NDIA FUZE CONFERENCE

Fuzes for Air Force Unguided and Precision Guided Weapons

17 April 01

Air Armament Center
AAC/WMG
Eglin AFB, Florida

Mr. Frank Robbins
Director
Precision Strike SPO

OUTLINE

- Current Weapon Systems
- Fuzes: Inventory, Production
- Challenges For Today's and Tomorrow's Fuze Programs

CURRENT WEAPON SYSTEMS

- AGM-130
- AGM-142
- GBU/EGBU-15
- GBU/EGBU-24/27
- GBU/EGBU-28
- JDAM
- JASSM

AGM-130 MISSILE SYSTEM DESCRIPTION

- Rocket Powered Standoff Precision Guided Missile
  - Man-in-the-Loop (MITL) Terminal Control
  - Interchangeable TV or IR Seekers
  - Interchangeable MK 84 or BLU-109 Penetrator Warhead
  - Fully Autonomous INS/GPS Adverse Weather Capability
- Only U. S. Fighter Launched Air Force Standoff Weapon With 2,000 Pound Warhead
- Integrated on the F-15E Strike Eagle
- Over 100 Used During Operations NORTHERN WATCH SOUTHERN WATCH and ALLIED FORCE

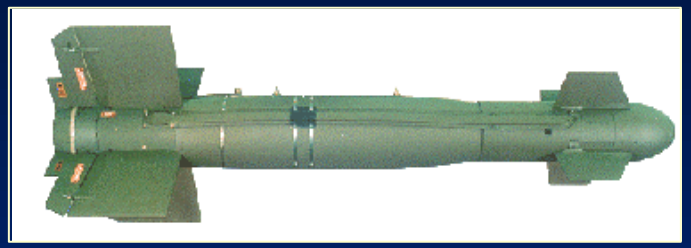
AGM-130 EXPANDED EFFECTIVENESS

- Weapon Improvements
  - Television Guidance Seeker (CCD)
    - Charge Coupled Device
    - Rate Stabilized Platform
    - Correlation Tracker
  - Improved Modular IIR Seeker
    - Focal Plane Array
    - Correlation Tracker
  - Digital Autopilot With GPS/INS
  - Switchable Data Link
  - Performance Enhancements
    - Horizontal Target Attack
    - Envelope Expansion
    - Real Time Information in the Cockpit
  - Support Equipment Improvements

AGM-142 MISSILE SYSTEM DESCRIPTION

- Precision Guided, Standoff Weapon for Use Against High-Value/ Heavily Defended Fixed Targets
  - Data Link Pod Augments Inertial Navigation
  - Interchangeable TV, IIR, or Z-Seeker
  - Interchangeable 750 Lb. Blast/Frag or 800 Lb. Penetrator Warheads
- Only U.S. Bomber Launched Precision Weapon System
- Weapon of Choice for Multiple Allied Fighter Aircraft

GBU-15 MISSILE SYSTEM DESCRIPTION



- Standoff Precision Guided Weapon System For Use Against High-Value Fixed Targets
  - Man-in-the-Loop (MITL) Terminal Control
  - Interchangeable TV or IIR seeker
  - Interchangeable MK 84 or BLU-109 Penetrator Warhead
- Integrated on the F-15E Strike Eagle

EGBU-15 DESCRIPTION

- Platform - F-15E
- Warheads - MK-84/BLU-109
- Seekers - TV or IIR
- Guidance - Autonomous GPS/INS, Man-in-the-Loop
- Data Link - AXQ-14, ZSW-1

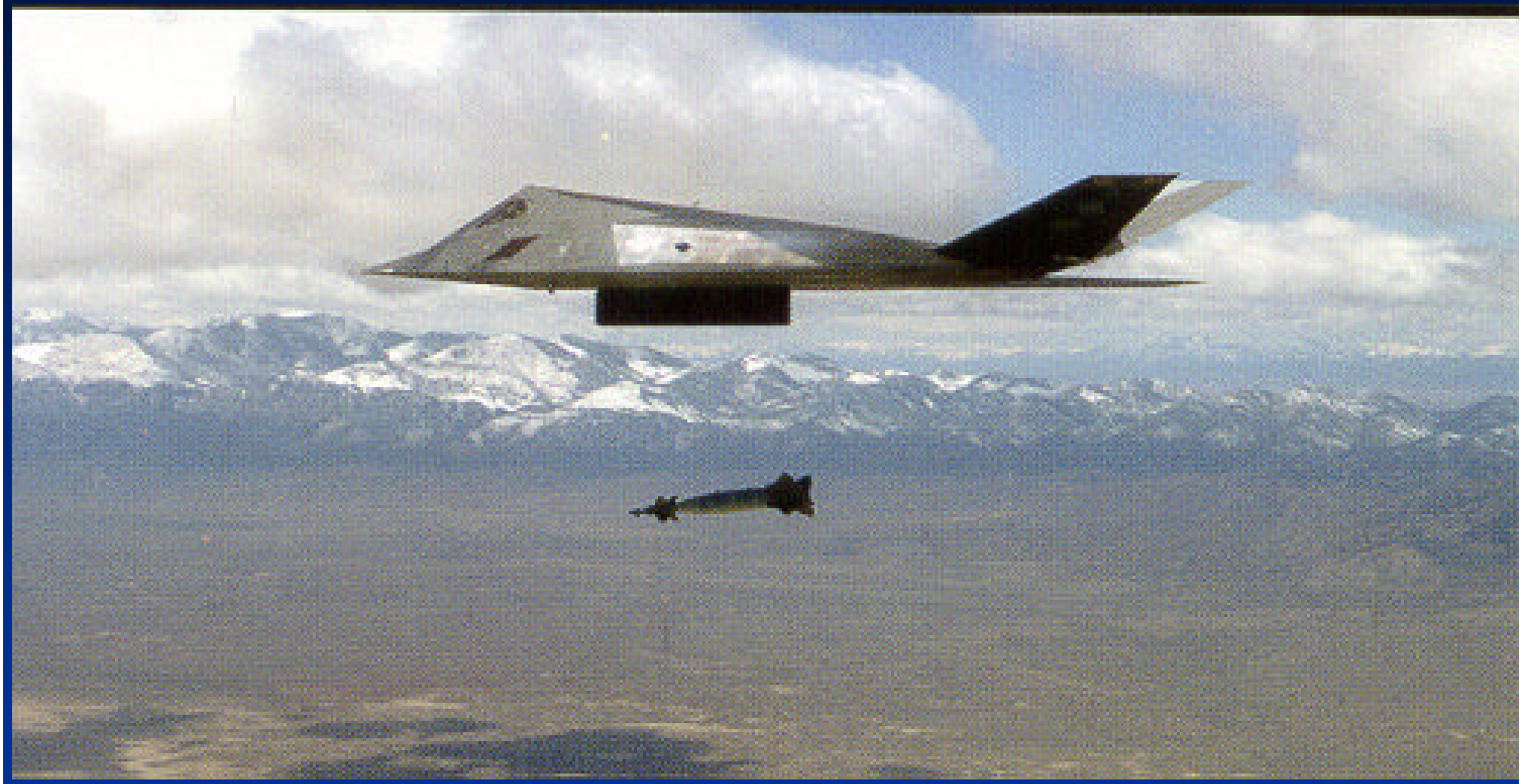
EGBU-15 PROGRAM BACKGROUND

- Chief of Staff, Air Force Directed Quick Reaction Capability Program to Provide Adverse Weather Enhancement to Legacy GBU-15 Weapon System
  - Based upon "Urgent and Compelling Combat Need"
  - Balkans Conflict Depleted Inventory of Precision, Standoff Weapons
- Two-Phased Approach
  - Phase I Program
    - Design, Test, Produce, and Field 100 weapons in 45 days
    - Provide "Interim" integration
  - Phase II Program
    - Design, Test, Produce, and Field 1200 weapons in 12 months
    - Provide "Complete integration"

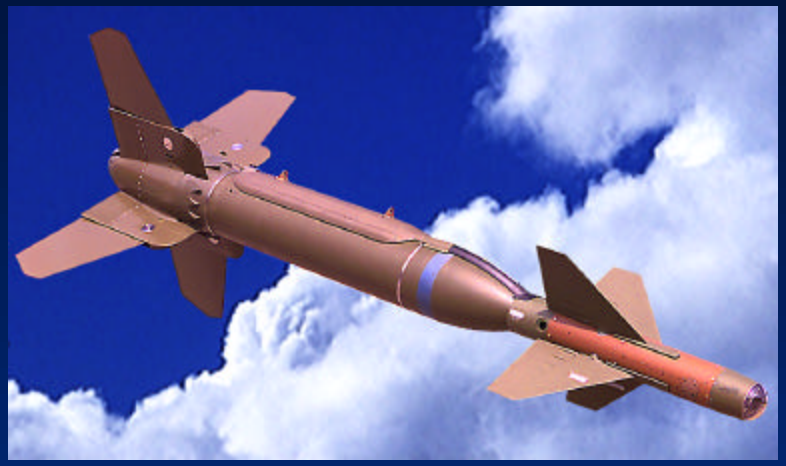
EGBU-15 STATUS

- Phase I Deliveries Complete; 50 Weapons Delivered in 44 Days; 100 Total Weapons Delivered in 69 Days
- Phase II Deliveries Complete; 1200 Weapons Delivered in 12 Months
  - 5 Development Test and 6 Operational Test Drops -- 11 direct hits!
  - Field Modifications Efforts Completed at Many Locations Worldwide
  - Final Advance Support Equipment, Mission Planning System, and Mission Squadron Trainer Upgrades Nearing Completion
  - Operational Training Completed at Most Operational bases Worldwide

LASER GUIDED WEAPONS



GBU/EGBU-24/27 MISSILE SYSTEM DESCRIPTION

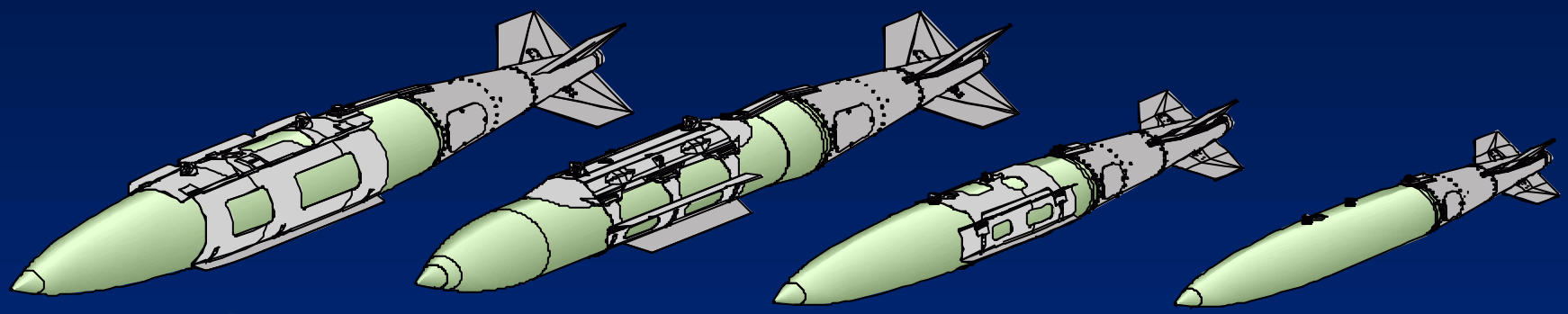


- Laser Guided Munition Designed for Horizontal and Vertical, Hardened and Deeply Buried Targets
  - Laser Designator (Aircraft or Ground)
  - Laser Guided MK 84 or BLU-109A/B 2000 Lb. Warhead
- Used on Heavily Reinforce Concrete Bunkers, SAM Sites, Etc...
- Integrated on the F-117, F-15, F-16, Navy F-14 & F-18
- Improvement Program
  - Autonomous INS/GPS Laser Guided Provides Adverse Weather Capability

GBU/EGBU-28 MISSILE SYSTEM DESCRIPTION

- Laser Guided Munition Designed for Super Hardened and Deeply Buried Targets
  - Laser Designator (Aircraft or Ground)
  - WGU 36A/B Laser Guidance Unit
  - BLU-113A/B Penetrator Warhead (5000 LB)
- Developed in 34 days during Operation DESERT STORM
- Integrated on the F-15E Strike Eagle
  - On Going Integration on the B-2
- Improvement Program
  - Examining Improved Penetration
  - Autonomous INS/GPS Adverse Weather Capability
  - Hard Target Smart Fuze

Joint Direct Attack Munition (JDAM) System Description



Mk-84 BLU-109 Mk-83, BLU-110 Mk-82

- Joint Air Force/navy Program to Develop Affordable, Adverse Weather, & Accurate Guidance Kit for 1000 and 2000 Pound Bombs… Eliminate Higher Cost, Limited Utility Interim Weapons
- INS/GPS Guidance Kit Attached to the Bomb Useing Controlled Tail Fin Movements to Direct Bomb to Target
- Fuzes: FMU-139, FMU-143, FMU-152 & DSU-33
- Allows US Forces Precision Engagement in All Flyable Weather
- Lethal...Multiple Kills Per Pass + Fire and Forget
- Interoperable…Bmbers, Fighters, Carrier, Bare Base
  - B-2, B-52, B-1, FA-18, AV-8B, F-22, F-117, F-16, F-15, JSF
- Affordable - Extremely High Capability to Cost Ratio

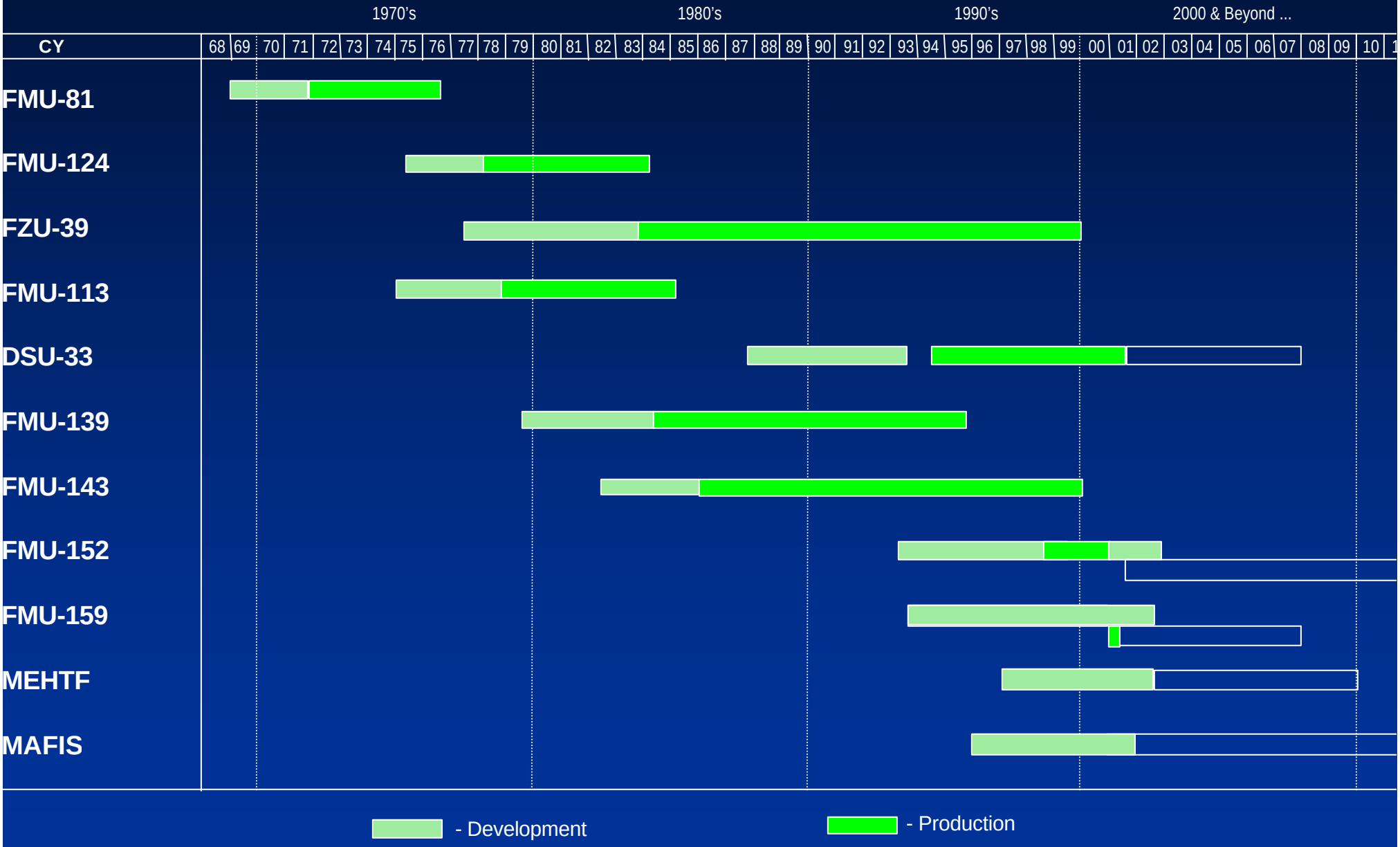
BLAST FRAGMENTATION/PENETRATOR COMBINED/DESIGNS

- AGM-158 Joint Air-to-Surface Standoff Munition (JASSM)
- A Joint Air Force and Navy Program to Provide an Autonomous, Medium Range, Conventional, Air-to-Surface, Precision Missile Able to Strike Highl Defended, High Value Targets
  - WDU-42/B (1000 Lb..) Warhead Provides Penetration, Blast & Fragmentation Kill Mechanism Against all Designated JASSM Targets
  - INS/GPS Mid-Course Guidance
  - I2R Seeker
  - Adverse Weather Capability
  - Fuze: FMU-156
- For Integration on F-16, B-52, B-1B, B-2, F/A-18
- 15 Year Bumper-to-Bumper Warranty

FUZE/WEAPON COMPATIBILITY

Weapon System	FMU 143	FMU 124	FMU 152	JUF	DSU 33	FMU 159	FMU 139	FMU 156	MEHTF	MAFIS	FMU 155
Mk 80 Series			X		X		X		O		
BLU-109/113	X		X			X			O		
JDAM	X		X		X	O	X		O		
GBU-15/AGM-130	X	X	X								
GBU-24/27	X		X			X	X		O		
JASSM								X			
GBU-28/37	X		X			X			O		
AGM-142	X	X									
AGM-86D						X					
SDB			TBD			TBD			TBD		
AUP						X					
TTPV						X					
JSOW Unitarv				X						X	
SLAM/SLAM ER											X

FUZES/SENSORS SCHEDULE HISTORY



Inventory Fuzes

Production/EMD Fuzes

USAF FUZE INVENTORY UNGUIDED CLUSTERS

Status March 2001

Function	Type	Quantity	Weapon	Remarks
Time	MK-339	81K	M129E1	Leaflets
Time or Proximity	TMD Fuze/ FZU-39	132K	CBU-87/ 89/97	

USAF FUZE INVENTORY
GUIDED BOMBS

Status as of March 2001

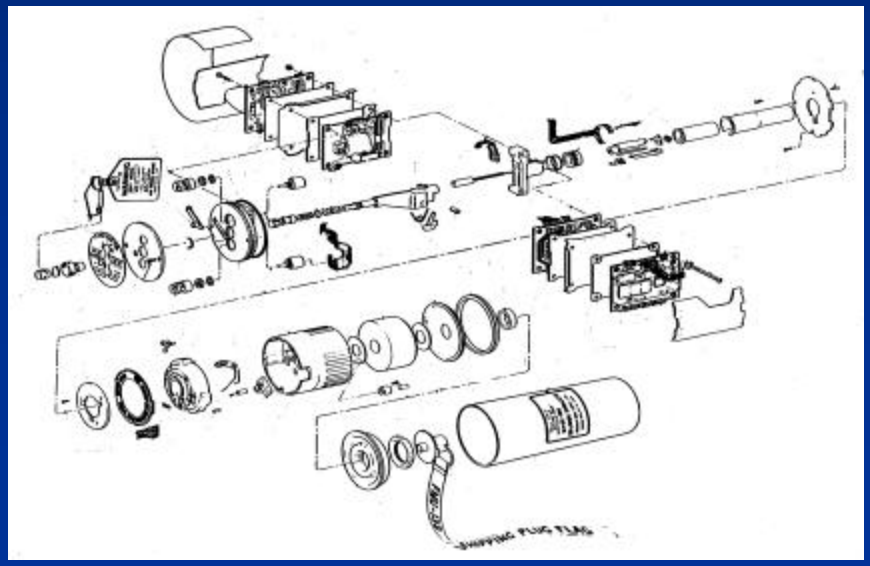
Function	Type	Quantity	Weapon	Remarks
Impact or Impact Delay (Optional)	FMU-81/B	37K	GBU-10/12 (LGB) MK-82, MK-84	
	FMU-124	2.5K	GBU-15, AGM-130, AGM-142, MK-84	
	FMU-139A/B	244K	GBU-24, AGM-65	Replaces FMU-81/B
	FMU-143 B/B	11K	GBU-10/24/27, GBU-15, AGM-130, AGM-142, BLU-109/B	
	FMU-143 F/B,	112	GBU-28	
	G/B	157		
	H/B	73		

FUZE INVENTORY
GENERAL PURPOSE BOMBS

Status as of March 2000

Function	Type	Quantity	Weapon	Remarks
Time	M-904	824K	No Hi Drag	
	M-905	1.1M	No Hi Drag	
	FMU-54A/B	24K	No Hi Drag	
	FMU-54/B	8K		
	FMU-139 A/B	244K		
Proximity	FMU-113	34.6K	No Hi Drag	
	DSU-33A/B	5010		
	DSU-33B/B	2447		(5635 in transit/Prod)

FMU-139B/B FUZE PRODUCT DESCRIPTION



- Electronic impact/impact-delay fuzing system designed for use with general purpose high-explosive bombs
- Delivered with FZU-48/B initiator, power cable (attached) and closure ring
- Provides multiple fuzing options for:
  - Tail fuzing only
  - Nose fuzing only, and
  - Nose and tail fuzing

FMU-139B/B FUZE

- FMU-139B/B fuze is interoperable with all FMU-139A/B applications
- Compatible with laser guided bombs and with low and high speed drag air foil groups
- Compatible with DSU-33A/B and DSU-33B/B proximity sensor
- FMU-139 currently in use with MK80 series Joint Direct Attack Munition (JDAM)
- Being Replaced by FMU-152 Joint Programmable Fuze

FMU-143 A-H/B FUZE DESCRIPTION

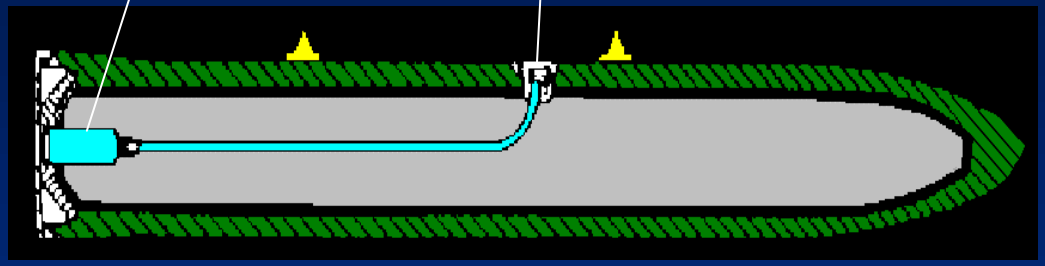
- Impact Delay Fuze for Penetrating Warheads (Single 0.060 Sec. Delay)
- Interface - BLU-109, BLU-113, AGM-142 I-800
- Power/safety - FZU-32B/B Bomb Fuze Initiator, GBU-15/AGM-130 Battery
- Used On -GBU-10, 24, 27, 28, 31, AGM-142, and AGM-130, (With BLU-109 or BLU-113 Warheads)
- Being Replaced By FMU-152, JPF
- Manufacturer - Dayron Inc., Orlando FL.

FMU-143 A-H/B FUZE SYSTEM

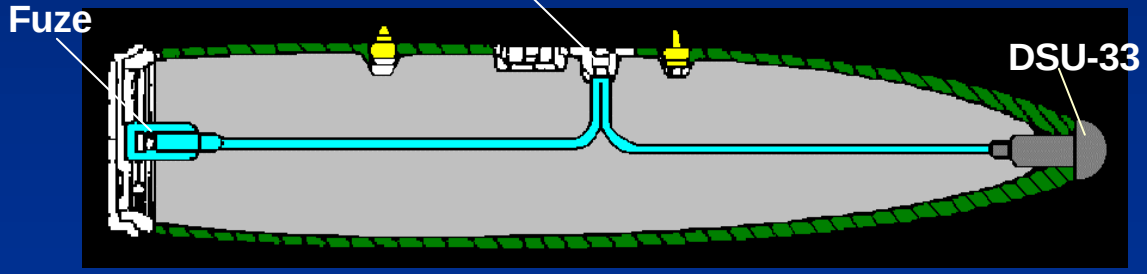
Configuration	User	Modification
FMU-143B/B and FMU-143B(D-2)/B	AF, FMS, JDAM	Basic - 60ms Delay, 5.5 or 12 sec Arm Time
FMU-143D/B and FMU-143D(D-2)/B	AGM-142	21 Sec Arm Time
FMU-143E/B and FMU-143(D-1)/B	Navy	PBXN-7 Booster/Lead
FMU-143F/B	GBU-28	30ms Delay/21 Sec Arm
FMU-143G/B	GBU-28	60ms Delay Same
FMU-143H/B	GBU-28	120ms Delay Same

ADVANCED FUZES AND SENSORS

Joint Programmable Fuze



Hard Target Smart Fuze



DSU-33B/B Proximity Sensor

JOINT PROGRAMMABLE FUZE (JPF)

FMU-152/B

FMU-152/B JPF SYSTEM DESCRIPTION

- Single Fuze Compatible With Mk82, Mk83, Mk 84, BLU-109, BLU-113 for Use in AGM-130, GBU-10/12/15/16/24/27/28 and All JDAM Variants
- Can Be Used in Current FMU-139 and FMU-143 Applications
- Cockpit Selectable Arm/delay Times
  - Instantaneous to 24 Hours
- Multi-function Capability
  - Hard Target Penetrator Weapons
  - Blast Fragmentation
  - Backward Compatibility With Current Weapons

FMU-152/B JPF REQUIREMENTS

Performance	Threshold Parameters
Weapon Interface	AGM-130, GBU-10/12/15/16/24/27/28, JDAM
Warhead Interface	MK-82/83/84, BLU-109/113
Low Drag Arm Time (Sec)	4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 10.0, 14.0, 21.0, 25.0
High Drag Arm Time (Sec)	2.0, 2.6, 3.0, 3.5, 4.0, 5.0
Impact Delay Times	0, 5, 15, 25, 35, 45, 60, 90, 180, 240 Msecs 15, 30, 45, 60 Min 4, 8, 12, 16, 20, 24 Hrs
Reliability	0.98
Service Life	10 Years
Shelf Life	20 Years

Note: Yellow Denotes Fuze Panel Switch settings

FMU-152/B JPF PROGRAM OVERVIEW

- Program Phase: Production
- Contractor: Dayron
- Current Unit Price : $2.167K
- Quantities: 62,000 (AF)/25,496 (Navy)
- Joint Service: Air Force (Lead)/Navy
- First Article Acceptance Testing - Summer 01
- JDAM High Altitude Low Airspeed Release Challenges
  - FZU- 55 Improvements - LRIP 2 and Beyond
  - Additional FMU-152 Improvements - LRIP 4 and Beyond

HARD TARGET SMART FUZE (HTSF)

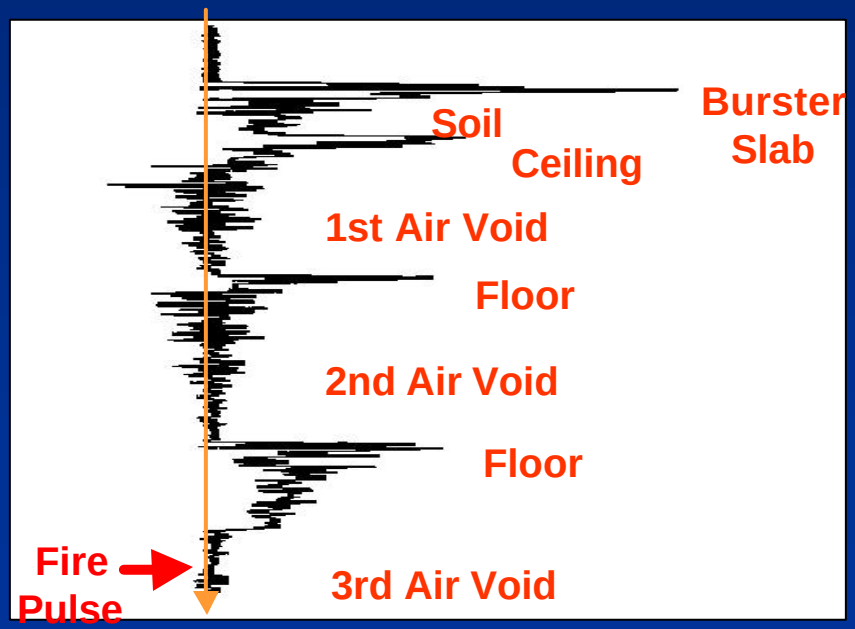
FMU-159/B

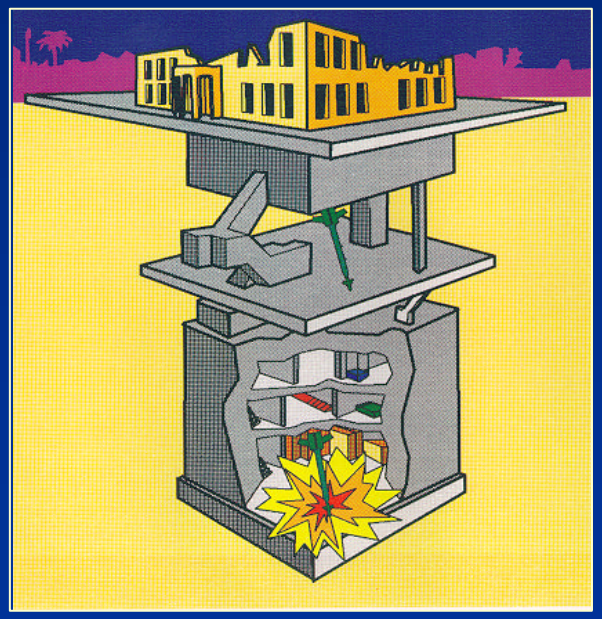
FMU-159/B HARD TARGET SMART FUZE PROGRAM OVERVIEW

- Program Phase: EMD
- Contractor: Alliant Techsystems
- Value: EMD $18.5M, Prod $34M
- Quantities: 500+ (AF) / 500+ (Navy)
- Joint Service: Air Force (Lead)/Navy
- “Smart” Fuze for Penetrator Weapons
- Allows Defeat of High Value Hard Targets

VOID SENSING, LAYER COUNTING, DEPTH OF BURIAL CAPABILITIES

- Contains a precision accelerometer and microcontroller
- Senses voids and layers, computes depth of burial
- Detonates warhead at user programmed point within target
- Programmable modes
  - Void or Layer Count, and Depth of Burial
  - Function Distance/Time after Void/Layer event
  - Redundant Backup Timer 0 to 255ms





FMU-159/B HARD TARGET SMART FUZE EMPLOYMENT PLATFORMS & WEAPONS

B-52H

AGM-86D
CALCM Penetrator

B-2A

GBU-37, EGBU-28

F-15E

GBU-28, EGBU-28,
GBU-24/27

F-117A

GBU-27

F/A-18

F-14

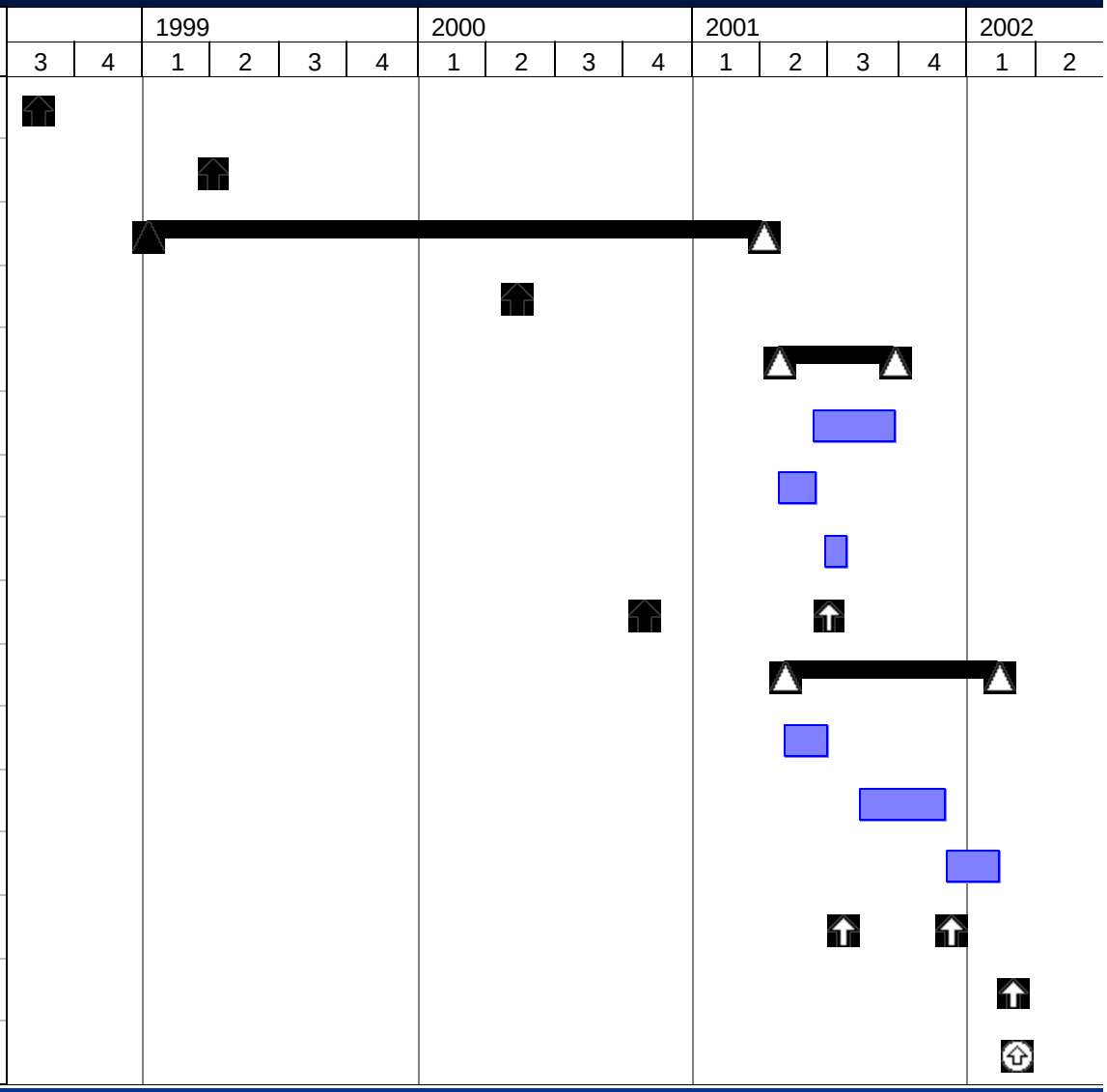
GBU-24G/B
(BLU-116)

Missile Cruisers & Destroyers

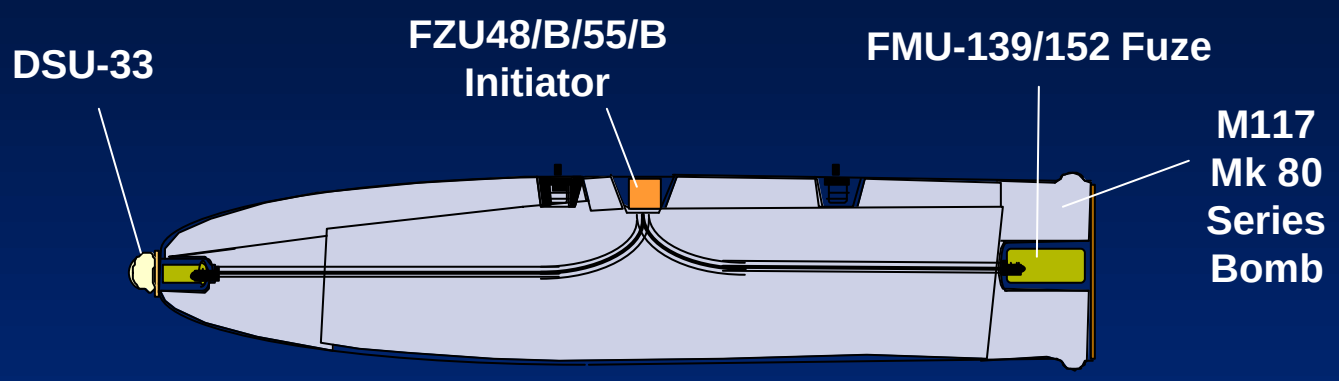
BGM-109H
Tactical Tomahawk Penetrator

FMU-159/B HARD TARGET SMART FUZE SCHEDULE SUMMARY MAR 01

Task Name	Start	Finish
Contract Award	8/11/98	8/11/98
Prelim Design Review	3/31/99	4/1/99
Design/Development	1/4/99	4/5/01
Critical Design Review	5/10/00	5/11/00
Contractor Test & Eval	**4/23/01**	**9/26/01**
Qual Tests	6/7/01	9/26/01
Cannon Tests	4/23/01	6/13/01
Sled Tests	6/25/01	7/25/01
PPO1 Exercise / Begin Build	10/26/00	6/29/01
DT&E/OT	**5/1/01**	**2/12/02**
FZU-60 Flt Test	5/1/01	6/29/01
Sled Testing	8/9/01	12/4/01
Flt Test	12/5/01	2/12/02
PPO2 Exercise / Begin Build	7/17/01	12/11/01
NNMSB / WSESRB Final	2/27/02	2/27/02
PCA / PRR MSIII	3/6/02	3/6/02



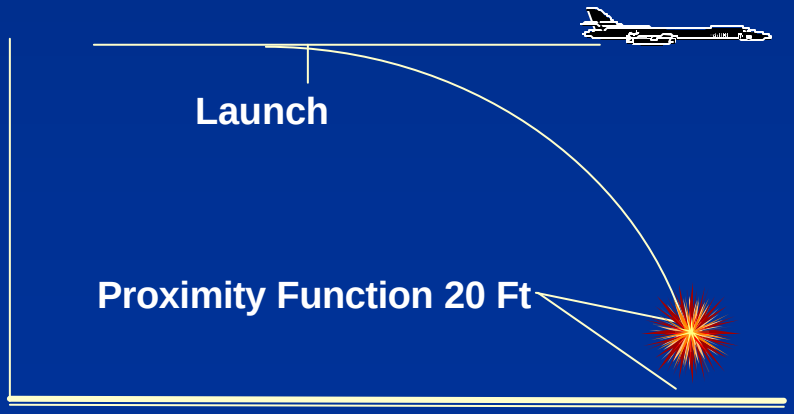
DSU-33 PROXIMITY SENSOR



Air Force Configured System

DSU-33 B/B PROXIMITY SENSOR

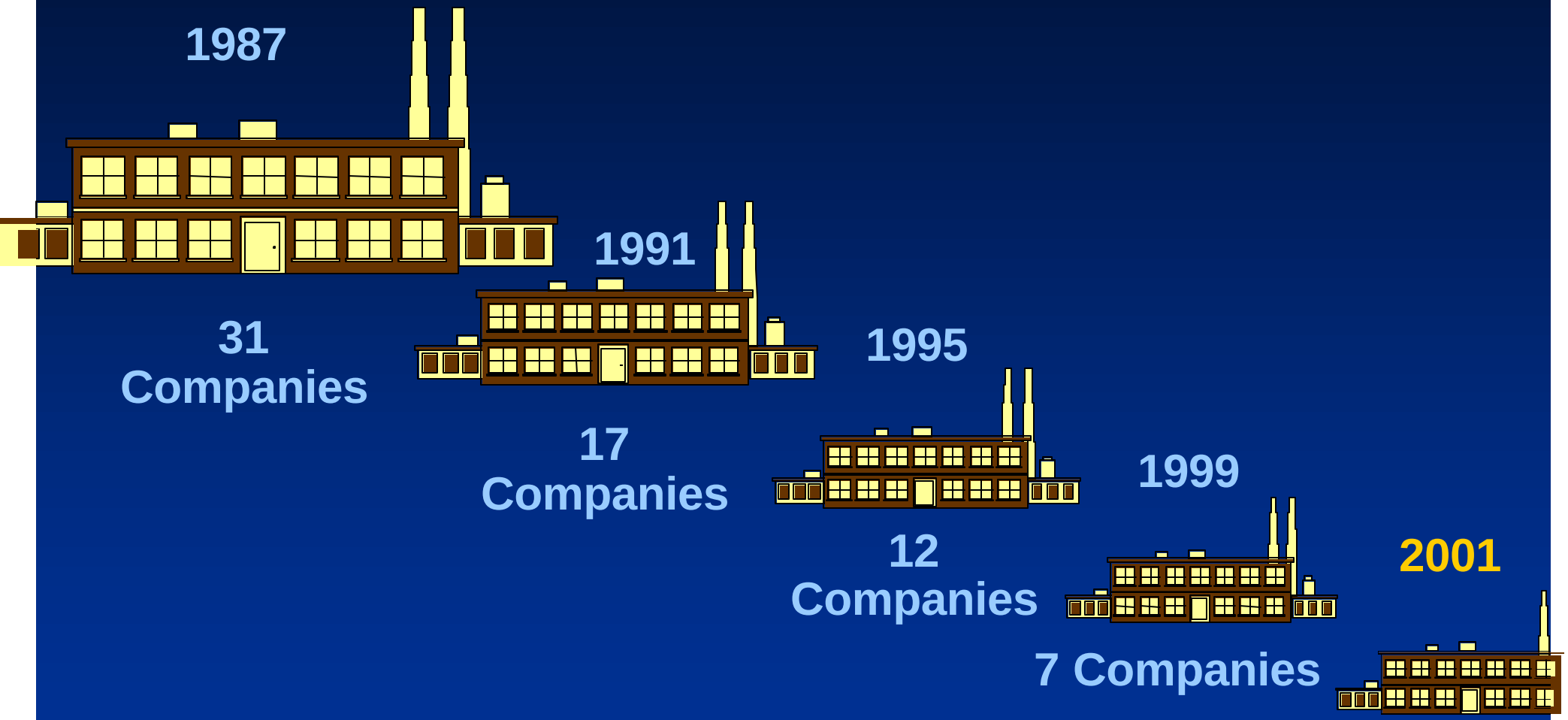
- Current Production With Alliant Techsystems
- Air Burst Proximity Fuzing for Mk80 Series/m117 General Purpose Bombs and JDAM Variants
- Continuous Wave Doppler Radar Provides Fire Pulse Signal to the FMU-139 and FMU-152/B
  - Height of Burst (HOB): 20 Feet
  - Over All Water and Land Surface Conditions
- Attacks Surface Level Targets
- 9,996 Units Deliverd Thru Mar 2001 (AF & Navy)
  - 3501 Remaining



CHALLENGES FOR TODAY'S AND TOMORROW'S FUZE PROGRAMS

- Shrinking Industrial Base
- Increasing Complexity & Cost
- Diminishing Verification Opportunities
- Aging Inventory
- Increasing Expectations
- Aircraft & Missile Interface Challenges

SHRINKING CONVENTIONAL FUZE INDUSTRIAL BASE



* Source: Army Fuze Management Office

JOCG Fuze Subgroup Meeting 11 Aug 99

7 US & Internatio Consortiums

SHRINKING INDUSTRIAL BASE
(CONT)

- Funding Requirements in Support of Current Operations and Declining Acquisition Budgets Negatively Impact Development and Production Efforts
  - Fewer New Starts
  - Smaller Production Quantities Spread Over Longer Periods
- Increasing Reliance on Electronic Fuzing Reduces the Need for Older Mechanical Fuzes
  - Requires Higher Level of Technical Ability
  - Fuze Contractors Must Adapt or Face Dwindling Business
- Opportunity - DSU-33 Production Competition for FY 02-07 Requirements

SHRINKING INDUSTRIAL BASE
(CONT)

- Erosion of Essential Human Resources
  - Technical Expertise is there, but in insufficient numbers
  - Lack of Technical Breadth/Experience impacts Problem Solving
    - No Technical Surge Capability
    - Failure Analysis Slow
    - Limited Understanding of Fuze Design and Operation
  - Government In-house Expertise is Retiring (Vietnam/Post-Vietnam era)
  - Recruiting and Retention is a major Challenge in this Market Sector
- JOCG Fuze Subgroup to Brief JOCG in Sep 01 on Industrial Base Status

INCREASING COMPLEXITY AND COST

- Single Fuze Combining the Function of Several Fuzes
  - e.g., FMU-152/B JPF Is Both a Blast-frag and Penetrator Fuze
- Designs Take Advantage of Modern Electronics and Computer Technology
  - More Versatile, More Precise
  - More Complex Sensing and Logic Functions
- Mission Planning Becomes More Detailed and Critical
- FMU-159/B Hard Target Smart Fuze
  - Void/layer Count, Timer, Back-up Timer
  - Programmable With 22 Settings on the Ground, 11 From the Cockpit
- Multi-event Hard Target Fuze
  - Thin Layer Detection, in Addition to Voids/timers
  - Cockpit Programmable
  - Fuze Information for Bomb Damage Information

DIMINISHING VERIFICATION OPPORTUNITIES

- Advanced Fuze Verification Programs Are Very Expensive and Necessitate Limited Test Programs
  - Targets to Verify Fuze Performance Are Large, Multi-floor Structures
- FMU-152/B - 5 Sled Tests, 193 Flight Tests (DT/OT)
- FMU-157/B (ACTD) - 23 Sled Tests, 32 Flight Tests
- FMU-159/B - 18 Sled Tests, 11 DT Flight Tests, 2 OT Flight Tests
  - No AF GBU OT&E Because of High Cost and Limited AFOTEC Budget
  - Original AF GBU OT&E Planned for 13 Flights Using 19 Weapons

AGING INVENTORY

- Much of Fuze Inventory Is Approaching End of Expected Life
  - Historically at 20 Years Reliability Problems Begin
  - AF Generally Accepts Older Fuzes at 90% Reliability With 90% Confidence
    - After That Either Double Fuze or Put 2 Weapons on Target
- Reliability of Older Fuzes Is a Current Issue
  - FMU-124B/B Surveillance Testing Failures (6 out of 72)
- Lack of Comprehensive Replenishment Plan
  - Insufficient Budgets to Efficiently Replace Older Inventory
- Refurbish or Replace?
  - FMU-139
    - AF - Replace With FMU-152 Over Time
    - Navy - Rebooster Challenges

INCREASING EXPECTATIONS

- Warfighters Expect “First Time - Every Time” Performance
  - Objectives of 98% Reliability
- “Smart” Communications
  - Cockpit Programming Is Now Standard
  - Bomb Damage Information Is Desired for the Future
- Fuze Must Perform in Ever-expanding Performance Envelopes
- Fuze Design Capturing System Responsibilities
  - High Altitude, Low Airspeed Release Conditions
  - Navy Fuze Function Control Set (FFCS)
- Safety Certification of Electronic Fuzes Is More Difficult Than Mechanical Fuzes
  - Old Paradigms Don’t Apply

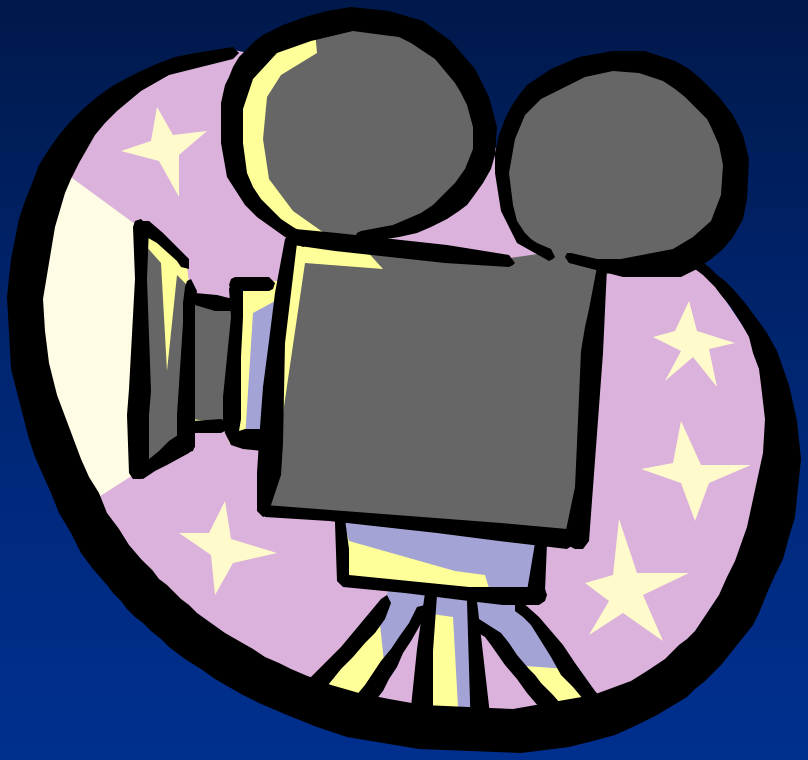
AIRCRAFT AND MISSILE INTERFACE CHALLENGES

- Navy Fuze Function Control Set
  - Anomalies Yielding Low Reliability With Electrically Fuzed Bombs (E.G., F/A-18 - 88%)
- High Altitude - Low Airspeed Release
  - Initiator Turbine Starved for Air Causes Arming Problems
  - JDAM Roll Stabilized Flight and AoA Compounds the Situation
- Long Term Storage Reliability and Safety Requirements While Installed in Cruise Missiles
- Allied Interoperability
  - Fuze Well Size
  - Fuze Power Source
  - Communications Interface

POSITIVE RESULTS

- Significantly Increased Capabilities
  - Performance Characteristics
    - Void/layer Detection
    - Increased Survivability
    - Cockpit Programmability
  - Very High Reliability Requirements
    - HTSF and JPF - .98 (Mission),.95 (Storage)
    - MEHTF - .99 (Mission and Storage) Goal
- Joint Programs Are the Norm
  - DSU-33, JPF, HTSF
- Growing Realization of Critical Nature of Fuzing
  - Fuzing Is Small Diameter Bomb's (SDB) #1 Risk
  - HTSF Is on CALCM 86-D Critical Path
  - Major Growth Area for JDAM

Video



Any Questions?