Safety and Reliability Through Technology

ESAD Technology
Benefits to ISD’s

New Global Impact
April 5-7, Seattle, Washington

49th Annual Fuze Conference
ESAD Technology Benefits to ISD’s

• Brief Personal Note, A Tragic Accident
• MIL-STD-1901A Requirements
• Typical ISD System, Safety Concern and Possible Remedy
• Traditional Out-of-Line ISD
• Out-of-Line Disadvantages
• New Component Requirements
• Inline ISD Architectures
• Conclusions
A Tragic Accident

- Fire Aboard the Aircraft Carrier USS Forrestal (CV 59)
  - Date: 29 July 1967
  - Time: 10:50 AM
  - Lives Lost: 134
  - Seriously Injured: 64

Source: Naval Weapons Center Report, China Lake, CA, January 1975
USS Forrestal (CV-59)
July 29, 1967
USS Forrestal (CV-59)
July 29, 1967
USS Forrestal (CV-59)
July 29, 1967
A GOOD DOCUMENTARY

SAILORS TO THE END

By

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Harper Collins Publishers
MIL-STD-1901A Requirements Revised June of ‘02

- Traditional Out-of-Line Still Acceptable
- Slight Revisions to In-Line Requirements
- Range of Application is Most Significant Change (Par. 4.2.a)
  - Safety Analysis is no longer a basis for non use of an ISD
- 1 Amp -1 Watt In-Line No Longer Acceptable
- An ISD is Now Mandatory for New Exploratory, Advanced Engineering, and Operational System Developments. Par. 1.2
Typical ISD System

Launcher Control

Intent to Launch:
- Target Recognition/Identification
- Executive Decision
- Computer Decision

Safety Interlocks Removed:
- Multiple Key Locks
- Guarded Toggles/PushButtons
- Safety Pins

Launch Command Issued

ISD Ignition Safety Device

Safety Features:
- Out-of-Line Energetics
- Safety Shorts
- Insensitive 1 A/1 W Squibs

Electrical Interface

Deflagrating Output
Typical Interface Details

Launch Control  

ARM (+28 VDC)  

Fire (+28 VDC)  

Return  

SHIELD  

ISD
Improved Interface

- Launch Control
- ARM (+28 VDC)
- Fire (Serial Interface)
- Return
- SHIELD

ISD
Traditional Out-of-Line ISD

- **Simple Operation:**
  - Arm Command (Solenoid Power)
  - Fire Command (Firing Energy)
  - Status Feedback
  - Current Limit Feature
Out-of Line Disadvantages

• Minimal Safety (Arm-Fire Device)
• Often Large and Heavy
• Physical Location Restricted to Near Ignition Point
• High Current Requirements
• Spring or Motor Driven Return to Safe Condition
• Relatively Expensive
New Component Requirements
EFDI (Exploding Foil Deflagrating Initiator)

- LEEFI with HNS-4 to BKNO3 Transition
- Based on Slapper Detonator Technology for Warheads
- Now Under Development and Qualification
New Component Requirements

EFDI In Standard LEEFI Package

MODEL LI 7010
Igniter™
Patent Pending

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- Igniter for
  Rocket Motors
  Gas Generators

- Pressure Cartridge
  Pyrotechnic Actuators,
  Ejectors, Pin Pullers, Valves
  and other piston driven
  devices.

3 X actual size

communications
KDI Precision Products, Inc.
New Component Requirements
IPS (Integrated Planar Switch)

- Part of Slapper Geometry
  - Zero Size
  - Near Zero Cost
- ARDEC Funded Development
- Now in Advanced Development
- Low Risk for Qualification
  - Passed Engineering Env. Testing
  - Based on Fully Qualified LEEFI
- Enhances Safety
  - MIL-DTL-23659
- Requires a Hermetic Seal
New Component Requirements

IPS Operation

- Electrical
  - $+V$ increased to exceed breakdown voltage of gap
  - Breakdown voltage set by gap size
  - Other characteristics set by surrounding circuitry
New Component Requirements
IPS (Integrated Planar Switch)

V

V_{\text{max}}

V_{\text{min}}

Jitter

IPS Threshold Jitter
• Tested to LEEFI Levels
  – Cold  -65°F
  – Hot   +160°F
  – Shock 2000g .5 ms
  – Vibe   F15 Buffet MIL-STD-810

• Test Results
  – 60 for 60 (30 hot, 30 cold)
Self-Contained ISD

- Single Unit
- Possible Drop-in Replacement
- Location Restricted
- All components at Ignition Point
Remote Ignition Module

- Simplest Remote Configuration
- Low Cost Ignition Module
- Requires Stripline Connection
- Limited Separation Distance

![Diagram of Remote Ignition Module](image)
Remote Ignition Module with IPS

- Low Cost Switch Located in Ignition Module
- Stripline Required
- Safety Enhanced by IPS
Ignition Module with IPS and Energy Storage

- No Strip-line Requirement
- Can Remote to Long Distance
ISD /ESAD Combination

**Electronics Safety Arm Device (ESAD)** (MIL-STD-1316)

**In-Line Ignition Safety Device (ISD)** (MIL-STD-1901)

- Safety Environments
- Warhead Trigger
- Missile Communication
- Power
- ARM (Dynamic Drive)
- Fire
- Power
- Feedback (Optional)
- Return

High Voltage to Ignition Module

Detonation Output

Warhead Initiation

**L3 Communications**
KDI Precision Products, Inc.
Conclusions

• ISD Safety Evolution Has Been Slow
• New Devices and Warhead ESAD Technology Is Ready to Offer Improvements in:
  – Safety
  – Reliability
  – Design Flexibility
  – Weight
  – Cost