M234 / M235 / M236
SELF-DESTRUCT FUZES

THE
48TH ANNUAL FUZE CONFERENCE

L3 communications
KDI Precision Products, Inc.

APRIL 2004
OUTLINE

• Self-Destruct (SD) Fuze Objectives
• SD Fuze Requirements
• KDI SD Fuze Design and Operation
• Safety Test and Army Certification
• Type Classification Test Results
• High Rate Fuze Equipment Status
• High Rate Battery Equipment Status
• Product Improvements
• SD Fuze Schedule
• Summary
SD Fuze Objective

- Reduce the Number of Hazardous DPICM Grenade Dud Submunitions on the Battlefield

Advantages:
- Enables Maneuverability
- Reduces Clean-up Efforts
- Addresses Humanitarian Issues
U.S. Army SD Fuze Requirements

- Artillery (M234)
  - 97% Primary Mode (Ground Impact)
  - 99.8% Tactical Mode (Includes SD Function)
- ER-MLRS (M235)
  - Less Than 1% Hazardous Duds
  - Less Than 5% UXO (Fly-Off Requirement)
KDI’s SD Fuze Key Design Feature

- Two Autonomous Fuzing Systems
  - PD Primary
  - Electronic Time SD
- Mechanical Arming of Primary Fuze **Not** Required to Arm SD Fuze
- Only SD Fuze Type Classified for U. S. Army and U. S. Navy Utilization

- 105 MM
- 5” 54
- ER-MLRS
- ERGM
- XM982
- GMLRS
Background Fuze Operation

- SD Fuze Replacement for M223 Designed to Reduce the Number of Submunition Duds
- Minor Differences Between Artillery and MLRS Fuze
- Primary Mode of Operation
- Self-Destruct (Secondary) Mode of Operation
Self-Destruct Fuze Operation
Safety Testing

- MIL-STD-331-B Testing
- Detonator Out-of-Line Testing
- New Shunt Design / Testing
- E3 Testing
- Power On Reset
- Grenade Stack Test
- Propagation Test

- EOD Issues
  - Ribbon Color
  - Battery Bleed Down
- Energetics Compatibility
- Approved Fuze Fault Tree
- MIL-1316 Checklist
Army Certifications

- M234 Type Classified 24 Mar 98
- M235 Type Classification Paperwork in Process
- M236 Passed U.S. Army Safety Certification Firings
- Approved Fuze Fault Tree
- Approved MIL-1316 Checklist
  - Waiver For Stored Energy Granted
- M234/235 Granted AFSRB Final Safety Certification
- Fuze Line Qualification Planned For 4th Quarter 2003
- Fuze First Article Planned For 4th Quarter 2003
## M234 SD Fuze Artillery Test Result

<table>
<thead>
<tr>
<th>TEST</th>
<th>CONFIGURATION</th>
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<tbody>
<tr>
<td></td>
<td>Primary Only</td>
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<tr>
<td>Grenade Functioning</td>
<td>(30/2585) 98.84%</td>
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<tr>
<td>Air Drop</td>
<td>(21/1081) 98.0%</td>
</tr>
<tr>
<td>Initial Safety &amp; Sequential Env.</td>
<td>(193/8125) 97.4%</td>
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<tr>
<td>DT&amp;E Total</td>
<td>97.6%</td>
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</table>
**M235 SD Fuze MLRS Test Results**

**DVT TESTING**

<table>
<thead>
<tr>
<th>Temperature / Range</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot @ 48Km</td>
<td>(5/461) 98.9%</td>
</tr>
<tr>
<td>Ambient @ 25Km</td>
<td>(2/1014) 99.8%</td>
</tr>
<tr>
<td>Cold @ 16Km</td>
<td>(9/1012) 99.1%</td>
</tr>
</tbody>
</table>

**Weighted Mission Total:** 99.52%

FOR VALIDATION, CALL:
AMSTA-AR-FSA-P
MR. Leon Springer
(973) 724-2208
Self-Destruct Fuze Assembly Line

PALOMAR PRODUCTS CHIP ON BOARD

Base Machine 1

Shunt Assembly Machine

Base Machine 3

QSI Slide Sub-Assembly Molding Machine

Base Machine 2

communications
KDI Precision Products, Inc.
Palomar Products Chip on Board
Printed Wiring Board (PWB) Assembly (Machine) Status
Printed Wiring Board (PWB) Assembly (Machine) Status

- **Palomar Line**
  - Palomar Line Has Been Accepted a Rate
  - Palomar Line Is Production Ready
Slide Subassembly Machine Status

• QSI Machine
  – QSI Line Has Been Accepted at 100% rate
  – QSI Line Is Production Ready
Spiral Safety Flag Assembly Machine (BM-2)
Spiral Safety Flag Assembly Machine (BM-2) Status

• Base Machine #2 (BM-2) Tilted Spiral Flag Assembly
  – BM-2 Has Been Accepted at 100% Rate
  – BM-2 Is Production Ready
Slide Assembly Machine (BM-1)
Slide Assembly Machine (BM-1) Status

• Base Machine #1 (BM-1) - Slide Assembly
  – BM-1 Has Been Proven Out at Rate
  – BM-1 Meets Product Quality Requirements
  – Final Acceptance Is Scheduled for First Quarter 2004
  – Final 100% Acceptance Is Prior to 200,000 Production Units
Unloaded Fuze Assembly Machine (BM-3)
Unloaded SD Fuze Assembly Equipment Status (BM-3)

- Base Machine #3 (BM-3) - Fuze Assembly
  - BM-3 Has Been Accepted at 96% Rate
  - BM-3 Final Acceptance Will Be First Quarter 2004
  - BM-3 Is Production Ready
Shunt Assembly Machine Status

- Proven Out at Datum At 100% Rate
- Shunt Machine is Production Ready
SDF Loading Equipment

LOADED FUZE ASSEMBLY

EED COVER

M55 STAB DETONATOR

SDF Loading Equipment
SDF Loading Equipment Status

- SDF Loading Equipment Has Been Proven Out at 75% Rate
- Final Acceptance Is Scheduled for First Quarter 2004
- Equipment Production Ready
Lithium Reserve Battery Line

- Battery Design Was Completed by ATK and Qualified
- High Rate Equipment Was Not Acceptable
- New Equipment Has Been Purchased From RD Systems
- Contract Awarded To RD Systems in May 2001
- Battery Line Was Installed At KDI in August 2003 (In Debug)
- KDI Has Retained THALES USFA, Netherlands to Consult on All Battery Issues
SELF-DESTRUCT LITHIUM RESERVE BATTERY

TERMINAL PLATE ASSEMBLY
TERMINAL PLATE INSULATOR
ETCHED NICKEL
ANODE
SEPARATOR (2)
CATHODE
END PLATE
RESERVOIR GTM
WICKING STRIP
TRANSFER DISC
CASE

KDI PRECISION PRODUCTS, INC.
AN ISO 9001 REGISTERED COMPANY
SDF Battery Animation
Lithium Reserve Battery

• Contract Structure
• Unique Battery HRE Contract
  – Preliminary Design Review (PDR)
    • Ampule Fill & Seal (Process)
    • Lithium Lamination Process
  – Brainstorming Review
  – Critical Design Review
    • Each Machine/Process
  – Release Component Fabrication
  – Proveout at RD Systems
  – Modified First Article
  – Final Acceptance KDI
Lithium Reserve Battery Automation Line

- Fill & Seal Machine
- Reservoir To Case Machine
- Final Assembly Machine
- Terminal Plate/Anode Assembly Machine
- Cleaner
- Transfer Disc To Case Machine
- Final Weld Machine
- Cap Weld Machine
- Heat Soak Machine
- Visual Inspection Machine
- Tinning Machine
- Support Area

Legend:
- Direction of Flow
- Dryroom
- Manual Feed
- Conveyor Feed
SDF (PIP)

- Two (2) Integrated Product Improvements
  - Packaged EED
  - Packaged IC
SDF (PIP) Current EED Design

- The Current EED Has Three (3) Explosive Elements That Are Loaded Into the Fuze and Consolidated
- After Consolidation, a Cover and Encapsulate Are Placed on Top of the Explosive Elements
SDF (PIP) Packaged EED Design

- The Packaged EED Is a Two (2) Pin Hermetic Sealed Detonator
- The Packaged EED’s are Inserted Into
- Receptacles That Are Surface Mounted on the PWB
SDF (PIP) Packaged EED Advantages

- Reduces the Printed Wiring Board Complexity
- Assembly Process Is Less Complicated
- Lot Acceptance Can Be Performed at the Component Level
- Explosive Output Is 1.5 Times Greater
- Requires Less Energy to Fire
SDF (PIP) Current IC Assembly Design

- The Current PWB Employs Chip-on-Board (COB) Technology
SDF (PIP) Packaged IC Assembly Design

- The Packaged IC Design Contains the Same Die Which Is Placed in an Micro Lead frame Package
SDF (PIP) Packaged IC Advantages

• Assembly Is Greatly Simplified
• Increase in Throughput
• Increase in Yield
• Test at the Component Level
• Design Is More Robust
SDF (PIP) Test History

- Packaged EED → Qualified to MIL-I-23659 by USN
- Packaged IC → Structural Test to Confirm Robustness
- Flight Test → Worst Case Environments
SDF (PIP) Packaged IC Structural Performance

• Both Specification and Margin Test Were Performed on the Same Hardware Set
• Test Performed Following 160 Thermal Shock Cycles (Specification Requires Eight)
SDF Warm Line & GMLRS Fly Off Tests (PIP) Flight Test

- M915 Artillery
- M915 Artillery (Hot)
- M915 Artillery (Cold)
- GMLRS @ 16 Km
- GMLRS @ 20 Km
- GMLRS @ 65 Km (Hot)
- GMLRS @ 65 Km (Cold)
- GMLRS @ 19.5 Lm (Cold)

FVT: Performance 99.88% Flight: March 03
FVT: Performance 99.98% Flight: October 03
FVT: Performance 99.99% Flight: October 03
FVT: Performance 100% Flight: March 03
FVT: Performance 100% Flight: August 03
FVT: Performance 100% Flight: December 03
FVT: Performance 100% Flight: December 03
FVT: Performance 97% Flight: January 04

GMLRS Mission Reliability 97% UXO’s & 99.6% Hazardous Duds
# SDF Integrated Schedule

<table>
<thead>
<tr>
<th></th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
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<tbody>
<tr>
<td><strong>Battery HRE Program</strong></td>
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<tr>
<td>Acceptance @ KDI</td>
<td>2003</td>
<td>2004</td>
<td>2005</td>
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<tr>
<td>First Article</td>
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<tr>
<td>Operational Sequence</td>
<td>2003</td>
<td>2004</td>
<td>2005</td>
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<tr>
<td>T&amp;H Testing</td>
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<tr>
<td>Battery Production</td>
<td>2003</td>
<td>2004</td>
<td>2005</td>
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<tr>
<td><strong>M234 Fuze First Article</strong></td>
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<tr>
<td>Contract Release 06/2003</td>
<td>2003</td>
<td>2004</td>
<td>2005</td>
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<tr>
<td>First Article Assembly</td>
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<tr>
<td>Complete Testing (KDI)</td>
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<tr>
<td>Complete Ballistic Testing</td>
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<tr>
<td>M234 Fuze Production</td>
<td>2003</td>
<td>2004</td>
<td>2005</td>
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</table>
# SDF Integrated Schedule

<table>
<thead>
<tr>
<th>Project</th>
<th>2003</th>
<th>2004</th>
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<tr>
<td>XM236 PIP Qualification</td>
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<tr>
<td>Design, Assemble, &amp; Test</td>
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<tr>
<td>Release Qualification Contract</td>
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<tr>
<td>Fabricate, Assemble, &amp; Qualification Test</td>
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<tr>
<td>XM235 PIP Fuze Testing</td>
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<tr>
<td>GMLRS Guided Special Test</td>
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<tr>
<td>(101 Fuzes)</td>
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<tr>
<td>GMLRS Guided Special Test</td>
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<td>(303 Fuzes)</td>
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<td>GMLRS Launcher Testing</td>
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<td>Fuze Fly to Buy</td>
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<tr>
<td>GMLRS Production</td>
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**Notes:**
- **PQT:** Project Qualified Test