INCH-POUND

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SUPERSEDING
MIL-STD-1904B (AR)
09 March 2016

TEST STANDARDS FOR LEVEL A AND LEVEL B PACKAGING FOR CONVENTIONAL AMMUNITION

AMSC N/A FSC 8140

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FOREWORD

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

2. Comments, suggestions, or questions on this document should be addressed to: U.S. Army DEVCOM Armaments Center: FCDD-ACE-QSA, Picatinny Arsenal, New Jersey 07806-5000 or emailed to usarmy.picatinny.ccdc-ac.list.ardec-stdzn-branch@army.mil Since contact information can change, you may want to verify the currency of this information using the ASSIST Online database at https://assist.dla.mil.

3. The logistical and tactical requirements for ammunition packaging/packing systems are varied and complex. In order to design packaging systems to meet these requirements, material and environmental criteria must be defined to ensure the success of the design and ultimate satisfactory use in the field. This standard interprets the environment that packed ammunition may be subjected to within the ammunition logistic system from time of production to time of expenditure and recommends material and design requirements to withstand that environment. The interpretation of the environment is in terms of test simulations which may be readily understood and executed during the packaging development period.

4. This revision has resulted in numerous changes/additions to MIL-STD-1904 Revision B, the most significant being:

a. Inclusion of requirements for Level B Ammunition Packaging from MIL-STD- 1905A, which was inactivated in April 2014. Level B packaging is for favorable worldwide shipping and storage conditions, without Level A pressure retention requirements. Test temperatures for Level B packaging are the same for Level A non-tactical (+145 deg. F, +72 deg. F, and -30 deg. F.

b. Level C Ammunition Packaging requirements from MIL-STD-1905A are no longer used by the Department of Defense. The latest revision to AR 700-15 only recognized two levels of Military Packaging: Level A and Level B.

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1. SCOPE

1.1 Purpose. The intent of this document is to supply packaging designers with guidelines on the material, performance, and testing requirements which will lead to a container (packaging system) that can provide adequate protection to the munitions packaged and be successfully fielded for Army use. These guidelines can be tailored or modified to suit particular requirements for a unique piece of ammunition as determined by the responsible design activity. However, prior to changing or altering the requirements it is mandatory that complete justification be made for these changes. The design activity will coordinate with the integrated product team, user, and/or responsible authority in identifying or changing requirements. At the satisfactory conclusion of the environmental tests listed in this standard it can be assumed that the fielded container will perform satisfactorily.

1.2 Scope. This standard establishes container material, performance, and environmental tests for use in development of packaging and packing for conventional ammunition (excluding nuclear, biological, and chemical). For purposes of this document, conventional ammunition includes a broad category of Class 1 hazardous material such as small arms, projectiles, propelling charges, fuzes, cartridges (i.e., tank, mortar), primers, detonators, rockets, grenades, mines, simulators, flares, etc. This document applies to packaged ammunition meeting Level A (maximum military protection) packaging classification and Level B (intermediate protection under generally favorable environmental conditions of worldwide shipment). It will also cover those packs and items (i.e., propellant) which require fielded Level A protection for long term storage but are not normally fielded as tactical ammunition.

The Level A and Level B packaging requirements, in general, exceed the requirements of the Code of Federal Regulations, Title 49 (49CFR). Conformance to 49CFR will ensure compliance with the Department of Transportation safety and legal requirements for CONUS and international movement whereas this standard should ensure the operability and safety of the Department of Defense munitions when subjected to world-wide distribution, storage, handling, transportation, and tactical deployment.

1.3 Application. This standard applies broadly to all those munitions and munitions related materials which must be packaged to a Level A or Level B protection. The tests include only those conditions that are recurrent in military operations and sufficiently fixed in procedure to permit standardization. Thus, for any special conditions of military operations not covered by this standard, it is the responsibility of the packaging designer to devise and apply the appropriate tests to cover the non-standard conditions.

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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 of 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 and standards. The following specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

FEDERAL SPECIFICATIONS

MILITARY

MIL-D-3464	Desiccants, Activated Bagged, Packaging Use and Static Dehumidification
MIL-DTL-27166	Valve, Pressure Equalizing, Gaseous Products
MIL-DTL-45449	Pallet, Units, Wood, for Shipment of Projectile Metal Parts, and Projectile Ammunition
MIL-DTL-53072	Chemical Agent Resistant Coating (CARC) System Application Procedures and Quality Control Inspection

STANDARDS

MILITARY

MIL-STD-129	Marking for Shipment and Storage
MIL-STD-648	Design Criteria for Specialized Shipping Containers
MIL-STD-650	Explosive Sampling, Inspection & Testing
MIL-STD-810	Environmental Test Methods and Engineering Guidelines
MIL-STD-882	System Safety Program Requirements
MIL-STD-1472	Human Engineering Design Criteria for Military Systems, Equipment and Facilities
MIL-STD-1660	Design Criteria for Ammunition Unit Loads
MIL-STD-1791	Designing for Internal Aerial Delivery in Fixed Wing Aircraft
MIL-STD-2073-1	Standard Practice for Military Packaging
MIL-STD-2105	Hazard Assessment Tests for Non-Nuclear Munitions

(Copies of these documents are available online at https://quicksearch.dla.mil.)

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

CODE OF FEDERAL REGULATIONS

49CFR	Code of Federal Regulations Title 49 - Transportation of Hazardous Materials

(The CFR titles available online at https://www.ecfr.gov/.)

JOINT TECHNICAL BULLETINS

TB 700-2	Department of Defense Explosives Hazard Classification Procedures

(The Joint Technical Bulletin is available online at https://www.ddesb.pentagon.mil/)

ARMY REGULATIONS

AR 40-10	Health Hazard Assessment Program in Support of the Army Materiel Acquisition Decision Process
AR 70-38	Research, Development, Test and Evaluation of Materiel for Extreme Climatic Conditions
AR 70-47	Engineering for Transportability
AR 70-75	Survivability of Army Personnel and Materiel
AR 700-15	Packaging of Materiel
AR 740-1	Storage and Supply Activity Operations
AR 700-143	Packaging of Hazardous Material

(Copies of these Army Regulation are available online at https://www.apd.army.mil/ and are available from the US Army Publications Distribution Center, 1655 Woodson Rd., St Louis,MO 63114-6181)

ITOP 01-2-601	Laboratory Vibration Schedules
TOP 08-2-111A	Test Operation Procedure for CBR Contamination Survivability, Small Items

(Copies of these documents may be obtained online at http://www.atec.army.mil/publications/topsindex.aspx.)

MS 20003	Indicator, Humidity, Card, Three Spot, Impregnated Areas (Cobaltous Chloride)

(Copies of this document may be obtained online at https://quicksearch.dla.mil .)

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2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of documents are those cited in the solicitation or contract.

ASTM INTERNATIONAL

ASTM A109/A109M	Steel, Strip, Carbon (0.25 Maximum Percent), Cold-Rolled
ASTM B117	Operating Salt Spray (Fog) Apparatus
ASTM D257	DC Resistance or Conductance of Insulating Materials
ASTM D880	Impact Test for Shipping Containers and Systems
ASTM D4279	Water Vapor Transmission of Shipping Containers - Constant and Cycle Methods
ASTM D6199	Quality of Wood Members for Containers and Pallets
ASTM E162	Surface Flammability of Materials Using a Radiant Heat Energy Source (Flame Spread Index)
ASTM E662	Specific Optical Density of Smoke Generated by Solid Materials (Smoke Density)
ASTM E800	Measurement of Gases Present or Generated During Fires

(Copies of these documents are available from https://www.astm.org/products-services/standards-and-publications.html9.)

SAE INTERNATIONAL

SAE AS26860	Indicator, Humidity, Plug, Color Change

(Copies are available online at https://www.sae.org .)

AMERICAN NATIONAL STANDARDS INSTITUTE

ISO/IEC 17025	General Requirements for the Competence of Testing and Calibration Laboratories

(Copies of these documents are available at www.iso.org or www.ansi.org or from the American National Standards Institute, 25West 43rd Street, 4th Floor, New York, NY 10036.)

NATIONAL CONFERENCE OF STANDARDS LABORATORIES

NCSL Z540.3	Requirement for Calibration of Measuring and Test Equipment

(Copies of these documents can be obtained online at https://www.ncsli.org or by contacting National Conference of Standards Laboratories, 2995 Wilderness Place, Suite 107, Boulder,CO 80310-5404.)

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INTERNATIONAL MARITIME ORGANIZATION (IMO)

IMDG-CODE International Maritime Dangerous Goods Code (IMDG)

(Copies of IMDG-CODE may be obtained at https://www.imo.org/Publications/IMDGCode/Pages/Default.aspx. Application for hard copies should be addressed to International Maritime Organization, 4 Albert Embankment, London SE1 7SR, England.)

UNITED NATIONS (UN)

Recommendations on the Transport of Dangerous Goods

(Copies of UN publication may be obtained at https://www.unece.org. Application for hardcopies should be addressed to United Nations Bookshop, GA-1B-103, New York, NY, 10017.)

INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA)

Dangerous Goods Regulation

(Copies of IATA publication may be obtained at https://www.iata.org/Pages/default.aspx. Application for hard copies should be addressed to International Transport Association, 2000 Peel Street, Montreal, Quebec, Canada H3A 2R4.)

INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO)

Technical Instructions for the Safe Transportation of Dangerous Goods by Air

(Copies of ICAO publication may be obtained online at https://www.icao.int/safety/dangerousgoods/pages/technical-instructions.aspx. Application for copies should be addressed to International Regulations Publishing and Distributing Organization, P.O. Box 60105, Chicago, IL 60660.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, 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.

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3. DEFINITIONS

3.1 Packaged item. Ammunition unit of issue that will be protected from physical and mechanical damage through packaging and packing.

3.2 Packaged item damage.

3.2.1 Physical damage. Damage from internal or external forces which results in breakage, denting, marring, distortion, displacement, or abrasion of the packaged item.

3.2.2 Mechanical damage. Damage resulting from any direct or indirect force which may impair the mechanical or operating function of the packaged item.

3.3 Packaging. The application or use of adequate protective measures to prevent deterioration including, as applicable, the use of appropriate cleaning procedures, preservatives, protective wrapping, cushioning, interior containers, and complete identification marking, up to, but not including, the exterior shipping container.

3.4 Pack or container. The device used to encapsulate ammunition, unit or intermediate packages, containing the ammunition unit of issue. It can be fabricated from wood, plastic, or metal and, in general, is the last handling/lifting vehicle prior to unitization or, if large enough, containing its own pallet or skids.

3.5 Pallet. A platform or base for the purpose of aiding in the handling of unitized loads by forklift trucks, slings, etc.

3.6 Unitization. Assembly of packs of one of more packaged item(s) of supply into a single load in such a manner that the load can be handled as a unit through the distribution system. Unitization (unitized loads/unit loads) encompasses consolidation in a container, placement on a pallet or load base, or securely binding together.

3.7 Marking. Application by stamping, printing, or painting of numbers, item name, national stock number, symbols, colors, etc., on containers, tags, labels, or items for identification during shipment, handling, or storage.

3.7.1 Ammunition and Explosives Palletization/Packaging Label (AEPPL) Marking. A 2D Bar Code marking used on the exterior shipping container for all ammunition and explosive items. The AEPPL is to meet the requirements per Drawing 12999545.

3.8 Level A Tactical. The degree of packaging or packing required for protection of material against the most severe conditions known or anticipated to be encountered during shipment, handling, and storage. Packaging and packing designated Level A is designed to protect material against direct exposure to all extremes of climatic, terrain, operational and transportation environments without protection other than that provided by the pack. The conditions to be considered include, but are not limited to:

(a) Multiple rough handling during transportation and in transit storage from point of origin to ultimate user.

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(b) Shock, vibration, and static loading during shipment.

(c) Deck ship loading and offshore or over-the-beach discharge to ultimate user, including transfer at sea.

(d) Environmental exposure during transit where port and warehouse facilities are limited or nonexistent.

(e) Outdoor storage in all climatic conditions for a minimum of 2 years.

(f) Static loads imposed by stacking.

(g) Special package and pack features for field combat operations (handling and utility).

(h) Special features as required by combat development agencies.

3.9 Level A Non-Tactical. For the purposes of this document, it includes those packaged items which require protection from moisture because of the detrimental effects which moisture causes even for limited periods. Due to this required protection, the item needs a sealed container but at a reduced testing level because of its non-tactical usage. This pack should meet environmental testing requirements that a packaged item would encounter during normal worldwide shipment from origin to user generally utilizing commercial vehicles for transportation and more controlled handling environment.

3.10 Level B. This packaging provides intermediate protection to packaged items under generally favorable environmental conditions of worldwide shipment, handling, and storage as defined in AR 700-15. For this standard, two Level B packs:

3.10.1 Level B maximum. This pack (e.g. training ammunition), unless otherwise specified, has the same environmental testing requirements (with the exception of test temperature) that a war reserve Level A packaged item would encounter during tactical field transportation and handling.

3.10.2 Level B standard. This pack (e.g. foreign military sales), meets environmental testing requirements that a packaged item would encounter during normal shipping generally utilizing commercial vehicles for transportation and a controlled handling environment.

3.11 Moisture Sensitive. For the purposes of this document, moisture sensitive items are those which may be reasonably expected to undergo a physical, mechanical, or chemical change when exposed to liquid water, water vapor, or other liquid or gaseous fluids.

3.12 Design Activity. For the purposes of this document, the design activity is the responsible packaging division and respective integrated product team.

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4. GENERAL REQUIREMENTS

4.1 Level A ammunition transportation, handling and storage.

4.1.1 Packaging. Service ammunition must be packaged and protected as required in AR 700-15 and AR 700-143. All packaging specified herein shall be designed so that it will function with no degradation after 20 years protected controlled storage and 2 years unprotected uncontrolled storage in all climatic conditions as prescribed in AR 70-38. The packaging must also protect the packaged items in accordance with AR 740-1 and AR 70-47 from natural and induced environments which occur during storage, transportation, and handling that the item cannot provide itself. Other requirements include but are not limited to as follows:

(a) The packaging (including dunnage) will minimize battlefield litter and signature.

(b) The packaging will not contribute to safety, health, or environmental hazards in accordance with AR 40-10 and MIL-STD-882.

(c) The packaging must provide for maximum density to reduce weight and cube and provide the most ammunition in the smallest and lightest package, at the least cost possible, consistent with weapon system or usage and protection to the packaged ammunition item.

(d) The ammunition packaging shall cause no restrictions which would preclude transportation by any type military or commercial aircraft, ship, rail, or wheeled vehicles unless specifically forbidden by regulations (e.g., 49CFR, IMDG Code, IATA, ICAO).

(e) The ammunition packaging must permit fast easy access to a clean round under all conditions, including the wearing of mission oriented protective posture gear or cold weather gear.

(f) The packaging must not contribute to the vulnerability of ammunition fires.

(g) The packaging will account for Insensitive Munitions (IM) requirements of MIL-STD-2105 to the extent practicable.

4.1.2 Unitization.

(a) The packaged ammunition must be capable of being unitized on pallets that can be handled by existing and anticipated future materials handling equipment, provide for ease of access and be unpacked without the use of any special tools or equipment. Packaged large missiles/rockets may not be applicable to unitization but must not require any special tools and/or equipment for unpacking.

(b) The packaged ammunition shall be unitized at the LAP facility in a configuration capable of being transported throughout the logistics system without reconfiguration. Generally, one dimension of the unitized load (either length or width) will not exceed 44 inches and the height, including the pallet, will not exceed 54 inches. Optimum unit load gross weight should be less than 2500 pounds. Small arms ammunition pallets can weigh up to 4000 pounds. Loaded pallets must permit 4-way entry of forklifts, have top lift capability, use of US and NATO handling devices, and be tested in accordance with MIL-STD-1660.

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(c) The unitized configuration must be designed to withstand stacking to a height of 16 feet as described in A.10. If the unitized load utilizes stacking supports between the top frame and the pallet base then the bottom container will only be required to support that load of containers which is above it to the top frame.

4.1.3 Containers.

4.1.3.1 Weight. The loaded ammunition container will be man-portable to the same extent as the bare ammunition where possible. If operational requirements preclude man-portability, then material handling features shall be provided as stated below:

(a) Any loaded container which weighs more than 75 pounds and less than 150 pounds shall be provided with lifting features (e.g., ropes, handles) for two-man carry.

(b) Any loaded container above 150 pounds should be considered to be non-portable and shall conform to the material handling requirements of MIL-STD-648.

4.1.3.2 Humidity control.

4.1.3.2.1 Pressure retention. All sealed ammunition containers shall be capable of withstanding a pressure differential of 3 psig with no apparent leakage when subjected to logistical and tactical transportation vibration and normal handling. Because of this capability, when coupled with the size of the container cover and the possibility of generating a partial vacuum, the force necessary to remove the cover may exceed those values for personnel as listed in MIL-STD-1472. In that case, a pressure relief valve must be installed on the container and meet the requirements of MIL-DTL-27166. The container must be capable of being resealed, after opening, and withstand the 3 psig pressure differential.

4.1.3.2.2 Desiccant. The use of desiccant and humidity indicating devices should be minimized for all ammunition containers. If the pressure retention requirement of 4.1.3.2.1 is met, then the use of desiccant is not generally required. If the munition item has some specialized requirement (as in the case of moisture sensitive components that require storage or field inspection), then desiccant use is required. If desiccant is necessary, easy replacement of desiccant and, depending upon container configuration, humidity monitoring is required. Desiccants shall meet the requirements of MIL-D-3464. The quantity of desiccant required to maintain a relative humidity (RH) of 40 or less shall be determined in accordance with paragraph 5.2.3.7 of MIL-STD-2073-1. Internally placed humidity indicating devices shall conform to MS 20003 and externally mounted humidity indicator devices shall conform to SAE AS26860.

4.1.3.2.3 Gasket. Any gasket used to seal the container shall be pliable and be capable of functioning at temperatures from -65 degrees F to +160 degrees F.

4.1.3.3 Container materials. Material selection should be in conformance with the requirements of 49CFR, unless a Competent Authority Approval (CAA) is obtained. The container system can be fabricated from any material, metal, non-metal (plastic, wood, fiberglass, fiber, etc.), or any combination thereof which, in conjunction with the design, will achieve the greatest possible chance of success in meeting the requirements. Porous materials (e.g., wood or fiber) can be used if water vapor proof seal and NBC survivability is not required.

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In considering any material, ultimate production cost, in addition to container performance, is a factor which should be considered. The container material must not contribute to the vulnerability of ammunition to fire and have good resistance to corrosion, petroleum, oil and lubricant products and be compatible with energetic materials.

4.1.3.3.1 Metal. The material for container hardware can be fabricated from aluminum or steel. The basic container structure could be aluminum or steel but the use of high strength low alloy steel is the preferred material because of its cost, strength to weight ratio, versatility, etc.

4.1.3.3.2 Plastic. Any plastic material selected for the containers shall have the following properties:

(a) The material shall have properties favorable to low temperature (-65 degrees F) impact strength and high temperature (+160 degrees F) creep strength and not be degraded by solar radiation, temperature shock or accelerated heat aging - environmental stress cracking.

(b) The material shall be sufficiently conductive to eliminate the hazard associated with the discharge (spark) of static electricity when a hazardous item is packed in the container. In lieu of specific data, the use of anti-static agent shall make the material sufficiently conductive so that the material has a volume resistivity below 10^{10} ohms-cm, at +72 degrees F, and 15% relative humidity. The use of this value does not negate the intent which is to eliminate any potential hazard associated with the discharge of the spark. The government reserves the right to have any test conducted which would prove conclusively that a hazard does not exist or the container contractor can forward data which will show that the energy required to ignite the hazardous item is more than the energy which can be produced by the container.

(c) The container material shall have a flame spread index of 25 or less when tested in accordance with ASTM E162 and a smoke density of 200 or less when tested in accordance with ASTM E662. The container material shall be free of significant toxic by-products when tested in accordance with ASTM-E800.

(d) The container will exhibit a water vapor transmission rate of less than .001 grams/100 sq. in. /24 hours if specified by the design activity.

4.1.3.3.3 Nuclear, biological, chemical (NBC) survivability. Containers used to package mission - essential items that may encounter an NBC environment shall be designed of materials that meet the following criteria.

(a) Selection of materials used in the construction, fabrication, and painting of containers shall be chemical agent decontaminable to acceptable levels as specified in the U.S. Army Nuclear and Combating WMD Agency (USANCA) criteria and AR 70-75 when tested in accordance with TOP 08-2-111. NOTE: The USANCA criteria and any questions pertaining therein may be addressed to USANCA, 5915 16th Street, Building 238, Fort Belvoir, VA 22060.

(b) For materials that do not meet the USANCA criteria, a Chemical Agent Resistant Coating (CARC) may be applied in accordance with MIL-DTL-53072 as required.

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(c) Container design shall be such that overall configuration will minimize contamination of NBC agents and facilitate effective decontamination to the maximum possible extent in view of the container's specific cost and functional restrictions imposed.

4.1.3.4 Security seal. All containers shall be designed such that a security seal may be applied to the container to detect unauthorized entry.

4.1.3.5 Interlock. Any container which may exhibit instability in the palletized mode (i.e. containers circular in cross section) shall incorporate interlocking features to connect each container in at least two axis.

4.1.3.6 Re-usability. The container shall be re-usable, may be repairable, and will be recoverable in peacetime but expendable under hostile conditions (except for large containers such as those used for missiles/rockets/bulk ammunition etc.).

4.1.3.7 Pallets. There are some munition items (such as 155mm projectiles) which are sealed and do not require a container for moisture protection. These items can be shipped on a wood pallet (MIL-DTL-45449) or a pallet fabricated from any other material provided that it can pass the environmental test for the load weight category. Under these circumstances the test plan has to be modified to eliminate the pressure retention test.

4.1.3.8 Markings.

4.1.3.8.1 Container/Identification Marking. All containers shall be designed such that they may be legibly and durably marked per the requirements of MIL-STD-129.

4.1.3.8.2 Performance oriented packaging (POP) Markings. POP markings shall be applied to the exterior pack only when the packaged items is identified as a hazardous material. When the container passes the POP tests as stated in 5.1.7 then POP markings shall be applied to the exterior container. The POP marking shall be as specified in Code of Federal Regulation Title 49.

4.2 Level B ammunition transportation, handling and storage.

4.2.1 Packaging. The packaging shall meet the requirements for Level B packs as defined in this document, AR 700-15 and the appropriate sections of Code of Federal Regulations, Title 49 (49CFR), and Performance Oriented Packaging in accordance with Code of Federal Regulations Title 49 and also meet or exceed the following minimum design and test requirements:

(a) All packaging materials that come in contact with energetic materials must be compatible with the energetic materials. Container material test requirements in accordance with this standard shall be met except that high and low temperatures shall be as specified herein for Level B pack.

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(b) Each item shall be encapsulated in a unit package, to include wrapping and cushioning as necessary, in such a manner that it will afford the required protection against physical and environmental damage during shipment, handling, and storage. The unit package shall meet the design requirements of MIL-STD-2073-1. Sets, kits, assemblies or packaged items consisting of more than one part shall be individually unit packaged. Contents shall be suitably segregated and identified within the unit pack. Each set, kit or assembly shall include a list of contents.

(c) A multiple quantity of unit or intermediate packages, bearing the same stock number, shall be placed in a close-fitting container conforming to federal or military specifications. The exterior pack shall meet MIL-P-116 requirements for the method utilized and meet the design requirements of MIL-STD-2073-1. An exterior pack (container) containing packaged items, either a) not exceeding a gross weightof 150 pounds or b) exceeding 150 pounds, shall sustain the applicable environmental tests, specified for Level B Maximum or Level B Standard cited in Table I or II. (NOTE: Rough handling tests specified in MIL-P-116 or MIL-STD-2073-1 do not apply.) A unit or intermediate package that meet all common carrier rules, sustain the tests specified in this paragraph and provide safe delivery to the final destination need not be packed into an exterior container, then the unit or intermediate package becomes the exterior pack.

4.2.2 Unitization. Unitization shall be required when quantities per destination makes unitization costs effective. A quantity of items packed for shipment shall be placed on pallets conforming to the federal or military specifications in accordance with MIL-STD-2073-1. The load shall be secured to the pallet by any means that will ensure safe delivery to destination and not contribute to the deterioration of the exterior pack or its contents.

4.2.3 Markings. In addition to any special marking required by the contract or purchasing order, all unit packages, intermediate packages, and exterior shipping containers shall be legibly and durably marked in accordance with MIL-STD-129 and 49CFR, if a hazardous material. AEPPL is required and shall be applied in accordance with MIL-STD-129.

4.2.4 Performance oriented packaging (POP) markings. POP markings shall be applied to the exterior pack only when the packaged item is identified as a hazardous material. When the container passes the POP tests as stated in 5.1.7 then POP markings shall be applied to the exterior container. POP marking shall be as specified in Code of Federal Regulations Title 49.

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4.3. General Test Description

4.3.1 Vibration and handling tests. These tests consist of subjecting packaged ammunition to transportation, storage, and handling tests at specified temperatures to determine the adequacy of the pack to protect the ammunition and to ensure its operation and safety.

4.3.1.1 Vibration. The vibration tests are meant to simulate three types of field environments.

4.3.1.1.1 Secured cargo vibration. This test is a random vibration test used to simulate the environment encountered when packaged ammunitionis transported in a "tied-down" condition carried in representative tactical wheeled and tracked vehicles from the port staging area to the using unit and in, when appropriate, the specific fightingtactical vehicle (FTV).

4.3.1.1.2 Loose cargo vibration. This test is used to determine survivability when packaged ammunition is transported over rough roads in an unrestrained condition.

4.3.1.1.3 Rack vibration. When ammunition in its packaging configuration is placed in racks in the FTV, this test is performed to simulate the random vibration that the packaged configuration will experience.

4.3.1.2 Free fall drops. The freefall drop tests are used during the development of ammunition packaging to determine the adequacy of the package and the protection provided to the ammunition following accidental drops.

4.3.1.2.1 Three foot drop. This test simulates accidental free fall drops of packaged ammunition during storage, maintenance, transportation and/or handling. The tests are conducted on the packages of de-palletized ammunition weighing 150 pounds or less.

4.3.1.2.2 Seven foot drop. This test simulates free fall drops of packaged ammunition from a truck or a hovering helicopter dropping packaged ammunition from a sling and is normally conducted on packages of de-palletized ammunition weighing 150 pounds or less. However, tests on unitized packaged ammunition shall be conducted if this mode of tactical shipment is anticipated.

4.3.1.2.3 Forty foot drop. This test simulates accidental free fall drops during ship loading/unloading operations, and is normally performed on de-palletized packaged ammunition. NOTE: The destructive nature of this test and the quantities of ammunition items required to perform this test usually precludes conducting this test in the unitized configuration.

4.3.1.3 Edgewise-cornerwise-rollover. These tests simulate accidental drops of large (over 150 pounds) loaded containers during receipt, storage, maintenance, or issue operations.

4.3.1.4 Hoisting. This test simulates the mechanical handling of a loaded container through the use of appropriate slings utilizing the container lifting provisions.

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4.3.1.4.1 Sudden lift. This test is primarily designed for 155MM projectile palletsin order to determine the ability of the pallet cover and restraining components to withstand a sudden force when the pallet drops while being hoisted.

4.3.1.5 Tiedown. This test simulates the restraining of a loaded container applied through the container tiedown provisions.

4.3.1.6 Forklift. This test simulates the ability of a loaded container to withstand handling by mechanical handling equipment (forklift truck).

4.3.1.7 Stacking. This test simulates the stacking of similar containers to a height of 16 feet in a storage environment.

4.3.2 End impact. The end impact test is intended to determine the ability of large (over 150 pounds) containers and unitized loads to resist impacts, such as severe railcar humping, and for determining the ability of the packaging to provide protection to the ammunition.

4.3.3 Humidity control.

4.3.3.1 Pressure retention. The pressure retention test is used to determine the ability of the container to prevent the entrance of moisture and NBC contaminants or loss of packaged item volatiles after normal logistical and tactical transportation/handling, during extreme storage conditions, and air delivery. It is to be decided by the design activity if a water vapor proof seal and NBC survivability is required.

4.3.3.2 Desiccant (Humidity). This test is conducted to determine the ability of a properly desiccated container to maintain the humidity within the container to an acceptable level.

4.3.4 Container material. The container material tests are conducted to determine the ability of the container to survive the various environments, both natural and induced, which can be expected to occur throughout worldwide deployment of ammunition containers. Obviously, all environments are not included but only those which are expected to have an impact on the containers. Those material tests which are non-destructive should be conducted first (before physical type tests) because (a) if the material is affected there is no point in continuing the tests and (b) the effect of the material tests on the container may surface after the same container is then subjected to the physical tests.

4.3.4.1 Solar radiation. This test is conducted to determine the effects of solar radiation (ultraviolet) on containers that may be exposed to sunshine during operation or unsheltered storage on the earth’s surface or in the lower atmosphere.

4.3.4.2 Temperature shock. Temperature shock tests are conducted to determine if material can withstand sudden changes in the temperature of the surrounding atmosphere without experiencing physical damage or deterioration in performance.

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4.3.4.3 High temperature. The high temperature tests are performed to determine if material can be stored and operated under hot climate conditions without experiencing physical damage or deterioration in performance.

4.3.4.4 Chemical resistance. These tests are conducted to determine if various fluids used in transportation, material handling, and tactical vehicles which through carelessness or accident can come in contact with the container and have a detrimental effect on the material.

4.3.4.5 Container burning characteristics. The container burning characteristics tests are applicable to containers and pallets (if used as exterior packs) when used to carry ammunition and are intended to determine the fire resistance characteristics against fire originating from sources outside the container. It is the intent of this requirement to indicate package performance during the test but not necessarily to require suitability of the ammunition or container for use after fire exposure.

4.3.4.6 Water vapor transmissibility. This test is used to determine the ability of the container to prevent moisture from entering through the container.

4.3.4.7 Electrical conductivity. This test is used to determine if, as a result of a material being a non-conductor, a static electric charge can be generated which could produce a potentially hazardous condition upon discharge.

4.3.4.8 Compatibility. These tests are conducted to determine the compatibility of any material that comes in contact with energetic materials.

4.3.4.9 Corrosion resistance (salt spray). This test is conducted to determine the capability of the container material and protective finish to resist corrosion.

4.3.4.10 Accelerated heat aging - Environmental stress cracking (AHA-ESC). This test determines the susceptibility of polyethylene plastic containers (see NOTE) or parts to fail prematurely by environmental stress cracking and heat aging at stresses far below normal design stresses and at times far shorter than expected.

NOTE: This test is designed primarily for polyethylene. Other plastic materials such as ABS, polystyrene, nylon, PBT and PET polyesters, polypropylene, PPO Noryl, polycarbonate, including alloys and glass-reinforced grades and any combination thereof, can stress crack due to “heat aging” and “coming in contact with various solvents and/or reagents”. These and other plastic materials should be tested using the solvent(s) and/or the reagent(s) the material is sensitive to in place of Igepal (CO-630, see 30 of Appendix C).

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5 DETAILED REQUIREMENTS

5.1 Container testing - Level A ammunition packaging.

5.1.1 Purpose. The purpose of container testing is to determine the ability of the container to protect the ammunition against the adverse effects of normal and abnormal logistical and tactical transportation and handling conditions. Many of the following tests may be conducted singularly; however, the vibration-handling tests shall be performed in the sequence shown in Figures 1, 2 and 3 because the information obtained at a particular point in the test sequence may reveal survivability at a point in the logistic chain and because some of the tests may be destructive and prevent further testing. It is intended that the tests will serve for engineering investigation, design evaluation, design margin determination, or quality control dependent upon the specific technical need. The test procedures cover a wide range of environments and constitute a general criteria for evaluation of the packaging to ensure end item reliability. The tests in this section should be performed only on packaged ammunition requiring a Level A packaging classification.

5.1.2 Background. The type of container (pack) used to protect ammunition is a function of the protection required by the ammunition. Because of the cost and weight consideration, the package should provide only that protection necessary to meet Level A requirements. If as a result of some unique operational requirements, a container is designed which has properties or performs a function that is different from that normally specified for Level A requirements, then the tests required to prove the unique operational requirements should supplement the tests listed below. The packaging engineer should select all those tests which will adequately determine the ability of the container to protect the item based upon the design of the container (including unique operational requirements) and the logistical and tactical environment expected.

5.1.3 Temperature range. In general, all containers must protect the packaged item(s) and survive the transportation and handling environment at temperature range from +160 degrees F to -65 degrees F. Testing will be conducted in these temperature ranges, as specified, except when it is indicated that the packaged item(s) will be adversely affected by these temperature extremes. In those instances, the test temperature shall be adjusted when the packaged items are used for container testing.

5.1.4 Test conditions. All tests, unless otherwise specified, shall be performed at three temperatures (-65 degrees F, ambient (+72 degrees), and +160 degrees F). Three foot drop (see 5.1.5.1.4), loose cargo (see 5.1.5.1.5), seven foot drop (see 5.1.5.1.6), and rack vibration (see 5.1.5.1.7) tests may be performed at the operational temperature extremes for the item(s) being packaged. Ambient temperature tests should be conducted first in order to evaluate container performance under a “less severe” environment. Low and high temperature tests should be conducted after ambient temperature tests. Live or inert ammunition (equivalent mass and configuration) should be tested, as applicable, in the exterior pack (unit of issue). Live ammunition will be used to the maximum extent possible and is required for some tests. If, for safety reasons, a full load of explosive is deemed unacceptable, then live primers, fuzes or other explosive components can be used instead of the full-up explosive round and provision must be made to determine if initiation took place during the test. All tested containers must have a full “load” (inert plus live) to bring the tested weight up to the tactical loads. A container requiring more live ammunition than available for the full load will have the live ammunition located (within the

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exterior pack) to produce test results equivalent to the expected results as if the entire load was live. These tests can be modified as the situation requires, but containers should be packed, sealed, and tested as near to the shipping configuration as possible. When the test item contains explosive materials or components, the test must be performed with proper safeguards established for personnel and equipment. Safety procedures and equipment consistent with the hazard level involved must be utilized to provide adequate protection in case of explosion at any point in the performance of the test. These requirements apply to every test in this document when the test item contains explosive components or materials. At the conclusion of each test the acceptance criteria of Section 5.3 will apply, as stated. It is obvious that some acceptance criteria will have to be subjective and will rely upon the packaging engineer to determine if the container performed satisfactorily. Once the container tests begin no major repair, re-torque, or any modification to the container will be allowed without repeating the entire test. If the container does not pass any test without modification or rework, it can be considered a failure in its present configuration and consideration should be given to stopping the tests and/or redesigning the container.

5.1.5 Sequential testing of Level A tactical containers.

5.1.5.1 Exterior containers under 150 pounds. For loaded exterior containers under 150 pounds, the sequence (see Figure 1) and tests shall be performed as stated below. Unless otherwise specified, six loaded containers will constitute a test sample at each of three temperatures, for a total requirement of 18 containers. If the exterior container requires more than six packaged items (live and inert) or the total number of items to load the required eighteen containers are not available or too costly, then the quantity of loaded containers required for testing can be reduced to a total of six. When using six containers, the tests shall be as described below except that the six orientations of the seven foot drops shall be reduced to two orientations, each different, per temperature. This will provide for a total of six different orientations of the seven foot drops over 3 temperatures. After the above tests are conducted on a total of 18 or 6 loaded containers as applicable, an additional six loaded untested containers are also required for the 40 foot drop test. The stacking or four foot drops required to meet POP requirements (see 5.1.7) need not be performed if the container passes the previous conducted stacking and seven foot drops. The loose cargo vibration conducted as part of the vibration/handling tests (see Figure 1) partially satisfies the loose cargo vibration environment for POP. To fully satisfy this requirement, an additional 30 minutes at a temperature of +72 degrees F, unless otherwise specified, with inputs as specified in 49CFR (see 5.1.7), shall be conducted at the conclusion of all vibration/handling tests.

5.1.5.1.1 Pressure retention test. Six (or two) containers shall be subjected to the pressure retention test (see 5.3.6). When the test procedures of 5.1.5.1.2, 5.1.5.1.3, 5.1.5.1.4, 5.1.5.1.5, and 5.1.5.1.6 are conducted at the specified temperatures (see 5.1.4), the pressure retention test shall be performed at the conclusion of each procedure as indicated in Figure 1 at ambient temperature. The intent is to assist the packaging engineer to determine the capability of the container to retain pressure without the detrimental effects of extreme temperatures causing pressure fluctuations inside the container while trying to read or record a pressure gauge or electronic sensor (meter). For acceptance criteria, see 5.3.6.1and 5.3.6.2.

5.1.5.1.2 Stacking test. At least one container shall be subjected to the stacking test (see A.2.10). For acceptance criteria, see 5.3.7.1.

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5.1.5.1.3 Secured vibration test. Six (or two) containers shall be subjected to the secured vibration test (see A.2.3) in three axes. For acceptance criteria, see 5.3.1, 5.3.3 and 5.3.4.

5.1.5.1.4 Three-foot drop test. Six (or two) containers shall be subjected to the three-foot drop test (see A.2.4) in the all six different orientations. For acceptance criteria, see 5.3.1, 5.3.3 and 5.3.4.

5.1.5.1.5 Loose cargo test. Six (or two) containers shall be subjected to the loose cargo test (see A.2.13) in the vertical plane and in the horizontal plane, +90 degrees from the vertical plane. For acceptance criteria, see 5.3.1, 5.3.3 and 5.3.4.

5.1.5.1.6 Seven-foot drop test. Six (or two) containers shall be subjected to the seven-foot drop test (see A.2.4). Each container shall be dropped only once. Each orientation shall have one of the six containers dropped in that orientation. If two containers are tested, the orientation used is as specified in 5.1.5.1. For acceptance criteria, see 5.3.1, 5.3.3 and 5.3.4.

5.1.5.1.7 Rack vibration test. Six (or two) containers shall be subjected to the rack vibration test (see Appendix C) in three axes. For acceptance criteria, see 5.3.1, 5.3.3 and 5.3.4.

5.1.5.1.8 Forty-foot drop test. The forty-foot drop test (see A.2.12.1) shall be performed on untested containers with live ammunition. The quantity of containers is to be determined by coordinating with the proper Systems Safety Office prior to testing. For acceptance criteria, see 5.3.1 and 5.3.2.

5.1.5.1.9 Desiccant (humidity) test. Two containers shall be subjected to the desiccant (humidity) test (see A.2.26). For acceptance criteria, see 5.3.9. This test can be conducted on any container (preferably untested) that maintains a 3 psi seal.

5.1.5.2 Exterior containers over 150 pounds. For loaded exterior containers over 150 pounds, the sequence (see Figure 2) and tests shall be performed as stated below. Unless otherwise specified, one container will constitute a test sample at each of three temperatures, for a total requirement of three containers for all tests except the forty-foot drop. Additional container(s) will be required for the forty foot drop test, to be conducted at ambient or at temperature extremes depending on whether or not the container material is temperature dependent. The container quantities and temperatures are to be determined by coordinating with the proper Systems Safety Office. To meet POP requirements, the POP stacking test need not be done if previously conducted stacking test passed, however, see 5.1.8.2 for information relative to the four foot drop test and 5.1.5.1 for additional 30 minutes of loose cargo vibration. NOTE: POP tests only apply to containers weighing less than 882 pounds.

5.1.5.2.1 Pressure retention test. Each of the three containers shall be subjected to the pressure retention test (see A.2.2). For acceptance criteria, see 5.3.6.1 and 5.3.6.3.

5.1.5.2.2 Stacking test. One container shall be subjected to the stacking test (see A.2.10). For acceptance criteria, see 5.3.7.2.

5.1.5.2.3 Hoisting test. One container shall be subjected to the hoisting test (see A.2.11). For acceptance criteria, see 5.3.4.b and 5.3.4.f.

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5.1.5.2.3.1 Sudden lift test. One pallet (used for 155mm projectiles) shall be subjectedto the sudden lift test (see A.2.11.1). For acceptance criteria, see 5.3.4.d, 5.3.4.e and 5.3.5.

5.1.5.2.4 Secured vibration test. One container shall be subjected to the secured vibration test (see A.2.3) in three axes. For acceptance criteria, see 5.3.1, 5.3.3 and 5.3.4.

5.1.5.2.5 Loose cargo test. One container shall be subjected to the loose cargo test (see A.2.13) inthe vertical plane only. For acceptance criteria, see 5.3.1, 5.3.3 and 5.3.4.

5.1.5.2.6 Edgewise-cornerwise-rollover test. One container shall be subjected to the edgewise drop test (see A.2.5), cornerwise drop test (see A.2.6), and rollover test (see A.2.7). For acceptance criteria, see 5.3.1, 5.3.3 and 5.3.4.

5.1.5.2.7 End impact test. One container shall be subjected to the pendulum impact test (see A.2.8). For acceptance criteria, see 5.3.1, 5.3.3 and 5.3.4.

5.1.5.2.8 Tiedown test. One container shall be subjected to the tiedown test (see A.2.14). For acceptance criteria, see 5.3.4.b and 5.3.4.f.

5.1.5.2.9 Forty-foot drop test. Container(s), to be determined by the Systems Safety Office, shallbe subjected to the forty-foot drop test (see A.2.12.2). For acceptance criteria, see 5.3.2.

5.1.5.2.10 Forklift. One container shall be subjected to the forklift test (see A.2.9). For acceptance criteria, see 5.3.4.d.

5.1.5.2.11 Desiccant (humidity) test. This is the same test as specified in 5.1.5.1.9.

5.1.6 Container material tests. Unless otherwise specified by the packaging engineer, any of the following tests will be performed when it is deemed necessary for those container materials which may be affected. As an example, there is no reason to conduct the solar radiation test on a steel container because steel will not be affected. However, the effect of solar radiation on non-metallic materials (e.g., plastic) may be significant. In general, all plastic containers must be subjected to these tests unless it is known beforehand that the container material will pass. The material tests (see 5.1.6.1, 5.1.6.2, 5.1.6.3) which are non-destructive shall be performed first on those containers which will subsequently be used for the physical tests. For those containers that carry loads under 150 pounds (see 5.1.5.1), two containers of those scheduled for the physical tests are required for each material test. Six containers will be tested, one material test for two containers. At the conclusion of these tests, the containers will be distributed among those required for the physical tests so that the two containers subjected to the same material tests will be subsequently tested at a different temperature. Distribution of the containers shall be such that no more than one container from each tested pair shall be tested at each temperature. For those containers that carry loads over 150 pounds (see 5.1.5.2), each of the three containers to be used for the physical tests will be subjected to one of the above mentioned material tests. This will ensure that each container will be subjected to at least one material test prior to the physical tests. The remaining material tests (5.1.6.4 through 5.1.6.10) can be conducted on any available container or material (if the material alone can meet the test requirements), provided that the test does not preclude the use of thecontainer for subsequent tests.

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5.1.6.1 Solar radiation test. One or two containers, as applicable, see 5.1.6, shall be subjected to the solar radiation test (see A.2.15). For acceptance criteria, see 5.3.4 and 5.3.10.

5.1.6.2 Temperature shock test. One or two containers, as applicable, see 5.1.6, shall be subjectedto the temperature shock test (see A.2.16). For acceptance criteria, see 5.3.4 and 5.3.10.

5.1.6.3 High temperature test. One or two containers, as applicable, see 5.1.6, shall be subjected to the high temperature test (see A.2.17). For acceptance criteria, see 5.3.4 and 5.3.10.

5.1.6.4 Chemical resistance test. One or two containers (or material), as applicable, see 5.1.6, shall be subjected to the chemical resistance test (see A.2.18). For acceptance criteria, see 5.3.4, 5.3.8.4 and 5.3.10.

5.1.6.5 Container burning characteristics test. One or two containers (or material), as applicable, see 5.1.6, shall be subject to the burning characteristics test (see A.2.19). For acceptance criteria, see 5.3.8.2.

5.1.6.6 Water vapor transmissibility test. One or two containers, as applicable, see 5.1.6, shall be subject to the water vapor transmissibility test (see A.2.20). For acceptance criteria, see 5.3.8.1.

5.1.6.7 Electrical conductivity test. One container (or material) shall be subjected to the electricalconductivity test (see A.2.21). For acceptance criteria, see 5.3.8.3.

5.1.6.8 Compatibility test. Any packaging materials, protective finish coatings, volatile corrosioninhibitor (VCI) materials, etc., used in the fabrication of containers or dunnage which can come into contact with the hazardous material shall be subject to these tests unless it is known that there is no compatibility problem.

5.1.6.8.1 Reactivity test (non-volatile packaging materials). When non-volatile packaging materials are used for packaging, a reactivity test (see A.2.22) shall be conducted. For acceptance criteria, see 5.3.8.5.

5.1.6.8.2 Reactivity test (volatile packaging materials). When volatile packaging materials, such as VCI coated material, are used for packaging, a reactivity test (see A.2.23) shall be conducted. For acceptance criteria, see 5.3.8.6.

5.1.6.8.3 Vacuum stability test (non-volatile packaging materials). When non-volatile packagingmaterials are used for packaging, a vacuum stability test (see A.2.24) shall be conducted. For acceptance criteria, see 5.3.8.7.

5.1.6.8.4 Vacuum stability test (volatile packaging materials). When volatile packaging materialsare used for packaging, a vacuum stability test (see A.2.25) shall be conducted. For acceptance criteria, see 5.3.8.8.

5.1.6.9 Corrosion resistance (salt spray) test. One or two containers, as applicable (see 5.1.6), shall be subjected to the corrosion resistance test (see A.2.27). For acceptance criteria, see 5.3.8.9.

5.1.6.10 Accelerated heat aging - Environmental stress cracking (AHA-ESC) test. The test specimens (containers/components/material tensile-bars, as applicable) shall be subjected to the AHA-ESC test (see A.2.28). For acceptance criteria, see 5.3.11.

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5.1.7 Performance Oriented Packaging (POP) tests. In order to ship Class I hazardous material domestically and internationally, the packaged items must meet the criteria specified in both the Code of Federal Regulations Title 49 and UN Recommendations for Transport of Dangerous Goods. If the tests previously conducted to qualify the container are the same or more severe and meet the pass criteria for those tests specified in the Code of Federal Regulations Title 49 (49CFR), then no separate tests are required for the 49CFR tests. If not, then the tests must be conducted and the container meet the pass criteria as stated in the 49CFR. If a container is approved via alternate testing, the DOT must be petitioned to approve the alternate tests. Container designs which differ from the packaging type specified under DOT or UN regulations can be used provided they are proved equivalent by testing and are acceptable to the competent authority. NOTE: POP testing discussed in this standard applies to solid Class I hazardous materials only since most ammunition is classified as solid. If however, the ammunition is classified as a liquid (e.g., liquid propellant), additional tests as delineated in 49CFR must be conducted.

5.1.8 Sequential testing for Level A Non-tactical. The Level A non-tactical tests are based upon a different criteria because the environment to which the container will be subjected is less severe. The procedures for performing the tests will be as specified previously except that the test temperatures will be -30 degrees F, +72 degrees F and +145 degrees F. The criteria for passing the tests are the same as that used for Level A tactical packs for similar tests.

5.1.8.1 Packs 150 pounds and under. The tests (Figure 3) shall be performed sequentially on each packaged container. Six containers shall be considered a test sample with two loaded containers tested at each of the three temperatures. Additionally, four-foot drop and loose cargo vibration tests are conducted to meet the requirements for Performance Oriented Packaging (POP) (see 5.1.7) for Class I hazardous material and shall be tested at ambient temperature (+72 degrees F) unless otherwise specified. However, the POP stacking test need not be done if previously conducted stacking test passed. NOTE: For economy reasons, the POP four foot drops and loose cargo vibration are conducted as follow-on tests to the vibration/handling tests. POP testing requires that only one four foot drop be conducted per virgin container. If after any four foot drop any container fails to meet the acceptance criteria, a new container must be subjected to a single drop at the failed drop orientation. Additional untested containers will be required for the 40 foot drop test. Container quantity for the forty-foot drop tests to be determined by coordinating with the proper Systems Safety Office.

5.1.8.2 Packs over 150 pounds. The tests (Figure 3) shall be performed sequentially on each packaged container. Unless otherwise specified, one loaded container will constitute a test sample at each of the three temperatures for a total of three containers. Additionally, four foot drop and loose cargo vibration tests are conducted to meet the requirements for Performance Oriented Packaging (POP) (see 5.1.7) for Class I hazardous material and shall be tested at ambient temperature (+72 degrees F) unless otherwise specified. However, the POP stacking test need not be done if previously conducted stacking test passed. NOTE: POP tests only apply to containers weighing less than 882 pounds. Also for economy reasons, the POP four foot drops and loose cargo vibration are conducted as follow-on tests to the vibration/handling tests. POP testing requires that only one four foot drop be conducted per virgin container. If after any four foot drop any container fails to meet the acceptance criteria, a new container must be subjected to a single drop at the failed drop orientation. After the above tests are completed, additional container(s) will be required for the forty foot drop test, to be conducted at ambient or at temperature extremes depending on whether or not the container material is temperature dependent. The container quantities and temperatures are to be determined by coordinating with the proper Systems Safety Office.

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LEVEL A TACTICAL TEST PROCEDURES/SEQUENCE – Notes 1 & 2

PRESSURE RETENTION TEST - A.2.2, 5.3.6 (NOTE 3)
STACKING TEST - A.2.10 (NOTE 3)
PRESSURE RETENTION TEST - A.2.2, 5.3.6 (NOTE 3)
VIBRATION (SECURED) TEST - A.2.3 6 CONTAINERS IN 3 AXIS
PRESSURE RETENTION TEST - A.2.2, 5.3.6 (NOTE 3)
THREE FOOT DROP TEST - A.2.4 6 CONTAINERS (NOTE 4)
PRESSURE RETENTION TEST - A.2.2, 5.3.6 (NOTES 3, 5)
HORIZONTAL LOOSE CARGO TEST - A.2.13 6 CONTAINERS
VERTICAL LOOSE CARGO TEST - A.2.13 6 CONTAINERS
PRESSURE RETENTION TEST - A.2.2, 5.3.6 (NOTE 3, 5)
SEVEN FOOT DROP TEST - A.2.4 6 CONTAINERS - ONE DROP PER CONTAINER (NOTE 4)
PRESSURE RETENTION TEST - A.2.2, 5.3.6 (NOTES 3, 6)
VIBRATION (RACK) (NOTE 7)
POP TEST - 5.1.5.1, 5.1.7 (NOTE 3)

FIGURE 1. Level A transportation vibration/handling test (for exterior packs 150 pounds or less)

NOTES:
1. These tests are normally conducted at each of the three temperatures, -65 degrees F, ambient (72 degrees F), and +160 degrees F, thus requiring 18 total exterior packs for a complete test program (see 5.1.5.1).
2. Three-foot drop (A.2.4), loose cargo vibration (A.2.13), seven-foot drop (A.2.4), and, if necessary, rack vibration (Appendix C) tests may be performed at the operational temperature extremes for the item being packaged.
3. Pressure retention (A.2.2), stacking (A.2.10), and POP (5.1.7) tests, as applicable, should beconducted at ambient temperature unless otherwise specified.
4. For package orientation see Figure 4.

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5. For non-moisture sensitive items, the pressure retention test (A.2.2) following three-foot drop (A.2.4) and loose cargo vibration (A.2.13) tests shall be conducted for information only.
6. Pressure retention test (A.2.2) shall be conducted for information only following seven-foot drop (A.2.4) regardless of whether the item is determined to be moisture sensitive or not.
7. If the ammunition in the packaged configuration is transported in the fighting tactical vehicle, conduct appropriate rack vibration tests in accordance with Appendix C. Pressure retention test (A.2.2) shall be conducted for information only on containers thatpass following seven-foot drop.

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LEVEL A TACTICAL TEST PROCEDURE/SEQUENCE – Note 1

PRESSURE RETENTION TEST - A.2.2, 5.3.6 (NOTE 2)
STACKING TEST - A.2.10 (NOTE 2)
PRESSURE RETENTION TEST - A.2.2, 5.3.6 (NOTE 2)
VIBRATION TEST A.2.3 1 CONTAINER - 3 AXIS
PRESSURE RETENTION TEST - A.2.2, 5.3.6 (NOTE 2)
LOOSE CARGO TEST - A.2.13 1 CONTAINER - 1 AXIS
PRESSURE RETENTION TEST - A.2.2, 5.3.6 (NOTE 2)
EDGEWISE DROP TEST - A.2.5 1 CONTAINER (NOTE 3)
CORNERWISE DROP TEST - A.2.6 1 CONTAINER (NOTE 3)
ROLLOVER TEST - A.2.7 1 CONTAINER
PRESSURE RETENTION TEST - A.2.2, 5.3.6 (NOTE 2)
PENDULUM IMPACT TEST - A.2.8 1 CONTAINER
PRESSURE RETENTION TEST - A.2.2, 5.3.6 (NOTE 2)
HOISTING TEST - A.2.11 (NOTE 2)
PRESSURE RETENTION TEST - A.2.2, 5.3.6 (NOTE 2)
TIEDOWN TEST - A.2.14 (NOTE 2)
PRESSURE RETENTION TEST - A.2.2, 5.3.6 (NOTE 2)
FORKLIFT TEST - A.2.9 (NOTE 2)
POP TEST - 5.1.5.2, 5.1.7 (NOTES 2, 4)

FIGURE 2. Level A transportation vibration/handling test (for exterior packs 150 pounds or more)

NOTES:
1. These tests are normally conducted at each of three temperatures, -65 degrees F, ambient, and +160 degrees F, thus requiring 3 containers for complete test program (see 5.1.6.2).
2. This test is conducted at ambient temperature only unless otherwise specified.
3. For container orientation see Figure 5 or 6 as applicable.
4. Four foot drop and additional 30 minutes of loose cargo vibration tests shall be performed in accordance with 49CFR to meet POP requirements.

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LEVEL A NON-TACTICAL TEST PROCEDURES/SEQUENCE

FOR EXTERIOR PACKS 150 POUNDS OR LESS (Note 4)	FOR EXTERIOR PACKS 150 POUNDS OR MORE (Note 4)
PRESSURE RETENTION TEST - A.2.2, 5.3.6 (NOTE 7)	PRESSURE RETENTION TEST - A.2.2, 5.3.6 (NOTE 7)
STACKING TEST - A.2.10 (NOTE 7)	STACKING TEST - A.2.10 (NOTE 7)
PRESSURE RETENTION TEST - A.2.2, 5.3.6 (NOTE 7)	PRESSURE RETENTION TEST - A.2.2, 5.3.6 (NOTE 7)
VIBRATION (SECURED) TEST - A.2.3.1 (NOTES 1, 2)	VIBRATION (SECURED) TEST - A.2.3.1 (NOTES 1, 2)
PRESSURE RETENTION TEST - A.2.2, 5.3.6 (NOTE 7)	PRESSURE RETENTION TEST - A.2.2, 5.3.6 (NOTE 7)
THREE FOOT DROP TEST - A.2.4 (NOTE 5)	EDGEWISE DROP TEST - A.2.5
PRESSURE RETENTION TEST - A.2.2, 5.3.6 (NOTES 7, 8)	CORNERWISE DROP TEST - A.2.6
POP TEST - 5.1.7 (NOTES 3, 6, 7)	PRESSURE RETENTION TEST - A.2.2, 5.3.6 (NOTE 7)
	PENDULUM IMPACT TEST - A.2.8
	PRESSURE RETENTION TEST - A.2.2, 5.3.6 (NOTE 7)
	HOISTING - A.2.11 (NOTE 7)
	PRESSURE RETENTION TEST - A.2.2, 5.3.6 (NOTE 7)
	TIEDOWN - A.2.14 (NOTE 7)
	PRESSURE RETENTION TEST - A.2.2, 5.3.6 (NOTE 7)
	FORKLIFT - A.2.9 (NOTE 7)
	POP TEST - 5.1.7 (NOTES 3, 6, 7)
FORTY FOOT DROP TEST - A.2.12.1	FORTY FOOT DROP TEST - A.2.12.2

FIGURE 3. Level A non-tactical transportation vibration/handling test

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NOTES:

1. Perform test levels and conditions specified for Basic transportations, common carrier environment, vertical axis 514.3-1, longitudinal axis 514.3-2, and transverse axis 514.3-3.
2. Time per axis – 2 hours.
3. Four foot drop and loose cargo vibration tests shall be performed in accordance with 49CFR to meet POP requirements.
4. Unless otherwise specified, conduct tests at temperature of -30 degrees F, 72 degrees F, and +145 degrees F. For container quantities see 5.1.8.1 or 5.1.8.2 as applicable.
5. Perform 3-foot drop tests in accordance with A.2.4 except 7-foot drop test is not required.
6. Pressure retention test, A.2.2, shall be conducted for information only.
7. This test is conducted at ambient temperature only unless otherwise specified.
8. For non-moisture sensitive items the pressure retention test (A.2.2) following three-foot drop (A.2.4) test shall be conducted for information only.

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5.2 Container testing - Level B ammunition packaging.

5.2.1 Purpose. The purpose of container testing for Level B ammunition packaging is to determine the ability of the container to protect the ammunition against the generally favorable environmental conditions of worldwide shipment, handling, and storage as defined in AR 700-15. It is intended that the tests will serve for engineering investigation, design evaluation, design margin determination, or quality control dependent upon the specific technicalneed. The test procedures cover a wide range of environments and constitute a general criteria for evaluation of the packaging to ensure end item reliability.

5.2.2 Background. The type of container (pack) used to protect ammunition is a function of the protection required by the ammunition. The package should provide the adequate protection necessary to meet Level B requirements. The packaging engineer should select all those tests which will adequately determine the ability ofthe container to protect the item based upon the design of the container (including unique operational requirements) and the logistical and tactical environment expected.

5.2.3 Temperature range. The tests, except for the POP tests (four foot drops and loose cargo vibration) cited in Table I or Table II as applicable, and unless otherwise specified, shall be conducted at temperature of +145 degrees F, +72 degrees F (ambient) and -30 degrees F for Level B maximum and standard. The four foot drops and loose cargo vibration, as applicable, which will meet the Performance Oriented Packaging requirements for hazardous materials shall be conducted at a temperature of 72 degrees F and are conducted last in any given test sequence. For a given test sequence, ambient temperature testing should be conducted first in order to evaluate container performance under a “less severe” environment. Low and high temperature testing should be conducted after ambient temperature testing. For the extreme temperatures, the packaged item shall be conditioned for a minimum of 16 hours for metallic containers and a minimum of 24 hours for nonmetallic (e.g. plastic) containers immediately prior to each test. During testing two temperature conditions can apply as noted below for the type of testing required.

5.2.4 Test conditions. Live and inert packaged items (equivalent mass and configuration) shall be tested, as applicable, in the exterior pack (unit of issue). Live packaged items will be used to the maximum extent possible and may be required for some tests. If, for safety reasons, a full load of explosive is deemed unacceptable, then live primers, fuzes or other explosive components can be used instead of the full-up explosive round but provisions must be made to determine if initiation took place during the test. All tested containers must have a full "load" (inert plus live) to bring the tested weight up to the as shipped load. A container requiring more live packaged items than available for the full load will have the live packaged items distributed within the exterior pack to produce test results equivalent to that expected if the entire load was live. These tests can be modified as required but the container shall be packed, sealed and tested as equivalent to the shipping configuration as possible. When the test item contains explosive materials or components, the test must be performed with proper procedures and equipment, consistent with the hazard level involved to provide adequate protection in case of explosion at any point in the performance of the test. These safety requirements apply to every test in this document when the test items contain any hazardous or explosive components or materials. At the conclusion of each test the acceptance criteria cited in Section 5.3 will apply as stated in Table I or Table II, as applicable. It is obvious that some acceptance criteria will have to be subjective and will rely upon the packaging engineer to determine if the container performed satisfactorily.

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Once the container test begin no major repair, retorque, or any modification to the container will be allowed without repeating the entire test. If the container does not pass any test without modification or rework it will be considered a failure in its present configuration and consideration should be given to stopping the tests and /or redesigning the container.

5.2.5 Sequential testing for Level B ammunition containers (150 pounds or less). See Table I.

5.2.5.1 Level B maximum. The tests #1, 2, 3, 4, and 6 as cited in Table I shall be performed sequentially on each packaged container. Unless otherwise specified, six (6) loaded containers will constitute a test sample at each of the three temperatures specified in 5.2.3 for a total requirement of eighteen (18) containers. If the exterior pack (container) has more than six (6) packed items per container or the total number of packaged items (inert and live) required to load eighteen (18) containers are not available or too costly, then the total quantity of containers can be reduced to six (6). In this case the tests are the same as those specified in Table I, except that the six orientations of the seven foot drop shall be reduced to two orientations, each different, per temperature. This will provide for a total of six different orientations of the seven foot drops over three temperatures. Note: Performance Oriented Packaging (POP) Test for hazardous materials at four feet need not be conducted if sufficient test are conducted at seven feet to meet the POP requirements. However, if the POP requirements are not satisfied by the seven foot drop, a single four foot drop must be conducted on virgin containers for any drop orientation that failed or was not conducted. The loose cargo vibration (test No. 4) conducted as part of the vibration/handling tests partially satisfies the loose cargo vibration requirements for POP. To fully satisfy this requirement, an additional 30 minutes at a temperature of 72 degrees F with inputs as specified in 49CFR shall be conducted at the conclusion of all vibration handling tests. After the above stated tests are conducted on 18 or 6 containers, as applicable, an additional six loaded untested containers are required to perform the forty foot drop (test No. 8) for hazardous materials only.

5.2.5.2 Level B standard. The tests #1, 2, 3, 4, and 5 as cited in Table I shall be performed sequentially on each packaged container. Two (2) loaded containers will constitute a test sample at each of the three temperatures specified in 5.2.3 for a total of six (6) containers. The four-foot drops (test No. 5) meet the requirements for Performance Oriented Packaging (POP) for hazardous material and shall be performed as specified in Table I except that the six orientations of the four foot drops shall be conducted at a temperature of 72 degree F. (NOTE: For circular containers, {e.g. drums} the six (6) containers for the four-foot drop (test No. 5) shall be dropped as follows: 3 containers, dropped on the weakest part, such as on a chime, or if no chime, on a circumferential seam on an edge; the next 3 containers, dropped on the next weakest part, such as on a closure or welded longitudinal seam). Along with the four-foot drops (test No. 5), the loose cargo vibration (test No. 4) conducted in accordance with 49CFR at a temperature of 72 degrees F satisfies the POP requirements. NOTE: For economy reasons, the POP four-foot drops and loose cargo vibration are conducted as follow-on tests to the vibration/handling tests. POP testing requires that only one four-foot drop test or a loose cargo vibration test be conducted per virgin container. If any container fails to meet the POP acceptance criteria after any four-foot drop or loose cargo vibration, then a new container must be subjected to either a single drop at the failed drop orientation or the loose cargo vibration. After the above stated tests are conducted on 6 containers, an additional six loaded untested containers are required to perform the forty-foot drop (test No. 8) for hazardous materials only.

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5.2.6 Sequential testing for Level B ammunition containers (more than 150 pounds). See Table II.

5.2.6.1 Level B maximum. The tests 1 through 7 as cited in Table II, shall be performed sequentially on each packaged container. Unless otherwise specified, one (1) loaded container will constitute a test sample at each of the three temperatures specified in 5.2.3 for a total requirement of three (3) containers. The four-foot drops (test No. 7) meet the requirements for Performance Oriented Packaging (POP) for hazardous materials and shall be performed as specified in Table II except that the six orientations of the four-foot drop shall be performed at a temperature of 72 degrees F and two different drops per container. (NOTE: For circular containers (e.g., drums) the three containers for the four-foot drop (test No. 7) shall be dropped as follows: two different drops per container, one drop on the weakest part, such as on a chime, or if no chime,on a circumferential seam or an edge and the second drop on the next weakest part, such as a closure or welded longitudinal seam.) Along with the four-foot drops (test No. 7), the loose cargo vibration (test No, 6), conducted as part of the vibration/handling test, satisfies the POP requirements. NOTE: For economy reasons, the POP four-foot drops are conducted as follow-on tests to the vibration/handling tests. POP testing requires that only one four-foot drop test or a loose cargo vibration test be conducted per virgin container. If any container fails to meet the POP acceptance criteria after any four-foot drop or loose cargo vibration then a new container must be subjected to either a single drop at the failed drop orientation or the loose cargo vibration. After the above statedtests are conducted on the three containers, an additional one (or two containers if temperature extremes affect packaged item, container or packaging material) loaded untested container(s) is (are) required to perform the forty-foot drop (test No. 8) for hazardous materials only.

5.2.6.2 Level B standard. The tests #1, 2, 4, 5, 6, and 7 as cited in Table II shall be performed sequentially on each packaged container. Unless otherwise specified, one (1) loaded container will constitute a test sample at each of the three temperatures specified in 5.2.3 for a total requirement of three (3) containers. Along with the four-foot drops (test No. 7), the loose cargo vibration (test No. 6) conducted in accordance with 49CFR at a temperature of 75 degrees F satisfies the POP requirements. NOTE: For economy reasons, the POP four-foot drops and the loose cargo vibration are conducted as follow-on tests to the vibration handling tests. The number of containers (three), temperature and exceptions required for the four-foot drops or the loose cargo vibration shall be as specified in 5.2.6.1. After the above stated test conducted on the three containers, additional containers specified for the forty-foot drop (test No. 8) for hazardous material only.

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TABLE I. Level B Packs Weighing 150 Pounds or Less

TEST NUMBER	TEST NOMENCLATURE	LEVEL B MAXIMUM NOTE 1	LEVEL B STANDARD NOTE 1	ACCEPTANCE CRITERIA
1	STACKING	A.2.10	A.2.10	5.3.1, 5.3.3 & 5.3.4
2	VIBRATION (SECURED)	A.2.3	MIL-STD-810 (NOTES 2 & 3)	5.3.1, 5.3.3 & 5.3.4
3	FREE FALL DROP (3 FT)	A.2.4	A.2.4	5.3.1, 5.3.3 & 5.3.4
4	LOOSE CARGO (BUMP)	A.2.13 (NOTE 8)	49CFR (NOTE 8)	5.3.1, 5.3.3 & 5.3.4
5	FREE FALL DROP (4 FT)	A.2.4 (NOTES 4, 5, 7)	A.2.4 (NOTES 4 & 7)	5.3.1, 5.3.3 & 5.3.4
6	FREE FALL DROP (7 FT)	A.2.4	N/A	5.3.1, 5.3.3 & 5.3.4
7	FREE FALL DROP (40 FT)	A.2.12 (NOTE 6)	A.2.12 (NOTE 6)	5.3.2

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TABLE I. Level B Packs Weighing 150 Pounds or Less

1. Unless otherwise specified, conduct tests at temperatures of -30 degrees F, +72 degrees F, and +145 degrees F for Level B packs, see A.2.1.
2. Perform test levels and conditions specified for Procedure I (Secured Cargo), Test Configuration i. (Transportation), Category 4 - common carrier for vertical axis, transverse axis, and longitudinal axis.
3. Unless otherwise specified, time per axis – Level B Standard – 2 hours.
4. Perform test in accordance with 7 Foot Free Fall Drop except that the drop height shall be 4 feet and drop orientations as specified in 5.2.5.2. The 4 foot drops shall be conducted for packaged items containing hazardous material to meet Performance Oriented Packaging (POP) requirements.
   (NOTE: For some hazardous material, 6 or 2.6 foot drops may be required in lieu of 4 feet.)
5. Not applicable if exterior pack meets POP requirements after 7 Foot Drops.
6. Not applicable if item is non-hazardous.
7. Test shall be conducted at 72 degrees F.
8. Loose cargo in accordance with A.2.13 partially satisfies POP requirements. An additional 30 minutes of loose cargo with inputs in accordance with 49CFR at a temperature of 72 degrees F shall be conducted after the seven foot drops.

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TABLE II. Level B Packs Weighing More than 150 Pounds

TEST NUMBER	TEST NOMENCLATURE	LEVEL B MAXIMUM NOTE 1	LEVEL B STANDARD NOTE 1	ACCEPTANCE CRITERIA
1	STACKING	A.2.10	A.2.10	5.3.1, 5.3.3 & 5.3.4
2	VIBRATION (SECURED)	A.2.3	MIL-STD-810 (NOTES 2 & 3)	5.3.1, 5.3.3 & 5.3.4
3	EDGEWISE DROP	A.2.5	A.2.5	5.3.1, 5.3.3 & 5.3.4
4	CORNERWISE DROP	A.2.6	A.2.6	5.3.1, 5.3.3 & 5.3.4
5	PENDULUM IMPACT	A.2.8	A.2.8	5.3.1, 5.3.3 & 5.3.4
6	LOOSE CARGO	A.2.13	49 CFR (NOTE 7)	5.3.1, 5.3.3 & 5.3.4
7	FREE FALL DROP (4 FT)	A.2.4 (NOTES 4 & 6)	A.2.4 (NOTES 4 & 6)	5.3.1, 5.3.3 & 5.3.4
8	FREE FALL DROP (40 FT)	A.2.12 (NOTE 5)	A.2.12 (NOTE 5)	5.3.2

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TABLE II.
Level B Packs Weighing More Than 150 Pounds

1. Unless otherwise specified, conduct tests at temperatures of -30 degrees F, +72 degrees F, and +145 degrees F for Level B packs, see A.2.1.
2. Perform test levels and conditions specified for Procedure I (Secured Cargo), Test Configuration i. (Transportation), Category 4 - common carrier for vertical axis, transverse axis, and longitudinal axis.
3. Unless otherwise specified, time per axis – Level B Standard – 2 hours.
4. Perform test in accordance with 7 Foot Free Fall Drop except that the drop height shall be 4 feet and drop orientations as specified in 5.2.6.2. The 4 foot drops shall be conducted only for packaged items containing hazardous material to meet Performance Oriented Packaging (POP) requirements.
(NOTE: For some hazardous material, 6 or 2.6 foot drops may be required in lieu of 4 feet.)
5. Not applicable if item is non-hazardous.
6. Test shall be conducted at 72 degrees F.

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5.3 Acceptance Criteria for Level A and Level B Packaging

5.3.1 Ammunition - general. The basic criteria for passing a test is that the packaged ammunition remain (1) safe, or (2) safe and operable at the time or during the period specified. Each test contains its own criteria applicable to the test.

5.3.2 Ammunition/container/pallet - abnormal environment. At the conclusion of the test no explosive element should have burned or detonated and ammunition should be safe to dispose by applicable handling and disposal regulations without injury to personnel. The container or pallet need not be functional.

5.3.3 Ammunition - normal environment. The ammunition shall be safe and operable at the conclusion of the test. The decision that the ammunition has met or failed to meet "safe and operable" is based upon breakdown, visual and radiographic inspection, firing or other appropriate tests together with engineering judgment. Mechanical or physical damage to the ammunition which precludes the normal function of the ammunition is cause for container rejections.

5.3.4 Container - normal environment. The container shall not spill its contents. Minor damage to the exterior container (inner container or internal dunnage, if applicable) is permissible. Examples of minor damage are: split wood, bent box hardware, dents in fiber/plastic/metal containers, slight tears in protective liners or cracks in internal supports. The container must remain functional and suitable for its intended purpose. It is considered functional if it meets the following criteria:

(a) The container lid must be capable of being unlatched, open, reclosed, and latched shut.

(b) Handles, hoisting, and tiedown hardware are functional, if present.

(c) Stacking or handling capability is not impaired.

(d) Ammunition support and protection are maintained.

(e) Pressure relief/bleed valve remains functional, if present. (Level A Containers only.)

(f) Pressure retention capability is maintained and not impaired if required (see 5.3.6). (Level A Containers only.)

5.3.5 Pallet - normal environment. Pallet shall retain the projectiles and be capable of continued use to safely ship, store, and handle the projectiles. There shall be no evidence of extensive permanent deformation, cracking, or other failure of components that would preclude continued use.

5.3.6 Pressure retention. (Level A Containers only)

5.3.6.1 Acceptance. A container will have failed the pressure retention test per A.2.2 if there is an air flow exceeding 5 cc/min when container internal air pressure is maintained at 3 psig.

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5.3.6.2 Loaded containers under 150 pounds (see Figures 1 and 3). At the conclusion of the stacking, secured cargo vibration, three foot drop and loose cargo vibration tests, all the containers must pass the pressure retention test. No containers are required to pass the pressure retention test after the seven foot drop and POP tests, which is conducted for informational purposes only.

5.3.6.3 Loaded containers over 150 pounds (see Figures 2 and 3). All containers must pass the pressure retention test at the conclusion of the various environmental tests specified except for forklift and POP tests.

5.3.7 Stacking.

5.3.7.1 Loaded containers under 150 pounds. Loaded containers under 150 pounds normally require unitization. The stacking test on these types of containers is performed to determine whether or not the container can withstand normal stacking height of 16 feet or if it requires added protection by extraordinary means when unitized for shipping and storage. It is desired that any container defects be corrected prior to consideration of use of non-standard unitized loads. The container will need modifications or extra protection when unitized if it becomes distorted, fails to open, cracks, leaks, or in any way fails to perform as intended at completion of test.

5.3.7.2 Loaded containers over 150 pounds. Loaded containers over 150 pounds normally are skidded (self-unitized) and do not require unitization. Any instability, buckling, distortion, leaks, failure to open or any other visible damage and failure to perform as intended at completion of test is cause for rejection.

5.3.8 Container material tests.

5.3.8.1 Water vapor transmissibility. The container shall exhibit a water vapor transmissibility rate of less than .001 grams/100 sq. in/24 hours.

5.3.8.2 Container burning characteristics.

a) The container material shall have a flame spread index of 25 or less when tested in accordance with ASTM-E162.

b) The container material shall have a smoke density of 200 or less when tested in accordance with ASTM-E662.

c) The container material shall be as free as possible of significant toxic by-products when tested in accordance with ASTM-E800.

5.3.8.3 Electrical conductivity. The container shall have a volume resistivity below 10^{10} ohms-cm so that it will not generate a static discharge (spark) with enough energy to ignite any hazardous materials that may come in contact with the container. If another test was used instead of ASTM-D257 then the test results should show conclusively that any spark generated will not have enough energy to ignite the hazardous material.

5.3.8.4 Container integrity. The container shall be given a visual inspection. Any indication of exterior deterioration or fluid inside the container is cause for rejection. Any container cracks or seal damage from fluids which would cause the containers to no longer remain waterproof is cause for rejection.

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5.3.8.5 Reactivity (non-volatile packaging materials). No more than 3 ml of gas shall be generated when reactivity test is performed on sample.

5.3.8.6 Reactivity (volatile packaging materials). The increase in gas volume generated shall beno more than 3 ml above the volume of gas generated by the control sample.

5.3.8.7 Vacuum stability (non-volatile packaging materials). No more than 3 ml of gas shall be generated when vacuum stability test is performed on sample.

5.3.8.8 Vacuum stability (volatile packaging materials). An increase in gas volume generated shall be no more than 3 ml above the volume of gas generated by the control sample.

5.3.8.9 Corrosion resistance (salt spray). The container, with properly applied protective finish, shall show no apparent evidence of blistering, lifting of coating, system, or substrate corrosion after exposure to salt spray for 96 hours.

5.3.9 Desiccant (humidity). The sealed desiccated container shall achieve a relative humidity of 40% or less within 12 hours.

5.3.10 Container - performance degradation. The requirement that ammunition must be protected for 2 years unprotected uncontrolled storage and 20 years protected controlled storage is difficult to evaluate by using accelerated material tests. Since there is no minimum life requirement for container serviceability, any problem which does not cause ammunition or weapon performance degradation must be reviewed for its criticality before a container failure is charged. However, any container which is damaged so that it is no longer water vapor proof can be considered a failure as moisture has a deleterious effect on ammunition over long periods of time.

5.3.11 Accelerated heat aging - environmental stress cracking (AHA-ESC). A sealed plastic container shall meet the 3 psi pressure retentions requirement in accordance with 5.3.6 after 120 hours of testing as per A.2.28. For unsealed containers, components and material tensile bar specimens, the acceptance criteria shall be based on design performance requirements as specified by the design authority.

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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 Tailoring. This standards intent is to define broad criteria for ammunition packaging design. These criteria do not address all possible environmental scenarios and/or items of ammunition. The design activity is given freedom to tailor the specified tests, when justified, to their requirements. Care should be taken when tailoring any test to ensure the container is properly and thoroughly tested before fielding.

6.1.1 Test conditions. The design activity may reduce the extreme temperature conditioning for three foot, loose cargo, seven foot drop, and rack vibration tests to the packaged items operational temperature limits. The specific item operational temperature range must be verified by its applicable specification or Technical Data Package.

6.1.2 Moisture sensitivity. The design activity may choose to reduce the pressure retention requirement following three foot drop testing for items which are determined to not be moisture sensitive. It is left up to the designers to decide if the pressure retention is required after a certain point in the test sequence or in the items lifecycle. Before reducing the pressure requirement the design activity should consider the impacts and level of severity due to moisture contamination. Levels of severity due to moisture contamination may be categorized as, but not limited to, the following: Affect item or user safety, affects item performance and safety, affects item performance but not safety, cosmetic or superficial. Any impacts which affect safety and performance should be considered unacceptable. Consideration should also be given to NBC Hardness criteria, hardness being the ability of a system to withstand the damaging effects of NBC contamination and decontaminating agents. Once a container no longer retains pressure it may also be internally contaminated by NBC agents.

6.2 Additional testing. The packaging requirements, including tests cited in this standard, can be used to insure a satisfactory container (unit of issue). However, there are other tests or requirements necessary per regulation and/or law which are performed both on the individual container and/or the unitized load. These tests, in general, are conducted by Army agencies responsible for particular areas of concern and are coordinated through the item/system engineer. Before a container or unitized load can be considered ready for field use, the following tests should be performed.

6.2.1 Unitization. Containers should be unitized for shipment in order to meet Level requirements. The unitization drawings are generated by the AMC Defense Ammunition Center and School to meet the design requirements of MIL-STD-1660. In addition to the drawings, unitization tests are conducted, if necessary, to meet the test requirements of MIL-STD-1660 and to determine adequate tiedown/blocking and bracing procedures and provisions in various transport modes (e.g., rail or truck). Any unitized load of ammunition issued to the combat user in pallet size quantities should have top-lift capability. (NOTE: 1 Skidded containers may not require unitization for shipment but they should meet the requirements of this paragraph.)

6.2.2 Hazard classification. In order to determine hazard class of the packaged ammunition, tests per TB 700-2 should be conducted. Hazard class should be assigned prior to shipping any hazardous material.

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6.2.3 Testing of packaged ammunition ready for release. The Army Test and Evaluation Command (ATEC) should conduct safety and other tests deemed necessary prior to packaged ammunitions being production released to the field. This independent evaluation could include the same tests as listed in this standard or additional tests as deemed necessary prior to fielding.

6.2.4 Aircraft delivery. Aircraft delivery requires performing dynamic drop tests to determine adequacy of parachute rigging. If air delivery is required, the packaging design should support meeting the passing criteria of the Malfunction Parachute Test without detonation upon ground impact prior to airdrop testing. Aircraft delivery tests could include Low Altitude Parachute Extraction System (LAPES), Low and High Velocity Parachute and Malfunction Parachute Tests. The designof the rigging is the responsibility of the U.S. Army Combat Capabilities Development Command Solder Center in Natick, MA and testing is performed by ATEC.

6.3 Test planning and report. Prior to start of tests, a test plan should be formulated which will detail: number of containers to be tested, tests to be conducted, performance requirements, number of live/inert ammunition items, pre-test data and parameters for determining proper evaluation of the ammunition and pack before and after test, applicable configuration of ammunition and package, and temperature level if other than those given by these tests. Provision should be made for recording (both written and pictorial) the necessary test data to show test performance and test results. Refer to DI-PACK-80456, Packaging Test Plan. At conclusion of tests, a report should be written documenting the test plan, equipment used, test results, deviations or waivers from the original test plan along with the reasons for the changes,and appropriate data. Refer to DI-PACK-80457, Packaging Test Report. A suggested format for this report is as follows:

1. Purpose
2. Description of tests
3. Criteria for passing tests
4. Test equipment
5. Test procedure
6. Related information (deviations, waivers, etc.)
7. Supporting data (temperatures, performance requirements, photographs, etc.)
8. Test results
9. Conclusions
10. Recommendations

6.4 Performance Oriented Packaging (POP) tests. Upon completion of the tests or previously conducted tests that satisfy the POP test requirements, a test report in accordance with DD Form 1473 should be prepared and submitted to the proper government agency.

6.5 Subject term (keyword) listing.

Container
Corrosion resistance
Drop tests
Pallet
Pressure retention
Unitization

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APPENDIX A - TEST PROCEDURES

A.1 SCOPE

A.1.1 Scope. This appendix provides additional information on the container test requirements and procedures in Sections 4 and 5.

A2. TEST PROCEDURES

A.2.1 Temperature conditioning. The tests, unless otherwise specified, shall be conducted at the temperatures specified in the notes for the test procedure sequence. Three foot drop (see A.4), loose cargo (A.13), seven foot drop (see A.4), and rack vibration (Appendix C) tests may be performed at the operational temperature extremes for the item being packaged. The packaged ammunition shall be conditioned for a minimum of 16 hours for metallic containers and a minimum of 24 hours for nonmetallic (e.g., plastic) containers immediately prior to each test. During testing, two temperature conditions can apply as noted below.

A.2.1.1 Maintaining air temperature. By using portable conditioning equipment, the ambient air must be maintained at the specified temperature level for the duration of the test.

A.2.1.2 Removal of conditioned item. The item shall be conditioned and tested as quickly as possible after removal from the conditioning chamber to maintain the specified temperature level as close as possible to the required value. No more than 2 to 3 minutes shall elapse before the first drop is conducted with no more than 8 to 10 minutes elapsed time before tests are completed in a given sequence (e.g., 6-3 foot drops).

A.2.2 Pressure retention (for Level A ammunition only). The container shall be conditioned to ambient temperature prior to testing. Pressure shall be measured by means of connected pressure gages, manometers, electronic sensors, or other suitable means which are capable of recording the appropriate values. For test purposes, a hole and valve shall be provided in the new containers to allow the use of a hose to measure air flow into and pressure inside the container. The loaded container shall be assembled and sealed as if for shipment except that any container relief valve shall be blocked off. After sealing, the container shall be pressurized to a value of 3.0 + .5 psi gage by means of dry air introduced through an air connection in the container wall. The air connection can be through a drain plug, a fitting adapted to the pressure relief valve housing, or an air valve mounted to the container for this test only. Because of the potential difference in the temperature of the pressurized air, ambient air temperature, and the residual temperature of the container and its contents, the container pressure shall be monitored continuously by gage in addition to monitoring a flow meter. The sealed container shall withstand the 3 psi air pressure with an air flow rate which does not exceed 5 cc/min. If the container does not initially pass the acceptance criteria of 5.3.6, the container may be opened, reclosed to reset the gasket/seal, and pressure retention tested again. NOTE: Pressure retention need not be conducted on exterior packs that are not sealed (e.g., pallets for artillery projectiles).

A.2.3 Vibration (secured tactical). The loaded container shall be securely fastened to the vibrationtable. When size and explosive material limits permit, more than one container can be vibrated atone time in order to reduce total test time. Random vibration shall be applied along each

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of three mutually perpendicular axes of the container in turn. The vibration schedules as shown below willbe applied to the containers. Two wheel trailers and tracked vehicles can be deleted when determined that these modes of logistical transportation will not be experienced by the packaged items. In addition to the aforementioned transportation vibration schedules, when a round is transported in a fighting tactical vehicle in a packaged configuration, the loaded container shall also be subjected to the vibration expected to be encountered inside the vehicle. For several existing fighting tactical vehicles, appropriate vibration schedules are specified in Appendix C.

For temperature testing, A.2.1 shall apply. For a more detailed description and backgroundof the random vibration program, see ATEC ITOP 01-2-601. Time schedules for vibration of items transported as secured cargo are as follows:

Vehicle	Axis	Time/Axis (min)	Table
Wheeled	Vertical	40	III
	Trans	40	III
	Long	40	III
Two Wheel Trailer	Vertical	32	IV
	Trans	32	IV
	Long	32	IV
Tracked	Vertical	60	V
	Trans	60	V
	Long	60	V

A.2.3.1 Vibration (secured non-tactical). The loaded container shall be securely fastened to the vibration table. When size and explosive material limits permit, more than one container can be vibrated at one time in order to reduce total test time. Test levels and conditions specified for basic transportation, common carrier environment shall be performed as stated in test procedure 514.8 of MIL-STD-810 for vertical axis, transverse axis, and longitudinal axis. The vibration time per axis shall be 2 hours.

A.2.4 Free fall drop (3 foot/7 foot). The heights specified in subsequent paragraphs refer to the distance from rigid surface to the nearest corner, edge or flat surface of the exterior pack. For temperature testing, A.2.1 shall apply.

A.2.4.1 Rectangular shaped containers. For 3 foot drop testing, each container shall be dropped six times from a height of 36 inches onto the impact surface. The six drops shall consist of one drop in each orientation as specified in Figure 4. For 7 foot drop testing, each container will be dropped one time from seven feet. Each orientation specified in Figure 4 shall have one container dropped in that orientation.

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TABLE III. RANDOM VIBRATION SCHEDULE - WHEELED VEHICLE

VERTICAL AXIS*		LONGITUDINAL AXIS*		TRANSVERSE AXIS*	
FREQ.	PSD VALUE * *	FREQ.	PSD VALUE * *	FREQ.	PSD VALUE * *
5	.2308	5	.0605	5	.1373
8	.7041	6	.0577	9	.0900
12	.0527	8	.0455	12	.0902
16	.0300	12	.0351	14	.0427
20	.0235	15	.0241	16	.0496
22	.0109	16	.0350	18	.0229
24	.0109	19	.0092	119	.0008
26	.0154	25	.0159	146	.0013
69	.0018	37	.0041	166	.0009
79	.0048	41	.0060	201	.0009
87	.0028	49	.0017	273	.0053
123	.0063	105	.0006	298	.0021
161	.0043	125	.0004	371	.0104
209	.0057	143	.0013	382	.0019
224	.0150	187	.0013	402	.0077
247	.0031	219	.0028	422	.0027
278	.0139	221	.0068	500	.0016
293	.0037	247	.0325		
357	.0028	249	.0096		
375	.0052	270	.0026		
500	.0011	293	.0094		
		336	.0120		
		353	.0247		
		379	.0085		
		431	.0224		
		433	.0092		
		500	.0014		

* Test Duration 40 Minutes per Axis
** PSD – Power Spectral Density – G squared per HZ

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TABLE IV. RANDOM VIBRATION SCHEDULE - 2 WHEELED VEHICLE

VERTICAL AXIS*		LONGITUDINAL AXIS*		TRANSVERSE AXIS*	
FREQ.	PSD VALUE * *	FREQ.	PSD VALUE * *	FREQ.	PSD VALUE * *
5	.2252	5	.0474	5	.0536
8	.5508	6	.0303	6	.0536
10	.0437	7	.0761	8	.1102
13	.0253	13	.0130	13	.0140
15	.0735	15	.0335	16	.0303
19	.0143	16	.0137	20	.0130
23	.0358	21	.0102	23	.0378
27	.0123	23	.0268	27	.0079
30	.0286	25	.0090	30	.0208
34	.0133	28	.0090	33	.0068
36	.0416	30	.0137	95	.0019
41	.0103	34	.0055	121	.0214
45	.0241	37	.0081	146	.0450
51	.0114	46	.0039	153	.0236
95	.0266	51	.0068	158	.0549
111	.0166	55	.0042	164	.0261
136	.0683	158	.0029	185	.0577
147	.0266	235	.0013	314	.0015
185	.0603	257	.0027	353	.0096
262	.0634	317	.0016	398	.0009
330	.0083	326	.0057	444	.0027
360	.0253	343	.0009	500	.0014
500	.0017	384	.0018		
		410	.0008		
		462	.0020		
		500	.0007		

* Test Duration 40 Minutes per Axis
** PSD – Power Spectral Density – G squared per HZ

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TABLE V. - NARROWBAND RANDOM-ON-RANDOM VIBRATION - TRACKED VEHICLE

Test Phase	5-500 Hz Floor Level (g /HZ)	No. Sweeps	NARROWBAND 1 BW (Hz)	NARROWBAND 1 Ampl (g /Hz)	NARROWBAND 1 Sweep BW (Hz)	NARROWBAND 2 BW (Hz)	NARROWBAND 2 Ampl (g /Hz)	NARROWBAND 2 Sweep BW (Hz)	NARROWBAND 3 BW (Hz)	NARROWBAND 3 Ampl (g /Hz)	NARROWBAND 3 Sweep BW (Hz)	NARROWBAND 4 BW (Hz)	NARROWBAND 4 Ampl (g /Hz)	NARROWBAND 4 Sweep BW (Hz)	NARROWBAND 5 BW (Hz)	NARROWBAND 5 Ampl (g /Hz)	NARROWBAND 5 Sweep BW (Hz)
						VERTICAL AXIS (12 minutes per test phase)											
VO1	0.0041	2	30-35	0.0876	3	60-70	0.0405	6	90-105	0.0319	9	120-140	0.0131	12	150-175	1.1073	
VO2	0.0024	2	41-47	0.0686	3	82-94	0.0759	6	123-141	0.0073	9	164-188	0.0090	12	205-235	1.0173	15
VO3	0.0059	1	53-65	0.1480	6	106-130	0.0090	12	159-195	0.0717	18	212-260	0.0363	24	265-325	1.0655	30
VO4	0.0043	1	71-88	0.1389	9	142-176	0.0942	18	213-264	0.0873	27	284-352	0.0378	36	355-440	0.0078	45
VO5	0.0068	1	94-112	1.6288	9	188-224	0.7682	18	282-336	0.0787	27	376-448	0.0228	36	-------	------	--
						TRANSVERSE AXIS (12 minutes per test phase)											
TO1	0.0020	2	30-35	0.0220	3	60-70	0.0300	6	90-105	0.0151	9	120-140	0.0073	12	150-175	0.0050	15
TO2	0.0016	2	41-47	0.0223	3	82-94	0.0212	6	123-141	0.0105	9	164-188	0.0089	12	205-235	0.0174	15
TO3	0.0054	1	53-65	0.0716	6	106-130	0.0325	12	159-195	0.0238	18	212-260	0.0123	24	265-325	0.0153	30
TO4	0.0039	1	71-88	0.0722	9	142-176	0.1480	18	213-264	0.0483	27	284-352	0.0077	36	-------	------	--
TO5	0.0032	1	94-112	0.2826	9	188-224	0.1750	18	282-336	0.0360	27	376-448	0.0127	36	-------	------	--
						LONGITUDINAL AXIS (12 minutes per test phase)											
LO1	0.0031	2	30-35	0.0257	3	60-70	0.0182	6	90-105	0.0074	9	120-140	0.0116	12	150-175	0.0084	15
LO2	0.0016	3	41-47	0.0100	3	82-94	0.0155	6	-------	------	--	-------	------	--	-------	------	--
LO3	0.0051	1	53-65	0.0559	6	106-130	0.0306	12	159-195	0.0177	18	212-260	0.0223	24	265-325	0.0204	30
LO4	0.0038	1	71-88	0.0722	9	142-176	1.0128	18	213-264	0.0400	27	284-352	0.0284	36	355-440	0.0132	45
LO5	0.0047	1	94-112	1.2826	9	188-224	1.1501	18	282-336	0.0582	27	376-448	0.0208	36	-------	------	--

TEST DURATION FOR AXIS - 60 MIN.

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A.2.4.2 Cylindrical shaped containers. For 3 foot drop a testing, each container shall be droppedsix times from a height of 36 inches onto the impact surface. The six drops shall consist of one drop in each orientation as specified in Figure 4. For 7 foot drop testing, each container will be dropped one time from seven feet. Each orientation specified in Figure 4 shall have one containerdropped in that orientation.

A.2.5 Edgewise drop. The loaded container shall be supported on one end of its base on a block approximately five inches high and placed at right angles to the skids. The opposite end of the container shall be raised and allowed to drop freely from heights of 12, 24, and 36 inches onto a rigid horizontal impact surface. This test shall be applied to each end of the container. For container impact orientation, see Figure 5. For temperature testing, A.2.1 shall apply.

A.2.6 Cornerwise drop. The loaded container shall be supported at the corner of its base on a block approximately five inches high. A block approximately 12 inches high shall be placed under the other corner of the same end of the container. The opposite end of the container shall be raised and allowed to fall freely from heights of 12, 24, and 36 inches onto a rigid horizontal impact surface. This test shall be applied to the diagonally opposite corners of the container base. For container impact orientation, see Figure 6. For temperature testing, A.2.1 shall apply.

A.2.7 Rollover. The loaded container erected on its base on a rigid horizontal impact surface shallbe tipped slowly sideways until it falls freely and by its own weight from the base to the side, sideto the top, top to the other side and from the other side to the base thus completing one revolution.For temperature testing, A.2.1 shall apply.

A.2.8 Pendulum impact. The loaded container shall be freely suspended by ropes, chains or cablesand shall be swung as a pendulum against a rigid, flat, and vertical barrier. The longitudinal axis of the container shall be perpendicular to the barrier and the end shall rest lightly against it. The container shall be pulled back from the barrier until the center of gravity is raised 20.5 inches or to the required pendulum angle so that an impact velocity equal to 10.5 $\pm$ .5 ft. / sec will be attained and then released and allowed to swing freely against the barrier. The container should impact against the skids and not against the container closure flange area. This test shall be applied to both ends of the container along the longitudinal axis of the container. For palletized loads where shipping orientation of the pallet is not readily apparent, the test should be performed on a surface perpendicular to the “longitudinal” axis and also on a surface parallel to the “longitudinal” axis. For temperature testing, A.2.1 shall apply. See A.2.8.1 as an alternative test method to this test.

A.2.8.1 Incline impact. This test is an alternate to the pendulum impact test, see A.2.8. The test shallbe conducted in accordance with Procedure A, ASTM D880, Incline Impact Test for Shipping Containers, and the container shall project beyond the dolly by a minimum of 2 inches. The container shall strike the rigid back stop at a velocity of 10.5 $\pm$ .5 feet per second. This test shall be applied to the container as delineated in A.2.8.

A.2.9 Forklift. A loaded container lifted through the container forklifting provisions, using the appropriate forklift truck commensurate with container size, shall be subjected to the test specified in MIL-STD-648. The test shall be conducted at +72 degrees F.

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A.2.10 Stacking. A load equal to a stacking height of 16 feet including pallets, if applicable, shallbe applied to the top of the loaded container in any manner simulating the effect of similar containers being stacked on the test container. The load shall be maintained for a minimum of 24 hours. This test shall be conducted at ambient temperature. Non-metallic containers shall be tested in accordance with Table 501.7-III High temperature cycles, climatic category A1 (Hot-Dry/Induced) Method 501.7 of MIL-STD-810 for a period of 72 hours. If it is determined that the pallet design is such that the loads above the bottom pallet are supported by the pallet through stacking supports between the top frame and pallet base instead of the containers, then only that load which the bottom container supports shall be used in the test.

A.2.11 Hoisting. The loaded container/pallet shall be additionally loaded to four times its gross (loaded) weight and shall be lifted free of the ground or other support by means of lifting provisions provided and maintained in the position for a minimum of 2 minutes. This test shall be conducted at +72 degrees F. (If a non-metallic material is used as part of the lifting provisions or container structure, this test shall be conducted at +160 degrees F and -65 degrees F for a minimum of 1 hour at each temperature.) For +160 degrees F and -65 degrees F, the temperature shall be obtained using A.2.1. For special pallet hoisting test, see A.2.11.1.

A.2.11.1 Sudden lift test. Two diagonally opposite projectile lift plugs on the fully loaded pallet shall be engaged and the pallet lifted by a short two legged sling. The load shall be allowed to free fall 4 inches and brought to an abrupt stop. The test shall be repeated two additional times (all on the same pallet) through only a single lift plug located diagonally opposite to one another. The test shall be conducted at ambient temperature. If critical components are affected by temperature extremes then the test shall, be repeated at +160 degrees F and -65 degrees F on new pallets. Temperature, conditioning shall be in accordance with paragraphs A.2.1.

A.2.12 Forty-foot drop.

A.2.12.1 Containers under 150 pounds. Loaded containers (quantity, to be determined by coordination with the proper Systems Safety Office) shall be dropped free from a height of 40 feet onto a rigid horizontal impact surface. The impacting orientation and temperature shall be as determined by the proper Systems Safety Office. The temperature shall be as obtained using A.2.1.

A.2.12.2 Containers over 150 pounds. Loaded container(s) shall be dropped free fall from a height of 40 feet onto a rigid horizontal impact surface, quantity, to be determined by coordination with the proper Systems Safety Office. The impacting attitude shall be that most likely to induce arming or detonation of components. Unless otherwise specified, the impacting attitude shall be on skids and if two containers are used, on the end of the container of the second container. The test shall be conducted at a temperature of +72 degrees F. If critical components are affected by temperature extremes, then containers will be dropped at test temperatures to be determined by coordination with the proper Systems Safety Office.

A.2.13 Loose cargo. The loaded container shall be placed on the steel mounting surface (table) of the vibration equipment. The container shall not be restrained during vibration except by a fence attached to the test surface to prevent the package from falling off the table. A total free space between the container and the opposing side and end boards will not exceed two inches.

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Rectangular containers shall be tested for 10 minutes + 1 minute on each of the most vulnerable horizontal and vertical faces on the same package (two faces total). Cylindrical containers shall be tested for 10 minutes + 1 minute on the bottom face (or top, if more vulnerable) and for 10 minutes + 1 minute on the most vulnerable circumferential position. If the container shifts circumferentially during the test, it shall be allowed to do so. The vibratory frequency shall be 5 Hz and the vibratory surface shall have a 1 inch double amplitude. Total test time shall be 20 minutes for each type container. Loaded containers more than 150 pounds shall be tested for 120 minutes only in the normal shipping mode (usually on skids). In addition, the table frequency, starting at 3 Hz, shall be adjusted to assure that one edge of the container leaves the table not less than 3/16 inch on each cycle. The temperature shall be obtained using A.2.1.

A.2.14 Tiedown strength. A load shall be applied to each tiedown provision in the same way thatit would be applied in service. In the absence of clearly identified tiedown procedures, the load shall be applied at an angle of 45 degrees downward from the horizontal and simultaneously 45 degrees outboard from the container surface. The test load shall be equal to that which would be applied if the loaded container were subjected to the restraint loads required by MIL-STD-1791. The load shall be applied in each of the directions which may reasonably result from shipment. The duration of the test shall be 2 minutes in each of the test directions. This test shall be conducted at +72 degrees F temperature only. (If a non-metallic material is used as part of the tiedown provisions or container structure, this test shall be conducted at +160 degrees F and -65 degrees F for a minimum of 1 hour at each temperature.) For +160 degrees F and -65 degrees F, the temperature shall be obtained using A.2.1.

A.2.15 Solar radiation. The solar radiation test shall be performed in accordance with Method 505.7, Procedure II of MIL-STD-810.

A.2.16 Temperature shock. The temperature shock test shall be performed in accordance with Method 503.7 of MIL-STD-810.

A.2.17 High temperature. The high temperature test shall be performed in accordance with Method 501.7, Procedure I (Storage, Hot/Induced) of MIL-STD-810.

A.2.18 Chemical resistance. A non-metallic container shall be immersed in those representative solvents and lubricants which may come in contact with the fielded packaged ammunition. Ammunition used in specific vehicles will have the ammunition container tested with those fluidswith which it is most likely to come into contact. It is not required that a container be tested with every fluid, especially when the fluids are chemically similar. As an example, many greases can be considered to be one family of petroleum products. Some of the fluids to be considered for thistest are hydraulic fluid, gasoline, ethylene glycol, grease, lubricating oil, diesel oil, etc. The container should be immersed (depending upon container size) in each specific fluid for a minimum of 4 hours. The container will then be removed and inspected for damage.

A.2.19 Container burning characteristics. The container or material shall be subjected to the flamespread index (ASTM-E162), smoke density (ASTM-E662) and toxic products of combustion (ASTM-E800) tests.

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A.2.20 Water vapor transmissibility. Container(s) will be subjected to the water vapor transmissibility test (Method A) as specified in ASTM D4279.

A.2.21 Electrical conductivity. A container shall be subjected to the electrical test procedures ofASTM-D257 at +72 degrees F, and 15 percent relative humidity, to determine volume resistivity. In lieu of this test, any test which will prove that the charge generated by static electricity on the material will not ignite the hazardous item will be acceptable provided that the procedure is prior to test performance.

A.2.22 Reactivity (non-volatile packaging materials). The reactivity test for non-volatile packaging materials shall be performed in accordance with Method 503.1.1 per MIL-STD-650.

A.2.23 Reactivity (volatile packaging materials). The reactivity test for volatile packaging materials shall be performed in accordance with Method 503.1.1 per MIL-STD-650 with one difference from that of A.22 in that it is a comparison test. The volume of gas generated from pure virgin energetic material shall be noted. Then another sample of the same energetic material is placed in intimate contact with the volatile packaging materials in a sealed container and allowed to stand for a period of three weeks. The required sample (specimen) shall be recovered at the site where the energetic material made contact with the packaging material. The test will be conducted again and the volume of gas generated noted.

A.2.24 Vacuum stability (non-volatile packaging materials). The vacuum stability for non-volatile packaging materials shall be performed in accordance with Method 504.1 of MIL-STD-650.

A.2.25 Vacuum stability (volatile packaging materials). The vacuum stability test for volatile packaging materials shall be performed in accordance with Method 504.1.1 of MIL-STD-650 except that it is a comparison test. For specific procedure see A.2.23.

A.2.26 Desiccant (Humidity). The proper quantity of desiccant shall be placed in a receptacle within the container (or, if applicable, a receptacle with outside access). The container and, if applicable, the outside receptacle shall be sealed as for shipment and then subjected to the pressure retention test in accordance with A.2.2. Upon successful completion of the pressure retention test, reduce the internal pressure to atmospheric. If the container is equipped with an internally placed indicator, check the humidity after 12 hours. If the container is equipped with an externally mounted indicator, monitor the humidity until an acceptable level is achieved, but not to exceed 12 hours.

A.2.27 Corrosion resistance (salt spray). The container, with properly applied protective finish, if applicable, shall be subjected to the salt spray (fog) test performed in accordance with ASTM-B117 for a period of ninety-six (96) hours.

A.2.28 Accelerated heat aging - Environmental stress cracking (AHA-ESC). The AHA-ESC testshall be conducted in accordance with Appendix E.

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APPENDIX B - TEST EQUIPMENT

B.1 SCOPE

B.1.1 Scope. This appendix provides additional information on the requirements of test equipment to perform he tests in Sections 4 and 5.

B.2 GENERAL

B.2.1 Capability. All equipment required for the test must be capable of providing or meeting the conditions required.

B.2.2 Accuracy. The accuracy of instruments and test equipment used to control or monitor the test parameters shall be verified periodically (at least every 12 months, preferably once every 6 months, unless contractor procedures prepared to satisfy the requirements of ISO/IEC 17025 or NCSL Z540.3 for calibration cycle or specific instruments specify otherwise) to the satisfaction of the packaging engineer. All instruments and test equipment used in conducting the tests specified herein shall:

a) Conform to laboratory standards whose calibration is traceable to the National Institute of Standards and Technology.

b) Have an accuracy of at least one-fourth the tolerance for the variable to be measured.

c) Be appropriate for measuring the conditions concerned.

B.2.3 Tolerance of test conditions. The maximum allowable tolerances of test conditions (exclusive of accuracy of instruments) unless otherwise specified in any of the test procedures shall be as follows:

Temperature:	± 5 degrees F (applies to + 160 degrees F and -65 degrees F) ± 20 degrees F (applies to +72 degrees F (ambient))
Vibration Acceleration Power Spectral Density (PSD)	± 3db
Velocity:	± 5%
Distance:	± 5%
Time:	± 4%

B.2.4 Pre-conditioning and stabilization. The conditioning chamber shall be at the appropriate temperature in order to commence the conditioning period. At the conclusion of the specified soak time the container and its contents will be assumed to be at the correct temperature.

B.3 Forty-foot drop test. The 40 foot height necessary to perform this test can be obtained using any tower, derrick, or boom arrangement provided the conditions of free fall and impact are met. The impact surface shall be a steel plate having a minimum thickness of 3 inches and a Brinell hardness of not less than 200. It shall be solidly supported in a horizontal plane over its entire bearing area by a minimum of 24 inches of reinforced concrete with a minimum compressive strength of 4 ksi (28MPa). The plate shall have a flat surface (not deformed from previous test

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impacts to the point where further proper angular impacts are prevented) and shall have a length and width of at least 1.5 times the maximum dimension of the tested container. Equipment such as an electric hoist and a remotely controlled magnetic release are recommended.

B.4 Pressure retention test. The following equipment is required: a source of dry air, an air connection (valve or adapter that an air valve can be secured to) in the container wall to permit the introduction of air to the specified pressured and pressure gauge, manometer or other suitable device capable of recording flow rate to nearest 0.1 cc/min.

B.5 Vibration test. The vibration equipment required to conduct this test must be capable of covering the frequencies and power spectral densities specified in Tables I, II, III and the tables shown in Appendix C, if applicable, while supporting the exterior pack. The instrumentation required shall be capable of measuring the vibration values and the conditions of temperature specified. Reference should be made to ITOP 01-2-601 for specific details of the vibration testing equipment, controls, and procedures to be followed. Temperature conditioning equipment to establish and maintain the ambient air of the exterior pack shall be at a constant temperature in the range based on the packaging level being tested.

B.6 Loose cargo test. Vibration equipment required to conduct this test must have vertical circular synchronous motion and must be capable of providing the required amplitude at the required frequency. The mounting surface table must be steel-faced. If it is not, then a surface fabricated from carbon steel, cold rolled, temper 3 per ASTMA109/109M, a minimum of 1/16 inch thick, shall be prepared and securely fastened to the vibration table mounting surface. The only restraining mechanism shall be a fence attached to the mounting surface to prevent the exterior pack from falling off the table. A total free space between the container and the opposing side and end boards will not exceed two inches. Instrumentation required shall be capable of measuring the frequency and amplitude of the applied vibration and the conditions of temperature specified. Temperature conditioning equipment shall be required to establish and maintain the ambient air temperature of the exterior pack at a constant temperature in the range based on the packaging level being tested.

B.7 Free fall drop test. The following equipment is required:

(a) Lifting mechanism.

(b) Suitable quick release device.

(c) Suitable measuring device.

(d) Impact surface: same as required in B.2 except 24 inches of reinforced concrete is notnecessary for three and seven foot drop tests.

Instrumentation is not required unless otherwise specified. Temperature conditioning equipment shall be required to establish and maintain the ambient air of the exterior pack at a constant temperature in the range based on the packaging level being tested.

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B.8 Pendulum impact test. To conduct this test, the following is required:

(a) A vertical impact surface consisting of a flat, rigid concrete or masonry wall or other equally unyielding flat barrier high and wide enough to make full contact with container end.

(b) Four ropes, chains, or cables suspended at least 16 feet above ground.

Instrumentation is not required except for transducer capable of measuring the impact velocity. Temperature conditioning equipment shall be required to establish and maintain the ambient air of the exterior pack at a constant temperature in the range based on the packaging level being tested.

B.9 Incline impact test. To conduct this test, the following is required:

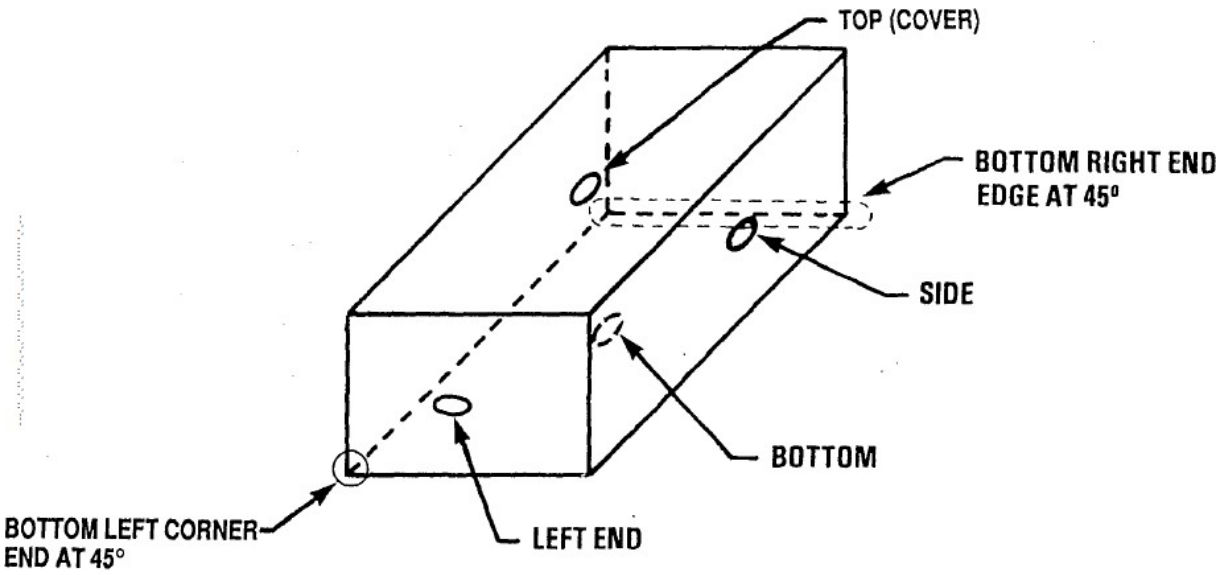
(a) A two rail steel track inclined 10 degrees from the horizontal.

(b) A rolling carriage dolly.

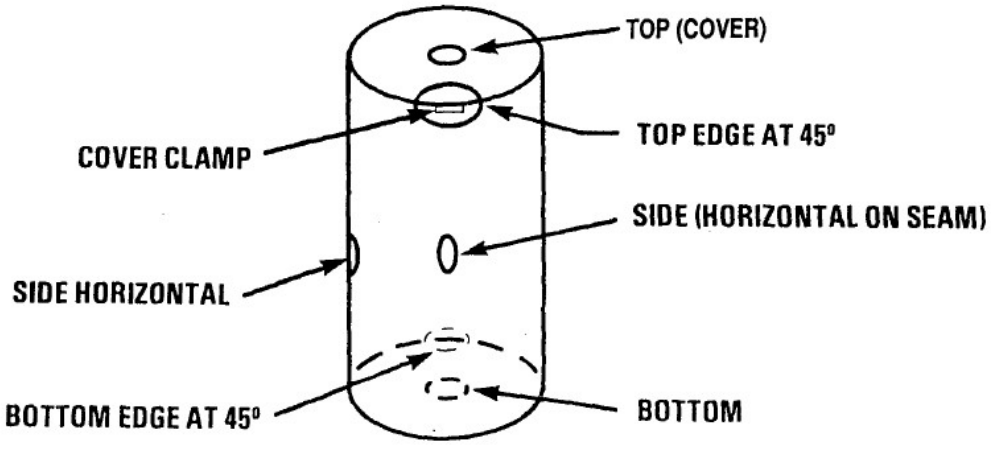
(c) A rigid backstop (barrier) perpendicular to the track with a face made of Group IV hardwood per ASTM D6199 of sufficient size to permit full contact with the container end. The backstop shall be perpendicular to the track.

Instrumentation is not required except for a transducer capable of measuring the impact velocity. Temperature conditioning equipment shall be required to establish and maintain the ambient air of the exterior pack at a constant temperature in the range based on the packaging level being tested.

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RECTANGULAR CONTAINER



CIRCULAR CONTAINER

FIGURE 4 - Package Orientation

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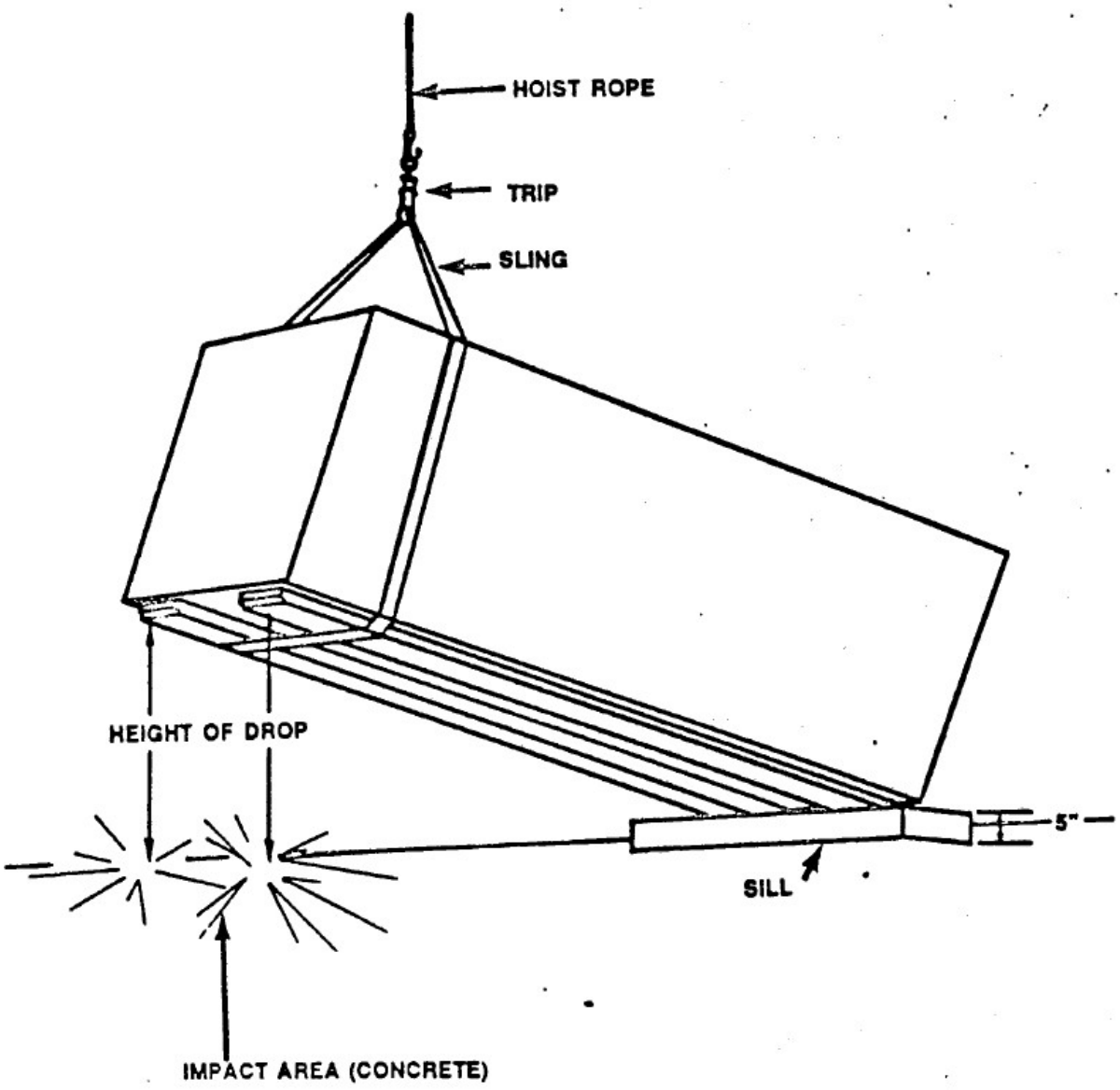


Figure 5. Edgewise drop (rotational)

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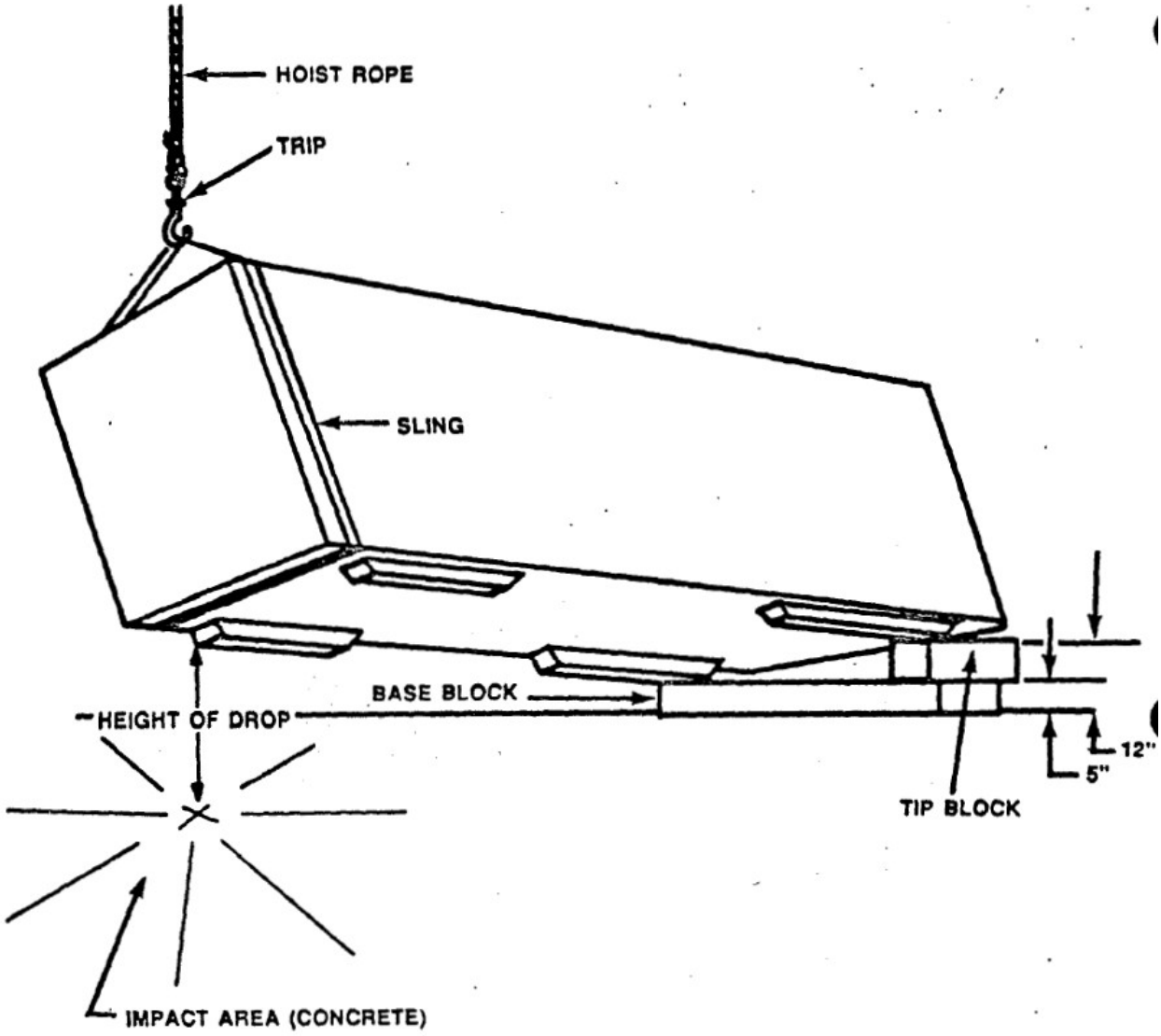


Figure 6. Cornerwise drop (Rotational)

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APPENDIX C - RACK VIBRATION

C.1 SCOPE

C.1.1 Scope. This appendix provides additional information on the requirements for the rack vibration test in Sections 4 and 5.

C.1.2 Vibration (rack). In addition to secured cargo transportation vibration (see A.3) to which all packaged ammunition is subjected, there are some ammunition items which are stored inside the fighting tactical vehicle in a packaged configuration which are exposed to additional vibration environments. In order to evaluate the protection provided by the container to the ammunition and determine whether the container is adequate, additional vibration tests must be performed on the packaged ammunition. The test schedule must be developed from service scenario which addresses vehicle, installation location, travel distance, and type of road traversed. If available, the operational mode summary/mission profile and service life can be extracted from the user requirements documents to tailor the service scenario to used expectations.

This rack vibration test shall be conducted at the conclusion of the previous tests specified on Figure 1, on the same containers, at three temperatures (-65 degrees F or cold item operational temperature extreme, ambient, +160 degrees F or hot item operational temperature extreme), in three planes, with all procedures as previously performed for secured vibration. Any container previously tested at 7 foot drop does not have to maintain a 3 psig seal, if the container did not pass the pressure retention test after the 7 foot drop.

Tables VI and VII are two examples of the vibration schedule for specific locations on specific fighting tactical vehicles. They can be considered representative of the vibration environment which the packaged ammunition must survive during fighting tactical vehicle use. Reference should be made to ITOP 1-2-601 for specific details of the vibration testing equipment, controls and procedures to be followed.

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TABLE VI - RANDOM-ON-RANDOM VIBRATION FOR THE M109A3 SELF-PROPELLED HOWITZER (PROPELLING CHARGE)

Test Phase	5-500 Hz Floor Level (g /HZ)	No. Sweeps	NARROWBAND 1 BW (Hz)	NARROWBAND 1 Ampl (g /Hz)	NARROWBAND 1 Sweep BW (Hz)	NARROWBAND 2 BW (Hz)	NARROWBAND 2 Ampl (g /Hz)	NARROWBAND 2 Sweep BW (Hz)	NARROWBAND 3 BW (Hz)	NARROWBAND 3 Ampl (g /Hz)	NARROWBAND 3 Sweep BW (Hz)	NARROWBAND 4 BW (Hz)	NARROWBAND 4 Ampl (g /Hz)	NARROWBAND 4 Sweep BW (Hz)	NARROWBAND 5 BW (Hz)	NARROWBAND 5 Ampl (g /Hz)	NARROWBAND 5 Sweep BW (Hz)
						VERTICAL AXIS * (38.25 minutes per test phase)											
V1	0.0037	3	24-36	0.1613	6	48-72	0.0495	12	72-108	0.0047	18	-------	------	--	-------	------	
V2	0.0053	4	42-48	0.0751	3	84-96	0.1382	6	126-144	0.0120	9	168-192	0.0201	12	210-240	0.0480	15
V3	0.0085	4	54-60	0.8679	3	108-120	0.0374	6	162-180	0.0312	9	216-240	0.1583	12	270-300	0.0528	15
V4	0.0103	2	66-78	0.5529	6	132-156	0.0464	12	198-234	0.0598	18	264-312	0.0317	24	-------	------	--
V5	0.0103	2	84-108	0.2031	12	168-216	0.0818	24	252-324	0.0846	36	-------	------	--	-------	------	--
						TRANSVERSE AXIS * (38.25 minutes per test phase)											
T1	0.0047	4	29-36	0.1556	4	58-72	0.0605	8	87-108	0.1356	12	116-144	0.0309	16	145-180	0.0398	20
T2	0.0066	4	42-48	0.5715	3	84-96	0.1398	6	126-144	0.1504	9	168-192	0.2819	12	210-240	0.0988	15
T3	0.0100	2	54-66	0.7530	6	108-132	0.2294	12	162-198	0.7143	18	216-264	0.0993	24	270-330	0.0740	30
T4	0.0113	2	72-84	1.7997	6	144-168	1.1840	12	216-252	0.2055	18	288-336	0.2092	24	360-420	0.0920	30
T5	0.0121	2	90-102	1.1329	6	180-204	0.6302	12	270-306	0.2222	18	360-408	0.0821	24	-------	------	--
						LONGITUDINAL AXIS * (47.8 minutes per test phase)											
L1	0.0056	5	36-42	0.7202	3	72-84	0.1161	6	108-126	0.1504	9	144-168	0.0870	12	180-210	0.0988	15
L2	0.0074	2	48-60	0.6747	6	96-120	0.1352	12	144-180	0.5833	18	192-240	0.2660	24	240-300	0.0677	30
L3	0.0111	2	66-78	1.4765	6	132-156	0.6035	12	198-234	0.5570	18	264-312	0.2119	24	330-390	0.0727	30
L4	0.0121	2	84-102	1.6440	9	168-204	1.1807	18	252-306	0.2158	27	336-408	0.0821	36	-------	------	--
L5	------	-	------	------	-	-------	------	--	-------	------	--	-------	------	--	-------	------	--

PSD - POWER SPECTRAL DENSITY

* TEST DURATION PER AXIS - 191.25 MINUTES

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TABLE VII - NARROWBAND RANDOM-ON-RANDOM VIBRATION FOR THE M109A3 SELF-PROPELLED HOWITZER

(155MM AMMUNITION TRANSPORTED ON THE SPONSON)

Test Phase	5-500 Hz Floor Level (g /HZ)	No. Sweeps	NARROWBAND 1 BW (Hz)	NARROWBAND 1 Ampl (g /Hz)	NARROWBAND 1 Sweep BW (Hz)	NARROWBAND 2 BW (Hz)	NARROWBAND 2 Ampl (g /Hz)	NARROWBAND 2 Sweep BW (Hz)	NARROWBAND 3 BW (Hz)	NARROWBAND 3 Ampl (g /Hz)	NARROWBAND 3 Sweep BW (Hz)	NARROWBAND 4 BW (Hz)	NARROWBAND 4 Ampl (g /Hz)	NARROWBAND 4 Sweep BW (Hz)	NARROWBAND 5 BW (Hz)	NARROWBAND 5 Ampl (g /Hz)	NARROWBAND 5 Sweep BW (Hz)
						VERTICAL AXIS * (38.25 minutes per test phase)											
V1	0.0022	5	36-48	0.0420	6	72-96	0.0155	12	------	0.0047	--	-------	------	--	-------	------	--
V2	0.0067	4	36-42	1.0916	3	72-84	0.2673	6	108-126	0.2593	9	144-168	0.0334	12	180-210	0.0524	15
V3	0.0096	2	48-60	2.2084	6	96-120	0.8362	12	144-180	0.0416	18	192-140	0.0597	24	240-300	0.0460	30
V4	0.0111	2	66-82	1.1492	8	132-164	2.0115	16	198-246	0.0777	24	264-328	0.1774	32	-------	------	--
V5	0.0118	2	90-108	2.1947	9	180-216	0.1052	18	270-324	0.1334	27	360-432	0.1078	36	-------	------	--
						TRANSVERSE AXIS * (38.25 minutes per test phase)											
T1	0.0018	10	18-24	0.0100	3	36-48	0.0088	6	------	------	--	-------	------	--	-------	------	--
T2	0.0052	4	36-42	0.1318	3	72-84	0.1507	6	108-126	0.0382	9	144-168	0.0352	12	180-210	0.0253	15
T3	0.0174	2	48-60	0.6971	6	96-120	0.1720	12	144-180	0.1021	18	192-140	0.1563	24	240-300	0.0457	30
T4	0.0072	2	66-78	0.4766	6	132-156	1.1241	12	198-234	0.0792	18	264-312	0.0934	24	330-390	0.0575	30
T5	0.0076	2	84-108	0.9133	12	168-216	0.1748	24	252-324	0.1324	36	336-432	0.0838	48	-------	------	--
						LONGITUDINAL AXIS * (38.25 minutes per test phase)											
L1	0.0012	5	24-36	0.0155	6	-----	------	--	-------	------	--	-------	------	--	-------	------	--
L2	0.0028	10	42-48	0.0094	3	84-96	0.0251	6	126-144	0.0067	9	168-192	0.0040	12	210-240	0.0058	15
L3	0.0026	2	54-66	0.0460	6	108-132	0.0172	12	162-198	0.0067	18	216-264	0.0098	24	270-330	0.0179	30
L4	0.0047	2	72-90	0.0364	9	144-180	0.0207	18	216-270	0.0179	27	288-360	0.1603	36	360-450	0.0064	45
L5	0.0032	2	96-108	0.0490	6	192-216	0.0310	12	288-324	0.0121	18	384-432	0.0245	24	-------	------	--

PSD - POWER SPECTRAL DENSITY

* TEST DURATION PER AXIS - 104.75 MINUTES

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APPENDIX D - TYPICAL TEST PLANS

D.1 SCOPE

D.1.1 Scope. This appendix provides examples of typical test plans for Level A ammunition packaging for hypothetical containers with a brief rationale regarding test plan formulation and selection.

EXAMPLE 1

TEST PLAN FOR PACKAGED 155MM PROPELLING CHARGES

10. Background. A 155MM propelling charge requires a water/vapor proof container capable of withstanding the hazards related to all modes of transportation as well as normal handling and storage.

20. Packaging solution. A lightweight metal container is developed to ship, handle, and store the propelling charge. The container is quick opening, cylindrical, sealed, and when loaded weighs 55 pounds. The loaded container will be unitized during the major portion of its logistic movement. However, the loaded container will be stored and transported inside the M109A3 Self Propelled Howitzer to complete its tactical mission.

30. Test program. Based upon the above information, the parameters which will determine the appropriate tests are as follows:

(a) Weight under 150 pounds (see Figure 1).

(b) Container material - steel.

(c) Sealed container.

(d) Packaged item will move in a fighting tactical vehicle.

(e) One propelling charge per container.

(f) POP tests are required.

30.1 Procedure. Twenty-four live loaded containers are required for the test program. Live propelling charges are used because inert charges are not readily available and the costs of live propelling charges are within acceptable levels. The test program developed is outlined below.

(a) Eighteen containers are pressure tested (see A.2.2).

(b) Container material tests (see 5.1.6) are not required because the container is steel and has an approved protection finish to meet NBC and corrosion requirements.

(c) A stacking test is conducted (see A.2.10).

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(d) Containers used to conduct stacking test are pressure tested (see A.2.2).

(e) The secured vibration test (see A.2.3) is conducted on six containers at ambient temperatures.

(f) The six containers (see 30.l(e)) are pressure tested (see A.2.2).

(g) The six containers are subjected to the three foot drop tests (see 6.4) at ambient temperature.

(h) The six containers (see 30.l(g)) are pressure tested (see A.2.2).

(i) The six containers are then subjected to horizontal and vertical loose cargo test (see A.2.13) at ambient temperature.

(j) The six containers (see 30.l(i)) are pressure tested (see A.2.2).

(k) If the containers have successfully passed all the previous tests, they are then subjected to the seven-foot drop test (see A.2.4) at ambient temperature.

(l) The six containers are pressure tested (see A.2.2) for information only since a seal is desired but not mandatory after the seven-foot drop.

(m) Since the loaded container is carried in a fighting tactical vehicle, the vibration schedule shown in Table I, Appendix C, will be conducted. Because these tests are conducted after the seven foot drop test, only the containers passing the pressure test (see 30.1(1)) need pass the pressure test after tactical vibration, but all containers shall be assessed for physical damage.

(n) All the previous tests (see 30.l(e) through 30.l(m)) conducted at ambient temperature willbe conducted on new containers at -65 degrees F and +160 degrees F, except for the pressure testsand stacking test (30.l(c)) which are conducted at ambient.

(o) POP tests (see 5.1.7), as required, are conducted on acceptable containers used during previous test. Note: The seven foot drops are more severe than the required POP four foot drops, therefore, the four foot drops need not be performed but 40 minutes of loose cargo vibration in accordance with inputs specified in 49CFR shall be conducted in addition to the 20 minutes of loose cargo vibration performed in 30.l(i).

(p) If the containers have passed all the previous tests, then the six untested loaded containers shall be subjected to the forty-foot drop test (see A.2.12.1) at the three temperatures.

(q) No other tests are required.

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EXAMPLE 2

TEST PLAN FOR 155M SEPARATE LOADED PROJECTILES

10. Background. The 155MM projectiles required a pallet for shipping and storage. There is no container used to package the individual projectiles. However, the pallet must be capable of withstanding the hazards related to all modes of logistical and tactical transportation as well as normal handling and storage. Projectiles after depalletization can be stored and transported inside the M109A3 Self Propelled Howitzer until ready to use.

20. Packaging solution. A wood pallet is selected to ship and store the projectiles. There are eight projectiles per pallet for a total weight of 875 pounds.

30. Test program. Based upon the above information, the parameters which will determine the appropriate test are as follows:

(a) Weight over 150 pounds (see Figure 2).

(b) Wood pallet (standard).

(c) Sealed projectile (No sealed container required).

(d) No packing material used affected by extreme temperatures unless previously tested (e.g., grommets).

(e) POP tests not required (Large articles without their means of initiation may be carried unpacked per 49CFR, see 5.1.7).

30.1 Procedure. The 155MM projectiles are rugged and can be reused, therefore, it is determined that only eight inert projectiles are required for the vibration/rough handling pallet tests and testing will be conducted at ambient temperature only because standard wood pallet is not affected by extreme temperatures. NOTE: Two live projectile will be required if the projectile is a cargo type to establish if the projectile submunitions are affected. An additional eight projectiles are required to complete the full pallet load forty foot drop test (two live loaded projectiles will be used in addition to the six inert), because safety considerations necessitate less than a full pallet load of live ammunition. The test program developed is outlined below.

(a) At ambient temperatures conduct a stacking test (see A.2.10), a hoisting test (see A.2.11), secured vibration test (see A.2.3), loose cargo test (see A.2.13), and handling tests (see A.2.5, A.2.6, A.2.7), and impact test (see A.2.8).

(b) At ambient temperature conduct sudden lift test (see A.2.11.1).

(c) After tests listed above are completed and if pallet is still serviceable, replace two inert projectiles with live loaded projectiles and conduct forty-foot drop test (see A.2.12.1) at ambient temperature.

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30.2 Alternate test plan. If the standard wood pallet design is modified (e.g., new design or materials that may be affected by extreme temperatures are used) or if the projectile is of a new design, then tests shall be conducted at -65 degrees F and +160 degrees F to establish design adequacy. In this situation the tests to be performed are as follows:

(a) Stacking test (see A.2.10) shall be conducted at +160 degrees F.

(b) Hoisting test (see A.2.11) and sudden lift test (see A.2.11.1) shall be conducted at -65 degrees F.

(c) Condition loaded pallet at -65 degrees F and while at temperature conduct secured vibration test (see A.3) and loose cargo test (see A.2.13).

(d) Condition loaded pallet at -65 degrees F and as rapidly as possible after removing pallet from conditioning chamber perform handling tests (see A.2.5, A.2.6, A.2.7 and A.2.8). NOTE: Reconditionloaded cargo pallet to -65 degrees F prior to each test.

(e) Repeat tests specified in paragraphs 30.2(b) and 30.2(d) at +160 degrees F.

(f) Replace two inert projectiles with live loaded projectiles on two pallets and perform forty-foot drop test (see A.2.12.1) at -65 degrees F and +160 degrees F.

Ambient temperature testing should be performed on a pallet prior to start of tests if it is deemed necessary to assure the packaging engineer that the pallet is rugged enough to survive the rough handling tests without effects of extreme temperature.

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EXAMPLE 3

TEST PLAN FOR 25MM, M762 HEI-T CARTRIDGE

10. Background. This 25MM cartridge will be used in the Bradley Fighting Vehicle and will be stored in its shipping container.

20. Packaging solution. A plastic container is developed to ship, handle and store the ammunition. This loaded container will be unitized.

30. Test program. Based upon the above information, the parameters which will determine the appropriate tests are follows:

(a) Weight under 150 pounds (see Figure 1).

(b) Container material - plastic.

(c) Sealed container.

(d) 30 cartridges per container.

(e) Packaged item will move in tactical vehicle.

(f) POP tests are required.

(g) Container materials used may be affected by extreme temperatures, react with energetic materials or environmental conditions.

30.1 Procedure. Twelve live loaded containers are required for the test program. The detailed test program is outlined below. Twelve containers are selected because the quantities of ammunition to load twenty four containers are not available.

(a) Twelve containers are pressure tested (see A.2.2).

(b) Six of the twelve are subjected in turn to the solar radiation test (see A.2.15), the temperature shock test (see A.2.16) and the high temperature test (see A.2.17). After completion of these tests conduct the pressure test (see A.2.2).

(c) These six containers shall be distributed as part of the six containers required for the environmental tests as follows: two for each of the three temperatures (-65 degrees F, +72 degrees F and +160 degrees F).

(d) A stacking test (see A.2.10) is conducted at +160 degrees F. Stacking test to be conducted on required containers prior to subsequent physical tests.

(e) Containers used to conduct stacking test are pressure tested (see A.2.2).

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(f) The vibration test (see A.2.3) is conducted on two containers at ambient temperatures.

(g) The two containers (see 30.l(f)) are pressure tested (see A.2.2).

(h) The same two containers are subjected to the three-foot drop test (see A.2.4) at ambient temperature.

(i) The two containers (see 30.l(h)) are pressure tested (see A.2.2).

(j) The two containers are then subjected to horizontal and vertical loose cargo test (see A.2.13) at ambient temperature.

(k) The two containers (see 30.l(j)) are pressure tested (see A.2.2).

(l) If the containers have successfully passed all the previous tests, they are then subjected to the seven-foot drop test (see A.2.4) at ambient temperature. Containers do not have to pass the pressure retention test after the seven foot drop, but it is desirable. Therefore, if containers do not show any outer damage they should be pressure tested for informational purposes.

(m) Since the loaded containers are carried in a fighting tactical vehicle, the vibration spectrum for the area where the containers are carried have to be obtained from the item engineer and the test conducted accordingly. The container does not have to pass the pressure test at the conclusion of this test if it did not pass the pressure test in 30.1(l), but all containers shall be assessed for physical damage.

(n) All the previous tests (see 30.l(d) through 30.l(m)) conducted at ambient temperature willbe conducted at -65 degrees F and +160 degrees F, except for pressure tests and stacking tests which are conducted at ambient and +160 degrees F respectively.

(o) POP tests (see 5.1.7), as required, are conducted on acceptable containers used during previous tests. NOTE: The seven-foot drops are more severe than the required POP four-foot drops, therefore, the four-foot drops need not be performed but 30 minutes of loose cargo vibration in accordance with inputs specified in 49CFR shall be conducted in addition to the 30 minutes of loose cargo vibration performed in 30.l(i).

(p) If the containers have passed all the previous tests, then the six untested loaded containers shall be subjected to the forty-foot drop test (see A.2.12.1) at the three temperatures.

(q) Upon successful completion of all the above physical tests, the next series of material tests can be conducted on empty new or acceptable used containers depending upon their physical condition.

(r) The following material tests shall be performed in any order depending upon availability of test equipment.

(1) Chemical resistance (see A.2.18).

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(2) Container burning characteristics (see A.2.19).

(3) Water vapor transmissibility (see A.2.20).

(4) Electrical conductivity (see A.2.21).

(5) Reactivity (non-volatile or volatile packaging materials, as applicable (see A.2.22/A.2.23).

(6) Vacuum stability (non-volatile or volatile packaging materials, as applicable (see A.2.24/A.2.25).

(7) Accelerated heat aging - environmental stress cracking (see A.2.28).

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EXAMPLE 4

TEST PLAN FOR 40MN CARTRIDGE BULK PACK

10. Background. It is proposed that a bulk pack of two hundred 40MM cartridges sensitive to moisture be developed to ship, store, and handle the ammunition. The ammunition will be delivered to the fighting tactical vehicle in the container and will be unloaded, and then stored and transported bare in ammunition storage racks inside the vehicle.

20. Packaging solution. A lightweight steel container is developed to ship, handle and store the ammunition. This loaded container is sealed and weighs 1400 pounds. The container will have built-in skids, hoisting rings, relief valve, externally mounted humidity indicator and desiccant receptacle and quick opening/closing latches. Plastic trays and internal blocking made from polyethylene (PE) foam are used to nest cartridges within the container.

30. Test program. Based upon the above information, the parameters which will determine the appropriate tests are as follows:

(a) Weight over 150 pounds (see Figure 2).

(b) Container material - steel (low alloy, high strength).

(c) Sealed desiccated container.

(d) Internal packing materials (e.g., plastic trays, PE foam, adhesives) used may be affected by extreme temperature or react with energetic materials.

(e) POP tests are not required (loaded container weight exceeds 882 pounds). Results of this test program shall be submitted to the DOT to obtain a Competent Authority Approval (CAA).

(f) Exterior container material and hardware may be affected by moisture.

30.1 Procedure. Four loaded containers, with the proper quantity of desiccant, will be used for the test program. Because of safety considerations, cartridges with only live primers and live fuzes will be used and the rest of the cartridges will be filled with inert material to bring total weight up to shipping weight. The test plan is as follows:

(a) Four containers are pressure tested (see A.2.2).

(b) At ambient temperature conduct a stacking test (see A.2.10), corrosion resistance (see A.2.27), and desiccant (humidity) test (see A.2.26). (These containers will continue to be used for subsequent environmental tests at low, ambient or high temperatures, as applicable.)

(c) The container used to conduct the stacking test (see 30.1(b)) is pressure tested (see A.2.2).

(d) At ambient temperature the container is subjected to a secured vibration test (see A.2.3).

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(e) The container is then pressure tested (see A.2.2).

(f) The container is then subjected to the loose cargo test (see A.2.13).

(g) The container is then pressure tested (see A.2.2).

(h) The container is then subjected to the rough handling/impact test (see A.2.5, A.2.6, A.2.7 and A.2.8)

(i) The container is then pressure tested (see A.2.2).

(j) The container is then subjected to the tiedown test (see A.2.14) and the hoisting test (see A.2.11) at ambient temperature.

(k) The container is then pressure tested (see A.2.2).

(l) The container is then subjected to the forklift test (see A.2.9) at ambient temperature.

(m) All the previous tests (30.l(d) through 30.1(l)) conducted at ambient temperature, and if satisfactorily passed, will be conducted at -65 degrees F and +160 degrees F except for pressure testing which shall be done at ambient temperature and hoisting test (see A.2.11), forklift (see A.2.9) and tiedown test (see A.2.14) need not be done. Use a container previously subjected to the desiccant (humidity) test (see 30.1(b)) and corrosion resistance (see 30.1(b)), one container at -65 degrees F and the other at +160 degrees F.

(n) Upon successful completion of all the above physical tests, the next series of material tests can be conducted on empty new or acceptable used containers depending upon their physical condition.

(o) The following material tests shall be performed, in any order, on internal packaging material depending on availability of test equipment.

(1) Electrical conductivity (see A.2.20).

(2) Reactivity (non-volatile or volatile packaging materials, as applicable, see A.2.22/A.2.23).

(3) Vacuum stability (non-volatile or volatile packaging material, as applicable, see A.2.24/A.2.25).

(p) At the successful conclusion of all the tests, then the one untested container shall be subjected to the forty foot drop test (see A.2.12.2) conducted at ambient temperature.

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APPENDIX E
ACCELERATED HEAT AGING - ENVIRONMENTAL STRESS CRACKING TEST (AHA-ESC)

E.1 SCOPE

E.1.1 Scope. This appendix provides additional information on the requirements for the accelerated heat aging – environmental stress cracking test in Sections 4 and 5.

E.1.2 Background. Although polyethylenes are typically tough, ductile materials with excellent chemical resistance to a wide range of chemicals, certain grades of polyethylene along with other plastic materials (see NOTE 10.1) are subject to failure by stress cracking. For critical applications, stress crack resistance should be part of the selection/acceptance criteria for both raw materials as well as for molded parts.

There are two common types of stress cracking that affect polyethylene:

- Environmental stress cracking (ESC)
- Thermal stress cracking (TSC)

ESC is a surface initiated brittle failure caused by a combination of stress and a surface active agent which is usually polar in nature. Chemicals such as aromatic and aliphatic hydrocarbons, animal, vegetable, and mineral oils and fats, soaps, some plasticizers, aldehydes, lower alcohols, silicones, acids, esters, some alkalis, wetting agents, and even water can act as ESC agents, see NOTE 10.2.

TSC creates cracks that appear similar to those caused by ESC. TSC is brought about by physical changes in the polymer due to the combined effects of stress and heat. Even moderately low temperatures at which no oxidation occurs can cause TSC if sufficient stress is present.

An ASTM test method, D1693, is used to rate the “Environmental Stress-Cracking of Ethylene Plastics”. The test method for the AHA-ESC of parts was developed by modifying the standard ASTM procedures and is contained in this Appendix. Also, the AHA-ESC test contained in this Appendix should be used during the initial part development as well as for production acceptance tests. The test method is provided as a guide and can be modified for specific application when so required and if acceptable to design authority.

NOTES:

10.1 Other plastic materials that may be susceptible to stress cracking due to “Heat Aging” and “Coming in Contact with Various Solvents and/or Reagents” are ABS, polystyrene, nylon, PBT & PET polyesters, polypropylene, PPO Norly, polycarbonate including alloys and glass reinforced grades and any combination thereof. These and other plastic materials should be tested using the solvent(s) and/or reagent(s) the material is sensitive to in place of Igepal (CO-630).

10.2 Anderson, Robert, 1958 SPE ANTEC, “Environmental Stress Cracking of Polyethylene Injection Molding - Practical Control and Test Methods,” p 940.

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20. Apparatus: Heating Oven/Chamber - An oven/chamber that can hold a constant temperature of +160 degrees F uniformly throughout the oven/chamber. Temperature fluctuations should not exceed ±5 degrees F.

30. Reagent: The test reagent (soap solution) may be a surface-active agent, or any liquid organic substance that is not absorbed appreciably by the polyethylene. One brand widely used is the Igepal CO-630 [nonylphenoxy poly(ethyleneoxy) ethanol]. For other plastic materials, replace the Igepal CO-630 with the solvent(s) and/or reagent(s) that the material is sensitive to. Reagents and/or solvents should be stored in closed metal or glass containers as applicable because of their hydroscopic nature.

40. Sample size:

(a) For containers under 150 pounds (total package weight): A sample size of 10 or more is desirable (a minimum of 5 is required).

(b) For containers over 150 pounds (total package weight): A sample size of a minimum of one is required.

(c) For components and material “tensile bars”: A sample size of 10 or more is desirable (a minimum of 5 is required).

50. Procedure:

(a) Stabilize oven/chamber to +160 degrees F.

(b) Examine and record the condition of each container. Make note of every nick or possible craze or crack internally as well as externally. For sealed containers, the test specimens shall be subjected to and shall pass the pressure retention test (see 5.3.6) prior to performing AHA-ESC test.

(c) Prepare a 2% aqueous reagent solution, enough to fill all the containers being tested. Fill each container with the 2% solution and close the containers with their covers secured tightly on their bodies/bases. Apply 100% pure reagent to exterior walls to each container by either dipping or brushing. For components apply 100% pure reagent throughout the part. Cover all containers/components/materials with a polyethylene covering (e.g., bags) to prevent evaporation.

(d) Place containers/components/materials (vertically and/or horizontally, as applicable) in the oven/chamber and record time, date and oven/chamber temperature.

(e) Examine the containers/components/materials after the first four hours and record any physical changes, including hairline cracks, using sketches, photographs, etc. Inspect twice a day after the first 24 hours for a total of 120 hours.

(f) Reapply reagent to the exteriors of the parts daily or more frequently as and when reagent evaporates.

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(g) Observe and record from the beginning of a hairline crack(s) to the development of a through crack(s). Record time, date, and temperature of oven/chamber when the observations are made.

(h) For sealed containers conduct 3 psig pressure retention tests per A.2.2. In the event of leakage, document location and size of the crack(s). The sealed containers with visible through cracks need not be tested for pressure retention.

60. Report: Record the following information:

- Complete identification of each container/component.
- Reagent strength, oven/chamber temperature, oven specification including make, model, size & date of calibration.
- Duration of test in hours.
- Percentage of containers failed along with number of containers tested.
- Acceptance criteria per 5.3.
- Date of test (start, finish), test operator and location of test facility.
- Record details of failure (3 psig seal, cracks, crazes, and through cracks) using sketches,photographs, etc.

10.3 Changes from previous revision. 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

Custodian:
Army-AR

Preparing activity:
Army-AR
(Project 8140-2022-004)

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