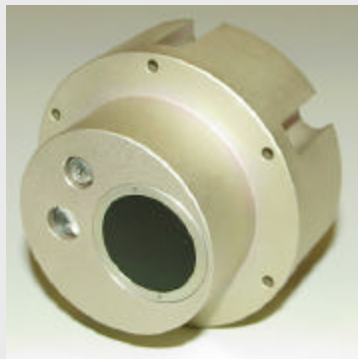




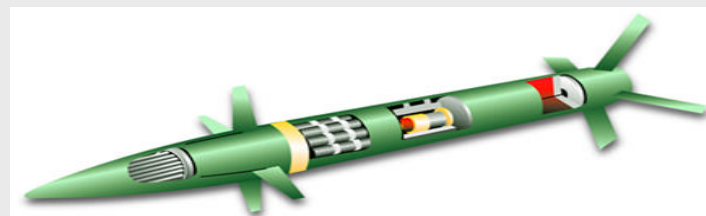
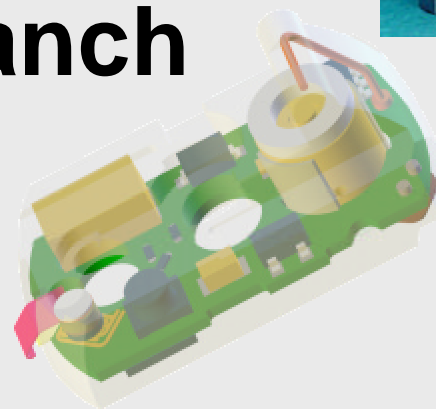
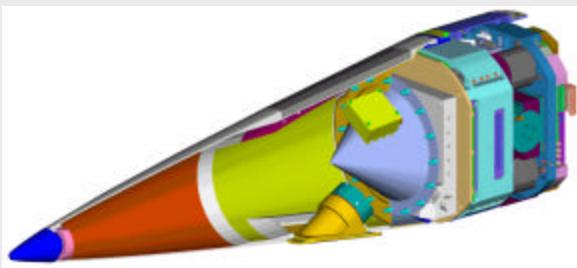
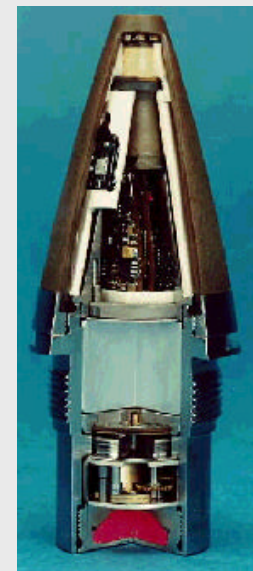
Fuzing at Dahlgren



Michael A. Till

NSWC Dahlgren Division

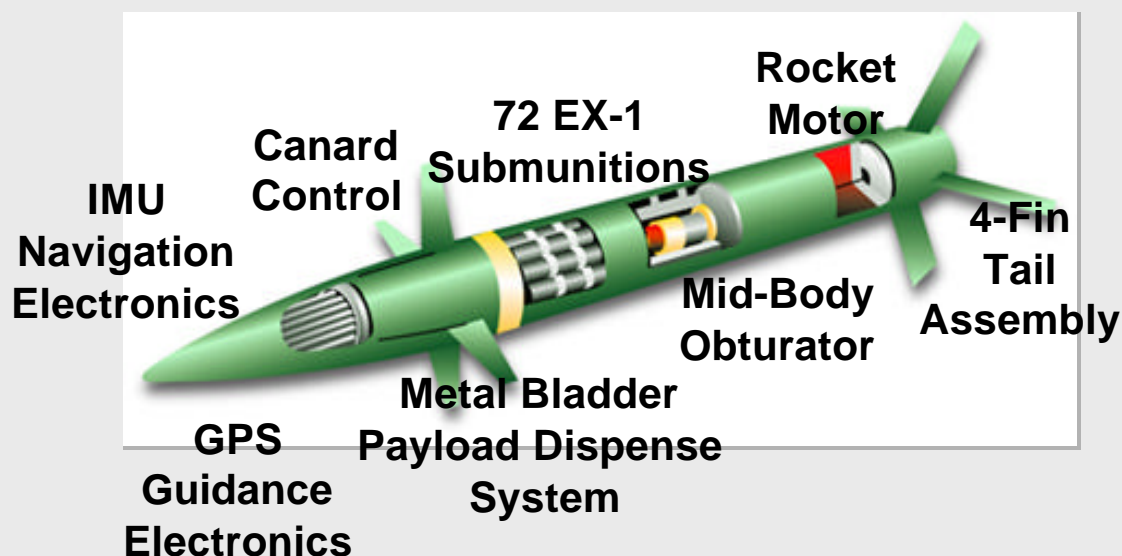
G34, Fuze Branch



Report Documentation Page

Report Date 16Apr2001	Report Type N/A	Dates Covered (from... to) -
Title and Subtitle Fuzing at Dahlgren	Contract Number	
	Grant Number	
	Program Element Number	
Author(s) Till, Michael A.	Project Number	
	Task Number	
	Work Unit Number	
Performing Organization Name(s) and Address(es) NSWC Dahlgren Division	Performing Organization Report Number	
Sponsoring/Monitoring Agency Name(s) and Address(es) NDIA (National Defense Industrial Association) 211 Wilson BLvd., Ste. 400 Arlington, VA 22201-3061	Sponsor/Monitor's Acronym(s)	
	Sponsor/Monitor's Report Number(s)	
Distribution/Availability Statement Approved for public release, distribution unlimited		
Supplementary Notes Proceedings from The 45th Annual Fuze Conference, 16-18 April 2001 Sponsored by NDIA, The original document contains color images.		
Abstract		
Subject Terms		
Report Classification unclassified	Classification of this page unclassified	
Classification of Abstract unclassified	Limitation of Abstract UU	
Number of Pages 44		

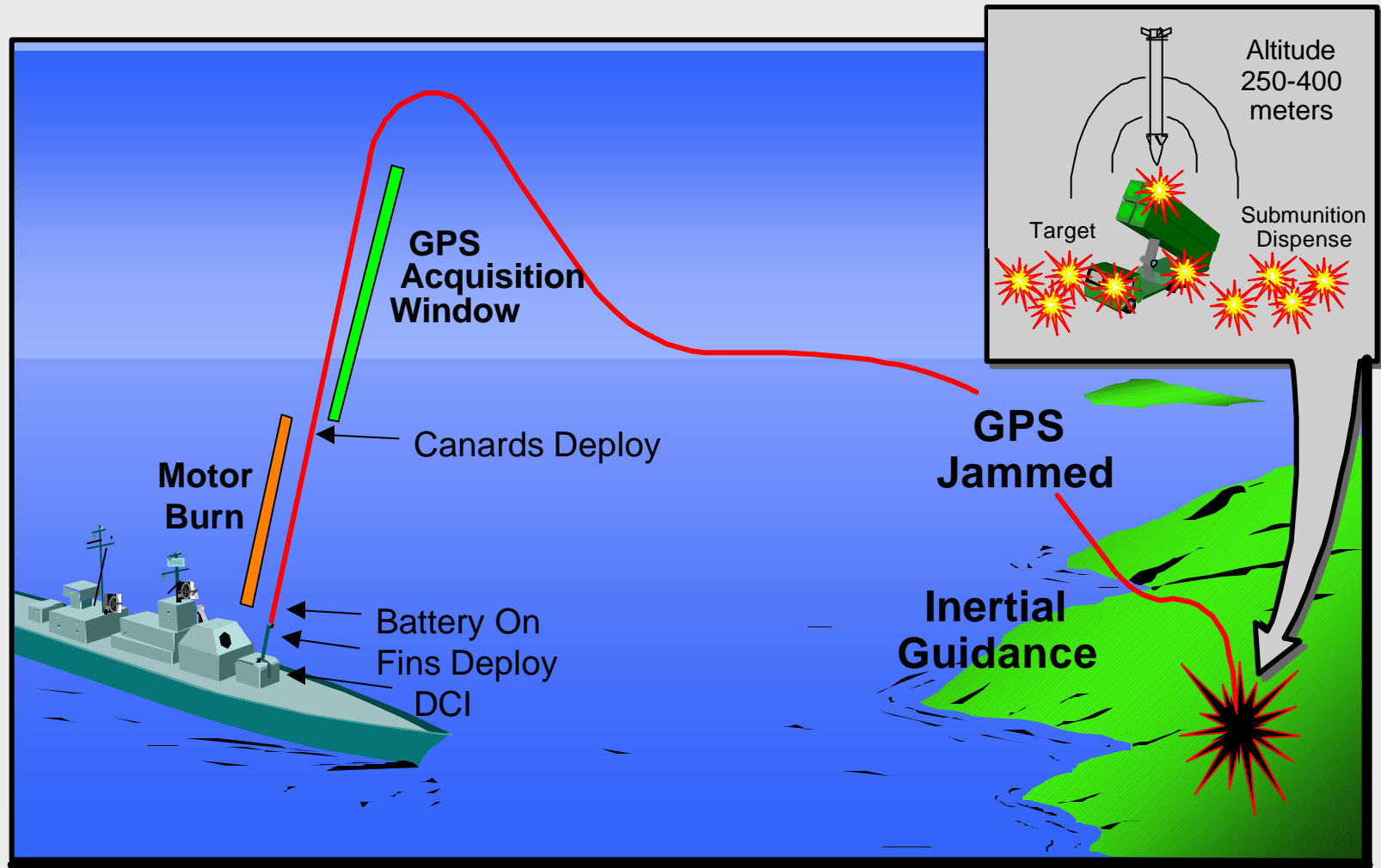
ERGM System Description



- Roll-Attitude Controlled Airframe
- Vertical Endgame Trajectory

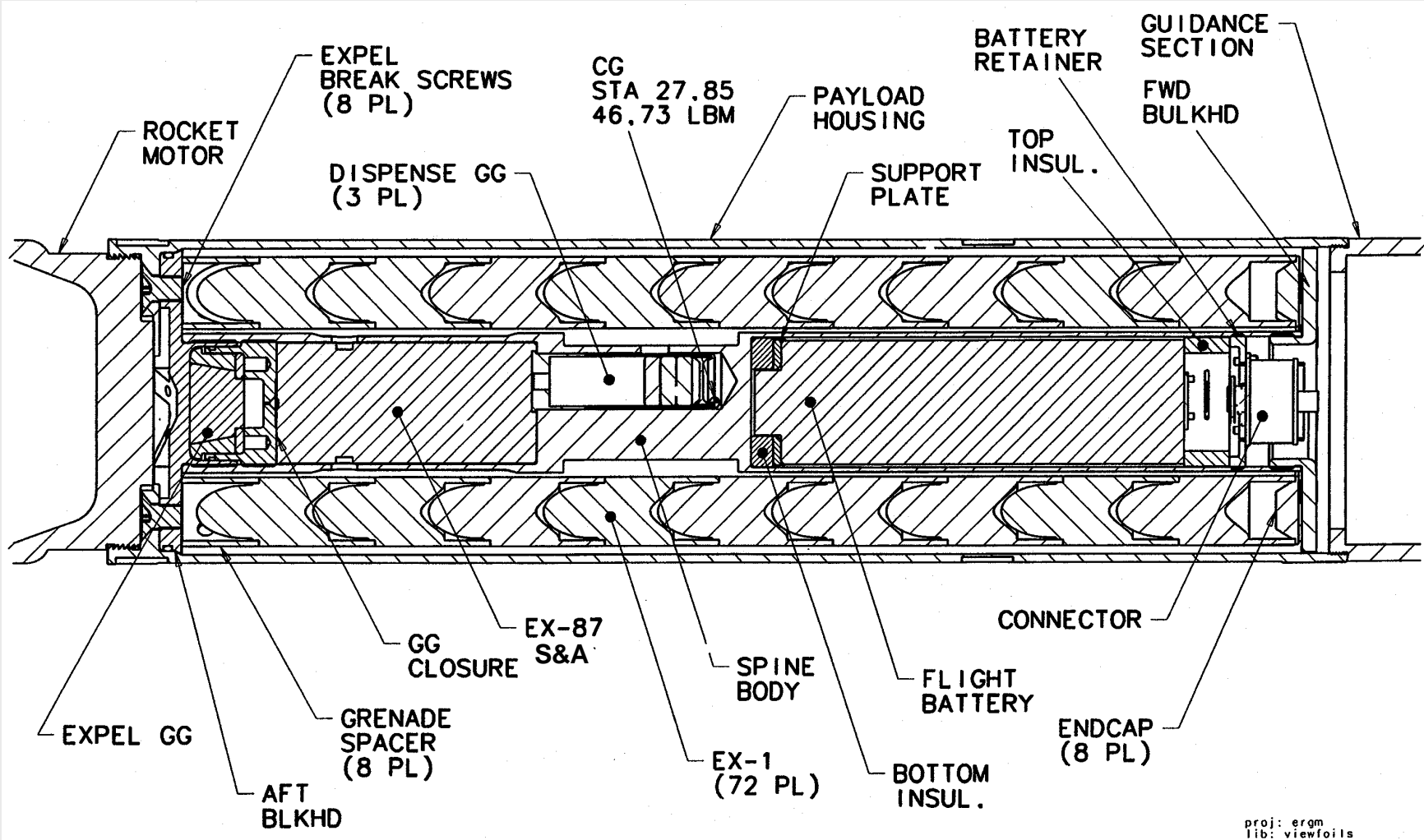
- ❑ Length: 61 Inches
- ❑ Weight: 110 Pounds
- ❑ **Fuze: Integral, GPS Initiated**
- ❑ **Guidance: GPS/INS**
- ❑ Accuracy: <20m CEP
- ❑ Payload: Submunitions
 - 72 EX-1s (Modified M80s)
 - **Self Destruct Fuze (M234)**
- ❑ Propulsion: Rocket Motor
- ❑ Range Objective: 63 nmi
- ❑ Prop Charge: 18 MJ
- ❑ Loading: Double Ram

ERGM Mission Profile





ERGM Payload Section



proj: ergm
lib: viewfoils



ERGM Fuzing Status

- ❑ **EX-87 Mod 1 S&A:**
 - Completed Design Validation Tests (DVT)
 - Successfully Fired 3 in Canister Projectiles
 - Successful Fired in Dynamic Dispense Air Drop Test (DD-1)
 - Lessons Learned from DVT have been Incorporated
- ❑ **Near Term Testing:**
 - S&A Qualification (July 01)
 - Piston Actuator Component Qualification (June 01)
 - Dynamic Dispense Gun Fire (May 01)
- ❑ **M234 E1 Self-Destruct Fuze:**



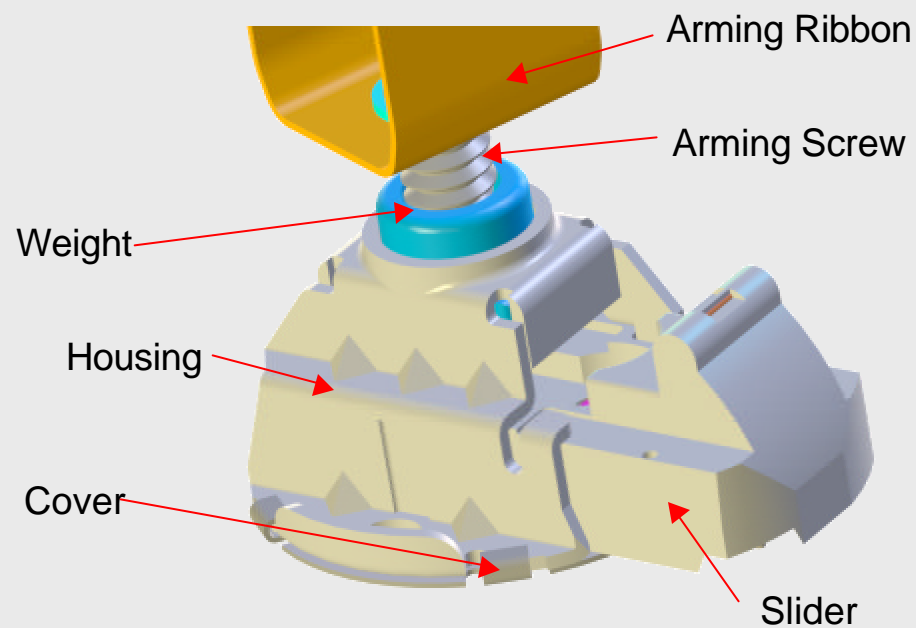
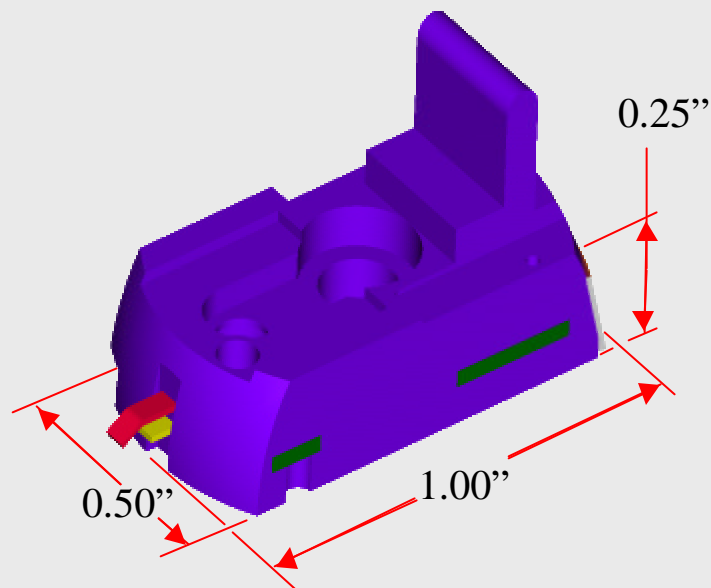
ERGM Fuzing Status

□ M234 E1 Self-Destruct Fuze:

- **DD-1 Test (YPG, 18 Aug 00)**
 - Slight Over-Test Condition (Expel/Dispense Altitude Too Low)
 - 13 Primary Mode Failures (82% Successfully Armed)
 - 0 ERGM Shunt Removal Failures (100% Successfully Armed)
 - 14 Spiral Flag Failures (81% Successfully Armed)
- **Additional Improvements Incorporated for Dynamic Dispense Gunfire Test (DD-2) Scheduled for early May '01**

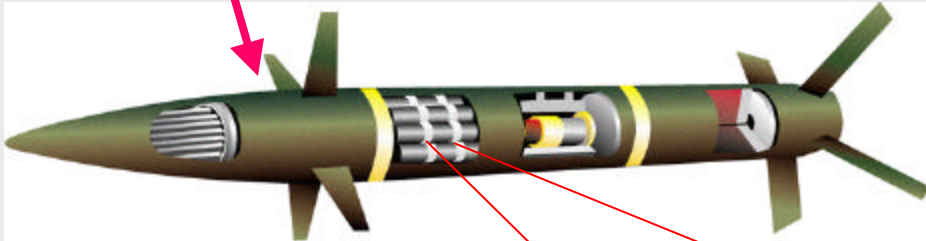
M80 PIP Objective

- ❑ To package the electronics and mechanical components of the Proximity Fuze in the shape and size of the current M234 SD Slider for the M80 Submunition for ERGM
 - One-for-One replacement of current Slider





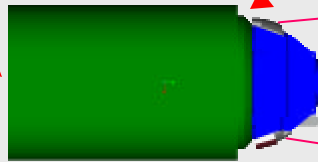
MK 45 MOD 4



ERGM



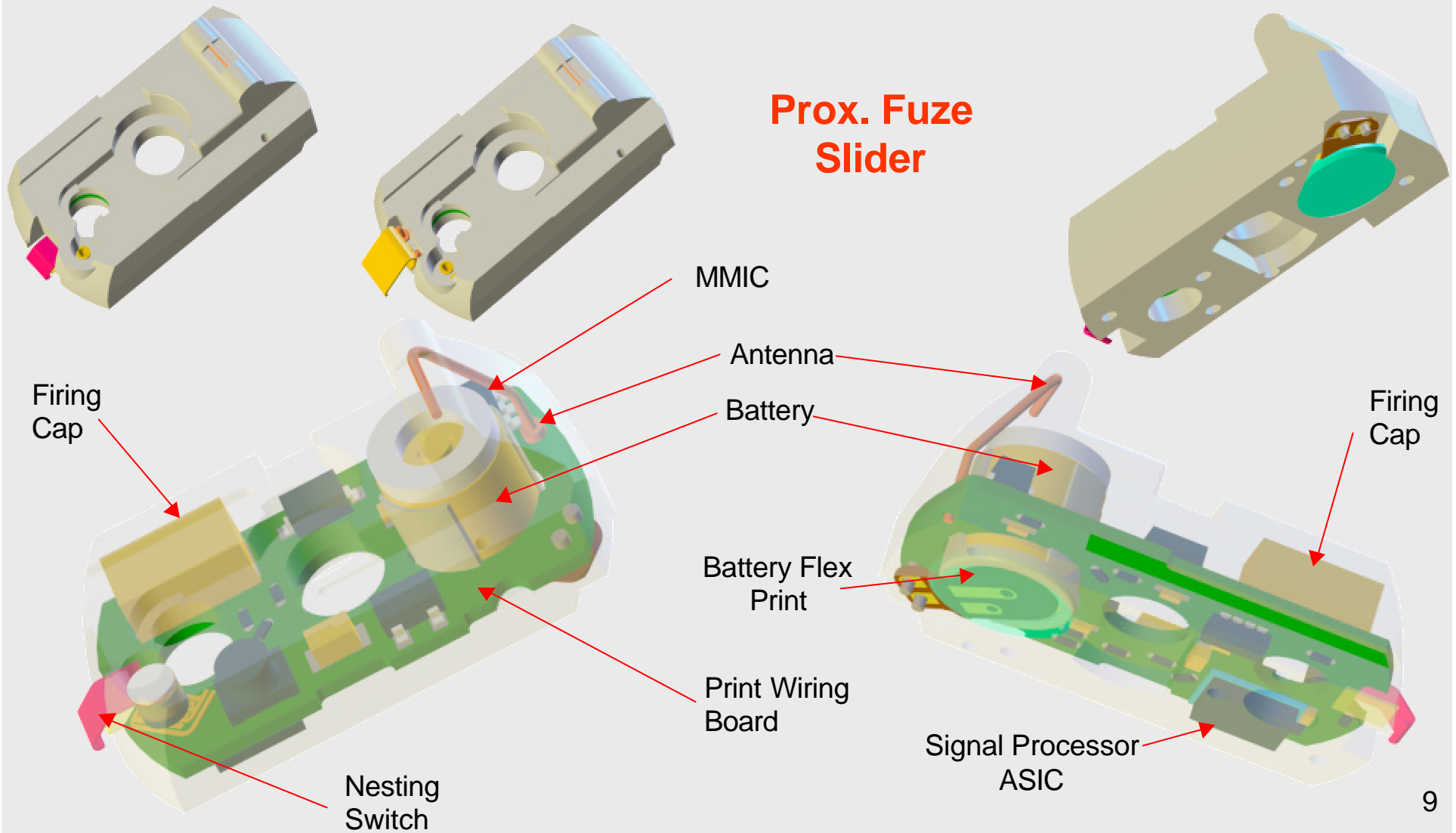
EX 3



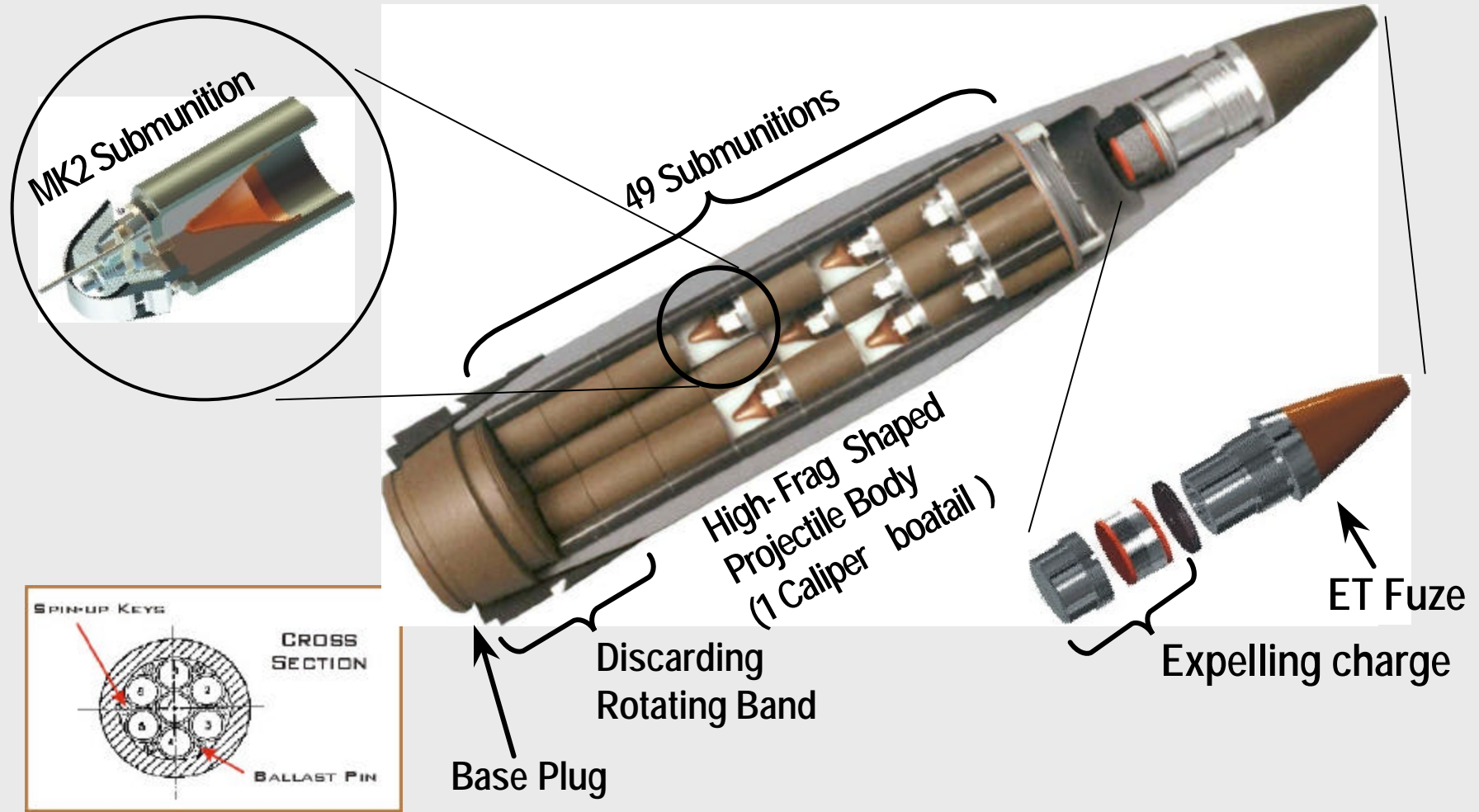
Proximity Fuze



Major Component Layout



Navy 5" Cargo Projectile





M80 Grenade Fuze, M223 Safety Modification

□ Design challenge:

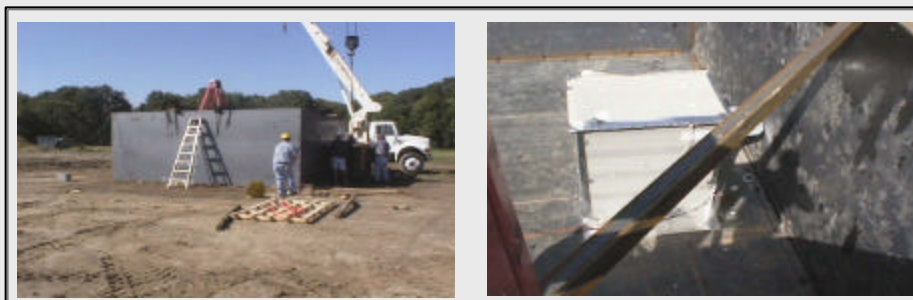
- Add a safety feature to the grenade for the 5” cargo round
- Minimal cost and ASAP - we’re already in production: 700,000 fuzes made
- Requirements driven from WSESRB letter (objective) & PEO “acceptance of risk” (threshold)



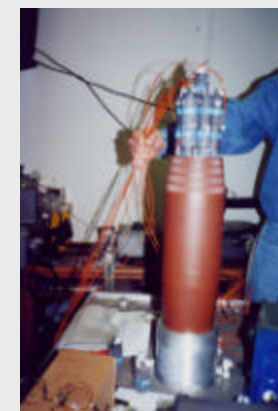
Resolution Efforts (Grenades already purchased)

Numerous add-on and redesign fixes were sketched and analyzed, then down selected a number of add-on fixes

Slow Cook-off Simulated Magazine Set-up



Thermocoupled Grenades



Shrink Tubing



Program has invested over \$1.5M to date to resolve issue

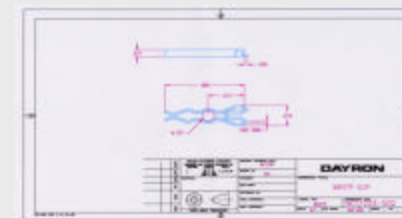
Dayron Setback Clip



Dayron Dual Mode Clip



Engineering Concept

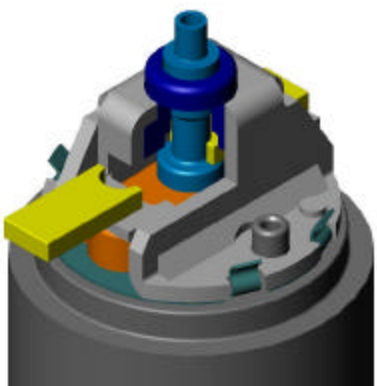


Metal spin clip line of designs stopped by WSESRB letter 12

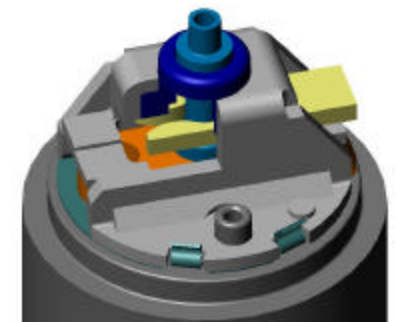


Resolution Efforts Downselect

**Dual
Meltable
Spin Locks**

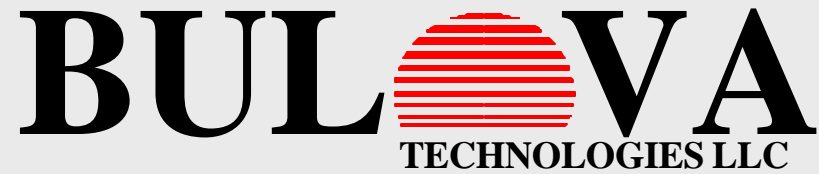


**Single
Meltable
Spin Lock**



- ❑ 1st tests show both significantly improve safety
- ❑ Solutions will meet 95% of the WSESRB concerns. May still leave 1 armed grenade plus 2 w/o an extra lock post cook-off
- ❑ Reliability testing and final downselect in May 01
- ❑ Cargo Program review at end of month. May change design course & require a 100% solution





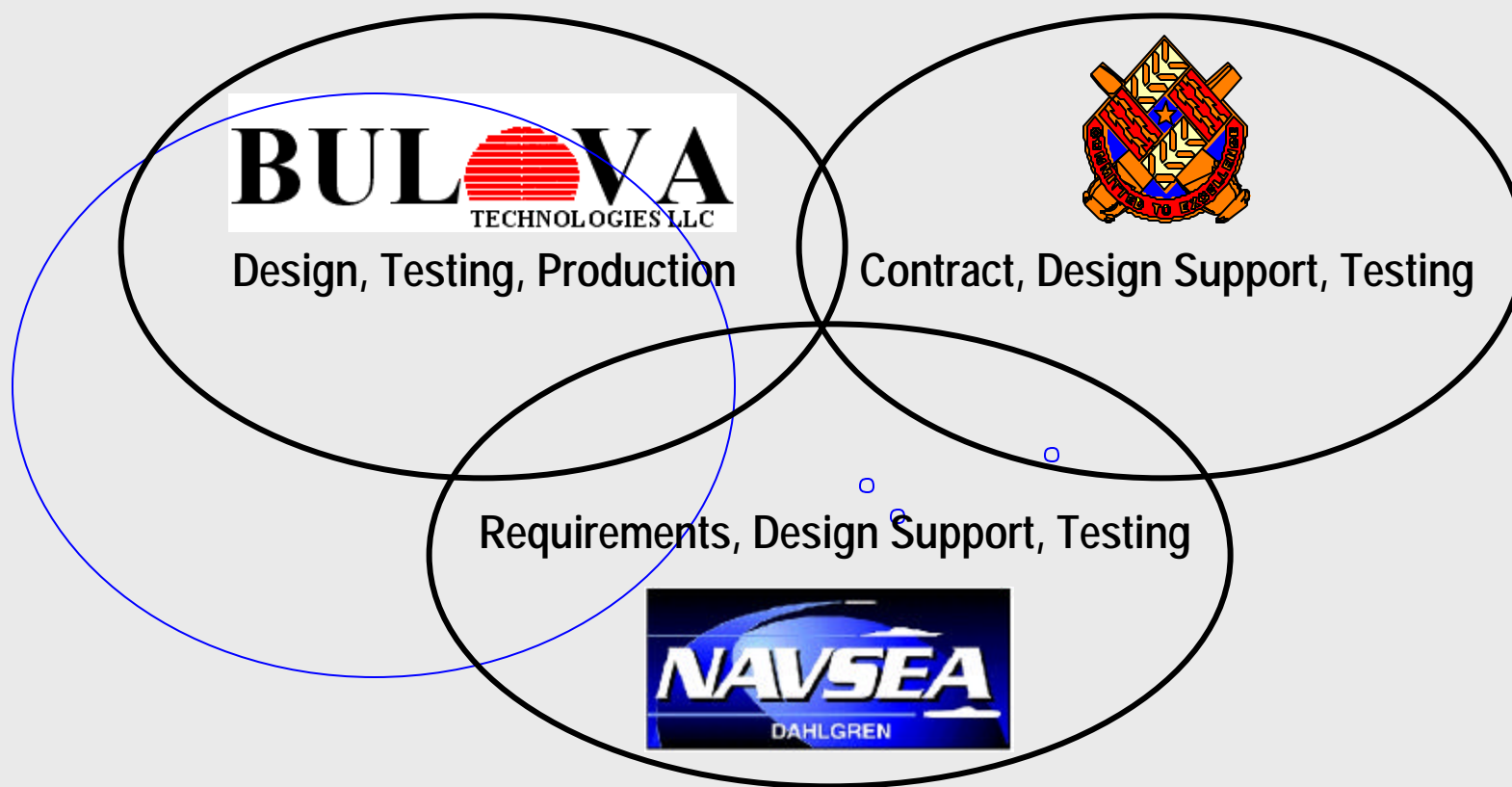
MK 432 ELECTRONIC TIME FUZE

A New Fuze for the US Navy





Team Approach





Navalization of the M762A1

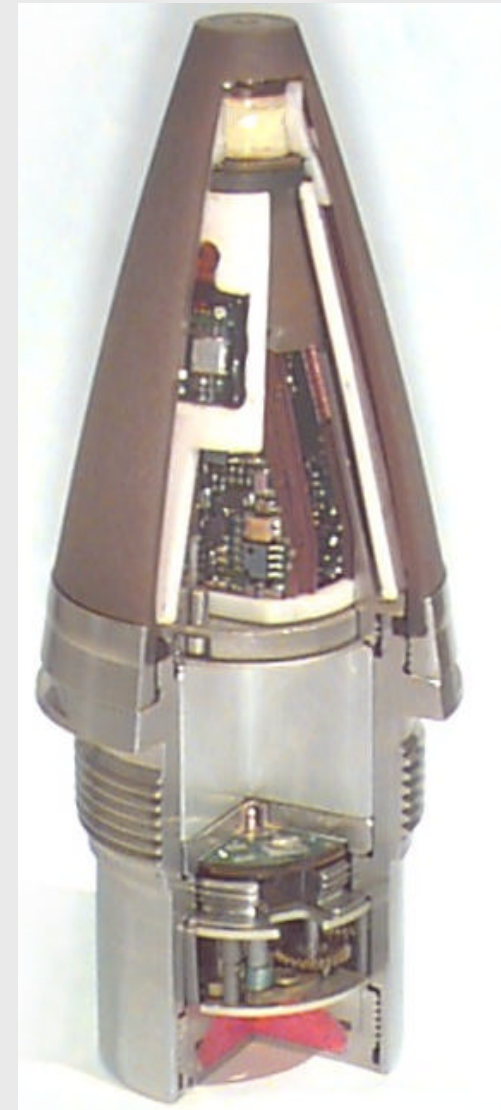
- ❑ **Inductive Set Compatibility**
- ❑ **Battery Activation**
- ❑ **Targets**
- ❑ **Remove PD back-up**
- ❑ **EEE improvements**
- ❑ **IM**



Qualification

- ❑ **Completed in 9 months:**
 - 400 fuzes delivered
 - Successful gun firings
- ❑ **Qualification Completed Summer 2001**
- ❑ **Production Scheduled to begin July 2001**
- ❑ **14,600 Fuzes Delivered October 2001**

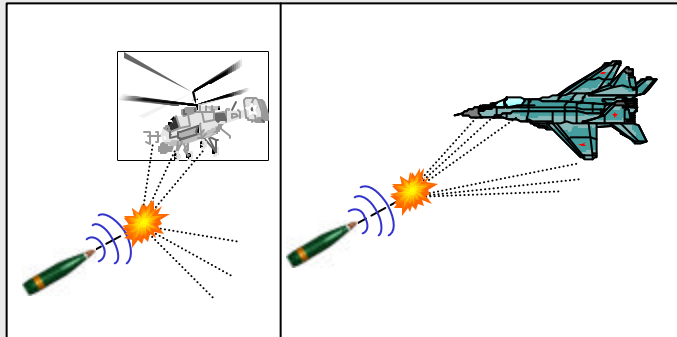
***Multi-function
Fuze
(MFF)***



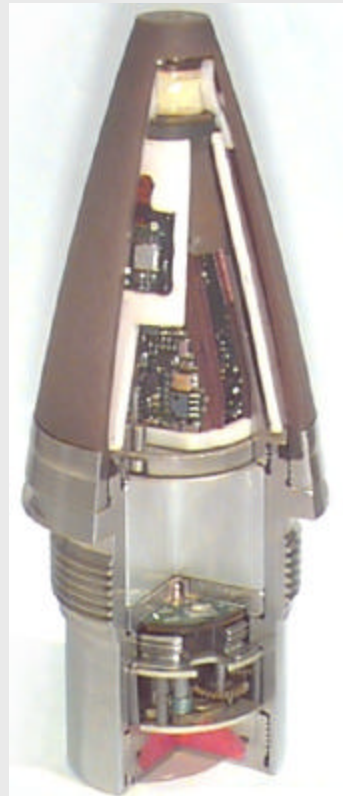
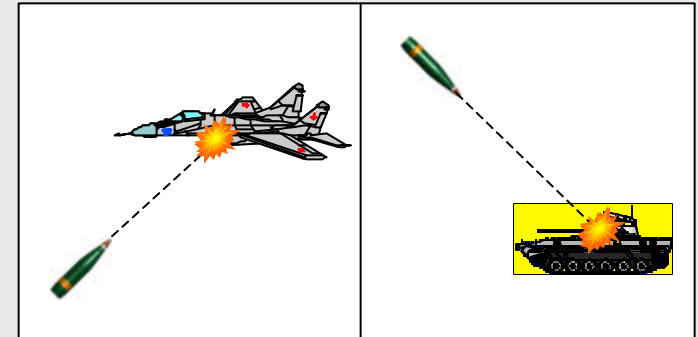


MFF Operational Modes

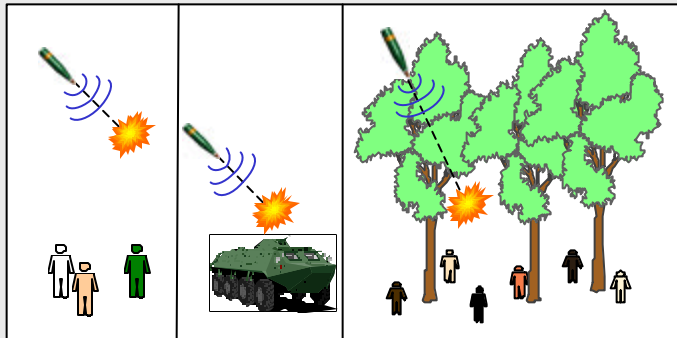
Air Proximity (AIR)



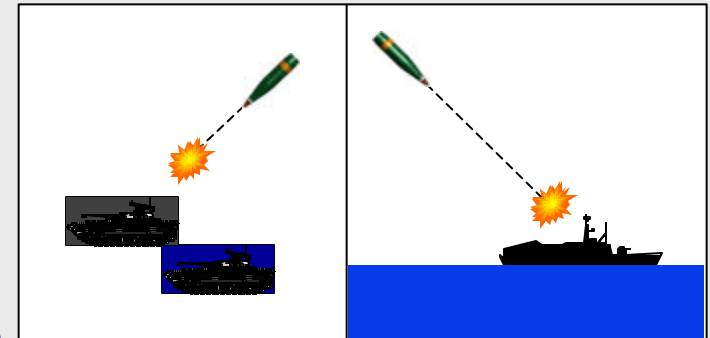
Point Detonating (PD)



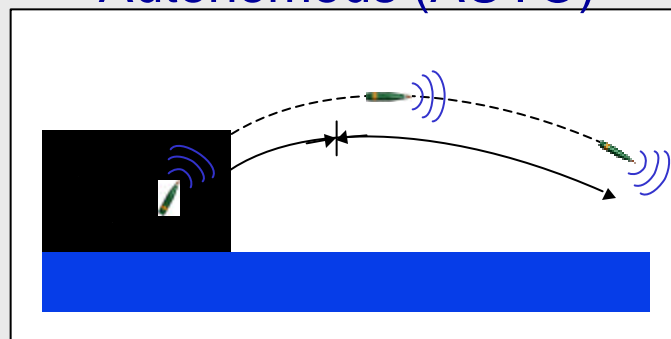
Surface Proximity (HOB)



Electronic Time (ET)



Autonomous (AUTO)



Replaces VT, CVT,
MT & PD fuzes on
HE rounds.
Simplifies logistics.
Uses IM Explosives.

Multiplies effectiveness
of ship's magazine.
Improves fuze
performance, accuracy,
reliability & versatility. 19



MFF LRIP

- ❑ IPT: NSWC Dahlgren, NSWC Crane & ATK
 - Performance Specification
- ❑ Production at Alliant Precision Fuze Company, L.L.C in Janesville, WI
- ❑ LRIP ~9500 fuzes in 3 lots
- ❑ Options for another 6000 to 12000
- ❑ Pre-First Article performance
 - Twice as sensitive as MK 418 VT-RF fuze against the same air target
 - E&MD performance & production issues resolved



MFF Schedule

- ❑ New Program Schedule Approved
- ❑ Updating the ORD and TEMP
- ❑ TECHEVAL 3rd Qtr FY01
- ❑ OPEVAL 4th Qtr FY01
- ❑ Milestone III Decision 1st Qtr FY02
- ❑ LRIP 1st Lot delivered 2nd Qtr FY02
- ❑ IOC 1st HE-MF rounds delivered 2nd Qtr FY02
- ❑ FOT&E for 5in/62 Gun Qualification in FY02





MK 419 TECHEVAL

- ❑ San Clemente Island, SHOBA, 3rd Qtr FY01
- ❑ USS Bunker Hill (CG 52)
- ❑ 57 MK 419 Test rounds, 90 rounds total
- ❑ Part of First Article
- ❑ Test HOB, PD, ET, AUTO(HOB) performance over land and water





MK 419 OPEVAL

- ❑ San Clemente Island, SHOBA, 4th Qtr FY01
- ❑ USS Bunker Hill (CG 52)
- ❑ 170 MK 419 Test rounds, 200+ rounds total
- ❑ Test AIR, HOB, PD, ET, AUTO(HOB),
AUTO(AIR) performance over land and water
- ❑ Towed RF air target



MFF Cost Reduction RF System



- ❑ MMIC Receiver
 - Plastic encapsulation vs. ceramic pkg
 - Adjust frequency to reduce tuning effort
 - Align with optimum antenna and transmitter frequencies
- ❑ MMIC Transmitter
 - Plastic encapsulation
 - Frequency tweak if required
- ❑ Antenna
 - Improve dielectric material properties to enhance producibility
 - Decrease raw material cost



MFF Cost Reduction Battery

- ❑ Use MOFA battery with minimal modification
 - Failed to meet performance requirements
- ❑ European battery conference held to identify potential battery sources

Technical Objectives

- ❑ Develop an alternative Low Cost Guidance Electronics Unit (LCGEU) for the EX171 Extended Range Guided Munition (ERGM)
 - design as a form, fit, & function replacement for existing ERGM GEU
 - identify & select performance trades versus affordability
 - demonstrate performance via a series of guided flight tests

*Form, Fit, Function GEU
replacement for EX-171*



**LOW
COST
GEU**



Technical Objectives (Contd)

- ❑ Prepare for transition to future EMD phase
 - Work closely with Rockwell / Collins (EMD prime) to develop cost as independent variable in LCGEU design
 - Deliver complete HW/ SW documentation package
 - Identify future production cost reduction opportunities

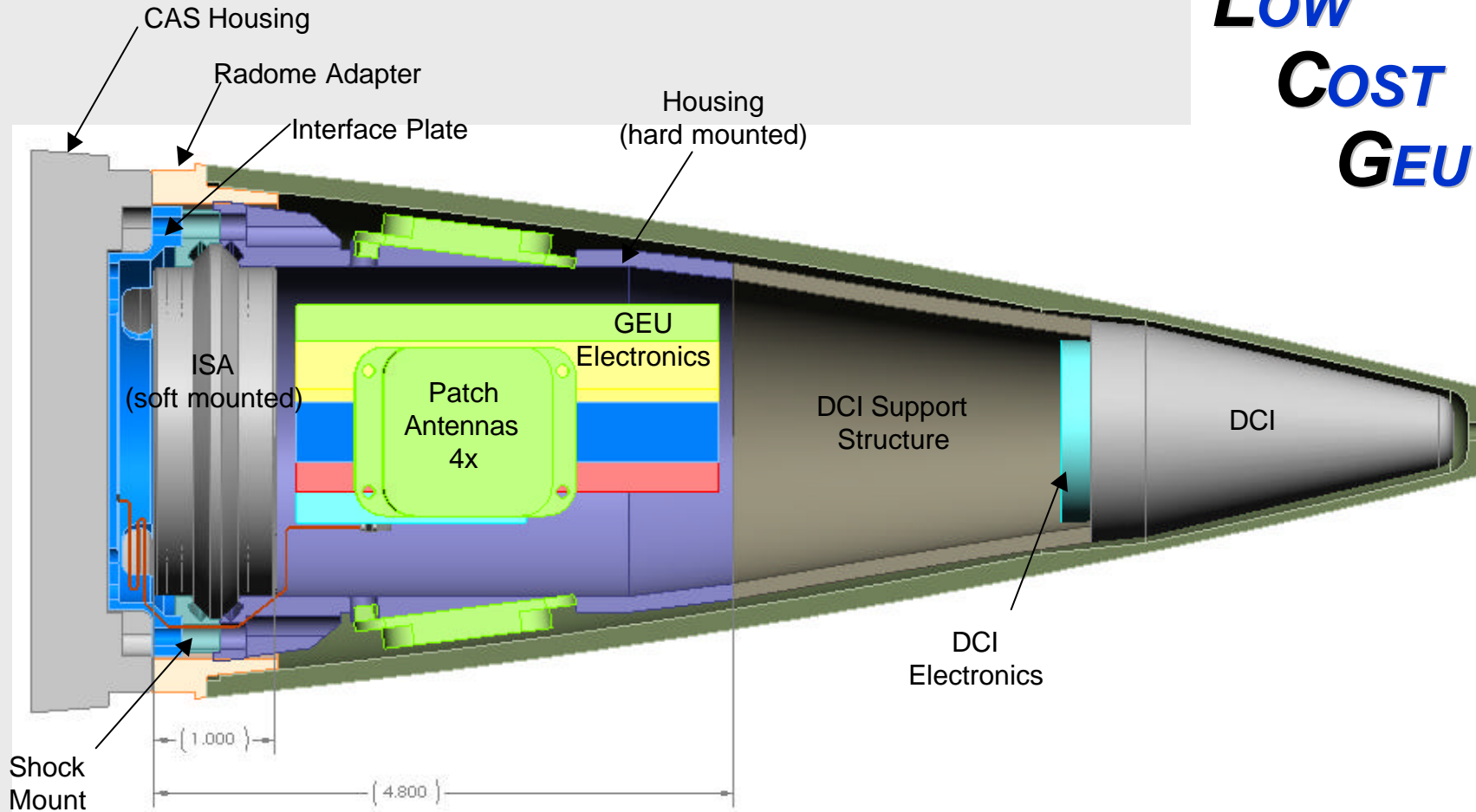
**LOW
COST
GEU**

*Form, Fit, Function GEU
replacement for EX-171*



Baseline Mechanical Design

**LOW
COST
GEU**





Standard Missile - 4 Height of Burst Fuze

Integrated Product Team (IPT) Assembled to Select a Height of Burst (HOB) Sensor and Incorporate as Primary Fuze for LASM

Raytheon

- HOB IPT LEAD
- MISSILE DESIGNER

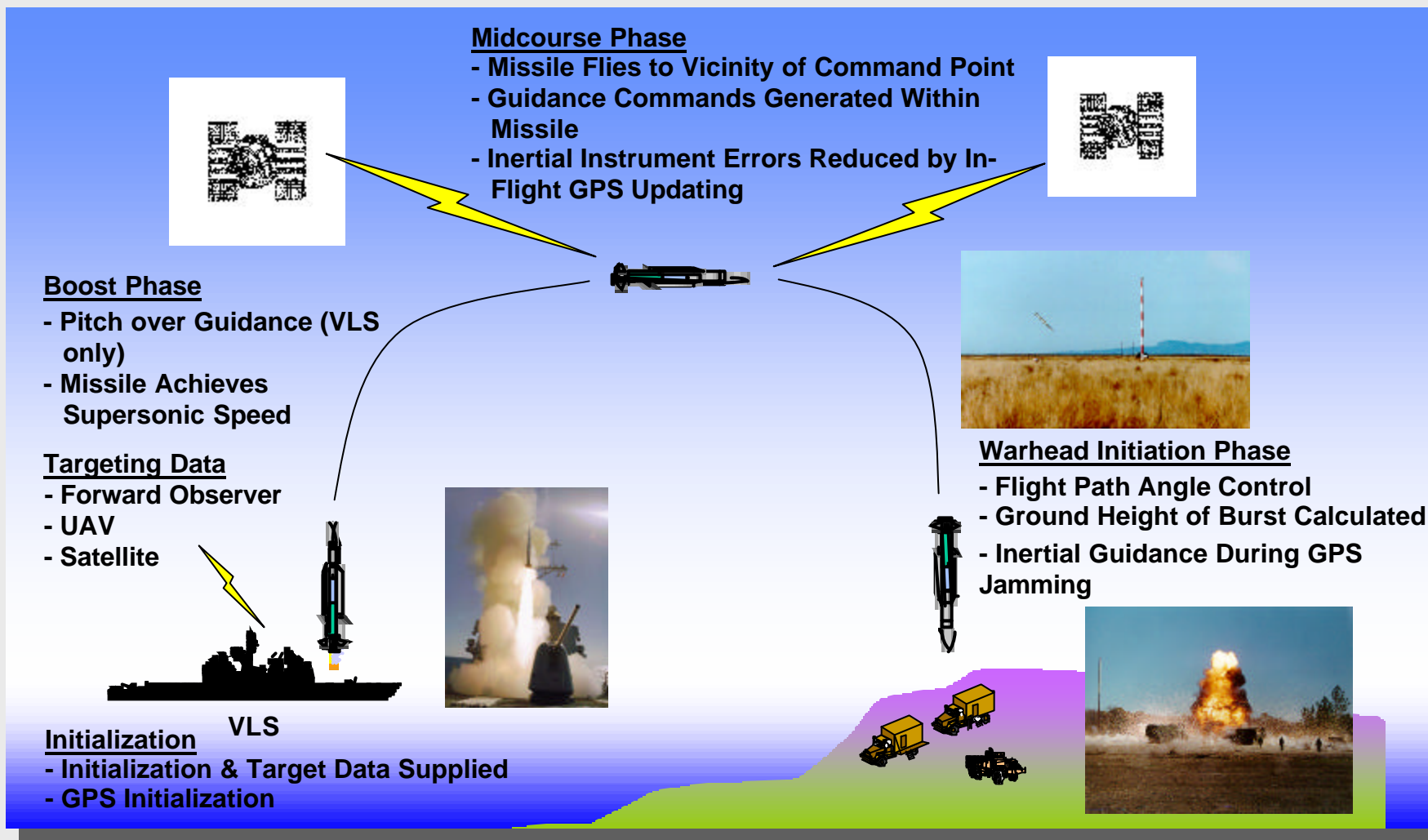


- TDA, REQUIREMENTS DEFINITION
- MODELING, TESTING



- GOVERNMENT FUZE EXPERT
- BAA

Mission Overview





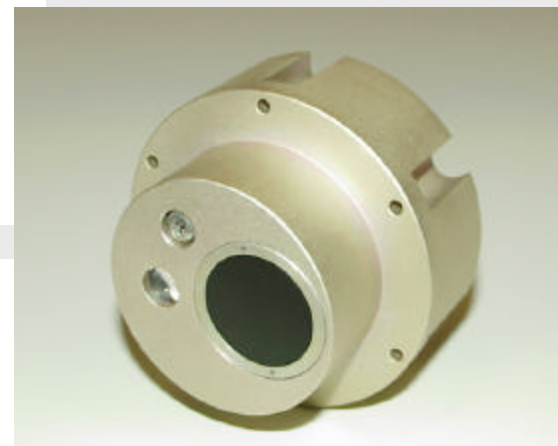
HOB Sensor Selection

- ❑ **Identify Candidate Sensors**
 - Broad Agency Announcement (BAA)
 - Previous Trade Studies
 - Recommendations from Team Members
 - 18 Sensors from 12 Vendors Identified
- ❑ **Sensors Fell into 3 Classes: Radio Frequency, Electro-Optical, Mechanical**
- ❑ **Down-select to Set of Sensors Meeting Minimum Requirements**
- ❑ **Used Quality Functional Deployment Matrix for Comprehensive Comparison of Down-selected Sensors**
 - Evaluation Criteria Split Between Cost and Performance
 - Relative Weights of Evaluation Criteria Determined by Team Consensus
 - Scores Awarded Each Sensor Determined by Team Consensus

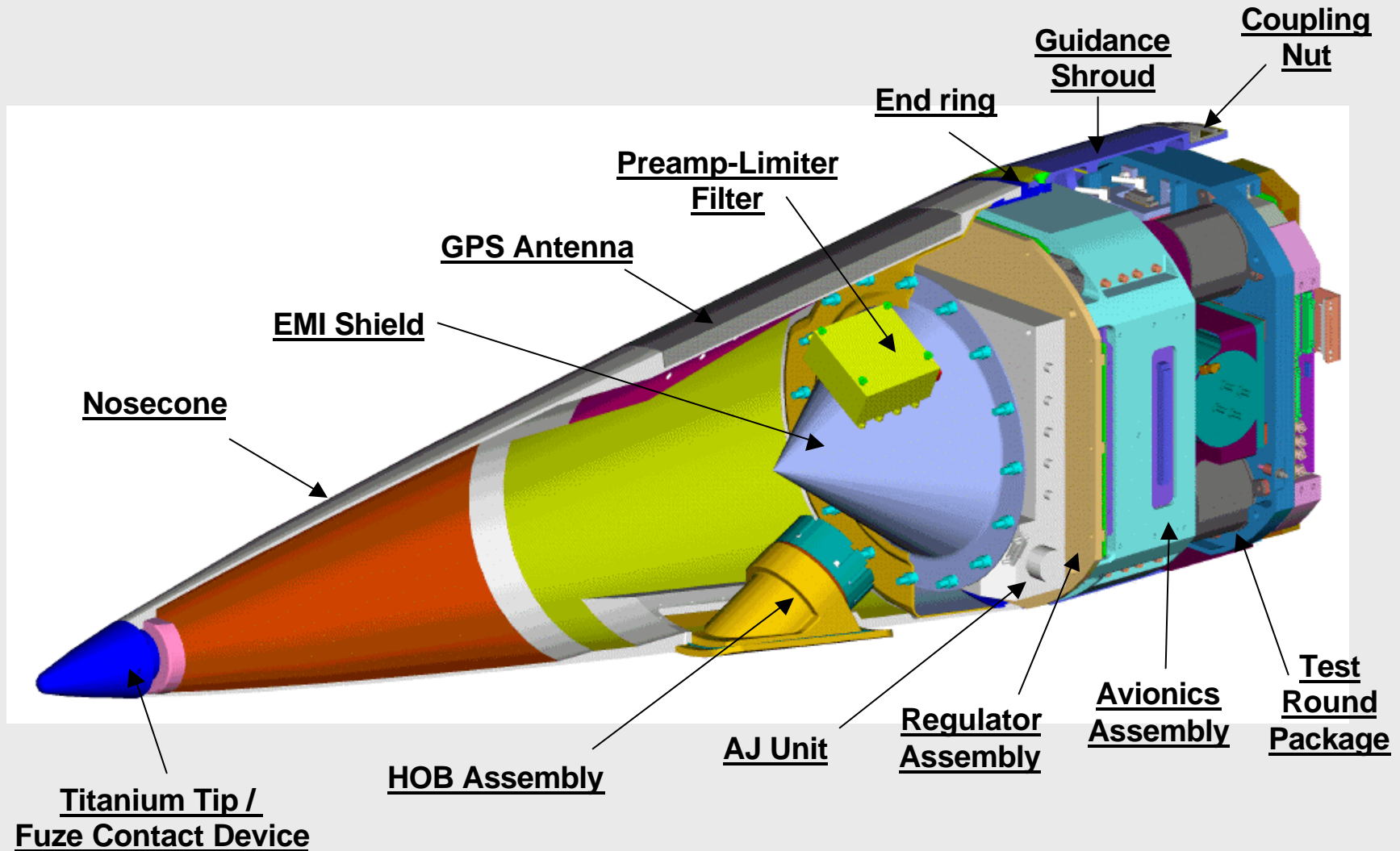
HOB Sensor

- ❑ Gen III - LASM Configuration
- ❑ Near IR Pulsed Diode Laser
- ❑ Low Cost, Rugged, Low Power, Array Logic, Microprocessor w/ EEPROM flash Memory, Serial Communication, Continuous Altitude readout, Obscurant Algorithms

- ❑ Gen III - Performance
- ❑ Cost Effective
- ❑ Will Meet Missile Environments
- ❑ Meets Clear Air Requirements
- ❑ Will Not Pre-trigger on Obscurant
- ❑ Will Distinguish Hard Targets from Obscurants
 - Degradation of Performance in Obscurants - TBD
- ❑ Mechanically and Electrically Interface with GS
- ❑ Adaptive Configuration for Future Growth



GUIDANCE SECTION ASSEMBLY





Summary

- ❑ Requirements Defined
- ❑ EO Sensor Characterized and Risks Identified With Mitigation Plans
- ❑ Preliminary Mechanical Design for HOB Main Assembly Complete
- ❑ Analysis and Test Performed



Future Efforts – Course Corrected Fuzes

- ❑ Trajectory error management
 - 1-D Corrections: drag chutes, drag fins, etc. to reduce range dispersion
 - 2-D Corrections: canards, pulse jets, etc. to reduce range dispersion and cross-track deflection
- ❑ Must not violate NATO standard fuze envelope during pre-flight
 - Ensures minimal impact on round handling equipment and procedures
 - MIL-STD-333B envelope selected
- ❑ Range increase not required
- ❑ Fielding by FY10



Future Efforts – Low Cost Projectile Fuze Alternatives

- Reduce Fuze Re-procurement Costs
 - Buy Fuzes with Army
 - Navalized MOFA
 - Buy Components with Army
 - Common S&A, battery, detonators
 - New Fuze
 - Low Cost Air Warfare Fuze
 - New Requirements



Issue #1: Batteries

- ❑ In the last few years, DOD has lost significant manufacturing and design ability to make batteries for gun fired munitions
 - Reduction in the last 10-15 years
 - Govt battery R&D personnel: approx 90% loss
 - Contractor companies: from 15 to 3
- ❑ The government has not maintained the expertise
- ❑ The contractors can not maintain the expertise
- ❑ No fundamental R&D conducted in the last 10 years in liquid reserve technology
- ❑ Applied chemical engineering has been conducted in a limited way on select programs with very limited success
 - Based on 15-20 year old technology



Impact to Navy Programs

- ❑ JMPSIB-IPT
 - Dahlgren is the Navy's lead on the Joint Service IPT
- ❑ MK 419 MFF Battery
 - MK 44 Lead-chemistry battery unproducibile within USA
 - No direct replacement
 - Lithium replacement program did not meet requirements
 - Investigating two European batteries
 - Lithium Chemistry
 - Lead Chemistry



Miniature Liquid RE

- ❑ EP, ATK, KDI have no success or limited experience in the cutting edge of power sources technology
- ❑ Major concern to ERGM program for both submunition programs
 - M234 SDF
 - EX 433 Prox Fuze



Objectives

❑ Current Navy Projectile Battery Requirements

- ERGM
 - 2 System batteries (1 thermal reserve, 1 liquid reserve)
 - 72 Submunition batteries
- MK 419 - MFF
- MK 418/MK 417 - VT-RF
- MK 404 - VT-IR
- EX 432 - ET

❑ Future Naval Gun launched projectiles requiring a power source

- GPS Rounds
- Best Buy - GPS, 100nmi
- Badger - GPS, Hypersonic projectile
- MRO Mission Responsive Ordnance
- AGS munitions



Issue #2: Submunitions

"On April 24, five children playing with colorful unexploded submunitions were reported killed, and two injured, near Doganovic in southern Kosovo."

-Steve Goose, program director of Human Rights Watch's arms division as reported in the Washington Post, Saturday, June 19, 1999; Page A19

"PRISTINA, Kosovo, May 22 -- One boy was killed and two other children were seriously wounded by a cluster bomb on Sunday..."

-Carlotta Gall; published on Tuesday, May 23, 2000 in the New York Times

"Submunition weapons employment in Southwest Asia and Kosovo, and major theater war modeling, have revealed a significant unexploded ordnance (UXO) concern."

-William Cohen, former U.S. Secretary of Defense in a memorandum dated 10 January, 2001





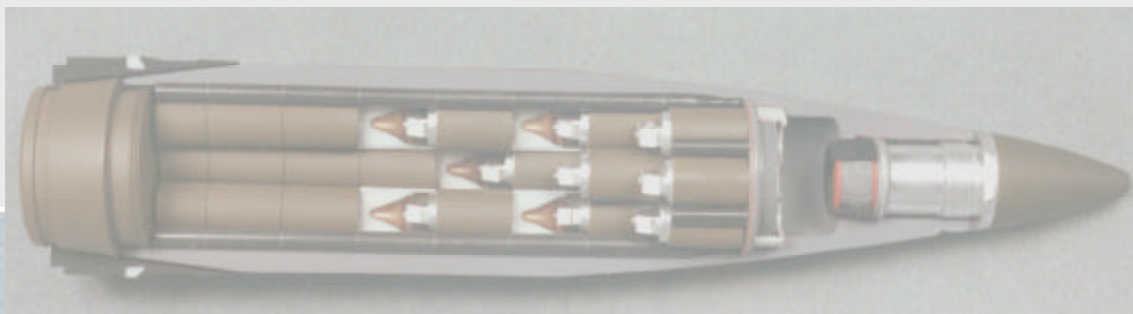
SecDef Memorandum

- ❑ “It is the policy of the DoD to reduce overall UXO...
- ❑ “...the desire is to field future submunitions with a 99% or higher functioning rate.”
- ❑ “Submunition functioning rates may be lower under operational conditions...”
- ❑ “Services may retain ‘legacy’ submunitions...”
- ❑ “Waivers to this policy...shall require approval by the JROC.”

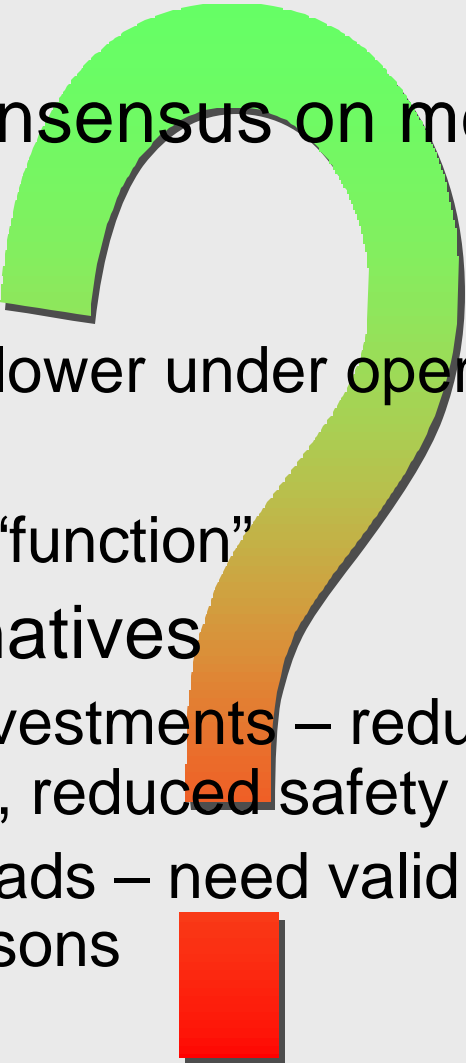


Navy Programs Affected

- ❑ ERGM
- ❑ Cargo
- ❑ MRO
- ❑ MLRS (Marine Corps)



What's Next?

- 
- ❑ Community Consensus on meaning of memorandum
 - “function”
 - “rates may be lower under operational conditions”
 - “waivers”
 - Safe UXO vs. “function”
 - ❑ Evaluate Alternatives
 - Technology Investments – redundancy, miniaturization, reduced safety
 - Unitary Warheads – need valid lethality models to make comparisons