Fuze and Initiation Systems Technical Review Panel

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Outline

- Background
- Purpose
- Membership
- Interface
- Design Safety Criteria
- Review Process
- Presentation/Data Package
- Recent Focus Areas
- Observations

HISTORY

USS Oriskany

- October 26, 1966
  - Magnesium parachute flare exploded in the flare locker of Hanger Bay 1, beneath the carrier's flight deck
  - A seaman threw the ignited flare back into the weapons locker where the flares were kept for storage instead of throwing it over the side into the water
  - Fire raced through five decks
  - Crewmen jettisoned heavy bombs which lay within reach of the flames, wheeled planes out of danger, and rescued pilots
- 44 killed
- 6 aircraft destroyed

USS Forrestal

- July 29, 1967
  - A ZUNI rocket was fired accidentally from an aircraft
  - 2 different teams bypassed a safety thinking the other safety would still provide the safety
  - The rocket screamed across the deck, struck the future Sen. John McCain's plane and ignited a fuel fire (3 months later he was shot down over Hanoi was a POW for 6 yrs)
  - 90 seconds after the fire started, a 1,000 lb bomb detonated
  - The detonation ruptured the flight deck, and burning fuel spilled into the lower levels of the ship
  - Bombs, warheads, and rocket motors exploded from the intensity of the fire
- 134 killed
- 161 wounded
- 21 aircraft destroyed

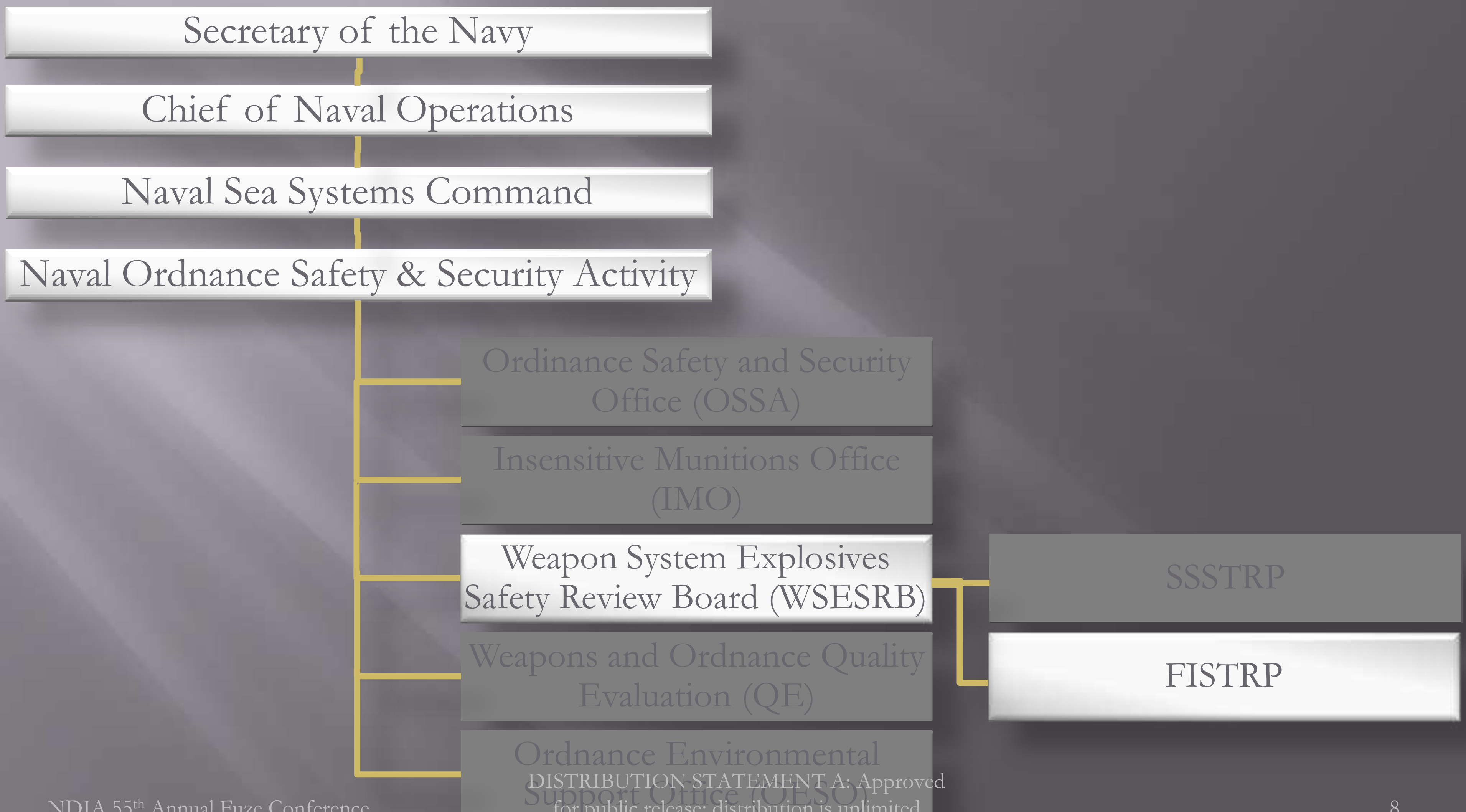
USS Enterprise

- January 14, 1969
  - Exhaust from an aircraft engine starter was directed at a pod containing 4 ZUNI rockets. Heat caused a warhead to detonate. Fragments ruptured the aircraft's fuel tank and ignited a fire.
  - Three more ZUNI warheads detonated less than a minute after the first explosion. The shaped charges blew holes through the flight deck allowing burning fuel to invade the lower decks.
- 28 killed
- 344 wounded
- 15 aircraft destroyed

Safety Program

- As a result of these accidents, a comprehensive ordnance safety program was initiated
  - Insensitive Munitions (IM)
    - Fast cook-off
    - Slow cook-off
    - Bullet impact
  - HERO
  - Environmental Testing
    - MIL-STD-331
  - Design Safety
    - MIL-STD-1316, MIL-STD-1901

Navy Safety Board Organization Chart



Technical Review Panels

- Weapon Systems Explosive Safety Review Board (WSESRB) established Technical Review Panels (TRPs) in late 1980's
  - WSESRB chairperson may establish TRPs to review specific safety aspects requiring special expertise
  - Regularly meeting TRPs currently consist of:
    - Software System Safety Technical Review Panel (SSSTRP)
      - SSSTRP reviews specific safety aspects requiring special expertise in the area of analysis and testing of safety-critical software, firmware, and software-like devices contained in weapons and weapon systems
    - Fuze and Initiation Systems Technical Review Panel (FISTRP)
      - FISTRP reviews specific safety aspects requiring expertise in the area of design, analysis, and testing of fuzes, safety and arming (S&A) devices, initiation safety devices, and initiators

Purpose

- Provide expert technical review of the safety programs for fuze designs, ignition safety devices, and related S&A devices used in Navy weapon systems (Ref. NAVSEAINST 8020.6)
  - Allows more in-depth review
  - Affords focused review by technical experts in specialized fields
  - Reduces time required at WSESRB review

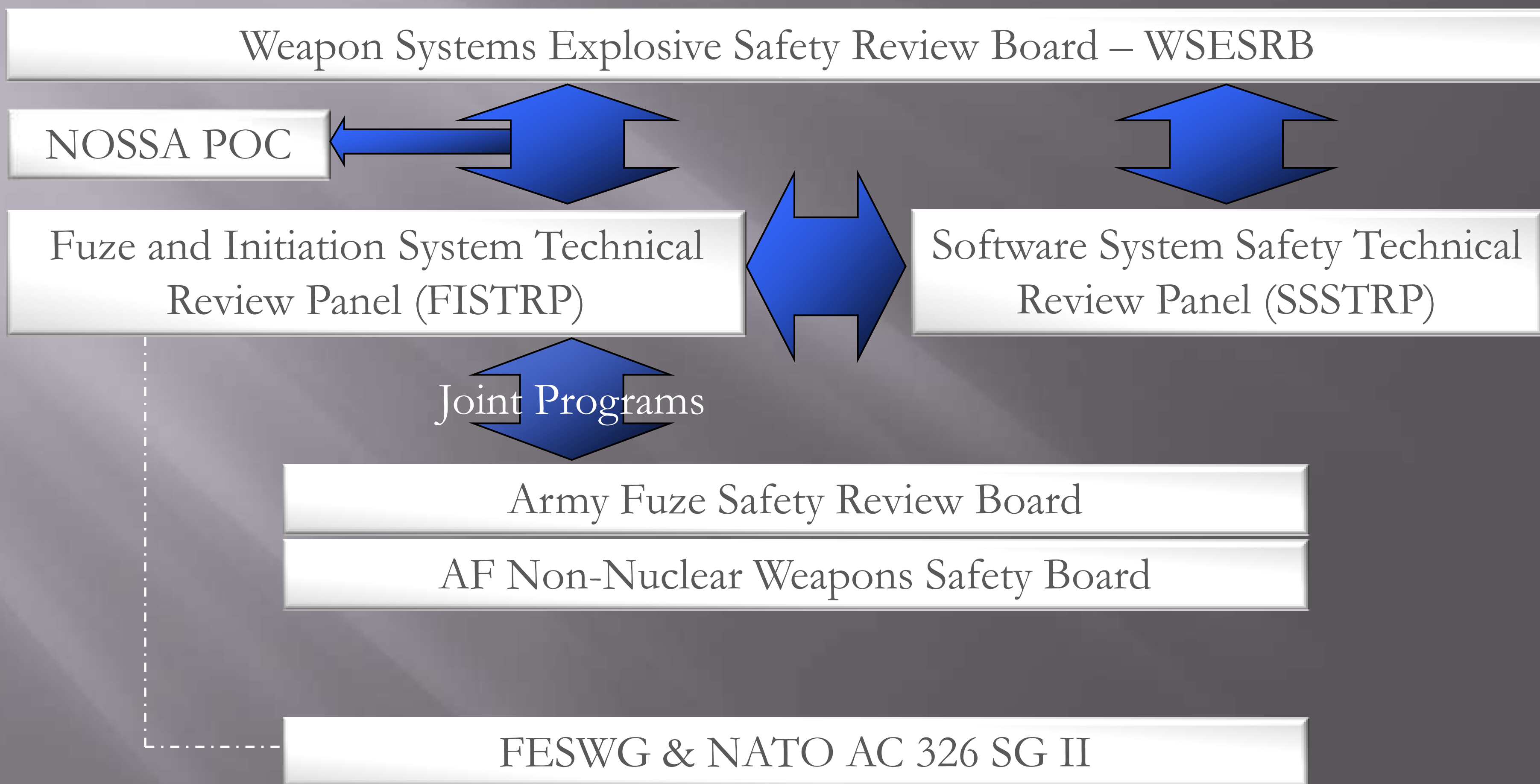
FISTRP Membership

- Chairperson appointed by the WSESRB chairperson
- Members and technical advisors appointed by TRP chairperson
  - Members are typically government employees from Navy Labs
  - Individuals must have experience and expertise in their respective areas
    - Specific areas of expertise include the following:
      - Fuze design, ignition system and ignition safety device design, explosive safety, initiators, logic devices, system safety, fuze development, and individual weapon systems design and development
  - Members are approved by WSESRB
- Individuals from the Air Force and Army safety boards may participate

2011 FISTRP MEMBERS

- Raymond Ash - Naval Air Warfare Center Weapons Division China Lake
- Ralph Balestrieri - Naval Surface Warfare Center Indian Head Division
- Tinya Coles-Cieply - Naval Surface Warfare Center Indian Head Division
- Randall Cope - Naval Air Warfare Center Weapons Division China Lake
- Michael Demmick - Naval Ordnance Safety and Security Activity
- Bradley Hanna - Naval Surface Warfare Center Dahlgren Division
- John Hendershot - Naval Surface Warfare Center Indian Head Division
- George Hennings - Naval Air Warfare Center Weapons Division China Lake
- John Hughes - Naval Air Warfare Center Weapons Division China Lake
- John Kandell - Naval Air Warfare Center Weapons Division China Lake
- David Libbon - Naval Surface Warfare Center Dahlgren Division
- Melissa Milani – EODTECHDIV Indian Head Division
- Scott Pomeroy - Naval Surface Warfare Center Dahlgren Division
- Gabriel Soto - Naval Air Warfare Center Weapons Division China Lake

FISTRP Interfaces



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Review Criteria

- Design Safety Criteria
  - Fuzes/S&As STANAG 4187/MIL-STD-1316
  - Initiation Systems STANAG 4368/MIL-STD-1901
  - Hand Emplaced Ord. STANAG 4497/MIL-STD-1911
  - Initiators STANAG 4560/MIL-DTL-23659
  - Explosive Materials STANAG 4170/AOP-7
  - Safety & Suitability STANAG 4157/AOP-20/MIL-STD-331
  - WSESRB Technical Manual on Electronic Safety and Arming Devices with Non-interrupted Explosive Trains

Review Criteria (continued)

- Design Safety Criteria (continued)
  - FESWG Technical Manuals on Logic Devices
  - FESWG Guideline for Qualification of Fuzes, S&As and ISDs (Draft)
  - Proposed Methodology for Electrical Stress Testing (EST) of Electronic Safe Arm Devices (Draft)
- Designs will be assessed against most current version

Review Process

- Program coordinates with NOSSA POC and FISTRP chairperson to determine appropriate type of review
  - Formal Review
    - Data package is required 21 days prior to review
    - Typical review will consist of no more than four to six hours of review/discussions and two or more hours for panel members to caucus
    - Draft findings will be briefed to the program at the conclusion of review
      - Findings are not final until presented to and accepted by the WSESRB
      - Findings are formally briefed to WSESRB at Executive Session
    - The agenda will be left to the discretion of the program office; however, it should take into consideration the above and should address the items listed in the Technical Data Package section below.
  - Letter Data Package
    - Requires limited review of data
    - Involves narrowly focused issue
  - Technical Assistance Meeting
    - Can be a specific device or concept
    - No findings or minutes generated

Data Package and Presentation Material

- Brief program and/or weapon system overview
- Identification of the specific application, platform, and/or weapon for which approval is being requested
- Design description including:
  - Detailed description of arming environment/user interactions
  - Detailed description of safety feature implementations to include mechanical drawings and/or electrical schematics
  - Identification of all energy sources, including stored energy devices, in the system
  - Identification of all energetic materials in the design and the qualification status of each
  - Identification of application unique hazards
- Design validation and qualification test program
  - Detailed description of the life cycle and life cycle environments to which the device is exposed throughout its service life
  - MIL-STD-331 qualification plan/report including number of units, sequence of tests, test parameters, pass-fail criteria, and justification of test selection
  - Comparison of qualification testing to "DoD Fuze Engineering Standardization Working Group Guideline for Qualification of Fuzes, Safe and Arm Devices and Ignition Safety Devices"
  - Justification of 'by similarity' claims

Data Package and Presentation Material

- Initiator Qualification Test Program, where appropriate
  - MIL-DTL-23659 Qualification plan/report
  - Justification of 'by similarity' claims
- Fault Tree Analysis including:
  - Failure modes, effects, and criticality analysis
  - Description of fault tree analysis process and underline assumptions
  - Description of minimum cut sets and causal factors
  - Independent assessment of fault tree analysis
- Assessment of the design to applicable safety standards such as MIL-STD-1316D, MIL-STD-1901, MIL-STD-1911, WSESRB Technical Manual, and other safety criteria to include:
  - Compliance matrices
  - Supporting documentation
  - For any areas of non compliance, quantification and acceptance of risk at the appropriate level
- Safe Separation/Arming Delay Analysis, where applicable
  - Joint Munitions Effectiveness Manual, or equivalent, safe separation analysis which includes effects of warhead blast, heat and fragmentation. Analysis should also include the effect of weapon parasitic and any unspent energetic
  - Identify any operational requirements which mandate early arming – arming where the probability of hit is less than one in 10,000 or probability of hazardous fragment (for human body damage) is less than one in 10,000 - and quantify the hazard to the user
- Draft presentation

Compliance with Requirements

- Compliant
  - Meet the requirement
  - Meet the intent of the requirement (as interpreted by the FISTRP)
- Non-Compliant
  - Seek risk acceptance in accordance with MIL-STD-882
    - The hazard associated with a non-compliance must be determined
    - The risk associate with this hazard must be quantified
    - Mitigations should be considered
    - The residual risk must be accepted at the appropriate level

Closing Findings

- Submit a Letter Data Package (LDP) through your NOSSA POC
  - Provide justification
- Request closure during a formal review
  - Present justification
- Finding are not closed at informal reviews

RECENT TECHNICAL TOPICS

Logic Devices

- Important updates concerning charge-based memory device usage
  - Evolving Requirements for the Use of Logic Devices in the Implementation of Safety Features
    - Mr. John Hughes
- Use of microprocessors/microcontrollers

Acceptable In-Line Energetics

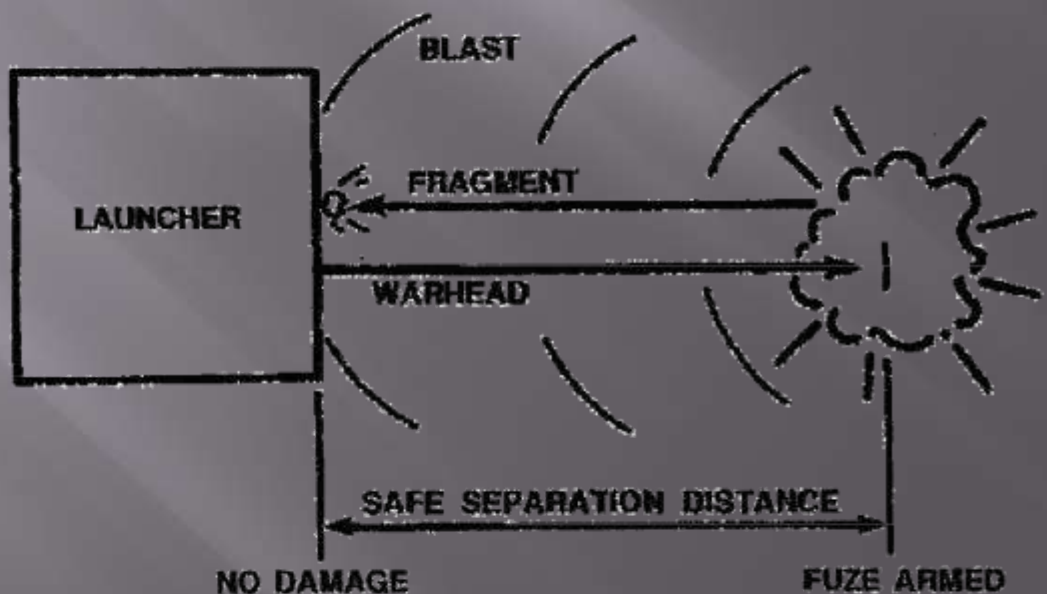
- Only those energetics listed in the appropriate standard are approved for use in a position leading to the initiation of the main energetic without interruption
- Other materials must be tested in accordance with AOP-7 and shown to be no more sensitive than RDX type I or II, class 5 conforming to MIL-DTL-398 (RDX or BKNO3 for pyrotechnic energetics)
  - Requires testing reference material contemporaneously with the candidate material
  - Must pass all mandatory AOP-7 requirements

Use of In-Line Initiators

- New or Modified Initiator
  - MIL-DTL-23659 qualification test series
    - ILIs not fully tested to MIL-DTL-23659 may be acceptable for a particular application, but will not be MIL-DTL-23659 qualified and will need to show a non-compliance in the applicable MIL-STD
  - Safety fireset testing
  - Must use energetics qualified and approved for in-line use
- Previously Qualified Initiator
  - Consider environments not covered in previous qualification
    - Electrical cook-off testing
    - Environmental exposure
  - Firing properties with intended use fireset
    - Transient electrical characteristics 25% rule
  - High fire testing

Safe Separation Distance

- The minimum distance between the launcher and the munition beyond which the hazards to the delivery system and personnel resulting from the functioning of the munition are reduced to an acceptable level



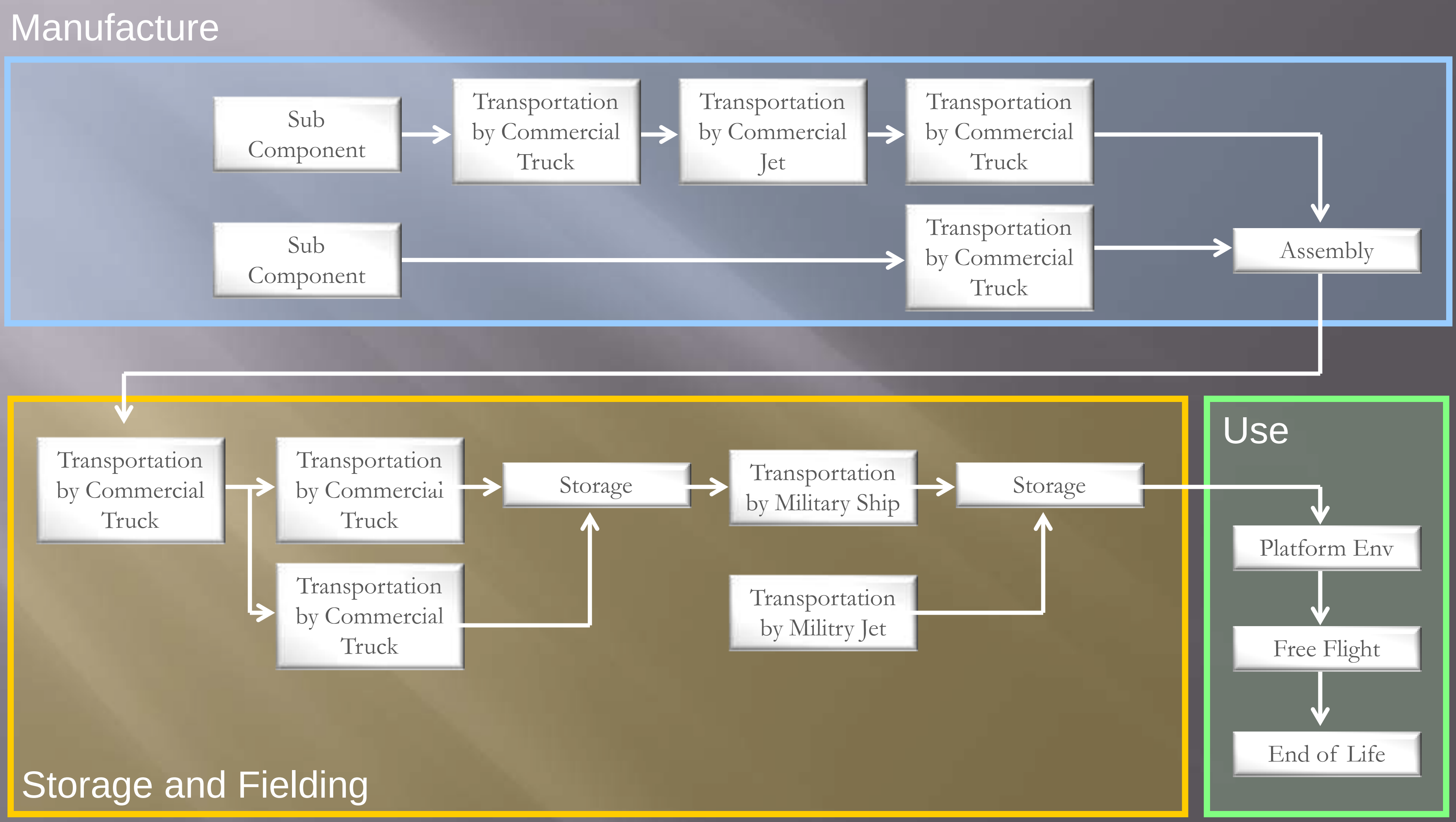
Safe Separation Analysis

- MIL-HDBK-504
  - Assumes function/detonation at minimum arming distance
  - < 1 in 10,000
    - Probability of Hit for launch platform (MIL-HDBK-504, appendix B)
    - Probability of hazardous fragment for personnel (MIL-HDBK-504, appendix A)
  - > 1 in 10,000 must seek risk acceptance
    - Residual risk < 1 in 1,000,000 for a 1E Hazard
      - Probability of function limited to 1 in 100
      - Probability of kill
      - Probability of lethal fragment

Fuze Qualification Testing

- MIL-STD-331C Environmental and Performance Tests for Fuze and Fuze Components Mechanical Shock Tests
  - Jolt - safe for use
  - Jumble - safe for use
  - 40 ft (12 m) drop - safe for disposal
  - 5 ft (1.5 m) drop - safe for use
  - Transportation Vibration
- Vibration/Climatic Tests – Operable
  - Thermal Shock
  - Long Term Storage @ -65°F / +160°F
  - Rough Handling
  - Salt Fog
  - Rain
  - Dust
- Safety, Arming and Functioning Tests
- Fuze Exposure to Physical Conditions During Complete Life Cycle

Example of Life Cycle Environments



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Review Tips

- Refresh our memory
  - Formal, informal, LDP
- Fuze/initiation system safety requirements can impact design; early start is essential to minimize this potential
- Advancement in technology often stresses safety assessment ability
- General requirements continuously being clarified for specific technology
- Keeping safety architecture and implementation simple is generally a good thing
- Misinterpretation of safety requirements
- Comprehensive testing is essential part of safety assessment