NOTICE OF CHANGE

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MIL-STD-1316D
INTERIM NOTICE 2 (AR)
31 MAY 1995

MILITARY STANDARD
FUZE DESIGN, SAFETY CRITERIA FOR

TO ALL HOLDERS OF MIL-STD-1316D:

1. THE FOLLOWING PAGES OF MIL-STD-1316D HAVE BEEN REVISED AND SUPERSEDE THE PAGES LISTED:

NEW PAGE	DATE	SUPERSEDED PAGE	DATE
iii	31 May 1995	iii	9 April 1991
iv	31 May 1995	iv	9 April 1991
1	31 May 1995	1	9 April 1991
2	31 May 1995	2	30 July 1993
3	31 May 1995	3	30 July 1993
4	31 May 1995	4	30 July 1993
7	9 April 1991	7	REPRINTED WITHOUT CHANGE
8	31 May 1995	8	9 April 1991
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10	31 May 1995	10	9 April 1991
11	31 May 1995	11	9 April 1991
12	31 May 1995	12	9 April 1991
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14	9 April 1991	14	REPRINTED WITHOUT CHANGE
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17	31 May 1995		NEW PAGE

2. RETAIN THIS NOTICE AND INSERT BEFORE TABLE OF CONTENTS.

3. Holders of MIL-STD-1316D will verify that page changes and additions indicated above have been entered. This Notice will be retained as a check sheet. This issuance, together with appended pages, is a separate publication. Each Notice is to be retained by stocking points until the Military Standard is completely revised or cancelled.

AMSC N/A FSC 13GP

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4. Vertical lines are used in this Notice to denote changes (additions, modifications, corrections, deletions) from the basic standard. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the basic standard.

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(Project 13GP–0050)

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1. SCOPE

1.1 Purpose. This standard describes standard practices pertaining to design safety criteria for fuzes for military application, and Safety and Arming (S&A) devices that are subsystems of fuzes.

1.2 Application. This standard applies to the design of fuzes and S&A devices.,

1.3 Excluded munitions. This standard does not apply to fuzes and S&A devices for the following:

a. Nuclear weapon systems and trainers.
b. Hand grenades
c. Flares and signals dispensed by hand-held devices.
d. Manually emplaced ordnance items.
e. Pyrotechnic countermeasure devices.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards and handbooks. The following specifications, standards and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Deparment of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.3).

SPECIFICATIONS
MILITARY

MIL-I-23659	–	Initiators, Electrical, General Design Specification For

STANDARDS

MILITARY

MIL-STD-331	–	Fuze and Fuze Components,Environmental and Performance Tests for
MIL-STD-461	–	Electromagnetic Interference Characteristics, Requriements for
MIL-STD-462	–	Electromagnetic Interference Characteristics, Measurements of
MIL-STD-1385	–	Preclusion of Ordnance Hazards in Electro-magnetic Fields, General Requirements for

MIL-STD-1512 – Electroexplosive Subsystems, Electrically Initiated, Design Requirements and Test Methods

MIL-STD-1757 – Lightning Qualification Test Techniques for Aerospace Vehicles and Hardware

MIL-STD-1795 – Lightning Protection of Aerospace Vehicles and Hardware

DOD-STD-2169 – High Altitude Electromagnetic Pulse (HEMP) Environment

(Unless otherwise indicated, copies of federal and military specifications, standards and handbooks are available from the Standardization Documents Order Desk, Bldg 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained, in which case the exception will be identified in the text and cited in the solicitation.

3.1 General. For interpretation of this standard, the following specific definitions apply: (See 6.9)

3.2 Armed. A fuze is considered armed when any firing stimulus can produce fuze function.

a. A fuze employing explosive train interruption (see 5.3.3) is considered armed when the interrupter(s) position is ineffective in preventing propagation of the explosive train at a rate equal to or exceeding 0.5 percent at a confidence level of 95 percent.

b. A fuze employing a non-interrupted explosive train (see 5.3.4) is considered armed when the stimulus available for delivery to the initiator equals or exceeds the initiator's maximum no-fire stimulus (MNFS).

3.3 Arming delay. The time elapsed, or distance traveled by the munition, from launch to arming (see 3.27 and 4.2.2).

3.4 Assembled fuze. The completed fuze with all component parts put together; a fuze requiring no added components or parts to prepare it for installation into the munition in which it is to function. Assembling the fuze is the process of putting the parts and components together.

3.5 Booster and lead explosives. Booster and lead explosives are compounds or formulations, such as those explosives listed in table I of 5.3.2, which are used to transmit and augment the detonation reaction.

3.6 Common mode failures. Multiple failures that result from, or are caused by, seemingly unrelated failures or an adverse environment. Examples include the failure of two gates on a single digital integrated circuit due to loss of the ground lead to the chip or failure of two transistors due to exposure to a high temperature environment.

3.7 Credible environment. An environment that a device may be exposed to during its life cycle (manufacturing to tactical employment, or eventual demilitarization). These include extremes of temperature and humidity, electromagnetic effects, line voltages, etc. Combinations of environments that can be reasonably expected to occur must also be considered within the context of credible environments.

3.8 Credible failure mode. A failure mode resulting from the failure of either a single component or the combination of multiple components, that has a reasonable probability of occurring during a fuzing system's life cycle.

3.9 Dud. A munition which has failed to function, although functioning was intended.

3.10 Enabling. The act of removing or activating one or more safety features designed to prevent arming, thus permitting arming to occur subsequently.

4. GENERAL REQUIREMENTS

4.1 General. The following general requirements apply to all fuzes and fuze components within the scope of this document.

4.2 Fuze safety system. In order to preclude unintended fuze arming, the fuze safety system shall:

a. not initiate the arming sequence except as a consequence of an intentional launch.

b. not be susceptible to common-mode failures.

c. not contain any single-point failure mode prior to or at the initiation of the arming cycle.

d. reduce to a minimum single-point failure modes during the arming cycle. The time window associated with these single-point failures shall be reduced to a minimum and shall exist only at or near the expiration of the intended arming delay.

In addition, the fuze design shall prohibit premature fuze arming or functioning if any or all electrical safety or energy control features fail in any given state or credible mode. These failure modes include both random and induced failures which occur prior to, during, or after application of electrical power to the fuze.

4.2.1 Safety redundancy. The safety system of fuzes shall contain at least two independent safety features, each of which shall prevent unintentional arming of the fuze. The stimuli enabling a minimum of two safety features shall be derived from different environments. Utilization in the fuze design of environments and levels of environmental stimuli to which the fuze may be exposed prior to initiation of the launch cycle shall be avoided. Operation of at least one of these safety features shall depend on sensing an environment after first motion in the launch cycle, or on sensing a post-launch environment. An action taken to initiate launch may be considered an environment if the signal generated by the action irreversibly commits the munition to complete the launch cycle.

4.2.2 Arming delay. A safety feature of the fuze shall provide an arming delay which assures that a safe separation distance can be achieved for all defined operational conditions.

4.2.3 Manual arming. An assembled fuze shall not be capable of being armed manually.

4.2.4 Electronic logic functions. Any electronic logic related to safety functions performed by the fuze shall be embedded as firmware or hardware. Firmware devices shall not be erasable or alterable by credible environments which a fuze would otherwise survive.

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4.3 Safety system failure rate. The fuze safety system failure rate shall be calculated for all logistic and tactical phases from fuze manufacture to safe separation or to the point at which friendly forces and equipment no longer need protection. The safety system failure rate shall be verified to the extent practical by test and analysis during fuze evaluation and shall not exceed the rates given for the following phases:

a. Prior to intentional initiation of the arming sequence: one failure to prevent arming or functioning (irrespective of arming) in one million fuzes.

b. Prior to the exit (for tubed launched munitions): one failure to prevent arming in ten thousand fuzes, and one failure to prevent functioning in one million fuzes.

c. Between initiation of the arming sequence or tube exit, if tube launched, and safe separation: one failure to prevent arming in one thousand fuzes. The rate of fuze functioning during this period shall be as low as practical and consistent with the risk established as acceptable for premature munition functioning.

4.3.1 Analyses. The following analyses shall be performed to identify hazardous conditions for the purpose of their elimination or control.

a. A preliminary hazard analysis shall be conducted to identify and classify hazards of normal and abnormal environments, as well as conditions and personnel actions that may occur in the phases before safe separation. This analysis shall be used in the preparation of system design, test and evaluation requirements. (See 6.9)

b. System hazard analyses and detailed analysis, such as fault tree analyses, and failure mode effects and criticality analyses, shall be conducted to arrive at an estimate of the safety system failure rate and to identify any single-point or credible failure modes.

c. For fuzing systems containing an embedded microprocessor, controller or other computing device, the analyses shall include a determination of the contribution of the software (see 4.2.4) to the enabling of a safety feature.

d. Where the software is shown to directly control or remove one or more safety features, a detailed analysis and testing of the applicable software shall be performed to assure that no design weaknesses, credible software failures, or credible hardware failures propagating through the software can result in compromise of the safety features.

4.4 Design for quality control, inspection, and maintenance.

a. Fuzes shall be designed and documented to facilitate application of effective quality control and inspection procedures. Design characteristics critical to fuze safety shall be identified to assure that the designed safety is maintained.

b. The design of the fuze shall facilitate the use of inspection and test equipment for monitoring all characteristics which assure the safety and intended functioning of the fuze at all appropriate stages. The fuze design should facilitate the use of automatic inspection equipment.

c. Embedded computing systems and their associated software (firmware) shall be designed and documented for ease of future maintenance. Software development shall be in accordance with accepted high quality software development procedures. (See 6.9)

4.5 Design approval. At the inception of engineering development, the developing activity should obtain approval from the cognizant safety authority of both the design concept and the methodology for assuring compliance with safety requirements. At the completion of engineering development, the developing activity shall present a safety assessment to the cognizant safety authority (see 4.9) for review to obtain approval of the design.

4.6 Design features.

4.6.1 Stored energy. Stored energy shall not be employed for enabling or arming when environmentally derived energy, after initiation of the launch cycle, can be practically obtained. Examples of stored energy components are:

a. Batteries
b. Charged capacitors
c. Compressed gas devices
d. Explosive actuators
e. Loaded springs

4.6.2 Compatibility of fuze elements. All fuze materials shall be chosen to be compatible and stable so that under all life-cycle conditions none of the following shall occur in an unarmed fuze:

a. Premature arming.
b. Dangerous ejection of material.
c. Deflagration or detonation of the lead or booster.
d. An increase in the sensitivity of explosive train components beyond the level appropriate for service use.
e. Compromise of safety or sterilization features.
f. Production of unacceptable levels of toxic or other hazardous materials.

4.6.3 Manually enabled safety features. When manually operable safety features critical to fuzing system safety are used, their design shall minimize inadvertent or unintended operation.

4.6.4 Electrical firing energy dissipation. For electrically initiated fuze explosive trains, the fuze design shall include a provision to dissipate the firing energy within 30 minutes of the expiration of the fuze arming life, or a fuze failure. The dissipation means shall be designed to prevent common-mode failures.

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4.6.5 Explosive ordnance disposal (EOD). Features shall be incorporated in fuzes that facilitate their being rendered safe by EOD tools, equipment and procedures even if sterilization or self-destruction features are incorporated.

4.6.5.1 EOD reviewing authority. All new or altered designs, or new applications of existing designs shall be presented to the appropriate service's EOD research, development, test and evaluation (RDT&E) authority for technical advice and assistance in determining viable design approaches or trade-offs for EOD as follows:

a. For Army:	Commander US Army ARDEC ATTN: AMSTA-AR-FSX Picatinny Arsenal, NJ 07806-5000
b. For Navy and Marine Corps:	Commanding Officer Naval Explosive Ordnance Disposal Technology Division, Code 60 2008 Stump Neck Road Indian Head, MD 20640-5070
c. For Air Force:	Commander Detachment 63 ASC 2008 Stump Neck Road Indian Head, MD 20640-5070

4.6.6 Non-armed condition assurance. Fuzing system designs shall incorporate one or more of the following:

a. A feature that prevents assembly of the fuzing system in an armed condition.

b. A feature that provides a positive means of determining that the fuzing system is not armed during and after its assembly and during installation into the munition. Where the fuzing system is accessible after installation into the munition, the positive means of determination shall also be available.

c. A feature that prevents installation of an armed, assembled fuzing system into a munition.

If arming and reset of the assembled fuzing system in tests is a normal procedure in manufacturing, inspection, or at any time prior to its installation into a munition, subparagraph a is not sufficient and either subparagraph b or c must also be met.

4.6.6.1 Visual indication. If visual indication of the non-armed or armed condition is employed in the fuze, visible indicators shall be designed tp provide a positive, unambiguous indication of condition. Indicator failure shall not result in a false non-armed indication. If color coding is used to represent condition, the colors and coding shall be as follows: (See 6.9)

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a. Non-armed condition. Fluorescent green background with the letter S or word SAFE superimposed thereon in white. Colors shall be nonspecular.

b. Armed condition. Fluorescent red or fluorescent orange background with the letter A or the word ARMED superimposed thereon in black. Colors shall be nonspecular.

4.7 Documentation. The evaluation program used as the basis of the safety assessment which is prepared by the developing agency shall be documented in both detail and summary form.

4.8 Electromagnetic environments. Fuzes, in their normal life cycle configurations, shall not inadvertently arm or function during or after exposure to: electromagnetic radiation (EMR), electrostatic discharge (ESD), electromagnetic pulse (EMP), electromagnetic interference (EMI), lightning effects (LE), or power supply transients (PST). In addition, fuzes shall not exhibit unsafe operation during and after exposure to the above environments. Fuzes shall be tested or evaluated for:

a. EMR - per MIL-STD-1512 and MIL-STD-1385
b. ESD - per MIL-STD-331
c. EMP - per DOD-STD-2169
d. EMI - per MIL-STD-461 and MIL-STD-462
e. LE - per MIL-STD-1795 and MIL-STD-1757
f. PST - by appropriate test and analysis

4.9 Reviewing authority. All new or altered designs, or new applications of existing designs, shall be presented to the appropriate service safety review authority for a safety evaluation and certification of compliance with this standard:

a. Army	Chairman, Army Fuze Safety Review Board ATTN: AMSTA-AR-FZ Picatinny Arsenal, NJ 07806-5000
b. Navy and Marine Corps	Chairman, Weapon System Explosives Safety Review Board (WSESRB) Naval Ordnance Center (N71) Indian Head, MD 20640-5035
c. Air Force	USAF Nonnuclear Munitions Safety Board ATTN: AFDTC/SES Eglin Air Force Base, FL 32542-5000

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5. DETAILED REQUIREMENTS

5.1 General. The following detailed requirements shall apply for specific fuze designs.

5.2 Post-safe-separation safety. When operational requirements necessitate protection of friendly forces in addition to the delivery system and its personnel, one of the following options shall be incorporated in the fuze design:

a. Extension of the arming delay.

b. Control of unintentional functioning after the proper arming delay.

The fuze requirements document shall specify for the selected option a minimum quantitative failure rate for the time frame after safe separation to attainment of the required protection.

5.3 Explosive materials and trains.

5.3.1 Explosive compositions. Explosive compositions in fuzes shall be qualified for use in their intended roles in explosive train components. (See 6.9)

5.3.2 Explosive sensitivity of lead and booster explosives.

a. Only those explosives listed in Table I (See 6.9) are approved by all services for use in a position leading to the initiation of a high explosive main charge without interruption.

b. Approval by all services must be received by the Chairman, DOD Fuze Engineering Standardization Working Group (see 6.4) before a new explosive can be added to Table I or a listed explosive can be deleted. Approved explosives shall also be qualified in the fuze and certified by the associated safety board of 4.9 as acceptable for that fuze.

c. The explosive material used in fuze systems shall not be altered by any means (precipitation, recrystallization, grinding, density changes, etc.) likely to increase its sensitivity beyond that at which the material was qualified and at which it is customarily used, unless it is requalified.

5.3.3 Explosive train interruption.

a. When an element of the explosive train contains explosive material other than allowed by 5.3.2, at least one interrupter (shutter, slider, rotor) shall functionally separate it from the lead and booster explosives until the arming sequence is completed as a consequence of intentional launch. The interrupter(s) shall be directly locked mechanically in the safe position by at least two independent safety features. These safety features shall not be removed prior to initiation of the launch cycle.

b. If the primary explosive is positioned such that omission of the interrupter will prohibit explosive train transfer, a single interrupter locked by the two independent safety features is acceptable.

c. If the primary explosive is positioned such that safety is dependent upon the presence of an interrupter, the design shall include positive means to prevent the fuze from being assembled without the properly positioned interrupter.

d. The effectiveness of interruption for the fuze explosive train in its configuration prior to initiation of the arming sequence shall be determined numerically in accordance with the Primary Explosive Component Safety Test of MIL-STD-331. If the explosive train interruption is removed progressively after intentional initiation of the launch sequence, the relationship between interrupter position and its effectiveness shall be established by a progressive arming test conducted in accordance with the Primary Explosive Component Safety Test, using a test strategy given by the Projectile Fuze Arming Distance Test of MIL-STD-331. The chosen test strategy and results shall be presented and justified to the appropriate service safety authority.

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...nterrupter assembly in ... 4.6.2.6.1 Functioning test. The device shall be assembled as an

5.3.4 Non-interrupted explosive train control. Explosive train interruption is not required when the explosive train contains only explosive materials allowed by 5.3.2. One of the following methods of controlling fuze arming shall be employed:

a. For systems using techniques for accumulating all functioning energy from the post-launch environment, the fuze shall not permit arming until verification, by the fuze, of a proper launch, and attainment of the required arming delay. Accumulation of any functioning energy shall not occur until as late in the arming cycle as operational requirements permit.

b. For systems using techniques that do not accumulate all functioning energy from the post-launch environment, at least two independent energy interrupters, each controlled by an independent safety feature shall prevent arming until proper launch is verified by the fuze and the required arming delay is attained. Additionally, the fuze shall not be capable of arming in cases of the absence, or malfunction, of any and all energy interrupters.

5.3.4.1 Electrical initiator sensitivity. The initiators for an electrically fired non-interrupted explosive train shall:

a. Meet the appropriate characteristics listed for Class B initiators of MIL-I-23659.

b. Not exhibit unsafe degradation when tested in accordance with MIL-STD-1512.

c. Not be capable of being detonated by any electrical potential of less than 500 volts.

d. Not be capable of being initiated by any electrical potential of less than 500 volts, when applied to any accessible part of the fuzing system after installation into the munition or any munition subsystem.

5.4 Sterilization. Fuzing systems shall incorporate a sterilization feature based on its applicability to system requirements.

5.4.1 Sterilization of torpedoes and sea mines. Fuze systems for torpedoes and sea mines shall provide for sterilization after safe jettison, after specified events and time, or when the munition is no longer capable of functioning reliably.

5.5 Fail-safe design. Fuzing systems shall incorporate fail-safe design features based on their applicability to system requirements.

5.6 Self-destruction. Fuzing systems shall incorporate a self-destruct feature which initiates munition destruction, based on applicability to system requirements. Self-destruction shall not be initiated or enabled prior to launch and attainment of the proper arming delay.

5.7 Fuze setting. If fuze setting is safety critical (e.g., arming time, function time, or proximity broadcast turn-on time), uncontrolled alteration of the set value shall be prevented.

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6. NOTES

This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.

6.1 Intended use. This standard establishes specific design safety criteria for fuzes and safety and arming devices.

6.2 Additional criteria. Individual services and service components may issue regulations or instructions which impose additional design safety criteria or add clarifying guidelines (e.g., U.S. Army Fuze Safety Review Board Guidelines for Evaluation of Electronic Safety & Arming Systems, WSESRB Technical Manual for Electronic Safety and Arming Devices With Non-Interrupted Explosive Trains).

6.3 Issue of DODISS. When this standard is used in acquisition, the applicable issue of the DODISS must be cited in the solicitation (see 2.1.1).

6.4 Custodian of service-approvals for lead and booster explosives.

Chairman
DOD Fuze Engineering Standardization Working Group
U.S. Army Armament Research, Development and Engineering Center
ATTN: AMSTA-AR-AEF-C
Picatinny Arsenal, NJ 07806-5000

6.5 Hazard analyses. Techniques for conducting hazard analyses are described in NAVSEA OD44942, AFSC Design Handbook DH 1-6, and Nuc Reg 0492.

6.6 Subject term (key word) listing.

Delay, arming
Explosive ordnance disposal
Explosive train
Explosive train interruption
Fail-safe
Function, premature
Fuze
Fuze design, safety criteria for
Fuzing system
Non-interrupted explosive train
Safe separation
Safety and arming device

6.7 International Standardization Agreements. Certain provisions of this standard are the subject of International Standardization Agreements (ASCC-AIR-STD-20/9, Design Safety Principles for Airborne Weapon Fuzing Systems, STANAG 4187, Fuzing Systems; Safety Design Requirements, and STANAG 3525, Design Safety Principles and General Design Criteria for Airborne Weapon Fuzing Systems). When change notice, revision or cancellation of this document is proposed which affect or violate the international agreement concerned, the preparing activity will take appropriate reconciliation action through international standardization channels, including departmental standardization offices, if required.

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6.8 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

6.9 Useful references.

a. Terms and definitions for munitions are contained in MIL-STD-444, "Nomenclature and Definition in the Ammunition Area." Definitions pertaining to explosives can be found in ADA-086259, Vol. 4, "Joint Services Safety and Performance Manual for Qualification of Explosives for Military Use." (See 3.1)

b. Requirements associated with a system hazard analysis are contained in MIL-STD-882, "System Safety Program Requirements." (See 4.3.1a)

c. Requirements associated with software development and documentation are contained in MIL-STD-498, "Software Development and Documentation." (See 4.4c)

d. Suggested color specifications for visual indication of the armed or non-armed condition of a fuze are in FED-STD-595, "Color," for Color No. 38901 (fluorescent green), Color No. 38905 (fluorescent red), and Color No. 38903 (fluorescent orange). (See 4.6.6.1)

e. Requirements associated with the qualification of explosive compositions are contained in ADA-086259, Vol. 4, "Joint Services Safety and Performance Manual for Qualification of Explosives for Military Use," and MIL-STD-1751, "Safety and Performance Tests for Qualification of Explosives." (See 5.3.1)

f. Explosives approved for use in a position leading to the initiation of a high explosive main charge without interruption are listed in Table I. (Unless otherwise indicated, copies of Navy Weapon Specifications (WS documents) are available from Officer-In-Charge, Naval Surface Warfare Center, Dahlgren Division Detachment White Oak, ATTN: Code R10, 10901 New Hampshire Avenue, Silver Spring, MD 20903-5000.) (See 5.3.2a)

TABLE I. Approved explosives

Explosive	Specification
Comp A3	MIL-C-440, Compositions A3 and A4
Comp A4	MIL-C-440, Compositions A3 and A4
Comp A5	MIL-E-14970, Explosive Composition A5
Comp CH6	MIL-C-21723, Composition CH-6
PBX 9407	MIL-R-63419, RDX/Vinyl Chloride Copolymer Explosive Composition (PBX 9407)
PBXN-5	MIL-E-81111, Explosive, Plastic-Bonded Molding Powder (PBXN-5)
PBXM-6	WS-12604, Explosive, Plastic-Bonded Molding Powder (PBXN-6)
DIPAM	WS-4660, Dipam Explosive
HNS Type 1 or Type 2 Gr A	WS-5003, HNS Explosive
HNS-IV	WS-32972, Material Specification for HNS-IV
*Tetryl	MIL-T-339, Tetryl
*Tetryl Pellets	MIL-P-46464, Pellets, Tetryl

*No longer manufactured; not for use in new developments.

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(Project 13GP-0087)

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