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DEPARTMENT OF DEFENSE
DESIGN CRITERIA STANDARD

MUNITION ROCKET AND MISSILE MOTOR IGNITION SYSTEM DESIGN, SAFETY CRITERIA FOR

AMSC N/A FSC 13GP

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

FOREWORD

1. This Military Standard is approved for use by all Departments and Agencies of the Department of Defense.

2. The purpose of this standard is to establish specific design safety criteria for Ignition Systems and Ignition Safety Devices intended for use with munition rockets and missile motors. The safety, arming, and firing requirements specified herein are mandatory fundamental elements of engineering design, development, and testing. Ignition systems shall provide primary safety for propulsion systems consistent with assembly, handling, storage, transportation, operational readiness, and use or disposal. The inadvertent actuation of a munition propulsion system can result in catastrophic material damage and injury or death to personnel. Every effort must be made during the development of munition propulsion systems with their associated initiation systems, to achieve a high degree of safety through the incorporation of good design features and the selection and use of materials and operating procedures. The thrust toward in-field testing of powered weapons further increases the exposure of operating personnel to the threat of inadvertent actuation of the munition propulsion system.

3. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document shall be addressed to: Commander, US Army TACOM-ARDEC, ATTN: AMSTA-AR-QAW-E, Picatinny Arsenal, NJ 07806-5000 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter. Comments should be forwarded through the designated Reviewing Activity listed for each Service in 4.14.

CONTENTS

1 SCOPE

1.1 Scope. This standard establishes the design safety criteria for munition ignition systems and associated ignition safety devices used to arm and fire munition propulsion systems.

1.2 Applicability This standard applies to the design of ignition systems and ignition safety devices in new exploratory, advanced, engineering, and operational system developments. Ignition systems incorporating or initiating one or more detonating components will be subjected to the requirements of this standard in the same manner as those incorporating only pyrotechnic components.

1.3 Excluded Munitions This standard does not apply to the following:

a. Nuclear weapon systems and trainers.
b. Flares and signals dispensed by hand held devices.
c. Pyrotechnic countermeasure devices.

2 APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3, 4, and 5 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 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 Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

DEPARTMENT OF DEFENSE

MIL-T-339 Tetryl (Trinitrophenylmethylnitramine)
MIL-C-440 Composition A3 and A4
MIL-E-14970 Explosive Composition A5
MIL-C-21723 Composition CH-6
MIL-I-23659 Initiators, Electric, General Design Specification
MIL-P-46464 Pellets, Tetryl
MIL-P-46994 Pellets/Granules, Boron/Potassium Nitrate
MIL-R-63419 RDX/Vinyl Chloride Copolymer Explosive Composition (PBX 9407) (For Use in Ammunition)
MIL-E-81111 Explosive, Plastic-Bonded Molding Powder (PBXN-5)
MIL-E-82903 Explosive, HNS-IV and HNS-V

STANDARDS

FEDERAL

FED-STD-595 Color Used in Government Procurement

DEPARTMENT OF DEFENSE

MIL-STD-331 Fuze and Fuze Components, Environmental and Performance Tests for

MIL-STD-461	Requirements for the Control of Electromagnetic Interference Characteristics, Requirements of Subsystems and Equipment
MIL-STD-464	Electromagnetic Environmental Effects, Requirements for Systems
MIL-STD 882	System Safety
MIL-STD-1316	Fuze Design, Safety Criteria for.
MIL-STD-1751	Safety and Performance Tests for Qualification of Explosives (High Explosives, Propellants and Pyrotechnics)

HANDBOOKS

DEPARTMENT OF DEFENSE

MIL-HDBK-1512	Electroexplosive Subsystems, Electrically Initiated, Design Requirement and Test Methods

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

2.2.2 Other Government Documents. The following other Government documents, drawings, and publications form a part of the document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

NAVY WEAPON SPECIFICATIONS

WS-4660	DIPAM Explosive
WS-5003	Explosive HNS
WS-12604	Explosive, Plastic-Bonded Molding Powder (PBXN-6)
OD 44811	Safety and Performance Tests for Qualification of Explosives

(Unless otherwise indicated, copies of the above documents are available from Naval Sea Systems Command, SEA 03R42, 2351 Jefferson Davis Highway, Arlington, VA 22242-5160.)

2.3 Non-Government Pulbications. The following documents(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE/EIA 12207.0	Software Life Cycle Processes
IEEE/EIA 12207.1	Software Life Cycle Processes – Life Cycle Data
IEEE/EIA 12207.2	Software Life Cycle Processes – Implementation Considerations

(Application for copies should be addressed to the IEEE Service Center, P.O. Box 1331, 445 Hoes Lane, Piscataway, NJ 08855-1331.)

2.4 Order of Precedence. In event of a conflict between 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.

3 Definitions

3.1 Armed. An ignition system is armed when the output of a primary explosive, a sensitive pyrotechnic or application of a firing stimulus can produce ignition of the munition propulsion system.

a. An ignition system employing an ignition safety device with pyrotechnic train interruption (see 5.2.2) is considered armed when the interrupter(s) position (or condition) is ineffective in preventing propagation of the pyrotechnic train, given initiation of the sensitive elements of the train, at a rate equal to or exceeding 0.5 percent at a confidence level of 95 percent.

b. An ignition system employing firing energy train interruption (see 5.2.3.1) is considered armed when the interrupters' position or condition is ineffective in preventing initiation of the first element of the pyrotechnic train at a rate equal to or exceeding 0.5 percent at a confidence level of 95 percent.

c. An ignition system employing a non-interrupted pyrotechnic train and a non-interrupted firing energy train (see 5.2.3.2) is considered armed when the firing energy available for delivery to the initiator equals or exceeds the initiator's maximum no-fire stimulus.

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

3.3 Enabling. The act of removing or deactivating any safety feature, which prevents arming.

3.4 Environment. A specific physical condition to which the ignition system may be exposed.

3.5 Environmental stimulus. A specific stimulus obtained from an environment.

3.6 Fail-safe design. A characteristic of an ignition system and/or part thereof, including the ignition safety device, designed to preclude ignition of the propulsion system or hazard to personnel when safety features malfunction.

3.7 Firing Energy Train. The path of all non-chemical energy leading to the first element of a non-interrupted pyrotechnic train.

3.8 Firmware. The combination of a hardware device and computer instructions or computer data that reside as read only software on the hardware device. The software cannot be readily modified under program control.

3.9 Igniter charge. A source of heat and pressure that actually ignites the motor propellant.

3.10 Ignition safety device (ISD). A device that is an integral part of the munition whose purpose is to prevent an unintended functioning of the rocket or missile motor through interruption of the pyrotechnic train, interruption of the firing energy train, or control of the energy required to arm the ISD and function the initiator.

3.11 Ignition system (IS). The aggregate of devices in a weapon system, including those in the munition, launcher and munition launch platform (e.g., fire control system, armament control unit), which control the arming and firing signals to cause the munition propulsion system to function.

3.12 Independent safety feature. A safety feature is independent if its integrity is not affected by the functioning or malfunctioning of the other safety features.

3.13 Initiator. The component or components which convert the firing energy resulting in initiation of the first explosive or pyrotechnic element, even in the case of a distributed system where the energy conversion may occur at some distance and in a physically different module from the explosive or pyrotechnic element. The first explosive or pyrotechnic element of the explosive train will always be considered as part of the initiator. Examples of Initiators include but are not limited to:

a. Exploding Bridgewire (EBW) devices;
b. Semi-Conductor Bridge (SCB) initiators;
c. Laser diodes, the first component of the explosive or pyrotechnic train, and the in between (transfer) components;
d. Exploding Foil Initiators (EFI) including the bridge and explosive component;
e. Stab Detonators.

3.14 Interrupted firing energy train. A firing energy train with its elements physically and functionally separated until arming to interrupt the firing energy path and thus prevent ignition of the first element of a non-interrupted pyrotechnic train in the event of unintended activation of any sensitive element in the firing energy train (e.g., low voltage laser diodes).

3.15 Interrupted pyrotechnic train. A pyrotechnic train (see 3.18) with elements of the train physically and functionally separated until arming to interrupt the firing path and thus prevent ignition of the motor propellant in the event of unintended ignition of any sensitive element of the train.

3.16 Maximum no-fire stimulus (MNFS). The stimulus level at which the initiator will not fire or unsafely degrade with a probability of .995 at a confidence level of 95%. Stimulus refers to characteristic(s) such as current, rate of change of current (di/dt), power, voltage, or energy which is (are) most critical in defining the no-fire performance of the initiator.

3.17 Pyrotechnic materials. Those energetic materials or compounds which do not ordinarily detonate in their intended function but rather burn or deflagrate. Typical examples include boron potassium nitrate ($BKNO_3$), black powder, and many metal/oxidant combinations.

3.18 Pyrotechnic train. The deflagration train beginning with the first pyrotechnic element and terminating in the munition propellant. For the purposes of this standard, the term pyrotechnic train refers also to those trains incorporating one or more detonating components.

3.19 Safety feature. An element or combination of elements that prevents unintentional arming or functioning.

3.20 Safety system failure. A failure of an ignition system or ignition safety device to prevent unintentional arming or functioning.

3.21 Sensitive pyrotechnics. Sensitive pyrotechnics are used to initiate or ignite other, less sensitive, materials in the pyrotechnic train. They are used in primers or squibs of ignition systems and are sensitive to ESD, heat, impact, or friction and undergo a rapid exothermic reaction upon initiation.

3.22 Sensor, environmental. A component or series of components designed to detect and respond to a specific environment.

4 GENERAL REQUIREMENTS

4.1 Ignition Systems

4.1.1 Ignition system design. The design of the ignition system shall take into account the aggregate of devices in the weapon system (munition, launcher, and munition launch platform) which generate and control the operating signal to cause the munition propulsion system to function.

4.1.2 Ignition safety device. The design of the munition employing a missile or rocket motor shall include an ignition safety device, based on munition system requirements, complying with the requirements of this document. The design of the ignition safety device shall be compatible with the ignition system(s) for the proposed platform(s).

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

a. A preliminary hazard analysis (PHA) shall be conducted to identify and classify, per MIL-STD-882 appendix A, hazards of normal and abnormal environments, as well as conditions and personnel actions that may occur in the phases before and during intentional arming (or firing) of the IS. This analysis shall form the basis for preparation of system design, test, and evaluation requirements.

b. System hazard analyses and detailed analyses, 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, common mode, or other credible failure modes that could result in inadvertent or premature arming or firing of the munition. These analyses shall include an assessment of the relative sensitivity of each component in the pyrotechnic train.

c. For the IS or ISD containing an embedded computer, microprocessor, micro-controller or other computing device, the analyses shall include a determination of the contribution of the software, firmware, or micro-code (see 4.8) 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 ensure that no design weaknesses, credible software failures, or credible hardware failures propagating through the software can result in compromise of the safety features.

e. For an IS or ISD containing Application Specific Integrated Circuits, Programmable Gate Arrays, or similar devices, the analyses shall include a determination of the safety criticality of these devices to the arming and functioning of the system. Detailed safety analyses and tests shall be performed on those devices shown to be safety critical or directly influence safety critical functions to determine their contribution to the safety failure rate.

4.3 Ignition System. In order to preclude unintended or premature ignition system arming or initiation the ignition system shall:

a. Inhibit the arming sequence except as a consequence of a valid launch or confirmation of the launch intent.

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. Delay arming as long as possible within operational constraints.

e. Utilize environmental forces, wherever possible, to enable safety features. When the IS utilizes stored energy to enable the safety feature(s), the stored energy source shall not be integral to the IS unless it can be demonstrated that it is impractical to do otherwise and that the required safety failure rate (see 4.5) can be achieved.

4.3.1 Ignition safety device. As an element of the ignition system, the ignition safety device shall:

a. Prevent arming or initiation of the propulsion system except in response to valid arming and launching signals from the ignition system.

b. Not contain any single point or common mode failure that could result in inadvertent or premature arming or firing prior to or at the initiation of the arming sequence

c. Delay arming as long as possible within operational constraints.

d. Utilize environmental forces, whenever possible, to enable safety features. When the ISD uses stored energy to enable the safety feature(s), the stored energy source shall not be integral to the ISD unless it can be demonstrated that it is impractical to do otherwise and that the required safety failure rate (see 4.5) can be achieved. In addition, if the ISD uses stored energy to enable safety features, it shall be as unique, in terms of level and type, as allowed by system requirements.

4.4 Manual Arming. The ignition safety device shall not be capable of being armed manually unless such capability is required by operational conditions and is specifically approved by the responsible reviewing activity of 4.14. Such systems shall be capable of being easily returned to a non-armed condition under the conditions of deployment.

4.5 Safety System Failure Rate. The safety failure rate of the IS shall be calculated by performing a safety analysis (see 4.2) and shall be verified to the extent practicable by test and analysis. As a minimum requirement, the safety failure rate shall not exceed one failure in one million prior to intentional initiation of the arming sequence**.**

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

4.7 Electromagnetic Environments. ISs and ISDs, in their normal life cycle configurations, shall not inadvertently arm or function during and 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, ISs and ISDs shall not exhibit unsafe operation during and after exposure to the above environments. ISs and ISDs installed in the host munition shall be tested or evaluated for:

a. EMR - per MIL-STD-464
b. ESD - per MIL-STD-464
c. EMP - per MIL-STD-464
d. EMI - per MIL-STD-464
e. LE - per MIL-STD-464
f. PST – by appropriate test and analysis based on the design of the power system for the IS.

4.8 Electronic Logic Functions. Any electronic logic related to safety functions performed by the IS or ISD shall be embedded as firmware or hardware. Firmware devices shall not be erasable or alterable by credible environments which the IS or ISD would otherwise survive.

4.9 Fail-Safe Features. Fail safe designs shall be considered for ignition systems and ignition safety devices. ISD designs shall incorporate fail-safe feature(s) based on munition requirements.

4.10 Explosive Ordnance Disposal. The IS and ISD shall incorporate Explosive Ordnance Disposal (EOD) features which insure that, in the event of accidents, extreme/hostile situations, or dud ordnance, EOD personnel can either return the munition to a safe to handle condition or, where necessary, implement field expedient disposal. Where practical, incorporate features that permit determination of the armed or unarmed state of the IS or ISD by EOD in the event of a misfire, hung store, etc.

4.10.1 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. Army:	Commander US Army ARDEC ATTN: AMSTA-AR-FSX Picatinny Arsenal, NJ 07806-5000
b. Navy and Marine Corps	Commanding Officer Naval Explosive Ordnance Disposal Technology Division Code 60 2008 Stump Neck Road Indian Head, MD 20640-5070
c. Air Force:	Commanding Officer ATTN: Detachment 63, 615 SMSQ Indian Head, MD 20640-5099

4.11 Armed or Non-armed Condition

4.11.1 Non-armed condition assurance. The IS and/or ISD design shall incorporate one or more of the following:

a. A feature that prevents assembly of the IS in the armed condition.
b. A feature that prevents assembly of the ISD in the armed condition.
c. A feature that provides a positive means of determining that the ISD is not armed during and after its assembly and during installation into the munition.
d. A feature that prevents installation of an armed, assembled ISD into a munition.

4.11.1.1 Arming and reset during manufacturing. If arming and reset of the assembled ISD in tests is a normal procedure in manufacturing, inspection, or at any time prior to its installation into a munition, subparagraph 4.11.1 b is not sufficient and either subparagraph 4.11.1 c or 4.11.1 d must also be met.

4.11.1.2 Arming and reset during test. If arming and reset of the IS is a normal test procedure at any time during its life cycle, subparagraph a is not sufficient and the Ignition System shall provide a positive means to determine whether the system is armed or unarmed whether or not a munition is present.

4.11.2 Visual indication. If visual indication of the non-armed or armed condition is employed in the ISD, visible indicators shall be designed to 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:

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

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

c. Suggested color specification.

(1) Fluorescent green, Color No. 38901 per FED-STD-595
(2) Fluorescent red, Color No. 38905 per FED-STD-595.
(3) Fluorescent orange, Color No. 38903 per FED-STD-595.

4.11.3 Electrical firing energy dissipation. Ignition Systems and Ignition Safety Devices accumulating and/or storing functioning energy (e.g., firing capacitors) shall dissipate the firing energy within 60 seconds whenever the arming signal is removed. The dissipation means shall be designed to prevent single point and common mode failures.

4.12 Design for Quality Control, Inspection and Maintenance

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

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

c. Embedded computing systems and their associate 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, such as DOD-STD-498.

4.13 Design Approval. At the inception of system development and demonstration, the developing activity should obtain approval from the cognizant safety authority with 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 4.14) for review to obtain approval of the design.

4.14 Reviewing Activity. New or altered designs or new applications of approved designs shall be presented to the appropriate service safety review board for a safety evaluation and certification of compliance with the standard:

a. Army:

Chairman
US Army Ignition System Safety Review Board
ATTN: AMSAM-SF
Redstone Arsenal, AL 35898

b. Navy and Marine Corps:

Chairman, Weapon System Explosives
Safety Review Board
Commander, Naval Ordnance Safety and Security Activity
Farragut hall, Building D323
23 Strauss Ave.
Indian Head, MD 20540-5555

c. Air Force:

USAF Nonnuclear Munitions Safety Board
ATTN: AAC/SES
1001 N. Second St., Suite 366
Eglin Air Force Base, FL 32542-6838

5 DETAILED REQUIREMENTS

5.1 Application Guidance. The following detailed requirements shall apply to ignition system designs.

5.2 Pyrotechnic Trains and Firing Energy Trains

5.2.1 Pyrotechnic or explosive sensitivity (transfer charge and igniter pyrotechnics)

a. Only pyrotechnic materials listed in Table 1 herein and those explosive materials listed in Table 2 are approved by all services for use in a position leading to the ignition of a rocket or missile motor 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 material can be added to these tables or before a listed material can be deleted. Approved pyrotechnic and explosive materials shall be qualified in the IS and certified by the associated safety board of 4.14 as acceptable for that IS.

c. The material used in ISD's shall not be altered by any means (precipitation, recrystalization, grinding, density changes, addition of materials, 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.

d. Subject to the associated service safety review authority, pyrotechnic materials which do not appear in Table 1 may be utilized physically in-line in the propulsion system prior to ISD arming if:

(1) The material has been qualified through actual testing to MIL-STD-1751 or OD44811 "Qualification Requirements for Booster Explosives" with the exception of the "Hot Wire Ignition Test," or

(2) For material that does not meet the test requirements of MIL-STD-1751 or OD44811 above, the material shall demonstrate, in comparative tests, sensitivity values and stability and aging properties equal to or less than unmodified Boron Potassium Nitrate ($BKNO_3$). $BKNO_3$ shall be tested alongside the proposed material to obtain the comparative values.

TABLE 1. Approved Pyrotechnics

Pyrotechnic	Specification
$BKNO_3$	MIL-P-46994

TABLE 2. Approved Explosives

Explosive	Specification
Comp A3	MIL-C-440
Comp A4	MIL-C-440
Comp A5	MIL-E-14970
Comp CH6	MIL-C-21723
PBX-9407	MIL-R-63419
PBXN-5	MIL-R-81111
PBXN-6	WS-12604
DIPAM	WS-4660
HNS Type 1or Type 2 Grade A	WS-5003
*Tetryl	MIL-T-339
*Tetryl Pellets	MIL-P-46464
HNS-IV	MIL-E-82903

5.2.2 Pyrotechnic train interruption. When the pyrotechnic train contains material(s) other than those allowed by 5.2.1, at least one interrupter (shutter, slider, rotor, for example) shall separate these materials from the balance of the pyrotechnic train until it is removed during ISD arming as a consequence of an intentional initiation of the launch sequence.

5.2.2.1 Methods of restraint. The interrupter(s) shall comply with one of the following methods of restraint:

a. The interrupter(s) shall be directly locked mechanically in the non-armed position by at least one safety feature. The safety feature shall not be removed prior to intentional initiation of the arming sequence.

b. The interrupter(s) shall be directly restrained mechanically in the non-armed position by at least one safety feature. The safety feature shall be overcome by the arming energy and shall automatically return the interrupter to a non-armed position upon removal of the arming energy.

5.2.2.2 Interruption position. If the sensitive pyrotechnic element is positioned such that safety is dependent upon the presence of an interrupter, the design shall include positive means to prevent the ISD from being assembled without the properly positioned interrupter. If the sensitive pyrotechnic element is positioned such that omission of the interrupter will prohibit pyrotechnic train transfer, a single interrupter is acceptable.

5.2.2.3 Interruption effectiveness. The effectiveness of the interruption prior to initiation of the arming sequence shall be determined numerically in accordance with MIL-STD-331 Primary Explosive Component Safety Test or by similar methodologies. The results shall be presented and justified to the appropriate service safety authority.

5.2.3 Non-interrupted pyrotechnic train control. When the pyrotechnic train contains only those materials allowed by 5.2.1, no pyrotechnic train interruption is required. In this case, one of the following methods of firing energy train control is required:

5.2.3.1 Firing energy train interruption with low voltage devices. An example of a firing energy train, which would require interruption, is an ignition system using a low voltage (activated by less than 500 volts) laser diode, with associated optical transmission hardware and an approved in line pyrotechnic. At least one firing energy train interrupter is required if low voltage devices are used. Low voltage devices are defined as those incorporating initiators requiring less than 500 volts or less than the maximum voltage available in the ignition system (see paragraph 5.2.4.3) prior to commit to launch (whichever is greater). Interruption of the low voltage alone in these applications is not an acceptable design. The design of the firing energy train interruption shall comply with the following:

a. The interrupter shall be rendered ineffective by the arming energy and automatically return to a non-armed state upon removal of the arming energy.

b. If the first pyrotechnic element is positioned such that safety is dependent upon the presence of an interrupter, the design shall include positive means to prevent the ISD from being assembled without the properly positioned interrupter.

c. If the first pyrotechnic element is positioned such that omission of the interrupter will prohibit transfer to the pyrotechnic train, a single interrupter is acceptable.

d. The effectiveness of the interruption prior to initiation of the arming sequence shall be determined numerically and the methodology and results presented and justified to the appropriate service safety authority.

5.2.3.2 Firing energy train interruption with high voltage devices. Firing energy train interruption is not required if only initiators meeting the requirements of paragraph 5.2.4.1 are used. However, function energy shall be controlled to preclude unintentional arming and firing. At least two energy interrupters, each controlled by an independent safety feature shall prevent arming until intent to launch the munition. The IS shall not be capable of functioning in the absence of or as a result of static failure of all of the energy interrupters. Removal of the arming signal shall automatically return the firing energy train to a non-armed state.

5.2.4 Initiator electrical sensitivity

5.2.4.1 High voltage non-interrupted pyrotechnic train. The initiator for an electrically fired non-interrupted train shall:

a. Be qualified in accordance with the requirements of MIL-I-23659, Appendix A

b. Not be capable of being initiated when exposed to the greater of:

(1) Any electrical potential up to 500 volts (see paragraph 5.2.4.3) or;
(2) Any electrical potential that may be present in the IS prior to an irreversible commit to launch.

Note: Deflagration of the initiator is acceptable if initiator detonation is required to propagate to the pyrotechnic train and does not otherwise adversely affect the safety of the system. Damage to or destruction of the initiator is acceptable if it does not otherwise adversely affect the safety of the system.

c. Not be capable of being initiated by any electrical potential as defined in paragraph 5.2.4.1.b when applied to any accessible part of the ISD after installation into the munition or any munition subsystem.

5.2.4.2 Interrupted firing energy train or pyrotechnic train. Unless otherwise specified, the initiator for an electrically fired interrupted firing energy or pyrotechnic train shall be qualified, as a minimum, to the following requirements:

a. Detonating or deflagrating devices shall meet the requirements listed for Class A initiators in MIL-I-23659

b. For those initiators where the requirements of MIL-I-23659 are not appropriate, the developer shall receive service safety review authority concurrence with the qualification test and acceptance criteria.

5.2.4.3 500 Volt test requirement. For initiators to be used in electrically fired non-interrupted firing energy trains, when the maximum allowable electrical sensitivity and electrical cookoff tests of MIL-I-23659 can not be applied to the initiator, the following applies. A 500 volt test program shall be developed and presented for approval to the appropriate service safety authority for the planned 500-volt test program for qualification of the initiator. The test shall include, as a minimum, both 500 volts at various frequencies, waveforms, and voltages that may be present in the ignition system, whether resulting from normal functioning or failures.

6 NOTES

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

6.1 Intended Use. This standard establishes specific design safety criteria for ignition systems and ignition safety devices.

6.2 Acquisition Documents. When this standard is used in acquisition, the applicable issue of the DoDISS must be cited in the solicitation (see 2.2.1) Acquisition documents should specify the title, number and date of this standard.

6.3 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).

6.4 Custodian. The Custodian of service-approvals for lead and booster explosives and pyrotechnic materials which are acceptable in-line prior to ignition system arming:

Chairman
DOD Fuze Engineering Standardization Working Group
US Army Armament Research,
Development and Engineering Center
ATTN: AMSTA-AR-CCF-D
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.

Arming control
Explosive ordnance disposal
Explosive train
Explosive train interruption
Fail-safe
Firing energy train
Function, premature
Fuze
Fuze design, safety criteria for
Ignition safety device
Ignition system
Propulsion systems

Pyrotechnic train
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 4368, Electrical and Laser Ignition Systems for Rockets and Guided Missile Motors – Safety Design Requirements). 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 action through international standardization channels, including departmental standardization offices, if required.

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 extent of the changes.

CONCLUDING MATERIAL

Custodians:
Army-AR
Navy-OS
Air Force-11

Preparing Activity:
Army-AR

(Project 13GP-0068)

Review activities:
Army-MI
Navy-AS
Air Force-99

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
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I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER **MIL-STD-1901A**	2. DOCUMENT DATE (YYMMDD)

3. DOCUMENT TITLE
MUNITION ROCKET AND MISSILE MOTOR IGNITION SYSTEM DESIGN, SAFETY CRITERIA FOR

4. NATURE OF CHANGE (*Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME *(Last, First, Middle Initial)*	b. ORGANIZATION	
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c. ADDRESS (*Include Zip Code)* **ATTN: AMSTA-AR-QAW-E, B-12** **Picatinny Arsenal, NJ 07806-5000**	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340

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