

AFRL-MN-EG-TP-2005-7412

HIGH-G TESTING FOR FUZE RESEARCH

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SEPTEMBER 2005

Symposium Presentation

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

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1. REPORT DATE (DD-MM-YYYY) 30-09-2005		2. REPORT TYPE Symposium Presentation		3. DATES COVERED (From - To) 01-10-2002 - 30-09-2003	
4. TITLE AND SUBTITLE High-G Testing for Fuze Research				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER 62602F	
6. AUTHOR(S) Howard G. White, Timothy Tobik, Richard Mabry, Alain Béliveau				5d. PROJECT NUMBER 2502	
				5e. TASK NUMBER 11	
				5f. WORK UNIT NUMBER 25	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Air Force Research Laboratory Applied Research Associates Munitions Directorate 962 W. John Sims Parkway AFRL/MNMF Niceville, FL 32578 Eglin AFB, FL 32542-5430				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) Air Force Research Laboratory Munitions Directorate AFRL/MNMF Eglin AFB, FL 32542-5430				10. SPONSOR/MONITOR'S ACRONYM(S) AFRL-MN-EG	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S) AFRL-MN-EG-TP-2005-7412	
12. DISTRIBUTION / AVAILABILITY STATEMENT APPROVED FOR PUBLIC RELEASE; Distribution Unlimited					
13. SUPPLEMENTARY NOTES This presentation was made at the 74th Shock & Vibration Symposium, San Diego, California, October 28, 2003. One or more of the authors is a U.S. Government employee working within the scope of his/her position; therefore, the U.S. Government is joint owner of the work. If published copyright may be asserted. If so, the U.S. Government has for itself and others acting on its behalf, the right to copy, distribute, and use the work by or on behalf of the U.S. Government.					
14. ABSTRACT The Fuzes Branch of the Air Force Research Laboratory, Munitions Directorate, has performed/instrumented numerous experiments in support of fuze development. These experiments include a wide shock spectrum ranging from relatively benign bench level experiments up to high velocity impact into multi-layered hardened structures. In this presentation we will discuss the Air Force requirements for high-g shock testing for fuze research and our testing and instrumentation capabilities.					
15. SUBJECT TERMS Fuzes, Ordnance, Shock Testing, High-g Shock, Dynamic Fuze Testing, VHG, Drop Tower, Hopkinson Bar					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT SAR	18. NUMBER OF PAGES 21	19a. NAME OF RESPONSIBLE PERSON Howard G. White
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified			19b. TELEPHONE NUMBER (include area code) (850) 883-0587



High-G Testing for Fuze Research



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**74th Shock & Vibration Symposium
San Diego, California
October 28, 2003**



Outline



- **What's a Fuze**
- **Requirements**
- **Testing Capabilities**
- **Challenges**

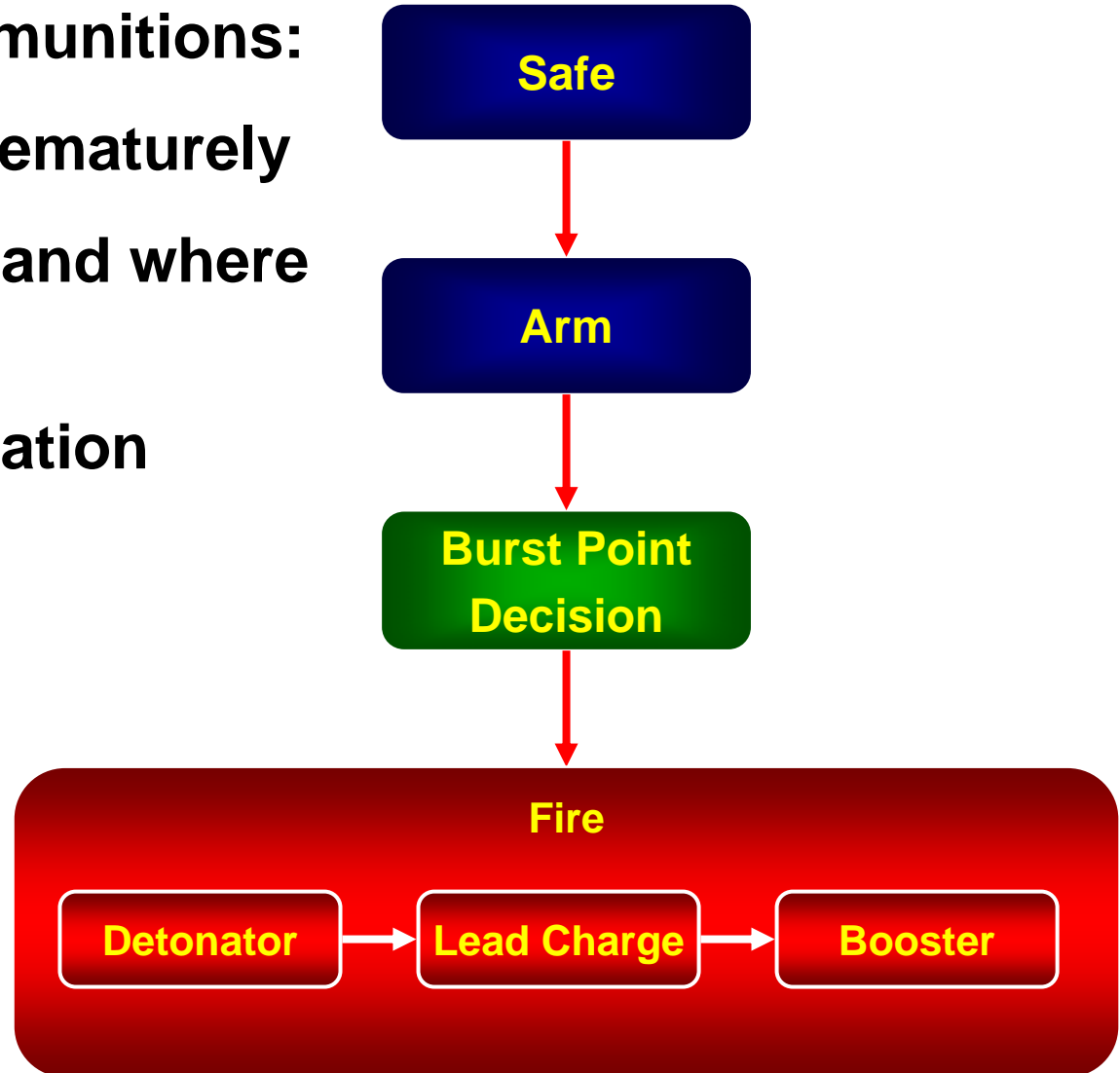


What's a Fuze



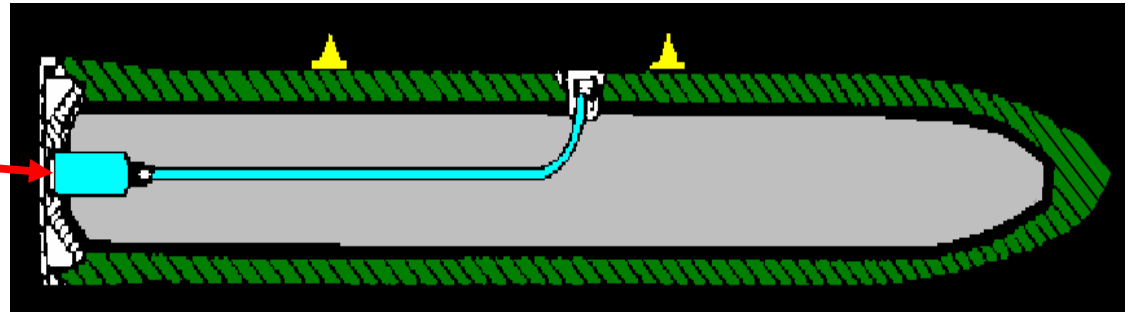
A fuze ensures that munitions:

- Do not explode prematurely
- Determines when and where to detonate
- Initiates the detonation





Penetrating Weapon





Penetration Fuzing



**Electronic Bomb Fuze
FMU-143 B/B
Fixed Pyrotechnic Delay**



**Joint Programmable Fuze
FMU-152 /B
Proximity Fire, Electronic Select,
Impact Delay**



**Hard Target Smart Fuze
FMU-159 /B
“Smart” Void, Layer, Time...**



The Future of Penetration Fuzing



- **More robust**
- **More reliable**
- **Smaller**
- **Smarter**
 - **Different sensors**
 - **Focused initiation**
- **Communication**
 - **Between munitions**
 - **During impact**



Guidelines



- **Safety Rules (MIL-STD 1316)**
 - Explosives
 - Environmental Sensors
 - Arming
 - Safe Separation
 - Launch
- **Safety rules evaluated in context of each Munition System**
 - e.g. safe separation for AMRAAM different than Mk-82 bomb
- **Rules applied depending on explosive train design**



The Problem At Hand



- **Understand the acceleration environment**
 - **Lower frequencies to determine rigid body response for development of burst point control fuzing**
 - **Higher frequencies to define the environment the fuze must survive**
- **Create realistic environments; known and repeatable**
- **No Mil Std for shock survivability, outside of transportation**



Testing Capabilities for Shock



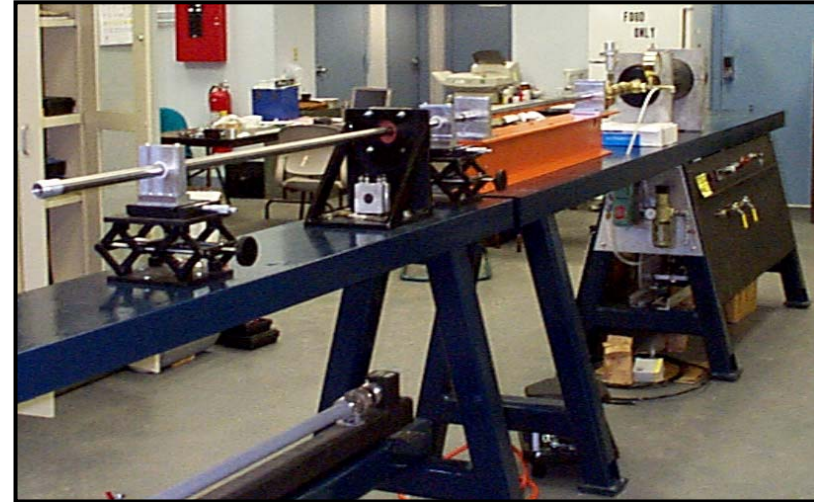
- **Dynamic Shock Facility**
 - **Hopkinson Bar**
 - **Drop Tower**
 - **Very High G (VHG) Machine**
 - **Centrifuge**
- **Field Testing**
 - **Cannon**
 - **Sled Track**
 - **Air-Delivered**



Hopkinson Bar



- **Attributes:**
 - Air driven impactor
 - 1 in. diameter titanium bar
 - Programmers used to shape leading edge of pulse
- **Used for:**
 - Instrumentation Studies
 - Material Properties Testing
 - Shock-isolation materials & techniques





Drop Tower



- **Attributes:**
 - Drop heights up to 10 ft.
 - Free fall or driven with a bungee cord
 - Programmers used to shape pulse
 - Payload – 25 lbs
- **Used for:**
 - Component Testing
 - Full-up Fuze





Very High G (VHG) Machine



- **Attributes:**
 - Air driven 10 lbs impactor
 - Payload – 10 lbs
 - Pulse shaped using:
 - Different anvil materials
 - Programmers
- **Used for:**
 - Instrumentation Studies
 - Component Testing
 - Full-up Fuze





Centrifuge



- **Attributes:**
 - 20-30 kg
 - Payload – 5 lbs
 - Long-duration high-g testing
 - RF data transmission
- **Used for:**
 - Instrumentation Studies
 - Component Testing





Cannon Testing



- **Attributes:**
 - **Howitzer Cannons**
 - various barrel sizes
 - Smooth bore and rifled
 - **Projectiles**
 - OD 3.6 - 8 in.
 - Weight between 25 – 250 lbs
 - **Targets**
 - 4 in. thick to 4 ft thick
 - 30 in. dia. to 7 ft x 9 ft
 - Single or multi-layer configurations
- **Used for:**
 - Full-up Fuze
 - Component Testing
 - Instrumentation Studies





Sled Track



- **Attributes:**
 - **2000 ft long**
 - **Velocities > 2000 fps for a 2000 lb item**
 - **Unlimited target size**

- **Used for:**
 - **Full-up Fuze**
 - **Full-scale weapon (integration) testing**





Air-Delivered



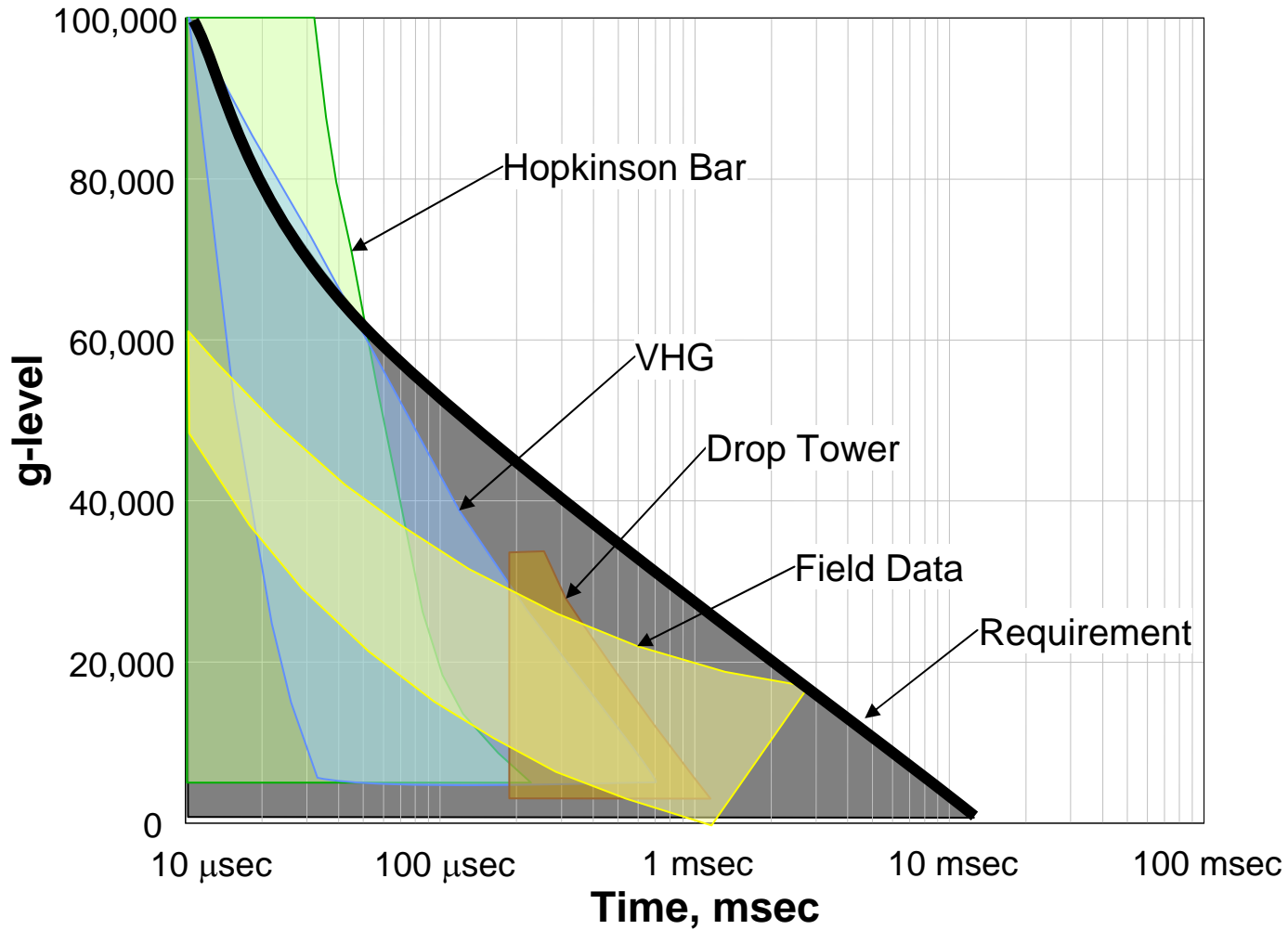
- **Attributes:**
 - Realistic missions
 - Realistic environment

- **Used for:**
 - Full-up fuze
 - Full-scale weapon system (integration) testing





Objective vs. Capabilities





Challenges



- **Can't afford to conduct just field tests (nor is it appropriate)**
- **Currently limited to 1-D environments in the lab**
- **Experience has shown that to survive a sled test an entire suite of tests must be conducted in the lab, e.g.,**
 - **Normal**
 - **Reverse**
 - **Lateral at varying angles (0, 45, 90, etc.)**



Summary



- **Changing requirements**
 - **More severe environments**
 - **Perform additional functions**
- **Combination of lab/field tests required**
- **Interesting testing and instrumentation challenges remain**
 - **Realistic environments**
 - **Testing techniques**
 - **Accurate, robust instrumentation**