Department of Defense
Fuze and Engineering Standardization Working Group
Qualification Guidelines for Fuzes and Ignition Safety Devices

51st Annual Fuze Conference
Nashville, TN
22-24 May 2007

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Fuze and ISD Qualification
Background

- **Widely varying qualification programs for fuzes and ignition safety devices (ISDs) continue to be proposed to the Tri-Service Safety Authorities**
  - **These proposed programs vary greatly in test basis, approach, population, applicability and success criteria**
- **Safety and test method standards, i.e. MIL-STD-1316, MIL-STD-1901, MIL-STD-331, do not directly address qualification**
  - **Appropriate modifications to these Standards in work**

Fuze and ISD Qualification
Background

- Fuze and Engineering Standards Working Group (FESWG) undertook effort in 2004
  - Task lead is Mr. Gene Henderson, US Army AMRDEC (Redstone Arsenal)
- Plan is to standardize the minimum qualification requirements acceptable to Service Safety Authority (SSA) for Safe-Arm Devices and Ignition Safety Devices
  - Other tests and methods may be required by program

Fuze and ISD Qualification
Scope

- **Standardize quantities, tests, and test sequence that the Service Safety Authorities (SSA) find minimally acceptable for qualification.**
- **Applies to fuzes, safe and arm devices and ignition safety devices (ISDs)**
  - **Exclusions: nuclear weapons systems and trainers, flares and signals dispensed by hand-held devices and pyrotechnic countermeasure devices.**
- **These tests do not replace other required system level safety tests, i.e. MIL-STD-2105.**
- **Will be adopted by the FESWG.**
- **Will be accepted by:**
  - **Army Fuze Safety Review Board**
  - **Air Force Non-Nuclear Munitions Safety Board**
  - **Navy Weapon System Explosive Safety Review Board**

Fuze and ISD Qualification
Required Tests

- Sequential Environment ("Waterfall") Tests
  - two methods
  - representative of "life-cycle" exposure
- Miscellaneous Safety Tests
  - bare fuze
  - packaged fuze
- Performance Tests
- E3 Tests

Fuze and ISD Qualification
Environmental Test Options

- **ENVIRONMENTAL TEST METHOD I**
  - Environmental Tests conducted sequentially
  - Options for inclusion of other environments as required by program
  - Options for "diagnostic" testing of assets after specific environments (requires additional assets in test population).
  - Baseline approach
- **ENVIRONMENTAL TEST METHOD II**
  - Same as method I except decreased duration of T&H and Extreme Temperature (storage) tests in sequential test flow.
  - Full duration T&H and ET tests conducted outside of sequential test
  - Decreased qualification test time
  - Requires additional units

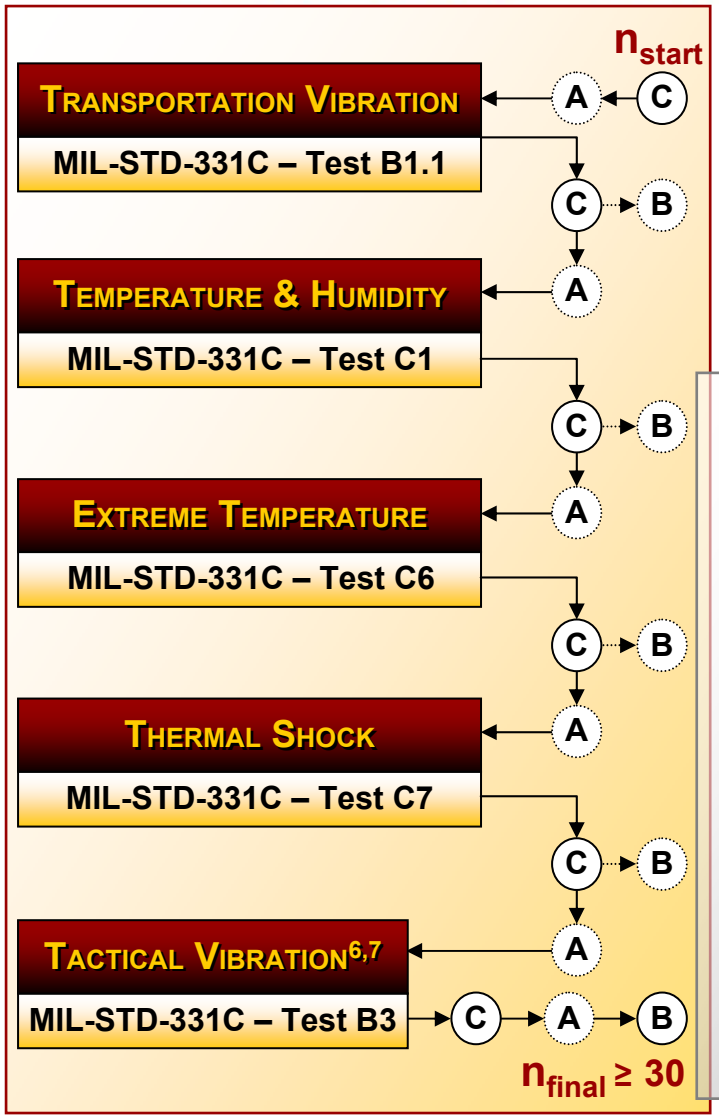
Fuze and ISD Qualification
Sequential Environment Tests

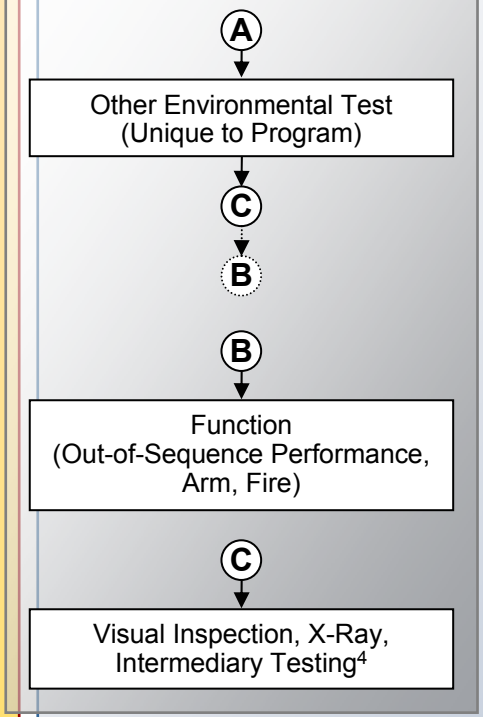
Method I Sequential Environment Tests (Bare Fuze) n ≥ 30	Method II Sequential Environment Tests (Bare Fuze) n ≥ 30	Method II Non-Sequential Environmental Tests (Bare Fuze) n = 3-5
Transportation Vibration	Transportation Vibration	Temperature and Humidity (28 days) 3 to 5 units
Temperature and Humidity (28 days)	Temperature and Humidity (14 days)	Extreme Temperature (Hot) (28 days) 3 to 5 units
Extreme Temperature Hot and Cold (28 days each)	Extreme Temperature Hot and Cold (14 days each)	Extreme Temperature (Cold) (28 days) 3 to 5 units
Thermal Shock	Thermal Shock	
5-Foot Drop[1]	5-Foot Drop[1]	
Tactical Vibration (Safe)[1]	Tactical Vibration (Safe)[1]	
Tactical Vibration (Armed)	Tactical Vibration (Armed)	
5-Foot Drop[1,2]	5-Foot Drop[1,2]	

1. Navy requirement only. Not required as part of sequential flow by Army, Air Force.
2. Applicable to field installable fuzes only. Not required to be same units which were previously subjected to 5-foot drop.

Fuze and ISD Qualification

Sequential Environment Tests – Method I (Bare Fuze)





Notes:

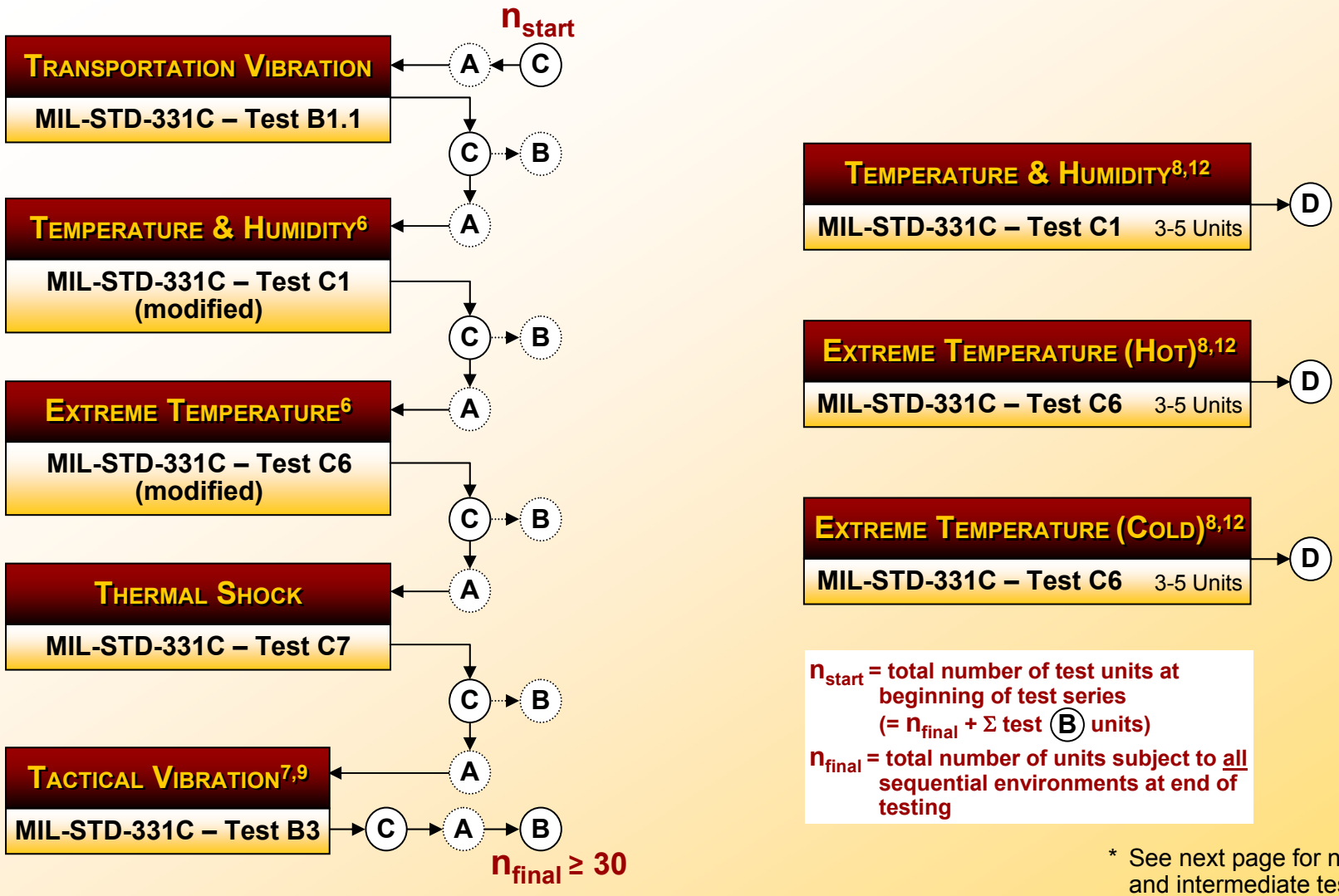
1. Does not include other unique environments that may be required by the weapon system program, i.e., acoustics, altitude, rapid decompression, mechanical (launch, dispense, other), shock, salt fog, etc.
2. Sequential environmental testing should be representative of fuze/munition life cycle. Non-operating environments should occur prior to operating environments in test series.
3. Total number of test assets sequentially exposed to all environments should be no less than 30. More than 30 assets total may be required depending on program. Ambient temperature testing is not required. Test assets should be split between hot and cold test tracks.
4. No mechanical arming and re-safing, (clearing of potential/growing failure mode).
5. Temperature pre-conditioning of test units does not apply to T&H, Extreme Temp and Thermal Shock tests.
6. This test only required when applicable. For example, in general, this applies to missiles and rockets, but not necessarily mortars.
7. Navy requires tactical vibration testing on fuzes in both safe and arm modes.
8. Navy prefers 1.5m (5ft) drop testing be conducted between thermal shock and tactical vibration. 1.5m drop testing may also be applicable after tactical vibration for field-installed fuzes.
9. Dashed events are optional.

n_{start} = total number of test units at beginning of test series (= n_{final} + Σ test (B) units)

n_{final} = total number of units subject to all sequential environments at end of testing

Fuze and ISD Qualification

Sequential Environment Tests – Method II (Bare Fuze)



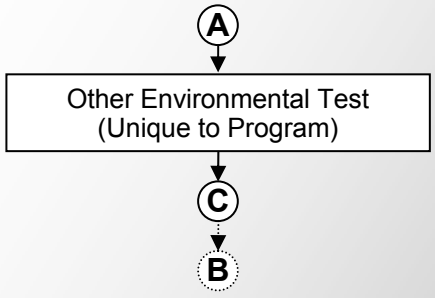
n_{start} = total number of test units at beginning of test series (= n_{final} + Σ test (B) units)

n_{final} = total number of units subject to all sequential environments at end of testing

* See next page for notes and intermediate test steps

Fuze and ISD Qualification

Sequential Environment Tests – Method II (Bare Fuze)



Notes:

1. Does not include other unique environments that may be required by the weapon system program, i.e., acoustics, altitude, rapid decompression, mechanical (launch, dispense, other), shock, salt fog, etc.
2. Sequential environmental testing should be representative of fuze/munition life cycle. Non-operating environments should occur prior to operating environments in test series.
3. Total number of test assets sequentially exposed to all environments should be no less than 30. More than 30 assets total may be required depending on program. Ambient temperature testing is not required. Test assets should be split between hot and cold test tracks.
4. No mechanical arming and re-safing, (clearing of potential/growing failure mode).
5. Temperature pre-conditioning of test units does not apply to T&H, Extreme Temp and Thermal Shock tests.
6. These tests can be of decreased duration (14 day duration each test, each test temperature).
7. This test only required when applicable. For example, in general, this applies to missiles and rockets, but not necessarily mortars.
8. Full 28-day duration tests.
9. Navy requires tactical vibration testing on fuzes in both safe and arm modes.
10. Navy prefers 1.5m (5ft) drop testing be conducted between thermal shock and tactical vibration. 1.5m drop testing may also be applicable after tactical vibration for field-installed fuzes.
11. Dashed events are optional.
12. Test quantities for these “parallel” test should be no less than three for each test.

Fuze and ISD Qualification
Additional Tests

- **Bare & Packaged Miscellaneous Safety Tests**
  - **Includes destructive tests (e.g. Jolt, drop, explosive component tests)**
- **Performance Tests**
  - **e.g. Function and output tests, subverted safety tests**
- **E3 Tests**
  - **e.g. ESD, EMR, EMP**

Fuze and ISD Qualification
Safety & Performance Tests

BARE FUZE SAFETY TESTS	PACKAGED FUZE SAFETY TESTS	PERFORMANCE TESTS
Primary Explosive Component Safety/Out-of-Line	Transportation Handling	Progressive Arm
Jolt[1]	Transportation Vibration	Brush Impact No-Fire[4]
Jumble[2]	40-Foot Drop	Extreme Temperature (Cold) (28 days) 3 to 5 units
Explosive Component Output		Subverted Jolt[1,5]
5-Foot Drop[3]		Subverted Jumble[2,5]
		Subverted 5-Foot Drop[5]
		Subverted 40-Foot Drop[5,6]
		Arm, All-fire, No-Fire Tactical Performance

1. Not required by Air Force. Not required by Army for in-line fuzes and ISDs. Navy required for all fuzes and ISDs.
2. Not required by Navy. Not required by Army for in-line fuzes and ISDs. Air Force required for all fuzes and ISDs.
3. Navy requires 5-foot drop as part of environmental sequence.
4. Conducted as part of an assembly. May not be applicable for some weapons.
5. Test conducted on inert fuzes and ISDs. Adequacy of each lock must be tested/demonstrated individually.
6. Test will be proposed at next FESWG meeting (1-2 May).

Fuze and ISD Qualification

Miscellaneous Safety Tests – Bare Fuze

Primary Explosive Component Safety/Out-of-Line[1]
MIL-STD-331C – Test D1

Jolt[2]
MIL-STD-331C – Test A1

Jumble[3]
MIL-STD-331C – Test A2.1

Explosive Component Output
MIL-STD-331C – Test D4

1.5m(5ft) Drop[4]
MIL-STD-331C – Test A4.1

Notes:

1. Primary Explosive Component Safety/Out-of-Line tests not required for in-line fuzes.
2. Army requires Jolt for out-of-line fuzes. Navy requires it for all fuzes. Air Force does not require it.
3. Army requires Jumble for out-of-line fuzes. Air Force requires it for all fuzes. Navy does not require it.
4. Navy prefers 1.5m (5ft) drop testing be conducted between thermal shock and tactical vibration. 1.5m drop testing may also be applicable after tactical vibration for field-installed fuzes.

Fuze and ISD Qualification

Miscellaneous Safety Tests – Packaged Fuze

TRANSPORTATION HANDLING[1]

MIL-STD-331C – Test A5

TRANSPORTATION VIBRATION

MIL-STD-331C – Test B1.1

12M/40FT DROP[2]

MIL-STD-331C – Test A3

Notes:

1. Test A5 meant to be conducted in conjunction with Trans Vib (B1.1). This test applies to fuzes packaged for Level A, maximum military protection, iaw AR 700-15.
2. Conducted on bare fuze or packaged configuration (warhead or inert-warhead assembly, cartridge, etc.).

Fuze and ISD Qualification
Performance Tests

Progressive Arm[3,4]
MIL-STD-331C – Test D8

(Subverted I) 1.5m/5ft Drop[1,2]
MIL-STD-331C – Test A4.1 ≥5 Units

Brush Impact No-Fire[5,6]
MIL-STD-331C – Test D6

(Subverted II) 1.5m/5ft Drop[1,2]
MIL-STD-331C – Test A4.1 ≥5 Units

(Subverted I) Jolt[1,2]
MIL-STD-331C – Test A1 ≥3 Units

(Subverted I) Jumble[1,2]
MIL-STD-331C – Test A2.1 ≥3 Units

(Subverted II) Jolt[1,2]
MIL-STD-331C – Test A1 ≥3 Units

(Subverted II) Jumble[1,2]
MIL-STD-331C – Test A2.1 ≥3 Units

Arm, All-Fire, No-Fire Tactical Performance
TBD

Notes:

1. Subverted Drop, Jolt, Jumble tests not required for Army in-line fuzes.
2. Subverted Safety tests should be conducted on inert fuzes.
3. Progressive Arm tests not required for in-line fuzes.
4. Progressive Arm test not applicable to zip/snap/non-progressive arm fuzes unless used for purposes of gathering statistics for out-of-line safety.
5. Conducted typically as part of an assembly, i.e., round level.
6. Required only for anti-armor munitions or where deemed applicable otherwise.

Fuze and ISD Qualification
E3 Tests

Personnel-Borne ESD[1]	Helicopter-Borne ESD[1,4]
MIL-STD-331C – Test F1.1/2 ➔ F1.2.1.1	MIL-STD-331C – Test F1.1/2 ➔ F1.2.1.3

Power Supply Transients (PST)	Lightning Effects (LE)
MIL-STD-1316, 1901 & 1911 ➔ TBD	MIL-STD-1316, 1901 & 1911 ➔ MIL-STD-464

Electromagnetic Radiation (EMR)
MIL-STD-1316 & 1911 ➔ MIL-HDBK-1512 & MIL-STD-464 MIL-STD-1901 ➔ MIL-STD-464 MIL-STD-331C – Tests F3.1, F4.1

Corona Discharge[5]
TBD

Electromagnetic Pulse (EMP)[2,3]
MIL-STD-1316 & 1911 ➔ MIL-STD-2169 MIL-STD-1901 ➔ MIL-STD-464 MIL-STD-331C – Test F2.1

Electromagnetic Interference (EMI)
MIL-STD-1316 & 1911 ➔ MIL-STD-461 MIL-STD-1901 ➔ MIL-STD-464

Notes:

1. Fuzes shall be tested in all expected electrostatically-significant handling configurations, i.e., with and without caps, covers, protective devices, etc.
2. MIL-STD-464 refers to MIL-STD-2169 (classified) for EMP.
3. This test should be conducted only as applicable to program.
4. This testing is typically conducted at a system level. HESD testing at the bare fuze level may be required.
5. This test is optional.

Fuze and ISD Qualification
Conclusion

- Imposes SSA minimally acceptable requirements for qualification of fuzes and ISDs
  - Raises awareness of SSA expectations for fuze and ISD qualification
- Only part of a full qualification program
- Addresses differing Service requirements
- Guideline is in draft form
  - Approach has been approved by FESWG
  - "Briefing Chart" format finalized – released in draft form to many parties
  - Guidelines Document - draft
  - Industry comments will be solicited by FESWG