Changes to MIL-STD-331

Progressive Arming and Primary Explosive Component Safety Testing

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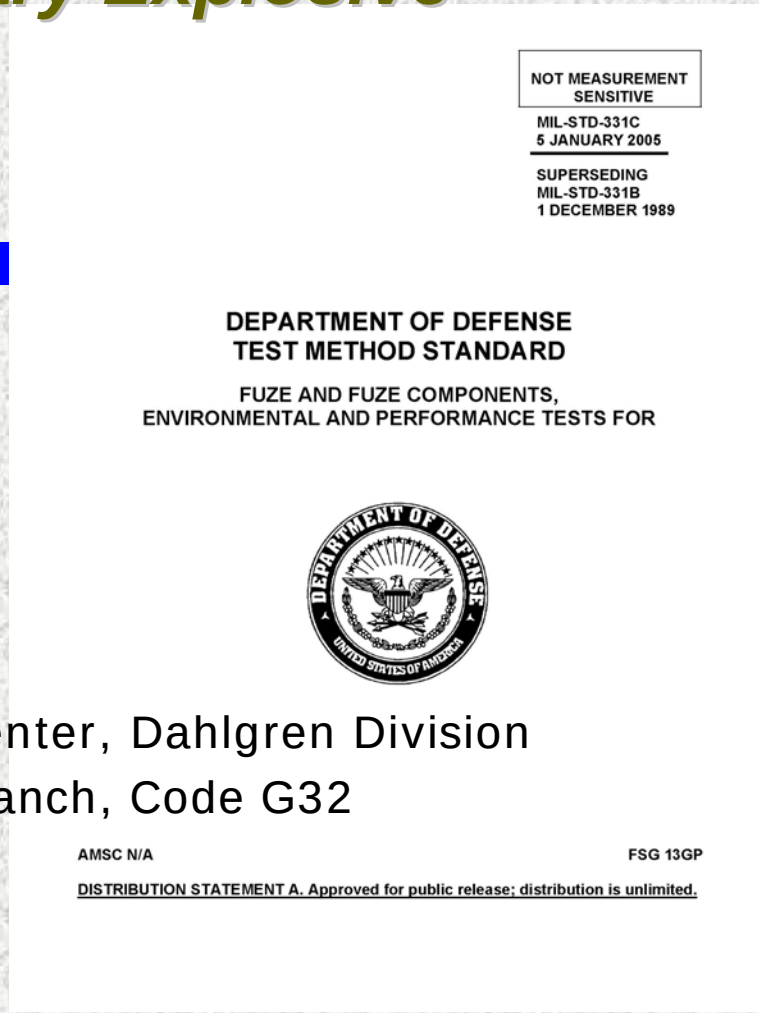

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MIL-STD-331C
5 JANUARY 2005

SUPERSEDING
MIL-STD-331B
1 DECEMBER 1989

DEPARTMENT OF DEFENSE
TEST METHOD STANDARD

FUZE AND FUZE COMPONENTS,
ENVIRONMENTAL AND PERFORMANCE TESTS FOR

AMSC N/A FSG 13GP

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- Document Custodian - **FESWG**
  - **F**uze **E**ngineering **S**tandardization **W**orking **G**roup
  - Joint service working group: Army, Navy, Air Force
  - Chairman: Homesh Lalbahadur, ARDEC, Picatinny,NJ
- Planned Release by 30 June 2008

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What's Changed?

- General Section
  - Cover Page
  - Contents List
- Appendix A - Mechanical Shock Tests
- Appendix B - Vibration Tests
- Appendix C - Climatic Tests
- Appendix D - Safety, Arming & Functioning Tests
- Appendix E - Aircraft Munition Tests
- Appendix F - Electric & Magnetic Influence Tests
- Appendix G - Statistical Methods To Determine The Initiation Probability Of One-shot Devices

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- Appendix D - Safety, Arming & Functioning Tests
  - ➔ D1 Primary Explosive Component Safety
  - D2 Projectile Fuze Arming Distance
    - Procedures (Probit, Bruston, OSTR, and Langlie statistical methods)
  - D3 Time to Air Burst
  - D4 Explosive Component Output
  - D5 Rain Impact
  - D6 Brush Impact No-Fire
  - D7 Mortar Ammunition Fuze Double Loading
  - D8 Progressive Arming Test

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D1 Primary Explosive Component Safety

D1.2. DESCRIPTION

D1.2.1 General. This test consists of two parts: the out-of-line safety test and the numerical determination of interrupter effectiveness.

D1.2.1.1 Out-of-line test. A modified fuze is mounted to a test fixture and the assembly placed in a fragmentation box. See Figure D1-1. Each sensitive explosive component in the sample fuze is fired. The effectiveness of the explosive train interrupter or any permanent barrier is then evaluated by determining whether or not there was initiation or incipient initiation of lead or booster explosives or ejection of parts, deformation, or shattering which might result in unsafe conditions. All primary explosive components, regardless of location within the fuze, shall be considered. Generally, such components are located in the explosive train before the interrupter. However, some primary explosive components may be located outside of the explosive train to serve a purpose other than initiation of the lead or booster charge.

D1.2.1.2 Interrupter effectiveness test. The numerical effectiveness of the interrupter is determined using one of the alternate and optional tests of D1.6 or using the Progressive Arm Test of D8. The choice of test must be made with regard to the fuze design and function.

D1.2.2 Fuze configuration. All fuze explosive elements shall be present in the fuze during the test.

D1.2.3 Applicable publications. All standards, specifications, [illegible] procedures

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- Interrupter Effectiveness test added to D1 to harmonize with MIL-STD-1316E (Para 5.3.3.d)

Requirement (1316)	***Test Method (331)***
4.6.2.b No ejecta, 4.6.2.c No initiation of lead or booster	D1.2.1.1 Out-Of-Line Safety Test
5.3.3.d Numerically determine interrupter Effectiveness	D.1.2.2 Interrupter effectiveness test 1. Barrier thickness 2. Increased output (Varidrive) 3. Increased sensitivity (Varicomp) 4. Progressive Arming

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- Appendix D - Safety, Arming & Functioning Tests
  - ☑ D1 Primary Explosive Component Safety
  - D2 Projectile Fuze Arming Distance
    - ➔Procedures (Probit, Bruceton, OSTR, Langlie statistical methods)
  - D3 Time to Air Burst
  - D4 Explosive Component Output
  - D5 Rain Impact
  - D6 Brush Impact No-Fire
  - D7 Mortar Ammunition Fuze Double Loading
  - D8 Progressive Arming Test

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- D2 Projectile Fuze Arming Distance
  - D2.5 Procedures (Probit, Bruston, OSTR, Langlie)
    - Procedures removed from D2 and placed in new Appendix G
    - These methods have applications in addition to the Fuze Arming Distance Test:
      - Interrupter effectiveness
      - Arming distance
      - Progressive arming
      - All-fire / no-fire determination

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- Appendix D - Safety, Arming & Functioning Tests
  - ☑ D1 Primary Explosive Component Safety
  - D2 Projectile Fuze Arming Distance
    - ☑Procedures (Probit, Bruston, OSTR, Langlie)
  - D3 Time to Air Burst
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  - D7 Mortar Ammunition Fuze Double Loading
  - ➔ D8 Progressive Arming Test

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D8 Progressive Arm Test

D8.2.3 Interrupter positions. Test positions shall be defined by an appropriate parameter that is varied from test-to-test. Usually this parameter will be the shortest distance between the sensitive element and the next explosive element, measured from edge-to-edge or center-to-center. This parameter is reported as the out-of-line distance. The parameter shall be varied following one of the statistical methods of Appendix G.

D8.2.4 Interpretation of results. There will only be two test outcomes: "transfer" and "non-transfer".

D8.2.4.1 Detonation train. In this case, transfer is defined as having occurred when there is detonation transfer to an explosive component after the explosive train interrupter as evidenced by a dent in the witness plate. Non-transfer is defined as having occurred when there is no dent in the witness plate. Any charring, scorching, melting, perforation, or deformation of any explosive component after the explosive train interrupter will be reported for information purposes only, but will not be considered as a "transfer".

D8.2.4.2 Pyrotechnic train. In this case, transfer is defined as having occurred when there is any reactive consumption in any pyrotechnic element after the interrupter. Non-transfer is defined as having occurred when there is no consumption. Any charring, scorching, melting, perforation, or deformation of any component after the interrupter will not be considered as a "transfer".

D8.2.5 Applicable publications. All standards, specifications, drawings, procedures and ma

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- Change in Definition of “transfer” for detonation trains
  - Old = Detonation or burning consumption
  - New = Detonation as evidenced by witness dent
- Addition of Definition of “transfer” for pyrotechnic trains
  - New = Reactive consumption of energetic material

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- D8 Progressive Arming

Requirement (1316)	***Test Method (331)***
4.2.2 Arming Delay to safe separation (3.2.a Armed defined as transfer probability > 0.005 @95% conf)	D8 Progressive Arming Test D8.3.1 Armed position – calculated from data
5.3.3.d Determine interrupter Effectiveness (4.3.a Failure Rate required (transfer probability) < 0.00001	D8 Progressive Arming Test D8.3.2 Effectiveness of interrupter – calculated from data

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- Caution on Using Progressive arm test to Determine Numerical Effectiveness of Interrupter

D8.3 INFORMATION TO BE DETERMINED

D8.3.1 Armed Position. The Armed position, identified per MIL-STD-1316 to be the point at which the probability of propagation (i.e. transfer) of detonation to an explosive component(s) on the barrier side opposite that of the sensitive explosive component(s) equals .005, at a confidence level of 95%, will be determined from this test. The upper single-sided confidence level shall be used.

D8.3.2 Effectiveness of the interrupter. The probability of propagation in the full out-of-line position may be calculated from the data. Caution should be taken to be sure that the extrapolation of the data is valid. A change in geometry of the explosive interface should be cause for examination of the validity of the extrapolation

D8.4 EQUIPMENT

D8.4.1 Test fixture. Any fixture that may be required to hold/restrain the test item shall not influence the test results.

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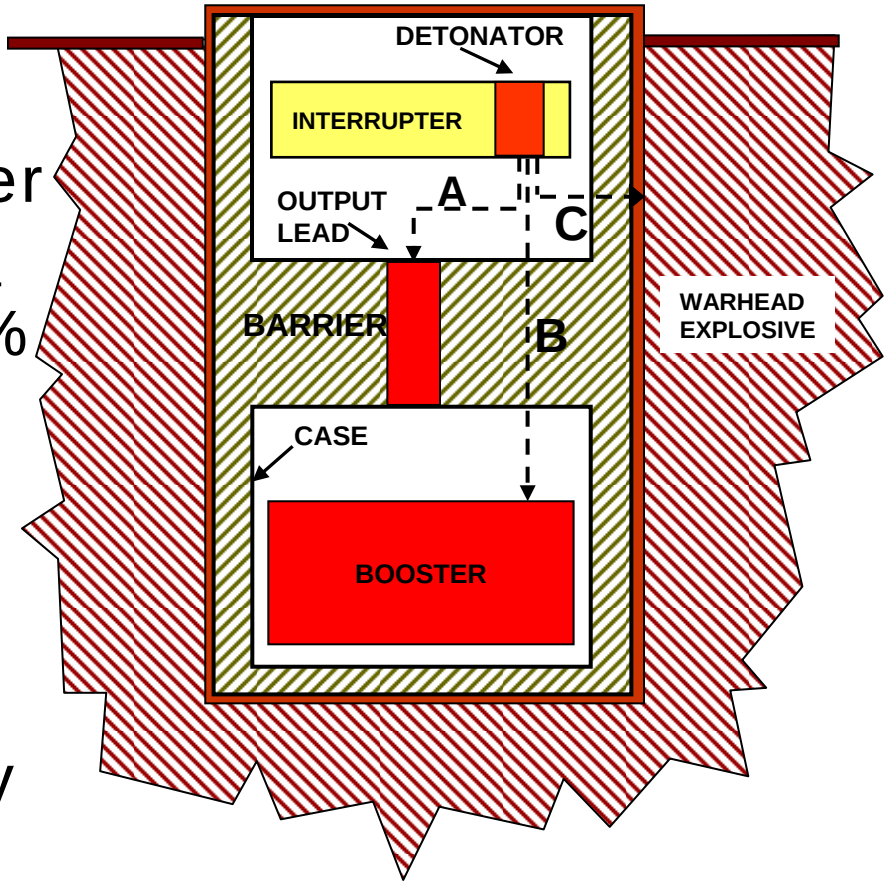
- Caution on using progressive arm test to determine numerical effectiveness of interrupter
- Progressive arm test data is collected about the 50% probability position.
- The interrupter effectiveness is for 0.00001% probabilities.
- The assumption is that transfer path A is the only factor in determining the transfer probability.



GAPS BETWEEN COMPONENTS ARE EXAGGERATED FOR CLARITY

Figure D1.5.
Typical components of a fuze explosive train.

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- General Section
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- ➔ Appendix G - Statistical Methods To Determine The Initiation Probability Of One-shot Devices

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- Appendix G - Statistical Methods To Determine The Initiation Probability Of One-shot Devices
  - Procedures
    - Probit,
    - Bruston,
    - OSTR,
    - Langlie
    - ➔ Neyer D-Optimal

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- Example Test Strategies
  - For progressively arming devices
  - For command arming device
  - For Alternate Explosive Paths
  - For Presence of Interrupter

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Test Strategy for a Progressively Arming Device

Requirement (1316)

4.6.2.b No ejecta
4.6.2.c No initiation of lead
4.2.2 Arming Delay
5.3.3.d Interrupter Effectiveness

Test Method (331)

- D1 Out-Of-Line Safety Test
  - Ejecta safety & Structural integrity
  - No transfer
- D8 Progressive arming test
  - Armed position
  - Numerical effectiveness of interrupter in Out-Of-Line position (extrapolation valid)

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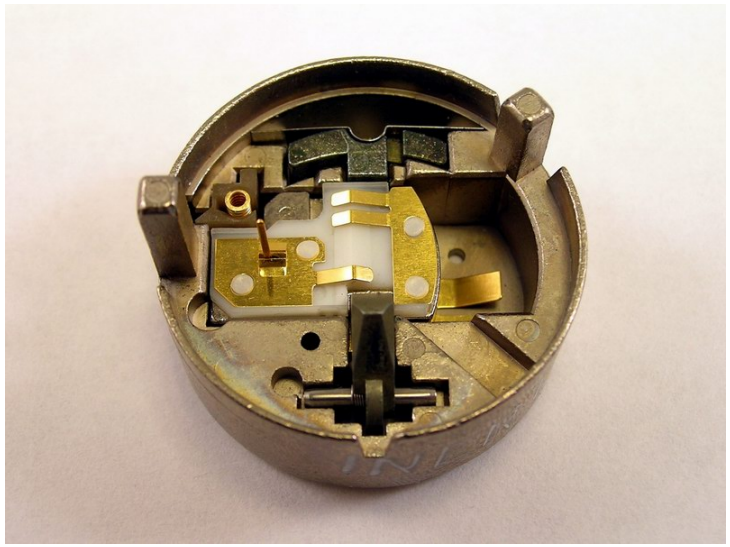
Test Strategy for a Command Arm Device

Requirement (1316)



4.6.2.b No ejecta,
4.6.2.c No initiation of lead
5.3.3.d Interrupter Effectiveness

Test Method (331)

- D1 Out-Of-Line Safety Test
  - Ejecta safety &Structural integrity
  - No transfer
- D1 Increased sensitivity (Varicomp) test
  - Numerical effectiveness of interrupter in OOL position

----- OR ------

- D8 Progressive Arming
  - Numerical effectiveness of interrupter in OOL position

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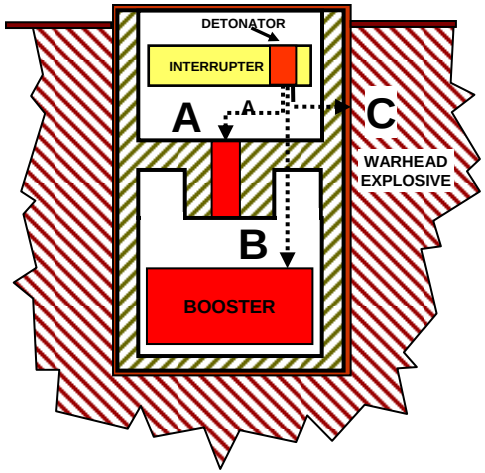
Test Strategy for Alternate Explosive Paths

Requirement (1316)



4.6.2.b No ejecta
4.6.2.c No initiation of lead
4.2.2 Arming Delay
5.3.3.d Interrupter Effectiveness

Test Method (331)

- D1 Out-Of-Line Safety Test
  - Structural integrity
  - Ejecta safety
  - No transfer
- D8 Progressive Arming
  - Arm point
- D1 Increased output (Varidrive)
  - Demonstrate interrupter effectives in regard to path B and C

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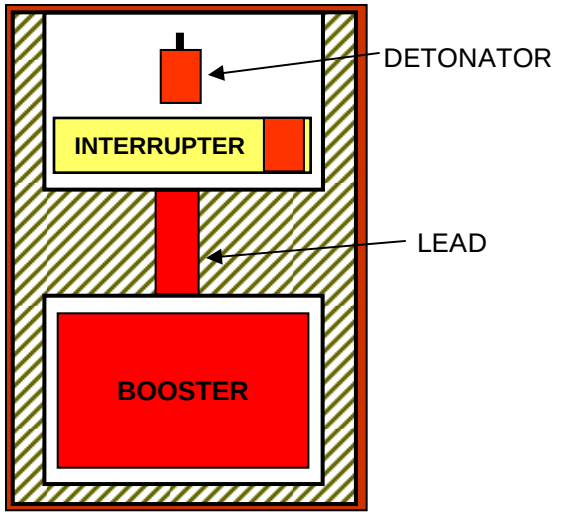
Test Strategy for Presence of Interrupter

Requirement (1316)



5.3.3.c Safety Dependent on Presence of Interrupter
And
Fuze has no malassembly feature.

Test Method (331)

- D1.6.6 Missing Barrier Test
  - Barrier thickness
  - Increased output (Varidrive)
  - Increased sensitivity (Varicomp)

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References

- Will, B. L., *Mk 437 Mod 0, Multi-option Fuze For Navy, Primary Explosive Component Safety Tests,* NSWCDD/TR-06/16, Naval Surface Warfare Center, Dahlgren, VA, Nov 2007

- Stresau, R. H., *Development of the Varicomp Method, Expansion of Applicability (to Determine Detonation Transfer Probabilities with Reduced Dependence upon System Variables) Part 5, Calibration of PETN for Use as a Surrogate for PBXN-5 in Safety Tests*, RSLR 73-2 for the United States Naval Weapons Center, China Lake, CA, 8 May 1973.

Acknowledgement

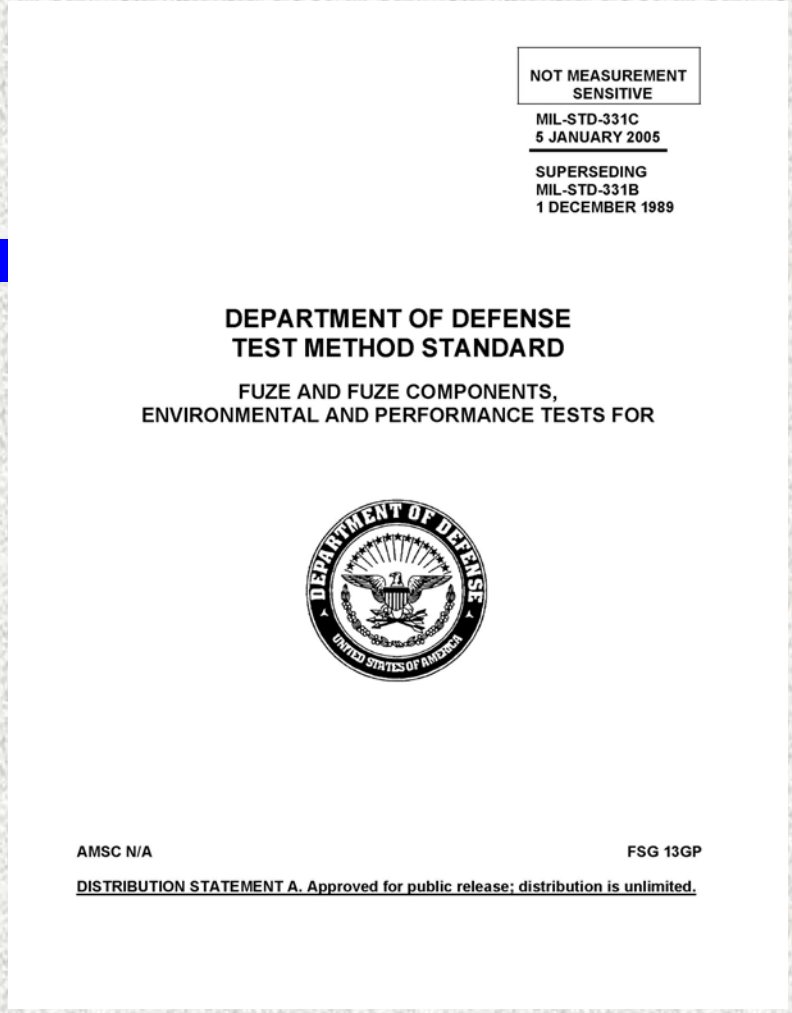
- Dr. Bary Neyer for his voluntary contributions in preparing Appendix G and for his extensive review and comments on other sections of MIL-STD-331.

- All the FESWG participants who care enough to work on maintaining and improving fuze standards, even though this work is unfunded.

Changes to MIL-STD-331

Fuze and Fuze Components, Environmental and Performance Tests for

QUESTIONS?



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