INCH-POUND

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MILITARY STANDARD

DESIGN AND TEST REQUIREMENTS FOR LEVEL A AMMUNITION PACKAGING

AMSC N/A

FSC 8140

FOREWORD

1. This military standard is approved for use by the U.S. Army Armament, Munitions and Chemical Command and is available for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, U.S. Army Armaments, Munitions and Chemical Command, ATTN: AMSMC-QA, Picatinny Arsenal, NJ 07806-5000 by using the self-addressed Standarization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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.

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1. SCOPE

1.1 Purpose. The intent of this document is to supply potential packaging designers with guidelines on the material, performance, and testing requirements which will lead to a container that can be successfully fielded for Army use. Obviously these guidelines can be tailored or modified to suit particular requirements for a unique piece of ammunition. However, prior to changing or altering the requirements it is mandatory that complete justification be made for these changes. At the satisfactory conclusion of the environmental tests listed 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 ammunition (excluding chemical). For purposes of this document conventional ammunition includes a broad category of hazardous material such as small arms, projectiles, propelling charges, fuzes, cartridges (i.e. tank, mortar), primers, detonators, rockets, grenades, mines, simulators, flares, etc. However, it will only apply to packaged ammunition meeting Level A (maximum military protection) packaging classification. It will also cover those packs and items (i.e. propellant) which require Level A protection for long term storage but are not normally fielded as tactical ammunition.

The Level A packaging requirements, in general, exceed the requirements of the Code of Federal Regulations, Title 49 and United Nations Transportation of Dangerous Goods. Conformance to Title 49 will insure compliance with safety and legal requirements for CONUS movement whereas this standard should insure the operability and safety of munitions when subjected to world-wide distribution, handling, transportation, and deployment.

1.3 Application. This standard applies broadly to all those munitions and munitions related materials which must be packaged to a Level A protection. The tests include only those conditions which 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.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 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 listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 2.4.1 and 9.1).

SPECIFICATIONS

FEDERAL

A-A-208	Ink, Marking, Stencil, Opague

MILITARY

MIL-Q-9858	Quality Program Requirements
MIL-V-27166	Valve, Pressure Equalizing, Gaseous Products
MIL-P-45449	Pallet, Units, Wood, for Shipment of Projectile Metal Parts, and Projectile Ammunition

STANDARDS

FEDERAL

FED-STD-595	Colors

MILITARY

MIL-STD-129	Marking for Shipment and Storage
MIL-STD-171	Finishing of Metal and Wood Surfaces
MIL-STD-648	Design Criteria for Specialized Shipping Containers
MIL-STD-650	Explosive: Sampling, Inspection & Testing
MIL-STD-731	Quality of Wood Member for Containers and Pallets
MIL-STD-810	Environmental Test Methods
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-45662	Calibration System Requirements

(Unless otherwise indicated, copies of federal and military specifications and standards are available from the Naval Publications and Forms Center (ATTN: NPODS), 5801, Tabor Avenue, Philadelphia, PA 19120-5099.)

2.1.2 Other Government documents, drawings and publications. The following other Government documents, drawings and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those in effect on the date of the solicitation (see 2.4.2).

CFR49	Code of Federal Regulations - Title 49
TB700-2	Department of Defense Explosives Hazard Classification Procedures
AR40-10	Health Hazard Assessment Program in Support of the Army Materiel Acquisition Decision Process
AR70-38	Research, Development, Test and Evaluation of Materiel for Extreme Climatic Conditions
AR70-47	Engineering for Transportability
AR700-15	Packaging of Materiel
AR740-1	Storage and Supply Activity Operations
AR746-1	Packaging of Army Materiel for Shipment and Storage
ITOP 1-2-601	Laboratory Vibration Schedules

2.2 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the document which are DOD adopted are those listed in the issue of the DODISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the non-Government documents which are current on the date of the solicitation (see 2.4.3 and 9.1).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM-A109	Steel Bars, Carbon, Cold Finished Standard Quality
ASTM-D257	DC Resistance or Conductance of Insulating Materials
ASTM-D880	Incline Impact Test for Shipping Containers
ASTM-D1008	Water Vapor Transmission of Shipping Containers

UNDERWRITERS LABORATORY

UL94	Test for Flammability of Plastic Materials for Parts in Devices and Appliances

INTERNATIONAL MARITIME ORGANIZATION

IMDG-CODE	International Maritime Dangerous Goods Code (IMDG)

UNITED NATIONS
TRANSPORT OF DANGEROUS GOODS UNITED NATIONS (UN)

INTERNATIONAL AIR TRANSPORT ASSOCIATION

IATA	Dangerous Goods Regulation

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.4 Sources of documents.

2.4.1 Government specifications and standards. Copies of the referenced federal and military specifications and standards are available from the Department of Defense Single Stock Point, Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120-5099. For specific acquisition functions, these documents should be obtained from the contracting activity or as directed by the contracting activity.

2.4.2 Other Government documents. Copies of other Government documents required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity. The documents listed may be obtained as follows:

a. Copies of the Code of Federal Regulations are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20404.

b. Army regulations are available at ARDEC, Picatinny Arsenal, NJ 07806-5000.

c. MIL-STD-1791 is available at ASD/ENES, Wright-Patterson AFB, OH 45433-6503.

2.4.3 Sources for non-Government publications. Non-Government documents are generally available for reference from libraries and technical groups. The documents listed may be obtained as follows:

a. ASTM: Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

b. Underwriters Laboratory (UL): Application for copies should be addressed to Underwriters Laboratory Inc., 333 Pfingsten Road, Northbrook, IL 60062.

c. IMDG: Application for copies shall be addressed to International Maritime Organization, London, England.

d. Transport of Dangerous Goods: United Nations, Sales Section, N.Y.

e. Dangerous Goods Regulations: International Air Transport Association, 2000 Peel Street, Montreal, Quebec CANADA H3A2R4.

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 or 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.

3.8 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 shall be 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 intransit storage from point of origin to ultimate user.

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

c. Deck shiploading 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 1 year.

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.

4. GENERAL REQUIREMENTS

4.1 Transportation, handling and storage.

4.1.1 Packaging. Service ammunition must be packaged and protected as required in AR700-15 and AR746-1 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 AR70-38. The packaging must also protect the packaged items in accordance with AR700-15, AR746-1, AR740-1, and AR70-47 from natural and induced environments which occur during 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 AR40-10 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 (i.e. CFR TITLE 49, IMDG Code, IATA).

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.

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 unpackaging.

b. The packaged ammunition shall be unitized at the LAP facility in a configuration with one dimension (length or width) not to exceed 44 inches, 54 inches in height, and 2500 pounds gross weight and be capable of being transported throughout the logistics system without reconfiguration. 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 IAW MIL-STD-1660.

c. The unitized configuration must be designed to withstand stacking to a height of 16 feet in all climatic conditions as prescribed in AR70-38. 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 (ropes, handles, etc.) 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 ammunition containers shall be capable of withstanding a pressure differential of $\pm$3 psi 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-V-27166. The container must be capable of being resealed, after opening, and withstand the $\pm$3 psi 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.

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 material. Material selection should be in conformance with the requirements of Title 49, CFR, unless a certificate of equivalency 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 (i.e. wood or fiber) can be used if watervaporproof seal is not required. 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 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 cold rolled steel. The basic container structure could be aluminum or hot or cold rolled 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. The material for container hardware shall be the same as 4.1.3.3.1. 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 or temperature shock.

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 material shall achieve a flame retardant rating of 94V-1 in accordance with Underwriters Laboratory (UL) Test for Flammability of Plastic Materials for Parts in Devices and

Appliances. If the proposed container packages the same hazardous material as an existing container then a comparison test can be conducted in lieu of the UL test. The external fire test described in TB700-2 shall be conducted on the proposed and the existing container. One container instead of five as the test sample shall be used and time to detonate compared. The time to detonation in the proposed container shall be equal to or greater than the time to detonation in the existing container.

d. The container will exhibit a water vapor transmission rate of less than .001 grams/100 sq. in./24 hours.

4.1.3.4 Container protective finish.

4.1.3.4.1 Metal container. The metal container shall be cleaned, pre-treated, and finished as indicated in Appendix A of MIL-STD-171 for the appropriate container material. Paint shall be lusterless, forest green, No. 34079, of FED-STD-595.

4.1.3.4.2 Plastic container. The color of the container shall be green matching any color equivalent to Nos. 34052, 34079, 34086, 34096, or 34102 of FED-STD-595.

4.1.3.5 Security seal. A security seal shall provide for the container to detect unauthorized entry.

4.1.3.6 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.

4.1.3.7 Re-useability. The container shall be re-useable, 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.).

4.1.3.8 Pallets. There are some munition items (such as 155mm and 8 inch projectiles) which are sealed and do not require a container for moisture protection. These items can be shipped on a wood pallet (MIL-P-45449) or a pallet fabricated from any other material provided that it can pass the environmental test for the load weight category. Obviously, under these circumstances the test plan has to be modified to eliminate the pressure retention test.

4.1.3.9 Markings.

4.1.3.9.1 Container marking. Required markings (ammunition nomenclature, national stock number, weight, etc.) on non porous materials (i.e. metal and plastic containers) or porous materials (i.e. wood boxes and pallets) shall be legibly and durably marked using ink, stencil, white, No. 37875 (FED-STD-595), Type I, III or IV per A-A-208 for non porous materials and Type II, III or IV per A-A-208 for porous materials. If stencil ink cannot be used for

marking plastic containers, other methods/procedures shall be investigated and presented to packaging engineer for approval. Use of MIL-STD-129 for location and required markings is suggested unless packaging engineer directs otherwise.

4.1.3.9.2 United Nations Performance Oriented Packaging (POP) Markings. When the container passes the POP tests as stated in 5.8 then POP markings shall be applied to the exterior container. The POP marking shall be as specified in "Transport of Dangerous Goods" published by the United Nations and shall be applied using white stencil ink as specified in 4.1.3.9.1. The POP markings shall be applied to end or side of container opposite the ammunition identification marking.

5. CONTAINER TESTING

5.1 Purpose. The purpose of container testing is to determine the ability of the container to protect the ammunition against the adverse affects 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 and 2 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, design qualification, 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 insure end item reliability. These tests should be performed only to packaged ammunition requiring a Level "A" packaging classification.

5.2 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.

5.3 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. At conclusion of tests, a report shall 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. 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

5.4 Test descriptions.

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

5.4.1.1 Vibration. The vibration tests are meant to simulate three types of field environment. One test, "loose cargo", is used to determine survivability when packaged ammunition is transported over rough roads in an unrestrained condition. The second test, "secured vibration", is a random vibration test used to simulate the environment encountered when packaged ammunition is 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 fighting tactical vehicle (FTV). When ammunition in its packaging configuration is placed in racks in the FTV, a third test, "rack vibration", is performed to simulate the random vibration that the packaged configuration will experience.

5.4.1.2 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.

5.4.1.2.1 Three-foot drop. This test simulates accidental free fall drops of packaged ammunition during storage, maintenance, or issue operations. The tests are conducted on packages of depalletized ammunition weighing 150 pounds or less.

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

5.4.1.2.3 Forty-foot drop. This test simulates accidental free fall drops during ship loading/unloading operations, and is normally performed on depalletized 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.

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

5.4.1.2.5 Sudden lift. This test is primarily designed for 155mm and 8 inch projectile pallets in order to determine the ability of the pallet cover and restraining components to withstand a sudden force when the pallet drops while being hoisted.

5.4.2 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.

5.4.3 Pressure retention. The pressure retention test is used to determine the ability of the container to prevent the entrance of moisture after normal logistical and tactical transportation/ handling, during extreme storage conditions, and air delivery.

5.4.4 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 affect of the material tests on the container may surface after the same container is then subjected to the physical tests.

5.4.4.1 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.

5.4.4.2 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.

5.4.4.3 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.

5.4.4.4 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.

5.4.4.5 Container combustibility. The container combustibility 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.

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

5.4.4.7 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.

5.4.4.8 Compatability. These tests are conducted to determine the compatability of any material that comes in contact with energetic materials.

5.4.5 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.

5.5 Test conditions. All tests, unless otherwise specified, shall be performed at three temperatures (-65 degrees F, ambient (72 degrees F), and +160 degrees F). 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 exterior pack) to produce test results equivalent to the expected if the entire load was live. These tests can be modified as 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 7 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.

5.6 Sequential testing of containers.

5.6.1 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) and the total number of items to load the required eighteen containers are not available, then the quantity of loaded containers required for testing can be reduced to 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.

5.6.1.1 Pressure retention test. Six (or two) containers shall be subjected to the pressure retention test, see 6.2. When the test procedures of 5.6.1.2, 5.6.1.3, 5.6.1.4, 5.6.1.5 are conducted at the specified temperatures, (see 5.5) 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 affects of extreme temperatures causing pressure fluctuations inside the container while trying to read or record pressure gauges. For acceptance criteria, see 7.6.1 and 7.6.2.

5.6.1.2 Stacking test. At least one container shall be subjected to the stacking test (see 6.10). For acceptance criteria, see 7.7.1.

5.6.1.3 Secured vibration test. Six (or two) containers shall be subjected to the secured vibration test (see 6.3) in three axes. For acceptance criteria, see 7.1, 7.3 and 7.4.

5.6.1.4 Three foot drop test. Six (or two) containers shall be subjected to the 36 inch drop test (see 6.4) in all six different orientations. For acceptance criteria, see 7.1, 7.3 and 7.4.

5.6.1.5 Loose cargo test. Six (or two) containers shall be subjected to the loose cargo test (see 6.13) in the vertical plane and in the horizontal plane, 90 degrees from the vertical plane. For acceptance criteria, see 7.1, 7.3 and 7.4.

5.6.1.6 Seven foot drop test. Six (or two) containers shall be subjected to the seven foot drop test (see 6.4) only once at each of six different orientations. For acceptance criteria, see 7.1, 7.3 and 7.4.

5.6.1.7 Rack vibration test. Six (or two) containers shall be subjected to the rack vibration test (see Appendix A) in three axes. For acceptance criteria, see 7.1, 7.3 and 7.4.

5.6.1.8 Forty foot drop test. The forty foot drop test (see 6.12.1) shall be performed on six untested containers. For acceptance criteria, see 7.1 and 7.2.

5.6.2 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. One additional container is required for the forty foot drop test to be conducted at ambient temperature unless the container is fabricated from a material which is effected by temperature extremes in which case two containers are required to be tested, one at -65 degrees F and one at +160 degrees F.

5.6.2.1 Pressure retention test. Each of the three containers shall be subjected to the pressure retention test (see 6.2). For acceptance criteria, see 7.6.1 and 7.6.3.

5.6.2.2 Stacking test. A container shall be subjected to the stacking test (see 6.10). For acceptance criteria, see 7.7.2.

5.6.2.3 Hoisting test. A container shall be subjected to the hoisting test (see 6.11). For acceptance criteria, see 7.4.b and 7.4.f.

5.6.2.4 Secured vibration test. A container shall be subjected to the secured vibration test (see 6.3) in three axes. For acceptance criteria, see 7.1, 7.3 and 7.4.

5.6.2.5 Loose cargo test. A container shall be subjected to the loose cargo test (see 6.13) in the vertical plane only. For acceptance criteria, see 7.1, 7.3 and 7.4.

5.6.2.6 Edgewise-cornerwise-rollover test. A container shall be subjected to the edgewise drop test (see 6.5), cornerwise drop test (see 6.6), and rollover test (see 6.7). For acceptance criteria, see 7.1, 7.3 and 7.4.

5.6.2.7 End impact test. A container shall be subjected to the pendulum impact test (see 6.8). For acceptance criteria, see 7.1, 7.3 and 7.4.

5.6.2.8 Tie down test. At ambient temperature a container shall be subjected to the tie down test (see 6.14). For acceptance criteria, see 7.4.b and 7.4.f.

5.6.2.9 Forty foot drop test. One (or two) container(s) shall be subjected to the forty foot drop test (see 6.12.2). For acceptance criteria, see 7.2.

5.6.2.10 Sudden lift test. A pallet (used for 155mm and 8 inch projectiles) shall be subjected to the sudden lift test (see 6.11.1). For acceptance criteria, see 7.4.d, 7.4.e and 7.5.

5.7 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 affect of solar radiation on non-metallic materials (i.e. 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 5.7.1, 5.7.2, 5.7.3) 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 5.6.1) 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 5.6.2), 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 insure that each container will be subjected to at least one material test prior to the physical tests. The remaining material tests (5.7.4 through 5.7.8) can be conducted on any available container or material provided that the test does not preclude the use of the container for subsequent tests.

5.7.1 Solar radiation test. One or two containers, as applicable, see 5.7, shall be subjected to the solar radiation test (see 6.15). For acceptance criteria, see 7.4 and 7.9.

5.7.2 Temperature shock test. One or two containers, as applicable, see 5.7, shall be subjected to the temperature shock test (see 6.16) except that the low temperature shall be -65 degrees F (-54 degrees C) instead of -71 degrees F (-57 degrees C). For acceptance criteria, see 7.4 and 7.9.

5.7.3 High temperature test. One or two containers, as applicable, see 5.7, shall be subjected to the high temperature test (see 6.17). For acceptance criteria, see 7.4 and 7.9.

5.7.4 Chemical resistance test. One or two containers (or material), as applicable, see 5.7, shall be subjected to the chemical resistance test (see 6.18). For acceptance criteria, see 7.4, 7.8.4 and 7.9.

5.7.5 Container combustibility test. One or two containers (or material), as applicable, see 5.7, shall be subjected to the combustibility test (see 6.19). For acceptance criteria, see 7.8.2.

5.7.6 Water vapor transmissibility test. One or two containers, as applicable, see 5.7, shall be subjected to the water vapor transmissibility test (see 6.20). For acceptance criteria, see 7.8.1.

5.7.7 Electrical conductivity test. One container (or material) shall be subjected to the electrical conductivity test (see 6.21). For acceptance criteria, see 7.8.3.

5.7.8 Compatability test. Any packaging materials, protective finish coatings, volatile corrosion inhibitor (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.

5.7.8.1 Reactivity test (non-volatile packaging materials). When non-volatile packaging materials are used for packaging, a reactivity test (see 6.22) shall be conducted. For acceptance criteria, see 7.8.5.

5.7.8.2 Reactivity test (volatile packaging materials). When volatile packaging materials, such as VCI coated material, are used for packaging, a reactivity test (see 6.23) shall be conducted. For acceptance criteria, see 7.8.6.

5.7.8.3 Vacuum stability test (non-volatile packaging materials). When non-volatile packaging materials are used for packaging, a vacuum stability test (see 6.24) shall be conducted. For acceptance criteria, see 7.8.7.

5.7.8.4 Vacuum stability test (volatile packaging materials). When volatile packaging materials are used for packaging, a vacuum stability test (see 6.25) shall be conducted. For acceptance criteria, see 7.8.8

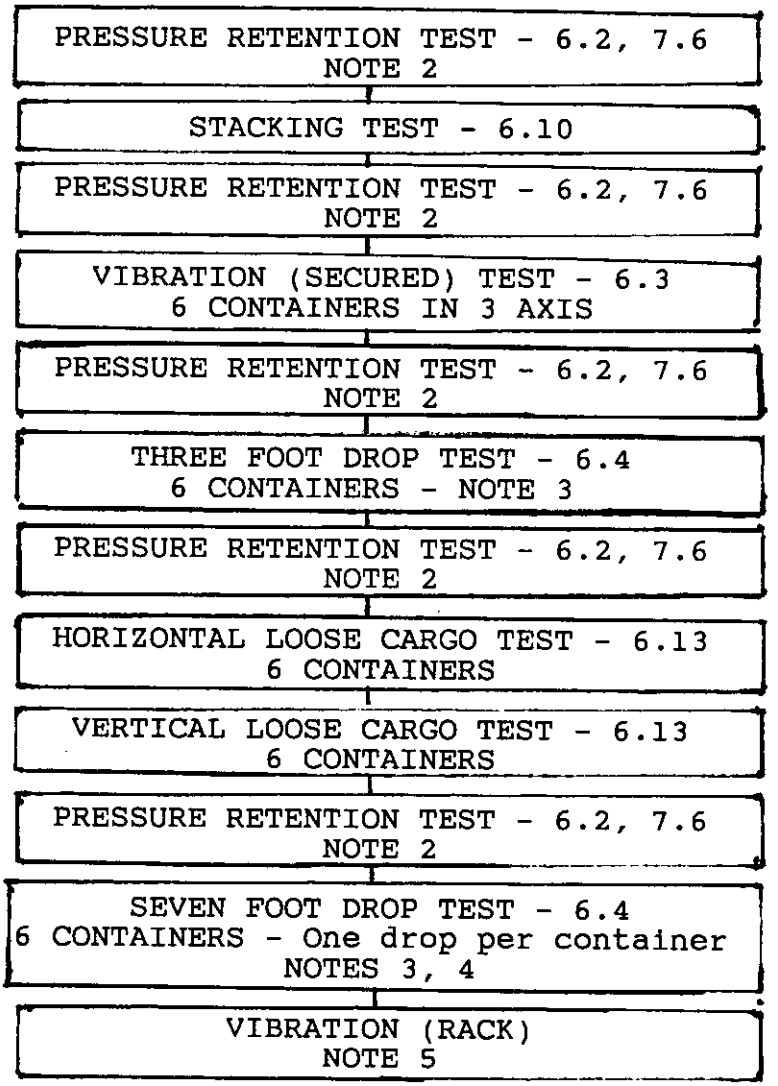
5.8 United Nations Performance Packaging (POP) Tests. In order to ship hazardous material worldwide the packaged items must meet the criteria specified in "Transport of Dangerous Goods" published by the United Nations. If the tests previously conducted to qualify the container are the same or more severe than those specified in the United Nations handbook then no separate tests are required for the U.N. tests. If not, then the tests must be conducted and the container meet the pass criteria as stated in the handbook. This UN document can be obtained from the United Nations Sales Section, New York, N.Y. Upon completion of the tests or previously conducted tests that satisfy the POP test requirements a test report in accordance with DD Form 1473 shall be prepared and submitted to the proper government agency.

5.9 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.

5.9.1 Packs under 150 pounds. 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. The four foot drop tests meet the requirements for Performance Oriented Packaging (POP) (see 5.8) for hazardous material and shall be tested at ambient temperature (72 degrees F). 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 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. An additional six untested containers will be required for the 40 foot drop test.

5.9.2 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. The four foot drop tests meet the requirements for Performance Oriented Packaging (POP) (see 5.8) for hazardous material and shall be tested at ambient temperature (72 degrees F) and two different drops for each container. NOTE: For economy reasons, the POP four foot drops are conducted as follow on tests to the vibration/handlilng 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, one additional container is required for the forty foot drop test to be conducted at ambient (72 degrees F) temperature. However, if the container is fabricated from a material which is affected by temperature extremes in which case two containers are required to be tested, one at -30 degrees F and one at +145 degrees F.

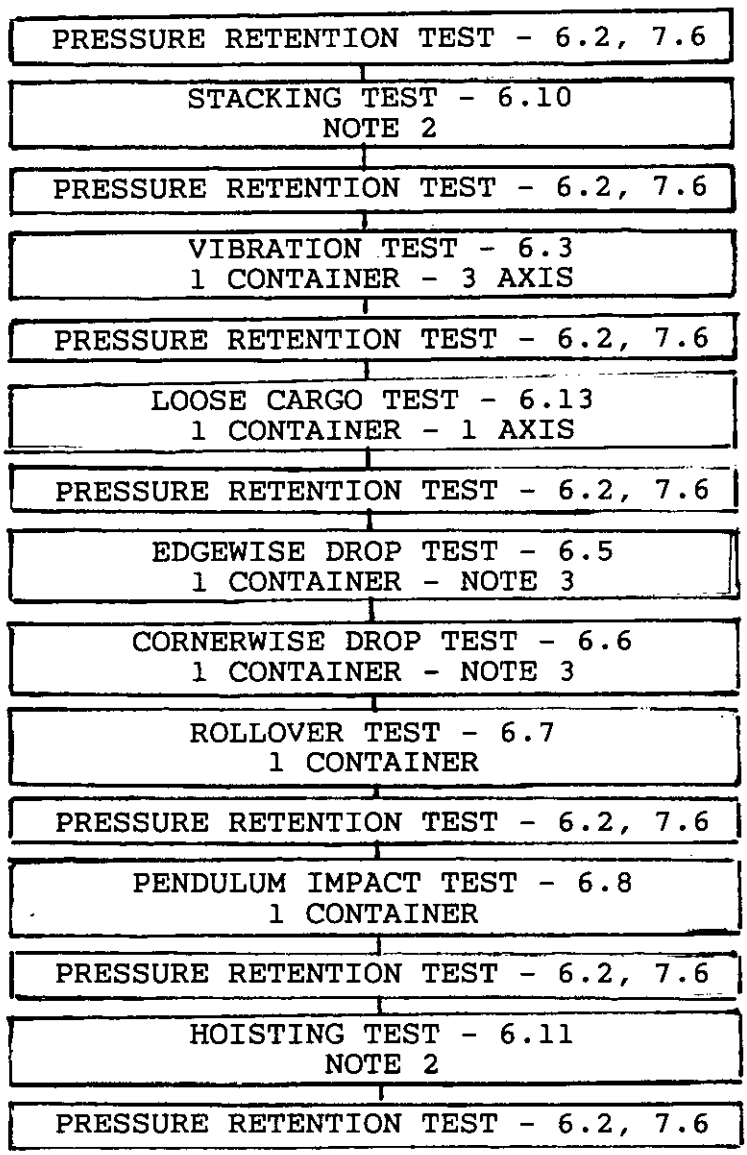
LEVEL A TACTICAL TEST PROCEDURES/SEQUENCE - Note 1



NOTES:
1. These tests are normally conducted at each of three temperatures, -65 degrees F, ambient, and +160 degrees F, thus requiring 18 exterior packs for complete test program (see 5.6.1).
2. Pressure retention test should be conducted at ambient temperature unless otherwise specified.
3. For package orientation see Figure 4.
4. Pressure retention test, 6.2, shall be conducted for information only.
5. If the ammunition in the packaged configuration is transported in the fighting tactical vehicle conduct appropriate rack vibration tests in accordance with Appendix A. Pressure retention test shall be conducted in accordance with 6.2 on containers that pass leak test after 7 foot drop test.

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

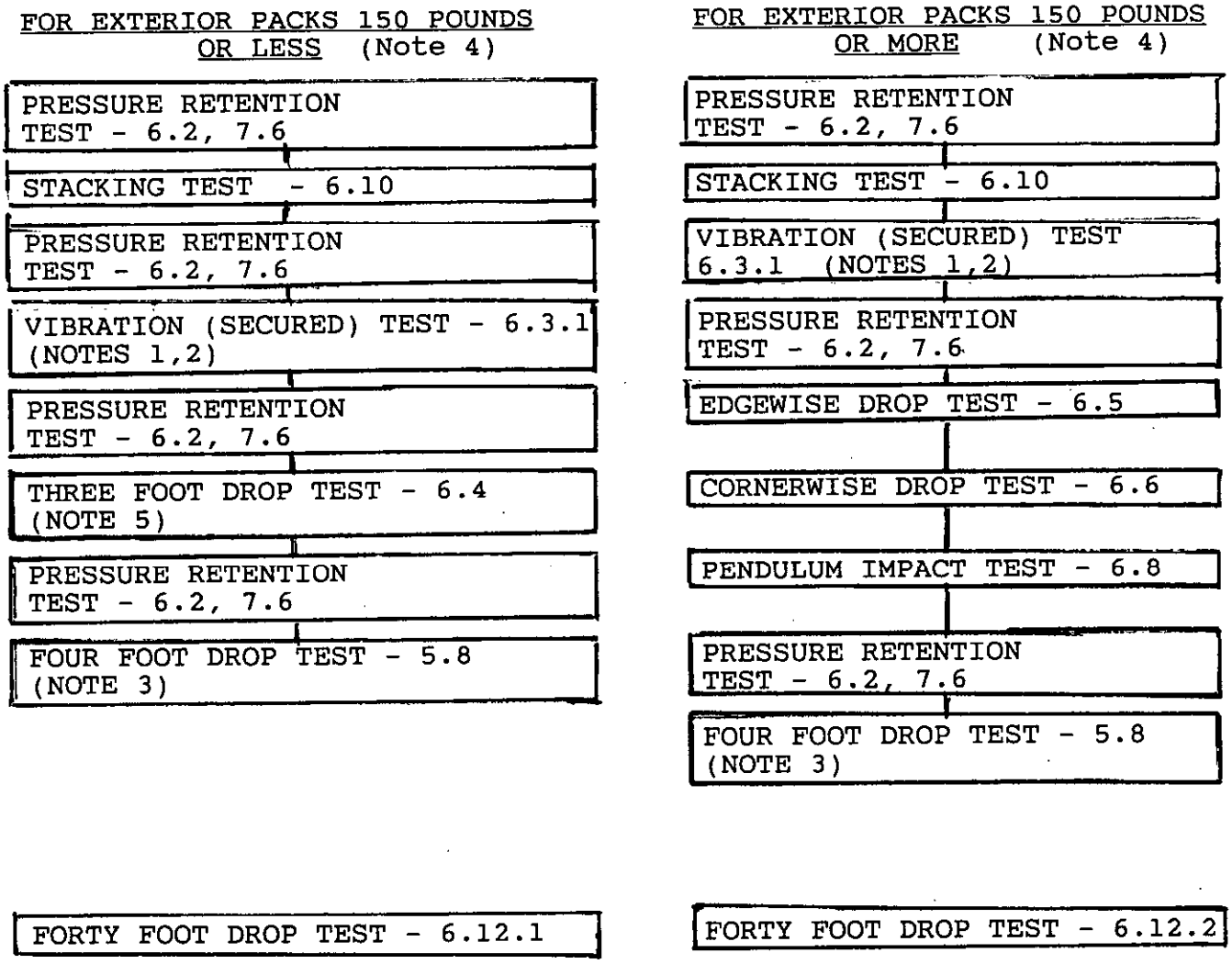
LEVEL A TACTICAL TEST PROCEDURES/SEQUENCE - Note 1



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 5.6.2).
2. These tests are conducted at ambient temperature only unless otherwise specified.
3. For container orientation see Figure 5 or 6 as applicable.

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

LEVEL A NON-TACTICAL TEST PROCEDURES/SEQUENCE



1. Perform test levels and conditions specified for Basic transportation, commom carrier environment, vertical axis 514.3-1, longitudinal axis 514.3-2, transverse axis 514.3-3.
2. Time per axis - 2 hours.
3. Environmental tests shall be performed in accordance with UN-Transport of Dangerous Goods at 72 degrees F. For container quantities see 5.9.1 or 5.9.2 as applicable.
4. Unless otherwise specified, conduct tests at temperatures of -30 degrees F, 72 degrees F, +145 degrees F.
5. Perform 3 foot drop tests in accordance with 6.4 except 7 foot drop test is not required.

FIGURE 3 - Transportation vibration/handling test

6. TEST PROCEDURES

6.1 Temperature conditioning. The tests, unless otherwise specified, shall be conducted at +160 degrees F, ambient (72 degrees F), and -65 degrees F. For the extreme temperatures, +160 degrees F and -65 degrees F, the packaged ammunition shall be conditioned for a minimum of 16 hours immediately prior to each test. Non metallic containers considered to be good insulators (i.e. plastic) may require longer periods of conditioning until the item temperature reaches the extremes. During testing, two temperature conditions can apply as noted below.

6.1.1 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.

6.1.2 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 (i.e. 6 - 3 foot drops).

6.2 Pressure retention. 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 than 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.

6.3 Vibration (secured 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. Random vibration shall be applied along each of three mutually perpendicular axes of the container in turn. The vibration schedules as shown below will be

applied to the containers. In addition to the afforementioned 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 A. For temperature testing 6.1 and 6.1.1 shall apply. For a more detailed description and background of the random vibration program see TECOM ITOP 1-2-601. Time schedules for vibration of items transported as secured cargo are as follows:

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

6.3.1 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 procedures 514.3-1 (vertical axis), 514.3-2 (longitudinal axis) and 514.3-3 (transverse axis) of MIL-STD-810. The vibration time per axis shall be 2 hours.

6.4 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, 6.1 and 6.1.2 shall apply.

6.4.1 Rectangular shaped containers. Each container shall be dropped six times from a height of 36 inches onto the impact surface at six different orientations (see Figure 4). Upon completion of the 36 inch drops, each container shall be dropped seven feet, once, at each orientation (see Figure 4).

TABLE I. RANDOM VIBRATION SCHEDULE - WHEELED VEHICLE

VERTICAL AXIS*		LONGITUDINAL AXIS*		TRANSVERSE AXIS*	
FREQ.	PSI VALUE**	FREQ.	PSI VALUE**	FREQ.	PSI 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

TABLE II. RANDOM VIBRATION SCHEDULE - 2 WHEELED TRAILER

VERTICAL AXIS*		TRANSVERSE AXIS*		LONGITUDINAL AXIS*	
FREQ.	PSI VALUE**	FREQ.	PSI VALUE**	FREQ.	PSI 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 32 Minutes per Axis.
** PSD - Power Spectral Density - G Squared per HZ

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

Test Phase	5-500 Hz Floor Level (g^2/HZ)	No. Sweeps	NARROWBAND 1 BW (Hz)	NARROWBAND 1 Ampl (g^2/Hz)	NARROWBAND 1 Sweep BW (Hz)	NARROWBAND 2 BW (Hz)	NARROWBAND 2 Ampl (g^2/Hz)	NARROWBAND 2 Sweep BW (Hz)	NARROWBAND 3 BW (Hz)	NARROWBAND 3 Ampl (g^2/Hz)	NARROWBAND 3 Sweep BW (Hz)	NARROWBAND 4 BW (Hz)	NARROWBAND 4 Ampl g^2/Hz	NARROWBAND 4 Sweep BW (Hz)	NARROWBAND 5 BW (Hz)	NARROWBAND 5 Ampl (g^2/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	1.0173	15
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	0.0079	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	1.0722	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.

6.4.2 Cylindrical shaped containers. Each container shall be dropped six times from a height of 36 inches onto the impact surface at six different orientations (see Figure 4). Upon completion of the 36 inch drops, each container shall be dropped seven feet, once, at each orientation (see Figure 4).

6.5 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, 6.1 and 6.1.2 shall apply.

6.6 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, 6.1 and 6.1.2 shall apply.

6.7 Rollover. The loaded container erected on its base on a rigid horizontal impact surface shall be tipped slowly sideways until it falls freely and by its own weight from the base to the side, side to the top, top to the other side and from the other side to the base thus completing one revolution. For temperature testing, 6.1 and 6.1.2 shall apply.

6.8 Pendulum impact. The loaded container shall be freely suspended by ropes, chains or cables and 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 raise 20.5 inches or to the required pendulum angle so that an impact velocity equal to 10.5± .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 if the container has been designed per MIL-STD-648. 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, 6.1 and 6.1.2 shall apply. See 6.9 as an alternative test method to this test.

6.9 Incline impact. This test is an alternate to the pendulum impact test, see 6.8. The test shall be 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 ± .5 feet per second. This test shall be applied to the container as delineated in 6.8.

6.10 Stacking. A load equal to a stacking height of 16 feet including pallets, if applicable, shall be 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 503.2-I (Hot - Dry) Method 503.2 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.

6.11 Hoisting. The loaded container /pallet shall be additionally loaded to three 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 ambient temperature only (+160 degrees F and -65 degrees F for a minimum of 1 hour if non-metallic material is used as part of the hoisting system or container structure). For +160 degrees F and -65 degrees F the temperature shall be obtained using 6.1 and 6.1.2. For special pallet hoisting test see 6.11.1.

6.11.1 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 effected by temperature extremes then the test shall be repeated at +160 degrees F and -65 degrees F on a new pallet. Temperature conditioning shall be in accordance with paragraphs 6.1 and 6.1.2.

6.12 Forty foot drop.

6.12.1 Containers under 150 pounds. Six loaded containers shall be dropped free from a height of 40 feet onto a rigid horizontal impact surface. The impacting orientation shall be as shown in Figure 4. At each temperature (-65 degrees F, 72 degrees F, and +160 degrees F) two of the six containers will be dropped at an orientation different from that previously done. The temperature shall be as obtained using 6.1 and 6.1.2.

6.12.2 Containers over 150 pounds. One (or two) loaded container(s) shall be dropped free fall from a height of 40 feet onto a rigid horizontal impact surface. 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. If one container is dropped, the test shall be conducted at a temperature of 72 degrees F. If two containers are dropped then the test temperature for one container will be -65 degrees F and the temperature for the other at 160 degrees F.

6.13 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. Rectangular containers shall be tested for 15 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 15 minutes + 1 minute on the bottom face (or top, if more vulnerable) and for 15 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 30 minutes for each type container. Loaded containers more than 150 pounds shall be tested for 30 minutes only in the normal shipping mode (usually on skids). The temperature should be obtained using 6.1 and 6.1.1.

6.14 Tiedown strength. A load shall be applied to each tiedown provision in the same way that it 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 (+160 degrees F for a minimum of 1 hours if non-metallic material is used as part of the tiedown system). For +160 degrees F, the temperature shall be obtained using 6.1 and 6.1.2.

6.15 Solar radiation. The solar radiation test shall be performed in accordance with method 505.2, Procedure II of MIL-STD-810.

6.16 Temperature shock. The temperature shock test shall be performed in accordance with method 503.2 of MIL-STD-810.

6.17 High temperature. The high temperature test shall be performed in accordance with method 501.2, Procedure II of MIL-STD-810.

6.18 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 fluids with 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 this test 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.

6.19 Container combustibility. The container shall be subjected to the combustibility test as specified in UL94, for Test for Flammability of Plastic Materials for Parts in Devices and Appliances. If there is an approved container for a similar ammunition item then a test to determine comparable cook-off times is acceptable. The test plan should be submitted to the packaging engineer for approval prior to test performance.

6.20 Water vapor transmissibility. Container(s) will be subjected to the water vapor transmissibility test (Method A) as specified in ASTM-D1008-64.

6.21 Electrical conductivity. A container shall be subjected to the electrical test procedures of ASTM-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 submitted to the packaging engineer for approval prior to test performance.

6.22 Reactivity (non-volatile packaging materials). The reactivity test for non-volatile packaging materials shall be performed in accordance with Method 503.1 per MIL-STD-650.

6.23 Reactivity (volatile packaging materials). The reactivity test for volatile packaging materials shall be performed in accordance with Method 503.1 per MIL-STD-650 with one difference from that of 6.22 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.

6.24 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.

6.25 Vacuum stability (volatile packaging materials). The vacuum stability test for volatile packaging materials shall be performed in accordance with Method 504.1 of MIL-STD-650 except that it is a comparison test. For specific procedure see 6.23.

7. ACCEPTANCE CRITERIA

7.1 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.

7.2 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 need not be functional.

7.3 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 judgement. Mechanical or physical damage to the ammunition which precludes the normal function of the ammunition is cause for container rejection.

7.4 Container - normal environment. The container shall not spill its contents. Minor damage to the exterior container, (inner container, if applicable,) for example: split wood, bent box hardware, dents in fiber/metal container, etc. are permissible. 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, opened, reclosed, and latched shut.

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

c. Pressure relief/bleed valve remains functional if present.

d. Stacking capability is not impaired.

e. Ammunition support and protection are maintained.

f. Pressure retention capability is maintained (see 7.6).

7.5 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.

7.6 Pressure retention.

7.6.1 Acceptance. A container will have failed the pressure retention test per 6.2 if there is an air flow exceeding 5 cc/min when container internal air pressure is maintained at 3 psi.

7.6.2 Loaded container under 150 pounds (see Figure 1). At the conclusion of the stacking and the vibration tests, all the containers must pass the pressure retention test. After the 3 foot drop test and the loose cargo test only two thirds of the containers tested are required to pass the pressure retention test at each temperature. As an example, if six containers are tested at 72 degrees F, two containers can fail the pressure retention test and the container can still be considered satisfactory. Air leakage as a result of container structural or weldment failure is not permissible regardless of the number of containers tested. If a test involves a total of six containers (5.6.1), two containers at each temperature, at least one container shall pass the pressure retention test at each temperature but a total of two containers can fail this test and the container design can still be considered satisfactory. No container is required to pass the pressure retention test after the 7 foot drop test, which is conducted for informational purposes only.

7.6.3 Loaded containers over 150 pounds (see Figure 2). All containers must pass the pressure retention test at the conclusion of the various environmental tests specified.

7.7 Stacking.

7.7.1 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.

7.7.2 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.

7.8 Container material tests.

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

7.8.2 Combustibility. The container shall achieve a rating of 94 V-1, (see 4.1.3.3.2c). If the munitions cook-off, test is performed, then there should be comparable results with a similar ammunition item in an approved container.

7.8.3 Electrical conductivity. The container shall have a volume resistivity below 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.

7.8.4 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 container to no longer remain waterproof is cause for rejection.

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

7.8.6 Reactivity (volatile packaging material). The increase in gas volume generated shall be no more than 3 ml above the volume of gas generated by the control sample.

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

7.8.8 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.

7.9 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.

8. TEST EQUIPMENT

8.1 General.

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

8.1.2 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 MIL-STD-45662 or MIL-Q-9858 for calibration cycle of 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 U.S. Bureau of Standards.

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.

8.1.3 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%

8.1.4 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.

8.2 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 18 inches of reinforced concrete or crushed rocks. The plate shall have a flat surface (not deformed from previous test impacts to the point where further proper angular impacts are prevented) and shall have a length and width of at least 2 times the maximum dimension of the tested container. Equipment such as an electric hoist and a remotely controlled magnetic release are recommended.

8.3 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 gauge pressure to nearest .05 psi per division and flow rate to nearest 0.1 cc/min.

8.4 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 A, 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 TECOM ITOP 1-2-601 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 at a constant temperature in the range of + 160 degrees F and -65 degrees F.

8.5 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 ASTM-A109, 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 of +160 degrees F to -65 degrees F.

8.6 Free fall drop test. The following equipment is required:

a. Lifting mechanism.

b. Suitable quick release device.

c. Suitable measuring device.

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 of +160 degrees F to -65 degrees F.

8.7 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 of +160 degrees F and -65 degrees F.

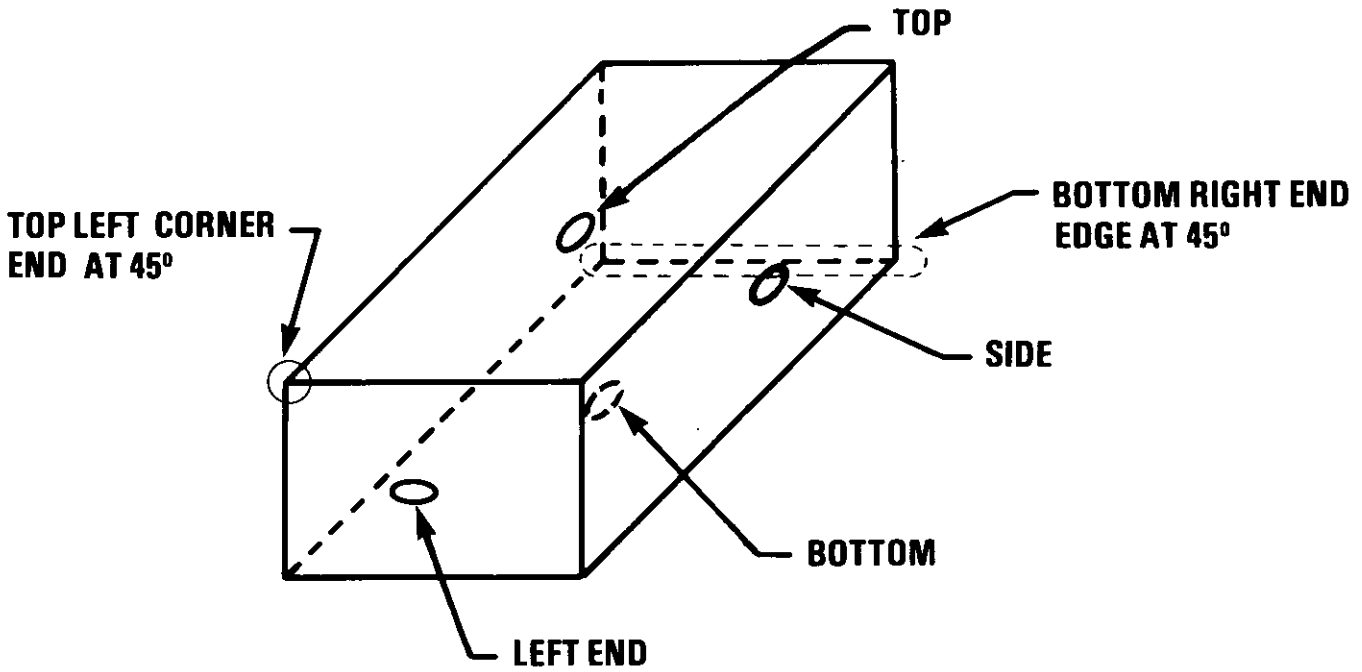
8.8 Incline impact test. To conduct this test, the following is required:

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

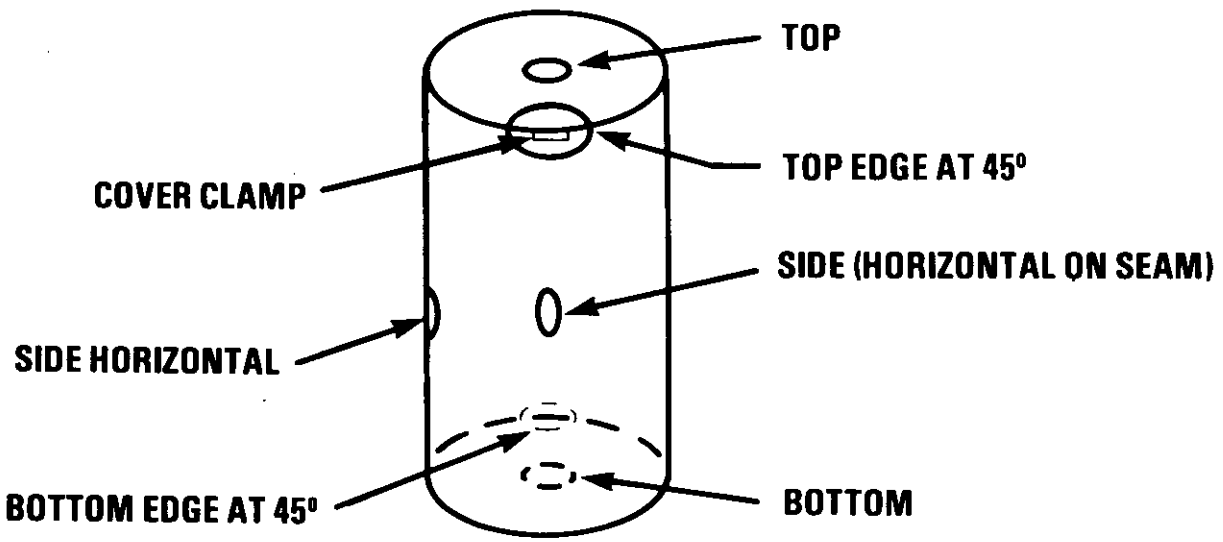
b. A rolling carriage dolly.

c. A rigid backstop (barrier) perpendicular to the track with a face made of group 4 woods (hard) per MIL-STD-731 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 of +160 degrees F and -65 degrees F.



RECTANGULAR CONTAINER



CIRCULAR CONTAINER

FIGURE 4 - Package Orientation

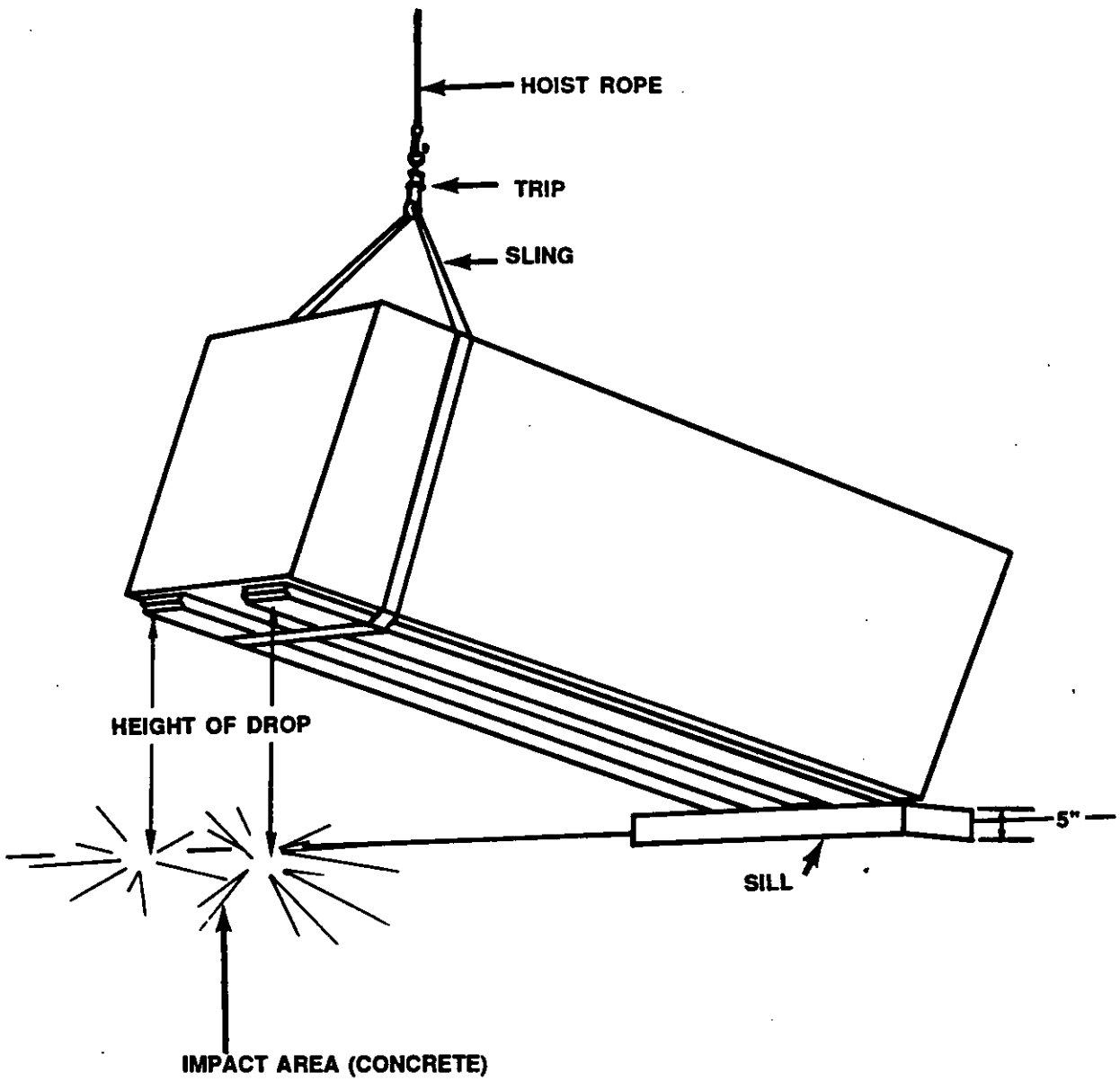


Figure 5. Edgewise drop (rotational)

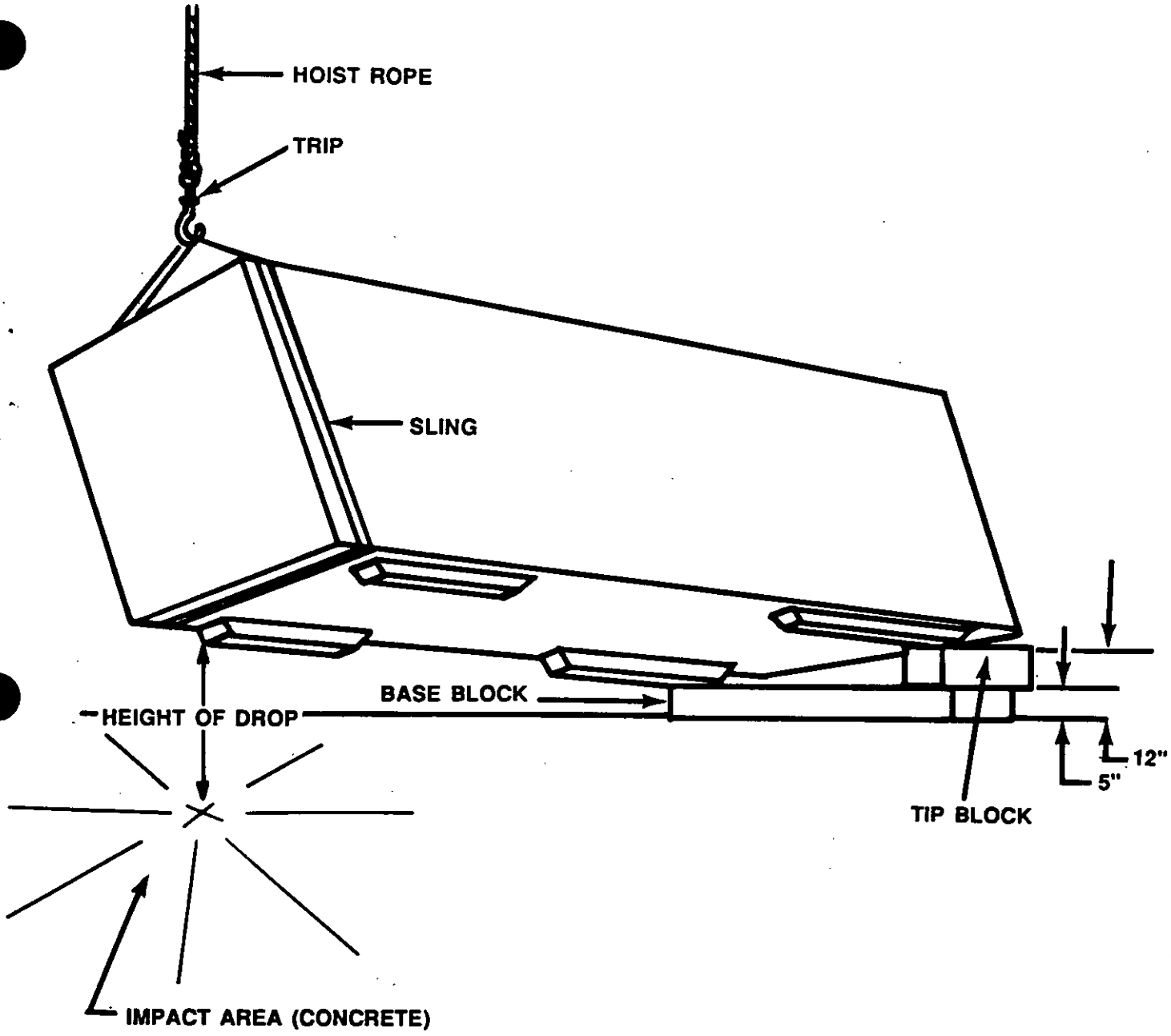


Figure 6. Cornerwise drop (Rotational)

9. NOTES

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

9.1 Issue of DODISS. When this standard is used in acquisition, the applicable issue of the DODISS must be cited in the solicitation (see 2.1.1 and 2.2).

9.2 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 must be performed:

9.3 Unitization. Containers must be unitized for shipment in order to meet Level "A" requirements. The unitization drawings are generated by the AMC Defense Ammunition Center and School. In addition to drawings, unitization tests are conducted, if necessary, to determine adequate tiedown/blocking and bracing procedures and provisions in various transport modes. Any unitized load of ammunition issued to the combat user in pallet size quantities shall have top lift capability. (NOTE: Palletized containers may not require unitization for shipment but they must meet the requirements of this paragraph.)

9.4 Hazard classification. In order to determine hazard class of the packaged ammunition, tests per TB700-2 must be conducted. Hazard class must be assigned prior to shipping any hazardous material.

9.5 Testing of packaged ammunition ready for release. The Test and Evaluation Command (TECOM) will 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.

9.6 Aircraft delivery. Aircraft delivery requires performing dynamic drop tests to determine adequacy of parachute rigging. These tests could include Low Altitude Parachute Extraction System (LAPES), Low and High Velocity Parachute and Malfunction Parachute Tests. The design of the rigging is the responsibility of Natick Research and Development Center and testing is performed by TECOM.

9.7 Subject term (keyword) listing.

Ammunition
Design, Packaging
Level A
Pack
Packaging
Testing, Packaging

APPENDIX A

RACK VIBRATION

10. Vibration (rack). In addition to secured-cargo transportation vibration (see 6.3) 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, ambient, +160 degrees F), 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 psi seal, if the container did not pass the pressure retention test after the 7 foot drop.

Tables IV and V 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.

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

Test Phase	5-500 Hz Floor Level (g^2/Hz)	No. Sweeps	NARROWBAND 1 BW (Hz)	NARROWBAND 1 Ampl (g^2/Hz)	NARROWBAND 1 Sweep BW (Hz)	NARROWBAND 2 BW (Hz)	NARROWBAND 2 Ampl (g^2/Hz)	NARROWBAND 2 Sweep BW (Hz)	NARROWBAND 3 BW (Hz)	NARROWBAND 3 Ampl (g^2/Hz)	NARROWBAND 3 Sweep BW (Hz)	NARROWBAND 4 BW (Hz)	NARROWBAND 4 Ampl (g^2/Hz)	NARROWBAND 4 Sweep BW (Hz)	NARROWBAND 5 BW (Hz)	NARROWBAND 5 Ampl (g^2/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

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

(155MM COPPERHEAD TRANSPORTED ON THE SPONSON)

Test Phase	5-500 Hz Floor Level (g^2/Hz)	No. Sweeps	NARROWBAND 1 BW (Hz)	NARROWBAND 1 Ampl (g^2/Hz)	NARROWBAND 1 Sweep BW (Hz)	NARROWBAND 2 BW (Hz)	NARROWBAND 2 Ampl (g^2/Hz)	NARROWBAND 2 Sweep BW (Hz)	NARROWBAND 3 BW (Hz)	NARROWBAND 3 Ampl (g^2/Hz)	NARROWBAND 3 Sweep BW (Hz)	NARROWBAND 4 BW (Hz)	NARROWBAND 4 Ampl (g^2/Hz)	NARROWBAND 4 Sweep BW (Hz)	NARROWBAND 5 BW (Hz)	NARROWBAND 5 Ampl (g^2/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	961202	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* (47.8 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	0.0-58	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 - 191.25 MINUTES

APPENDIX B

TYPICAL TEST PLANS

The following examples represent typical test plans 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/vaporproof 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 not required (7 foot drops exceed POP 4 foot requirement)

O30.1 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 6.2).

b. Container material tests (see 5.7) are not required because the container is steel.

c. A stacking test is conducted (see 6.10).

d. Containers used to conduct stacking test are pressure tested (see 6.2).

e. The secured vibration test (see 6.3) is conducted on six containers at ambient temperatures.

f. The six containers (see 30.1e) are pressure tested (see 6.2).

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

h. The six containers (see 30.1g) are pressure tested (see 6.2).

i. The six containers are then subjected to horizontal and vertical loose cargo test (see 6.13) at ambient temperature.

j. The six containers (see 30.1i) are pressure tested (see 6.2).

k. If the containers have successfully passed all the previous tests they are then subjected to the seven foot drop test (see 6.4) at ambient temperature.

l. The six containers are pressure tested (see 6.2) 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 A will be conducted. Because these tests are conducted after the seven foot drop test only the containers passing the pressure test (see 30.1l) need pass the pressure test after tactical vibration but all containers shall be assessed for physical damage.

n. All the previous tests (see 30.1e through 30.1m) conducted at ambient temperature will be conducted on new containers at -65 degrees F and +160 degrees F except for the pressure tests and stacking test (30.1c) which are conducted at ambient.

o. 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 6.12.1) at the three temperatures.

p. No other tests are required.

EXAMPLE 2

TEST PLAN FOR 155MM 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. Projectiles exposed to the atmosphere

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

e. POP tests may be required

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. 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 6.10), a hoisting test (see 6.11), secured vibration test (see 6.3), loose cargo test (see 6.13) and handling tests (see 6.5, 6.6, 6.7), and impact test (see 6.8).

b. At ambient temperature conduct sudden lift test (see 6.11.1).

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 6.12.1) at ambient temperature.

30.2 Alternate test plan. If the standard wood pallet design is modified (i.e. new design or materials that may be affected by extreme temperatures are used), 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 6.10) shall beconducted at +160 degrees F

b. Hoisting test (see 6.11) and sudden lift test (see 6.11.1) shall be conducted at -65 degrees F

c. Condition loaded pallet at -65 degrees F and while at temperature conduct secured vibration test (see 6.3) and loose cargo test (see 6.13).

d. Condition loaded pallet at -65 degrees F and as rapidly as possible after removing pallet from conditioning chamber perform handling tests (see 6.5, 6.6, 6.7 and 6.8). NOTE: Recondition loaded cargo pallet to -65 degrees F prior to each test.

e. Repeat tests specified in paragraphs 31.1.b and 31.1d at +160 degrees F.

f. Replace two inert projectiles with live loaded projectiles on two pallets and perform forty foot drop test (see 6.12.1) at -65 degrees F and +160 degrees F.

Ambient temperature testing can 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.

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 as 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 not required (7 foot drops exceed POP 4 foot requirements).

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 6.2).

b. Six of the twelve are subjected in turn to the solar radiation test (see 6.15), the temperature shock test (see 6.16) and the high temperature test (see 6.17). After completion of these tests conduct the pressure test (see 6.2).

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 6.10) is conducted at 160 degrees F. Stacking test to be conducted on required containers prior to subsequent physical tests.

e. Container used to conduct stacking test are pressure tested (see 6.2).

f. The vibration test (see 6.3) is conducted on two containers at ambient temperatures.

g The two containers (see 30.1f) are pressure tested (see 6.2)

h. The same two containers are subjected to the three foot drop test (see 6.4) at ambient temperature.

i. The two containers (see 30.1h) are pressure tested (see 6.2).

j. The two containers are then subjected to horizontal and vertical loose cargo test (see 6.13) at ambient temperature.

k. The same two containers (see 30.1j) are pressure tested (see 6.2).

l. If the containers have successfully passed all the previous tests, they are then subjected to the seven foot drop test (see 6.4) 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 30.1.1 if it did not pass the pressure test after 7 foot drop but all containers shall be assessed for physical damage.

n. All the previous tests (see 30.1d through 30.1m) conducted at ambient temperature will be 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. If the containers have passed all the previous tests, (see 30.1m) then the six untested loaded containers shall be subjected to the forty foot drop test (see 6.12.1) at the three temperatures.

p. 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.

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

1. Chemical resistance (see 6.18)

2. Container combustibility (see 6.19).

3. Water vapor transmissability (see 6.20).

4. Electrical conductivity (see 6.21).

5. Reactivity (non-volatile packaging materials) (see 6.22)

6. Vacuum stability (non-volatile packaging materials) (see 6.2.5)

EXAMPLE 4

TEST PLAN FOR 40MM CARTRIDGE BULK PACK

10. Background. It is proposed that a bulk pack of two hundred 40MM cartridges 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 and hoisting rings.

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.

c. Sealed container.

d. No packing is to be used affected by extreme temperatures.

e. POP tests not required (loaded container weight exceeds 880 pounds).

30.1 Procedure. Four containers 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 cartridge 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 6.2).

b. At ambient temperature conduct a stacking test (see 6.10). (This container will continue to be used for subsequent environmental tests at ambient temperatures.)

c. The container used to conduct the stacking test (see 30.1b) is pressure tested (see 6.2).

d. At ambient temperature the container is subjected to a secured vibration test (see 6.3).

e. The container is then pressure tested (see 6.2).

f. The container is then subjected to the loose cargo test (see 6.13).

g. The container is then pressure tested (see 6.2).

h. The container is then subjected to the rough handling/impact test (see 6.5, 6.6, 6.7 and 6.8).

i. The container is then pressure tested (see 6.2).

j. All the previous tests (30.1d through 30.1i) conducted at ambient temperature, 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

k. The container is then subjected to the tie down test (see 6.14) and the hoisting test (see 6.11) at ambient temperature.

l. At the successful conclusion of all the tests, then the one untested container shall be subjected to the forty foot drop test (see 6.12.2) is conducted at ambient temperature.

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