fighter with state-of-the-art and efficient fuzes
YOUR TRUSTED PARTNER
for smart and reliable fuze solutions

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