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DEPARTMENT OF DEFENSE
DESIGN CRITERIA STANDARD

AMMUNITION UNIT LOADS

AMSC N/A FSC 8140

FOREWORD

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

2. This standard establishes minimum design and evaluation procedures to be applied throughout the Department of Defense to unit loads of ammunition. It provides guidelines covering unit loads for ammunition designed to establish reliability, safety, and compatibility with handling equipment most commonly found in the distribution system.

3. When ammunition items, packaged or unpackaged, are moved from one place to another, they are usually combined into a larger assemblage which can be easily and safely handled by mechanized equipment; e.g., a forklift truck. This assemblage is called a unit load.

4. The ammunition logistics system of the Department of Defense is based on distribution in unit loads unless the item, as packaged, is too large or too heavy to be so assembled. A unit load may be stored for prolonged periods before it is needed. It may be shipped by truck, rail, ship, or aircraft. Depending upon the particular operations of the consuming combatant unit, the unit load must withstand the rigors of over the beach handling, local transport and handling over rough terrain, or delivery by external or internal carriage by helicopter under the threat of enemy action, or by transfer-at-sea, or by combinations of these methods, at any time and under poor weather conditions. In addition to possible adverse effects on the reliability of the ammunition, failures of unit loads can lead to death or injury from falling heavy objects or from disastrous explosion. Because of these factors, a detailed design must be prepared, tested, and documented showing how the ammunition is to be assembled into a unit load, which will be safe and efficient to handle, ship, store, and deliver to the combatant unit.

5. This is a mandatory standard for use by DoD ammunition design activities and when applicable is to be invoked in specifications, purchase descriptions, and/or contracts when such design service is to be procured. It applies to ammunition terms as prepared for shipment and not necessarily to metal parts, bulk, explosives, and other components.

6. Comments, suggestions, or questions on this document should be addressed to Commanding Officer, Naval Surface Warfare Center, Indian Head Division, Detachment Earle, Code E421, Colts Neck, NJ 07722 or emailed to CommandStandards@navy.mil with the subject line “Document Comment”. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil.”

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1. SCOPE

1.1 Scope. This standard establishes minimum design criteria and associated tests for ammunition unit loads.

1.1.1 Non-ammunition unit loads. This standard will not be used for the palletization of general supplies or semi-perishable subsistence (see 6.1.1).

2. APPLICABLE DOCUMENTS

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

2.2 Government documents.

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

INTERNATIONAL STANDARDIZATION AGREEMENTS

STANAG-2828	-	Military Pallets, Packages and Containers

INTERNATIONAL STANDARDIZATION DOCUMENTS

AAP-23	-	NATO Glossary of Packaging Terms and Definitions (English and French)

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-P-23312	-	Pallets, Material Handling, Metal (for Ordnance Items); Mark 3 Mod 0, Mark 12 Mod 0 and Mark 12 Mod 1

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-648	-	Design Criteria for Specialized Shipping Containers
MIL-STD-810	-	Environmental Engineering Considerations and Laboratory Tests
MIL-STD-2073-1	-	Standard Practice for Military Packaging

DEPARTMENT OF DEFENSE HANDBOOKS

MIL-HDBK-1791	-	Designing for Internal Aerial Delivery in Fixed Wing Aircraft

(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or http://assist.daps.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 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 of these documents are those cited in the solicitation or contract.

AERONAUTICAL SYSTEMS CENTER

AFSC Design Handbook DH 1-11	-	Air Transportability

(Copies of this document are available from the Aeronautical Systems Center, 2530 Loop Road West, Wright-Patterson AFB, OH 45433 or online at http://engineering.wpafb.af.mil/engstds/engstds.asp.)

MILITARY SEALIFT COMMAND

MSC TW023-AB-WHS-010	-	Handling and Stowage of Ammunition Aboard MSC Class Ships

(Copies of this document are available from the Naval PHST Center, 201 Highway 34, Colts Neck, NJ 07722.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA) (CODE 10001 & 53711)

DRAWINGS

564200	-	Mk 3 Mod 0 Pallet
2086479	-	Mk 12 Mod 0 Pallet
2614969	-	Mk 85 Mod 0 Pallet Sling
2614970	-	Mk 86 Mod 0 Pallet Sling
2614971	-	Mk 87 Mod 0 Pallet Sling
2642587	-	Mk 93 Mod 0 Pallet Sling
2642914	-	Mk 99 Mod 0 Weapons Handling Sling
2643919	-	Mk 100 Mod 1 Pallet Sling
2643482	-	Mk 105 Mod 0 Hoisting Sling
2644390	-	Mk 105 Mod 0 Hoisting Sling Long Leg Assembly
2645180	-	Mk 123 Mod 0 Pallet Sling
2645217	-	Mk 12 Mod 1 Pallet
5167555	-	Mk 109 Mod 1 Container Lifting Sling
7516578	-	Mk 85 Mod 1 Pallet Sling
7516579	-	Mk 86 Mod 1 Pallet Sling
7516580	-	Mk 87 Mod 1 Pallet Sling
7516581	-	Mk 100 Mod 2 Pallet Sling

(Copies of these documents are available from the Commander, Naval Sea Systems Command, ATTN: SEA 05M2, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or by email at CommandStandards@navy.mil.)

PUBLICATIONS

NAVSEA OP 3221 (Army TM 55-607)	-	Loading & Stowage of Military Ammunition & Explosives Aboard Break Bulk Merchant Ships; Rev 2
NAVSEA SW023-AJ-WHS-010	-	Technical Manual, Handling and Stowage of Amphibious Assault Ammunition Aboard Amphibious Ships

(Copies of these documents are available from the Naval Logistics Library, 5450 Carlisle Pike, Mechanicsburg, PA 17055 or online at http://nll.ahf.nmci.navy.mil.)

U.S. ARMY DEFENSE AMMUNITION CENTER

AC200000331	-	Sling, Adjustable, Double Basket
AC200000332	-	Sling, Multiple Leg Projectile Pallet
AC200000398	-	Sling, Multiple Leg Top-Lift Ammunition Pallet
ACV00561	-	Unit Load Marking for Shipment and Storage, Ammunition and Explosives
ACV00617	-	Pnuematic Sealles Combination Tool for 3/4" Steel Strapping (Clipless Seals)
AMC 19-48-4116-20PA1002	-	Basic Procedures – Unitization Procedures for Boxed Ammunition and Components on 4-Way Entry Pallets
DA PAM 746-1	-	Pallets and Storage Aids for Army Use

(Copies of these documents are available from the U.S. Army Defense Ammunition Center, Transportation Engineering Division, 1C Tree Road, Building 35, McAlester, OK 74501-9053 or online at https://www3.dac.army.mil/.)

CODE OF FEDERAL REGULATIONS (CFR)

46 CFR 146.29-180	-	Regulations Governing the Transportation of Military Explosives and Hazardous Munitions on Board Vessels
49 CFR 170-178	-	Hazardous Material Regulations of the Department of Transportation

(Copies of these documents are available from the Superintendent of Documents, U.S. Government Printing Office, Washington DC 20401 or online at www.gpoaccess.gov/index.html.)

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

AMERICAN LUMBER STANDARD COMMITTEE, INCORPORATED

Voluntary Product Standard PS 20	-	American Softwood Lumber Standard (DoD Adopted)

(Copies of this document are available from the American Lumber Standard Committee, Incorporated, P.O. Box 210, Germantown, MD 20875-0210 or online at http://www.alsc.org/untreated_ps20_mod.htm.)

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI S1.1	-	Acoustical Terminology

(Copies of these documents are available from the American National Standards Institute, 25 W. 43rd St, 4th Floor, New York, NY 10036 or online at http://webstore.ansi.org/.)

ASTM INTERNATIONAL

ASTM D3953	-	Standard Specification for Strapping, Flat Steel and Seals (DoD Adopted)
ASTM D4003	-	Standard Test Methods for Programmable Horizontal Impact Test for Shipping Containers and Systems
ASTM D5277	-	Standard Test Method for Performing Programmed Horizontal Impacts Using an Inclined Impact Tester

ASTM D6199 - Standard Practice for Quality of Wood Members of Containers and Pallets (DoD Adopted)

ASTM F1667 - Standard Specification for Driven Fasteners: Nails, Spikes, and Staples (DoD Adopted)

(Copies of these documents are available from ASTM International, 100 Barr Harbor Dr., P.O. Box C700, West Conshohocken, PA 19428-2959 or online at www.astm.org.)

BUREAU OF EXPLOSIVES

Pamphlet No. 6C - Illustrating Methods for Loading and Bracing Trailers and Less-than-Trailer Shipments of Explosives and Other Dangerous Articles Via Trailer-on-Flat-Car (TOFC) or Container-on-Flat-Car (COFC)

(Copies of this document are available from the Bureau of Explosives, Association of American Railroads, 1920 L Street, N.W., Washington DC 20036.)

INTERNATIONAL PLANT PROTECTION CONVENTION (IPPC)

ISPM No. 15 - Guidelines for Regulating Wood Packaging Material in International Trade

(Copies of this standards are available from IPPC Secretariat, FAO-AGPP, Viale Delle Terme di Caracalla, 00100 Rome, Italy, telephone (39) 06 5705 4812, facsimile (39) 06 5705 6347 or online at www.ippc.int.)

SAE INTERNATIONAL

SAE AS5389 - Pallet Lift Truck and Container Fork Pocket Interface

(Copies of this document are available from SAE World Headquarters, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or online at www.sae.org.)

2.4 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.

3. DEFINITIONS

3.1 General. The terms used throughout this standard are consistent with the following definitions. Packaging terms not defined below are in accordance with AAP-23. Definitions of shock and vibration terms are in accordance with ANSI S1.1.

3.1.1 Batten. A wooden member used to fill space, protect against damage, or to provide additional surfaces for strapping or bearing.

3.1.2 Cap. A cover with sides extending perpendicularly from the perimeter used as a protection against damage, or to help create a stable load. It may be used over the load, inverted under a load, or used under and over intermediate courses.

3.1.3 Design activity. The DoD activity responsible for designing ammunition unit loads, or if the design service is procured for approving the design as being compatible with service needs. Examples of design activities as defined herein are:

a. Army: U.S. Army Defense Ammunition Center.

b. Navy: Naval Packaging, Handling, Storage and Transportation Center; U.S. Naval Weapons Station Earle.

c. Air Force: Armament Development and Test Center; Ogden Air Logistics Center.

3.1.4 Edge protector. A light piece of material, used at the edge of a load to prevent damage by strapping.

3.1.5 Handling equipment. Any equipment or special handling device used for moving packages, packs, unit loads, containers, items, or components.

3.1.6 Overhang. The distance that the vertical edges of the components of a unit load extend beyond the edges of the pallet.

3.1.7 Pallet. A low portable platform of wood, metal, or other suitable material to facilitate handling, stowage, and transportation of materials as a unit by mechanical equipment. It is used as the base of a unit load to support and combine groups of commodities (or to confine single items) for handling and shipping as a single entity.

3.1.8 Pallet adapter. A wood or metal framework designed to secure irregular shaped articles to a pallet.

3.1.9 Pallet, special purpose. A pallet which is specifically designed for use with a particular ammunition item or for use in a specific handling or transportation environment.

3.1.10 Palletized unit load. A unit load which uses a pallet as a base.

3.1.11 Protection levels:

3.1.11.1 Level A – tactical (Army), fleet-issue unit load (FIUL) (Navy). The degree of packaging and unit load integrity required for protection of ammunition against the most severe conditions known or anticipated to be encountered during shipment, handling, and storage.

3.1.11.2 Level B – intermediate (Army), domestic (Navy). The degree of packaging and unit load integrity required for protection of ammunition under anticipated favorable conditions during worldwide shipment, handling, and storage.

3.1.11.3 Level C – minimum (Army). The degree of packaging and unit load integrity required for protection of ammunition under known favorable conditions.

3.1.12 Skid base. A type of pallet used as the base for unit loads of items which are packed in long wooden boxes 27 inches in length or greater.

3.1.13 Strapping. A length of flat steel, or other suitable material, placed in tension around a unit load to compact and secure the individual items into a single entity.

3.1.14 Underhang. The distance the edges of the pallet extend beyond the vertical edges of the items, containers, or unit load.

3.1.15 Unit load. An assemblage of items (in or out of containers) designed to facilitate handling these items as a single entity.

3.1.15.1 Amphibious unit load. A unit load which is specifically designed to be loaded as assault cargo in ships, such as LPHs, LHAs, and LPDs, for rapid unloading in specific amphibious operations.

3.1.15.2 FIUL (Navy). A unit load which is specifically designed to permit transfer-at-sea operations and which is compatible with shipboard handling and stowage procedures.

4. GENERAL REQUIREMENTS

4.1 General. This section presents general requirements for unit loads of materials which can be verified by visual observation, simple measurement, or by a certificate of compliance with material requirements. Inspection procedures are concerned only with those materials which are used to make up the unit load; i.e., pallets, adapters, battens, strapping, and dunnage materials. Inspection procedures for the ammunition items and its packaging are contained in documents relevant to the procurement or maintenance of the specific item.

4.2 Transportability requirement. The unit load, insofar as possible, shall be designed to move without restriction, special routing, or special escort throughout the ammunition distribution system used by the Department of Defense. See 49 CFR 170-178 and 46 CFR 146.29-180.

4.2.1 Airlift compatibility. Unit loads shall be in accordance with the general design and performance requirements of MIL-HDBK-1791 as amplified by AFSC Design Handbook DH 1-11. Air transportability criteria for nuclear weapons shall be in accordance with individual service regulations.

4.2.2 Railcar compatibility. The unit load shall, insofar as possible, be capable of being efficiently and safely loaded in standard commercial boxcars.

4.2.3 Truck trailer compatibility. Wherever practical, the unit load shall be capable of being efficiently and safely loaded into standard closed van trailers capable of meeting shipping requirements for explosives. In addition, consideration shall be given to providing appropriate strength members compatible with the fixed cross member spacing in the trailers or containers authorized for trailer on flat car (TOFC) or container on flat car (COFC) service shown in Bureau of Explosives Pamphlet No. 6C.

4.2.4 Ship compatibility. Wherever the distribution system is sufficiently known to identify the type of ships to be employed, the unit load shall be capable of being safely and efficiently loaded and stowed aboard those ships. Typical ship loading situations are described by Army TM 55-607, NAVSEA OP 3221, NAVSEA SW023-AJ-WHS-010 (formerly OP4550), and MSC TW023-AB-WHS-010 (formerly OP3206).

4.2.5 Container compatibility. Wherever practical, the unit load shall be capable of being safely and efficiently loaded into MILVANS and commercial ISO containers.

4.3 Handling equipment compatibility. The unit load shall be compatible with the handling equipment used throughout the expected logistic flow patterns.

4.3.1 Forklift/pallet truck capability . Unit load designs shall be capable of being handled safely by forklift trucks of rated capacity appropriate to the gross weight and geometry of the unit load. Minimum size of each forklift opening shall be in accordance with the limiting dimensions specified in STANAG-2828, minimum of 3.875 inches in height and 8.625 inches in width. Unit loads shall also be in accordance with SAE AS5389. Full 4-way entry capability shall be provided unless a deviation is justified by life cycle cost and technical analysis. If pallet trucks are to be used in the logistic flow pattern, the pallet design shall be compatible with their use.

4.3.2 Sling capability. Unit loads shall be capable of being safely handled by the authorized slings which are commonly used in ammunition stevedoring operations. Fleet-issue unit loads shall also be capable of being safely handled by the authorized slings which are commonly used for underway replenishment operations.

4.4 Shape. Insofar as practical, the complete unit load shall be in accordance with a shape in which all six sides are rectangles.

4.4.1 Protrusions. Protrusions from the individual items making up the unit load shall be oriented to minimize damage. Battens or other protective devices shall be used whenever protrusions are likely to cause damage or be damaged.

4.4.2 Item placement. Items (in or out of containers) making up the unit load shall be placed in such a way that space is utilized efficiently, the unit load meets all stability requirements, and the overhang requirements are met.

4.4.3 Strapping placement. Strapping shall be located in such a way that it is not susceptible to snagging by adjacent unit loads, handling equipment, or transportation equipment (i.e., additional strapping, over and above that required to equal or exceed the safe working load (see 4.8.1)) shall be used as necessary to ensure positive retention under the conditions of the tests contained herein. Strapping shall not pass under those elements of the unit load in contact with ground unless positive steps are taken to recess the strapping to prevent frictional wear. Unsupported strapping (i.e., strapping not directly bearing on the load structure or battens) shall be kept to a minimum.

4.4.4 Item orientation. Items shall be oriented in the unit load in accordance with pertinent instructions (e.g., THIS SIDE UP) or in the least fragile position. If there are no restrictions, the items shall be oriented in the attitude which will produce the most efficient unit load dimensions.

NOTE: Ammunition loaded with white phosphorous (WP) shall be loaded so that the long axis of the round is vertical unless otherwise specifically authorized.

4.4.5 Drainage. To the maximum extent practical, free drainage shall be provided in the normal storage position, i.e., all depressions or pockets which could hold water should be avoided.

4.5 Size and weight. Unless the ammunition item and its shipping container are larger than the limits given herein, dimensions, size, and weight shall be determined in accordance with the following:

4.5.1 Length and width. Length and width shall, insofar as practical and consistent with other dimensional rules contained herein, be close to the plan view sizes of table I.

TABLE I. Recommended unit load dimensions for transport and storage.

Equipment or facility	Size
Igloo magazine Minimum doorway dimensions: 48" wide × 90" high	One horizontal dimension should be less than 47": with forklift entry perpendicular to that dimension.
Conventional vans (typical) Interior size: 570" or 630" long × 98" wide × 110" high (Doorway height = 110")	One horizontal dimension of the unit load should be 46" – 48½" to permit two wide loading to avoid lateral bracing. Three wide loading requires a horizontal dimension of 30¾" – 32". Height should be 54½" for two high loading or 36" for three high loading.
MILVAN or 20' × 8' ISO containers Interior size: 232" long × 92" wide × 87" high (Doorway height = 84")	One horizontal dimension of the unit load should be 25" – 45½" to permit two wide loading. Three wide loading requires a horizontal dimension of 25" – 30½" Unit load height should not exceed 41" for two high loading or 27" for three high loads.
20' × 8' – 6" ISO containers Interior size: 232" long × 92" wide × 93" high (Doorway height = 90")	Horizontal dimensions should be same as for 20' × 8' ISO containers. Unit load height should not exceed 44" for two high loading or 29¼" for three high loads.
Side opening 20' × 8' – 6" ISO containers Interior size: 232" long × 89" wide × 88" high (Doorway height = 84")	Horizontal dimensions should be 25" – 44" to permit two wide loading. Three wide loading requires a horizontal dimension of 25" – 29¼". Unit load height should not exceed 40½" for two high loading or 26½" for three high loads.
Railcars (typical) Interior size: 606" or 720" long×101" – 114" wide × 120" high	One horizontal dimension should be less than 64": with forklift entry perpendicular to that dimension to permit entry through the railcar door. Height should not exceed 58" for two-high loading or 39" for three-high loading.
Ships (break-bulk) (No standard size)	Unit load design shall permit easy handling by approved slings and overhead crane. T-Class ship dimensional constraints may be found in MSC TW023-AB-WHS-010. L-Class ship dimensional constraints may be found in NAVSEA SW023-AJ-WHS-010.
Military airlift (with 463L system) 463L Handling system pallet: 84" × 104" (full size) 84" × 50" (half size)	Optimum unit load size is 42" × 52". For more information, see AFSC DH 1-11 for other sizes usable. *Logair pallet (HCU-10/C) is not compatible with the C-130, C-141, and C-5 aircraft.

4.5.1.1 Overhang. Unit loads shall be made up so as to ensure stability, to provide for efficient strapping application, and not to cause excessive bending force on those containers or items which may be structurally weak. When standard pallets are used (see 4.8.3), the recommended overhang should not exceed 2 inches per edge. Overhang greater than 2 inches can be allowed depending upon peculiarities of the commodity being unitized and identifiable factors that influence total cost effectiveness throughout the ammunition logistics system.

4.5.1.2 Underhang. Underhang shall not be permitted. When standard pallets are used, spacers, battens, or cap assemblies shall fill out the unit load so that the overall nominal view dimensions are at least flush with the pallet dimensions. The strength and dimensions of the materials shall be adequate to permit shipment by all means of transport, e.g., cap assemblies shall be of such size that it will withstand all loads imposed on it by adjacent unit loads under impact conditions. When non-standard pallets or skid bases are used, the overall plan view size shall be tailored not to exceed the load dimensions. Skid bases shall be in accordance with U.S. Army Defense Ammunition Center Drawing AMC 19-48-4116-20PA1002.

4.5.2 Transportability limitations. Unit loads shall be designed to be economically compatible with the methods by which they will be transported or stored. Guidance concerning the preferred length, width, and height characteristics for the more common conditions is given in table I.

4.5.3 Gross weight. Gross weight of an ammunition unit load shall not exceed 4,000 pounds unless specifically authorized by each using activity.

4.5.4 High density ammunition. Where optimization in all three dimensions produces a gross weight greater than 4,000 pounds, the number of complete layers of unit packs shall be reduced until the gross weight is less than 4,000 pounds.

4.5.5 Special rule for amphibious assault ammunition. Certain ammunition items are intended to be used in amphibious operations. This ammunition, at least during the assault phases, must be capable of being efficiently handled in specialized ships with fixed size elevators and horizontal or vertical conveyors. Maximum dimensions for these unit loads are:

a. Maximum length and width: 45 by 54 inches

b. Maximum height: 44 inches

c. Maximum weight: 3,000 pounds

4.6 Stability. Item placement shall be such that the assembled unit load is stable on a motionless level surface without depending on strapping. This criterion shall also apply following the rough handling tests of 5.4.2 to 5.4.9 if the assembly is not distorted by more than 2 inches.

4.7 Stacking capability. Unless otherwise specified by the design activity (see 6.2), unit loads shall be designed to ensure safe, stable, long-term stacking to an overall height of 16 feet.

4.8 Materials. Standard parts and materials shall be used unless they are technically or economically impractical. The material used shall not adversely affect the unitized items because of incompatibility of hydroscopic or chemical properties.

4.8.1 Strapping. All strapping shall be in accordance with ASTM D3953, Type 1, Heavy Duty, Finish B (Grade 2), brite or slit edges shall have Finish A overlay. Typical strapping size used for unit loads is ¾ inch or 1¼ inch wide by 0.035 inch or 0.031 inch thick. Current approved clipless tools for U.S. Army Ammunition loads are specified in U.S. Army Defense Ammunition Center Drawing ACV00617.

4.8.2 Strapping seals. All seals for metallic strapping shall be in accordance with ASTM D3953, Class H, Finish B (Grade 2), double notch type, Style I, II, III, or IV. If all surfaces are painted, an allowable alternative seal finish Signode or Delta painted seal may be used. Gritted backing is not permitted. Designs shall be based on the use of a single seal, double notched. Use of crimped seals is authorized with non-lubricated strapping provided two seals are used, each double crimped.

4.8.3 Pallets. Whenever practicable, and consistent with satisfying the other design and performance criteria of this standard, unit loads shall be designed to use Army pallets DA PAM 746-1, standard wood pallets, and standard steel pallets, MIL-P-23312 Style 1A (35 by 45½) and MIL-P-23312 Mk 3 Mod 0 (40 by 48) in accordance with Drawing 564200 or Mk 12 Mod 0 or 1 (35 by 45½) in accordance with Drawing 2086479 or 2645217, respectively. Unit loads designed to use standard steel pallets do not require the pushing and towing test, specified by 5.4.6, to be performed during qualification of the unit load. Special purpose pallets shall be used only when they are cost-effective on a life cycle basis.

4.8.4 Nails. Nails shall be in accordance with ASTM F1667 common steel nail (NLCMS or NLCMMS) of the style and size appropriate to the width and thickness of wood members being joined.

4.8.5 Staples. Staples shall be in accordance with ASTM F1667; STFCS-189 or STFCS-207, (15/16-inch or 1-inch crown width by ¾-inch leg length) for ¾-inch strapping, Type IV, Style 3 and 1 17/32-inch crown width by ¾-inch leg length for 1¼-inch strapping. For FIULs, only use staples if necessary. Staples are a known source of foreign object damage/debris (FOD) for jet aircraft engines.

4.8.6 Edge protectors. Edge protectors of a size appropriate for the strapping shall be used when specified by design activity (see 6.2).

4.8.7 Wood members. Lumber, in accordance with the quality requirements of ASTM D6199, shall be used as appropriate for all structural members. Non-structural members may be fabricated from lumber in accordance with either ASTM D6199 or Voluntary Product Standard PS 20, whichever is cost effective. Wood shall meet the guidelines of ISPM No. 15 and be marked in accordance with the document.

4.8.8 Plywood. Plywood shall be commercial Grade C-D with exterior glue.

4.9 Markings. Important markings or inspection data on the items shall not be concealed by the unit load members. Provisions shall be made or space allocated for attaching hazard marking placards to unit loads. For guidance for markings on Army ammunition unit loads, see DAC Drawing ACV00561.

4.10 FIULs (Navy), tactical (Army). All materials used to make up FIULs shall be nonflammable, with the exception of lumber items that may be used to construct the load (e.g., spacers or battens). Metal parts shall be suitably protected from corrosion.

4.10.1 Sling compatibility. FIULs shall be capable of being safely handled by the authorized slings commonly used in dockside stevedoring operations and at sea connected replenishment (CONREP) and vertical replenishment (VERTREP) operations as cited below. The following slings are currently authorized for use in Department of the Army and Navy handling operations:

Sling	Nomenclature	Drawing number	Area of use
Mk 85 Mod 0	Pallet sling	2614969	CONREP/VERTREP
Mk 86 Mod 0	Pallet sling	2614970	CONREP/VERTREP
Mk 87 Mod 0	Pallet sling	2614971	CONREP/VERTREP
Mk 93 Mod 0	Pallet sling	2642587	Dockside
Mk 100 Mod 1	Pallet sling	2643919	CONREP/VERTREP
Mk 99 Mod 0	Weapons handling sling	2642914	CONREP
Mk 105 Mod 0	Hoisting sling	2643482	VERTREP

Sling	Nomenclature	Drawing number	Area of use
Mk 105 Mod 0	Long leg assembly	2644390	VERTREP
Mk 123 Mod 0	Pallet sling	2645180	CONREP/dockside
Mk 109 Mod 1	Container lifting sling	5167555	CONREP
Mk 85 Mod 1	Pallet sling	7516578	CONREP/VERTREP
Mk 86 Mod 1	Pallet sling	7516579	CONREP/VERTREP
Mk 87 Mod 1	Pallet sling	7516580	CONREP/VERTREP
Mk 100 Mod 2	Pallet sling	7516581	CONREP/VERTREP
3940-01-209-6008	Sling, adjustable, double basket	AC200000331	Field vehicles with cranes
3940-01-241-7400	Sling, multiple leg projectile pallet	AC200000332	Lifting 155 mm & 8-inch projectile pallet units
1398-01-348-4670	Sling, multiple leg top-lift ammunition pallet	AC200000398	Field vehicles with cranes

4.11 Protection levels. Unit load(s) shall provide the adequate level of protection based upon the expected environment. Levels of protection that apply to preservation and packing of DoD materiel is described in MIL-STD-2073-1. More specific definitions of protection levels A, B, and C for ammunition unit loads are defined as follows:

4.11.1 Level A – tactical (Army), FIUL (Navy). (see 3.1.11.1) Unit loads designated Level A shall be designed to protect ammunition against direct exposure to all extremes of climatic, terrain, operational and transportation environments without protection other than that provided by the unit load. The conditions to be considered include, but are not limited to:

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

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

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

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

e. Outdoor storage in all climatic conditions for a minimum of 1 year.

f. Static loads imposed by stacking during shipment and 20-year storage.

4.11.2 Level B – intermediate (Army), domestic (Navy). (see 3.1.11.2) Unit loads designated Level B shall be designed to protect ammunition against physical damage and deterioration during favorable conditions of shipment, handling, and storage. This level of protection is typically used for OCONUS training ammunition. The conditions to be considered include, but are not limited to:

a. Multiple rough handling during transportation and in-transit storage.

b. Shock, vibration, and static loading of shipment worldwide by truck, rail, aircraft, or ocean transport.

c. Favorable warehouse environment for a minimum of 18 months.

d. Environmental exposure during shipment and in-transit transfers, excluding deck loading and offshore cargo discharge.

e. Stacking and supporting superimposed loads during shipment and extended storage.

4.11.3 Level C – minimum (Army). (see 3.1.11.3) Unit loads designated level C shall be designed to protect ammunition during favorable condition of limited shipment, handling, and storage. This level of protection is used for CONUS interplant shipments of training rounds (highway movement only). The conditions to be considered include, but are not limited to:

a. Use or consumption of the ammunition at the first destination.

b. Shock, vibration, and static loading during the limited transportation cycle.

c. Favorable warehouse environment for a maximum of 18 months.

d. Effects of expected environmental exposure during loading, unloading, and in-transit delays.

e. Stacking and supporting superimposed loads during shipment and temporary storage.

5. DETAILED REQUIREMENTS

5.1 General. This section contains requirements for unit loads which shall be verified by physical tests. Prototype unit loads shall be fabricated, inspected, and tested to determine whether loaded ammunition shall be replaced by inert items having similar physical characteristics. This section describes unit load testing requirements for protection Level A and Level B as defined in 4.11. For a description of unit load testing requirements for protection Level C, see 5.5.1.

5.2 Satisfactory performance criteria. The unit load shall remain intact and be capable of continued safe handling and tiering. The assembly structure (the pallet, structural, or protective members, strapping, etc.) shall not fail nor permit individual parts of the unit load assembly to become unattached or separated. If the ammunition item is not protected by separate packaging or individual containers, the unit load configuration shall protect each item from damage beyond usefulness (e.g., thin structural members, fins, or other protrusions shall not be broken or deformed). If individual containers are used, the unit load shall protect the containers (e.g., latches, handles, or other protrusions shall not be damaged beyond usefulness). These other protrusions shall not be damaged beyond usefulness. These criteria apply only to the unit load as a whole unit. The ability of the component packages, the internal ammunition items, and the pallet to withstand the hazards of transportation and storage must be determined by a separate evaluation process.

5.3 Test procedures. The prototype unit loads shall be inspected for damage after being subjected to each of the following tests in the order given. Rebanding or restrapping is permitted between but not during the tests. For example, restrapping may be done after drop testing but prior to incline impact testing.

5.4 Test temperature. Tests are normally conducted at an ambient temperature of 77±18 °F or 25±10 °C. If the materials used in the fabrication of the unit load are sensitive to temperature or moisture, refer to 5.5 for additional applicable tests that may be required in the appropriate logistic environment or as specified for testing specialized shipping containers in MIL-STD-648.

5.4.1 Stacking test. The unit load shall be loaded to simulate a stack of identical unit loads, stacked to a maximum of 16 feet high, for a period of 1 hour minimum.

5.4.1.1 Stacking test rationale. This test is conducted to examine the ability of the unit load (and packaging) to withstand the forces imposed on it from stacking at the potential maximum height of 16 feet within storage, and to determine if the strapping remains sufficiently tensioned to prevent subsequent disintegration of the load.

5.4.2 Repetitive shock test. This test shall be conducted in accordance with Appendix A.

5.4.2.1 Repetitive shock test (superimposed load). An alternate test which may be used when specifically required, the repetitive shock test shall be performed in its most severe transportation configurations (e.g., if the unit loads may reasonably be expected to be shipped by truck or rail up to three layers high, they should be tested in a configuration which simulates that condition). In this case, the 1/16-inch feeler gauge shall be used between the top unit load and the one beneath.

5.4.2.2 Repetitive shock test rationale. This test is conducted to validate the reliability and sufficiency of the pallet base and the method of securing the load (strapping, netting, dunnage, etc.) in a worst case vibration environment experienced in transportation (especially in movement of tactical vehicles). For additional information, see A.1 of Appendix A.

5.4.3 Drop test. FIULs shall be tested by using the cornerwise-drop (rotational) test. All others shall use one edgewise-drop (rotational) test.

5.4.3.1 Edgewise-drop (rotational) test. This test shall be conducted by using the procedures of Appendix B.

5.4.3.2 Cornerwise-drop (rotational) test. This test shall be conducted by using the procedures of Appendix C. The drop test shall be applied once on each bottom corner. The height of drop shall be selected from table C-I.

5.4.3.3 Drop test rationale. This test is conducted to examine the ability of the unit load to withstand drops that could potentially occur during handling of the unit load by material handling equipment (forklift, movement by slings, etc.) in the transportation of the unit load. For additional information, see B.1 of Appendix B and C.1 of Appendix C.

5.4.3.4 Drop surface recommendation. The drop surface should be a minimum of 3 inches (75 millimeters) thick and have a flat, smooth steel plate level to within 2 degrees of horizontal, possessing a Brinell hardness of 200-311. The steel plate should be of sufficient area to ensure that a dropped test item(s), including rebound(s), will be retained within its surface area. The steel plate should be uniformly supported throughout by a minimum thickness of 2 feet (60 centimeters) of reinforced 4,000 PSI (28 MN/m2) concrete or stronger. The drop test facility should be constructed such that no free water is retained on top of the steel plate. Any ice or debris should be removed from the impact surface prior to testing. Various guidance systems that do not reduce the impact velocity should be employed to ensure the impact angles; however, any guidance system should be eliminated at a sufficient height above the impact surface to allow unimpeded fall and rebound. The equipment should be checked at regular intervals for any degradation in its ability to provide a consistent, repeatable impact surface relevant to maximum weight and size of the test item(s). Existing drop test facilities consisting of concrete, faced with a steel plate, with a foundation 20 times the mass of the item being tested may be used for this test; however, construction of new facilities should be in accordance with the requirements above. These facilities should be constructed as soon as possible to ensure standardization of test facilities.

5.4.4 Impact test. This test shall be conducted by using either the procedures of Appendix D (Incline impact test), or Appendix E (Pendulum-impact test). Impact velocity will be determined by table II. The test shall be performed once on each of the four sides of the unit load. If the incline impact procedure is used, an optional timber shall be employed, which extends approximately 9 inches above the surface of the carriage.

5.4.4.1 Impact test (stacked). Unit loads likely to be stacked and shipped by railcar or flatbed trailer will be subjected to this test. The procedure will be identical to that of the impact test of 5.4.4 except that the unit loads will be stacked in the normal shipping configuration (typically two high). Dummy contents may be used. Unit loads likely to be stacked and shipped by railcar will be subjected to one impact on each end of the bottom unit load at 11.7 feet/second. Unit loads likely to be stacked and shipped by flatbed trailers only will be designed to pass one impact on each end of the bottom unit load at 5 feet/second. Evidence of failure of the connecting structures, which would permit any of the unit loads to become unattached, will be cause for rejection. In lieu of the stacked impact test, and at the option of the design agency, a rail impact test may be conducted in accordance with the requirements of the Association of American Railroads (AAR), Bureau of Explosives (BOE). Use MIL-STD-810, Method 516, procedure VIII.

5.4.4.2 Transfer-at-sea shock test(s). Unit loads planned for transfer-at-sea will be designed to withstand the shock test(s) associated with the appropriate mode of transfer as shown in table II. Following the tests, the unit load will continue to protect the contents and will not be damaged in any way that would prevent its use and continued safe handling.

TABLE II. Shock test for unit loads-at-sea.

Test	CONREP with STREAM	CONREP without STREAM	VERTREP[1/]	Dock side only
Impact velocity[2/]	7.0 feet/second	10.0 feet/second	7.0 feet/second	5.0 feet/second
Flat bottom drop	18.0"	18.0"	18.0"	18.0"

NOTES:

1/ Impact velocity does not account for any sea state conditions.

2/ Impact velocity testing will be performed on ends and sides.

5.4.4.3 Impact test rationale. This test is conducted to establish that unit loads can withstand shear forces (i.e., diagonally distorting loads and other horizontal forces resulting from accelerations and decelerations suffered in transit and impacts when being handled by a crane). For additional information, see D.1 of Appendix D or E.1 of Appendix E.

5.4.5 Tipover test. This test is to be performed only if the weight and balance are such that the unit load will tip over when an edge is lifted sufficiently to form a 20-degree angle with the floor. The procedures of Appendix F shall be used. The tipover test is not required to be performed if it can be proven that the unit load will not tip at or below 20 degrees of tilt.

5.4.5.1 Tipover test rationale. This test is conducted to determine the ability of the pallet unit to maintain integrity if the unit load is tipped over during transportation. The unit load must maintain sufficient cohesion to continue to be safely handled and stacked. For additional information, see F.1 of Appendix F.

5.4.6 Forklifting test. This test shall be conducted by using the procedures of Appendix G. As an alternate procedure, the forklift hazard course shown on figure 1 may be used. Unit loads designed to use standard steel pallets do not require the pushing and towing test to be performed during qualification of the unit load.

5.4.6.1 Forklifting test rationale. This test is conducted to determine the ability of the unit load to be safely handled by forklift trucks. For additional information, see G.1 of Appendix G.

5.4.7 Pallet truck test. Unit loads, which are designed to accept pallet trucks, shall be lifted clear of the ground, transported a distance of at least fifty feet, and lowered. Tests shall be conducted four times, i.e., forks entering the pallet from each side of the load. Any tendency for unit load to be unstable while on forks, or any difficulty in inserting or removing forks, shall be cause for rejection.

5.4.7.1 Pallet truck test rationale. This test is conducted to determine the ability of the unit load to be safely handled by pallet trucks. For additional information, see G.1 of Appendix G.

5.4.8 Sling compatibility test. Unit loads utilizing special design or non-standard pallets shall be lifted, swung, lowered, and otherwise handled as necessary, using slings of the types normally used for handling the unit loads under consideration. Slings shall be easily attached and removed. Evidence of slippage or disengagement when load is suspended shall be cause for rejection of the unit load.

5.4.8.1 Sling compatibility test rationale. This test is conducted to determine the ability of unit loads utilizing non-standard pallets to be safely moved during sling lifts. For additional information, see G.1 of Appendix G.

5.4.9 Disassembly test. Following all tests, the unit load may be squared up within 2 inches of its original shape and on a flat level surface. The strapping shall then be cut and removed from the palletized load. Assembly of the load shall be such that it retains its unity upon removal of the strapping.

5.4.9.1 Disassembly test rationale. This test is conducted to determine the integrity of the assembly of the packages within a unit load and to ensure the packages are stable and adequately protected following all rough handling tests after strapping and dunnage is removed. Final inspection of pallets, bases, unit load containers, etc. ensures that no damage that would affect safety or reliability and/or other potential safety hazards is present.

5.5 Testing. Tests specified herein fulfill the test requirements of STANAG-2828 and, therefore, may be used in lieu of STANAG-2828.

5.5.1 Unitized loads of ammunition within a limited (Level C (Army)) transportation and storage cycle testing. This test is conducted to determine the ability of the unit load and its strapping, bonding, or restraint methods to withstand the stresses, shocks, and impacts likely to be incurred during temporary storage, limited transport, and typical handling. For additional information, see H.1 of Appendix H.

5.5.2 Alternate material testing. Alternate material is considered any material other than wood or metal commonly used in the manufacture of pallets, containers, or unit loads. Alternate material test units shall be subjected to additional testing for materials which may be susceptible to damage from differing conditions during the life cycle of the test unit.

5.5.2.1 High temperature testing. Where applicable, the alternate material test units, such as those constructed of plastics, shall be subjected to a high temperature test. The test unit shall be pre-soaked in a chamber for 4 hours at 160 °F, then removed from the chamber and repetitive shock tested in accordance with 5.4.2. After the repetitive shock test, the test unit shall be pre-soaked in a chamber for 4 hours at 160 °F, and then removed from the chamber and drop tested in accordance with 5.4.3.

5.5.2.2 Low temperature testing. Where applicable, the alternate material test units, such as those constructed of plastics, shall be subjected to a low temperature test. The test unit shall be pre-soaked in a chamber for 4 hours at −65 °F, then removed from the chamber and repetitive shock tested in accordance with 5.4.2. After the repetitive shock test, the test unit shall be pre-soaked in a chamber for 4 hours at −65 °F, and then removed from the chamber and drop tested in accordance with 5.4.3.

5.5.2.3 Rain testing. Where applicable, the alternate material test units, such as those constructed of cardboard, shall be subjected to a rain test. The rain test shall be performed in accordance with Method 506.4 of MIL-STD-810.

5.5.2.4 Solar radiation testing. Where applicable, the alternate material test units, such as those constructed of cardboard or plastic shall be subjected to a solar radiation test. The solar radiation test shall be performed in accordance with Method 505.4 of MIL-STD-810.

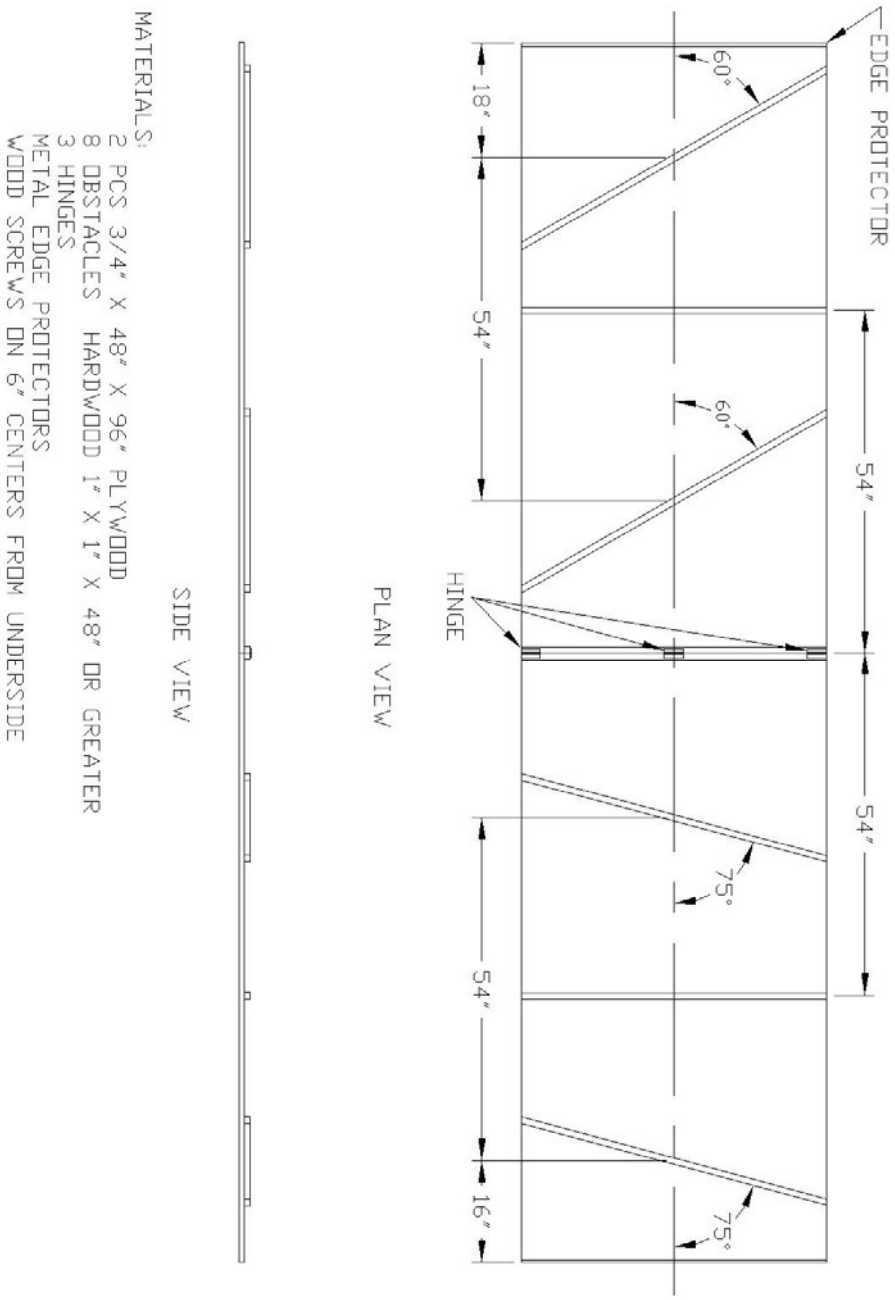

FIGURE 1. Optional rough handling course for forklift trucks.

6. NOTES

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

6.1 Intended use. It is intended to be used in the design and evaluation of unit loads for the end product ammunition line item as distributed to the user, not for those unit loads of inert components moving between contractors as a part of the manufacturing process. The criteria contained herein are not intended to be limiting or restrictive. When justified in individual cases, additional or modified procedures may be used. If deviations from this standard affect handling, transportation, or stowage characteristics, advance notice will be given by the design activity to all services who will handle the unit load.

6.1.1 Non-ammunition use. This standard will not be used for the palletization of general supplies or semi-perishable subsistence. General supplies will be in accordance with MIL-STD-147, Palletized Unit Loads, while semi-perishable subsistence unit loads will be in accordance with Defense Supply Center Philadelphia Form 3507, Loads, Unit: Preparation of Semi-perishable Subsistence Items. (Copies of Form 3507 are available online at http://www.dscp.dla.mil/subs/support/specs/forms/index.asp or from the Defense Supply Center Philadelphia, ATTN: DSCP-HSL, Bldg 6, 700 Robbins Avenue, Philadelphia, PA 19111-5092.)

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of the standard.

b. When unit loads are required to be stacked to a height other than 16 feet (see 4.7).

c. When edge protectors are required and the size required (see 4.8.6).

d. When special conditioning of the specimen is necessary (see A.5, D.6, E.5, F.5, and G.4).

e. When other cause(s) for rejection are applicable.

f. Drop height, number of drops, and/or drop temperature other than that specified (see B.6 and C.6).

g. Surface impacts and/or velocity at time of impact other than that specified (see D.7 and E.5).

h. The definition of a large container or unit load other than that specified (see E.2.1 and F.2.1).

i. When containers or unit loads having widths greater than one-fourth the height are subject to the tipover test (see F.1).

j. Sequence of testing handling provisions other than that specified (see G.5.1).

k. When conditions of the pushing test differ from those specified (see G.5.5).

l. When conditions of the towing test differ from those specified (see G.5.6).

m. When the conveyed distance differs from that specified (see G.5.7).

6.3 Subject term (key word) listing.

FIUL
Pallet
Skid base
Strapping
Unit load, fleet issue

6.4 International standardization agreement implementation. This standard implements STANAG-2828, “Military Pallets, Packages and Containers.” When changes to, revision, or cancellation of this standard are proposed, the preparing activity must coordinate the action with the U.S. National Point of Contact for the international standardization agreement, as identified in the ASSIST database at http://assist.daps.dla.mil.

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

VIBRATION (REPETITIVE SHOCK) TEST

A.1 SCOPE

A.1.1 Scope. This procedure is intended to indicate whether or not a unit load is adequate to prevent damage to either the packaging or the contents when the unit load is tested unattached on the platform of a vibration testing machine at frequencies below 5 hertz. Either the unit load bounces on the platform and receives repetitive shock and vibration of an indiscrete and variable nature; or the unit load does not leave the platform. Shocks applied to the unit load excite each component at its own natural frequency, but when the unit load does not leave the platform only those components that vibrate in resonance with the platform vibration are excited. This procedure is useful to predict whether or not such vibrations in transportation are likely to cause damage to the packaging or contents when the shipment is not securely tied down to the floor of the vehicle. Supplementary functional tests of the package contents may be necessary to evaluate functional damage. The procedure is not intended for the development of design parameters for shock and vibration isolation systems. This Appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

A.2 DEFINITIONS

A.2.1 Shock. A blow, impact, collision, jar, or similar instantaneous application of energy or force. (A shock will cause some vibration in an item or package.)

A.2.2 Vibration. The continuous oscillation of an element or body relative to a suitable reference point.

A.3 APPARATUS

A.3.1 Platform. A platform of suitable size and weight-carrying capacity supported on a mechanism that will maintain the surface essentially horizontal as it vibrates the platform so that the vertical component of the motion is approximately sinusoidal. (A rotary motion of the platform is acceptable.) The amplitude of the vibration shall be ½ inch (1-inch double amplitude). The frequency shall be variable within the approximate range from 3 to 5 hertz and shall be controlled to produce the platform vibration specified in A.6.

A.3.2 Restraining devices. Fences, barricades, or blocking that can be attached to the platform to keep the specimen in position on the platform without unnecessarily restricting the vertical or rotational movements of the specimen.

A.4 SPECIMENS

A.4.1 Contents. One unit load and its contents shall constitute a single specimen. The unit load shall be loaded for the test with the interior packing and the actual contents for which it was designed. If use of the actual contents is not practical, a dummy load shall be substituted to simulate such contents in weight, weight distribution, rigidity, shape, and position in the container. The contents, or dummy load, shall be blocked, braced, and cushioned in place as for shipment.

A.4.1.1 Specimen condition. If the intended contents, or a fully representative dummy load such as a reject item are to be used in the package, their condition, before and after test, must be determined by appropriate methods to establish the extent of damage suffered in the test.

A.4.1.2 Dummy load. If a dummy load is to be used, unless it is fully representative of the intended contents, the ability of the package to prevent damage can be determined only by indirect methods such as comparison of accelerations measured on the dummy load and fragility factors for the intended contents.

A.5 CONDITIONING

A.5.1 Test specimen. Unless otherwise specified (see 6.2), no special conditioning of the specimen shall be necessary. The condition of the specimen and any tests performed prior to the vibration test shall be recorded.

A.6 PROCEDURE

A.6.1 Positioning. The specimen shall be placed on but not fastened to the platform. If the specimen might be shipped in other than an upright position, the specimen shall be placed in such a position; and if more than one position is reasonable, the test shall be interrupted and the position changed so that the specimen is tested for equal periods of time in each reasonable shipping position. Midway in the period of time that the specimen is tested resting on each surface, the specimen shall be rotated 180 degrees if the specimen rocks on the platform. Unless failure occurs, the total time of vibration shall be 2 hours if the specimen is tested in one position; and if tested in more than one position, the total time shall be 3 hours.

A.6.2 Restraining devices. Restraining devices shall be attached to the platform to prevent the specimen from moving off the platform and, if necessary, to prevent excessive rocking of the specimen. The restraining devices should be adjusted to permit unrestrained movement of the specimen from its centered position about ½-inch in any horizontal direction.

A.6.3 Frequency. With the specimen in one position, vibrate the platform at ½-inch amplitude (1-inch double amplitude) starting at a frequency of about three cycles per second. Steadily increase the frequency until the specimen leaves the platform (i.e., until a $\frac{1}{16}$-inch thick "feeler" may be momentarily slid freely between every point on the specimen and the platform at some instant during each cycle) or until the frequency reaches that at which the maximum platform acceleration is 1±0.1 times the acceleration of gravity. If circular input motion is used, table frequency shall be adjusted to assure that one edge of the unit load leaves the table not less than $\frac{3}{16}$ inch on each cycle. This test is normally conducted at an ambient temperature of 70±20 °F. While observing to detect development of any failure, continue to vibrate at such frequency until the total time of vibration in the position is completed. Observe and record whether or not the specimen leaves the platform and the frequency maintained.

A.6.4 Additional positioning. If the specimen is to be tested in more than one position, repeat A.6.3 for each position.

A.6.5 Inspection. After the total period of vibration is completed, inspect the specimen, the packaging, and the contents for evidence of damage. Make appropriate functional or other tests to establish whether or not the item suffered damage.

EDGEWISE-DROP (ROTATIONAL) TEST

B.1 SCOPE

B.1.1 Scope. The following procedure is applicable for determining the ability of unit loads to resist the impacts of being dropped on their edges and for determining the ability of the packaging and packing methods to provide protection to the contents when the unit load is dropped on its edges. This Appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

B.2 DEFINITIONS

B.2.1 Level of packing. The level of packing to be provided for any item or contents is dependent upon the handling and shipping conditions which the container, pack, or unit load may be expected to encounter. For the purpose of this standard, the levels of packing shall be defined as:

B.2.1.1 Level A. This protection level is generally considered for unit loads subjected to tactical environments and is fully defined in 4.11.1.

B.2.1.2 Level B. This protection level is generally considered for unit loads subjected to the tactical logistics cycle but not for long-term storage and is fully defined in 4.11.2.

B.3 APPARATUS

B.3.1 Edgewise-drop test. In conducting the edgewise-drop test, the unit load may be handled with any convenient equipment, such as a forklift truck, a hoist, or a block and tackle. A smooth, level, concrete surface (or similarly unyielding surface) shall be used in performing the edgewise-drop test.

B.4 SPECIMEN

B.4.1 Contents. One unit load and its contents shall constitute a single specimen. The unit load shall be loaded for the test with the interior packing and the actual contents for which it was designed. If use of the actual contents is not practical, a dummy load shall be substituted to simulate such contents in weight, rigidity, shape, and center of gravity position in the container and appropriately instrumented to record shock forces or deflections during the test. The contents or dummy load, shall be blocked, braced, and cushioned in place as for shipment.

B.5 CONDITIONING OF SPECIMEN

B.5.1 Test specimen. All tests shall be conducted at room temperature (77±18 °F).

B.6 PROCEDURE

The specimen shall be placed on its bottom with one end of the base of the unit load supported on a sill nominally 6 inches high. The height of the sill shall be increased if necessary to ensure that there will be no support for the base between the ends of the unit load when dropping takes place, but should not be high enough to cause the unit load to slide on the supports when the drop end is raised for the drop. The unsupported end of the unit load shall then be raised and allowed to fall freely to the concrete surface or similarly unyielding surface from a prescribed height (see figure B-1). Unless otherwise specified (see 6.2), the height of drop for Levels A and B protection shall be in accordance with table B-I. The maximum heights shall not exceed 36 inches for Level A and 27 inches for Level B protection. Unless otherwise specified (see 6.2), a total of four drops constitute a complete test. If the size of the unit load and the location of the center of gravity are such that the drop cannot be made from the prescribed height, the height of the sill shall be increased. Rectangular unit loads shall be dropped once on each edge of the unit load base. Cylindrically shaped unit loads shall be dropped on the top and bottom rims at diagonally opposite quadrants. The quadrant pairs shall be separated by approximately 90 degrees. If a total of more than four rim drops is specified, the additional drops shall be on sections not previously dropped upon. If the test specimen contains materials which are affected by temperature, the test shall be conducted while the unit load is stabilized at the extremes of temperature. Unless otherwise specified (see 6.2), half the total number of drops shall be made at -20±5 F and half shall be made at 140±5 °F.

B.7 NOTES

a. This test is meant to simulate the impacts of accidentally dropping a unit load on its edges. It is intended that the edgewise-drop test shall be used only on unit loads that are susceptible to accidental edgewise drops. The edgewise-drop test was designed specifically for large and/or heavy shipping containers or unit loads that are likely to be handled mechanically rather than manually. Details are given with the qualification, “unless otherwise specified”, in paragraphs regarding:

(1) Conditioning of specimens (see B.5).

(2) Number and height of drops (see B.6).

b. When the edgewise-drop test is performed to evaluate the protection provided for the contents, the rigidity of a dummy load should closely approximate that of the actual contents for which the packaging used within the unit load was designed.

TABLE B-I. Height of rotational drops for unit loads of various sizes and weights. [1/]

Gross weight (within range limits)	Dimensions of any edge, height, or width (within range limits)	Height of drops on edges	
Pounds	**Inches**	**Level A (inches)**	**Level B (inches)**
150 – 250	60 – 66	36	27
250 – 400	66 – 72	32	24
400 – 600	72 – 80	28	21
600 – 1,000	80 – 95	24	18
1,000 – 1,500	95 – 114	20	16
1,500 – 2,000	114 – 144	17	14
2,000 – 3,000	Above 145 – No limit	15	12
Above – 3,000		12	9

NOTE:

[1/] Use the lowest drop height indicated by either gross weight or dimension. For example, a unit load having a gross weight of 440 pounds and a maximum edge dimension of 95⅝ inches, shall be dropped 20 inches for Level A tests or 16 inches for Level B tests.

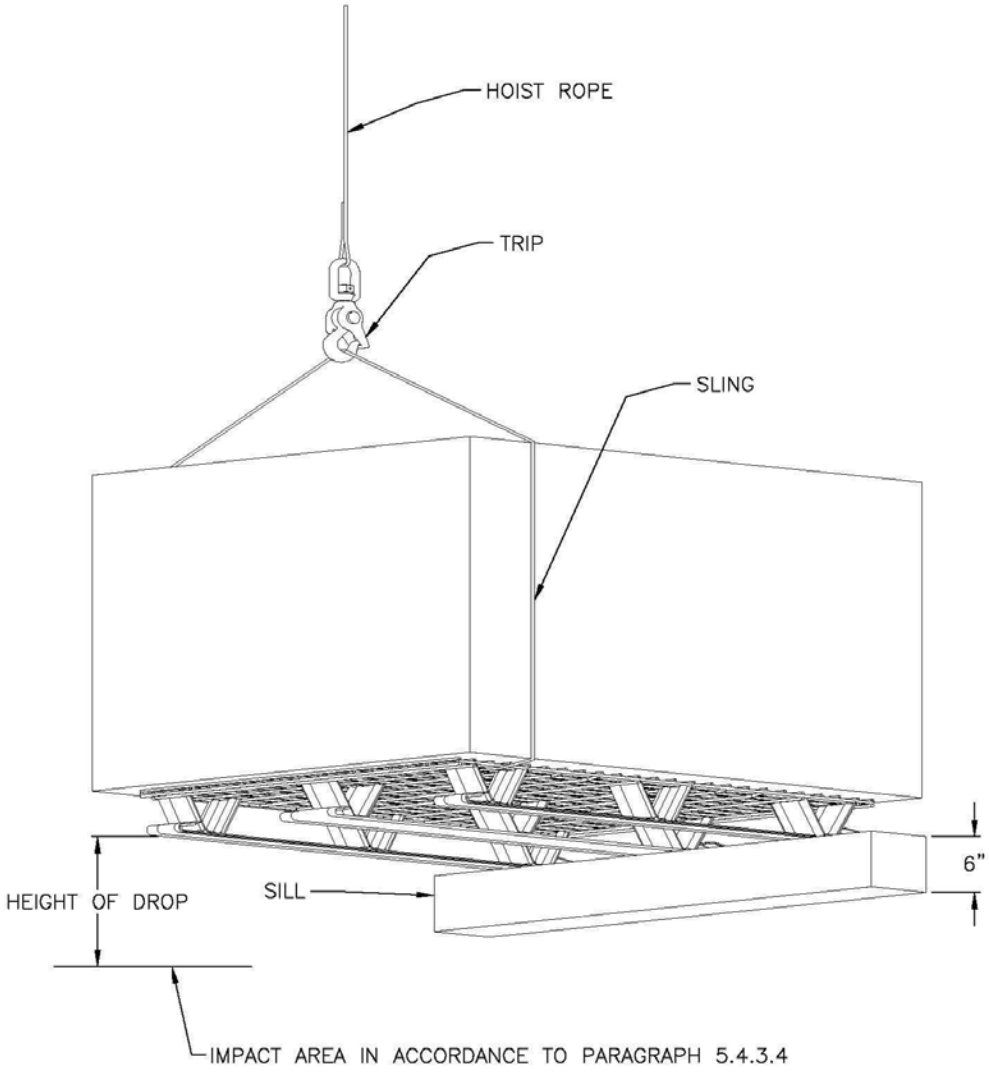

FIGURE B-1. Edgewise-drop (rotational).

CORNERWISE-DROP (ROTATIONAL) TEST

C.1 SCOPE

C.1.1 Scope. The following procedure is applicable for determining the ability of unit loads to resist the impacts of being dropped on their corners and for determining the ability of the unit load, the packaging and packing methods to provide protection to the contents when the pack is dropped on its corners. This Appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

C.2 DEFINITIONS

C.2.1 Level of packing. The level of packing to be provided for any item or contents is dependent upon the handling and shipping conditions which the container, pack, or unit load may be expected to encounter. For the purpose of this standard, the levels of packing shall be defined as:

C.2.1.1 Level A. This protection level is generally considered for unit loads subjected to tactical environments and is fully defined in 4.11.1.

C.2.1.2 Level B. This protection level is generally considered for unit loads subjected to the tactical logistics cycle but not for long-term storage and is fully defined in 4.11.2.

C.3 APPARATUS

C.3.1 Cornerwise-drop test. In conducting the cornerwise-drop test, the unit load may be handled with any convenient equipment, such as a forklift truck, a hoist, or a block and tackle. A smooth, level, concrete surface (or similarly unyielding surface) shall be used in performing the cornerwise-drop test.

C.4 SPECIMEN

C.4.1 Contents. One unit load and its contents shall constitute a single specimen. The unit load shall be loaded for the test with the interior packing and the actual contents for which it was designed. If use of the actual contents is not practical, a dummy load shall be substituted to simulate such contents in weight, rigidity, shape, and center of gravity, position in the unit load, and appropriately instrumented to record shock forces or deflections during the test. The contents, or dummy load, shall be blocked, braced, and cushioned in place as for shipment.

C.5 CONDITIONING OF SPECIMEN

C.5.1 Test specimen. All tests shall be conducted at room temperature (77±18 °F) except as noted below.

C.6 PROCEDURE

The specimen shall be placed on its bottom. One corner of the base of the unit load shall be supported on a block nominally 6 inches in height, and a block nominally 12 inches in height shall be placed under the other corner of the same end. If the dimensions of the unit load are such that the 12-inch height cannot be attained without instability, a block of the greatest attainable height shall be substituted. These heights shall be increased, if necessary, to ensure that there will be no support for the base between the ends of the unit load when dropping takes place, but should not be high enough to cause the unit load to slide on the supports when the drop end is raised for the drop. The unsupported end of the unit load shall be raised so that the lower corner of that end reaches the prescribed height, and then allowed to fall freely to the concrete surface or similarly unyielding surface (see figure C-1). Unless otherwise specified (see 6.2), the height of drop for Levels A and B protection shall be in accordance with table C-I; the maximum heights shall not exceed 36 inches and 27 inches, respectively. Unless otherwise specified (see 6.2), there shall be one drop on each corner of the unit load base (four drops). If the test specimen contains materials which are significantly affected by temperature, the test shall be conducted while the unit load is stabilized at the extremes of temperature. In this case, one drop shall be made on each of two diagonally opposite corners at -20±5 °F. The test specimen shall be allowed to come normally to room temperature prior to conditioning at the other extreme. One drop shall then be made on each of the other two diagonally opposite corners at 140±5 °F. Thus, a total of four drops constitutes a complete test.

C.7 NOTES

a. This test is meant to simulate the impacts of accidentally dropping a unit load on its corners. It is intended that the cornerwise-drop test shall be used only on unit loads that are susceptible to accidental cornerwise drops. The cornerwise-drop test was designed specifically for large and/or heavy shipping containers or unit loads that are likely to be handled mechanically rather than manually. Details are given with the qualification, “unless otherwise specified”, in paragraphs regarding:

(1) Conditioning of specimens (see C.5).

(2) Number and height of drops (see C.6).

b. When the cornerwise-drop test is performed to evaluate the protection provided for the contents, the rigidity of a dummy load should closely approximate that of the actual contents for which the packaging used within the unit load was designed.

TABLE C-I. Height of cornerwise drops (rotational) for unit loads of various sizes and weights.[1/]

Gross weight (within range limits)	Dimensions of any edge, height, or width (within range limits)	Height of drop on corners	
Pounds	**Inches**	**Level A inches**	**Level B inches**
150 – 250	60 – 66	36	27
250 – 400	66 – 72	32	24
400 – 600	72 – 80	28	21
600 – 1,000	80 – 95	24	18
1,000 – 1,500	95 – 114	20	16
1,500 – 2,000	114 – 144	17	14
2,000 – 3,000	Above 144 – No limit	15	12
Above – 3,000		12	9

NOTE:

[1/] Use the lowest drop height indicated by either gross weight or dimension. For example, a unit load having a gross weight of 440 pounds and a maximum edge dimension of 95⅝ inches, shall be dropped 20 inches for Level A tests, or 16 inches for Level B tests.

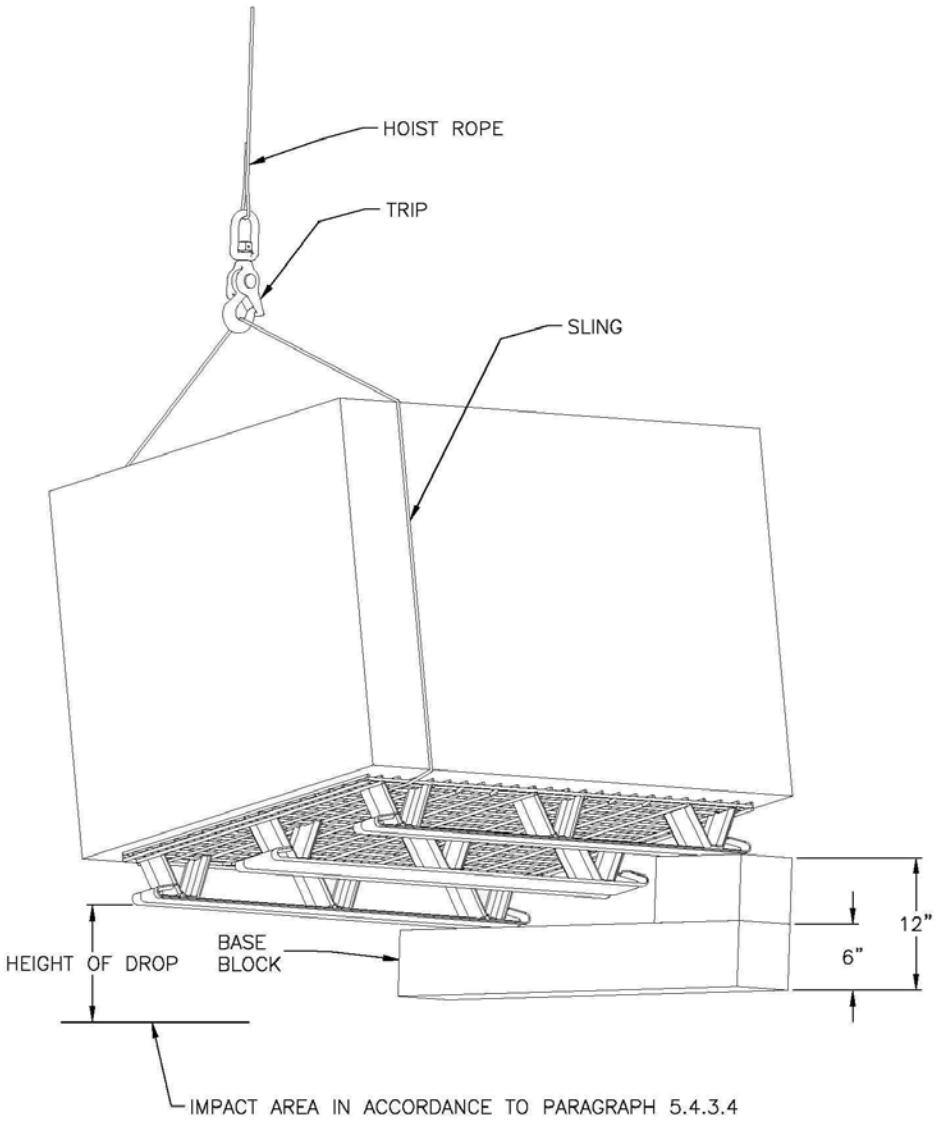

FIGURE C-1. Cornerwise-drop (rotational).

INCLINE IMPACT TEST

D.1 SCOPE

D.1.1 Scope. The following procedure is applicable for determining the ability of unit loads to resist impacts on their surfaces or edges, and for determining the ability of the unit load, the packaging, and packing methods to provide protection to the contents when the pack is impacted on its surfaces or edges. This Appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

D.2 APPLICABLE DOCUMENTS

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

D.2.2 Non-government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ASTM INTERNATIONAL

ASTM D880 - Standard Test Method for Impact Testing for Shipping Containers and Systems

(Copies of this document are available from ASTM International, 100 Barr Harbor Dr., P.O. Box C700, West Conshohocken, PA 19428-2959 or online at www.astm.org.)

D.3 DEFINITION

D.3.1 Inline impact tester. For the purpose of this test, an incline impact tester shall consist of a two-rail steel track inclined 10 degrees from the horizontal, a rolling carriage or dolly, and a rigid bumper (see D.4).

D.4 APPARATUS

D.4.1 Inclined track. The inclined track shall accommodate the carriage which shall be equipped with steel wheels, not less than 3 inches in diameter, and a renewable face made of dense hardwood or plywood. The bumper at the bottom of the incline shall be constructed integrally with the track and with the plane of its face perpendicular to the direction of movement of the carriage. The bumper shall be faced with dense hardwood members of such thickness as to resist the impacts without breakage or excessive deflection. The faces of the bumper and the carriage shall be kept free of any protrusions, such as bolts or nailheads, abrasions, and splits that might affect the test results. The track shall be clean and the wheels well lubricated. The apparatus may also have a cable and winch to aid in pulling the carriage to the elevated end of the track, and an automatic tripping device for releasing the carriage from a predetermined point of the incline. A detailed description of this apparatus with construction drawings appears in ASTM D880.

D.5 SPECIMEN

D.5.1 Contents. One unit load and its contents shall constitute a single specimen. The unit load shall be loaded for the test with the interior packing and the actual contents for which it was designed. If use of the actual contents is not practical, a dummy load shall be substituted to simulate such contents in weight, shape, and position in the container. The contents, or dummy load, shall be blocked, braced, and cushioned in place as for shipment.

D.6 CONDITIONING OF SPECIMEN

D.6.1 Test specimen. Unless otherwise specified (see 6.2), no special conditioning of the test specimen shall be necessary.

D.7 PROCEDURE

The specimen shall be placed on the carriage with the surface or edge which is to be impacted projecting at least 2 inches beyond the front end of the carriage. The carriage shall be brought to a predetermined position on the incline and released. To concentrate the impact at any particular position on the unit load, a 4- by 4-inch timber is attached to the bumper in the desired position before the test. No part of the timber shall be struck by the carriage. The position of the unit load on the carriage and the sequence in which the surfaces and edges are subjected to impacts may be at the option of the testing activity and will depend upon the objective of the tests. When the test is conducted to determine satisfactory performance of a unit load, and unless otherwise specified (see 6.2), the specimen shall be subjected to one impact on each surface that has each dimension less than 9.5 feet. Unless otherwise specified (see 6.2), the velocity at time of impact (which may be assumed equal to twice the average velocity) shall be 7 feet per second. A record shall be made of each impact to show velocity at impact and any changes or breaks in the unit load, such as apparent racking, nail pull, or broken parts and their locations. The packing (blocks, braces, cushions, or other devices) and the contents shall be examined carefully and a record made of their condition. (See figure D-1).

D.8 NOTES

D.8.1 Incline impact test. This test is meant to simulate railroad humping, switching, or other accidental handling impacts. It is intended that the incline impact test shall be used only on unit loads that are susceptible to such accidental impacts. Details are given with the qualification, “unless otherwise specified”, in paragraphs regarding:

a. Conditioning of specimens (see D.6).

b. Number and velocity of impacts (see D.7).

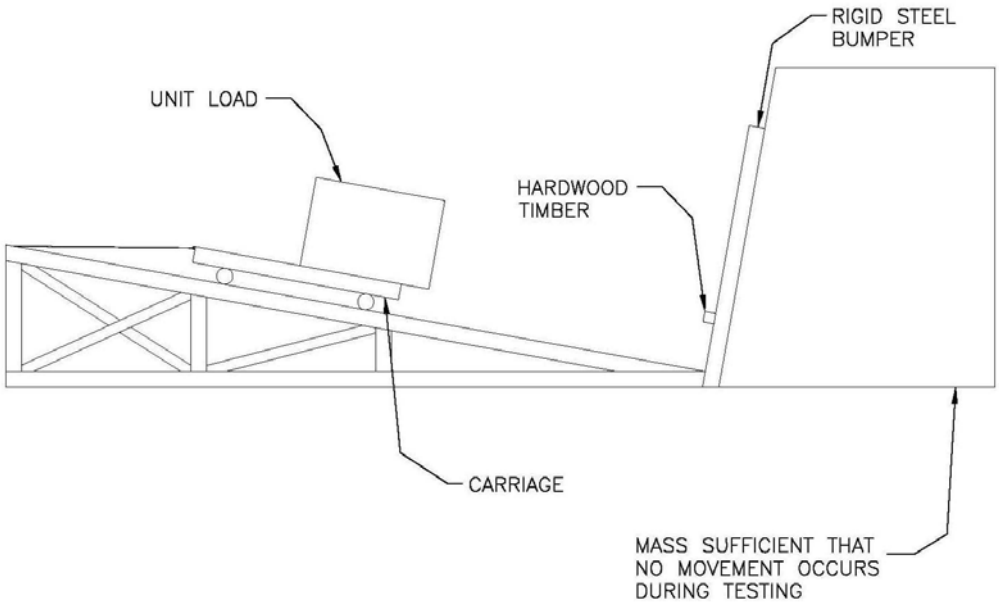

FIGURE D-1. Incline impact test.

PENDULUM-IMPACT TEST

E.1 SCOPE

E.1.1 Scope. The following procedure is applicable for determining the ability of unit loads to resist horizontal impacts and for determining the ability of the packaging and packing methods to provide protection to the contents when the unit load is impacted. This Appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

E.2 APPARATUS

E.2.1 Pendulum-impact tester. A pendulum-impact tester which consists of a platform suspended from a height at least 16 feet above the floor by four or more ropes, chains, or cables; and a bumper consisting of a flat, rigid concrete, or masonry wall, or other equally unyielding flat barrier. The bumper shall be 18 inches high, wide enough to make full contact with the end of the unit load, and shall have sufficient mass to resist the impacts without displacement. The impact surface shall be oriented perpendicular to the line of swing of the platform. The platform shall be large enough to support the unit load, and when hanging free, shall have its top surface approximately 9 inches above the floor, and its leading edge at least 3 inches from the surface of the bumper. The suspension chains shall be vertical and parallel so that when the platform is pulled straight back it will rise uniformly but remain at all times horizontal and parallel to the floor.

E.3 SPECIMEN

E.3.1 Contents. One unit load and its contents shall constitute a single specimen. The unit load shall be loaded for the test with the interior packing and the actual contents for which it was designed. If use of the actual contents is not practical, a dummy load shall be substituted to simulate such contents in weight, shape, and position in the container. The contents, or dummy load, shall be blocked, braced, and cushioned in place as for shipment.

E.4 CONDITIONING OF SPECIMEN

E.4.1 Test specimen. Unless otherwise specified (see 6.2), no special conditioning of the test specimen shall be necessary.

E.5 PROCEDURE

The specimen shall be placed on the platform with the surface which is to be impacted projecting beyond the front end of the platform so that the specimen just touches the vertical surface of the bumper. The platform shall be pulled back so that the center of gravity of the pack is raised to the prescribed height, and then shall be released to swing freely so that the surface of the unit load impacts against the bumper (see figure E-1). When the test is conducted to determine satisfactory performance of a unit load and unless otherwise specified (see 6.2), each specimen shall be subjected to one impact to each side and each end that has a horizontal dimension of less than 9.5 feet. Unless otherwise specified (see 6.2), the vertical height of drop shall be 9 inches, which results in a velocity of 7 feet per second at impact. A record shall be made of any changes or breaks in the unit load, such as apparent racking, nail pull, or broken parts and their locations. The packing (blocks, braces, cushions, or other devices) and the contents shall be examined carefully and a record made of their condition.

E.6 NOTES

a. This test is meant to simulate severe railroad humping or other accidental handling impacts. It is intended that the pendulum-impact test shall be used only on unit loads that are susceptible to accidental end impacts. The pendulum impact was designed specifically for large and/or heavy shipping containers or unit loads that are likely to be handled mechanically rather than manually. Details are given with the qualification, “unless otherwise specified”, in paragraphs regarding:

(1) Conditioning of specimens (see E.4).

(2) Number and height of drops (see E.5).

b. When the pendulum-impact test is performed to evaluate the protection provided for the contents, the rigidity of a dummy load should closely approximate that of the actual contents for which the packaging within the unit load was designed.

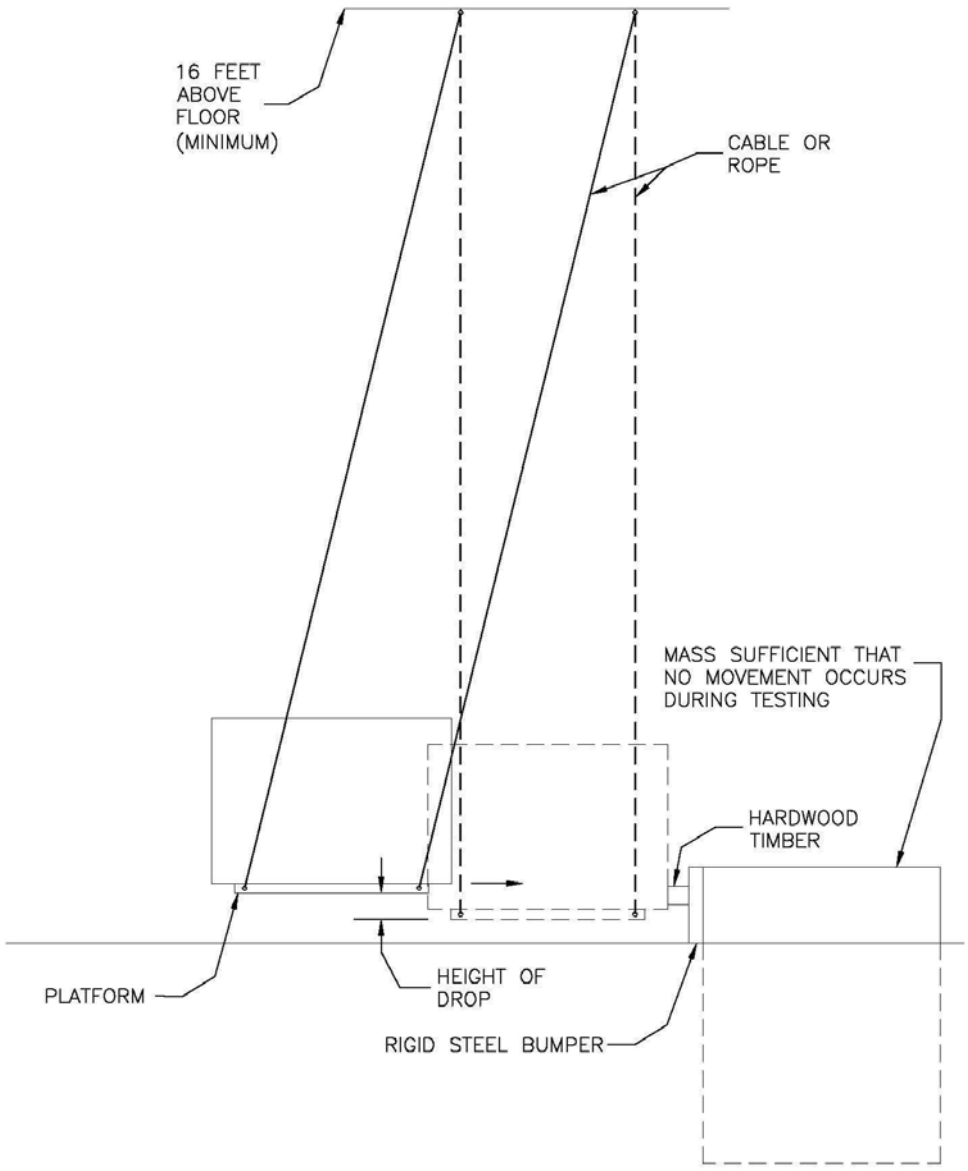

FIGURE E-1. Pendulum-impact test.

TIPOVER TEST

F.1 SCOPE

F.1.1 Scope. The following procedure is applicable for determining the ability of unit loads to resist the impacts of being tipped over, and for determining the ability of the unit load, packaging, and packing methods to provide protection to the contents, when the pack is tipped over. Unless otherwise specified (see 6.2), unit loads having widths greater than one-fourth the height shall not be tested in this manner. This Appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

F.2 APPARATUS

F.2.1 Tipover test. In making the tipover test, the unit load may be handled with any convenient equipment, such as a forklift truck, a hoist, a block and tackle, or by hand. A smooth, level, concrete slab, pavement, or similarly unyielding surface shall be available upon which to perform the tipover test.

F.3 SPECIMEN

F.3.1 Contents. One unit load and its contents shall constitute a single specimen. The unit load shall be loaded for the test with the interior packing and the actual contents for which it was designed. If use of the actual contents is not practical, a dummy load shall be substituted to simulate such contents in weight, shape, and position in the container. The contents, or dummy load, shall be blocked, braced, and cushioned in place as for shipment.

F.4 CONDITIONING OF SPECIMEN

F.4.1 Test specimen. Unless otherwise specified (see 6.2), no special conditioning of the test specimen shall be necessary.

F.5 PROCEDURE

The specimen shall be placed on its bottom and slowly tipped until it falls freely (by its own weight) on its side to a smooth, level, concrete slab or similarly unyielding surface. Two of these tipovers shall be made, one on each side or 180 degrees apart on a cylinder. A record shall be made of any changes or breaks in the unit load, such as apparent racking, nail pull, or broken parts and their locations. The packing (blocks, braces, cushions, or other devices) and the contents shall be examined carefully and a record made of their condition.

F.6 NOTES

a. This test is meant to simulate the impacts of accidentally tipping over a unit load. It is intended that the tipover test shall be used only on unit loads that are susceptible to accidental tipovers. Details are given with the qualification, “unless otherwise specified”, in paragraphs regarding:

(1) Scope – excluded unit loads (see F.1)

(2) Conditioning of specimens (see F.4)

(3) Number and direction of tipover (see F.5)

b. When the tipover test is performed to evaluate the protection provided for the contents, the rigidity of a dummy load should closely approximate that of the actual contents for which the packaging within the unit load was designed.

MECHANICAL HANDLING TEST

G.1 SCOPE

G.1.1 Scope. This test determines the ability of a unit load to withstand handling by mechanical handling equipment. These procedures do not include every conceivable mechanical handling hazard to a unit load. If the unit load must withstand other known hazards not represented by these procedures, other tests should be used. Conversely, any of these procedures not appropriate for a specific unit load should not be applied. This Appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

G.2 APPARATUS

G.2.1 Forklift handling.

a. A forklift truck having hard, rubber tires of sufficient capacity for the weight to be handled. Forks shall be adjusted to a spacing appropriate for the specimen under test, but not greater than 30 inches center to center.

b. Six nominal 1- by 4-inch boards longer than the width of the forklift truck.

G.2.2 Hoisting with slings.

a. A crane, hoist, or other arrangement of sufficient capacity for the weight to be lifted.

b. Slings of the lengths required to test the specimen (see G.5.3).

G.2.3 Hoisting with grabs.

a. A crane, hoist, or other arrangement of sufficient capacity for the weight to be handled.

b. A pair of chain- or cable-operated gravity-type grabs. The length of the operating chain or cable shall be adjustable if necessary. The gripping surface of each grab shall be appropriate for the specimen being tested. For example, the surface for use on wood boxes or crates might be a flat plate with several conical teeth that with pressure will become embedded into the wood of the unit load and prevent slipping.

G.2.4 Pushing.

a. A vehicle of sufficient capacity to push the specimen.

G.2.5 Towing.

a. A vehicle of sufficient capacity to pull the specimen.

b. A towline of sufficient strength.

G.2.6 Conveying.

a. A level length of skate-wheel conveyor not less than 10 feet long and wide enough to handle the specimen. Width may be made up of more than one section of conveyor.

b. If necessary, equipment to move the specimen.

G.3 SPECIMENS

G.3.1 Contents. One unit load and its contents shall constitute a single specimen. The unit load shall be loaded for the test with the interior packing and the actual contents for which it was designed. If use of the actual contents is not practical, a dummy load shall be substituted to simulate such contents in weight distribution, shape, rigidity, and position in the unit load. The contents, or dummy load, shall be blocked, braced, and cushioned in place as for shipment.

G.4 CONDITIONING

G.4.1 Test specimen. Unless otherwise specified (see 6.2), no special conditioning of the test specimen shall be necessary.

G.5 PROCEDURE

G.5.1 Sequence of tests. Unless otherwise specified (see 6.2), handling provisions shall be tested as follows in the sequence given.

G.5.2 Lifting and transporting by forklift truck. The specimen shall be lifted clear of the ground by a forklift truck at one side of the specimen and transported on the forks in the level or the back-tilt position across a hard pavement for a distance not less than 100 feet. Parallel pairs of 1-inch boards spaced 54 inches apart shall be laid flatwise on the pavement across the path of the forklift truck. The first pair shall be placed squarely across the truck's path and centered 30 feet from the starting point; the second pair shall be laid 60 feet from the starting point at an angle of about 60 degrees to the truck's path so the left wheel strikes first; and the third pair shall be laid 90 feet from the starting point at about 75 degrees to the truck's path so the right wheel strikes first. If the specimen is less than 40 inches high and weighs less than 500 pounds, a load shall be superimposed on the specimen throughout the test to simulate stacking of the minimum number of specimens that will attain either a height not less than 80 inches or a weight not less than 1,000 pounds. For example, if a specimen were 30 inches high and weighed 200 pounds, superimposed load would be required. A stack of three would measure 90 inches high, which is not less than 80, so the weight of two (400 pounds) would be superimposed on the test specimen. Similarly, if a test specimen were 15 inches high and weighed 300 pounds, a stack of four would weigh 1,200 pounds, which is not less than 1,000, so the weight of three (900 pounds) would be superimposed on the test specimen. If the test specimen is more than 36 inches wide and is stable on 36-inch-long forks, the forks shall extend only 36 inches under the specimen. The forklift truck carrying the specimen and superimposed load, if required, shall travel the 100 feet in about 23 seconds at a uniform speed (normal walking speed), and then shall be brought to a stop. The specimen shall be carefully observed during the traverse and while the forklift truck is at a stop for any damage, evidence of inadequacy, or deflection of the specimen that might cause damage or displacement of the contents. A record shall be made of the observations. The specimen with its superimposed load, if any, shall then be lowered to the ground. The forklift truck shall be moved from the side to the end of the specimen. The forks shall be run under the specimen as far as possible and then operated to lift the end 6 inches. Observe the specimen, particularly in the vicinity of the ends of the forks, and record observations. If the specimen can thus be lifted clear of the floor, transport it on the forks over the same 100-foot course, and record observations. If it cannot be thus lifted, report the length of forks used and state that the specimen could not be carried on the forklift truck at either end.

G.5.3 Hoisting with slings. If the specimen is less than 40 inches high and weighs less than 500 pounds, a load shall be superimposed on the specimen throughout the test to simulate stacking to not less than either a height of 80 inches or a weight of 1,000 pounds (see G.5.2 for examples). Such superimposed load shall not contact the slings or lend reinforcement to the top structure of the unit load.

G.5.3.1 Undersling handling. (see figure G-1) Two slings without spreaders shall be placed around the specimen, each passing beneath the specimen, one near each end where indicated on the unit load and bought to a common point above the center of balance for attachment to the hoist. When no indication is provided, locate slings at outside end of rubbing strips if possible. If not possible, locate slings about midway between the center of balance and the ends. Lift the specimen and any superimposed load, and hold suspended for not less than 2 minutes. Observe carefully for any indications of inadequacies and let the specimen down again. Record observations.

G.5.3.2 Sling handling with attachments.

G.5.3.2.1 Two-place attachment. Attach slings to two hoisting attachment provisions (lift rings, eyes, lugs, or other devices), one on each side or each end, so that the specimen will remain upright when hoisted. The length of the slings shall be such that when lifting they form angles between 20 degrees and 25 degrees with a horizontal plane (see figure G-2, view A). Lift the specimen clear of the floor and hold it suspended for not less than 2 minutes. Observe carefully for any indications of inadequacies of the specimen. Record observations and let the specimen down again. Repeat with other hoisting attachment provisions until each has been tested. If the specimen has only one attachment provision, attach only one sling to hold the specimen suspended for 2 minutes.

G.5.3.2.2 One-place attachment. If more than one attachment point is provided, remove the superimposed load, if any, from the specimen. Attach one sling to one lifting attachment provision, and lift the specimen clear of the ground (see figure G-2, view B). Observe for any indications of inadequacies of the specimen. Record observations and lower the specimen to the ground. Repeat with each lifting attachment point provided on the specimen.

G.5.4 Hoisting with grabs. (see figure G-3) Align the grabs on opposite sides or ends of the specimen above its center of balance. Adjust the grab operating chain or cable so that while the specimen is suspended, the grab pressure normal to the surface of the unit load will be about 1.2 times the specimen's weight. (For an operating line extending continuously from the hoist attachment downward to a pulley on one grab and then horizontally to a pulley on the other grab and then upward to the hoist attachment, the required pressure will result when the inclined portion of the line forms 45-degree angles (±5 degrees) to the horizontal. For an operating line extending from one grab up to the hoist attachment and then down to the other grab (not horizontally between the grabs), the required pressure will result when the inclined portions of the line form angles of 22½±2½degrees with a horizontal plane.) Connect the hoist to the lifting point of the grab operating line and slowly lift. If the specimen tilts excessively upon lifting, lower it and relocate the grabs and the lifting point, if necessary, to align with the center of gravity of the specimen. Hoist the specimen clear of the floor, hold it suspended for 2 minutes, and return it to the floor. Observe for any evidence of inadequacy or damage to the container or unit load, or deflection of the container or unit load that might cause damage or displacement of contents. A record shall be made of observations.

G.5.5 Pushing. Position the vehicle to abut the end of the specimen near the floor. If a forklift truck is used, the mast shall be vertical or at a slight back-tilt, and the forks shall extend beneath the specimen but shall not support it. Operate the truck to push the specimen along a hard, dry pavement a distance of 35 feet in about 85 seconds at a uniform speed, observing the specimen for any inadequacies or damage. Record observations. Move the vehicle to abut the side of the specimen near the floor and move the specimen sidewise over the same distance. Record observations. When specified (see 6.2), the pushing test shall be repeated with one end of the unit load lifted off the ground about 6 inches by the tips of the forks inserted between the skids. The strength of the unit load structure as well as the skids, shall survive the test without failure or permanent deformation.

G.5.6 Towing. Attach a sling to the towline attachment fittings at one end, and connect with a towing vehicle at a height not greater than the fittings. If no fittings are provided, use a sling- or gravity-type grab at the base of the specimen for attaching the towline, or some other feasible arrangement may be devised. Operate the vehicle to tow the specimens along a hard, dry pavement a distance of 100 feet in about 23 seconds at a uniform speed (normal walking speed), observing the specimen for any inadequacies or damage. Record observations and the method of attaching the towline. Then reattach the towline and tow the specimen sidewise over the same distance. Record observations. When specified (see 6.2), the towing test shall be repeated with one end of the unit load lifted off the ground about 6 inches by the tips of the forks inserted between the skids. The strength of the unit load structure, as well as the skids, shall survive the test without failure or permanent deformation.

G.5.7 Conveying. Place the specimen lengthwise on the conveyor, and convey the specimen back and forth until the specified distance lengthwise is accumulated. Each movement shall be not less than the length of the unit load. Place the specimen crosswise on the conveyor and convey the specimen back and forth until the specified distance crosswise is accumulated. Observe and record any damage to the unit load or conveyor and record any difficulties in conveying the specimen. Unless otherwise specified (see 6.2), the total conveyed distance shall be 1,000 feet lengthwise and another 1,000 feet crosswise.

G.5.8 Inspection after handling. Open the specimen and examine the inner surfaces of the unit load and inspect the contents for evidence of inadequacies or damage. Record observations.

G.6 NOTES

G.6.1 Test procedure. This test procedure is intended to demonstrate the effects of handling a unit load by each of the several types of mechanical handling equipment. For example, the procedure for lifting and transporting by forklift truck demonstrates the effect of lifting or carrying from ends or sides, and the effect of carrying the specimen across simulated railroad tracks, thresholds, or other irregularities. The test is intended also to evaluate provisions for the attachment of mechanical handling devices. Procedures are given independently for the various handling techniques so that a procedure for any technique inappropriate for a specific unit load may be accepted. For example, a unit load may have no lifting eyes or lugs for the attachment of slings; so only G.5.3.1, which is a test for handling with an encircling sling, should be applied and G.5.3.2, which is a test for sling attachment, should be accepted. References to this standard should list any of the methods of handling (see G.5.2, G.5.3, G.5.4, G.5.5, G.5.6, and G.5.7) that are to be excluded from the test procedures.

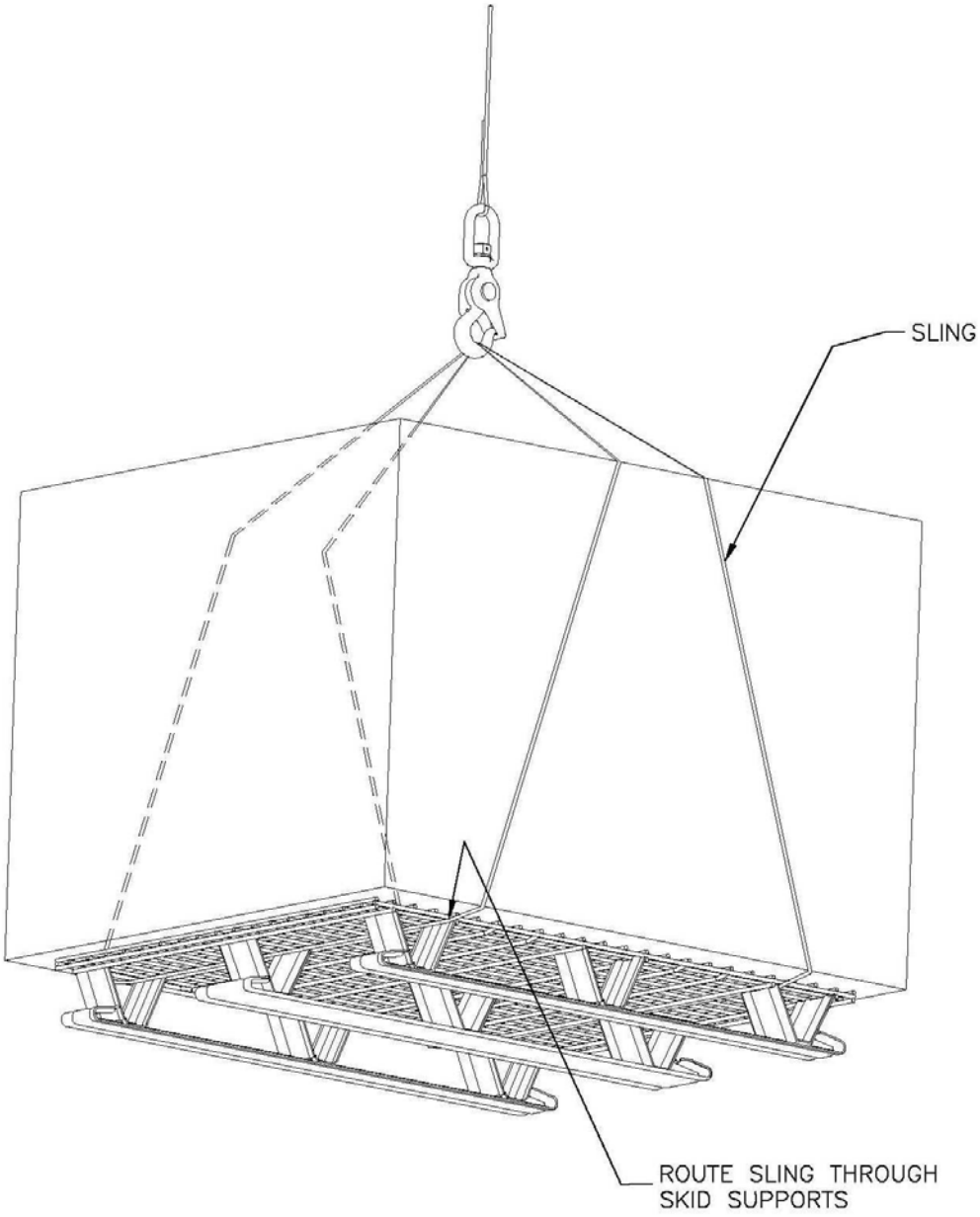

FIGURE G-1. Slings placed around specimen with load superimposed.

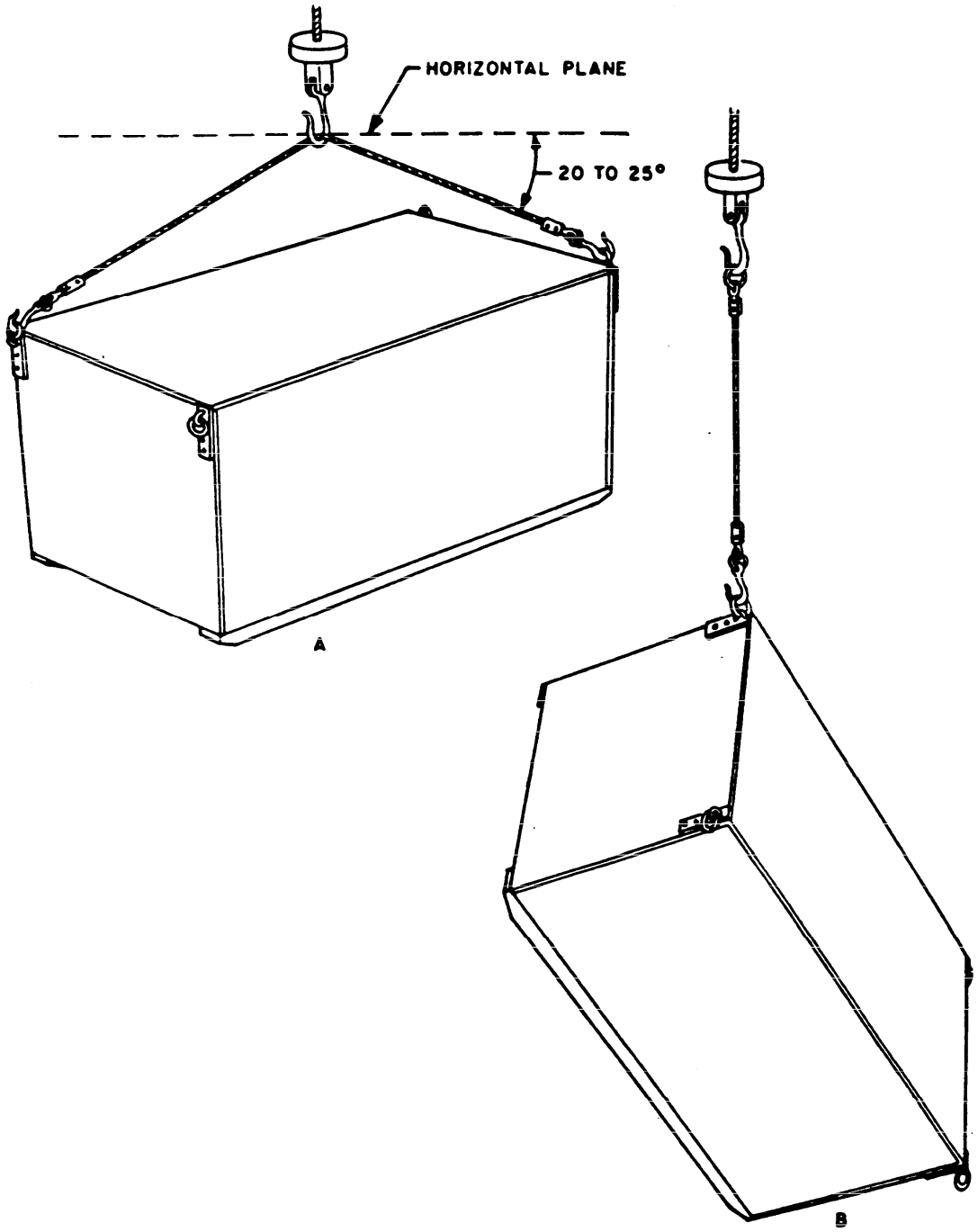

FIGURE G-2. Hoisting with sling attachment provisions.

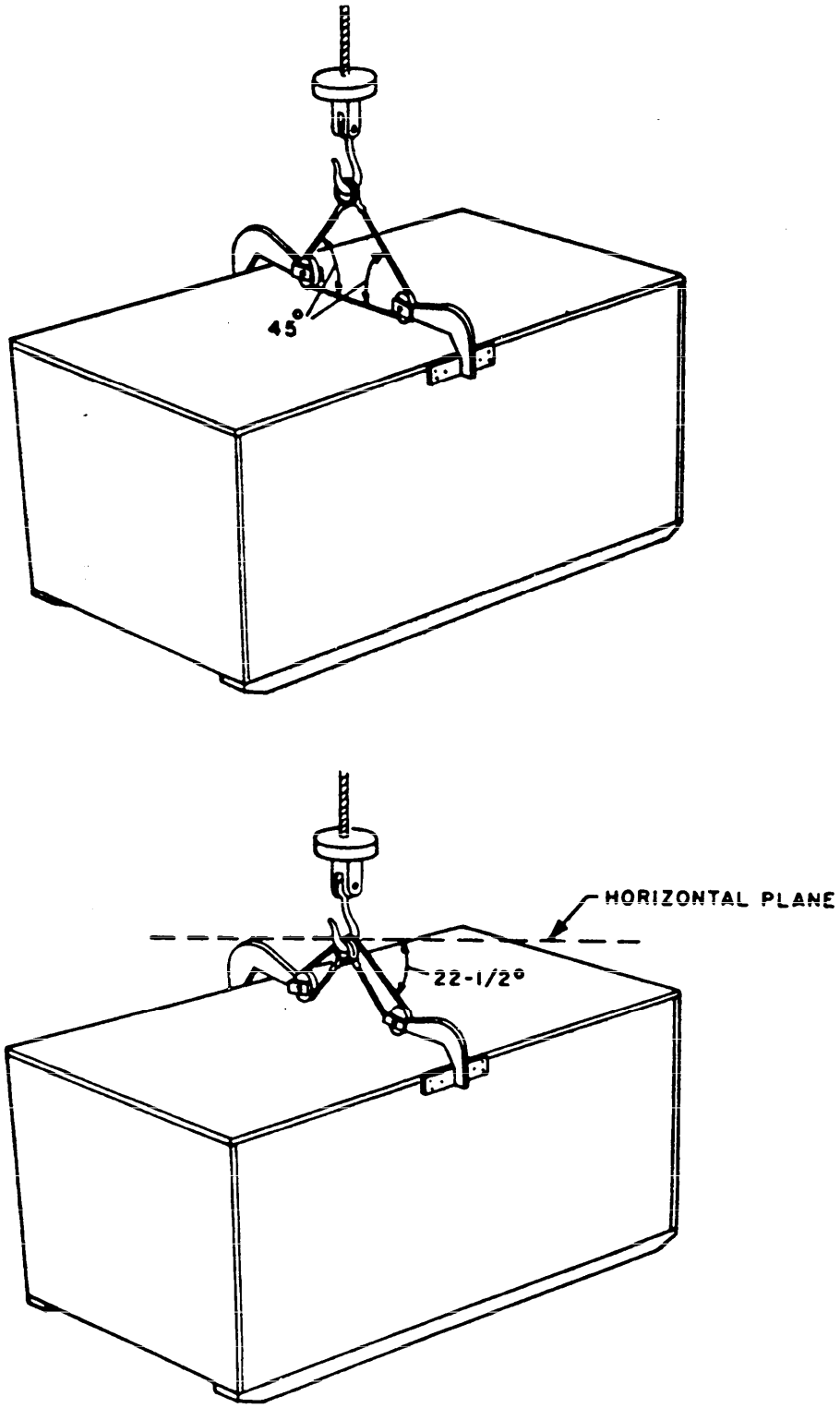

FIGURE G-3. Hoisting with grabs.

TESTING OF AMMUNITION LOADS UNITIZED TO PROTECTION LEVEL C

H.1 SCOPE

H.1.1 Scope. The following test procedures and criteria contained herein are applicable to unit loads of ammunition components/hazardous materials packaged for Level C protection. The component packages and pallet should have already passed acceptance tests to prove their structural and climatic reliability. This Appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

NOTE: Level C (minimum) packing protection is defined in section 4.11.3.

H.2 REQUIREMENTS

H.2.1 General. These test procedures and criteria do not establish the adequacy of the packaging of the individual items, but the ability of the unit load and its strapping or bonding means to withstand the stresses, shocks, and impacts likely to be incurred during temporary storage, limited transport, and typical handling.

H.2.2 Alternate tests. The test methods contained herein are recommended for use; however, other test methods may be substituted provided they will impart the same or a greater degree of structural stress, shock forces, and impact pulse times.

H.3 SPECIMEN

H.3.1 Test specimen. For safety purposes during testing, explosive loaded ammunition components should be replaced by inert items having similar physical characteristics. A test specimen shall simulate an entire unit load and shall be subjected to all tests in the sequence as presented herein, i.e., stacking, vibration, drop, mechanical handling, and disassembly tests. Failure of the test specimen to complete any one or more of the tests shall prove unacceptability of the load. Criteria, as presented herein, shall be utilized for determining failure.

H.4 CONDITIONING OF SPECIMEN

H.4.1 Conditions. Tests should normally be conducted at an ambient temperature of 25±10 °C (77±18 °F). If the materials used in the fabrication of the unit load are sensitive to temperature or humidity, the tests should be conducted in the conditions which occur in the appropriate logistics environment, e.g., conditions prevailing at unsheltered loading and receiving docks.

H.5 PROCEDURES

H.5.1 Stacking test.

a. Purpose.

(1) To examine the ability of the unit load to resist the forces that may occur during temporary storage due to stacking.

(2) To ensure that a safe, stable, and supportive stacking condition will exist.

b. Procedure.

(1) The test specimen shall be loaded to simulate an actual stack of identical unit loads as high as expected to occur during storage.

(2) The stacking condition will be maintained for a period of 24 hours minimum after which time observations shall be made and recorded.

(3) The typical stacking height for storage of ammunition unit loads for Level C is assumed to be two unit loads high. If the unit load is to be designed for stacking more than two units high, the durability and stability of the packaging, the dimensions and weight of the unit load, and the anticipated storage environment should be considered. If the stability of stacking more than two unit loads is questionable based on the previously mentioned considerations, it is recommended that an actual stack of unit loads be either observed for a period of 18 months or subjected to appropriate accelerated life cycle tests prior to approval of stacking more than two unit loads high.

c. Rejection criteria.

(1) Excessive settlement within the unit load, which is evidence of packaging failure or restraint method failure, shall constitute an unacceptable unit load. Packaging failure will be determined by inspection for permanent deformation, broken components, or inability to protect the contents. After removing the stacking load, the degree of compaction should not be so excessive that the restraint method, e.g., strapping or stretch wrap, has lost all tension. If the loss of tension is not easily discernable, then the next phase of testing, the vibration test, should be invoked to aid in the determination.

(2) A tendency for the unit load to create an unstable and unsafe stacking condition shall also constitute an unacceptable unit load. Generally, a stack of units, which leans 10 degrees or more from the vertical angle, is unstable and unsafe.

H.5.2 Vibration test.

a. Purpose.

(1) To evaluate the unitization restraint method for securing the load to the pallet/skid.

(2) To determine the reliability of the restraint method.

(3) To ensure that the restraint and unit load integrity will be maintained after the unit load has been subjected to vibration as could be experienced by the load in its journey from origination to destination.

b. Procedure.

(1) The unit load specimen shall be placed on, but not fastened to, the platform of a vibration tester of suitable size and weight-carrying capacity. If the unit load may be shipped in a stacked configuration, then a corresponding stack of specimens should be placed on the vibration tester. Unless failure occurs, the time period of vibration shall be 60 minutes, if the specimen is tested in one orientation. If tested in more than one position, the time period shall be 30 minutes for each orientation. Unless failure occurs, the specimen should be subjected to a second series of vibration periods as described above. Observations of unit load condition should be made and recorded after both series.

(2) Retainment devices shall be attached to the platform to prevent the specimen from moving off of or rotating on the platform during the test. The retainment devices should be adjusted to permit unrestrained movement of the specimen from its centered position of no more than 3 inches either forward or aft in the direction of vibration and no more than 1 inch side-to side across or aft in the direction of vibration. Forward and aft bulkheads/retainers used for this purpose should be rigid and have smooth-supportive surfaces such as plywood. Floor cleats adjacent and parallel to the unit load pallet/skid may be used to retain the side to side movement.

(3) The vibration imparted to the test specimen shall be at ½-inch amplitude (1-inch double amplitude) sinusoidal motion starting at a frequency of about three cycles per second (180 cycles per minute). The vibration speed should then be adjusted for each test position of the specimen to achieve the condition at which the pallet/skid of the unit load is just lifting from the vibration platform. This conditional shall be determined when a 1/16-inch feeler gage can be momentarily slid freely between each point common to the specimen and the platform at some instant during each cycle.

c. Rejection criteria.

(1) Failure of the unit load will be indicated by loss of package(s) from the unit or loss of securement to the pallet/skid.

(2) Loss of tension within the unit load restraint method shall also be cause for rejection. Loss of tension shall be determined by measuring any shifting of packages relative to other packages or relative to the pallet/skid. If the relative shifting/displacement exceeds 2 inches, the unit load is unacceptable. If the loss of tension is not easily discernable, then the next phase of testing, the drop test, should be invoked to aid in the determination.

(3) Damage to the packaging, which may compromise protection of the contents, shall constitute failure.

H.5.3 Drop test (edgewise-drop).

a. Purpose.

(1) To examine the ability of the unit load to resist certain shock forces which could be imposed on it from typical rough handling and minor shipping hazards during transportation from origination to destination.

(2) To further evaluate the restraint method for adequate tension and ability to maintain unit load integrity.

b. Procedure.

(1) In conducting the edgewise-drop test, the unit load may be handled with any convenient equipment, such as forklift truck, a hoist, or a block and tackle. The edgewise-drop test shall be performed on a smooth, level concrete surface or similarly unyielding surface. The unit load shall be positioned with one edge of the base supported on a sill approximately 6 inches high. The unsupported opposite edge shall then be raised and allowed to fall freely to the concrete surface from a height as determined below:

TABLE H-I. Height of edgewise drops for unit load specimens of various sizes and weights.[1/]

Gross weight of unit load (within range limits)	**Height of raised edge of base/pallet (within range limits)**
Pounds	**Inches**
Below – 600	L/2.7+6
600 – 3,000	L/8+6
Above – 3,000	L/16+6

NOTE:

[1/] L is defined as the length in inches of the pallet/skid edge which is perpendicular to the raised edge. Drop height should be calculated to the nearest ¼ inch.

(2) The test shall be applied once to each base edge of the unit load. If the size of the unit load and the location of the center of gravity are such that the drop cannot be made from the determined height, the greatest safe attainable height shall be substituted.

c. Rejection criteria.

(1) Structural damage to the unit load, which would result in either spilling of the contents or failure of the unit load during subsequent handling tests, will be cause for rejection. There should be no evidence of a substantial amount of shifting of the contents within the unit load that would create conditions likely to cause damage during shipment, storage, or handling. A substantial amount of shifting shall be determined by measuring the relative displacement of packages relative to other packages or relative to the pallet/skid. If the relative shifting/displacement exceeds 2 inches, the unit load is unacceptable.

H.5.4 Mechanical handling test.

a. Purpose.

(1) To prove the ability of the unit load to be adequately handled on all sides (4-way) by conventional forklift truck.

(2) To prove the ability of the unit load to be adequately handled by pallet truck (if deemed necessary for expected handling conditions).

b. Procedure.

(1) The unit load shall be lifted clear of the ground by a forklift truck of suitable size and capacity and transported in the level or back-tilt position for a distance of at least 100 feet. Part of the path, which the forklift truck traverses, should simulate ramps, dock plates, or whatever obstacles that would actually be encountered during the expected handling cycles. For this purpose, a typical hazard course for forklifts, as delineated by figure 1, may be utilized. This test should be conducted with the unit load lifted from each unique direction (i.e., both sideways and endways for most unit loads, and from all sides of unit loads with an offset center of gravity). If two-high or higher unit load carries will be permitted during any handling cycle, the unit loads shall also be tested in the stacked configuration.

(2) The unit load shall be lifted clear off the ground by pallet truck and transported to a distance of at least 50 feet. This test should be conducted with the unit load lifted from each unique direction and the pallet truck utilized should be similar in size and capacity to the pallet trucks common to the expected distribution system.

c. Rejection criteria.

(1) Any tendency for unit load(s) to be unstable while being transported, or any difficulty with inserting or removing the forklift tines shall constitute failure of the test. Inability to insert the fingers of a pallet truck on all unique directions will be cause for rejection of the unit load only if this condition results in an undue restriction within the expected distribution system.

(2) Damage, evidence of inadequacy, or deflection of the specimen that causes damage or excessive displacement of the packages, or contents, shall be unacceptable.

H.5.5 Disassembly and final inspection test.

a. Purpose.

(1) Although the foregoing tests may have caused movement within the unit load and the restraint method may have become strained, the unit load specimen may still maintain sufficient cohesion to indicate that an actual unit load could complete its journey from origination to destination and continue to be safely handled and stored. The purpose of the final test and criteria is to ensure that the unit load integrity has not been lost and that the package contents have not been damaged.

b. Procedure.

(1) Following completion of all the aforementioned tests, the unit load specimen shall be positioned on a flat, level surface. Any observations regarding condition of the unit load, which had not been made previously, should be recorded. The restraining devices, e.g., strapping, stretch wrap, wires, staples, etc., shall be removed. Packages shall then be removed from the unit load and inspected for both exterior and interior damage.

c. Final rejection or acceptance criteria.

(1) The assembly structure (the pallet, structural or protective members, strapping, stretch wrap, etc.) shall not have failed nor have permitted individual parts of the unit load assembly to become unattached or separated to such a degree that safe transport and storage of the unit load is sacrificed. The unit load configuration shall have protected the packaged items form damage. Broken or damaged inner packing components/supports is unacceptable. Minor damage such as chipping of wood members or pallet, negligible denting of outer packaging not compromising access to contents, paint chipping, marks in stretch wrapping, etc. are not necessarily causes for rejection.

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

Review activities:
Army – CR4, EA, MI, SM
Navy – AS, MC, SH
DLA – GS

Preparing activity:
Navy – OS
(Project 8140-2006-058)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at http://assist.daps.dla.mil.