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The Army Fuze Safety Review Board Process & Spider

Mines, Demolitions and Non-Lethal Weapons Conference

New Orleans, LA - September 9-11 2003

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Research, Development & Engineering COMmand

Chronological Perspective

Fuzes were either mechanical, electrical or electro-mech designs w/o SW

Many fielded munitions & fuzes have sophisticated electronics with ICs, ASICs, etc. containing SW but not performing safety critical functions

More SW intensive munitions, e.g.,Spider & IMS, are being developed.

ARMY FUZE SAFETY REVIEW BOARD

- In existence since early 1970s
- Authority:
  - Army Regulation 385-64, U.S. Army Explosives Safety Program, (paragraph 1-4.e. (3))
  - Chartered by CG, AMC in 1995
- Chaired by the Director, Army Fuze Management Office

WHY IS THERE AN AFSRB?

- Safety is an Inherent Governmental Function
  - Need to assure munitions issued to field are safe for intended application
  - Fuzes are heart of munition's safety system
  - DoD is repository of corporate memory
- Appraisal of safety is judgmental & based on:
  - Experience
  - Testing
  - Engineering principles and best practices
- Above has led to generation of Mil-Stds-1316 (Fuze Design Safety Requirements) and 1911 (Design safety requirements for hand-emplaced munitions), and corresponding STANAGs 4187 and 4497

WHAT DOES THE AFSRB DO?

- Performs a safety review of fuze designs by an independent panel of experts
- Renders an appraisal of the level of safety inherent in the design
- Strives to ensure an acceptable level of safety is present in all Army fuzes and hand emplaced munitions
- Presents findings and recommendations to PM
- Issues Safety Certifications

SAFETY CERTIFICATIONS

- Three Types
- Initial Safety Certification issued at request of test agency or project team (non mandatory)
- Interim Safety Certification issued prior to Type Classification to allow beginning of initial production (mandatory)
- Final Safety Certification issued prior to Materiel Release to allow fielding (mandatory)

WHAT ITEMS ARE REVIEWED?

- Any new fuzing system design
- Any modification (including product improvements) of an existing fuzing system design that affect the fuze safety system or a safety critical item
- A new application of an existing fuzing system
- Fuzes adapted for Army use from other U.S. Military Services
- Foreign fuzes for U.S. applications
- Fuzes procured using performance specs or in munitions that are procured using performance specs
- Non-Lethal Weapons as deemed necessary by Safety

WHAT IS A FUZE?

- Fuze or Fuzing System: A system designed to provide as a a primary role safety and arming functions in order to preclude munition arming before the desired position or time, and to sense a target or respond to one or more prescribed conditions, such as elapsed time, pressure, or command, and initiate a train of fire or detonation in a munition.
- Fuze safety system: The aggregate of devices (e.g., environment sensors, command functioned devices, logic logic functions, plus the initiation or explosive train interrupter, if applicable) included in the fuze to prevent arming or functioning of the fuze until a valid launch environment has been sensed and the arming delay has been achieved.

WHAT IS HAND EMPLACED ORDNANCE?

- Hand-emplaced munition (or ordnance): A munition (or ordnance) that is manually emplaced at, or hand-thrown to to the point of intended function, and requires user action action both to begin its operation and to achieve safe separation.

- Safety and arming device: A device that prevents the fuzing system from arming until an acceptable set of conditions has been achieved and subsequently affects arming and allows functioning of the payload.

WHAT IS THE BASIS FOR THE AFSRB REVIEW?

- Experience
- Mil-Std-1316, Fuze Design, Safety Criteria For
- Mil-Std-1911, Hand-Emplaced Ordnance Design, Safety Criteria For
- Mil-Std-331, Fuze and Fuze Components, Environmental and Performance Tests For
- STANAG 4187, Fuzing Systems - Safety Design Requirements & Annex C for Mines
- STANAG 4497, Hand-Emplaced Munitions (HEM), Principles for Safe Design
- AOP-20, Tests for the Safety Qualification of Fuzing Systems

HOW DOES THE AFSRB OPERATE?

- US Government sponsor
- Meetings held quarterly
- Information to be presented to AFSRB at Review:
  - Description of complete munition system and operation
  - Description of fuzing system including operational sequence,
  - Environments, explosive system design, etc.
  - Safety tests planned or performed
  - List of safety critical features
  - Fault Tree Analysis and other Hazard Analyses
  - Review by Fuze Energetic Materials Evaluation Board
  - Compliance with AFSRB guidelines for Electronic Safe & Arm design
  - Compliance with AFSRB guidelines for safe separation
  - Checklist showing compliance with MIL-STD 1316 (Tube Launched) and/or 1911 (Hand Emplaced)

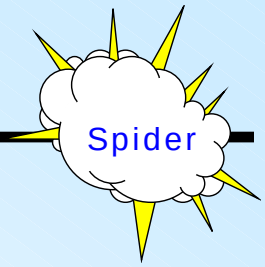
ARMY FUZE SAFETY REVIEW BOARD

- **CHAIRMAN:**
  Director, Army Fuze Management Office

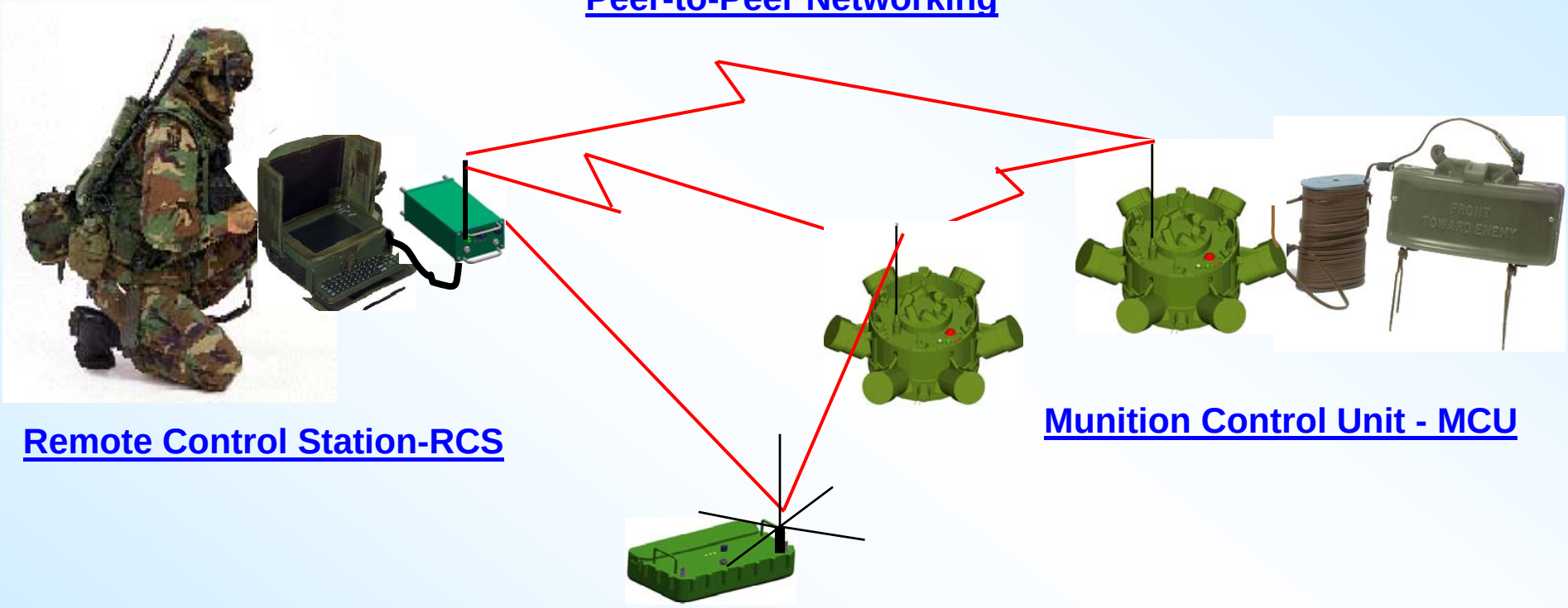
- **EXECUTIVE SECRETARY:**
  ARDEC Fuze Division

- **VOTING MEMBERS:**
  - **AMC (Safety Office)**
  - **TRADOC (Command Safety Office)**
  - **AMCOM (RDEC)**
  - **ARL**
  - **ARDEC**
  - **JMC (Joint Munitions Command – Rock Island)**

SPIDER SYSTEM SUMMARY



Peer-to-Peer Networking



Remote Control Station-RCS

Munition Control Unit - MCU

Repeater

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NOVA ENGINEERING

TEXTRON Systems

SPIDER SYSTEM DESCRIPTION

- Hybrid system – combination of a tube launched system (MGLs) and a hand emplaced system (RCS/MCU/Repeater)
- Requirements from both MIL-STDs 1911 and 1316 apply to the various subcomponents
  - 1911: Hand Emplaced (RCS/MCU/Repeater)
  - 1316: Tube Launched (MGL's)
- Software is distributed and interactive (a requirements standard for software does not currently exist)

SPIDER Unique Features

- Spider Program is a leading edge effort
  - unattended munitions remotely controlled via radio link to laptop PC
- Functionality of the munition's fuze is dependent on system software and the communication subsystem
- ➢ SW control of Safety Critical Functions
  - ➢ Safety Critical Software certification process and requirements were not defined
- Man in the loop control for Safe Passage Mode & Reuse are challenges (10^{-6})
- First program of this type to go before the AFSRB

Spider AFSRB Approach

- Demonstrate compliance with applicable MIL-STD (1911/1316) requirements based on mandated analysis and testing

- Software Safety compliance will utilize STANAGs 4404 and 4452, and the Joint System Software Safety Handbook for design criteria and guidance
  - System & Software System Safety Working Groups (SSWG & SSSWG)
  - Develop and monitor a formal Software Safety Program Plan
  - Identify software that controls critical safety functions
  - Perform safety analysis of software within the design
  - Perform software safety verification & validation through analysis and testing

NAVSEA
NAVAL SEA SYSTEMS COMMAND
Ordnance Safety & Security Activity

Navy Software Safety Summit Apr 03
The Challenge

- Establish a recommended, best approach, software safety certification process.
- Navy proposes not certifying software, but certifying a process that will result in safe software when properly followed
  - Process with fixed steps
  - Input and output for each step
  - Metrics that can be monitored and evaluated

FESWG SW Certification Process Meeting, 9-11 Sept 03

- What is required to certify software used in safety-critical applications?
- Navy SW Safety Summit Results
  - SW is a Systems Safety Process
- NASA Lessons Learned
- SW Testing, Strategies & Techniques
- Comparison of SW related definitions
- Software Reliability
- *Discussion of Spider's SW cert. strategy*

Summary

- Spider Program is a leading edge effort consisting of unattended munitions remotely controlled
- Mil-Stds don't fully cover Spider safety issues
  - No Approved Software Safety Certification Methodology exists
  - Safe Passage & Reuse are unique requirements
- AFSRB basic requirements (MIL-STDs 1911&1316) are still valid
  - the certification process is tailored and evolves as the system evolves
- Software Certification approach and requirements for Spider are being addressed by the SSWG and the SSSWG
- USG/JV Team working closely with fuze community (AFMO, AFSRB advisors/experts) is the best road to Fuze Safety Certification