INCH-POUND
MIL-STD-648E
1 November 2016
SUPERSEDING
MIL-STD-648D
10 April 2008

DEPARTMENT OF DEFENSE
DESIGN CRITERIA STANDARD

SPECIALIZED SHIPPING CONTAINERS

FOREWORD

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

2. This standard establishes the general design criteria and associated tests for specialized shipping containers used by the Department of Defense. The initial step in the creation of a specialized shipping container is to distill the general design criteria within this document into specific design criteria. By filling out a container requirements checklist (see Appendix A) prior to initiating the design, a focused list of unique needs can be identified to ensure that the container's contents are properly protected throughout its planned distribution and stowage logistics.

3. A specialized container is uniquely configured to support and protect its prescribed contents while being handled, stored, shipped to, and unpacked by the user; or to protect personnel and equipment from hazardous contents. Containers of this type frequently incorporate energy absorbing systems, temperature control systems, or special features to make handling or shipment possible, easier, or safer. Engineering drawings, or equivalent, are used to define form, fit, function, materials, tolerances, and manufacturing techniques.

4. A specialized shipping container is designed for use with a specific item when general container specifications are not sufficiently detailed to assure required protection, safety, reliability, maintainability, or configuration control. The need for a specialized container may arise with any deliverable item and invariably does so with nuclear and conventional ammunition and explosives. The container may be the result of a completely original design effort or of the modification of existing or standard container designs.

5. Copies of this standard are available online at http://quicksearch.dla mil.

6. Comments, suggestions, or questions on this document should be addressed to Commander, Naval Sea Systems Command, ATTN: SEA 05S, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard, DC 20376-5160 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 https://assist.dla mil.

CONTENTS

PARAGRAPH PAGE

PARAGRAPH PAGE

PARAGRAPH PAGE

PARAGRAPH PAGE

PARAGRAPH PAGE

APPENDIX PAGE

APPENDIX PAGE

APPENDIX PAGE

APPENDIX PAGE

APPENDIX PAGE

APPENDIX PAGE

FIGURE PAGE

TABLE PAGE

1. SCOPE

1.1 Scope. This standard establishes general design guidelines and associated tests for specialized shipping containers used by the Department of Defense. Definitive requirements for specific containers will be defined by the individual specification, acquisition, or task order. This standard is intended to be used as the basic reference document in all specifications and standards prescribing performance requirements to be applied to a specialized shipping container. Compliance with this intent is expected through normal application of the specification or standard preparation and revision processes.

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

STANAG 2829 - Material Handling Equipment

STANAG 4240 - Liquid Fuel/External Fire, Munition Test Procedures

STANAG 4241 - Bullet Impact, Munition Test Procedures

STANAG 4375 - Safety Drop, Munition Test Procedures

STANAG 4382 - Slow Heating, Munitions Test Procedures

STANAG 4396 - Sympathetic Reaction, Munition Test Procedures

STANAG 4496 - Fragment Impact, Munitions Test Procedure

STANAG 4526 - Shaped Charge Jet, Munitions Test Procedure

FEDERAL STANDARDS

FED-STD-H28 - Screw-Thread Standards for Federal Services

COMMERCIAL ITEM DESCRIPTIONS

A-A-55057 - Panels, Wood/Wood Based; Construction and Decorative

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-S-901 - Shock Tests, H.I. (High-Impact) Shipboard Machinery, Equipment, and Systems, Requirements for

MIL-DTL-2427 - Box, Ammunition Packing: Wood, Nailed

MIL-D-3464 - Desiccants, Activated, Bagged, Packaging Use and Static Dehumidification

MIL-D-3716 - Desiccants, Activated for Dynamic Dehumidification

MIL-DTL-53072	-	Chemical Agent Resistant Coating (CARC) System Application Procedures and Quality Control Inspection
MIL-PRF-81705	-	Barrier Materials, Flexible, Electrostatic Discharge Protective, Heat-Sealable

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-129	-	Military Marking for Shipment and Storage
MIL-STD-130	-	Identification Marking of U.S. Military Property
MIL-STD-209	-	Lifting and Tiedown Provisions
MIL-STD-709	-	Ammunition Color Coding
MIL-STD-810	-	Environmental Engineering Considerations and Laboratory Tests
MIL-STD-814	-	Requirements for Tiedown, Suspension and Extraction Provisions on Military Materiel for Airdrop
MIL-STD-889	-	Dissimilar Metals
MIL-STD-913	-	Requirements for the Certification of Sling Loaded Military Equipment for External Transportation by Department of Defense Helicopters
MIL-STD-1320	-	Standard Practice for Designing Unit Loads, Truckloads, Railcar Loads, and Intermodal Loads for Ammunition and Explosives
MIL-STD-1365	-	General Design Criteria for Handling Equipment Associated with Weapons and Related Items
MIL-STD-1366	-	Transportability Criteria
MIL-STD-1472	-	Human Engineering
MIL-STD-1660	-	Ammunition Unit Loads
MIL-STD-1686	-	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)
MIL-STD-1791	-	Designing for Internal Aerial Delivery in Fixed Wing Aircraft
MIL-STD-1904	-	Design and Test Requirements for Level A Ammunition Packaging
MIL-STD-2073-1	-	Military Packaging
MIL-STD-2105	-	Hazard Assessment Tests for Non-Nuclear Munitions
MIL-STD-3010	-	Test Procedures for Packaging Materials and Containers
MIL-STD-3028	-	Joint Modular Intermodal Container

DEPARTMENT OF DEFENSE HANDBOOKS

MIL-HDBK-304	-	Package Cushioning Design
DOD-HDBK-743	-	Anthropometry of U.S. Military Personnel (Metric)

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

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.

CODE OF FEDERAL REGULATIONS (CFR)

40 CFR 261.24	-	Protection of Environment, Identification and Listing of Hazardous Waste, Toxicity Characteristic
49 CFR Parts 100-180	-	Transportation, Chapter 1, Pipeline and Hazardous Materials Safety Administration, Department of Transportation

(Copies of these documents are available online at https://www.gpo.gov/fdsys/search/home.action.)

DEPARTMENT OF THE ARMY DOCUMENTS

TP-94-01 Revision 2	-	Transportability Test Procedures

(Copies of this document are available online at http://www3.dac.army mil.)

DEPARTMENT OF DEFENSE JOINT SERVICE DOCUMENTS

(The following publication is jointly issued for the Department of Defense. Each service refers to the document using its unique numbering system. The numbers listed are for the Air Force, Army, Navy, Marine Corps, and Defense Logistics Agency.)

Air Force Regulation (AFR) 80-18	-	DoD Engineering for Transportability
Army Regulation (AR) 70-44		
Naval Operations Instruction (OPNAVINST) 4600.22		
Marine Corps Order (MCO) 4610.14		
Defense Logistics Agency Regulation (DLAR) 4500.25		

(Copies of this document are available online at http://www.dla.mil, http://www.army.mil/usapa/epubs, http://www.usmc.mil/directiv.nsf/web+orders, or http://usahec.contentdm.oclc.org/cdm/ref/collection/p16635coll11/id/802.)

(The following publication is jointly issued for the Department of Defense. Each service refers to the document using its unique numbering system. The numbers listed are for the Air Force, Army, Navy Supply Systems Command, Marine Corps, and Defense Logistics Agency.)

Air Force Manual (AFM) 24-210	-	Packaging of Hazardous Material
Army Regulation (AR) 700-143		
Naval Supply Corps System Command Instruction (NAVSUPINST) 4030.55		
Marine Corps Order (MCO) 4030.40		
Defense Logistics Agency Regulation (DLAR) 4145.41		

(Copies of this document are available online at http://www.dla.mil, http://www.army.mil/usapa/epubs, http://www.usmc.mil/directiv.nsf/web+orders, https://nll2.ahf nmci.navy.mil/default.cfm, or http://www.e-publishing.af.mil.)

Army Regulation (AR) 70-75 - Survivability of Army Personnel and Materiel

(Army application for publication copies should be addressed to: Army Publishing Directorate, 9351 Hall Rd., Fort Belvoir, VA 22060.)

Test Operations Procedure (TOP) 8-2-111 - Chemical, Biological, and Radiological (CBR) Contamination Survivability, Small Items of Equipment

(Copies of this document are available online at http://www.dtic.mil/whs/directives/.)

DEPARTMENT OF DEFENSE ISSUANCES

DOD 4140.65-M - Issue, Use, and Disposal of Wood Packaging Material (WPM)

DODI 5100.76 - Safeguarding Sensitive Conventional Arms, Ammunition, and Explosives (AA&E)

(Copies of these documents are available online at http://www.dtic mil/whs/directives/.)

DEPARTMENT OF THE NAVY DOCUMENTS

NWP 4-01.4 - Underway Replenishment

(Copies of this document are available online at http://www.maritime.org/doc/pdf/unrep-nwp04-01.pdf.)

MILITARY STANDARD (MS) DRAWING

MS17868 - Indicator, Propellant Leak, Plug, Color Change, for Unsymmetrical Dimethylhydrazine and Fuming Nitric Acid

(Copies of this document are available online at http://quicksearch.dla.mil.)

DTIC TECHNICAL REPORTS

Technical Report 93003 - Weapons Container Stacking Study

(Copies of this document are available online at http://www.dtic.mil.)

NAVAL AIR SYSTEMS COMMAND (NAVAIR) DRAWINGS

799AS105 - Records Holder

3214AS110 - Center Lift

2602910 - Decal, Leak Detector

(Copies of these documents are available online at https://mynatec.navair navy mil.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA) DRAWINGS

5166322 - Holder, Records

5166628 - Plug, Humidity Indicator

5167399 - Extrusion, Endlift

5167401 - Endlift-Adapter

5167633 - Fork Pocket

5167693 - Fork Pocket

6212630 - Handle

6212706	-	Observation Window
6212707	-	Access Port
6212862	-	Shackle
6212863	-	Valve, Breather
6212868	-	Desiccator
6212876	-	Beam, Container Handling MK 52 MOD 0
6213102	-	Latch
6213893	-	Beam, Container Handling MK 52 MOD 1
6214106	-	Ring, Container Lift
6214131	-	Container Endlift Interface
804-5184187	-	Tiedown Assembly, Universal Pallet

(Copies of Drawings 6213893 and 6214131 are available from Naval Surface Warfare Center Indian Head EOD Technology Division, Detachment Picatinny, Code G12, Bldg. 458, Whittemore Ave., Picatinny Arsenal, NJ 07806-5000.)

(Copies of the remaining listed drawings are available from the Naval Ships Engineering Drawing Repository (NSEDR) online at https://199.208.213.105/webjedmics/index.jsp. To request an NSEDR account for drawing access, send an email to NNSY_JEDMICS_NSEDR_HELP_DESK@navy.mil.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA) INSTRUCTIONS

NAVSEAINST 8024.2 - Magazine Stowage Layout Standards

(Copies of this document are available online at https://navsea.portal.navy.mil/hq/Docs/Instructions.)

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)

Public Law 91-596 - Occupational Safety and Health Act of 1970

(Copies of this document are available online at www.osha.gov.)

UNDER SECRETARY OF DEFENSE (USD) ACQUISITION, TECHNOLOGY & LOGISTICS (AT&L) MEMORANDUMS

Radio Frequency Identification Policy

(Copies of this document are available online at http://www.acq.osd.mil/log/sci/ait.html.)

Update to Unique Identification

(Copies of this document are available online at http://www.acq.osd.mil/dpap/pdi/uid/index.html.)

UNITED STATES DEPARTMENT OF AGRICULTURE (USDA)

Agriculture Handbook 72 - Wood Handbook: Wood as an Engineering Material

(Copies of this document are available online at http://naldc.nal.usda.gov/catalog.)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION

Executive Order 12196 - Occupational Safety and Health Programs for Federal Employees

(Copies of this document are available online at http://www.archives.gov/federal-register/executive-orders/disposition 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 WOOD PROTECTION ASSOCIATION (AWPA)

AWPA Book of Standards

(Copies of this document are available online at www.awpa.com.)

ASME INTERNATIONAL

ASME B1.1	-	Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B18.5	-	Round Head Bolts (Inch Series)
ASME B18.9	-	Plow Bolts
ASME B18.18	-	Quality Assurance for Fasteners

(Copies of these documents are available online at www.asme.org.)

ASTM INTERNATIONAL

ASTM A153/A153M	-	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A380/A380M	-	Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
ASTM A967/A967M	-	Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts
ASTM B117	-	Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B633	-	Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM B841	-	Standard Specification for Electrodeposited Coatings for Zinc Nickel Alloy Deposits
ASTM D257	-	Standard Test Methods for DC Resistance or Conductance of Insulating Materials
ASTM D573	-	Standard Test Method for Rubber-Deterioration in an Air Oven
ASTM D642	-	Standard Test Method for Determining Compressive Resistance of Shipping Containers, Components, and Unit Loads
ASTM D880	-	Standard Test Method for Impact Testing for Shipping Containers and Systems
ASTM D991	-	Standard Test Method for Rubber Property-Volume Resistivity of Electrically Conductive and Antistatic Products
ASTM D996	-	Standard Terminology of Packaging and Distribution Environments
ASTM D999	-	Standard Test Methods for Vibration Testing of Shipping Containers

ASTM D1149	-	Standard Test Methods for Rubber Deterioration-Cracking in an Ozone Controlled Environment
ASTM D2000	-	Standard Classification System for Rubber Products in Automotive Applications
ASTM D4003	-	Standard Test Methods for Programmable Horizontal Impact Test for Shipping Containers and Systems
ASTM D4577	-	Standard Test Method for Compression Resistance of a Container Under Constant Load
ASTM D5276	-	Standard Test Method for Drop Test of Loaded Containers by Free Fall
ASTM D5277	-	Standard Test Method for Performing Programmed Horizontal Impacts Using an Inclined Impact Tester
ASTM E162	-	Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source
ASTM E662	-	Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials
ASTM F1166	-	Standard Practice for Human Engineering Design for Marine Systems, Equipment, and Facilities
ASTM F1667	-	Standard Specification for Driven Fasteners: Nails, Spikes, and Staples

(Copies of these documents are available online at www.astm.org.)

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA 649 - Configuration Management Standard

(Copies of this document are available online at http://www.techstreet.com/info/eia.tmpl.)

INSTITUTE OF ENVIRONMENTAL SCIENCES AND TECHNOLOGY (IEST)

IEST-RD-DTE012.2 - Handbook for Dynamic Data Acquisition and Analysis

(Copies of this document are available online at www.iest.org.)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 14644-1	-	Cleanrooms and Associated Controlled Environments – Part 1: Classification of Air Cleanliness
ISO 14644-2	-	Cleanrooms and Associated Controlled Environments – Part 2: Monitoring to Provide Evidence of Cleanroom Performance Related to Air Cleanliness by Particle Concentration

(Copies of these documents are available online at www.iso.org.)

INTERNATIONAL PLANT PROTECTION CONVENTION (IPPC)

ISPM 15 - Regulation for Wood Packaging Material in International Trade

(Copies of this document are available online at http://www.ippc.int.)

INTERNATIONAL TEST OPERATIONS PROCEDURES (ITOP)

ITOP 4-2-601 - Drop Tests for Munitions

ITOP 4-2-602 - Rough Handling Tests

(Copies of these documents are available online at www.atec.army.mil/publications/topsindex.aspx.)

SAE INTERNATIONAL

SAE AMS2700 - Passivation of Corrosion Resistant Steels

SAE AMS3269 - Sealing Compound, Polysulfide (T) Synthetic Rubber for Integral Fuel Tank and Fuel Cell Cavities High Strength, for Intermittent Use to 360 °F (182 °C)

SAE AMS3281 - Sealing Compound, Polysulfide (T) Synthetic Rubber for Integral Fuel Tank and Fuel Cell Cavities Low Density (1.20 to 1.35 sp gr), for Intermittent Use to 360 °F (182 °C)

SAE AS5017 - Air Filling Valves

SAE AS5135 - Desiccant Port and Desiccant Holder

SAE AS5389 - Pallet Lift Truck and Container Fork Pocket Interface

SAE AS8879 - Screw Threads – UNJ Profile, Inch Controlled Radius Root with Increased Minor Diameter

SAE AS26860 - Indicator, Humidity, Plug, Color Change

SAE AS27166 - Valve, Pressure Equalizing, Gaseous Products

(Copies of these documents are available online at http://www.sae.org.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS

3.1 General. The terms used throughout this standard, and their interpretation, will be in accordance with the following definitions. Packaging terms are in accordance with ASTM D996. Hazardous materials (HAZMAT) terms are defined in 49 CFR Parts 100-180.

3.1.1 Ambient (temperature). Defined as 77±18 °F.

3.1.2 Anthropometry. Numbers defining size of human body. Normally, expressed as percentile (i.e., 5th and 95th) of total range. Anthropometric data can be found in ASTM F1166. The full data set can be found in DOD-HDBK-743.

3.1.3 Clinch. To fix or secure (e.g., a nail) by bending down or flattening the pointed end that protrudes.

3.1.4 Commercial-off-the-shelf (COTS). Items commercially available for procurement.

3.1.5 Competent authority. A national agency responsible under its national law for the control or regulation of a particular aspect of the transportation of HAZMAT (dangerous goods). The Associate Administrator, Pipeline and Hazardous Materials Systems Administration, U.S. Department of Transportation (DOT) is the competent authority for the United States.

3.1.6 Connected replenishment-at-sea (CONREP). The transfer of material between two Navy ships while underway holding station between 180 and 200 feet of separation via a tensioned wire connecting the two ships.

3.1.7 Cracking pressure (relief valve). The pressure(s) at which the container's relief valve first opens when subjected to a pressure differential, either pressure or vacuum.

3.1.8 Critical item development specification (CIDS). A document that identifies the performance, design, development, and test requirements for the container.

3.1.9 Cushion (compressive) creep. A permanent loss of some percentage of thickness when placed under a constant load over a period of time.

3.1.10 Distributed isolation material (DIM). Rubber-type pads used on smaller equipment for filtering high frequency vibrations.

3.1.11 Elastomer. A polymeric material, such as a synthetic rubber or plastic, which at room temperature, can be stretched under low stress to at least twice its original length and, upon immediate release of the stress, will return with force to its approximate original length.

3.1.12 Energy absorbing devices. For the purpose of this standard, container components employed to provide shock and vibration isolation. They may be composed of elastomers bonded to metal parts (commonly referred to as elastomeric shear mounts, shock mounts, resilient mounts, or sandwich mounts), cushioning (open or closed-cell plastic foams), spring assemblies (usually helical), torsion bars, cable isolators (utilizing wire rope), or single-use energy dissipaters.

3.1.13 Explosive limit. The upper explosive limit (UEL) and lower explosive limit (LEL) of percentage composition of a combustible gas mixed with other gases or air, within which the mixture explodes when ignited.

3.1.14 Faying surfaces. Surfaces which are in contact with one another, but are not continuously joined together, so as to prevent water intrusion between the two surfaces.

3.1.15 Fire-retardant materials. Materials that do not ignite readily or propagate flames under small to moderate fire exposures. While these materials are combustible, their fire-retardant nature tends to reduce the intensity and spread of fire, smoke, and toxic products of combustion.

3.1.16 Flexible barriers. Auxiliary, non-rigid materials which primarily function to resist the penetration of water vapor and air permeance. Their secondary functions include mechanical strength in tension, shear impact and flexure, adhesion, elasticity, thermal stability, fire and flammability resistance, inertness to other deteriorating elements, ease of fabrication, applications, and joint sealing.

3.1.17 Fragility levels. Fragility levels, or damage boundaries, are the limits below which damage or malfunction of the packaged item will not occur. They may be expressed by parameters, such as maximum allowable shock response, spectrum peak acceleration, pulse shape and pulse duration, velocity change, bending moments, axial loads, shear loads, and surface pressure. An accurate determination of the fragility level is necessary for the design of an efficient, economical container. Whenever possible, an item’s fragility levels, or damage boundary, should be determined by the manufacturer’s testing.

3.1.18 Galling. Surface damage on mating, moving metal parts due to friction caused by local welding of high spots.

3.1.19 Grade A container. Items which are essential to the safety and continued combat capability of the ship or user.

3.1.20 Grade B container. Items whose operation is not essential to the combat capability of the ship, but can be a hazard to personnel, Grade A items, or to the ship/air delivery vehicles as a whole as a result of exposure to shock.

3.1.21 Hazardous material (HAZMAT). A substance or material that the Secretary of Transportation has determined is capable of posing an unreasonable risk to health, safety, or property when transported in commerce, and has been designated as hazardous under 49 U.S.C. 5103. Includes hazardous substances, hazardous wastes, marine pollutants, elevated temperature materials, and those materials designated as hazardous in the Hazardous Materials Table of 49 CFR §172.101.

3.1.22 Human systems integration (HSI). The technical process of integrating the areas of human factors, such as engineering, manpower, personnel, training, safety and health, personnel survivability, and habitability, into the system's engineering process, in order to optimize human performance. HSI recognizes that in addition to the hardware and software, the human is a vital part of the system; therefore, HSI designs, produces, supports, fields, and modernizes systems by a complete and careful integration of the human into the system.

3.1.23 Hydrogen embrittlement. Low ductility of a metal due to its adsorption of hydrogen gas that may occur during an electrolytic process or during cleaning, also known as acid brittleness.

3.1.24 Hygroscopic. Pertaining to a substance whose physical characteristics are appreciably altered by effects of water vapor.

3.1.25 Level A. The degree of preservation or packing required for protection of materiel against the most severe conditions, known or anticipated to be encountered, during shipment, handling, and storage. Preservation and packing designated Level A will be designed to protect materiel against direct exposure to extremes of climate, terrain, and operational and transportation environments without protection, other than that provided by the container. The conditions to be considered include, but are not limited to:

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

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

c. Loading on ship deck, transfer-at-sea, helicopter delivery, and offshore or over-the-beach discharge to ultimate user.

d. Environmental exposure during shipment or during in-transit operations where port and warehouse facilities are limited or non-existent.

e. Extended open storage in all climatic zones.

f. Static loads imposed by stacking.

3.1.26 Level B. The degree of preservation or packing required for protection of materiel under known favorable conditions during shipment, handling, and storage. Preservation and packing designated Level B will be designed to protect materiel against physical damage and deterioration during favorable conditions of shipment, handling, and storage. The conditions to be considered include, but are not limited to:

a. Multiple 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 extended periods.

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.

3.1.27 Life cycle environmental profile (LCEP). Design and test decision baseline document outlining real-world, platform-specific, environmental conditions that a specific materiel system or component will experience during service-related events (e.g., transportation, storage, operational deployment/use) from its release from manufacturing to the end of its useful life. The LCEP is a document that should be developed early in any project. Once developed, information within the LCEP can be used to define the test criteria based upon in-service usage. MIL-STD-810 provides information on the LCEP.

3.1.28 Minimum flow rate (relief valve). The minimum rate of flow (expressed in standard cubic feet per minute) required to allow a sufficient exchange of air through the relief valve in order to prevent damage to the container during handling, transportation, and storage.

3.1.29 Nematode. Any member of the group of unsegmented worms that have been variously recognized as an order, class, and phylum with an affinity to consume wood.

3.1.30 Non-combustible materials. Materials known to be inherently nonflammable, such as steel and aluminum.

3.1.31 Non-person portable container. A container possessing qualities (e.g., weight, size) that is not ergonomically suitable for manual transport.

3.1.32 Passivation. To reduce the reactivity of a chemically active metal surface by electrochemical polarization or by immersion in a passivating solution.

3.1.33 Performance Oriented Packaging (POP). Packaging/container system design standards and testing methods based on performance of the packaging/container system rather than material or construction specifications, as derived from United Nations Recommendations and incorporated into national law.

3.1.34 Reseal pressure (relief valve). The pressure(s) at which the container's relief valve reseals after being open.

3.1.35 Shock response spectrum (SRS). A plot of the peak responses of a large number of single-degree-of-freedom systems of differing natural frequencies to a specific input transient. It gives an indication of the maximum dynamic loads various parts of equipment will experience as a function of their natural frequency. Damping is almost always employed in the SRS calculations to avoid unreasonably high SRS peak responses. A comparison of the packaged item's allowable shock spectra to the test SRS is often used to determine relative damage potential.

3.1.36 Specialized shipping container. Specialized shipping containers are generally the long-life variety and are uniquely configured to support and protect a specific item, or limited variety of items, during handling, storage, forward and return shipment, unpacking by the user, or to protect personnel and equipment from hazardous contents. Containers of this type frequently incorporate energy absorbing systems, temperature control systems, or special features to make handling or shipment possible, easier, or safer. Engineering drawings, or equivalent, are used to define form, fit, function, materials, tolerances, and manufacturing techniques. Specialized shipping containers, internal fixtures, and other fitments result from original design efforts or the redesign or modification of an existing container to meet a specific application or need.

3.1.37 Springwood. The portion of an annual ring that is formed principally during the growing season. It is softer, more porous, and lighter than summerwood because of its higher proportion of large, thin-walled cells.

3.1.38 Standard parts and materials. Parts or materials identified or described by military or federal specifications or standards, or an industry standard formally adopted by the Department of Defense (DoD) for general applications. Standard parts and materials will be used to the fullest extent possible.

3.1.39 Standard tension replenishment alongside method (STREAM). Specific transfer method for U.S. Navy CONREP.

3.1.40 Summerwood. The less porous, usually harder portion of an annual ring that forms in the latter part of the growing season.

3.1.41 Sympathetic reaction. [DoD/NATO] The reaction of a munition or an explosive charge induced by the detonation of another like munition or explosive charge.

3.1.42 Transmissibility. The ratio of response vibration magnitude to input vibration magnitude.

$$TR = \frac{\textit{Response vibration magnitude}}{\textit{Input vibration magnitude}}$$

3.1.43 Underway replenishment at sea (UNREP). The process of transferring ammunition, food, and stores between two Navy ships while underway by Vertical Replenishment (VERTREP), CONREP, or a combination of the two.

3.1.44 Unitized load. An assemblage of specialized shipping containers arranged and secured to permit easy handling as a single entity by common handling equipment. A unitized load can also consist of a single large container or cradle. Materials handling pallets may or may not be used.

3.1.45 Vertical replenishment (VERTREP). The transfer of material from ship-to-ship at sea by helicopter, usually as an external load.

4. GENERAL REQUIREMENTS

4.1 General. Specialized shipping containers shall be designed to be consistent with the maintenance concept, with the planned distribution and stowage logistics of the contents, and to provide reliable protection at lowest life cycle cost (LCC) to the contents. An LCC analysis involves all the costs of a system or a component over its entire life span. Typical costs for a system may include acquisition, design, development, operating (failures, repairs, spares, downtime, and loss of production), and disposal costs. A complete LCC analysis may also include other costs, as well as other accounting/financial elements, such as discount rates, interest rates, depreciation, present value of money, etc. With respect to cost inputs for such an analysis, costs involved are either deterministic, such as acquisition costs, disposal costs, etc., or probabilistic, such as cost of failures, repairs, spares, downtime, etc. Most of the probabilistic costs are directly related to reliability and maintainability characteristics of the design. Estimations of the associated probabilistic costs are the challenging aspect of LCC analysis, since engineering judgment is the overriding factor. The LCEP shall be used in conjunction with MIL-STD-810 to identify each system's environmental requirements and associated test methods to be used for validation. These environmental requirements shall be included in the shipping container CIDS as appropriate.

4.1.1 HAZMAT and devices. Containers designed for domestic and international shipment and storage of HAZMAT shall be designed to comply with the POP requirements of both the UN/International modal regulations and 49 CFR Parts 100-180, governing the transport of HAZMAT in addition to service design requirements as specified herein. For certification of HAZMAT containers, the regulatory test parameters shall be as stipulated in 49 CFR. Any test conducted in accordance with this standard that meets or exceeds 49 CFR requirements may be incorporated by reference into the POP certification test report. Container designs or testing which differ from the requirements prescribed by 49 CFR Parts 100-180 shall be certified as equivalent by DOT Special Permit (SP), Certificate of Equivalency (COE), or Competent Authority Approval (CAA), as applicable, and shall be processed through the Service Focal Point in accordance with DLAR 4145.41/AR 700-143/NAVSUPINST 4030.55/ AFM 24-210/MCO 4030.40.

4.2 Interfaces. Containers shall be designed to satisfy the following interfaces as a minimum.

4.2.1 Contents. The container shall be designed to be compatible with and protect the contents when subjected to tests prescribed herein.

4.2.2 Handling equipment. The container shall be designed to be compatible with designated and approved handling equipment used throughout the logistic system including that used to pack and unpack the container. Existing handling equipment shall be identified in the detailed design specification, or by the container design agent, prior to initiating the container's design. This will enable the new design to be seamlessly moved within the existing handling logistics without necessitating the introduction of new handling equipment. New handling equipment will be introduced only when capacities or interfaces must be altered, and then only when designed for the possibility of multiple use. Any new ordnance handling equipment shall be designed in accordance with MIL-STD-1365.

4.2.3 Distribution network. The container, insofar as possible, shall be designed to move without restriction, special routing, or special escort throughout the material distribution system used by the DoD. When practical, the container will meet the requirements of MIL-STD-3028 and optimize the use of the Joint Modular Intermodal Container (JMIC) system. Details of the container design shall comply with the criteria established as part of the logistic analysis required by the Packaging, Handling, Storage, and Transportation (PHST) Program requirements. Handling and mobility features shall be incorporated into containers as required to facilitate handling and movement consistent with existing or planned equipment, facilities, and procedures. Design, test, and production of containers and packaging needed to conduct and support Development and Operational Test and Evaluation (DT&E and OT&E) and production will be so accomplished, as to assure their availability at the time and place required. They shall be suitable for use throughout the system program life without further major design and test effort, unless program objectives, cost, or schedules justify otherwise, or unless deficiencies are detected which require correction. The most cost-effective item-to-container design interface shall be determined using trade-off study techniques based upon program LCCs. Trade-off studies and transportability analyses shall be conducted to ensure compatibility between item, transportation, and handling equipment and to determine the most efficient and cost-effective packaging design required to satisfy functional requirements.

4.2.4 Unitized load compatibility. Approved, specialized shipping container designs, which are to be formed into unitized loads as a part of the logistic distribution plan, shall consider the use of features which permit ready assembly into such unitized loads without the use of banding. Appropriate tests shall be conducted, using the unitized load configuration, to validate the integrity and suitability of the design features provided to the container. Requirements for unitized loads of ammunition shall be as specified in MIL-STD-1660.

4.3 Configuration. When required, configuration management practices will be consistent with the invoked requirements of EIA 649.

4.4 Transportability requirements. Specialized shipping container designs shall reflect consideration of techniques for truck, rail, air, and ship loading to ensure that applicable DOT requirements are met, and that transportation costs are minimized consistent with safety considerations and container integrity (see MIL-STD-1366 and MIL-STD-3028). When military airlift is anticipated, containers used as unit loads shall be in accordance with the general design and performance requirements of MIL-STD-1791. For dimensional constraints and weight requirements, see MIL-STD-1366. For the definition of a transportability problem and reporting requirements, see AR 70-44/OPNAVINST 4600.22/AFR 80-18/MCO 4610.14/DLAR 4500.25.

4.4.1 Sensitive materials (transportation security). Containers shall be designed to be compatible with the requirements of DODI 5100.76 when the container contents are "sensitive" as defined therein.

4.4.2 Transfer-at-sea (UNREP). Containers and container unit loads intended to be transferred-at-sea, either by CONREP or VERTREP, shall be designed to withstand the shock test of 5.2.7. Containers designed for VERTREP shall also be designed to protect the container's contents from static charges and Electromagnetic Interference (EMI) emissions generated by the helicopters. Two major factors to consider for CONREP load transferability are load draft and total container weight. Load draft is defined as the distance from the centerline of the highline wire rope to the bottom of the container being transferred. The highline wire rope is the load bearing wire rope the CONREP trolley travels on. The total container/load weight transferred is an important factor due to the catenary it causes on the highline wire rope. The more catenary in the system, the less transferable the cargo becomes relative to the load draft. As load draft increases, transferability decreases. If the combination of load draft and weight get too high, the CONREP system will not be able to carry the load over the ship's deck edge and, therefore, will not be able to complete the transfer or damage the container. A minimum distance of 12 inches from the bottom of the transfer strongback to the top of the container is required. Containers will be connected to a MK 5 MOD 1 Cargo Stream Heavy Lift (Gullwing) strongback as shown on figure 1. If unique logistics considerations dictate, containers that weigh more than 5700 pounds or have dimensions greater than 80 inches by 50 inches by 52 inches shall require analysis and approval from the Navy's UNREP Technical Warrant Holder (TWH), NAVSEA 05Z.

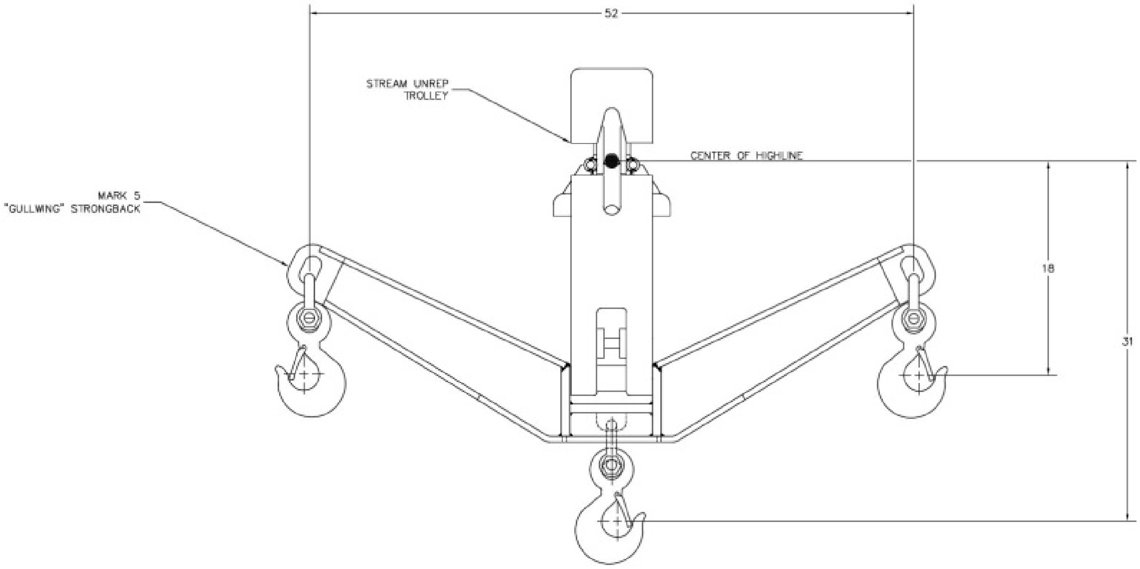


FIGURE 1. View of STREAM trolley and transfer strongback.

4.5 Cube and weight. Containers shall be designed for smallest cube and lightest weight consistent with protection of contents, durability, intended use, economy, safety, transportability, and interfacing equipment. When practical, the container shall meet the requirements of MIL-STD-3028. Pallet size container length and width combinations in inches of 52 by 44, 48 by 40, 44 by 44, 36 by 45, and 33 by 44 result in excellent transport efficiency. The 44- and 88-inch dimensions are especially suitable for lengths of containers. Handling equipment safe working loads (SWLs) may limit maximum container weight. Height limiting factors include ISO containers, vans, railcars, as well as Igloo or shipboard magazines, along with their stacking clearances. MIL-STD-1366, MIL-STD-1320, NAVSEAINST 8024.2 (series), and appropriate ship or ship class manuals should be consulted as necessary. For containers whose logistics indicate ship movement or stowage, passageways, aisles, elevators, and doors shall be considered both dimensionally and for weight limitations. Handling and stowage manuals for each specific ship or ship class should be consulted as necessary. For those items that will be unpackaged in low overhead environments utilizing hoists or fork trucks with specific handling equipment, consideration shall be given to the container base height to ensure that available overhead clearances and equipment limitations allow for the item to clear the container base. These limitations shall be documented in individual CIDS prior to initiation of designs. Conveyor clearances and road overpass clearances can be limiting factors for larger containers. Small containers shall be designed to fit on standard pallets with no under hang to reduce the need for battens. Style and size should be selected, or adjusted, to reduce the need for additional and repetitive blocking and bracing in trucks and ISO containers or for additional battens to square off or eliminate under hang on unit loads. These recurring costs shall be considered in the container dimension selection. Round drum containers are rarely cost effective for long-life specialized shipping containers due to transportation blocking costs, as well as difficulty of handling and palletizing.

4.5.1 Naval aircraft carrier container size limits. To allow maximum flexibility of movement and stowage of ordnance containers aboard naval aircraft carriers, single container height shall not exceed 45 inches and container height shall maximize stowage density in a 90-inch high clearance. Container length shall be limited to 180 inches. From a handler's standpoint, a limit of 176 inches would greatly increase movement flexibility and decrease handling times. These dimensional limitations assure that containers can be moved on and off weapon's elevators through side loading doors with the use of fork trucks. Container width shall be limited to 40 inches to ensure ability to navigate emergency handling paths between forward and aft weapon's complexes. If unique logistics considerations dictate container dimensions beyond those listed above, approval from the Navy's PHST TWH, NAVSEA 05E, shall be required.

4.6 Materials and manufacturing methods. Standard commercially available materials and manufacturing processes shall be the first preference, whenever feasible. However, the application of technological advancements in materials and processes is always encouraged where superior performance characteristics and economical considerations justify it. Proprietary or sole source components shall be specified on technical drawing packages (TDPs), only when absolutely needed, to meet the defined requirements. The TDP shall not specify any material or component that can only be produced or purchased from the container designer. Paints, preservative treatments, coatings, additives, and so forth, shall meet or exceed the safety standards established by the Environmental Protection Agency (EPA) 40 CFR 261.24 and Occupational Safety and Health Act (OSHA) Public Law 91-596 and Executive Order 12196.

4.6.1 Plating. When plated hardware is required to accomplish a design parameter, the following alternative plating methods shall be considered for use:

a. Electrodeposited alkaline Zinc-Nickel Alloy, in accordance with ASTM B841, Class 1, Type B, Grade 3,

b. Zinc plating, in accordance with ASTM B633, or

c. Hot dip galvanize, in accordance with ASTM A153/A153M.

When plating hardware, it is the responsibility of the design agency to specify an adequate material, application method, and thickness to meet anticipated user environments, as well as any follow on heat treatment process to eliminate hydrogen embrittlement. Commercial products can be galvanized by high-speed, in-line galvanizing technology. This allows a thin zinc coating to be applied to the steel at low cost. This type of thin zinc coating is frequently coated with a clear polymer topcoat to enhance storage characteristics. The addition of organic coatings to zinc-plated parts is another common technique manufacturers use to claim improved corrosion resistance of their products. Zinc plating involves the electrolytic application of zinc by immersing clean steel parts in a zinc salt solution and applying an electric current. This process applies a layer of pure zinc that ranges from a few microns on inexpensive components to 15 microns on quality components. In-line galvanized coatings are applied during the manufacturing process with the cleaned steel passing into the galvanizing bath. This process applies a coating of zinc to the surface that can be controlled in thickness. This coating is usually measured as coating mass in weight per area. Accelerated weathering testing of coatings has traditionally been done in salt spray cabinets. This testing technique has been largely discredited with respect to metallic coatings, as it does not reflect the way metallic coatings weather in atmospheric exposure conditions where the development of stable oxide films give these coatings their excellent anti-corrosive performance. The addition of polymer topcoats to metallic coatings will significantly improve their apparent performance in salt spray tests, but field performance will not necessarily reflect this. Zinc-plated parts have an attractive appearance when new as the zinc coating is bright and smooth, where a hot dip galvanized coating has a duller and less smooth surface. There is typically about 10 times as much zinc applied to small parts in the hot dip galvanizing process as with zinc plating. A bright, shiny, smooth, zinc finish typically indicates a plated coating that will not provide adequate corrosion resistance and will rarely provide more than 1 year’s protection in coastal environments.

4.6.1.1 Cadmium-plated hardware. Cadmium plating any part developed under this standard is discouraged and shall not be specified for North Atlantic Treaty Organization (NATO) containers. Cadmium-plated standard parts, such as small hardware items, may be used until current supplies are exhausted.

4.6.2 Dissimilar metals. Dissimilar metal combinations shall be avoided as much as possible. MIL-STD-889 may be consulted for guidance. When the best design solution results in the coupling of aluminum and PH 17-4/7, information contained in Tech Memo No. PHST-30-99 (see Appendix Q) shall be used for guidance. When unavoidable, any or all of the following methods of corrosion prevention shall be implemented:

a. Appropriate surface treatments and coatings shall be applied to the material or materials in contact. If surface treatments or coatings are used, they shall be resistant to physical removal, such as wear or abrasion, from the base metal being protected.

b. The design will attempt to have the larger of the two dissimilar metals in contact as the anode.

c. The design will attempt to use dissimilar metals which are as close to one another on the galvanic scale as possible.

4.6.2.1 Acceptance criteria. Dissimilar metal combinations will continue to perform their functions. The following are cause for rejection:

a. Any corrosion which penetrates to a material depth that will render the design unsafe (no longer meet defined factors of safety from a strength stand point).

b. Any corrosion which allows penetration completely through the shell of a sealed or controlled breathing container.

c. Any corrosion which allows surface coatings (e.g., Chemical Agent Resistant Coating [CARC]), stenciled markings, adhesive backed labels, any other items to lose their adhesion to the applied surface, inside or outside of the container, in such a way that they no longer meet their intended purpose.

4.6.3 Screw threads. Screw threads will comply with FED-STD-H28 and all supplements thereto, or be in accordance with SAE AS8879 or ASME B1.1.

4.6.4 Elastomeric parts. All elastomeric parts shall have cure date traceability. Elastomeric shock mounts shall have their cure date molded into the elastomer in such a manner as to clearly identify their date of manufacture. Small elastomeric parts, such as sealing washers, are exempt from individual piece part identification. However, their lowest unit of packaging shall be clearly marked as to their piece part identification (e.g., flexible barrier bag, fiberboard box). All designs that require the use of elastomeric parts shall have those parts oriented in the design in such a manner that the cure date is clearly visible for inspection when possible. All elastomeric parts shall be formulated to survive in the defined logistic operating environments including exposure to ozone (external mounts).

4.6.5 Standard parts and materials. Standard parts and materials shall be used unless they are technically or economically impractical. Items and processes shall be selected or tailored from existing standards, specifications, and TDPs (or an individual drawing) which are technically suitable in every respect for the intended application. Factors such as function, environment, quality, transportability, reliability, strength, safety, and interchangeability shall be considered in the selection to satisfy the design parameters in every respect. The use of a standard, specification, TDP (or individual drawing), or other document does not, in itself, ensure the suitability of an item or process for any specific application. A sample listing of common standard parts, which may be used on appropriate applications for Navy containers, is given in table I.

TABLE I. Common standard parts for Navy containers. [1/]

Description	**Commercial specification**	**Navy drawing**	**Paragraph reference**
Access port		6212707	4.9 4.15.4.4
Holder, records (receptacle)		799AS105 5166322	4.9 4.9
Latch		6213102	4.10
Desiccator	SAE AS5135	6212868	4.15.4.4
Plug, humidity indicator	SAE AS26860	5166628	4.15.4.5
Valve, breather	SAE AS27166	6212863	4.15.4.11
Observation window		6212706	4.15.4.13
Handle		6212630	4.17.2 4.17.2.1
Rings, container lift		6214106	4.17.3
Shackle		6212862	4.17.3
Fork pocket [2/] & pallet jack	SAE AS5389	5167633 5167693	4.17.6
Extrusion, endlift		5167399	4.17.8.a
Endlift-adapter		5167401	4.17.8.a

TABLE I. Common standard parts for Navy containers [1/] - Continued.

Description	Commercial specification	Navy drawing	Paragraph reference
Center lift		3214AS110	4.17.8.b

NOTES:

[1/] See Appendix B for drawings. For a complete listing of standard parts, contact NSWCIHEODTD, Detachment Picatinny, Code G13.

[2/] For designs required to interface with NATO interoperability, reference STANAG 2828 and STANAG 2829.

4.6.6 Material stability. All material used shall be stable after prolonged exposure to climatic extremes which may be reasonably encountered during the expected logistic cycle (reference the system's LCEP and MIL-STD-810 for information on the system's environmental requirements and associated test methods). In this sense, stability shall be considered after return to room conditions and will be construed as freedom from the following defects:

a. Change of state of the material, such as crystallization, hydrolytic conversion, and so forth.

b. Permanent deformation which adversely affects serviceability under normal static load pertinent to the manner in which the material is used, such as sagging or irreversible creep.

c. Significant changes in physical properties, such as degradation in modulus of elasticity.

4.6.7 Internal packaging materials.

4.6.7.1 Materials compatibility. Internal packaging materials shall not adversely react with the contents because of incompatibility of chemical and hygroscopic properties. Where packaging materials are placed in direct contact with the contents, the design shall provide adequate protection to the contact surface(s) of the contents.

4.6.7.2 Wood dunnaging. For those unique specialized shipping containers whose logistics requires internal wooden blocking and bracing, design guidance is as follows:

a. In order to comply with ISPM 15, all lumber shall be marked and heat treated in accordance with DOD 4140.65-M.

b. Wood or plywood may be used alone or in combination for blocking and bracing. Wood or plywood blocking and bracing members will bear against only those parts of the packed item capable of withstanding the applied dynamic forces or will bear against blocking pads or pressure strips that adequately distribute these forces. Wood or plywood blocking and bracing will be designed to permit easy removal without damage to the item. Strengths of wood and plywood members may be calculated from information given in USDA Agriculture Handbook 72.

c. Wood used for blocking and bracing shall be of sufficient structural quality for the application. Whenever possible, wood blocks or braces shall be socketed or fitted and secured into appropriate notches in load-bearing members. Wood used for internal wood box or crate blocking and bracing that will be a permanent part of the container does not require separate wood packaging material certification marking. Blocking and bracing with wood that could be considered dunnage requires its own wood packaging material treatment certification markings to meet import and export requirements in accordance with ISPM 15.

d. Plywood used for blocking and bracing shall be in accordance with A-A-55057, Type B.

e. Nails shall be in accordance with the requirements of ASTM F1667. All nails that are not clinched shall be cement coated, etched, or mechanically deformed (helically or annularly threaded). Unclinched nails shall be as long as practicable without splitting the material, but not shorter than three times the thickness of the member holding the nail head for tenpenny nails and smaller, or not shorter than the thickness of the same member plus 1½ inches for twelvepenny nails and larger. Nails loaded in shear blocking and bracing joints need not be clinched. End grain nailing in solid wood or edge nailing in plywood shall not be permitted. Nails shall be driven through the thinner member into the thicker member wherever possible. Nails shall not be subject to withdrawal stresses. Nails shall be driven not closer to the end of a piece of lumber than the thickness of the piece and not closer to its side than one-half of its thickness. There shall be at least two nails in each joint.

Ends of blocks and braces shall not be fastened to a wood container by end-grain nailing, toe nailing, or similar methods, but shall be fastened to a sturdy part of the container or held in place by parallel cleats or other side-grain nailing methods. Blocking and bracing shall be applied against areas of the item(s) that are of sufficient strength and rigidity to resist damage.

f. Bolts shall be used as fasteners for wood or plywood blocking and bracing, wherever necessary, to facilitate disassembly for removal of container contents. Bolts shall also be used for fastening, blocking, and bracing members that are too thick for proper fastening with nails. Bolt holes in wood or plywood shall be of the same diameter as the bolts. A flat washer of proper size shall be used under the nut of each bolt. Bolts, nuts, and washers shall be in accordance with the requirements of ASME B18.5 and ASME B18.9 with ASME B18.18.

4.6.7.3 Cushioning materials. Wherever practical, materials conforming to Government specifications or Government-adopted industry specifications shall be used in preference over those conforming to other industry specifications. Unless justified, materials conforming solely to manufacturers’ specifications shall be avoided. However, containers requiring shock protection at temperature extremes may require limiting cushion manufacturers to those tested at extremes due to performance variations resulting from different manufacturing processes. Refer to MIL-HDBK-304 for cushion characteristics important to container design. In addition to these characteristics, consideration shall be given to the following:

a. Cushion assemblies in reusable containers should be suitably located in or attached to the interior of the containers so that cushioning is applied at the intended areas. The attachment should not be so permanent as to prevent replacement of the cushion.

b. Wherever molded shapes are used, surfaces having a skin should be in contact with the packaged article if material compatibility exists and if consistent with other objectives of the cushion.

c. Cushion (compressive) creep should be consistent with the life or maintenance cycle of the container. A thorough understanding of operational temperature range conditions should be known prior to initiating a design using cushioning materials. Cushioning materials experience significant shifts in allowable static loading pressures over temperature variations.

d. Use of foam cushioning at high temperature extremes is not recommended due to possible structural degradation of the foam.

e. The cushion’s ability to absorb and retain moisture should be considered in the event that the container’s logistic cycle dictates use in cold environments where any retained moisture will freeze and stiffen the cushion system. Closed-cell foam systems should be used whenever possible. Care will be taken when designing with closed-cell foam systems that utilize the perforation method to accelerate out gassing during the curing phase of foam manufacturing. These gas paths allow for ingress of moisture into the closed-cell foam that results in a stiffening of the foam due to internal ice needles formation at low temperatures.

f. When the container’s contents are susceptible to damage by electrostatic discharge (ESD), the cushioning material shall have an average decay time of not greater than 2.0 seconds. See Appendix C for information as to how this test may be performed. The resistivity of surface conductive cushioning material shall be equal to or greater than 1.0 by 10^5 ohms per square but less than 1.0 by 10^{12} ohms per square. The resistivity of volume conductive cushioning material shall be 1.0 by 10^4 ohm-centimeter (cm) but less than 1.0 by 10^{11} ohm-cm. Surface and volume resistivity shall be measured in accordance with ASTM D257 and ASTM D991. MIL-STD-1686 shall be used as a guide for the control of ESD conditions.

g. Cushioning materials shall not emit (outgas) any volatile gas within the container to the extent that 10 percent of the LEL may be reached.

h. When performance requirements at temperature extremes produce different results between manufacturers meeting the same commercial specification, the manufacturers that meet the requirements may be specified along with information on what testing would be required to qualify another manufacturer.

i. When the size or shape of a particular cushion requires that it be constructed of multiple sections bonded together, the lamination plane(s) shall be perpendicular to the direction of the load on that cushion. This minimizes the effect that the bond/joint has on the cushion's overall performance.

4.6.7.4 Resilient mounts. Resilient mounts shall be designed to meet the shock and vibration requirements of 5.2 and 5.3, respectively, of this standard. The resilient materials shall be resistant to aging and deterioration over the expected life cycle of the container.

4.6.7.5 Dynamic characteristics. Materials for use in shock or vibration attenuation systems shall protect the contents to fragility levels established by the designer of the contents; preferably by actual fragility assessment testing. The required tests of section 5 of this standard shall be the criteria by which this requirement is satisfied.

4.6.8 Interchangeability. All parts having the same part number shall be directly and completely interchangeable with respect to installation and performance.

4.6.9 Fasteners and closure devices. All fasteners and closure devices shall have mechanical provisions to prevent loosening, such as self-locking nuts, safety wiring, or other suitable devices.

4.6.10 Wood treatment and preservation. Generally, a protective finish need not be applied to wood containers (boxes/crates), pallets, or finished wood products. To meet the wood treatment certification and marking requirements of the USDA (ISPM 15), wood used in wood packaging products, boxes, crates, pallets, drums, etc., shall be heat treated, certified, and marked with American Lumber Standard Committee (ALSC) or DoD self-certification markings. Certain wood product use (e.g., ammunition containers, pallets) may specify that after heat treatment, wood members shall be dip treated with a preservative suitable to prevent deterioration. Finished wood parts shall be completely immersed for a minimum of 1 minute in a solution of wood preservative consisting of one of the following:

a. A solution of 1.8 percent copper-8-quinolinolate preservative (PA) as solution.

b. A solution of 2 percent copper as metal copper naphthenate (PC).

See MIL-DTL-2427 for preservative treatment procedures. All wooden boxes, crates, pallets, etc. shall be marked with the preservative used: PA or PC. The letters will be not less than 1 inch in height (see MIL-DTL-2427). If a protective finish is required, the finish shall meet the paint requirement of 4.19.1. Additional information for wood preservation can be found in the American Wood Protection Association (AWPA) Book of Standards.

4.6.10.1 Nematodes. When wood products are used in the construction of containers or container components, they shall be processed in such a way that any nematodes present in the material are neutralized prior to use. The following is a typical note that may be applied to drawings or specifications that require the use of wood products:

"In order to comply with ISPM 15, all lumber shall be marked and heat treated in accordance with DOD 4140.65-M."

4.6.11 Nonmetallic materials. Permanent deformation of nonmetallic materials shall not exceed 1 percent when loaded to 1.5 times the rated load, when measured 24 hours after removal of the load. To avoid creep, the design load should be selected in the range of $\frac{1}{10}$ to $\frac{1}{5}$ of the breaking strength; the former being preferred. In addition, the material shall withstand a load not less than 5 times the rated load without any sign of failure.

4.6.12 Corrosion. All metal parts of the container, both internal and external, shall be corrosion resistant. Parts shall show no sign of corrosion, pitting, or scaling when exposed to 12 hours of salt spray in accordance with ASTM B117. For containers meant for use aboard ships, or near marine environments, external non-replaceable metal parts shall show no sign of corrosion, pitting, or scaling when exposed to a 96-hour salt spray test in accordance with ASTM B117, consisting of alternating 24-hour durations of salt spray and drying conditions. Additional corrosion testing information can be found in MIL-STD-810, Method 509.

4.6.13 Stainless steel. When stainless steel fasteners are used, an anti-seizing compound should be specified for use to minimize the probability of galling. When the best design solution results in the coupling of aluminum and PH 17-4/7 stainless steel, information contained in Tech Memo No. PHST-30-99 (see Appendix Q) can be used for guidance. The designer shall also consider passivation in accordance with SAE AMS2700, ASTM A380/A380M, or ASTM A967/A967M when the specific design dictates.

4.7 Fire performance. Containers intended for use aboard naval ships shall utilize external packaging materials that are either noncombustible or fire-retardant and meet the requirements of section 5.10.

4.8 Drainage. To the maximum extent practical, free drainage shall be provided in the normal storage position (i.e., all pockets on the exterior of containers will have provisions for drainage). Where containers are of such size that water cannot be conveniently poured out of the lower shell, drain plugs may be included in the design at locations where water is apt to collect. The drain plugs are not a requirement of all containers, they are only necessary when unique elements of the container's logistics cycle dictate their use. When drain plugs are employed either in sealed or controlled breathing containers, they shall maintain a seal integrity equal to or greater than the overall container's allowable leakage pressure rating. All containers shall have all faying surfaces and discontinuous welds filled with a sealing compound in accordance with SAE AMS3269, SAE AMS3281, or other suitable sealing compound in areas where water intrusion may result in damage to the container.

4.9 Records receptacle. When the container's contents are to be accompanied by pertinent records, such as logbooks, a suitably-sized externally accessible watertight record receptacle or access port shall be provided. If a Navy standard part is desired for this application, see the reference for records holder or access port in table I. If permitted by the logistics associated with the container's contents, the receptacle may be located within, and protected by, the interior of a sealed or controlled-breathing container. Otherwise, the receptacle shall be a separate enclosure, and if additional protection is required for the records, it shall provide an environment controlled to specified limits.

4.10 Closure devices. Latches or other closure fasteners shall permit rapid packing and unpacking without the use of tools. If unique requirements dictate the use of tools for closures or fasteners, they shall be standard issue such as screwdrivers and wrenches. All such fasteners shall be captive to the container and shall be either recessed or provided with a protective guard. The requirement for rapid packing may be waived for those containers which will not be opened frequently for maintenance or inspection and which contain materials not likely to be urgently needed. When elements of the container's logistics cycle dictate, rapid packing and unpacking shall be accomplished while wearing arctic gloves. If a Navy standard part is desired for this application, see the reference for latch and wide handle latch in table I.

4.11 Static electricity. The effect of static electricity on the contents of the container and the environment in which it will be unloaded shall be considered in the design of the container. ESD Control Programs shall be in accordance with MIL-STD-1686. However, MIL-STD-1686 specifically excludes electrically initiated explosive devices. Approved barrier materials used in the preservation of ESD sensitive items shall be in accordance with MIL-PRF-81705. In those instances where a potential hazard exists, the design shall prevent buildup of a static charge or provide a conducting path to ground by one or more of the following practices:

a. Firm metal-to-metal contact shall be used to provide an acceptable ground.

b. Items suspended in a shock-mounted cradle shall be grounded to the container structure. If the container structure is nonmetallic, a clearly identified metallic external grounding connection shall be provided. The maximum resistance of the ground path is dependent on the acceptable limits of the container's contents. If no maximum resistance is known, then the maximum resistance of the ground path will be 1 ohm.

c. Flexible barriers shall discharge to ground (a grounding connection to structure will be provided) in 2 seconds when tested in accordance with MIL-STD-3010, Method 4046, or Appendix C, with the following conditions:

(1) Definition: Decay time is defined as the time it takes to dissipate 99 percent of the initial 5000-volt charge (both positive and negative).

(2) The average value for the specimens (three required) tested for each exposure condition (as received, after aging, and after shower exposure) will discharge to ground in 2 seconds. Only conductive flexible barriers will be used for explosives or materials which generate flammable vapors or for devices which are sensitive to static electricity.

NOTE: See Appendix C for information as to how this testing may be performed.

(3) Plastic material in contact with the contents shall be conductive or shall be surface treated to reduce static charge buildup.

4.12 Preservation. Containers shall be designed to be compatible with methods of preservation selected for the contents.

4.13 Clean-room operations. The container system shall be designed to be compatible with clean-room operations and maintain required component cleanliness during shipment and storage, whenever such requirements exist. Clean-room criteria shall be as defined in ISO 14644-1 and ISO 14644-2.

4.14 Security seal. The container shall be designed to enable detection of unauthorized entry. Unless designed for a specific security seal, security seal holes in both the cover and base shall be ⅜ inch (9.5 millimeters) diameter or larger. External covers for accessing container built-in-test (BIT) cables shall also be designed to accommodate a security seal to enable detection of unauthorized entry. When security seals are used to enable detection of unauthorized entry, the following provisions shall be accounted for:

a. As a minimum, two seals shall be installed on the container.

b. As a minimum, seals shall be on diagonally opposite corners, sides, or ends.

c. The seals shall be attached to the container in such a way that separation of the container's cover from base will result in the removal/breakage of the seal.

d. BIT cable cover connectors shall have one seal that is attached in such a way that separation of the cover from the cable connector will result in the removal/breakage of the seal.

e. The seals shall be protected from damage during normal handling operations.

Seals may take many forms, such as adhesive backed stickers, wire rope with aluminum seals, or flat strip seals. Lead disks or pellets are not authorized for use. Depending on the style, selected provisions shall be included for their installation and removal. For adhesive backed stickers, sufficient area shall be provided on the container for their installation and for security seal information to be scribed on the base material. The base material shall also be manufactured using appropriate materials such that the seal information shall not be lost due to environmental conditions that the container is subjected to, and that any tampering with the information is clearly evident. For wire rope with aluminum seals or flat strip seals, sufficient provisions shall be integral to the container's base and cover structures to allow for installation based on their geometry.

4.15 Protection of contents against corrosion and water damage.

4.15.1 General. The nature of the contents and the expected environments encountered in the logistic pattern determine the type of container and its closure and sealing requirements. Design criteria for the various classes of container sealing are provided in 4.15.2 through 4.15.4.

4.15.2 Closed containers without auxiliary barriers. These are conventional boxes or crates, which are both unit containers and shipping containers; but the class also includes ventilated metal shipping containers. Larger containers and containers with contents, which fill the enclosed volume only partially, should incorporate provisions for ventilation and drainage as follows:

4.15.2.1 Ventilation. Ventilators shall be placed in the ends of containers, but in such fashion as not to interfere with primary structural members. Louvered metal ventilators, slotted ventilators, or drilled hole ventilators shall be screened on the inside with 1/16-inch or smaller, galvanized or aluminum wire cloth. Slotted ventilators (without external louvers) and drilled-hole ventilators shall also be furnished with an interior baffle structure designed to trap driving rain, draining to the outside. Except for lumber sheathed crates, total surface area of ventilating openings shall be not less than 0.15 square inch per cubic foot of contained volume. Maximum size of any one slot in a ventilator shall be 4 by 12 inches. For lumber sheathed crates, drilled-hole ventilators, with each hole drilled upward as viewed from the outside on a 45-degree angle, may be used. Holes shall be 3/4 inch in diameter. The number of holes shall be not less than one hole per 20 cubic feet of the container volume. Holes may be clustered in each end or may be uniformly spaced about the periphery of the crate.

4.15.2.2 Drainage. For containers either too heavy or bulky to easily manually empty, each low point in the container shall be furnished with a drain hole so located as to freely drain all water which might collect in the affected area. For flat bottomed containers, one drain hole shall be provided in each corner of a potential water trap in the base. Satisfaction of this requirement can also be achieved by spacing lumber floor board members approximately 3/8 inch apart and cover with screen.

4.15.3 Closed containers with auxiliary barriers. Design features of these containers are essentially the same as those previously described (see 4.15.2) except that provision is incorporated for use of an auxiliary water vapor barrier of sufficiently low water vapor transmission rate, and desiccant contained therein, to provide Method 50 preservation as defined in MIL-STD-2073-1.

4.15.4 Integral-barrier containers. Containers of this class use the container walls to form the protective barrier. The controlled breathing type of integral-barrier container is most commonly specified or chosen. One of the other two types; non-breathing or free breathing, may be specified or justified based on size considerations, the expected logistics flow, or cost-effectiveness. The following features will be provided in all integral-barrier containers:

4.15.4.1 Structural. Integral-barrier containers shall be designed to meet the pressure requirements of 5.4.

4.15.4.2 Leakage. Integral-barrier containers shall be sufficiently leak-proof to meet the requirements of 5.5.

4.15.4.3 Closures (except removable head drums). Mating surfaces shall be resistant to mechanical damage and prevent gasket overloading. Assembly guides shall be provided when appropriate to assure alignment of mating surfaces and to prevent shear action on gasket surfaces. The removable cover shall be designed such that the gasket sealing surface is protected from mechanical damage while the cover is apart from the base during container loading/unloading operations. Preformed gaskets or seals that can be readily replaced and which are retained in place by the structure shall be used. Gaskets shall be in accordance with ASTM D2000, unless otherwise specified in the CIDS, and be of the class and grade required to be compatible with any content, service liquid lubricants, or liquid fuels shipped therewith. Molded one-piece gaskets are preferred, but joints may be cemented or joined by vulcanizing, provided the joints are the same dimensions as any other place on the gasket and that all minimum tensile strength characteristics specified by the container specification are met. If no minimum is specified, a value of 40 percent will be used. Nominal gasket compression shall be 15 to 25 percent unless specifically designed otherwise, and sufficient to meet the structural/pressure or leakage requirements of 4.15.4.1 or 4.15.4.2, respectively.

4.15.4.4 Desiccant storage. A container's desiccant storage enclosure shall be such that a sufficient volume exists to contain the proper quantity of desiccant required, in accordance with MIL-STD-2073-1. Depending on the desiccant type to be used, the design agent shall consider the volume of saturated desiccant when sizing the storage volume. The desiccant storage enclosure may be a cordoned off area within the container or an ancillary container component. Volume of bagged desiccant in accordance with MIL-D-3464 is approximately 3 cubic inches per unit of dry desiccant. Desiccant swell testing should be performed prior to design, to account for volume growth when saturated. For containers requiring a large quantity of desiccant, eight unit bags are commonly used. Approximate dimensions of those marginally flexible bags are 3.5 inches (89 millimeters) by 6.5 inches (165 millimeters) by 1 inch (25 millimeters). Air enclosed in the container shall have free access to the contained desiccant. Desiccant shall not be located in the container so as to come into direct contact with any accumulation of condensate (i.e., on the container's walls). When the container's logistics dictate that the desiccant be easily removable/refillable without removing the container's cover, a desiccant port or desiccator shall be supplied. Desiccant ports and desiccators shall possess the following common traits: covers capable of being removed and replaced by hand without the use of tools, provision to install tamper evident seal, and have covers that remain attached to their mating component when opened (for instance, by lanyards). For containers requiring desiccant ports or desiccators, the ergonomics of desiccant bag removal shall be considered. Most COTS desiccant ports and desiccators possess 3.5-inch diameter openings for desiccant passage. For containers whose requirements can be met by those COTS components, see the Navy's standard part listing in table I. For containers whose requirements cannot be met by those COTS components, unique desiccant ports or desiccators may have to be designed for that specific application once all of the ergonomic envelope parameters have been clearly specified.

4.15.4.5 Humidity indicator. A humidity indicator in accordance with SAE AS26860 or as specified by the design activity shall be provided in all dehumidified packages. The inside of the container shall be configured to provide free access of the enclosed air to the indicator. Electrical humidity-indicating devices may be used, provided the logistic flow indicates prolonged storage in one place. The content's sensitivity to moisture will dictate the percentage of relative humidity, which is to be sensed for each specific design as well as the type of indicator (i.e., reversible or maximum) to be used. If required, the humidity indicator shall be designed such that the indicator card may be replaced without removing the cover of the container. The humidity indicator shall be located apart from the desiccant storage area while remaining on the same end of the container, unless otherwise dictated by the container's maintenance logistics. If a Navy standard part is desired for this application, see the reference for humidity indicator plug in table I.

4.15.4.6 Pressurizing fitting. When required for pressure or leak testing, each container will be provided with a ⅛-inch National Pipe Thread (NPT) boss for convenient installation of a pressurizing fitting. The threaded boss will be closed with a ⅛-inch pipe plug. As an option, each container will be provided with a standard size tire valve in accordance with SAE AS5017. The tire valve will be corrosion resistant. When the container's logistics permit, the container's pressure equalizing valve may be removed and the resulting port be used for the installation of a pressurizing fitting of a corresponding size.

4.15.4.7 Leakage indicator. When the packaged items contain or can produce toxic or flammable liquids or gases (for example, Class A or B poisons), externally visible indicators shall be considered for use and shall be located at both ends of the shipping container to detect leakage of the packaged item into the shipping container. For mixed amine fuels and for fuming nitric acid, the indicator shall be in accordance with MS17868. For Fuel Air Explosive (FAE) bombs, containing either ethylene oxide or propylene oxide, the indicator shall be in accordance with NAVAIR Drawing 2602910.

4.15.4.8 Container accessories. Valves (except drain valves), humidity indicators, record receptacles, pressure fittings, desiccant ports, leakage indicators, umbilical connectors, and so forth, that are subject to routine inspection shall be grouped in one end of the container, unless the size of the container would warrant placement of an accessory item in more than one location or unless the logistics of the component dictate another location (for example, observation windows require one on each end or one on each side). All container accessories, such as desiccant port or records receptacle, possessing removable covers shall have them captive to the container by lanyards or other suitable means.

4.15.4.9 Transparent window in auxiliary barrier. Where a transparent window is used in the auxiliary barrier to permit viewing an internal indicator, either a corresponding opening with a readily removable cover or an observation window shall be provided in the container. If a Navy standard part is desired for this application, see the reference for observation window in table I.

4.15.4.10 Special requirements for non-breathing integral-barrier containers. Except for smaller sizes of standard drums (15 gallons or less), a simple, manually-operated bleeder valve to equalize pressure before opening shall be provided.

4.15.4.11 Special requirements for controlled-breathing integral-barrier containers. Unless otherwise specified in the CIDS, each container shall be provided with a pressure and a vacuum relief valve in accordance with SAE AS27166. A simple, manually-operated bleeder valve shall also be provided to equalize pressure before opening the container. This valve may be integral with any required automatic relief valve. Container designs shall be based upon the design and testing requirements of 5.4.2.1 and 5.5.2.1, unless superseded by the operational logistics requirements of the container and its contents. If a Navy standard part is desired for this application, see the reference for breather valve in table I.

4.15.4.12 Special requirements for free-breathing containers. Free breathing should be considered only for very large structures where pressure tightness, on the order of one pound per square inch gage (psig), is not a practical design solution. A refillable desiccant breather unit for each container shall be provided. The breather unit shall have the following general characteristics:

a. The breather shall be designed to accommodate 1 ounce of Type I, Grade H, MIL-D-3716 desiccant per cubic foot of empty container volume.

b. A sight glass on the container side of the desiccant bed shall be provided to determine bed exhaustion.

c. End filters and plenum chambers to assure air flow distribution over the full face of the bed shall be provided. Filter characteristics shall be determined by cleanliness requirements of internal voids and desiccant particle size.

d. Spring loaded devices, or their equivalent, shall be provided to prevent development of voids in the breather charge resulting from packing or reduction of charge particle size.

e. Openings to ambient environment shall face downward and shall have a length-to-diameter ratio of at least 10 to 1.

f. Minimum flow rate through breather shall be 6 percent of container volume-per-minute at design pressure.

g. Provisions for a charge of MIL-D-3464 desiccant shall be provided to assist in initial drawdown and to compensate for sudden weather changes. The size of the charge shall be in accordance with the rigid barrier formula of MIL-STD-2073-1.

4.15.4.13 Observation window. When the container or content's logistics so require, observation windows shall be placed in each end or each side of the container such that an unbroken light path will indicate that the container is void of its intended contents. If a Navy standard part is desired for this application, see the reference for observation window in table I.

4.15.4.13.1 Alternate observation window location. When necessary, the design agent may specify as an alternative the installation of observation windows on the same surface (side or end) 6 to 24 inches (152 to 610 millimeters) apart. The window's opening shall be large enough to allow the user to clearly identify whether the container is loaded or empty.

4.16 Stacking and stowing.

4.16.1 General. Containers shall be capable of being stacked in warehouses or magazines and stowed in ships for prolonged periods. Open storage capability is required for all troop issue containers, for all containers which will be transferred at sea, and in other cases, as specified by the design agency. For items requiring insensitive munitions protection, consideration should be given to designing the stacking features, such that containers can be stacked forward to forward or forward to aft, interchangeably.

4.16.2 Stacking stability. Design features shall assure a stable stacking configuration. Containers designed to be shipped or stored stacked shall have the widest footprint practical for the container size for stability; however, they shall not be designed to roll. Stacking stability provisions shall, in general, include positive means for restricting relative displacement under impact or internal loads encountered in shipment. As a result of ship motion during truck deceleration or rounding of curves, or multiple package handling, they shall meet the requirements of 5.2.6.3. Where the interface between like containers is wood-to-wood, fiberboard-to-fiberboard, or combinations of these two materials, the design may utilize friction and palletizing or car loading procedures in combination to achieve a stable load. Flat-surfaced, metal, plastic, or fiberglass containers shall be provided with interlocking dimples, ribs, or panels to provide longitudinal and transverse (lateral) restraint. Stacking brackets (with interlocking features) and tie bars, where required, shall be furnished to provide vertical as well as longitudinal and transverse (lateral) restraint. When containers are stacked (vertically), there shall be no provisions in the load path that are allowed to move rotationally or otherwise. If structural provisions in the vertical load path must be removable to meet special handling logistics requirements (i.e., for removal or loading clearances), they shall be designed in such a way that they be rigid when in the installed orientation. The use of Naval PHST Center Technical Report 93003 shall be used to determine the stability of container stacks.

4.16.3 Stackability. Unless justified by logistic considerations, each container shall be designed to support a load of like containers placed thereon in an orderly fashion. The total load shall be determined by the procedures of the test method depicted in Appendix D. Provisions shall be included in the container’s design that allow for easy stacking interface of containers. These interfaces may also serve as the interlocking features described in 4.16.2. If the container’s logistics dictate, it may be desirable to provide visual alignment marks on the container’s cover and base to assist operators during stacking operations. These marks may be in the form of stampings, etchings, engravings, stencilings, etc.

4.16.4 Distributed load. The top structure of large, flat-topped containers, such as crates, shall be designed to carry a uniformly distributed long-term static load and meet the requirements of the test method depicted in Appendix E. Containers designed for ammunition and explosives do not need to meet this requirement because the piling of many small heavy packages on ammunition or explosives containers is not allowed.

4.16.5 Stacking strength. Stacking strength for like-on-like containers shall be determined in accordance with the test of 5.6.2.

4.17 Handling.

4.17.1 General. Specialized shipping containers shall be provided with lifting, hoisting, and tiedown provisions commensurate with their weight, size, and intended mode of transportation to ensure safe and efficient movement. Handling provisions for overhead lifting shall be designed as much as possible to avoid lifting through welded joints. Stress analysis calculations should be prepared demonstrating the adequacy of all container handling provisions. The analysis should address the integrity of all structural members involved, as well as their method of attachment (welds, adhesive bonding, mechanical joints, etc.). The calculated stress values shall be equal to or below the specified allowable stress values when applying the proper factor of safety for the specific handling provision.

4.17.2 Manual lifting/carrying. Handles or handholds shall be provided on all containers, or removable container components whose handling logistics require manual lifting or movement. Two examples of removable container components are its cover and insensitive munitions shield(s). The quantity of handles or handholds required to support manual lifting or movement shall be of sufficient number to satisfy the ergonomic requirements of the operation. Geometry, weight, carry distance, and vertical lift of the container or container component to be lifted or moved are the basis for determination as to the need for handles or handholds. For those containers or container components that are of convenient size or light enough weight, handles or handholds may not be required for use. Where containers are destined for common use, there may be a requirement for the accommodation of female users in the lower 5 percent strength group. Where containers are destined for special operations, there may only be the requirement for accommodation of male users in the upper 5 percent strength group. Once the operational system logistics are known, requirement specifiers may reference numerous sources of HSI design specifications, such as ASTM F1166 and MIL-STD-1472, to clearly define manual lifting parameters and handle design.

4.17.2.1 Handle characteristics.

a. When not in use, non-stationary handles shall either swing/rotate down against or retract into the side or end of the container, regardless of the container's angle relative to horizontal.

b. When in use, non-stationary handles shall stop open at a 90-degree angle ±10 degrees in relation to the surface that possesses the handle when lifting.

c. For a Navy common standard part example for non-stationary handles, see table I.

d. Stationary handles shall be designed such that they do not extend beyond the container's outer envelope.

e. Dimensionally, it is best that design guidance be obtained from ASTM F1166. When the container's shell is a Military Standard (MS) drum or existing standard military ammunition box, handle opening sizes may be relaxed by the design activity, if all of the container's handling logistics can still be accommodated.

f. Handles shall meet the strength requirements of 4.17.3.2.a.

g. Handles solely used to lift empty containers, container covers, or container components shall be clearly labeled to avoid misuse.

h. Handles used as tiedown provisions shall meet the strength requirements of 4.17.3.2.b.

i. When multiple handles are required to support manual lifting or movement, they shall be located conveniently about the center of balance of the container, cover, or container component in an ergonomic manner best suited to the lifter(s).

4.17.2.2 Handhold characteristics.

a. Handholds shall be designed such that they do not extend beyond the container's outer envelope.

b. For handhold loads in excess of 40 pounds, the grip diameter shall be not less than ½ inch; the clear inside dimension shall be not less than 4¼ inches in length and 2 inches in depth. For use with arctic mittens, these dimensions shall be 5¼ inches in length and 3 inches in depth.

c. Handholds shall meet the strength requirements of 4.17.3.

d. Handholds solely used to lift empty containers, container covers, or container components shall be clearly labeled to avoid misuse.

e. Handholds used as tiedown provisions shall meet the strength requirements of 4.17.3.2.b.

f. Handholds intended for use with two hands shall be a minimum of 9½ inches in length and 3 inches in depth.

g. When multiple handholds are required to support manual lifting or movement, they shall be located conveniently about the center of balance of the container, cover, or container component in an ergonomic manner best suited to the lifter(s).

4.17.3 Hoisting. Means shall be provided for hoisting all specialized shipping containers weighing more than 150 pounds gross weight. Hoisting provisions shall result in safe and stable handling, compatible with the intended logistic cycle (for example, containers intended for airdrop will meet the requirements of MIL-STD-814 and MIL-STD-1791, containers intended for transfer-at-sea shall be compatible with the transfer system, and containers intended for shipboard use shall have provisions to make them compatible with common shipboard handling equipment used in limited-access stowage areas).

4.17.3.1 External air transport. Containers which are to be transported via helicopter externally shall be certified for External Air Transport (EAT)/Helicopter Sling Loading (HSL) by rotary wing aircraft by the U.S. Army Natick Soldier Research, Development and Engineering Center in Natick, MA. Those containers with EAT/HSL requirements that are limited to Navy VERTREP only shall have hoisting provisions with a minimum 2½-inch opening and shall interface with the MK 105 MOD 0 Sling and the MK 109 MOD 1 Sling. If a Navy standard part is desired for VERTREP only applications, see the references for container lift rings and shackles in table I. Details for Navy VERTREP can be found in NWP 4-01.4. Those containers requiring full EAT/HSL certification shall have hoisting provisions in accordance with MIL-STD-913 and MIL-STD-209. Containers which are to be transported via VERTREP shall be designed to withstand crushing loads associated with slings used during VERTREP operations.

4.17.3.2 Hoisting provisions. Hoisting provisions shall have the following characteristics and be located as follows:

a. Hoisting provisions shall meet the minimum hoisting strength requirements of 5.7. The tests require that each hoisting point be capable of lifting the total gross weight of the container or unit load if it is to be so shipped by single-point suspension.

b. Hoisting provisions, which are to be used as tiedown provisions, shall meet the strength requirements of 5.7.

c. Lift rings shall be placed as high as practical on the container base for lifting stability on unit loads.

d. When practical, hoisting provisions shall be placed as far from the loaded center of balance as practical to provide the greatest handling stability. Consideration should be given to specific hoisting sling configurations which may be used so that the spacing of the hoisting provisions will not result in sling leg angles with the horizontal of less than 30 degrees (45 degrees preferred). If the sling configuration is not known, lift rings should not be placed more than 120 inches (3048 millimeters) apart. Ideal hoisting provision spacing for Navy CONREP and VERTREP is 110 to 120 inches apart on the long side of the container to allow compatibility with the MK 105 MOD 0 sling with green legs. Care will be taken to ensure that no sharp edges on the container can damage the sling legs. Loaded container unit load center of gravity (CG) shall be centered between the hoist fittings. Under typical conditions, a loaded container shall be designed such that it is within 5 degrees from horizontal when lifted. If multiple content configurations can result in different CGs, then a compromise position shall be selected provided no configuration exceeds more than 5 degrees from the horizontal when lifted. Additional lift rings may only be included in the design if the container is adequately marked to identify the conditions for use. If none of these conditions can be met, unbalanced containers shall be compatible with the MK 109 MOD 1 sling and will be limited to CONREP.

e. Unless the configuration of the hoisting sling is known, strength of the fittings and supporting structure shall be based on sling leg angles of 30 degrees to the horizontal.

f. Hoisting provisions shall not protrude beyond the container envelope when not in use.

g. When practical, hoisting provisions shall not be placed at locations which require the container closure fittings to carry the lifting loads (for example, containers having a removable top section or cover will not have the hoisting provisions located on the cover). However, when cover weights approach or exceed the weight limitation for a two-person lift, hoisting provisions clearly labeled “COVER LIFT ONLY” may be utilized in the cover design. If unique logistics considerations require a design where the hoisting provisions are located in such a manner that require the container closure fittings to carry the lifting loads, the container closure fittings shall meet the strength requirements of 5.7 with all corner closure fittings engaged, but every other non-corner closure fitting disengaged.

h. The hoisting fittings shall have a clear inside opening large enough to accommodate all handling equipment, which will be employed through its logistics cycle. If the container’s logistics are not known, the hoisting fittings shall be in accordance with the requirements of MIL-STD-209 and MIL-STD-913.

i. Unless specifically permitted otherwise in the CIDS, wire rope or other materials, which are capable of fraying, shall not be used for the construction of hoisting fittings.

j. Hoisting fittings shall be replaceable without damaging or requiring alteration of any other part of the container.

k. Joint service containers, especially those for items where sea base replenishment is a future requirement, shall limit hoist ring spacing to 26 inches to 42 inches apart on the container width and 120 inches apart on the long side with the hoisting provisions centered about the loaded CG.

4.17.4 Tiedown. Tiedown provisions shall only be provided on specialized shipping containers in those instances where unique logistics mandate their inclusion in the design. In most anticipated modes of transportation, the vehicle of transport provides external means to adequately tie down shipped commodities (for example, trucks provide their own tiedown strap systems, naval ships use either stanchions or chains through fork pocket openings, while aircraft provide cargo net tiedown systems). For those instances where tiedown fittings must be provided in the design, the tiedown provisions shall meet the strength requirements of 5.7.4. If the container’s design permits, hoisting fittings may also be utilized as a provision for tiedown.

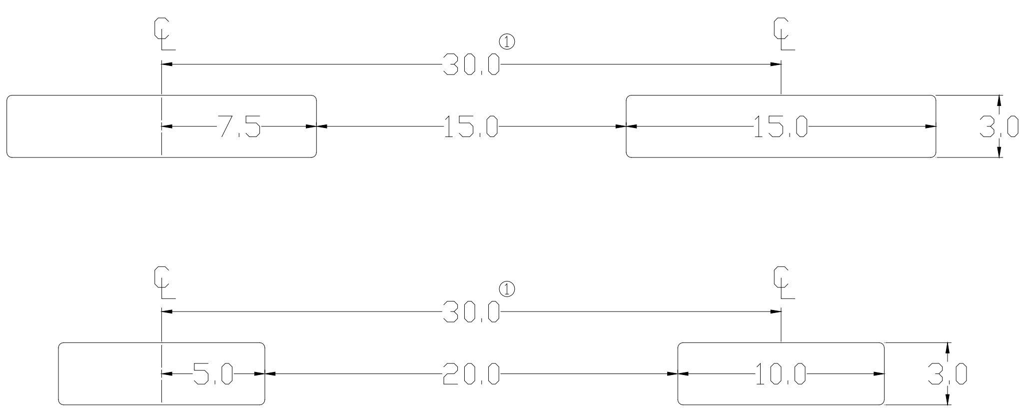
4.17.5 Skids. Skids or rubbing strips shall be provided on all containers over 40 inches in the longest dimension and exceeding 150 pounds gross weight. They shall be arranged to permit handling by forklift trucks and shall permit easy blocking and bracing in railcar loading and truck loading. Preferred orientation of skids is parallel to the long dimension of the container base, if consistent with meeting forklift capability requirements. Any ramping of skid ends to accommodate skidding of containers shall be kept to a minimum (a 15-degree ramp angle is recommended with a maximum ramp rise of ¾ inch) to minimize blocking and bracing problems. Additionally, the protrusion of skid ends beyond the end of the container shall be limited to the minimum length necessary for protecting the container surface and accessories. The design activity may incorporate inseparable skids into the container's shell or frame. For containers whose unique logistics dictate the use of wooden skids, the wooden members shall be fabricated from Group II, III, or IV woods of 4.6.7.2 and impregnated with a non-hazardous preservative suitable to prevent deterioration. Skid attachments shall meet the forklift truck compatibility test of 5.8 and the shock test of 5.8.1.

4.17.6 Forklift truck compatibility. Containers of over 40 inches in the longest dimension or over 150 pounds gross weight shall be capable of being handled safely from at least two sides (4-way entry is preferred) by forklift trucks of rated capacity appropriate to the gross weight and geometry of the container. When unique logistics of the container so require, smaller containers shall be designed to permit forklift handling. In such cases, the dimensions and spacing of forklift openings may be compromised as necessary; a vertical clearance of 2.0 to 3.0 inches, with no enclosure features, may be adequate. If a Navy standard part is desired for this application, see the reference for fork pocket in table I.

4.17.6.1 Containers having a length greater than 88 inches. Containers having a length greater than 88 inches and containers requiring a fork lift interface that are handled aboard ship, or as dictated by the container's logistics, shall have completely enclosed fork tine pockets which straddle the center of balance. Completely enclosed fork tine pockets are defined as pockets that will completely encompass the fork tine for the entire length of the pocket (i.e., width of the container). The need for completely enclosed fork tine pockets on other containers shall be determined by a design analysis or by the performance of the applicable forklift truck compatibility test of 5.8. Both the empty and loaded conditions shall be considered. These containers typically will be shipped on flat bed trailers, not enclosed in vans. End handling will typically be accomplished by the use of MK45 handlift truck fittings that are designed for shipboard containers. Some containers may require special end accessible fork tine pockets for direct loading of container's contents onto Air Force aircraft. Unless unique logistics of the container dictate the following:

a. Minimum inside dimensions of each fork tine pocket shall be 3 by 10 inches (3 by 15 inches for containers intended for use on ships or in other areas having restricted movement areas) (see figure 2) and,

b. Fork tine openings shall be spaced 30 inches apart (28 inches apart if interface with Rough Terrain Trailer is required) on centers with the CG located between forklift pockets (see figure 2).



NOTE: 28 inches if Rough Terrain Trailer interface is also required.

FIGURE 2. Standard fork tine spacings.

4.17.6.2 Containers ranging in length from 50 to 88 inches. Containers ranging in length from 50 to 88 inches shall have partially enclosed fork tine pockets on each side of the container. Partially enclosed fork tine pockets are defined as pockets that will completely encompass the fork tine at both the entry and exit locations (two container sides) yet remain unenclosed on its bottom in the central section of the container to allow for pallet jack wheel usage. Each of the enclosed fork tine areas shall be structurally sound to withstand the input forces associated with all handling logistics. Size and spacing shall accommodate either long containers as defined above, or pallet size containers as defined below.

4.17.6.3 Pallet size containers (52 by 44 inches or smaller). Pallet size containers (52 by 44 inches or smaller) shall be 4-way fork tine entry compatible where possible. Partially enclosed fork tine pockets shall be designed into the long side of the container. Open or partially enclosed fork tine pockets shall be designed into the short side of the container to allow for pallet jack wheel usage. For the long side, pallet jack compatibility to SAE AS5389 is desirable if it does not add significant cost to the design. (See figure 3)

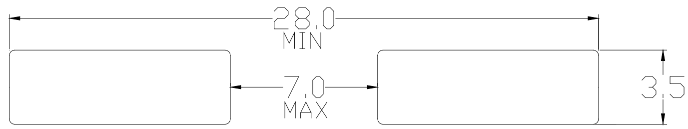


FIGURE 3. Pallet size container fork tine spacings.

4.17.6.4 Direct interface with military aircraft loading operations. In unique instances, containers may be required to directly interface with military aircraft loading operations. The backbone of aircraft loading operations is the Air Force's 463L cargo system, which is comprised of a pallet, nets, Material Handling Equipment (MHE), and aircraft rail/roller systems. Overall dimensions of the 463L pallet are 88 by 108 inches, with usable dimensions of 84 by 104 inches. This allows 2 inches around the load to attach straps, nets, or other restraint devices. Containers with flat bottoms, that are to be transported almost exclusively by air shipment, will be handled by long fork lift tines underneath the container on approximately 48-inch centers. These containers will have to be placed on wood supports while awaiting loading. Fully enclosed fork lift tine pockets shall be incorporated in these types of containers that will be moved by other methods of transportation. These fork tine pockets shall be on 48-inch centers and possess the standard fork tine opening of 3 by 15 inches. For additional information on the 463L, see MIL-STD-1791.

4.17.6.5 Secondary uses for fork pockets. If the container fork tine pockets are to be used for unitizing or tiedown, special consideration shall be given to the loads and forces which are involved. If the fork pockets are to be used for creating a unit load by use of steel strapping through the fork pockets, then the top and bottom edge of each opening of the fork pockets shall be either beveled or rounded to prevent sharp creasing of the strapping during tensioning. If a Navy standard part is desired for this application, see table I. SAE AS5389 may be used for additional information on container fork pocket interfaces.

4.17.7 Pallet jack compatibility. For containers possessing forklift truck provisions that are also required to be moved by pallet jacks, provisions shall be made to allow for pallet jack interface capability. SAE AS5389 may be used for additional information on container pallet jack interfaces.

4.17.8 Shipboard handling. Containers of over 300 pounds gross weight, or at least 3 feet long and without 4-way fork tine entry, which are intended to be end handled by mechanical means aboard combatant or auxiliary naval ships, shall have special provisions for handling and stowage in confined and limited-access stowage areas as follows:

a. A metallic fitting shall be provided at each end of the container to permit handling with the Handlift Truck, MK 45, all MODs. Each container fitting shall be capable of supporting three times the maximum weight, including Fleet issue unit loads, if applicable, that it is required to support. The fittings shall be located and meet the requirements as shown on NAVSEA Drawing 6214131 (see Appendix B). The container structure shall be sufficiently stiff to permit a minimum clearance of 3 inches between the bottom of the container and a level deck, along the container's entire length, with the handlift truck in its fully elevated position, and when tested in the configuration in which it will be used (for example, with or without cover applied). The fitting and container structure shall meet the strength requirements of the tests described in 5.9. If a Navy standard part is desired for this application, see table I.

b. Where appropriate, containers handled and stowed on aircraft carriers shall have provisions to permit overhead handling of a loaded container at the center of balance via direct hoist pick up or by utilizing the HLU-216A/E Beam, the MK 52 MOD 0 Beam, or the MK 52 MOD 1 Beam. The provisions shall be designed to be capable of supporting three times the maximum weight that it is required to support. Fleet issue unit loads are not to be lifted by the HLU-2l6A/E, MK 52 MOD 0, or MK 52 MOD 1 Beams. Only single containers are to be handled by these handling beams. The provisions shall not protrude beyond the container's envelope when not in use. Provisions shall be made to allow for stacking of like containers in both the forward-to-forward or forward-to-aft configurations in their up position, unless the provisions are designed to slide vertically into the cover's wall while remaining recessed and accessible without the use of tools. Wire rope or other materials that are capable of fraying shall not be used for the construction of provisions. If a Navy standard part is desired for this application, see table I.

c. For containers that will be opened in Navy ship's magazines, possessing covers weighing in excess of 174 pounds, the cover shall be designed with a mechanical provision that interfaces with standard shipboard handling equipment. This provision shall be clearly marked, "FOR COVER LIFT ONLY" if it does not possess adequate capacity to lift the entire container fully loaded. Unless specifically permitted otherwise, wire rope or other materials that are capable of fraying shall not be used in the design. If a Navy standard part is desired for this application, see table I.

4.17.9 Handling provision maintainability. Handling provisions shall be designed as much as possible to be readily repairable and replaceable without damaging or requiring alteration of any other part of the container.

4.18 Special protection devices.

4.18.1 Temperature control. Special provisions for controlling or limiting the extremes of temperature within a container shall be avoided. In those cases where such provisions may be justified and specifically required by the design activity, they shall be as simple and as lightweight as possible and meet all the performance requirements of this standard. Detailed design requirements shall be established on a case-by-case basis by the design activity by consideration of the thermal properties of the item to be protected and the temperature environment in which it shall survive.

4.18.2 Field-force protection. When the contained item is susceptible to damage from electrostatic, electromagnetic, magnetic, microwave, radio frequency, or radioactive forces during handling, shipment, and storage, the container shall be designed to provide the required protection from the appropriate field-force, as specified by the design activity.

4.18.3 Magnetic shielding. For packaging and transportation purposes, magnetic items may be handled as non-magnetic material when the maximum field strength at a distance of 7 feet from the package of the item is 0.002 gauss or less. However, items in this category, when consolidated, may exceed the 0.002-gauss limitation and labeling or shielding may be required. When the magnetic field strength of an item exceeds 0.002 gauss at 7 feet, but does not exceed 0.00525 gauss at 15 feet, labeling only shall be required. Containers for items which are considered to possess a magnetic field strength exceeding 0.00525 gauss when measured at a distance of 15 feet from any face of the packaged item and which may be shipped by air shall be provided with appropriate shielding. Adequacy of shielding shall be determined in accordance with 5.11.

4.19 Protecting and identifying the container.

4.19.1 Painting requirements. Painting, when required, shall be as specified by the design agent and shall meet OSHA and EPA guidelines. Painting shall be primarily required for Nuclear, Biological, and Chemical (NBC) survivability, corrosion prevention, or to provide camouflage. Interior surfaces of closed painted containers shall be painted with primer only. Where the contents incorporate plated hardware (see 4.6.1.1), the primer shall be of a synthetic type known to be compatible with the plating in use. The specific color and paint grade, required for exterior top coats, shall be as indicated by the design activity. CARC requirements shall be defined by the using agency.

4.19.2 Identification and instructional markings.

4.19.2.1 Identification marking. Unless otherwise specified by the design activity, fully reusable containers shall be identified in accordance with MIL-STD-130. When the name of the contents is classified, the permanent identification shall include only the approved nomenclature (for example, MK and MOD number, Container Numerical Unit [CNU] number) and National Stock Number (NSN) of the container. Shipping containers shall be compatible with Automatic Identification Technology (AIT), Radio Frequency Identification (RFID), and Unique Identification (UID) policies as contained in the Under Secretary of Defense (USD) Acquisition, Technology & Logistics (AT&L) Memorandum Radio Frequency Identification Policy and the USD (AT&L) Memorandum Update to Unique Identification. Provisions shall be taken to ensure that AIT components do not violate high energy radio frequency (HERF)/hazards of electromagnetic radiation to ordnance (HERO)/hazards of electromagnetic radiation to personnel (HERP) standards.

4.19.2.2 Basic instructional markings. Markings on shipping containers shall be permanent and legible for a minimum of 10 years in the defined logistics environments and shall include all basic instructional and operating caution markings required for safe, expeditious handling and use of the container. Markings shall include, but shall not be limited to, the following as applicable:

a. Center of balance
b. ESD sensitive contents
c. Forklift and stacking points
d. Identification of any special sling needed
e. Records receptacle
f. Desiccant receptacle
g. Pressure relief valve(s)
h. Humidity indicator
i. Hoisting and tiedown attachment points
j. Warning notes
k. Instructions for opening, closing, and repressurizing the container
l. Aft
m. Cover lift
n. Fwd
o. Lift arm
p. Observation window
q. Reusable container—do not destroy
r. Unitization attachment points
s. BIT cable access port
t. MK 45 handlift interface
u. Single container lift

4.19.3 Container markings. Unless otherwise specified in the CIDS, provisions, along with an identified placement location, shall be incorporated into the design for applying container markings and bar coding(s), in accordance with MIL-STD-129.

4.20 NBC survivability. Containers used to package mission-essential items that may encounter an NBC environment shall be designed of materials that meet the following criteria:

a. Selection of nonmetallic materials used in the construction/fabrication of containers shall be chemical agent decontaminable to acceptable levels in accordance with the U.S. Army Nuclear and Chemical Agency (USANCA) criteria and AR 70-75 when tested in accordance with TOP 8-2-111.

NOTE: The USANCA criteria and any questions pertaining therein may be addressed to the Edgewood Chemical Biological Center, U.S. Army Research, Development and Engineering Command, Aberdeen Proving Grounds, MD 21010-5424.

b. For metallic materials, application of a CARC shall be applied in accordance with MIL-DTL-53072.

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

4.21 HSI. HSI aspects shall be considered in the design of specialized shipping containers. HSI design specifications, as found in ASTM F1166 and MIL-STD-1472, shall be used in the design of labels, handles/grasp areas, fasteners, covers, and hoisting/carrying devices. HSI considerations include, but are not limited, to the following:

a. Human factors engineering. The application of knowledge about human capabilities and limitations to system or equipment design assures that the system or equipment design, required human tasks, and work environment are compatible with the sensory, perceptual, mental, and physical attributes of personnel who will operate, maintain, control, and support the system or equipment. Location and size of equipment shall assure easy operation and maintenance by personnel in the 5^{th} – 95^{th} percentile or other defined (expected) population.

b. Safety and health. Safety and health factors are those system design features that serve to minimize the risk of injury, acute or chronic illness, or disability; or reduce job performance of personnel who operate, maintain, or support the system. Prevalent issues include noise, chemical safety, atmospheric hazards, vibration, ionizing and non-ionizing radiation, and repetitive stress injuries.

c. Manpower, personnel, and training. The number of trained personnel required to operate, maintain, and support system equipment in its operational environment requires consideration of the user population and the knowledge, skills, and abilities (KSAs) required by the intended user to effectively and safely operate, maintain, and support the system.

d. Personnel survivability. Considerations include the development and use of personnel protective equipment (PPE), such as required clothing and gear necessary to effectively and safely operate, maintain, and support the system.

5. DETAILED REQUIREMENTS

5.1 Fit and compatibility.

5.1.1 General. The container shall be designed to be compatible with the contained item. It shall permit easy loading, movement, and unloading. It shall be compatible with the normal logistic patterns for its contents, as well as with any special requirements which are specified design constraints. The container shall be designed so that the intended load will fit securely, but without interference or binding. It shall support and restrain the item at points and by methods which are not likely to result in damage due to careless manipulation or handling. Loading and unloading shall be a simple process by the normal handling equipment intended to be available at the points of use. If a container's isolation system requires replacement during qualification testing, all previous testing shall be repeated with the new isolation system.

5.1.2 Fit test. This test shall be conducted by bringing together the container and the intended load. The load shall be placed in position in the container and the container shall be assembled in its normal shipping condition by fitting the cover, fastening all restraining devices, placing desiccant, and otherwise completely securing the container for shipment. If the container possesses installation instructions, they shall take precedence over any other loading sequence, and shall be followed to verify fit when performing both the loading and unloading sequence. The container is then unloaded. Only the normal handling equipment likely to be available at points of loading and unloading shall be used. Details of number of personnel required, all slings, beams, shackles, hoists, etc. shall be recorded. Care shall be exercised to assure that both the container and the load are representative of the final configuration and that normal dimensional variations are considered. A lack of "fit" or extreme awkwardness during the necessary loading and unloading process is cause for rejection. Loading and unloading times shall be recorded if such times are a specified design constraint. Not meeting specified loading or unloading times with the specified number of appropriately qualified personnel shall be cause for rejection.

5.2 Mechanical shock.

5.2.1 General. Containers shall be designed to protect the contents from damage resulting from exposure to applicable shock tests described herein. Tests shall be selected from 5.2.2 through 5.2.10, as applicable, or as specified by the design activity. Unless otherwise specified in the CIDS, shock tests shall be at the Level A severity. When the container's design requirements mandate that it be carried by hand, ergonomics shall be allowed to dictate the qualification test drop heights. Anthropometry data shall be used to determine these heights. The qualification drop height in these instances shall equal the average palm grip elevation above floor level minus distance from the container's handle elevation in the carrying position to the lowest position of the container's shell.

5.2.1.1 Acceptance criteria. The function of a container shall not be significantly impaired by the shock tests, except as specifically noted. Evidence of one or more of the following shall be cause for rejection:

a. Damage to the contents. Such damage may be established by either functional tests or other specific evidence of sensitivity to the test conditions.

b. Failure of the container's energy absorbing devices to protect the contents to the fragility level established as a design constraint by the contents designer.

NOTE: SRS analysis is the preferred method for analysis of shock data. IEST-RD-DTE012 is a good source for information on dynamic data acquisition and analysis. In the absence of specific frequency information, it is assumed that only those frequency components under 10 times the natural frequency of the shock isolation system are damaging. As such, prior to actual SRS analysis, all time history data shall be filtered at no less than 15 times the natural frequency of the isolation system with a linear phase filter. Improper filtering can result in corruption of data. The SRS analysis shall then be performed to 10 times the natural frequency of the isolation system's natural frequency. In those cases where SRS analysis is not required, time history data shall be filtered no less than 10 times the natural frequency with a linear phase filter. Unless otherwise specified in the CIDS, SRS analysis shall be performed using a damping factor of 0.05.

c. Failure of a water vapor or water-proof container to prevent water vapor transmission or water leakage within the specified limits given in 5.5.2.1.

d. Failure of the container to retain the contents.

e. Failure of the container to permit continued safe handling.

f. Loosening of restraining material or devices which may permit the contents to be damaged if further handling is experienced.

g. Permanent deformation of any portion of the container that affects its functional performance throughout the anticipated logistic cycle.

h. Evidence of the contents striking the container walls, unless it can be shown that such contact does not degrade performance of the item being packaged.

NOTE: Weld cracks in other than principal load paths, which do not result in rejection as stipulated above, and are repairable, will not be cause for rejection.

5.2.1.2 Test loads. Operable articles shall be used, wherever possible, during the container development and evaluation phase. These articles shall be completely representative of the container's intended contents with the exception that any explosive or HAZMAT is to be replaced by inert materials of equivalent mass properties. In the event that operable articles are not available, test loads, such as Dynamic/Dimensional Inert Missiles (DIMs) or Inert Operational Shapes (IOSs), may be used if the weapons developer agrees that it is a valid representative test shape. As a minimum, the test load's characteristics shall as closely as possible represent those of the object being simulated (within the tolerance envelope of the real operable article) as follows:

a. Envelope dimensions including external features, such as safing pins, antennas, and lanyards, which may have a bearing on the package design.

b. Mounting points or external hard zone area geometry and strength (i.e., bending and shear moment along the operable article's entire length, skin thicknesses representing soft zones, etc.).

c. Surface finishes which require special handling provisions.

d. Weight, CG, and radii of gyration in the three principal axes for the overall test load as well as for each section of the test load.

e. Internal joints and shock mounts identical to the operable article.

f. Identified stations where fragility readings are critical and allowable levels of fragility at those locations.

g. For operable articles which possess electronic systems, operable electronics within the shape that possess BIT features that are to be queried prior to and upon completion of testing.

h. At no time is a steel pipe a viable test shape.

5.2.1.3 Instrumentation. When required, the test load shall be suitably instrumented (minimum forward, CG, and aft locations) and data will be collected during testing to assure that established fragility levels are not exceeded. Unless otherwise specified in the CIDS, shock time histories (Gs vs. time) in the major directions shall be recorded on the test load at hard zones near the CG, hard zones near the extremities, or at zones where the fragility is clearly defined. The recorded shock histories shall then be reduced into shock spectra plots as a means of supplying additional information for evaluation of the isolation system. For uniquely configured or irregularly shaped items, and in cases where known fragility points have not been established, engineering judgment shall be used in selecting instrumentation locations.

5.2.1.4 Temperature combined with shock. Container designs using materials which may be affected by temperature variations shall be subjected to the shock tests of this section, except as noted, at the extreme temperatures which may be expected in service. Table II contains guidelines for expected temperature extremes. At the discretion of the design activity, a single container may be required to survive all shock tests at the required temperature extremes. In such cases, wherever possible, the impact points shall be at locations not previously impacted. When required by the design activity, ambient testing shall also be performed.

TABLE II. Expected temperature extremes.

Minimum extremes for all containers	**Typical extremes for ground troop usage**
-20±5 °F	-65±5 °F
+120±5 °F 1/	+160±5 °F

NOTE:
1/ For desert stowage, use +140±5 °F.

5.2.1.5 Drop surface requirements. The drop surface shall be a minimum of 3 inches thick, flat, smooth steel plate, level to within 2 degrees of horizontal, and shall possess a Brinell hardness of 200-311. The steel plate shall be uniformly supported throughout by a minimum thickness of 2 feet of reinforced 4000 PSI concrete or stronger. The steel plate shall be of sufficient area to ensure that a dropped test item(s), including rebound(s), will be retained within its surface area. The drop test facility shall be constructed such that no free water is retained on top of the steel plate. Any ice or debris shall be removed from the impact surface prior to testing. Various guidance systems that do not reduce the impact velocity may be employed to ensure the impact angles; however, any guidance system shall be eliminated at a sufficient height above the impact surface to allow unimpeded fall and rebound. It is recommended that the equipment is checked at regular intervals for any degradation in its ability to provide a consistent, repeatable impact surface relevant to the maximum weight and size of the test item(s). Existing drop test facilities consisting of concrete, faced with steel plate, with a foundation effectively 20 times the mass of the item being tested may be used for this test; however, construction of new facilities shall be in accordance with the requirements above to ensure standardization of test facilities.

5.2.2 Repetitive shock test. This test shall be conducted in accordance with Appendix F (ASTM D999, Method A1 or A2, as applicable, may be used as an acceptable alternative test method). If circular input motion is used, table frequency shall be adjusted to assure that one edge of the container leaves the table not less than $\frac{1}{16}$ inch on each cycle. This test is normally conducted at an ambient temperature. For containers possessing shock mounts, the temperature of the resilient mounts shall not be allowed to exceed the safe operating temperature of the elastomer. Army munition containers issued to ground troops shall be tested in accordance with MIL-STD-1904 or MIL-STD-810, Method 514, Category 5, Loose Cargo at the three temperatures (-65 °F, ambient, 160 °F) specified in 5.2.1.4.

5.2.2.1 Repetitive shock test (stacked). This test shall be conducted as specified in 5.2.2, except for the following:

a. The containers shall be tested in a stack of two, unless they have been designed to be shipped in a unit load configuration that exceeds two containers in height. In that instance, the stacked test shall be comprised of two unit loads stacked one atop the other.

b. The distance the upper container lifts from the lower container shall be measured.

c. If the containers to be tested are normally shipped rigidly joined together in a stacked configuration (for example, strapped or latched together), then the distance to be measured shall be taken between the lower container's base and input table.

5.2.3 Drop test (free-fall). This test shall be conducted in accordance with Appendix G; Procedure D shall be used for cylindrical containers and Procedure G shall be used for rectangular containers (when appropriate, ITOP 4-2-601 and ITOP 4-2-602 may be used as acceptable alternative test methods). Unless otherwise specified in the CIDS, Level A protection shall be used.

Army munition containers issued to ground troops shall include 3- and 7-foot free-fall drops tested in accordance with MIL-STD-1904 at the three temperatures (-65 °F, ambient, 160 °F) specified in 5.2.1.4. ASTM D5276 may be used as an alternative test method if specified in the CIDS. Drop heights from Appendix G may be used with this alternate test method, or at the option of the design agency, a more representative drop test height, which duplicates the maximum potential drop expected for a special shipping container during its normal service life, may be substituted in lieu of the value found in table G-I.

As a guideline for normal handling and transportation mishaps by non-U.S. Navy logistics of non-person portable containers for Level A protection, 15 inches is an acceptable height; for Level B protection, 12 inches is an acceptable height regardless of overall gross weight or dimensional size. For person portable containers, the anthropometry guidelines in 5.2.1 may be used to establish the drop heights.

5.2.4 Cornerwise-drop (rotational) test. This test shall be conducted in accordance with Appendix H. Unless otherwise specified in the CIDS, Level A protection shall be used. At the option of the design agency, a more representative drop test height, which duplicates the maximum potential drop expected for a special shipping container during its normal service life, may be substituted in lieu of the value found in table H-I. As a guideline, for normal handling and transportation mishaps by non-U.S. Navy logistics of non-person portable containers for Level A protection, 15 inches is an acceptable height; for Level B protection, 12 inches is an acceptable height regardless of overall gross weight or dimensional size. For non-U.S. Navy containers whose isolation systems restrict load shifting, when symmetry permits, these tests shall be conducted in accordance with figure 4 and table III to prevent generation of redundant data. Army munition containers issued to ground troops shall be tested in accordance with MIL-STD-1904 at the three temperatures (-65 °F, ambient, 160 °F) specified in 5.2.1.4.

5.2.5 Edgewise-drop (rotational) test. This test shall be conducted in accordance with Appendix I. Unless otherwise specified in the CIDS, Level A protection shall be used. At the option of the design agency, a more representative drop test height, which duplicates the maximum potential drop expected for a special shipping container during its normal service life, may be substituted in lieu of the value found in table I-I. As a guideline, for normal handling and transportation mishaps by non-U.S. Navy logistics of non-person portable containers for Level A protection, 15 inches is an acceptable height; for Level B protection, 12 inches is an acceptable height regardless of overall gross weight or dimensional size. For non-U.S. Navy containers whose isolation systems restrict load shifting, when symmetry permits, these tests shall be conducted in accordance with figure 4 and table III to prevent generation of redundant data. Army munition containers issued to ground troops shall be tested in accordance with MIL-STD-1904 at the three temperatures (-65 °F, ambient, 160 °F) specified in 5.2.1.4.

5.2.6 Impact test. Containers likely to be shipped by truck or railcar shall be subject to the following tests:

5.2.6.1 Truck transport. This test shall be conducted in accordance with either the procedures of Appendix L (incline-impact test), Appendix M (pendulum-impact test), or MIL-STD-810, Test Method 516.6, Procedure VII. Impact velocity shall be 5 feet/second. Containers restricted to transport by flatbed truck only shall be subject to impacts on both ends. Containers capable of being shipped by van trailers shall be subject to impacts on both ends and both sides. U.S. Navy containers intended to be transferred at sea shall be tested in accordance with table IV with impacts on all four sides at an impact velocity of 7 feet/second. For containers whose isolation systems restrict load shifting, when symmetry permits, these tests shall be conducted in accordance with figure 4 and table III to prevent generation of redundant data. Army munition containers issued to ground troops shall be tested in accordance with MIL-STD-1904 at the three temperatures (-65 °F, ambient, 160 °F) specified in 5.2.1.4. ASTM D880 may be used as an alternate test method if specified in the CIDS.

5.2.6.2 Rail transport. Containers over 9.5 feet long that are likely to be shipped by railcar shall be subject to one impact on each end at 11.88 feet/second in accordance with 49 CFR using specified securing materials or devices. Containers under 9.5 feet long shall be subject to one impact on each container end and one impact on each container side. The rail impact test shall be conducted in accordance with the requirements of the Association of American Railroads (AAR), Bureau of Explosives (BOE) as documented in TP-94-01, Test Method 1. ASTM D4003 may be used as an alternate test method if specified in the CIDS.

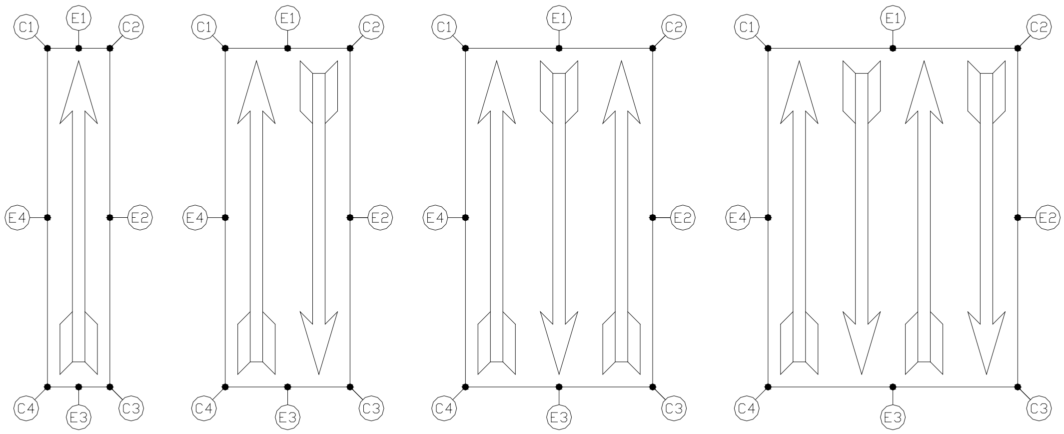


FIGURE 4. Samples of symmetrical packaging.

TABLE III. Mechanical shock input locations to containers.

Single pack					
Corner		Edge		Impact [1/]	
Hot	Cold	Hot	Cold	Hot	Cold
C1		E1	E1	E1	E1
	C2	E2		E2	
C3		E3	E3	E3	E3
	C4		E4		E4

Dual pack					
Corner		Edge		Impact	
Hot	Cold	Hot	Cold	Hot	Cold
C1		E1		E1	
C2		E2		E2	
	C3		E3		E3
	C4		E4		E4

Triple pack					
Corner		Edge		Impact	
Hot	Cold	Hot	Cold	Hot	Cold
C1		E1		E1	
	C2	E2		E2	
C3			E3		E3
	C4		E4		E4

Quad pack					
Corner		Edge		Impact	
Hot	Cold	Hot	Cold	Hot	Cold
C1		E1		E1	
C2		E2		E2	
	C3		E3		E3
	C4		E4		E4

NOTE:

[1/] For multi-packs that are all oriented in the same direction, use the single pack impact locations.

5.2.6.3 Impact test (stacked). Containers likely to be stacked and shipped by railcar or flatbed trailer shall be subject to this test. Procedures shall be identical to that of the impact tests of 5.2.6.1 and 5.2.6.2, except that containers shall be stacked in the normal shipping configuration in accordance with the truckload or railcar load drawing (typically two high) and only the bottom container shall be impacted. Dummy contents may be used. Evidence of failure of the connecting structures which would permit any of the containers to become unattached shall be cause for rejection.

5.2.7 Transfer-at-sea shock test. Containers and container unitized loads planned for transfer-at-sea shall be designed to withstand the shock test associated with the appropriate mode of transfer, as shown in table IV, at anticipated temperature extremes. Following the tests, the container shall continue to protect the contents and shall not be damaged in any way that would prevent its use and continued safe handling.

TABLE IV. Shock test for containers-at-sea.

Test	CONREP with STREAM	VERTREP [1/]	Dock side only
Impact velocity [2/]	7.0 feet/second	7.0 feet/second	5.0 feet/second
Flat bottom drop	18.0"	18.0"	18.0"

NOTES:
[1/] Impact velocity does not account for any sea state conditions.
[2/] Impact velocity testing shall be performed on ends and sides.

5.2.8 Tipover test. The tipover test shall be performed in accordance with Appendix J if the container and content weight and balance are such that the container will tip over when an edge or side is raised sufficiently for the base to form a 20-degree angle with the floor. At the option of the design activity, the rollover test (see Appendix K) may be substituted for this test. Army munition containers issued to ground troops shall be tested in accordance with MIL-STD-1904 at the three temperatures (-65 °F, ambient, 160 °F) specified in 5.2.1.4.

5.2.9 Shipboard shock test. When the loaded container is to be used aboard naval ships and contains an item which is required to survive the near-miss environment, the loaded container shall be designed to pass the shock tests of MIL-S-901. Items to be tested shall be classified as either Grade A or Grade B and Class I or Class II as stated in the LCEP.

NOTE: The container alone will not be “qualified” for shipboard use. Formal MIL-S-901 qualification shall be granted only for shipboard equipment and ordnance when stowed in the container and shock tested as a system. The test container shall be loaded with a live asset when possible. A weight simulator with a shape and mass distribution similar to the intended ordnance item or a DIM or IOS shape may be substituted with the approval of the NAVSEA Shipboard Shock TWH, NAVSEA 05P1.

5.2.9.1 Shipboard shock test (eligibility). When specified in the CIDS, the container in its shipping condition shall be subjected to a drop test (free-fall) on its base by raising it vertically from its normal storage position and then allowing it to fall freely onto a rigid surface from a height of 18 inches at ambient temperature. The purpose of this test is to collect shock data and structural integrity information. If the container’s contents are adequately protected from damage and the structural integrity of the container and contents are not compromised, then the container can be considered a viable candidate for possible success when being subjected to MIL-S-901 testing.

5.2.9.2 Pass-fail criteria. Pass-fail criteria is applicable to the payload and container system. Both parts of the system have to function or be safe to pass the criteria.

5.2.9.3 Grades of containers.

a. Grade A items shall withstand shock tests conducted in accordance with MIL-S-901 without unacceptable effect upon performance and without creating a hazard.

b. Grade B requirements include safety when there is an attempt to function (use the commodity for its intended purpose) a piece of ordnance either on or off the ship. Ordnance shall not endanger users if an attempt to function is performed post-shock anywhere in the field of operations. Damage to the container is permissible, provided it is possible to remove the contents without special tools and provided the container can be handled in a conventional manner. The loaded container shall be arranged and secured during shock tests in a similar manner to its intended arrangement and securement aboard ship.

5.2.9.4 Classes of containers.

a. Class I containers do not use shock isolation devices that allow the payload to impact in such a manner that there is a significant velocity change. Class I examples are hard foam, rubberized fiber, and minimal DIM layers.

b. Class II containers use shock isolation devices that allow payload deflection such that an impact can occur with a significant change in velocity. Examples of shock isolation devices used with Class II containers are resilient mounts, heli-coil mounts, shear mounts, and rubber mounts.

5.2.9.5 Class I containers (foam or rubberized fiber isolation systems). Mitigation of a shock event is achieved by the compressing isolation material, which reduces the velocity of the packaged item. As the isolation material compresses, it becomes nonlinearly harder and harder to compress. The isolation system shall be located between the packaged item and the container's walls. The container's contents shall not be imparted a sudden complex HI-shock, as long as the packaged item is not allowed to contact the container's walls.

5.2.9.5.1 Container testing. These types of containers may be able to be tested on the Medium Weight Shock Machine (MWSM), Lightweight Shock Machine (LWSM), or Floating Shock Platform (FSP), if within the MIL-S-901 guidelines.

5.2.9.5.2 Weight limitations. If eligible for MWSM testing, the maximum allowable weight on the MWSM is 7400 pounds. Standard fixturing for inclined testing effectively limits the maximum loaded container weight to 5000-5500 pounds depending on specific fixture design. The foam isolation system shall not have a deflection capability in excess of 3 inches in any direction.

5.2.9.5.3 Size limitations. Containers tested on the MWSM shall not exceed practical size limitations. Containers using the MWSM shall not use shock mitigation, which allows bottoming of the payload (such systems are considered MIL-S-901, Class II).

5.2.9.5.4 Testing orientations. Containers tested on the MWSM shall be subjected to testing in three distinct orientations. One (1) level and two (2) in different inclined orientations for a total of nine blows, as suggested by MIL-S-901 (see special requirements for inclined mounting) for items oriented in different directions aboard ship.

5.2.9.5.5 Method of securing the container to the MWSM. Whenever possible, the method of securing the container to the MWSM shall be the same as that used aboard ship. When using HI-shock chains in accordance with 804-5184187, the setup shall account for chain angle, length, and quantity. HI-shock chains shall be replaced after each blow. Another similar container or containers shall be placed on top of the test unit as a fixture.

5.2.9.5.6 Design criteria. If a new fixture needs to be designed, it shall be in accordance with MIL-S-901. Fixture frequency for the MWSM shall also be part of the design criteria based upon the ship class(es) on which the item will be stowed. If the size of the container precludes the use of shipboard securing methods on the MWSM, it is permissible to use a clamping bar arrangement with NAVSEA Shipboard Shock TWH, NAVSEA 05P1, concurrence.

5.2.9.5.7 FSP testing. If not eligible for LWSM or MWSM testing, the test item shall be subjected to a heavyweight shock test on the FSP.

5.2.9.5.8 Deck-stowed containers. Deck-stowed containers using shock mitigation, which does not allow bottoming, shall be tested on an FSP with a nominal 25-hertz deck simulating fixture (DSF) target frequency, unless otherwise directed by the NAVSEA Shipboard Shock TWH, NAVSEA 05P1.

5.2.9.5.9 Method of securing the container to the FSP. The method of securing the container to the FSP shall be the same as that used aboard ship. When using HI-shock chains, the setup shall account for chain angle, length, and quantity. HI-shock chains shall be replaced after each shot. Another similar container or containers shall be placed on top of the test unit as a fixture.

5.2.9.6 Class II containers (resilient mount isolation systems). Deck-stowed items using shock mitigation, which allows bottoming, shall be tested on an FSP with a nominal 12- to 16-hertz DSF target frequency, unless otherwise directed by the NAVSEA Shipboard Shock TWH, NAVSEA 05P1. The method of securing the container to the FSP shall be the same as that used aboard ship. When using HI-shock chains, the setup shall account for chain angle, length, and quantity. Another similar container or containers shall be placed on top of the test unit as a fixture.

5.2.9.6.1 Testing to HI-shock events. When tested to HI-shock events, resilient mount isolation systems might allow the container's contents, or cradle system holding the contents, to exceed the available sway space in the container. This could result in the packaged item, or cradle, contacting the inside walls of the container, producing a complex HI-shock event.

5.2.9.7 Chain tiedown assembly. Containers are secured to deck cargo holds using a HI-shock chain tiedown assembly or blocked using stanchions. These methods of securing do not attach containers rigidly to the ship decks like other isolated shipboard equipment (for example, computer consoles are bolted directly to the ship's deck). The chain tiedown assembly consists of a shock mitigator, steel forged connecting link, chain, and tensioner (over center latch-type with automatic lever lock, steel forged deck fitting, and a special forged hook keeper). The use of chain tiedown assemblies greatly reduces the energy transfer of the deck's natural frequency during a HI-shock event.

5.2.10 Safety drop test. Specialized containers, when specified by the design activity, shall be designed to survive a 40-foot drop test in accordance with MIL-STD-2105 and STANAG 4375 without the creation of unsafe conditions. The test shall be conducted by allowing a completely assembled container to fall onto a rigid surface (5.2.1.5). The container's impact surface shall be that which is the most critical with respect to safety. The container may be completely destroyed, but the contents shall not be ejected from the container, and shall be safe for subsequent handling for disposal. Army munition containers issued to ground troops shall be tested in accordance with MIL-STD-1904 at the three temperatures (-65 °F, ambient, 160 °F) specified in 5.2.1.4. When appropriate, ITOP 4-2-601 may be used as an alternate test method.

5.3 Vibration.

5.3.1 General. Containers which employ special energy-absorbing devices for shock isolation purposes, or which have sufficient structural flexibility with resonances below 50 hertz, shall be designed to satisfactorily survive exposure to the appropriate vibration test. The nature of the contents and the expected logistic pattern shall determine both the type of vibration testing to be utilized (e.g., random, sinusoidal, etc.) and the temperature of the container and contents. Test loads, as defined in 5.2.1.2, shall be used. The container and associated isolation system shall meet the requirements of 5.2 and the following:

a. For random vibration testing, clearly defined vibration fragility levels shall be provided by the developer of the packaged item being tested. Since random vibration test input levels are significantly different based on which logistics vibration environment is being tested, the allowable fragility level needs to consider the intended mode of transportation and corresponding test input levels. Peak fragility levels shall be defined in g^2/hertz breakpoints at defined frequencies. MIL-STD-810, Method 514 has numerous defined input profiles for environmental vibration exposures.

NOTE: IEST-RD-DTE012.2 is a good source for information on dynamic acquisition and analysis.

b. For sinusoidal testing, peak transmissibility and associated natural resonant frequency shall be clearly defined by the developer of the packaged item. In the event that this information is not available, the design goal of peak transmissibility across the isolation system in the major translational modes of vibration (as measured during the resonance search portion of the test of 5.3.2) is 5.0 if the resonant frequency is less than 15 hertz, 8.0 if the resonant frequency is between 15 and 25 hertz, and 10.0 from 25 to 50 hertz.

c. The isolation system's natural resonant frequency in the major translational modes of vibration shall be above 7.5 hertz.

d. For Navy containers employing elastomeric mounts, vibration testing (see 5.3) shall be interrupted when the external temperature of any elastomeric mount exceeds the manufacturer's recommended maximum temperature. In this case, testing may resume when the mount temperature has cooled to 90 °F or lower.

5.3.1.1 Acceptance criteria. The container and the isolation system shall continue to perform their functions following vibration tests. Evidence of any of the following shall be cause for rejection:

a. Damage to the contents. Such damage may be established by either functional tests or other specific evidence of sensitivity to the test conditions.

b. Permanent deformation of any portion of the container that affects its functional performance throughout the anticipated logistic cycle.

c. Structural failure of the isolation system.

d. Failure of the isolation system to meet random vibration fragility level or the transmissibility and resonant frequency requirements of 5.3.1.

e. Loosening of the restraining material or devices which may permit the contents to be damaged if further handling is experienced.

f. Evidence of the contents striking the container walls, unless it can be shown that such contact does not degrade performance of the item being packaged or the container.

g. Leakage in excess of the criteria given in 5.5.2.1, if the container is intended to be leak-proof.

h. Excessive rotation or shifting of the contents which could cause damage or prohibit removal of the contents by the intended means.

NOTE: Weld cracks in other than principal load paths, which do not result in rejection, as stipulated above, and are repairable, will not be cause for rejection.

5.3.2 Random vibration. Random vibration is a test that can be run in a test lab to better recreate the real world environment. All containers will be transported by some type of road conveyance (tractor trailer, stake truck, van trailer, etc.). Other modes of transportation could include aircraft, ship, rail, etc. MIL-STD-810, Method 514, provides many different input profiles for each of these transportation environments. All of these possible transportation environments need to be considered and accounted for in the life cycle logistics for the container. Rail and sea random vibration profiles are generally at a lower level than the truck transportation profiles and may not be required, provided the higher level truck transportation tests are performed. At a minimum, the Truck Transportation Over U.S. Highways Test of MIL-STD-810 (Method 514, Category 4) shall be required.

5.3.2.1 Truck transportation over U.S. highway. When specified in the CIDS, random vibration testing in accordance with MIL-STD-810 (Method 514, Category 4, Truck Transportation Over U.S. Highways) shall be conducted in the vertical direction using the vertical input profile. Exposure duration shall be 60 minutes per 1000 miles of road travel. Typically, a 3-hour test is run to represent a coast-to-coast Continental United Stated (CONUS) trip. Testing shall be conducted with appropriate axis vibration excitation applied in the transverse and longitudinal directions with the container in its normal shipping position. The test frequency range shall be 5 to 500 hertz. When the container is so small that it may be shipped in a transverse or a longitudinal direction, the longitudinal input profile shall be used in both of these container orientations. Army munition containers issued to ground troops shall be tested in accordance with MIL-STD-1904 at the three temperatures (-65 °F, ambient, 160 °F) specified in 5.2.1.4. The test shall be conducted on the same container used in and preferably prior to the mechanical shock tests of 5.2, utilized for the ground troop testing.

5.3.2.2 Mission/field transportation. When specified in the CIDS, random vibration testing in accordance with MIL-STD-810 (Method 514, Category 4, Mission/Field Transportation) shall be conducted. This testing may include both composite two-wheeled trailer and composite wheeled vehicle profiles. An LCEP study shall determine which profiles will be needed. Testing shall be conducted in the vertical direction using the vertical input profiles. Exposure duration shall be 32 minutes per 32 miles of travel (per axis) for the two-wheeled trailer and 40 minutes per 500 miles of travel (per axis) for the composite wheeled vehicle. Testing shall be conducted with appropriate axis vibration excitation applied in the transverse and longitudinal directions with the container in its normal shipping position. The test frequency range shall be 5 to 500 hertz. When the container is small enough that it can be shipped in a transverse or a longitudinal direction, the longitudinal input profile shall be used in both of these container orientations. Army munition containers issued to ground troops shall be tested in accordance with MIL-STD-1904 at the three temperatures (-65 °F, ambient, 160 °F) specified in 5.2.1.4. The test shall be conducted on the same container used in and preferably prior to the mechanical shock tests of 5.2, utilized for the ground troop testing.

5.3.2.3 Jet aircraft. When specified in the CIDS, random vibration testing in accordance with MIL-STD-810 (Method 514, Category 7, Aircraft-Jet) shall be conducted. To represent most jet aircraft (C-5, C-17, KC-10, C/KC-135, C-141, T-43), the general exposure profile shall be used, unless it is known that only one type of jet will be used. In that case, use only that profile. Test duration shall be 1 minute per takeoff. The number of takeoffs shall be determined from the LCEP. If the number of takeoffs is unknown, the test shall be 30 minutes. All three orthogonal axes shall be tested with the same aircraft input profile.

5.3.2.4 Propeller aircraft. When specified in the CIDS, random vibration testing in accordance with MIL-STD-810 (Method 514, Category 8, Aircraft-Propeller) shall be conducted. The primary propeller aircraft for military shipments is the C-130. The propeller aircraft profiles will differ based on the number of propeller blades of the aircraft. The more recent aircraft have more blades. A second factor is location of cargo placement in the fuselage. For container shipments, the fuselage aft of propeller exposure factor shall be used. Test duration shall be determined from the LCEP. In the absence of this information, the test shall be run for a duration of 1 hour in all three orthogonal axes. The same aircraft input profile may be used for all axes.

5.3.2.5 Shipboard. When specified in the CIDS, random vibration testing in accordance with MIL-STD-810 (Method 514, Category 21, Shipboard Random Vibration) shall be conducted. Since the truck transportation over U.S. highway levels are generally more severe than the random vibration ship levels, this test may not be required, although MIL-STD-810, Method 528 testing may be required if long-term storage on ships is required. Since this test is intended to represent a 30-year life cycle for equipment on a ship, some tailoring shall be required for the time duration at each frequency. Test time may be reduced in accordance with the LCEP of the container.

5.3.3 Sinusoidal testing. Sinusoidal testing is a laboratory test that can be used to determine the isolation system's balance, natural frequency, and damping characteristics. When the more representative random vibration testing is used, this test may not be required, but may be performed to verify design characteristics.

5.3.3.1 Resonance survey and dwell test. The container, in its normal position, shall be rigidly attached to a minimum of one vibration exciter. Suitable instrumentation shall be used to obtain transmissibility data at the points of interest. A search for resonance shall be conducted by applying sinusoidal vibration excitation in the vertical direction. Transmissibility data shall be obtained for the fundamental translational vibration mode over a frequency range of 5 to 50 hertz. Input vibration should follow a schedule level associated with the intended logistic cycle as defined by the design activity. Sweep rate shall be approximately ½ octave per minute. A dwell test of 30 minutes total duration (the test may be interrupted, if necessary, to prevent excessive temperature rise of resilient materials) shall be conducted at the predominant resonance for elastomeric and mechanical suspension systems (helical springs, torsion bars, and other types of mechanical suspensions). Dwell tests shall not be performed on plastic foam isolation systems. The input excitation for the dwell test shall be equal to that used during the sweep test at the indicated frequency. An adjustment in frequency may be necessary during the course of the test to compensate for shifts in resonant frequency due to temperature rise of the isolator(s). If the logistic environment is undefined, the input vibration for the search and dwell tests shall be 0.125-inch double amplitude or 1.0 g (0 to peak), whichever is the lesser value. When specified by the design activity, the test shall be repeated with vibration excitation applied in the transverse and longitudinal directions with the container in its normal shipping position. Unless otherwise specified in the CIDS, testing shall be at ambient temperature. The temperature of resilient materials shall not be allowed to exceed the safe operating temperature of the isolator as specified by the manufacturer.

5.3.4 Sinusoidal cycling test. When specified in the CIDS, a cycling vibration test shall be performed in accordance with Appendix N. If this test is specified in addition to the test of 5.3.3, the dwell test at resonance of Appendix N shall not be performed. Variations in frequencies and amplitude may be made by the design activity.

5.4 Structural integrity.

5.4.1 General. Containers with an integral barrier (non-breathing or controlled-breathing) shall be designed to withstand internal pressures or vacuum as specified in 5.4.2.1.

WARNING: Container may explode or fasteners may fail during this test! Use protective barriers and PPE to avoid injury to personnel and other equipment.

5.4.2 Pressure test. The container shall be prepared for test by sealing all breathing devices and inserting suitable pressurizing fittings and gages. However, if so desired, the breathing device(s) may be removed and replaced by the pressurizing fittings and gages through the breathing port. The container shall be closed and sealed as it would be in service. The test shall be conducted by raising or lowering the internal pressure so that the desired test pressure is obtained. The failure of latches, fasteners, or any part of the container structure in such a way that any unsafe condition could exist shall be cause for rejection. Permanent deformation of the container structure sufficient to prevent the safe removal of the contents or inability to stack containers shall also be cause for rejection. Leakage is not a consideration.

5.4.2.1 Test pressures (structural integrity). The test shall be accomplished after all other testing of the container (being qualified) is complete. The following are recommended test pressures for each style container. Based on known unique container lifetime logistics, the design agency may impose other pressure levels (higher or lower) to verify structural integrity.

a. Non-breathing containers. The test pressures shall be set as follows: 15.00±0.25 psig and -3.00±0.25 psig.

b. Controlled-breathing containers. The test pressures shall be set as follows: 1.50±0.25 psig above the required positive reseal pressure and 1.50±0.25 psig below the required vacuum reseal pressure; at a minimum, a test pressure of 3.00+0.50/-0.00 psig. For containers issued to ground troops, the positive and vacuum cracking pressure shall be 3.00+0.50/-0.00 psig and -3.00+0.00/-0.50 psig, respectively.

5.5 Leakage integrity.

5.5.1 General. Internal barrier containers shall be designed to prevent leakage from the inside of the container in excess of the pressure drop criteria indicated in 5.5.2.1. Leakage requirements apply before and after all testing, except the 40-foot safety drop test, unless specified by the design activity.

5.5.2 Leak test. The container shall be prepared for testing by sealing all breathing devices and inserting suitable pressurizing fittings and gages. However, if so desired, the breathing device(s) may be removed and replaced by the pressurizing fittings and gages through the breathing port. The container shall be closed and sealed by the same procedures used in service. The test shall be conducted by raising or lowering the internal pressure so that the desired test pressure is obtained. The pneumatic-pressure technique or vacuum retention test shall be used to detect leakage in accordance with Appendix O.

5.5.2.1 Test pressures. The test for leakage integrity shall be accomplished following each series of shock, vibration, and handling tests, or at the discretion of the design activity, shall be accomplished before the first test and upon completion of all testing, and shall adhere to the following criteria:

a. Non-breathing containers. The test pressures shall be set as follows: 3.50±0.50 psig and -3.00±0.25 psig. The continuous formation of bubbles or intrusion of fluid into the containers using either the immersion or soap solution test method shall be cause for rejection. For Army munition containers issued to ground troops, a flow rate which exceeds 0.3 cubic inches per minute shall be cause for rejection.

b. Controlled-breathing containers. The test pressure shall be set as follows: 1.00+0.25/-0.00 psig above the required positive reseal pressure and 1.00+0.00/-0.25 psig, below the required vacuum reseal pressure or a minimum 1.50+0.50/-0.00 psig. Plastic containers shall be tested with a minimum test pressure of 0.50+0.25/-0.00 psig. A drop in pressure magnitude in excess of 0.05 psig per hour, corrected for variations in air temperature and ambient pressure, shall be cause for rejection. For Army munition containers issued to ground troops, the positive and vacuum cracking pressure shall be 3.00+0.50/-0.00 psig and -3.00+0.00/-0.00 psig, respectively. A flow rate which exceeds 0.3 cubic inches per minute shall be cause for rejection.

5.6 Superimposed load.

5.6.1 General. Containers shall be designed to permit the stacking of like containers, or to support other lading, without structural failure of the stacking features or damage to the contents. Deformation sufficient to result in any unsafe stacking configuration or condition shall be cause for rejection.

5.6.2 Load test (like containers). Proof of adequate stacking strength shall be determined by testing in accordance with the procedure of Appendix D. If the principal support structure is a plastic or other nonmetallic material or material which may deteriorate when exposed to elevated temperatures or very humid conditions, the test shall be conducted at a temperature of 120±5 °F and 90 percent relative humidity for a period of 168 hours. ASTM D642 or ASTM D4577 may be used as alternate test methods if specified in the CIDS. When using the alternate ASTM tests, the period of test and applied loads shall be equal to or greater in value to those specified in Appendix D.

5.6.3 Load test (unlike containers). Containers required to support loading different than like containers shall be tested in accordance with Appendix E.

5.7 Hoisting fittings, closure fittings, and tiedown attachment points.

5.7.1 General. Containers shall be designed to permit handling by a set of hoisting fittings and shall be equipped, unless otherwise justified by logistic considerations with tiedown attachment points. If the container's design allows for it, the hoisting fittings may also be utilized as a provision for tiedown.

5.7.2 Acceptance criteria. Each tiedown attachment point, hoisting fitting, and set of hoisting fittings shall be identified and shall be capable of safely supporting the required test load. If the hoist ring location requires the closure fittings to carry a lifting load, the closure fittings shall be capable of safely supporting the required test load as outlined in 5.7.6. Evidence that a single hoisting fitting or the set of hoisting fittings, closure fittings, or tiedown attachments show the following conditions shall be cause for rejection.

a. Failure of any part of the hoisting, closure, or tiedown structure.

b. Permanent deformation (for example, necking) of any part of the structure, supporting or attachment point, which renders the container unsafe or unsuitable for continued handling.

c. Inadequate geometry of tiedown or hoisting fitting attachment point, or inability of hoisting fitting to properly interface with identified handling equipment in a safe manner.

(1) Inability of handling equipment hooks to interface with container.

(2) Inability of hooks to lift the container in a manner where there is no side loading imparted to the handling equipment hooks.

(3) Inability of lifting slings to interface with container while maintaining sling leg angles within allowable lift angle envelope.

d. Leak test failure.

5.7.3 Hoisting fittings strength test. The container shall be loaded to five times the gross weight of the container. If the container is to be assembled into a unitized load and if the hoisting fittings can be used to handle the unitized load, the total test load shall be equal to five times the gross weight of the unit load. A sling, lifting beam, or other device representing normal procedure shall be attached to the hoisting provisions and the container lifted until it is free of the support. It shall be allowed to hang for 5 minutes prior to examination for damage. Alternatively, the container may be suitably restrained and the hoisting loads applied to the container in a manner which simulates the conditions given above. Hoisting fittings on containers intended for external air transport beyond Navy VERTREP shall be tested in accordance with the requirements of MIL-STD-209 and MIL-STD-913 for full EAT/HSL certification. If any part of the hoisting provision or container structure is a plastic or nonmetallic material, the test duration shall be 1 hour each at -65±5 °F and +160±5 °F. The specimen shall be stabilized at the specified temperature for a minimum of 4 hours immediately prior to testing.

5.7.4 Single hoisting fitting strength test. Each hoisting provision on the container or unit load shall be individually tested by hoisting the loaded container or loaded unit load into the air and keeping it suspended for a period of 5 minutes. If any part of the hoisting structure is a plastic or nonmetallic material, the test duration shall be 1 hour each at -65±5 °F and +160±5 °F. The specimen shall be stabilized at the specified temperature for a minimum of 4 hours immediately prior to testing. As an alternate procedure, for single containers only, the container may be suitably restrained and the hoisting loads applied to the container in a manner which simulates the conditions given above.

5.7.5 Tiedown strength test. The tiedown strength test shall only be performed when placement of the tiedown fittings on the container is a minimum of 30 inches above its bottom edge. A load shall be applied to each tiedown provision in the same way that it would be applied in service. In the absence of clearly identified tiedown procedures, the load shall be applied at an angle of 45 degrees downward from the horizontal and simultaneously 45 degrees outboard from the container surface. The test load shall be equal to that which would be applied if the loaded container were subjected to the restraint loads contained in MIL-HDBK-1791. The load shall be applied in each of the directions which may reasonably result from shipment. The duration of the test shall be 5 minutes in each of the test directions. If any part of the tiedown provision or container structure is a plastic or nonmetallic material, the test duration shall be 1 hour each at -65±5 °F and +160±5 °F. The specimen shall be stabilized at the specified temperature for a minimum of 4 hours immediately prior to testing. For nuclear weapons containers, a test load shall be applied in accordance with the individual service regulations. The combined tiedown features shall restrain the container in the shipping orientation without loss of structural integrity when subjected to the following loads applied statically and independently: 3.0 g forward/aft, 1.5 g laterally, and 2.0 g downward. For four tiedowns on containers or unit loads under 108 inches long, each tiedown feature shall be separately loaded to 1.5 times the container weight forward, aft, and perpendicular (as containers can be shipped in any orientation) to the container. A single test with the appropriate vectored components may be substituted for the independent direction tests.

5.7.6 Closure fitting strength test. The container shall be prepared for the test by engaging all corner closure fittings and disengaging every other non-corner closure fitting. The engaged closure fittings shall then be overloaded to five times the required lifting load of the container closures. This can be accomplished by overloading the base of the container to five times the lifting load, attaching a sling, lifting beam, or other device representing normal procedure to the hoisting provisions, and lifting the container until it is free of the support. It shall be allowed to hang for 5 minutes prior to examination for damage. Alternatively, the container base may be suitably restrained and the hoisting loads applied to the container in a manner which simulates the conditions given above.

5.8 Forklift truck (fully captive fork tine enclosures) compatibility test. This test shall be conducted in accordance with the “lifting and transporting by forklift truck” portion of Appendix P. In addition, the “pushing” and “towing” portions of Appendix P shall be conducted on empty containers. When the container is more than 45 inches wide or more than 91 inches long, the pushing and towing tests shall be repeated with one end of the container lifted off the ground about 6 inches by the tips of the forks inserted between the skids. The strength of the container structure as well as the skids shall survive the tests without failure of any part or permanent deformation of any part which renders the container unsafe or unsuitable for continued handling. The handling provisions shall be convenient to use and shall create no unsafe condition or practice.

5.8.1 Forklift truck (non-captive lift) compatibility test. This test shall be conducted in accordance with the “lifting and transporting by forklift truck” portion of Appendix P, except that the first pass shall be conducted with the tines in the full back tilt position. The first pair of boards shall be nominal 2 inches by 4 inches, instead of the 1-inch boards required in the test. After the first pass is completed over the required 100-foot course, turn around maintaining the required speed, and proceed with a second pass in the opposite direction with fork tines in the level position. Containers with offset forklift openings shall be picked up from the opposite container side prior to completing the second pass over the course. In addition, the “pushing” and “towing” portions of Appendix P shall be conducted on empty containers. When the container is more than 45 inches wide or more than 91 inches long, the pushing and towing tests shall be repeated with one end of the container lifted off the ground about 6 inches by the tips of the forks inserted between the skids. The strength of the container structure as well as the skids shall survive the tests without failure or permanent deformation. The handling provisions shall be convenient to use and shall create no unsafe condition or practice.

5.9 Handlift truck MK 45 compatibility.

5.9.1 General. Containers and containers assembled into a unit load which are without 4-way fork tine entry, over 300 pounds, 3 feet long or longer, and to be used and stowed aboard U.S. naval ships shall have fittings which permit the handlift truck MK 45 to be used. The following tests define the required strength of the fittings and container structure.

5.9.2 Static overload. Each end lift fitting shall be loaded to three times the actual load (but not to exceed three times the handlift truck capacity) that it is required to support for a period of not less than 5 minutes. The supporting device may be either a handlift truck MK 45 or a test fixture which simulates the loading conditions. The container end lift fittings shall not show any permanent structural deformation. For containers stowed aboard ship, the test shall be run two times; once each in the level position and once at a 15-degree angle with one end elevated. The end lift fitting shall not show any permanent structural deformation.

5.9.3 Shock test. The container or containers assembled into a unit load, weighted to its maximum normal load, shall be supported on each end by a handlift truck MK 45, all MODs (or test fixture which simulates the loading conditions), and raised to a height of 3 inches above ground level. It shall then be moved longitudinally at a speed of not less than 2 feet per second up a 30-degree ramp to a height of 1 inch and then allowed to fall abruptly onto a rigid surface. The entire container shall be tested six times in this manner; three times with the forward end first, then three times with the aft end first. The end lift fittings shall not show any permanent structural deformation.

5.9.4 Rolling test. Move the container or containers assembled into a unit load, weighted to its maximum normal load, at a speed of not less than 4 feet per second on a dry, smooth level concrete surface or a surface on which the wheel of the end lift fitting test fixture will have a coefficient of sliding friction of 0.6. After 20 feet of movement, engage brakes of the trailing end lift fitting test fixture only. In addition, the test shall be repeated during both right- and left-hand sharp turns (approximately 45 degrees) with the brakes being abruptly applied during each turn. The container end lift fittings shall not show any permanent structural deformation.

5.10 Fire performance requirements. Ordnance containers to be stowed aboard naval ships shall meet the following fire performance requirements.

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

5.10.2 Smoke density test. The container shall have a smoke density of 200 or less when tested in accordance with ASTM E662.

5.10.3 Stacked container fire test. A minimum of two containers shall be placed in a stacked configuration (minimum height of 24 inches) under simulated environmental conditions (i.e., as they would be stowed aboard naval ships). The containers shall be placed on a stand, with a bottom corner of the lower container cantilevered off the stand as shown on figures 5 and 6. The test area shall be a simulated magazine, or similar confined space, to provide a draft-free environment with sufficient air available to furnish oxygen for combustion. A propane torch with a soldering tip with entrained air for the oxidizer and propane flow rate adjusted to result in a 2.5-inch flame shall be utilized as the ignition source. The torch shall be held in place, with the burner tip located such that the blue part of the flame is in contact with a bottom corner of the lower container in an orientation of 45 degrees from horizontal, for a 5-minute period at each location tested. The containers shall be acceptable for stowage and use aboard naval ships if sufficient flames are not generated by the lower containers to ignite upper containers; flames, if any, generated by the lower container self-extinguish after removal of the ignition source; and toxic fumes are not emitted from either the upper or lower container during application of the torch.

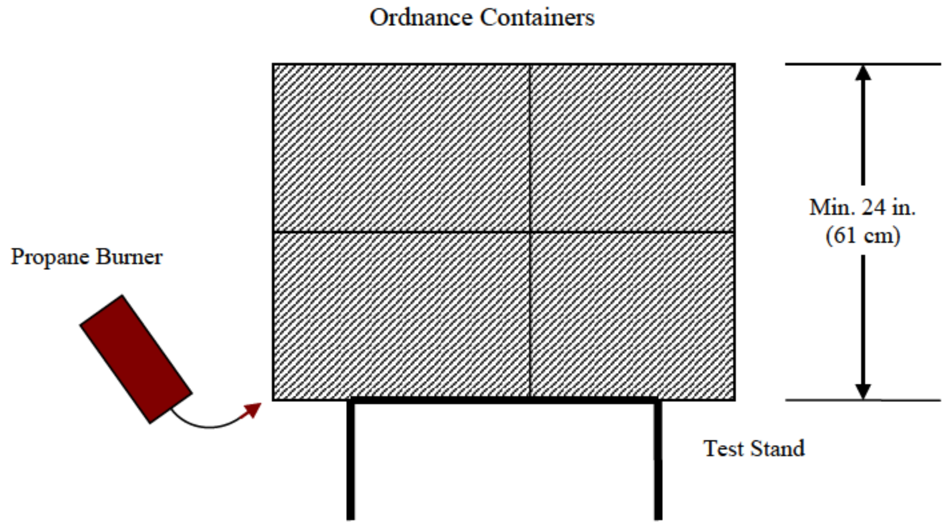


FIGURE 5. Front view of stacked container fire test setup.

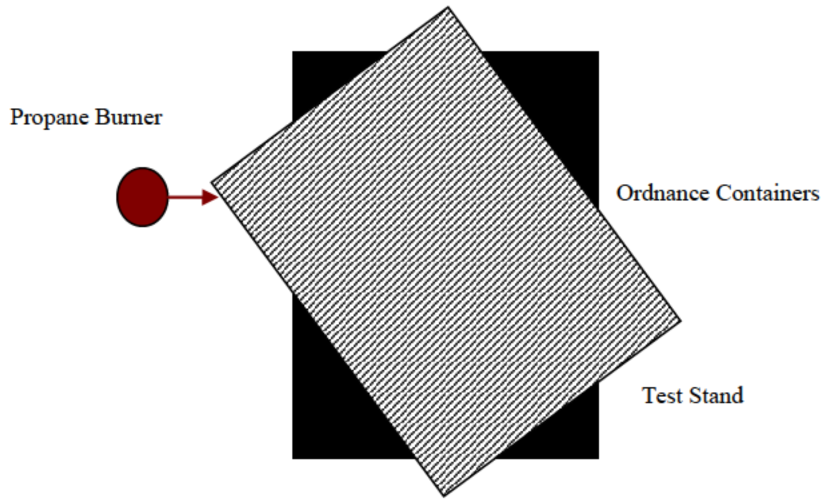


FIGURE 6. Plan view of stacked container fire test setup.

5.11 Measurement of magnetic fields. The container, with all the intended contents packed as ready for normal shipment, shall meet the requirements of 4.18.3. All shielded units shall be inspected to determine compliance with 4.18.3. A gauss meter capable of measuring a magnetic field strength of 0.002 gauss with an accuracy of ±5 percent shall be used. The shielded container shall not have a field strength exceeding 0.00525 gauss when measured 15 feet from the container. Containers meeting this requirement, but exceeding 0.002 gauss when measured 7 feet from the container, shall be labeled appropriately.

5.12 Insensitive munitions. For containers whose contents pose an insensitive munitions threat, and when intended handling logistics dictate, provisions shall be included, as required, to assist in the prevention of specific insensitive munitions threats in accordance with MIL-STD-2105 and the appropriate STANAGs as follows: STANAG 4240, STANAG 4241, STANAG 4382, STANAG 4396, STANAG 4496, and STANAG 4526.

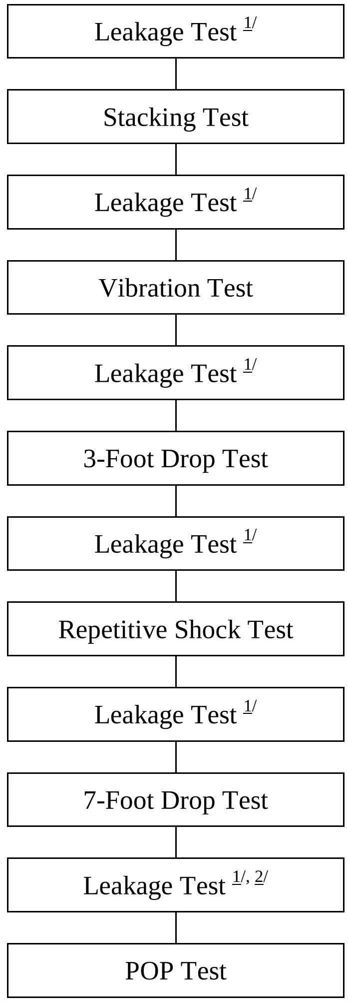
5.13 POP testing for HAZMAT. Containers (packagings) intended to transport a regulated HAZMAT shall undergo testing in accordance with either the non-bulk or large packaging standards of 49 CFR Part 178, Subparts M and Q, respectively, for both design qualification and periodic retesting. Repetitive shock, stacking, top lift, and bottom lift testing as outlined in 5.2.2, 5.6.2, 5.7.3, and 5.8, respectively, meeting the requirements called out in Subpart M or Q, need not be repeated. Modification of container design shall be reviewed in accordance with 49 CFR Part 178 requirements to determine if the modifications warrant retesting.

5.14 Certificate of equivalency (COE). Containers (packagings) intended to transport a regulated HAZMAT, but which do not meet the requirements of 49 CFR Parts 100-180 based on either content characteristics (volume, weight, forbidden, etc.) or packaging specifications (capacity, material of construction, etc.), shall be of equal or greater strength and efficiency as certified by the DoD in accordance with the procedures prescribed by DLAR 4145.41/AR 700-143/NAVSUPINST 4030.55/AFM 24-210/MCO 4030.40. A COE will be issued by the DoD to reflect such certification.

5.15 Testing sequences.

5.15.1 Army containers. The sequence of testing shall be as shown on figures 7 and 8. These tests are normally conducted at each of the following three temperatures: -65 °F (low), ambient, and +160 °F (high).

5.15.2 Air Force containers. The sequence of testing shall be as shown on figures 9 and 10. These tests are normally conducted at each of the following three temperatures: -40 °F (low), 72±20 °F (ambient), and 140 °F (high).



NOTES:

1/ Unless otherwise specified in the CIDS, leakage retention tests shall be conducted at ambient temperature.

2/ Leakage test shall be conducted for information only.

FIGURE 7. Army test sequence for containers under 150 pounds and issued to ground troops.

Leakage Test [1/]

Stacking Test

Leakage Test [1/]

Vibration Test

Leakage Test [1/]

Repetitive Shock Test

Leakage Test [1/]

Edgewise-Drop Test

Cornerwise-Drop Test

Leakage Test [1/]

Tipover Test

Leakage Test [1/]

Impact Test

Leakage Test [1/]

Hoisting Test [1/]

Leakage Test [1/]

Tiedown Test [1/]

Leakage Test [1/]

Forklift Test

POP Test

NOTE:

[1/] Unless otherwise specified in the CIDS, tests shall be conducted at ambient temperature only.

FIGURE 8. Army test sequence for containers 150 pounds or more and issued to ground troops.

Initial Leakage Test [1/]

↓

Weight Test

↓

Stacking Test

↓

Freefall Drops Test

↓

Leakage Test [1/, 2/]

↓

Resonance Dwell Test

↓

Repetitive Shock Test

↓

Leakage Test [1/, 2/]

↓

Handle Pull Test

↓

Final Leakage Test [1/]

↓

Pressure Test

↓

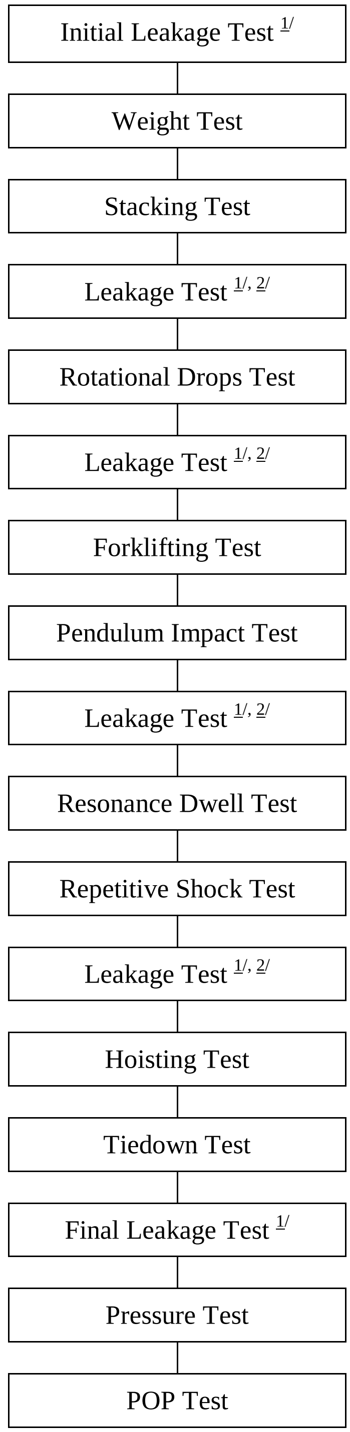
POP Test

NOTES:

1/ Unless otherwise specified in the CIDS, leakage retention tests shall be conducted at ambient temperature.

2/ Leakage test shall be conducted for information only.

FIGURE 9. Air Force test sequence for containers under 150 pounds.



NOTES:

1/ Unless otherwise specified in the CIDS, leakage retention tests shall be conducted at ambient temperature.

2/ Leakage test shall be conducted for information only.

FIGURE 10. Air Force test sequence for containers 150 pounds or more.

5.15.3 Navy containers. Although no sequence is required, leakage integrity (see 5.5) shall be verified before and after mechanical shock (see 5.2) and before and after vibration (see 5.3). A final verification of leakage integrity shall be conducted at the conclusion of all testing. The same container shell shall be used for all testing with the exception of MIL-S-901 shipboard shock testing, shipboard suitability testing, and any required insensitive munitions (IM) testing.

6. NOTES

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

6.1 Intended use. This standard is intended to be used as a guide in preparing a development specification, or equivalent, to establish the interface constraints and performance requirements of shipping containers for specific items of equipment. It is not intended that all of the requirements or tests contained herein will be invoked in any particular case. Instead, the development specification should contain only appropriate requirements from this document, along with any other requirements which may be dictated by unique operational, logistic, international shipment, or safety considerations. Packaging requirements defined by this standard are intended to determine the suitability of packaging encountered in military-unique environments. Subsequently, defined test methods are used to simulate the high levels of shock and vibration at extreme temperatures that may be encountered in war-fighting environments.

6.2 Acquisition requirements. Acquisition documents should specify the following:

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

b. For HAZMAT containers, that the most current 49 CFR applies at the time of manufacture.

6.3 Subject term (key word) listing.

CONREP

UNREP

VERTREP

6.4 International standardization agreement implementation. This standard implements STANAG 2828, Military Pallets, Packages and Containers; STANAG 2829, Material Handling Equipment; STANAG 4240, Liquid Fuel/External Fire, Munition Test Procedures; STANAG 4241, Bullet Impact, Munition Test Procedures; STANAG 4375, Safety Drop, Munition Test Procedures; STANAG 4382, Slow Heating, Munitions Test Procedures; STANAG 4396, Sympathetic Reaction, Munition Test Procedures; STANAG 4496, Fragment Impact, Munitions Test Procedure; and STANAG 4526, Shaped Charge Jet, Munitions Test Procedure. 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 https://assist.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.

CONTAINER REQUIREMENTS CHECKLIST

A.1 SCOPE

A.1.1 Scope. This appendix is a compilation of questions to aid the specification author in preparing a detailed container requirements document. This appendix is not a mandatory part of the standard. The information contained herein is intended for guidance only.

1. How many rounds/items are required to be packaged per container? unknown ☐
2. Will container always be shipped fully loaded? yes ☐ no ☐ unknown ☐
   a. If no, then what are the alternate (partial) shipping loads?
3. How many rounds/items will be manufactured per year? unknown ☐
4. Is there a manufacturing schedule? yes ☐ no ☐ unknown ☐
   a. If there is a manufacturing schedule, what is that schedule?
5. What warranty considerations does the manufacturer require for packaging? (Example: Will the warranty be void if units, returned for service or maintenance, are not shipped in original packages?)
6. Where can items be secured/gripped/touched? unknown ☐
7. Is there a handling interface drawing locating hard point zones? yes ☐ no ☐ unknown ☐
   a. If yes, what is the drawing number:
8. If known, what is the allowable handling pressure in the hard point zones? psi unknown ☐
9. Does the handling interface drawing show handling areas for restraint in all directions other than at the removal locations? yes ☐ no ☐ unknown ☐
10. Can rounds/items be placed vertically in the container? yes ☐ no ☐ unknown ☐
11. Must the rounds/items be placed horizontally in the container? yes ☐ no ☐ unknown ☐
12. How fragile is the item? unknown ☐
13. If known, how does the item manufacturer define the item's fragility? (Example: G's/ms, shock response spectrum)
    a. Are there different levels of fragility along varying axes? yes ☐ no ☐ unknown ☐
       (1) If yes, what are they?
14. Was the bare (unpackaged) item tested to any shock (drops) or vibration tests? yes ☐ no ☐ unknown ☐
    a. If yes, supply any known information.
15. Is a Weapon Specification available for the item? yes ☐ no ☐ unknown ☐
    a. If no, will one be developed? yes ☐ no ☐ unknown ☐
16. Will the item be shipped by:
    a. Rail? yes ☐ no ☐ unknown ☐
    b. Flatbed truck? yes ☐ no ☐ unknown ☐
    c. Closed van? yes ☐ no ☐ unknown ☐

NOTE: Special consideration should be given to container length, so containers can be shipped and loaded perpendicular in closed vans, depending on the trailer inside width, which ranges from 92 to 95 inches, or for new larger trailers, which range from 98 to 101 inches.

    d. Commercial air? yes ☐ no ☐ unknown ☐
    e. Military air? yes ☐ no ☐ unknown ☐
    f. ISO containers? yes ☐ no ☐ unknown ☐
    g. On base only? yes ☐ no ☐ unknown ☐
17. Is there a requirement to ship a specific number of containers per shipment? yes ☐ no ☐ unknown ☐

a. If yes, what is the requirement and why?

18. What type of ship or amphibious vehicle will the item go on? unknown ☐

19. Will the containers be stored aboard ship? yes ☐ no ☐ unknown ☐

20. What is the mission load allowance? unknown ☐

21. Will the container be UNREPed? yes ☐ no ☐ unknown ☐

a. VERTREPed? yes ☐ no ☐ unknown ☐

b. CONREPed? yes ☐ no ☐ unknown ☐

c. Is a FIUL required? yes ☐ no ☐ unknown ☐

22. What are the tiedown requirements? unknown ☐

23. Are stacking features required? yes ☐ no ☐ unknown ☐

a. If yes, how high a stack is required?

24. Are interlocking features for unitization required? yes ☐ no ☐ unknown ☐

25. Must the construction of a FIUL be strapless? yes ☐ no ☐ unknown ☐

26. Will container be handled by:

a. One person? yes ☐ no ☐ unknown ☐

b. If more than one person, how many?

c. Lifted only? yes ☐ no ☐ unknown ☐

d. Is a person required to carry the loaded container? yes ☐ no ☐ unknown ☐

(1) If yes, what distance? (feet)

(2) Frequency of carrying over the specified distance?

27. Are full pallet loads of the item usually shipped? yes ☐ no ☐ unknown ☐

28. If normally transported as a pallet load, will the individual containers be carried by hand for long distances? yes ☐ no ☐ unknown ☐

29. Is fork truck handling required? yes ☐ no ☐ unknown ☐

a. From sides? yes ☐ no ☐ unknown ☐

b. From ends? yes ☐ no ☐ unknown ☐

c. From sides and ends? yes ☐ no ☐ unknown ☐

d. Maximum expected fork truck capacity? (Ks) unknown ☐

30. Is hand lift truck handling required? yes ☐ no ☐ unknown ☐

a. From sides? yes ☐ no ☐ unknown ☐

b. From ends? yes ☐ no ☐ unknown ☐

c. From sides and ends? yes ☐ no ☐ unknown ☐

d. Maximum expected hand lift truck capacity? (Ks) unknown ☐

31. Is the MK45 end lift truck handling required? yes ☐ or no ☐

32. Is overhead hoisting required? yes ☐ no ☐ unknown ☐

a. External to magazines? yes ☐ no ☐ unknown ☐

b. Internal to magazines? yes ☐ no ☐ unknown ☐

(1) If yes, is it required at the center of balance? yes ☐ no ☐ unknown ☐

33. Other OHE requirements:

a. Marine Rough Terrain Trailer (AM32K-4A): yes ☐ no ☐ unknown ☐

b. AERO 21: yes ☐ no ☐ unknown ☐

c. MHU-191/M Munitions Transporter: yes ☐ no ☐ unknown ☐

d. Are other OHE interfaces required? yes ☐ no ☐ unknown ☐

(1) If yes, what are they?

{brake holding capability: AERO 21 - 4K, MHU-191/E - 5K [AERO 21's can be upgraded to MHU-191/E's with existing upgrade kit]}

34. Are there any special requirements for removing the item from its container? yes ☐ no ☐ unknown ☐

a. If yes, what are they?

35. Do you have to load a weapon system directly from the container? yes ☐ no ☐ unknown ☐

a. Top loading? yes ☐ no ☐ supply any additional known information

b. Side loading? yes ☐ no ☐ supply any additional known information

c. End loading? yes ☐ no ☐ supply any additional known information

d. While still in a palletized configuration? yes ☐ or no ☐

(1) If yes, define the load interfaces.

36. Is there a time restriction to can or de-can the weapon from its container? yes ☐ no ☐ unknown ☐

a. If yes, what is it? minutes

37. Environmental protection:

a. Can the item go on a pallet or skid? yes ☐ no ☐ unknown ☐

b. Is protection from condensation needed? yes ☐ no ☐ unknown ☐

(1) If yes, describe desired level of protection.

c. Is protection from dust needed? yes ☐ no ☐ unknown ☐

(1) If yes, describe desired level of protection.

d. Is protection from hail needed? yes ☐ no ☐ unknown ☐

(1) If yes, describe desired level of protection.

e. Is protection from humidity needed? yes ☐ no ☐ unknown ☐

(1) If yes, describe desired level of protection.

f. Is protection from rain needed? yes ☐ no ☐ unknown ☐

(1) If yes, describe desired level of protection.

g. Is protection from salt fog needed? yes ☐ no ☐ unknown ☐

(1) If yes, describe desired level of protection.

h. Is protection from salt water needed? yes ☐ no ☐ unknown ☐

(1) If yes, describe desired level of protection.

i. Is protection from temperature extremes needed? yes ☐ no ☐ unknown ☐

(1) If yes what is the high limit? (°F)

(2) If yes what is the low limit? (°F)

j. Is protection from ultra-violet needed? yes ☐ no ☐ unknown ☐

(1) If yes, describe desired level of protection.

k. Is protection from wind needed? yes ☐ no ☐ unknown ☐

(1) If yes, describe desired level of protection.

38. Does the container need to provide any special Insensitive Munitions protection, in accordance with NAVSEAINST 8020.05? yes ☐ no ☐ unknown ☐

a. If yes, what is the requirement?

39. Is there a copy of the weapon threat hazard assessment? yes ☐ no ☐ unknown ☐

a. If no, will one be developed? yes ☐ or no ☐

(1) If yes, when will it be available?

(2) If no, why?

40. Are there any Electrostatic Discharge (ESD) protection requirements? yes ☐ no ☐ unknown ☐

a. If yes, what are they?

b. Is grounding to container shell allowable to accomplish ESD protection? yes ☐ no ☐ unknown ☐

(1) If no, how is ESD protection to be accomplished?

(2) If yes, what should the resistance of the grounding device be?

(3) If yes, what feature on the item should the grounding device be connected to?

c. What feature on commodity to be packaged will the grounding device be connected to?

41. Is protection from magnetism needed? yes ☐ no ☐ unknown ☐

a. If yes, define the requirement.

42. What are the known dimensional restrictions for container movement thorough out the logistics of movement?

a. Conveyors? L×W (feet)

b. Doors? L×W (feet)

c. Elevators? L×W (feet)

d. Hatches? L×W (feet)

e. Ladders? L×W (feet)

f. Passageways? L×W (feet)

g. Other? L×W (feet)

43. What is the maximum allowable container envelope? L×W×H (feet)

a. What is the cause of this restriction?

44. Does the container have to be collapsible when empty? yes ☐ no ☐ unknown ☐

a. If yes, is there a known collapsed height? yes ☐ no ☐ unknown ☐

b. If yes, what is that height?

45. Will the container always be stored in a shelter? yes ☐ no ☐ unknown ☐

a. If the container will be stored external to a shelter, what are the known environmental conditions?

b. If the container will be stored external to a shelter, is any unique camouflage required? yes ☐ no ☐ unknown ☐

c. If the container will be stored external to a shelter, is CARC paint required? yes ☐ no ☐ unknown ☐

46. Are hazardous materials (HAZMAT) being shipped? yes ☐ no ☐ unknown ☐

a. If yes, what are they?

(1) Will a leak detector be required that can sense leakage of the packaged commodity's HAZMAT? yes ☐ no ☐ unknown ☐

b. If yes, what are the Hazard Class and UN Number?

47. Are lithium batteries contained in the commodity to be packaged? yes ☐ no ☐ unknown ☐

48. Is the container intended to be reusable? yes ☐ no ☐ unknown ☐

a. If yes, how many use cycles are anticipated?

b. If yes, where will containers be repaired?

49. What is the life expectancy of the container?

a. If 'other', specify duration.

50. Are any special markings needed on the package? yes ☐ no ☐ unknown ☐
    a. If yes, what are they?
51. Are there any logbooks or records to be shipped with the item? yes ☐ no ☐ unknown ☐
    a. If yes:
        (1) What is their size? L×W×H (inches)
        (2) Are they rigid or flexible?
        (3) Environmental needs to protect them? yes ☐ no ☐ unknown ☐
            (a) Must they be accessible without opening the container? yes ☐ no ☐unknown ☐
52. Does the container require a security seal? yes ☐ no ☐ unknown ☐
53. Does the container require a tamper evident seal? yes ☐ no ☐ unknown ☐
54. Are view ports required for the container? yes ☐ no ☐ unknown ☐
    a. What are the view ports for?
    b. If something is different, what is it?
55. Do you have to calibrate or reprogram the item while it is inside the container? yes ☐ no ☐ unknown ☐
    a. If yes, what size access port is required?
56. Are wings, canards, control surfaces, or other removable parts required to be shipped within the container? yes ☐ no ☐ unknown ☐
    a. If yes, what are they?
57. Are there any special tests or requirements, such as:
    a. Bullet fragmentation? yes ☐ no ☐ unknown ☐
    b. Fast cook-off? yes ☐ no ☐ unknown ☐
    c. HERO? yes ☐ no ☐ unknown ☐
    d. HI-shock (Grade A or B)? yes ☐ no ☐ unknown ☐
        (1) If yes, what is the input?
    e. IM? yes ☐ no ☐ unknown ☐
    f. Nuclear hardness? yes ☐ no ☐ unknown ☐
    g. POP? yes ☐ no ☐ unknown ☐
    h. Random vibration? yes ☐ no ☐ unknown ☐
    i. Slow cook-off? yes ☐ no ☐ unknown ☐
58. What type of shape or round will be used during testing?
59. Is the shape dynamically representative of the actual item? yes ☐ no ☐ unknown ☐
    a. If no, what are the differences?
60. Do the item's drawings adequately define the shape and mass properties? yes ☐ no ☐ unknown ☐
    a. If no, what are the differences?
    b. Is there more than one configuration of the item to be packaged? yes ☐ no ☐ unknown ☐
        (1) If yes, describe all known variants.
61. Where will the shape be instrumented during testing? (missile station or specific location(s) on the shape)
62. Have the Joint Integrated Logistic Working Group's (JILWG) Joint Modular Intermodal Container (JMIC) container dimensions that allow for transportation throughout the Joint Ordnance Logistic Cycle been considered as a candidate for use? yes ☐ no ☐
    a. Note: If early in a weapons program, alerting the program office of the dimensions could influence weapon design and size.

b. Note: The basic dimensions of the JMIC are 44 inches wide by 54 inches long by 46 inches high with a capacity of 3000 pounds.

63. Does the container have to serve any other function? (For example: a butter-dish style serving as a work stand for the packaged item when the cover is removed)

64. Is there a not-to-exceed cost requirement for the container? yes ☐ no ☐ unknown ☐

a. If yes, what is it?

65. Does the container require any Unique Identification (UID)? yes ☐ no ☐ unknown ☐

a. If yes, what is it?

66. Does the container require any Radio Frequency Identification (RFID)? yes ☐ no ☐ unknown ☐

a. If yes, what system is required?

DRAWINGS OF COMMON STANDARD PARTS FOR NAVY CONTAINERS

B.1 SCOPE

B.1.1 Scope. This appendix is a compilation of drawings of common standard parts for Navy containers. This appendix is not a mandatory part of the standard. The information contained herein is intended for guidance only.

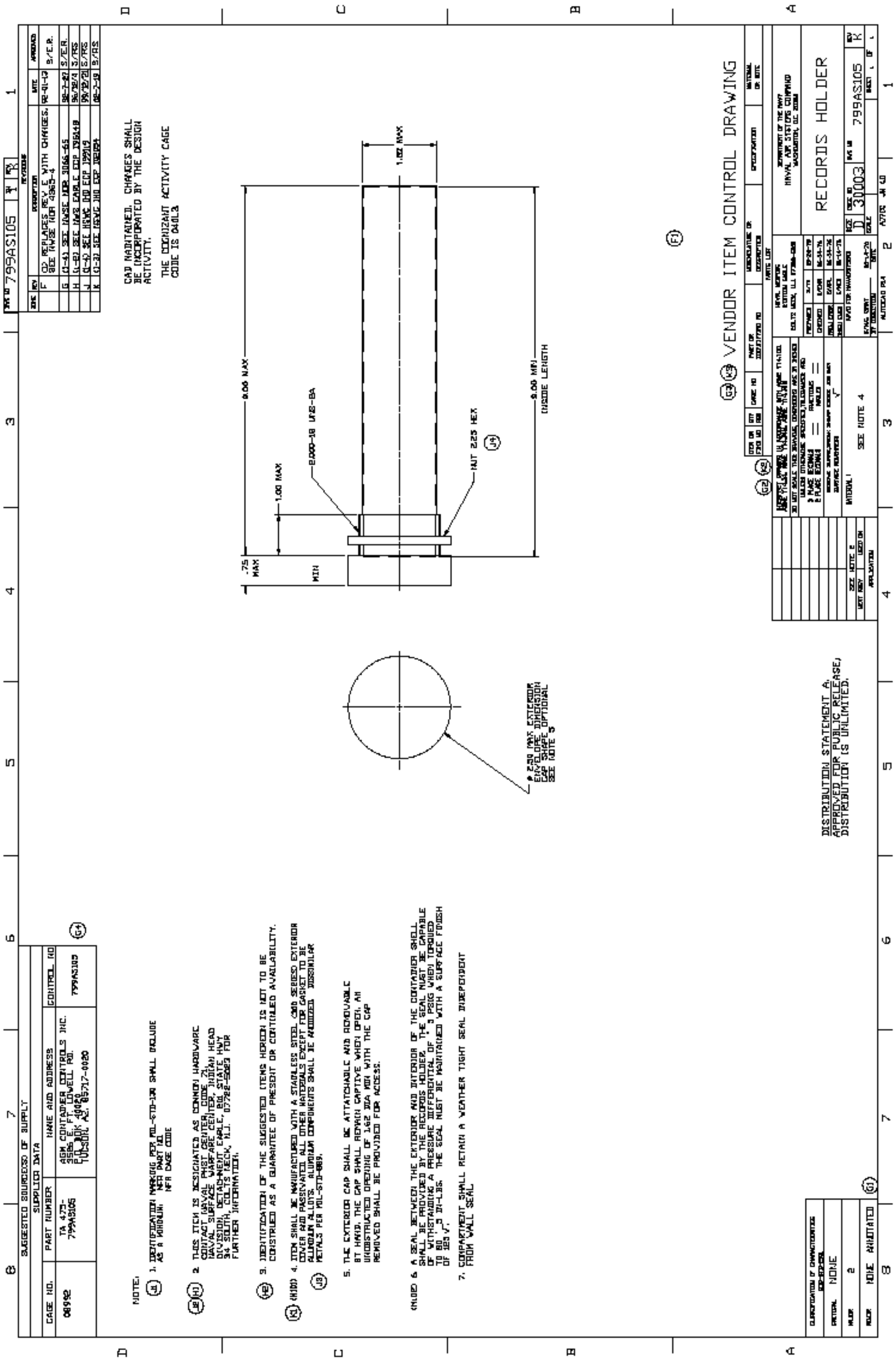


FIGURE B-1. Records holder (Drawing 799AS105).

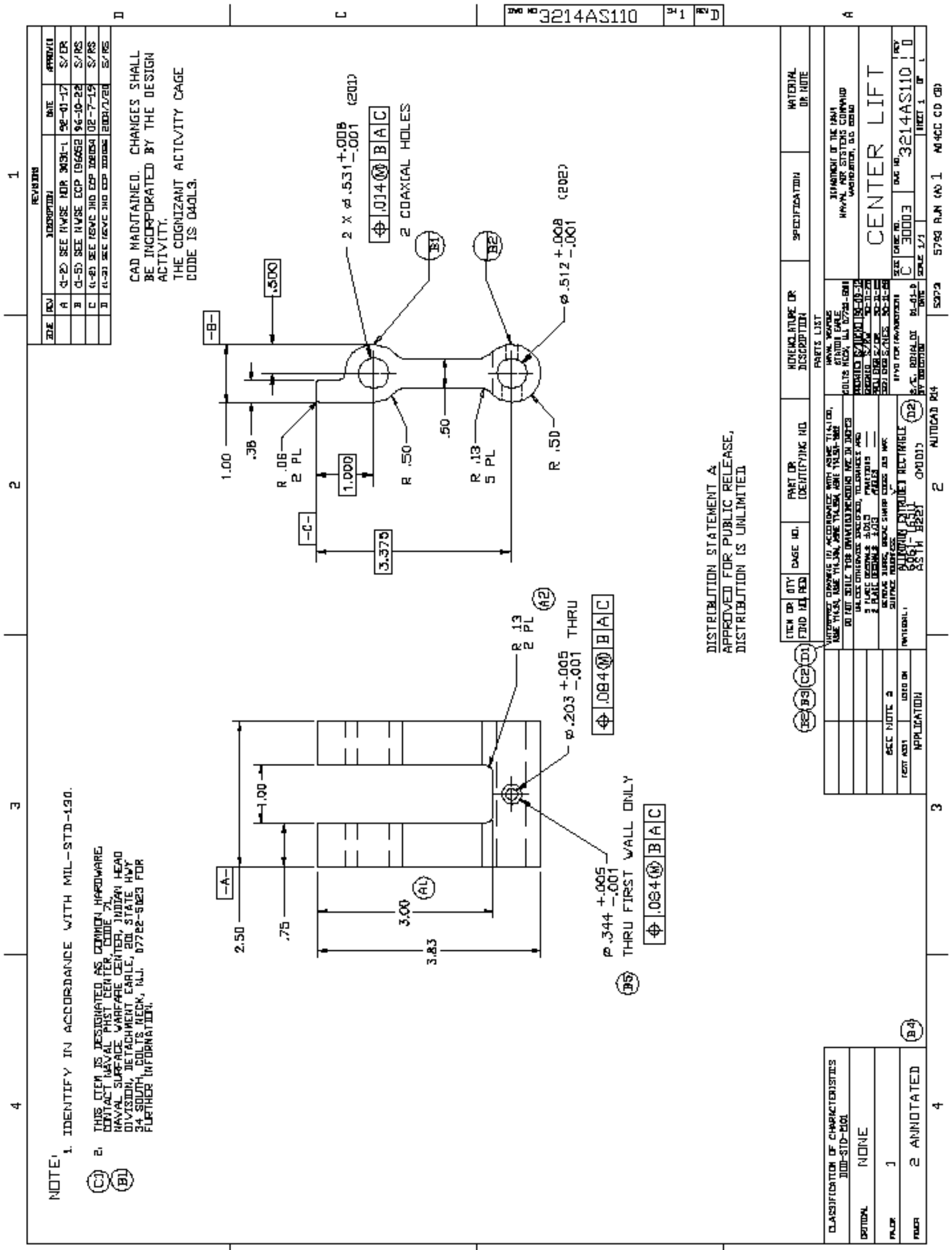


FIGURE B-2. Center lift (Drawing 3214AS110).

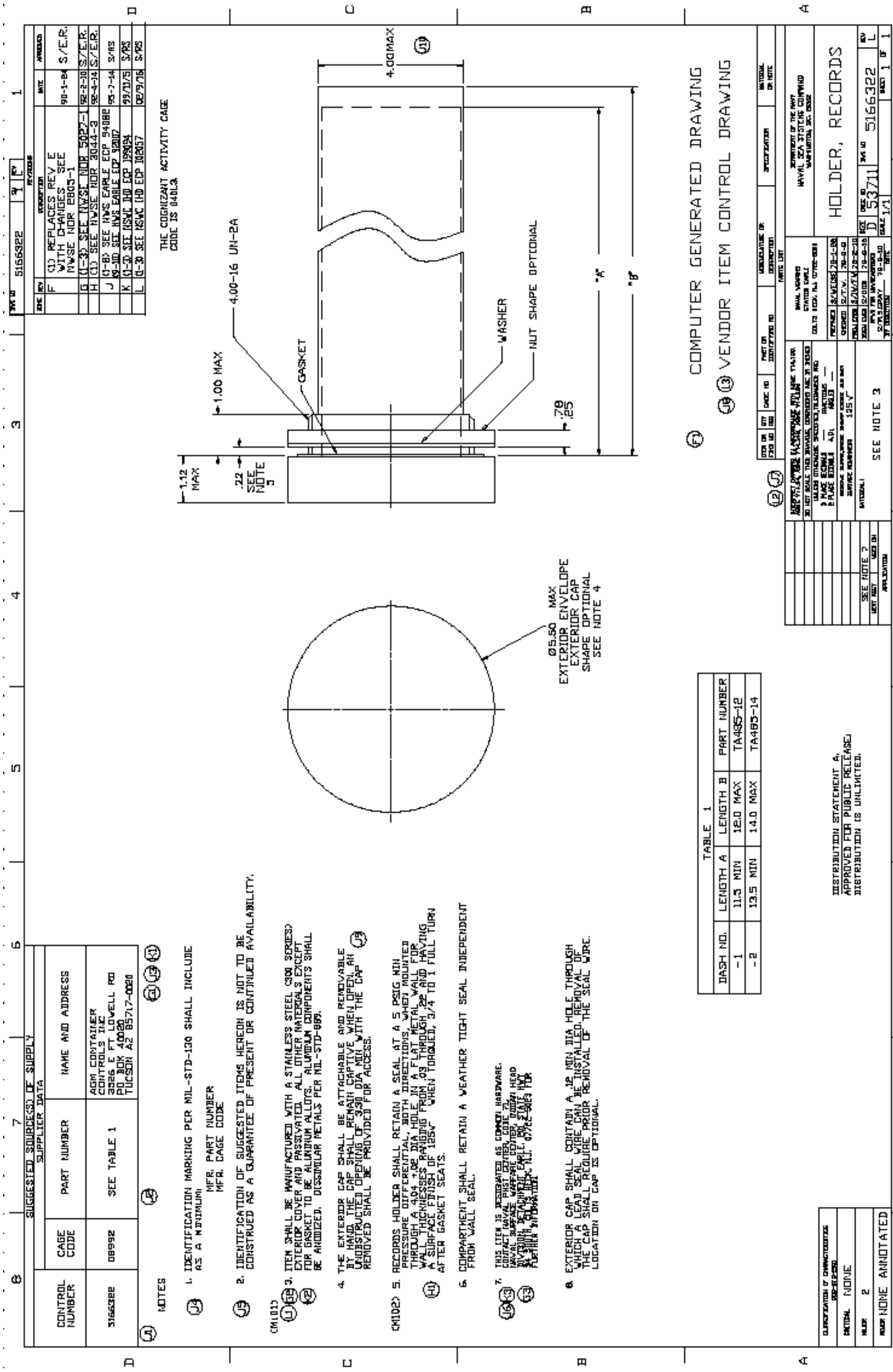


FIGURE B-3. Holder, records (Drawing 5166322).

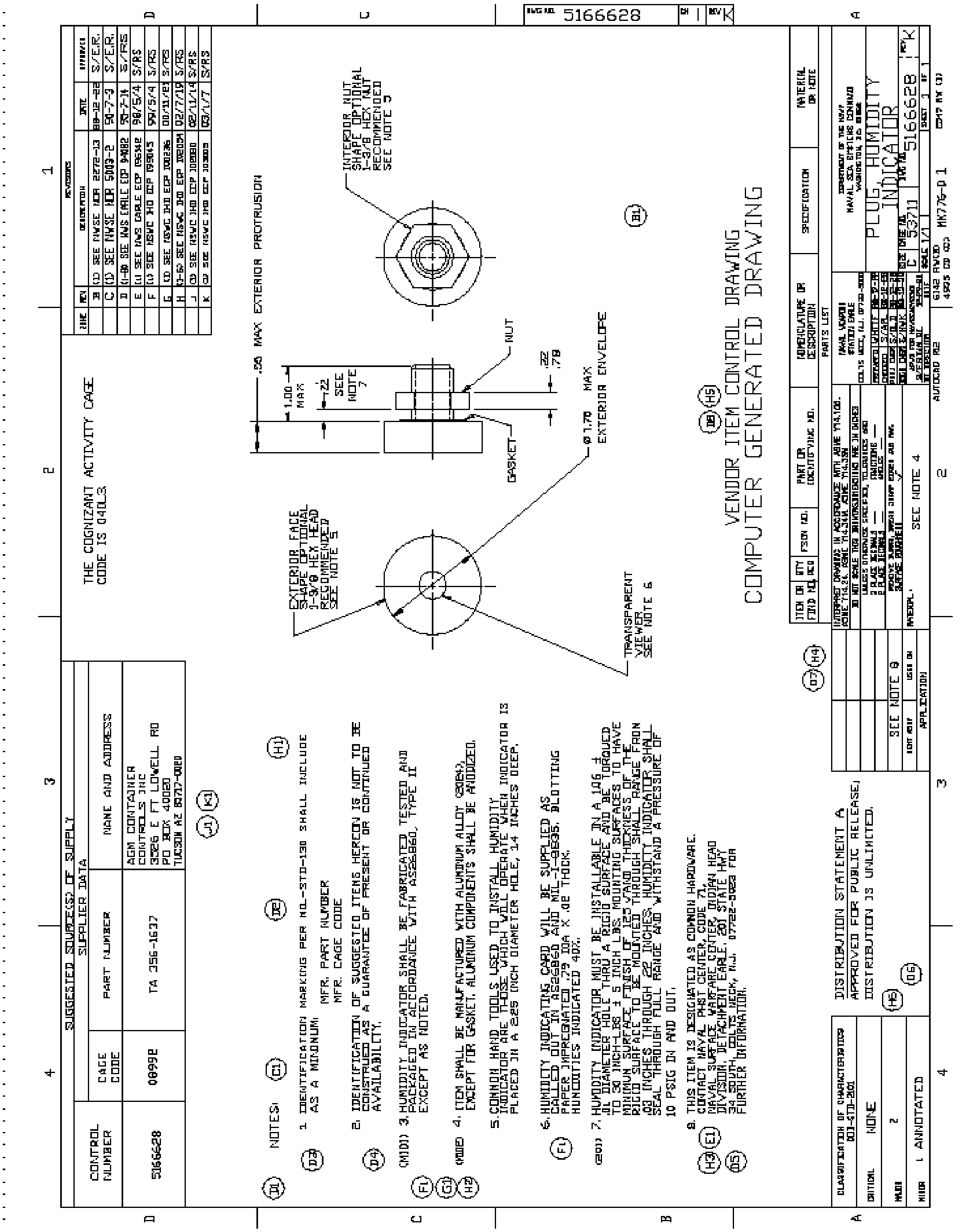


FIGURE B-4. Plug, humidity indicator (Drawing 5166628).

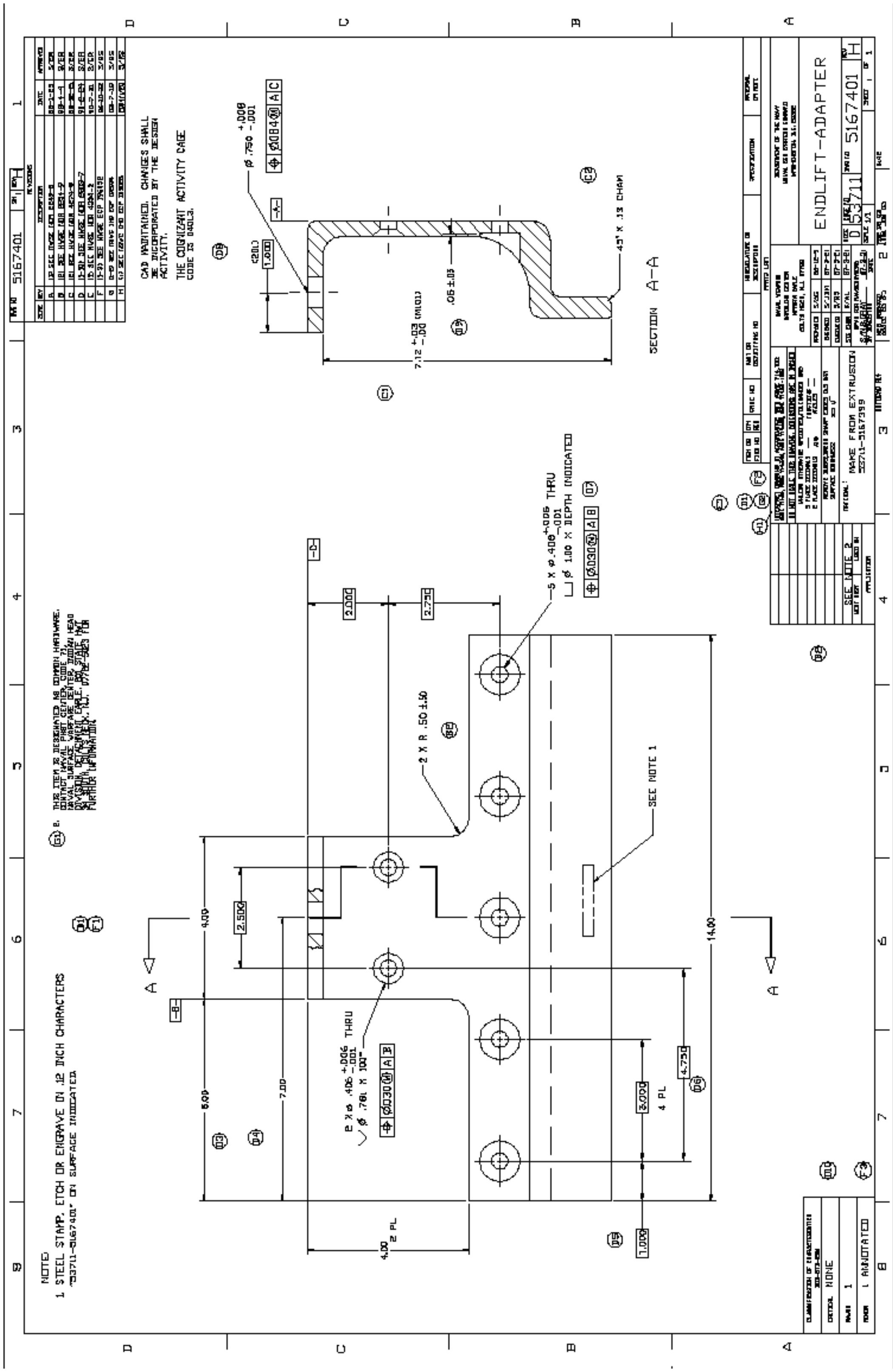


FIGURE B-5. Endlift-adapter (Drawing 5167401).

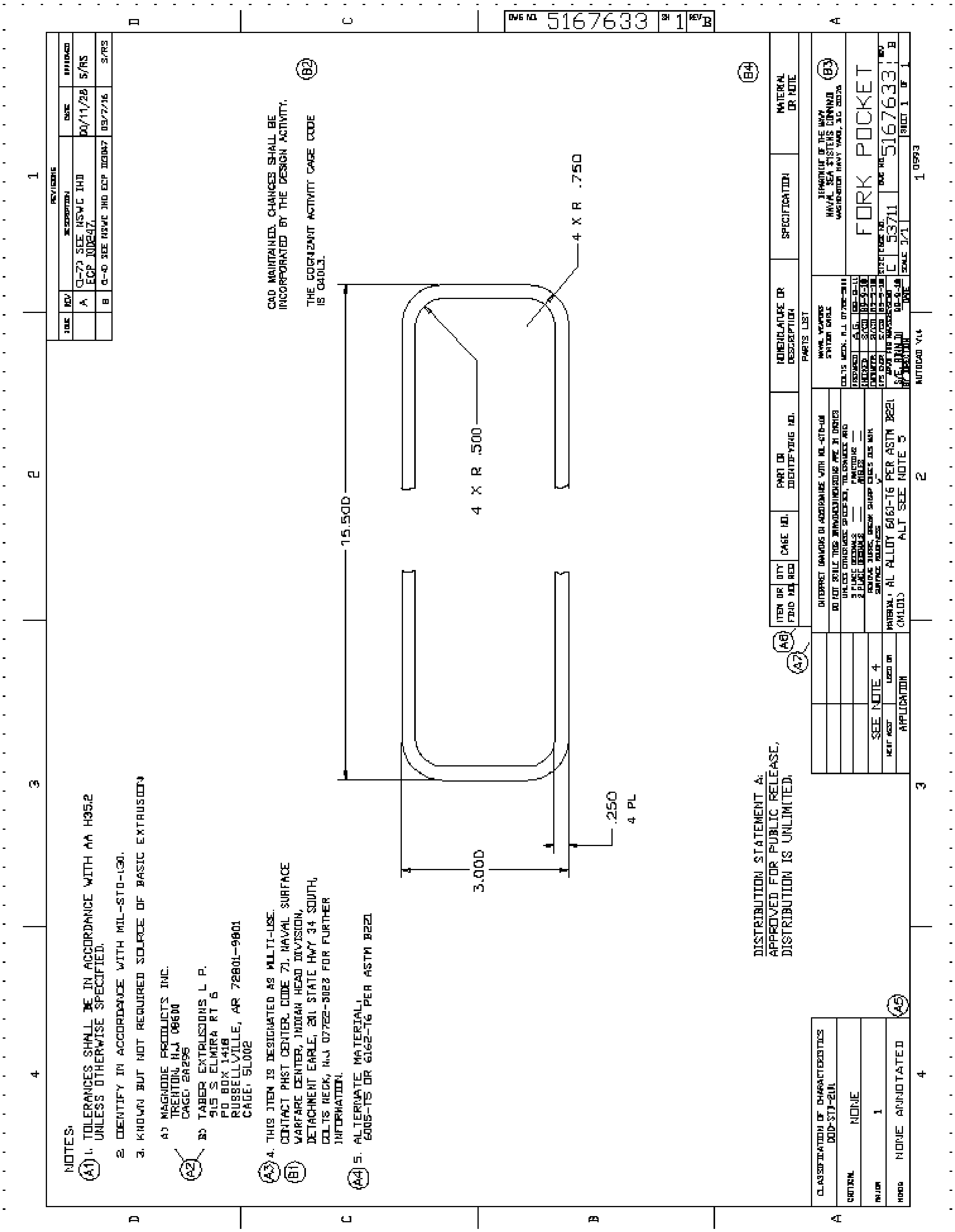


FIGURE B-6. Fork pocket (Drawing 5167633).

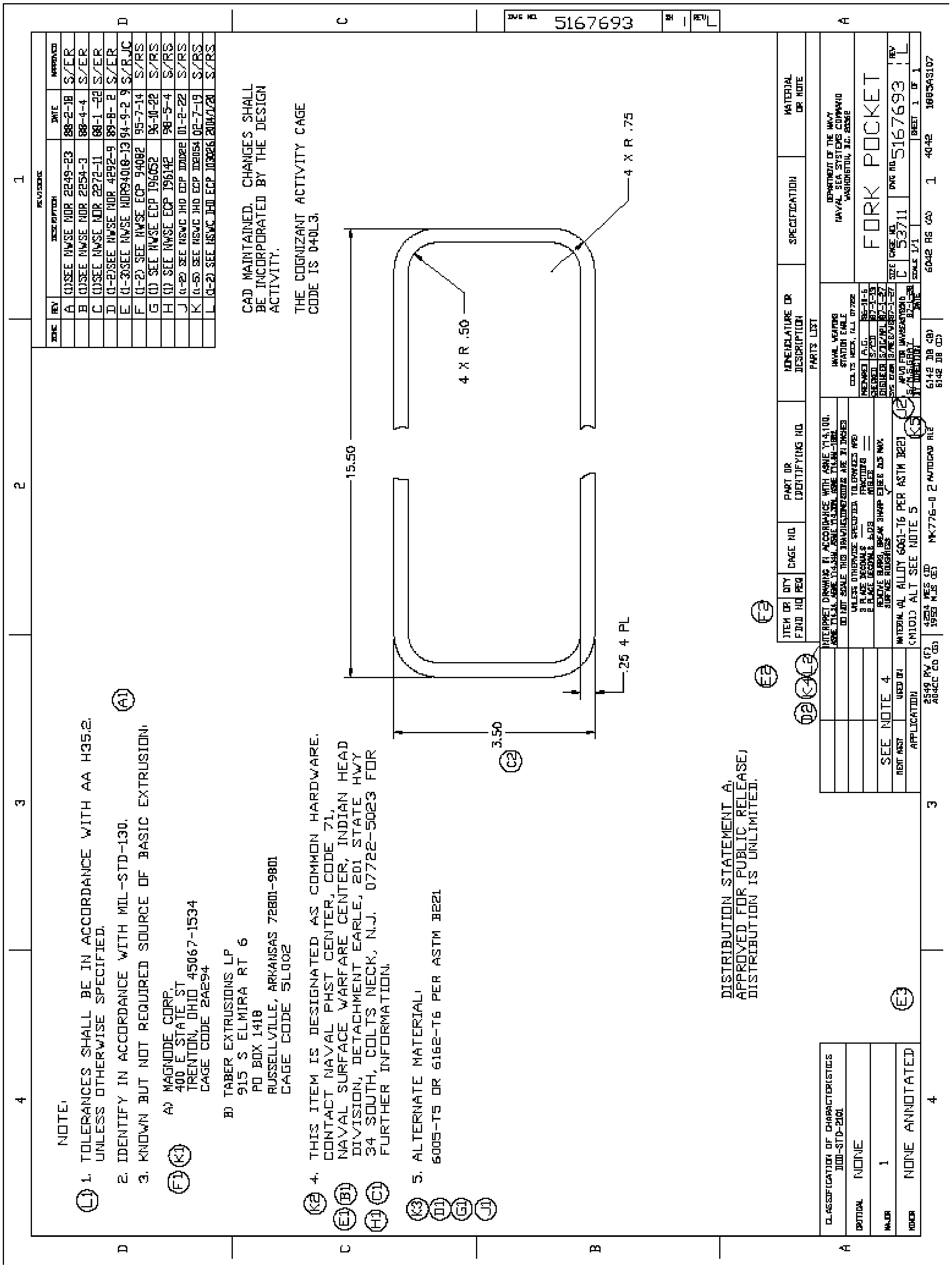


FIGURE B-7. Fork pocket (Drawing 5167693).

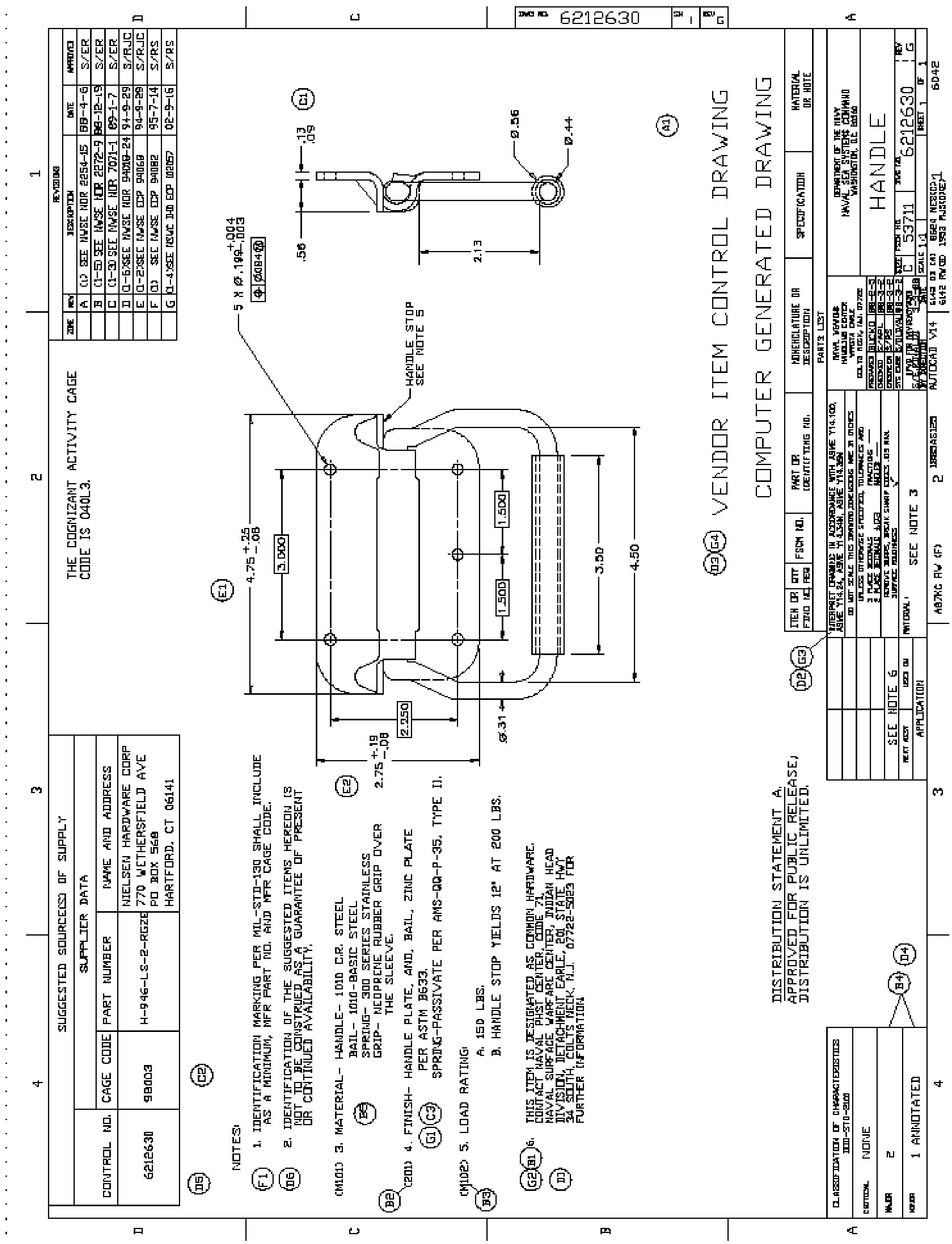


FIGURE B-8. Handle (Drawing 6212630).

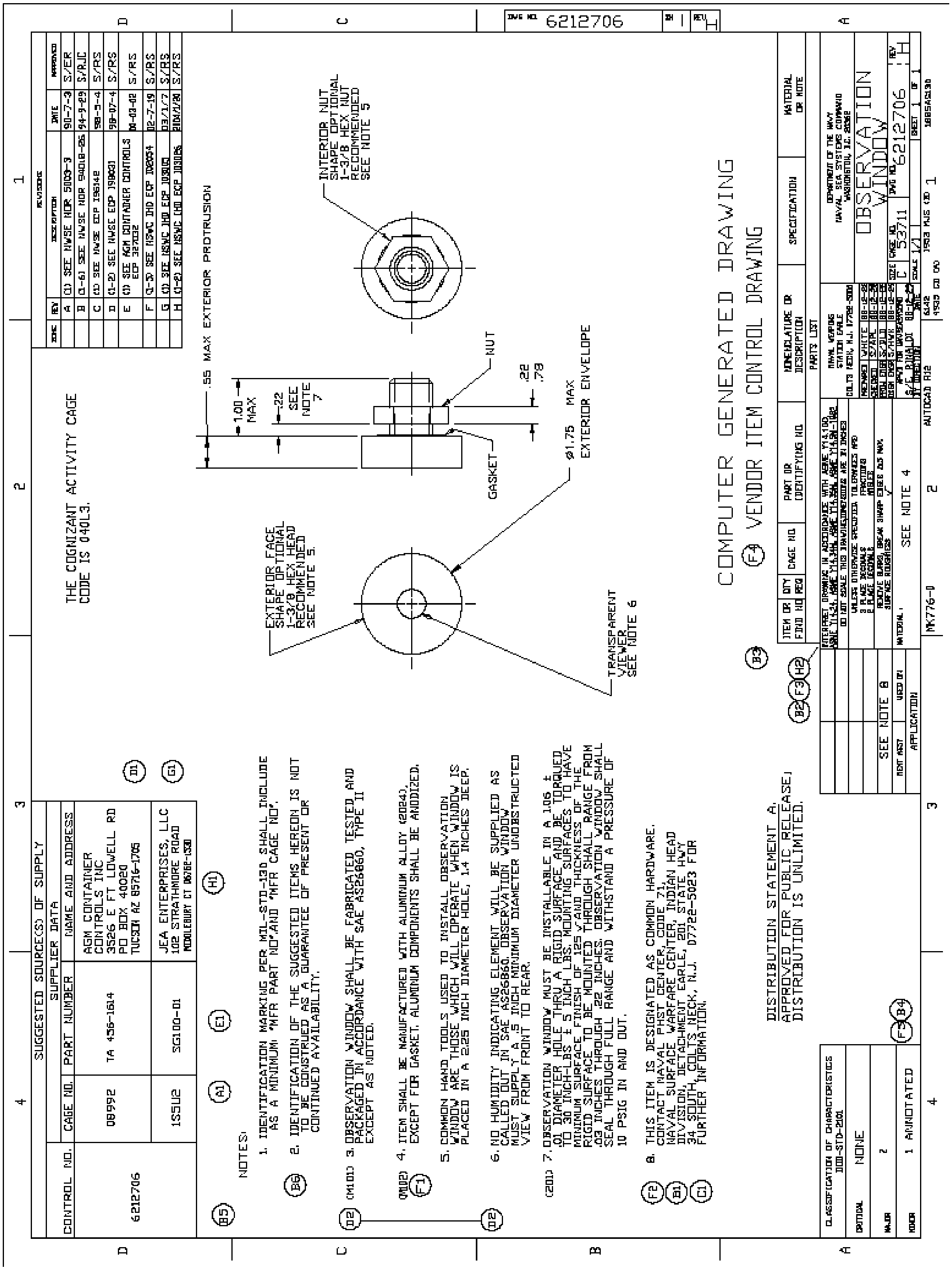


FIGURE B-9. Observation window (Drawing 6212706).

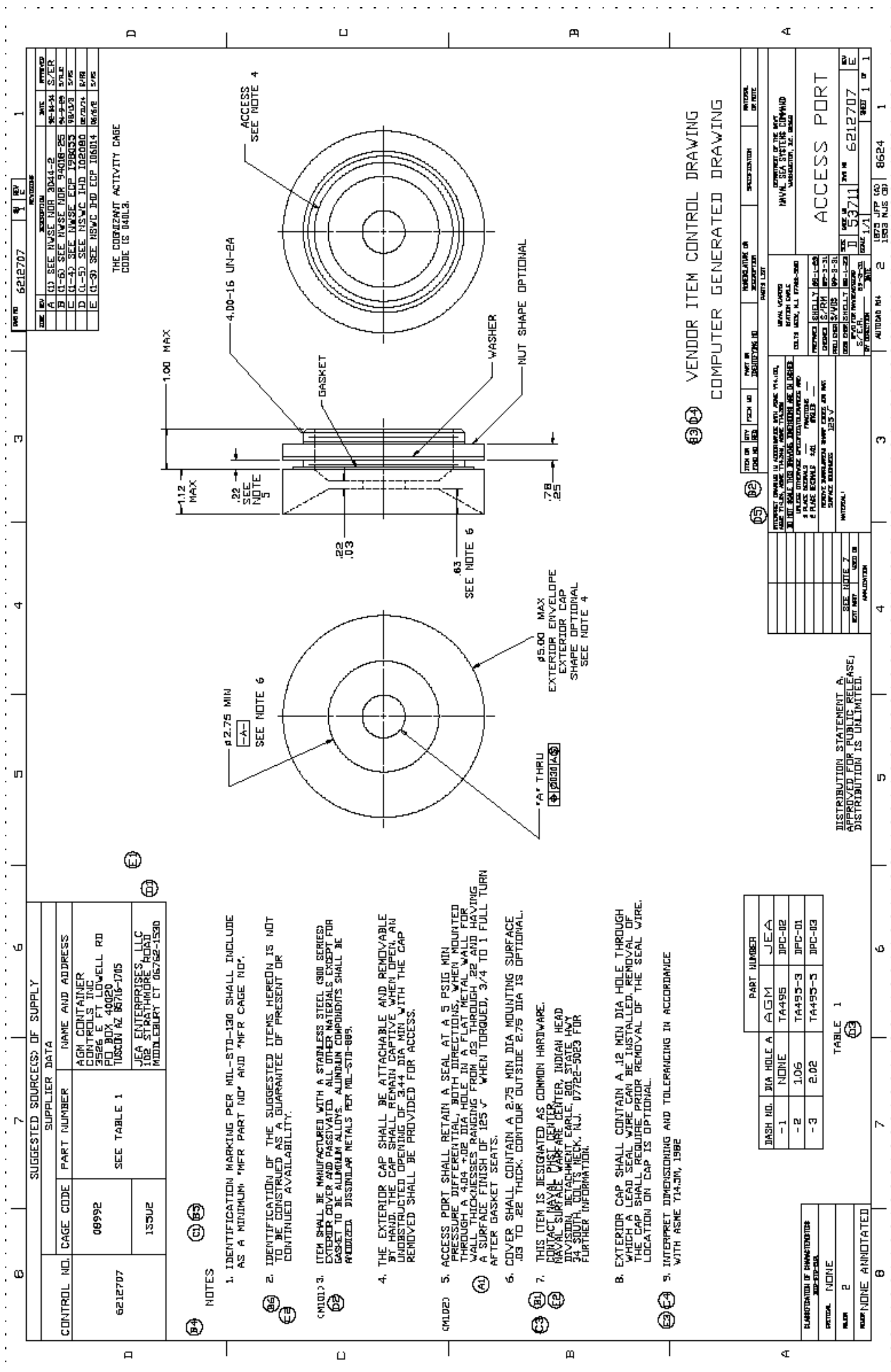


FIGURE B-10. Access port (Drawing 6212707).

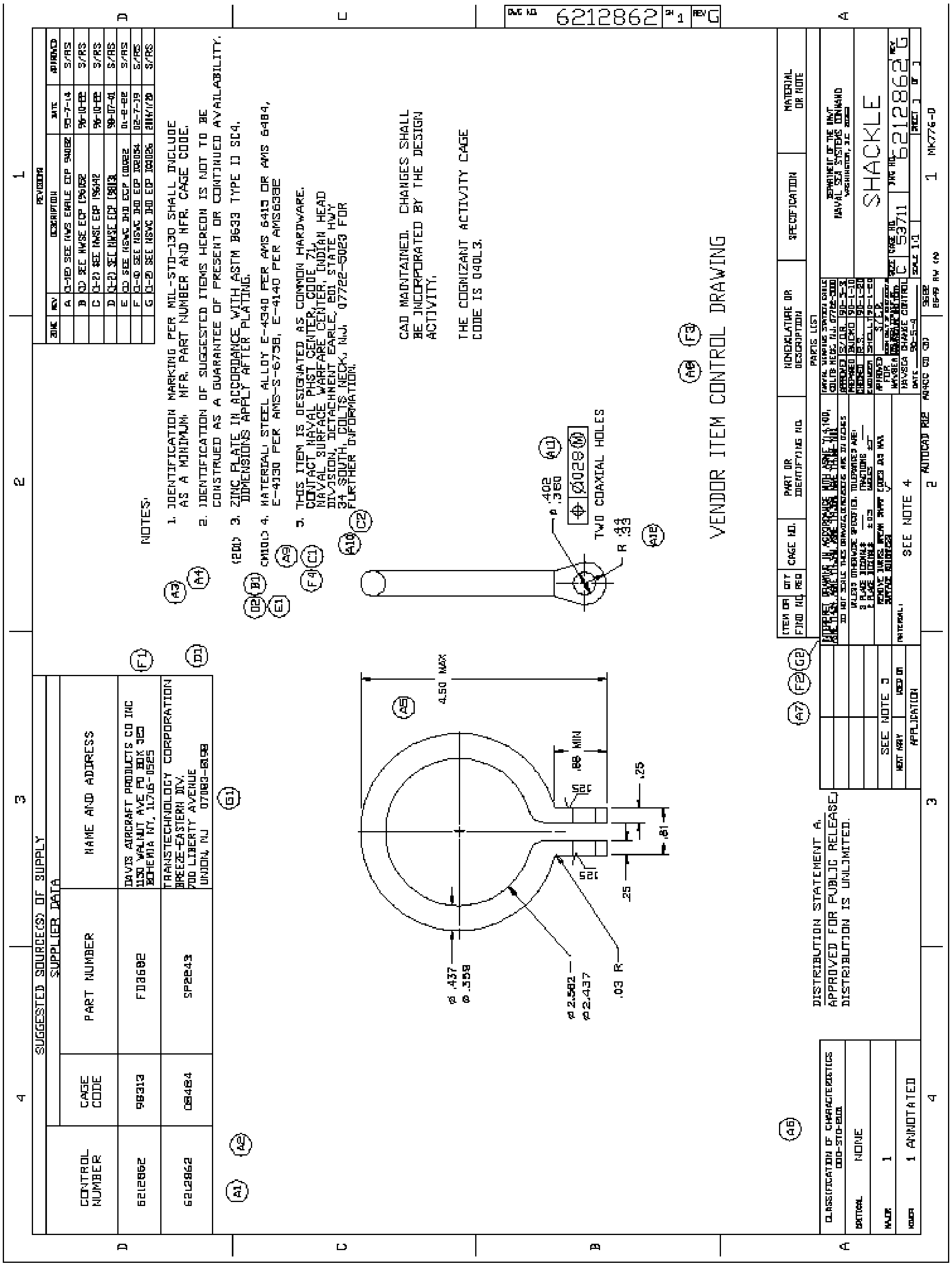


FIGURE B-11. Shackle (Drawing 6212862).

SUGGESTED SOURCE(S) OF SUPPLY			
	SUPPLIER DATA		
CONTROL NUMBER	CAGE CODE	PART NUMBER	NAME AND ADDRESS
6212863	08992	SEE TABLE	AGM CONTAINER CONTROLS INC 3526 E FT LOWELL RD PO BOX 40020 TUCSON, AZ 85716-1705

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED
	A	(1-8) SEE NWS EARLE ECP 94082	95-7-14	S/RS
	B	(D) SEE NWS EARLE ECP 196142	98/5/4	S/RS
	C	(1-7) SEE NSWC IHD ECP 102054	02-7-19	S/RS
	D	(1-30) SEE NSWC IHD ECP 102047	03/7/16	S/RS

THE COGNIZANT ACTIVITY CAGE CODE IS 040L3.

NOTES:

1. IDENTIFICATION MARKING PER MIL-STD-130 SHALL INCLUDE AS A MINIMUM: MFR. PART NUMBER AND MFR. CAGE CODE.
2. IDENTIFICATION OF SUGGESTED ITEMS HEREON IS NOT TO BE CONSTRUED AS A GUARANTEE OF PRESENT OR CONTINUED AVAILABILITY.
3. (M101) BREATHER VALVE SHALL BE IN ACCORDANCE WITH AS27166 TYPE III EXCEPT AS NOTED.
4. (N102) ITEM SHALL BE MANUFACTURED WITH ALUMINUM ALLOY (2024), EXCEPT FOR GASKET. ALUMINUM COMPONENTS SHALL BE ANODIZED.
5. COMMON HAND TOOLS USED TO INSTALL VALVE ARE THOSE WHICH WILL OPERATE WHEN THE VALVE IS PLACED IN A 2.82 MIN DIA HOLE, .75 MIN DEEP.
6. VALVE MUST FUNCTION WHEN INSTALLED IN A 2.02 ±.01 DIA HOLE IN A FLAT ALUMINUM WALL FOR WALL THICKNESSES RANGING FROM .03 THROUGH .22 AND HAVING A SURFACE FINISH OF √125 WHEN TORQUED TO 80 ±12 INCH-LBS.
7. THIS ITEM IS DESIGNATED AS MULTI-USE. CONTACT NAVAL PHST CENTER, CODE 71, NAVAL SURFACE WARFARE CENTER, INDIAN HEAD DIVISION, DETACHMENT EARLE, 201 STATE HWY 34 SOUTH, COLTS NECK, N.J. 07722-5023 FOR FURTHER INFORMATION.

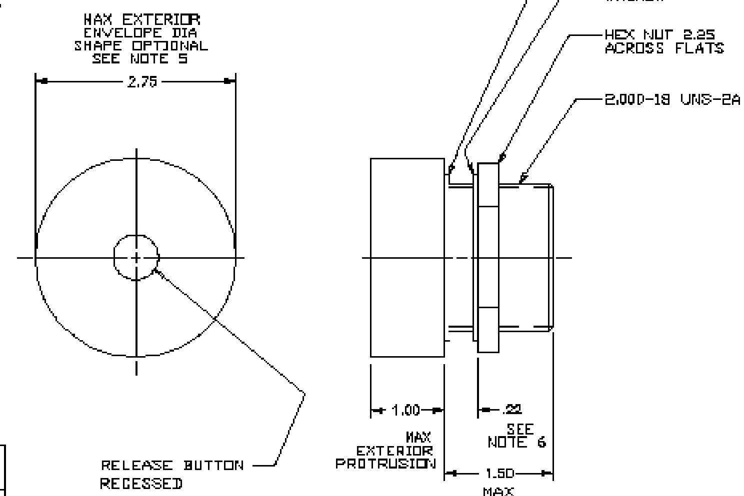


TABLE I

DASH NO	PART NUMBER	RESEAL PRESSURE IN AND OUT	MIN FLOW RATE IN AND OUT	FLOW RATE PRESSURE
-1	TA770-05-05-R	.50 PSIG	20 CFM	2.0 PSIG
-2	TA770-10-10-R	1.0 PSIG	18 CFM	2.5 PSIG
-3	TA770-15-15-R	1.5 PSIG	16 CFM	3.0 PSIG
-4	TA770-20-20-R	2.0 PSIG	14 CFM	3.5 PSIG
-5	TA770-25-25-R	2.5 PSIG	12 CFM	4.0 PSIG
-6	TA770-30-30-R	3.0 PSIG	10 CFM	4.5 PSIG

VENDOR ITEM CONTROL DRAWING

COMPUTER GENERATED DRAWING

DISTRIBUTION STATEMENT A.
APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION IS UNLIMITED.

CLASSIFICATION OF CHARACTERISTICS DOD-STD-2101	
CRITICAL	NONE
MAJOR	2
MINOR	NONE ANNOTATED

ITEM OR FIND NO	QTY REQ	FSCM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL OR NOTE

PARTS LIST

INTERPRET DRAWING IN ACCORDANCE WITH ASME Y14.100, ASME Y14.24, ASME Y14.34M, ASME Y14.35M
DO NOT SCALE THIS DRAWING, DIMENSIONS ARE IN INCHES
UNLESS OTHERWISE SPECIFIED, TOLERANCES ARE:
3 PLACE DECIMALS ± — FRACTIONS ± —
2 PLACE DECIMALS ± — ANGLES ± —
REMOVE BURRS, BREAK SHARP EDGES .015 MAX
SURFACE ROUGHNESS √
MATERIAL: SEE NOTE 4

SEE NOTE 7
NEXT ASSY | USED ON
APPLICATION

NAVAL WEAPONS HANDLING CENTER
VPHSTA EARLE
COLTS NECK, N.J. 07722
PREPARED SHELLY 85-2-15
CHECKED A.G. 80-15-04
ENGINEER SHELLY 85-2-15
SYS ENGR S/G.B. 07-7-00
APVD FOR NAVSEA (WEAPONS) S/F.R. 9-10-99
DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND
WASHINGTON NAVY YARD, DC 20376

VALVE, BREATHER

SIZE C | FSCM NO. 53711 | DWG NO. 6212863 | REV D
SCALE 1:1 | SHEET 1 OF 1

AUTOCAD R12
3262
8549 RW 400
MK776-0

FIGURE B-12. Valve, breather (Drawing 6212863).

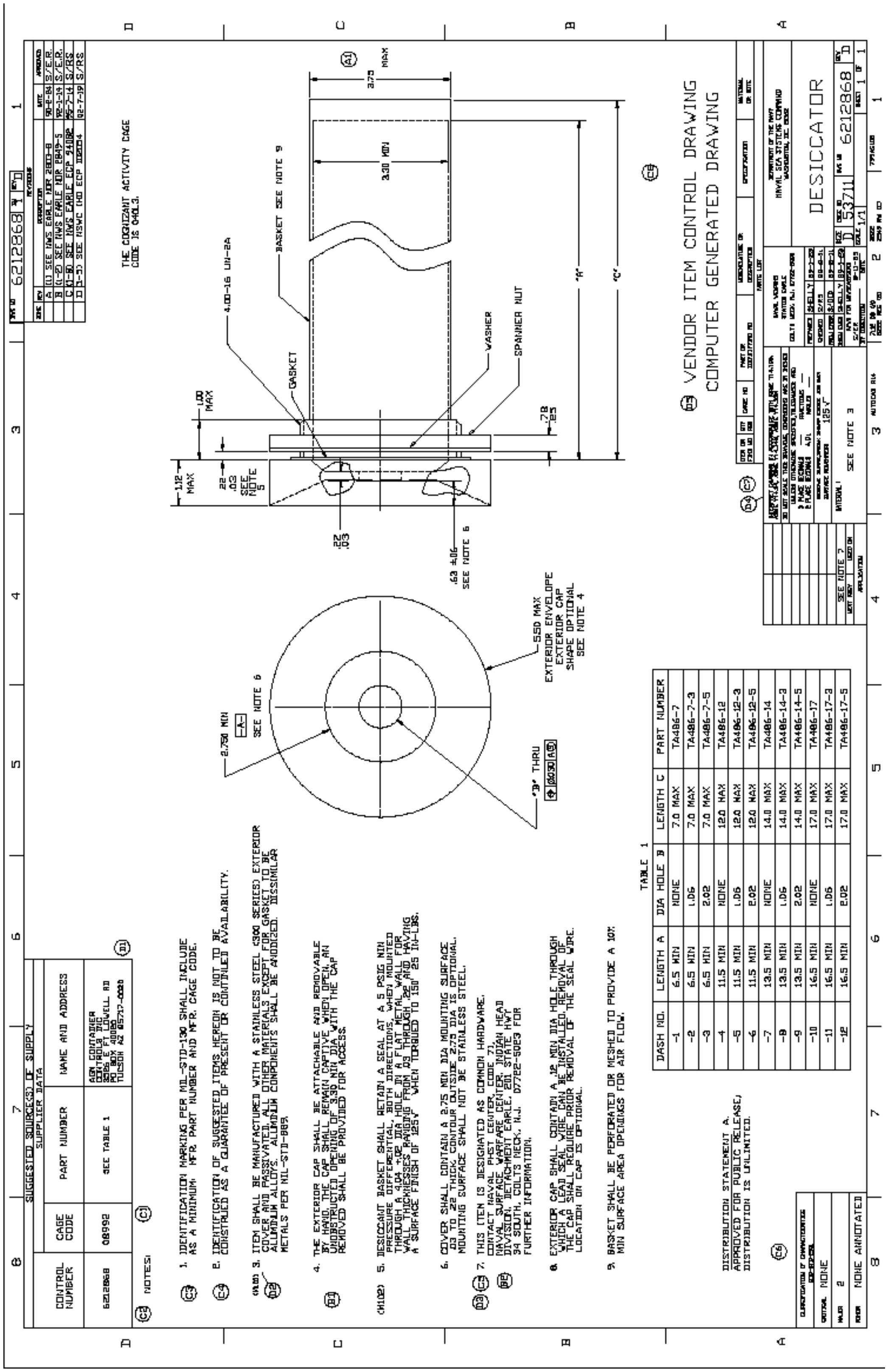


FIGURE B-13. Desiccator (Drawing 6212868).

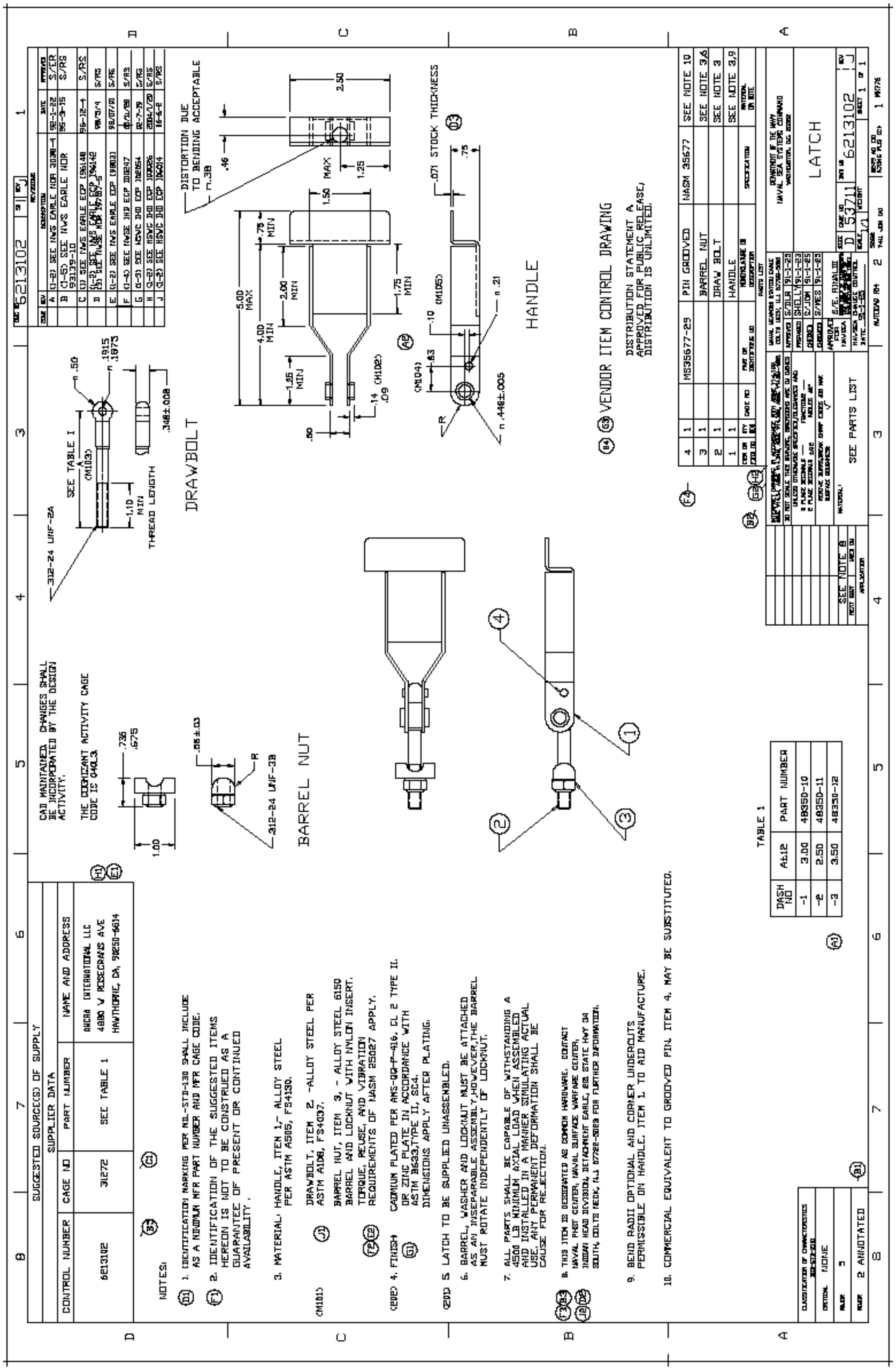


FIGURE B-14. Latch (Drawing 6213102).

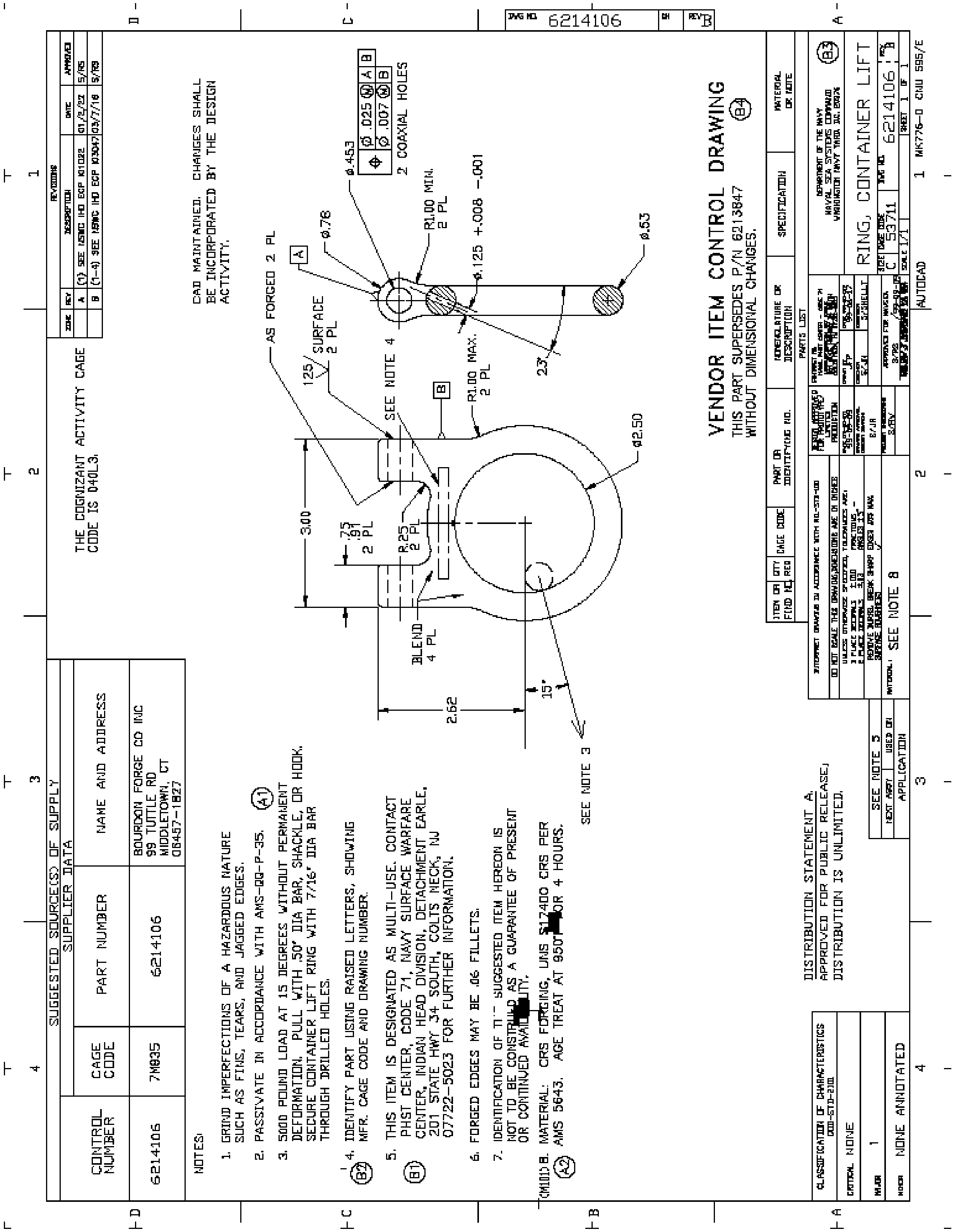


FIGURE B-15. Ring, container lift (Drawing 6214106).

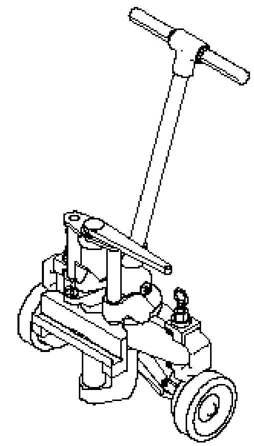
NOTES:

1. THIS INTERFACE DRAWING IS TO BE USED WHEN DESIGNING CONTAINERS OR SKIDS OVER 72 INCHES LONG OR OVER 36 INCHES LONG WITHOUT 4-WAY FORKLIFT/PALLET JACK COMPATIBILITY AND 300 POUNDS GROSS WEIGHT THAT WILL BE HANDLED ON BOARD NAVY SHIPS. ONE INTERFACE SHALL BE ON EACH OF THE SMALLEST SIDES (ENDS) OF THE CONTAINER OR SKID.
2. ENDLIFT INTERFACE SHALL BE STRUCTURALLY INSEPARABLE FROM THE CONTAINER OR SKID.
3. THE INTERFACE FEATURE SHALL BE PROTECTED FROM DAMAGE CAUSED BY END IMPACTS AT 10 FEET PER SECOND.
4. DIMENSIONS REPRESENT MAXIMUM ENVELOPE RELATIVE TO THE BEARING SURFACES AND REQUIRED INTERFACE FEATURES.
5. THE INTERFACE SHALL BE TESTED IAW MIL-STD-648 SECTION UNDER HEADING "HANDLIFT TRUCK MK 45 COMPATIBILITY".
6. THE CONTAINER OR SKID "LIFTING" SURFACE SHALL BE DESIGNED TO LIFT 3 TIMES THE WORKING STATIC LOAD OF THE CONTAINER, SKID, OR UNIT LOAD WEIGHT AS APPLICABLE FOR WORST CASE HANDLING WITH THE MK 45 MOD 2 HANDLIFT TRUCK. LOADS WILL BE PROPORTIONALLY MORE IF THE LOADED CG IS NOT CENTERED BUT CLOSER TO ONE HANDLIFT TRUCK THAN THE OTHER. VERTICAL LOADS WILL BE TRANSFERRED FROM A FLAT SURFACE 12.0 TO 13.0 INCHES WIDE AND .75 MINIMUM INCHES THICK. LOADED CONTAINERS UNDER 2000 LB. WILL BE UNITIZED FOR HANDLING UNLESS OTHERWISE SPECIFIED.
7. THE "BEARING" AND "PULLING" SURFACES SHALL BE DESIGNED TO RECEIVE EQUAL LOADS OF AT LEAST 214% OF THE CONTAINER OR UNIT LOAD WEIGHT. (LOAD =(3*CONTAINER OR UNIT LOAD WEIGHT/2) * 8.89 / (8.50-2.25)). SEE WORST CASE DIMENSIONS IN FIGURE 1. LOAD ON THE "BEARING" SURFACE CAN OCCUR IN A .50 BY .50 AREA (SHOWN HATCHED ON SHEET 2). THE COMPRESSIVE LOAD IS APPLIED BY A SLIGHTLY ROUNDED BLUNT NOSE OF THE HANDTRUCK. THE BEARING SURFACE SHOULD BE FLAT AND AS LARGE AS REQUIRED TO PREVENT DAMAGE. THE .750 DIA HOLE IS FOR ALIGNMENT WHEN ON A FLAT SURFACE. IT TAKES A LATERAL LOAD WHEN ON A SLOPED SURFACE THAT MAY BE AS HIGH AS 15 DEGREES.
8. FOR CONTAINERS OR SKIDS GOING ONBOARD SHIPS WITH ANGLED HATCHES, TESTS MUST BE PERFORMED WITH THE MK 134 LEVEL ADAPTER ON ONE END ONLY. STATIC LOADS ON "BEARING" AND "PULLING" SURFACES WILL INCREASE TO AT LEAST 367% (INCLUDING FACTOR OF SAFETY (3.0)) OF THE CONTAINER WEIGHT. (LOAD = (3*WEIGHT/2) * 15.39 / (8.56-2.26)) SEE FIGURE 3 FOR WORST CASE DIMENSIONS.
9. THE CONTAINER OR SKID MAY EXTEND UP TO 1.00 INCH BEYOND "BEARING" SURFACE, 7.00 OR MORE INCHES BEYOND THE CONTAINER OR SKID LONGITUDINAL CENTERLINE, WITHOUT INTERFERING WITH HANDTRUCK WHEELS IN ORDER TO PROTECT THE ENDLIFT INTERFACE. SEE PLAN VIEW SHEET 2.
10. EQUIPMENT INTERFACING WITH THIS FITTING ARE SHOWN ON SHEET 3. DIMENSIONS AFFECTING LOADING ARE PROVIDED. EXAMPLES OF CONTAINER AND SKID FITTINGS ARE SHOWN.
11. A 3D SIMPLIFIED MODEL OF THE MK 45 HANDLIFT TRUCK IS IN THIS DRAWING'S ELECTRONIC DATABASE.
12. ADAPTERS INCLUDE: MK 26 MOD 2 TRUCK ADAPTER (DWG 10001-2644932); MK 28 MOD 1 HANDLIFT TRUCK ADAPTER (DWG 10001-1330565); MK 93 MOD 0 HANDLIFT TRUCK ADAPTER (DWG 2643391); MK 160 MOD 1 HANDLIFT TRUCK ADAPTER (DWG 5597790-19); AND MK 28 MOD 1 HANDLIFT TRUCK ADAPTER (DWG 1330565).

ZONE	REV	DESCRIPTION	DATE	APPROVED

CAD MAINTAINED. CHANGES SHALL BE INCORPORATED BY THE DESIGN ACTIVITY.

THE COGNIZANT ACTIVITY CAGE CODE IS 0R0L3



TRUCK, HANDLIFT MK 45 MOD 2

INTERFACE CONTROL DRAWING

ITEM OR FIND NO.	QTY REQ	CAGE CODE	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL OR NOTE

PARTS LIST

CLASSIFICATION OF CHARACTERISTICS DOD-STD-2101	
CRITICAL	NONE
MAJOR	NONE
MINOR	NONE ANNOTATED

DISTRIBUTION STATEMENT A.
APPROVED FOR PUBLIC RELEASE:
DISTRIBUTION IS UNLIMITED.

SHEET 1	SHEET 2	SHEET 3
–	–	–

REVISION STATUS OF SHEETS

DO NOT SCALE THIS DRAWING. DIMENSIONS ARE IN INCHES
UNLESS OTHERWISE SPECIFIED, TOLERANCES ARE:
3 PLACE DECIMALS ±.030
2 PLACE DECIMALS ±.06 ANGLES ± 5°
REMOVE BURRS, BREAK SHARP EDGES .015 MAX
SURFACE ROUGHNESS 125
MATERIAL: N/A

04-03-15 MARK SHELLY 98-10-1 MARK SHELLY
APPROVED FOR NAVSEA S/R. SMITH /04/03/18

DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND
WASHINGTON, D.C. 20362

CONTAINER ENDLIFT INTERFACE

SIZE	CAGE CODE	DWG NO.	REV
C	53711	6214131	–

SCALE 1/4 SHEET 1 OF 3

AUTOCAD V12 INTERFACE

DWG NO. 6214131 SH 1 REV –

FIGURE B-16. Container endlift interface (Drawing 6214131, sheet 1 of 3).

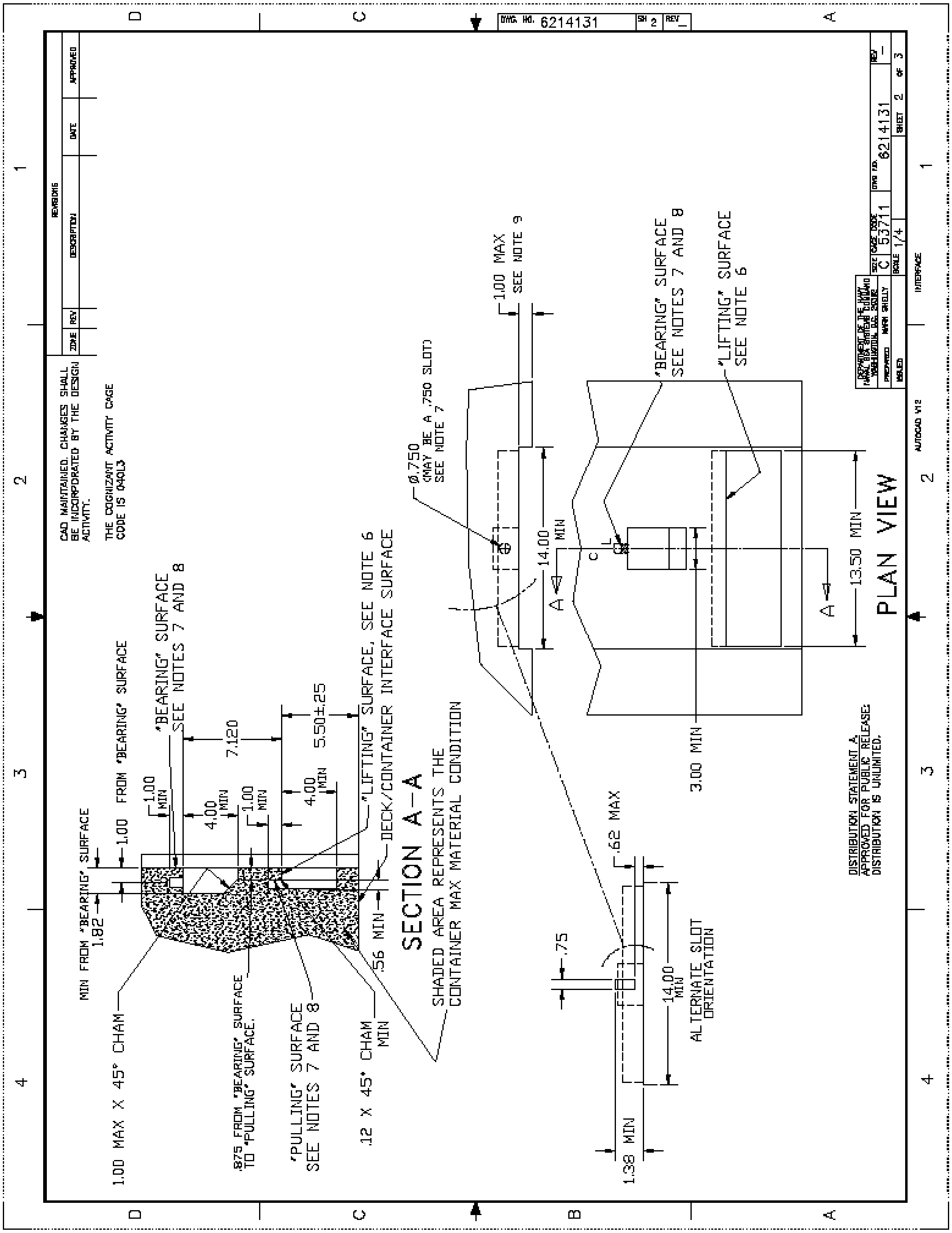


FIGURE B-16. Container endlift interface (Drawing 6214131, sheet 2 of 3) - Continued.

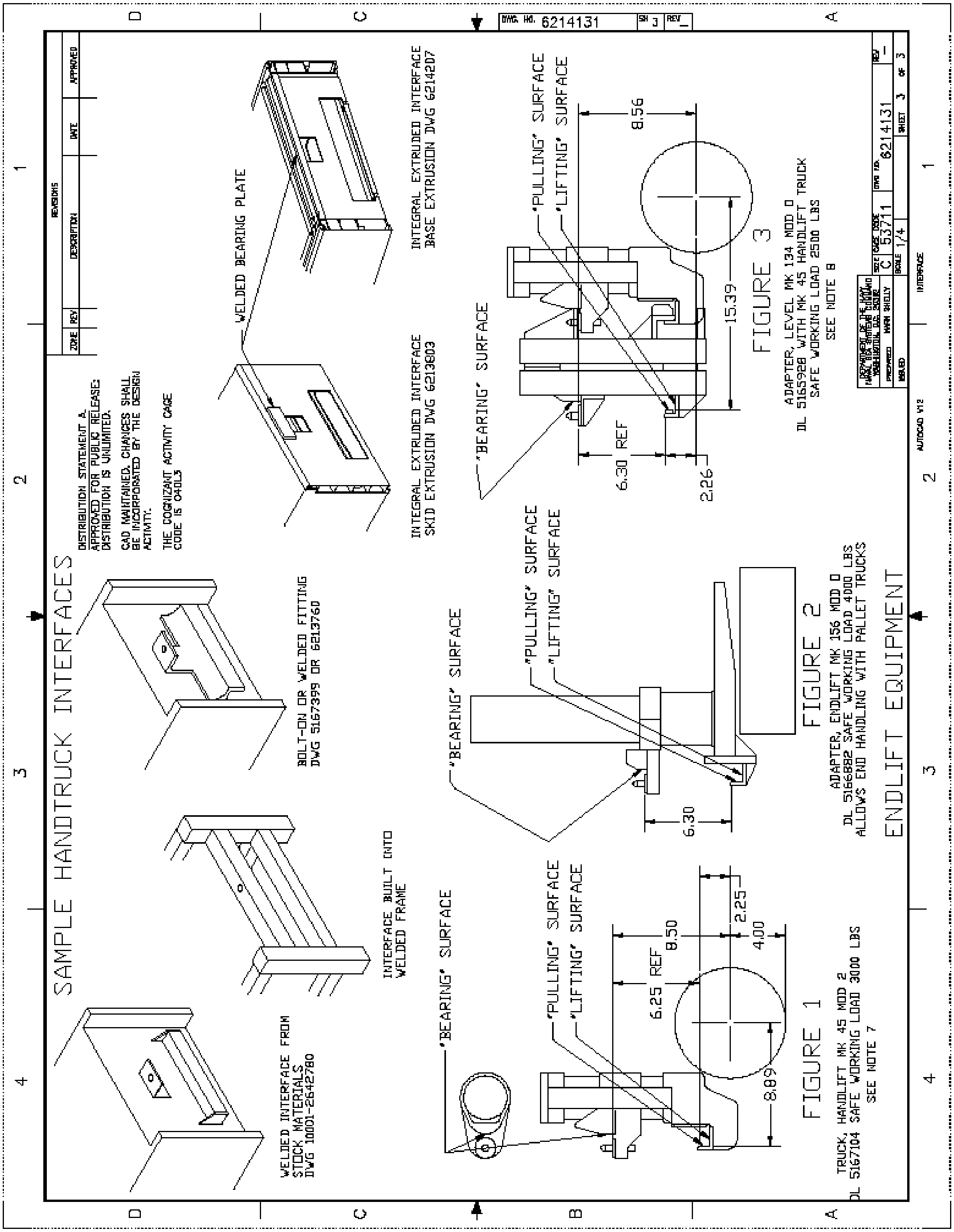


FIGURE B-16. Container endlift interface (Drawing 6214131, sheet 3 of 3) - Continued.

ELECTROSTATIC PROPERTIES OF MATERIALS

C.1 SCOPE

C.1.1 Scope. This appendix describes the test used to determine the electrostatic properties of materials in film and sheet form by measuring the time required to induce a charge on the surface of the material, measuring the intensity and polarity of the charge, and determining the time required for complete dissipation of the induced charge. This method does not determine the surface, volume, or insulation resistivities of the materials. This appendix is not a mandatory part of the standard. The information contained herein is intended for guidance only.

C.2 DEFINITION

C.2.1 Electrostatic properties. Electrostatic properties are defined as the ability of a material, when grounded, to dissipate a charge induced on the surface of the material.

C.3 APPARATUS

The following equipment applies for testing electrostatic properties:

a. A metal template, 5 by 3 by ⅛ inches.

b. A high voltage source, 0 to 15 kV, positive and negative.

c. An electrometer for measuring volts, amperes, and ohms with a full scale reading on 0.01, 0.1, 1.0, 10, and 100, or an oscilloscope with a response of 1 microsecond per division, or equivalent.

d. Electrostatic test chamber illustrated on figure C-1.

e. A single channel, pen type recorder with speeds of 0.5, 1.0, 2.0, 4.0, and 8.0 inches per minute and per second.

f. A desiccating chamber for conditioning specimens.

g. Two knife blade switches, hooked up so that when one is opened, the other will close.

h. The equipment will be assembled as illustrated on figure C-2.

i. A chamber or room uniformly maintained at 73±3.5 °F and 50±5 percent relative humidity in which to perform tests.

C.4 SPECIMENS

The following applies for selecting specimens for testing electrostatic properties:

a. Select specimens at random and in sufficient number to represent the variation of the material. A minimum of three specimens per condition per sample are required.

b. Each specimen will be 5 by 3 inches and will be free of defects, such as holes, cracks, and tears. If the specimen is coated, the coating will be continuous.

C.5 CONDITIONING

The following applies for conditioning specimens for electrostatic properties testing:

a. Prior to testing, expose ⅓ of the specimens for 12 days in an oven uniformly maintained at 160±5 °F; ⅓ of the specimens in a horizontal position for 24 hours under a continuous water shower; and ⅓ of the specimens in an atmosphere uniformly maintained at 73±5 °F and 50±5 percent relative humidity.

b. Unless otherwise specified in the CIDS, all specimens will be placed in the desiccating chamber for a minimum of 24 hours immediately before testing as specified in C.6.

C.5.1 Test environment. Perform tests in an atmosphere uniformly maintained at 73±5 °F and dry a condition of less than 15 percent relative humidity. This relative humidity can be obtained by inserting a dish (approximately 4-inch diameter) containing 50 grams of anhydrous calcium chloride into the test chamber. The anhydrous calcium chloride will be replaced daily.

C.6 PROCEDURE

The following procedures apply for testing electrostatic properties:

a. Calibration is as follows:

(1) Turn on all components and allow to warm up as noted in the operations manual for the particular item.

(2) Set the multiplier switch of the electrometer at 10 and the “operate” switch at “zero check”.

(3) Close the ground switch and adjust the high voltage for 5-kV output.

(4) Mount a 0.1- by 3- by 5-inch aluminum panel between the electrodes in the test chamber so that the detector head is directly in the center of the panel. Tighten the four wing nuts to secure the panel.

(5) Adjust the speed of the recorder chart at 1 inch/minute, move the “operate” switch to the “operate” position, and close the high voltage switch to apply 5 kV to the test panel.

(6) Move the multiplier switch until the meter needle reads maximum without exceeding the limits of the meter. Check to see if the charge indicated by the meter is identical to that being recorded on the chart.

(7) Close the ground switch to remove the charge. When the meter reaches zero, stop the chart and move the “operate” switch on the electrometer to the “zero check” position.

(8) Repeat this procedure for both positive and negative charges.

b. Each specimen will be mounted vertically between the electrodes and the wing nuts tightened to ensure intimate contact between specimen and electrodes.

c. Set chart speed at 0.5 inch/second. Turn on recorder. Turn meter switch to plus or minus, depending on charge to be applied. Move “operate” switch to position and then close charging switch to apply 5 kV to test specimen.

d. When the meter needle stops rising, indicating the specimen has received its maximum charge, close the ground switch to remove the charge.

e. When the needle reaches zero or after 10 seconds, whichever comes first, stop recorder and move “operate” switch to zero.

f. Charge each specimen three times for both positive and negative charges, allowing specimen to remain grounded for 10 minutes after each charging cycle to remove any residual charge on the specimen.

g. Calculate charge decay time by measuring the horizontal distance on the chart from the point where the specimen was grounded to the point where the needle reached zero. With the speed of the chart known, calculate the decay time for each specimen.

C.7 NOTES

a. The purpose of this procedure is to evaluate the electrostatic buildup and dissipation properties of packaging materials used to fabricate enclosures primarily for missiles and missile components subjected, in a small degree, to direct climatic exposure. The test is particularly applicable to barrier materials especially formulated to prevent the buildup or retention of electrostatic potential under any atmospheric conditions, the objective being to maximize explosive safety and to preclude ignition of stray flammable materials by ESD.

b. The Keithley 621 Electrometer may be used. Other settings may apply if another suitable electrometer of different design is used.

c. Test equipment and procedures for typical electrostatic properties are depicted in figures C-1 through C-5.

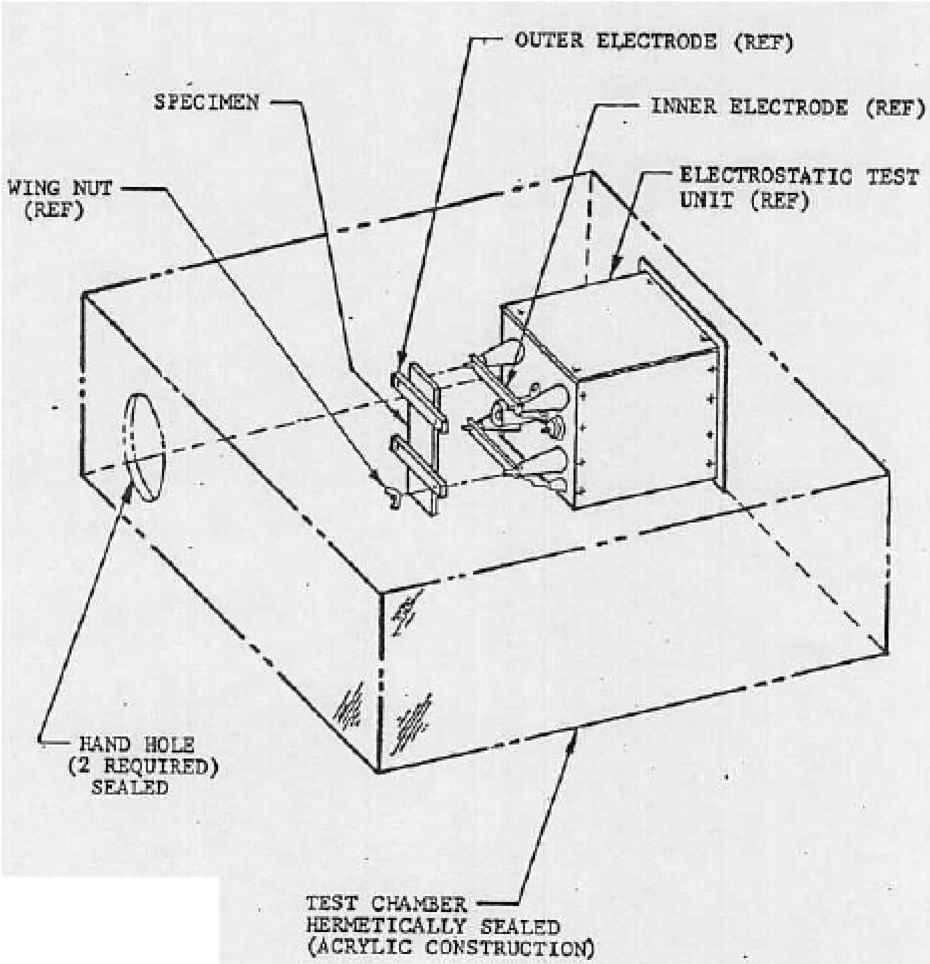


FIGURE C-1. Electrostatic test chamber.

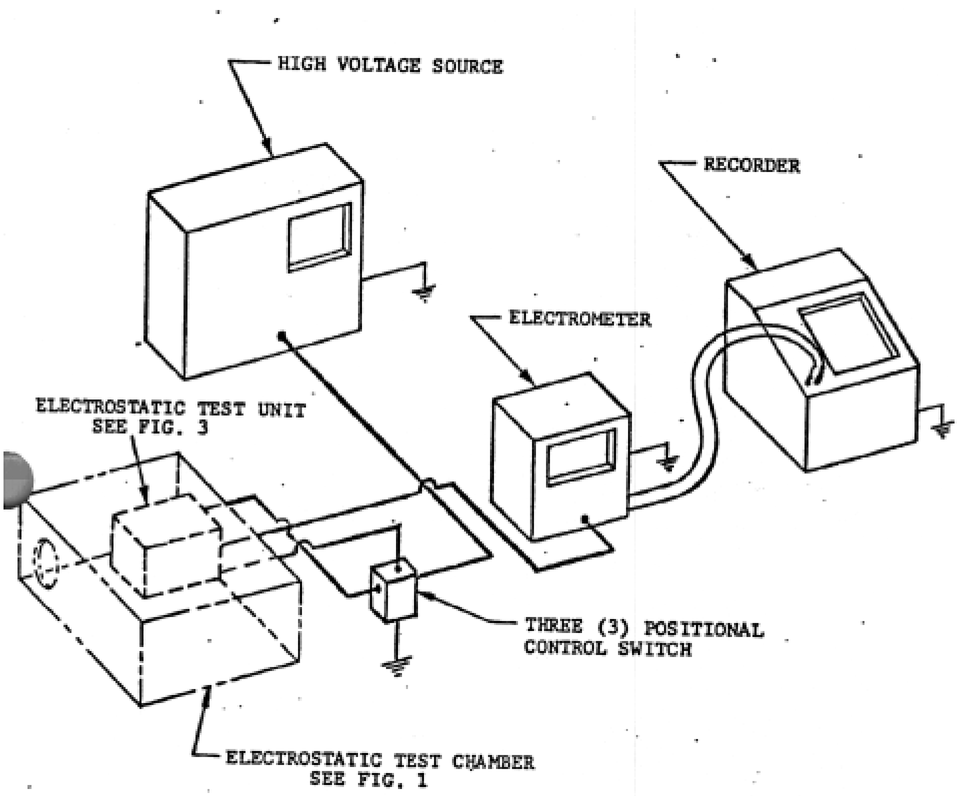


FIGURE C-2. Electrostatic test arrangement.

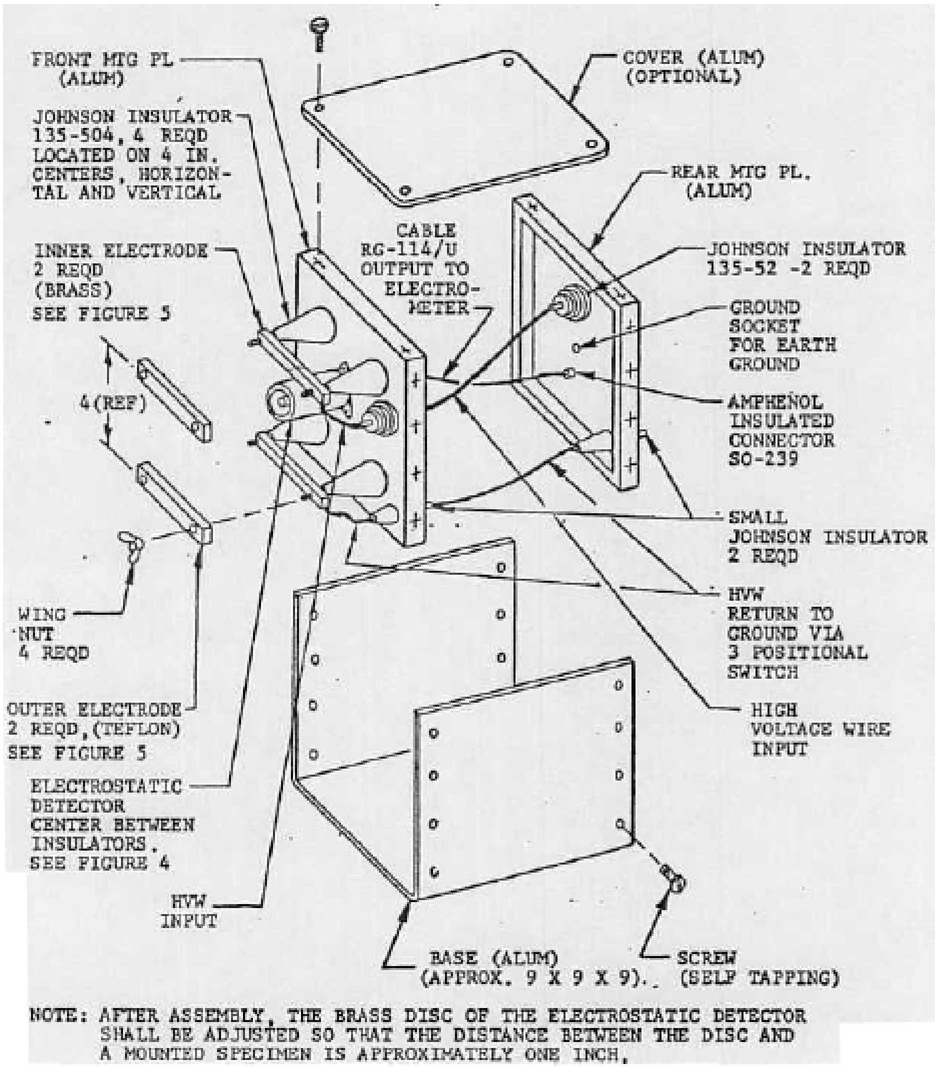


FIGURE C-3. Electrostatic test.

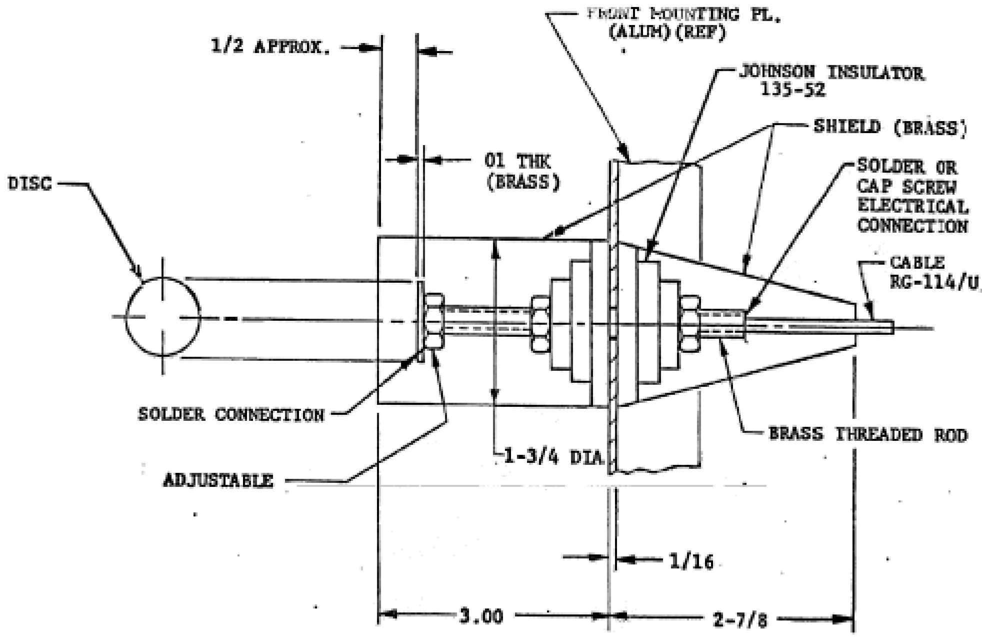


FIGURE C-4. Electrostatic detector.

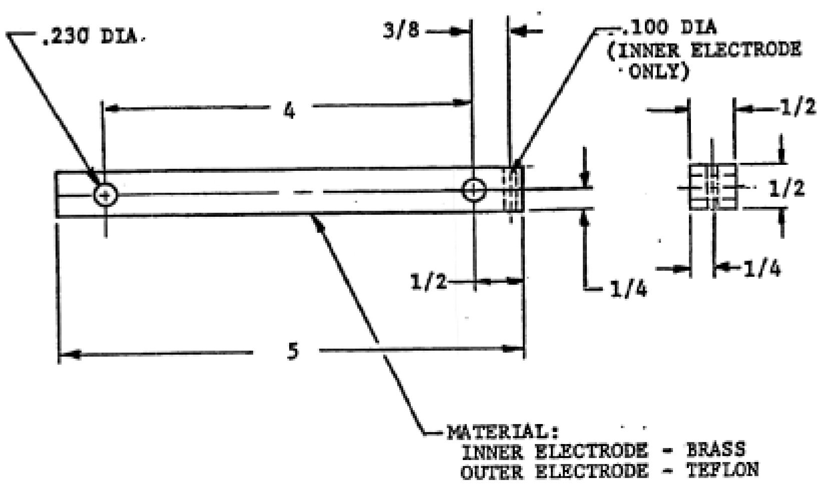


FIGURE C-5. Electrode.

SUPERIMPOSED-LOAD TEST (STACKABILITY, WITH DUNNAGE)

D.1 SCOPE

D.1.1 Scope. This appendix provides procedures for determining the ability of shipping containers to resist loads, such as imposed on the bottom container of a stack of similar containers in storage, or on a container supporting top dunnage and superimposed lading; and for determining the ability of the packaging and packing methods to provide protection to the contents when the pack is so loaded. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

D.2 DEFINITIONS

D.2.1 Top dunnage. Pieces of relatively stiff material, usually wood, laid across the top of a container or layer of containers to carry the weight of superimposed lading to the sides of the containers.

D.3 APPARATUS

D.3.1 Top superimposed-load test. In conducting the top superimposed-load test, any convenient method may be used for placing the load on top of the container such as a hoist, a block and tackle, or by hand. The load may also be applied and maintained by means of a testing machine.

D.4 SPECIMEN

D.4.1 Contents of container. One container shall constitute a single specimen. If the container's ability to support a load is enhanced by interior packaging or the intended contents, then the container shall be loaded for the test with the interior packaging 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.5 CONDITIONING

D.5.1 Test specimen. Unless otherwise specified in the CIDS, no special conditioning of the test specimen shall be necessary.

D.6 PROCEDURE

a. The specimen shall be placed on its bottom on a flat, level, rigid floor. A prescribed load shall be applied to the top of the container in a manner simulating the effect ("footprint") of similar containers being stacked on top, and the load shall be allowed to remain in place for a prescribed period of time. The bearing of the top superimposed load shall be on the same load-bearing areas that the skids, rubbing strips, or other base members would make on the container top. Unless otherwise specified in the CIDS and when the test is conducted to determine satisfactory performance of a container, the prescribed period of time shall be 1 hour and the prescribed load shall be as follows:

$$W = P \times \frac{16-H}{H} \times S \quad or \quad 200 \times A \times S$$

(1) Whichever is larger.

(2) Where:

(a) W = Prescribed top superimposed load, in pounds.

(b) P = Weight of the loaded container, in pounds.

(c) H = Height of container, in feet.

(d) A = Area of top of container, in square feet.

(e) S = 2.0 for Level A packing.

(f) S = 1.5 for Level B packing.

1 If the principal support structure is a plastic or other nonmetallic material with a tendency to creep or deteriorate when exposed to elevated temperatures or very humid conditions, the test shall be repeated at a temperature of 120±5 °F and 90 percent relative humidity for a period of 168 hours. In this latter case, the constant “S” shall be 1.5.

b. A record shall be made of any changes or breaks in the container, such as apparent buckling or failure of members in the sides or ends. Any vertical deflections of the sides and ends shall be measured from taut horizontal string lines stretched between nails in the top corners of each side and end. In addition, bulging of the side and end panels shall be measured from a vertical straight edge (see figure D-1). Observations shall be made to determine if the distortions were sufficient to damage or dislodge the interior packing or contents.

D.7 NOTES

a. This test is meant to simulate the top superimposed loads imposed by stacking of like containers, as in storage, or by stowing lading upon top dunnage in the hold of a ship. It is intended that this test be used only on containers that are likely to be stressed in this manner. Details are given with the qualification “unless otherwise specified” in paragraphs regarding:

(1) Conditioning of specimens (see D.5.1).

(2) Load and duration of load (see D.6.a).

b. Although the recommended period of time for the top superimposed-load test is only 1 hour, the use of the factor for Levels A and B packing ensures a load-carrying capacity adequate for longtime loading and an occasional application of impact loads.

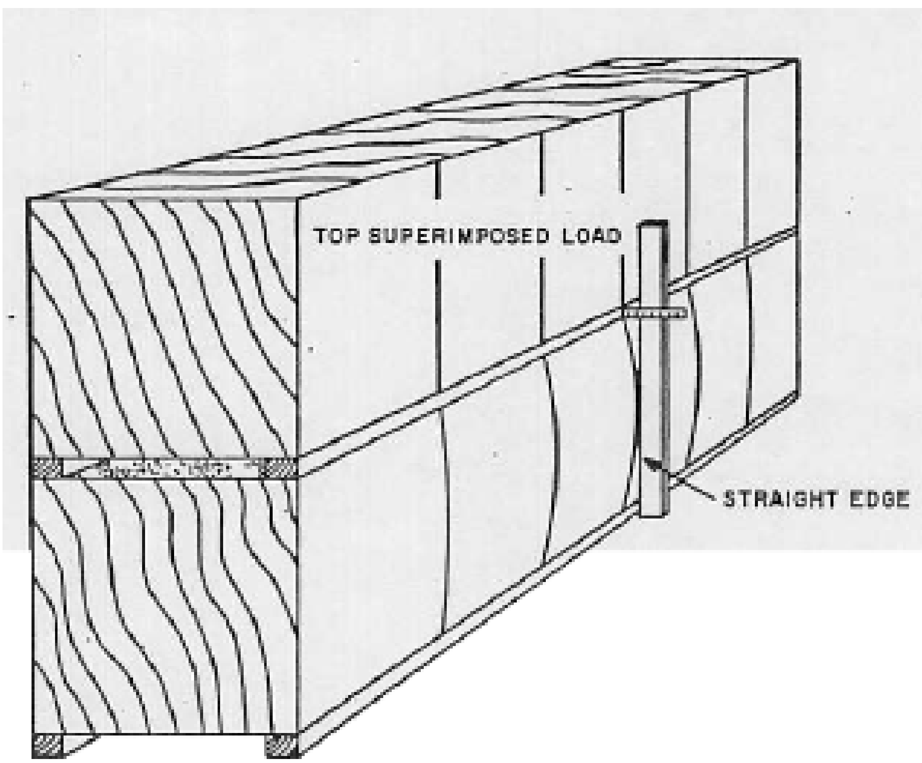


FIGURE D-1. Top superimposed-load test (stackability, with dunnage).

SUPERIMPOSED-LOAD TEST (UNIFORMLY DISTRIBUTED, WITHOUT DUNNAGE)

E.1 SCOPE

E.1.1 Scope. This appendix provides procedures for determining the ability of shipping containers to resist loads superimposed on their tops, as imposed by piling without top dunnage, many small, heavy packages on a container, and for determining the ability of the packaging and packing methods to provide protection to the contents when the pack is so loaded. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

E.2 DEFINITIONS

E.2.1 Packing. The levels of packing to be provided for any item or contents are dependent upon the handling, shipping, and storage conditions which the container or pack may be expected to encounter. For the purpose of this appendix, the levels of packing will be defined as follows:

E.2.1.1 Level A. Adequate packing to provide protection against handling, shipping, and storage hazards during worldwide distribution.

E.2.1.2 Level B. Adequate packing to provide protection against handling, shipping, and storage hazards that may occur during multiple domestic shipments or which are known to be less hazardous than those for Level A.

E.2.2 Top dunnage. Pieces of relatively stiff material, usually wood, lain across the top of a container or layer of containers to carry the weight of superimposed lading to the sides of the containers.

E.3 APPARATUS

E.3.1 Top superimposed-load test. In conducting the top superimposed-load test, any convenient method may be used for placing the load on top of the container; such as a hoist, a block and tackle, or by hand. A sufficient quantity of weights not greater than 10 by 10 inches in outside length and width will be provided. Weights may be boxes loaded with lead or other material.

E.4 SPECIMEN

E.4.1 Contents of container. One container shall constitute a single specimen. If the container's ability to support a load is enhanced by interior packaging or the intended contents, then the container shall be loaded for the test with the interior packaging 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.5 CONDITIONING

E.5.1 Test specimen. Unless otherwise specified in the CIDS, no special conditioning of the test specimen shall be necessary.

E.6 PROCEDURE

a. The specimen shall be placed on its bottom on a flat, level, rigid floor. Weights shall be placed on top of the container in a symmetrical pattern approximating uniform loading, so that they do not extend over the sides or ends of the top surface. There shall be one weight to each 1-foot square of top surface and each weight shall be whatever is necessary to attain the prescribed load for the top area. The load shall be allowed to remain in place for a prescribed period of time. Unless otherwise specified in the CIDS and when the test is conducted to determine satisfactory performance of a container, the prescribed period of time of loading shall be 1 hour and the prescribed load shall be as follows:

W = Top area in square feet by 50 by S

Where:

(1) W = Prescribed top superimposed load, in pounds.

(2) S = 2.0 for Level A packing.

(3) S = 1.5 for Level B packing.

(a) If the principal support structure is a plastic or other nonmetallic material with a tendency to creep or deteriorate when exposed to elevated temperatures or very humid conditions, the test shall be repeated at a temperature of 120±5 °F and 90 percent relative humidity for a period of 168 hours. In this latter case, the constant "S" shall be 1.5.

b. Measurements of distortion and of any changes or breaks in the container, such as apparent buckling or failure of members in the tops, sides, or ends, shall be made and recorded immediately before the load is removed. Any vertical deflections of the sides and ends shall be measured from taut horizontal string lines stretched between nails in the top corners of each side and end. In addition, bulging of the side and end panels shall be measured from a vertical straightedge. The cupping of the top shall be measured similarly by using a straightedge across the top midlength of the specimen (see figure E-1). Observations shall also be made and recorded to determine if the distortions are sufficient to damage or dislodge any portion of the container, the interior packing, or contents. After removal of the load, the extent of recovery from distortions shall be observed and recorded.

E.7 NOTES

a. This test is meant to simulate the top superimposed loads, as imposed by piling without dunnage many small, heavy packages on a container. It is intended that this test be used only on containers that are likely to be stressed in this manner. Details are given with the qualification "unless otherwise specified" in paragraphs regarding:

(1) Conditioning of specimens (see E.5.1).

(2) Load and duration of load (see E.6.a).

b. Although the recommended period of time for the top superimposed-load test is only 1 hour, the use of the factor for Levels A and B packing ensures a load-carrying capacity adequate for longtime loading and an occasional application of impact loads.

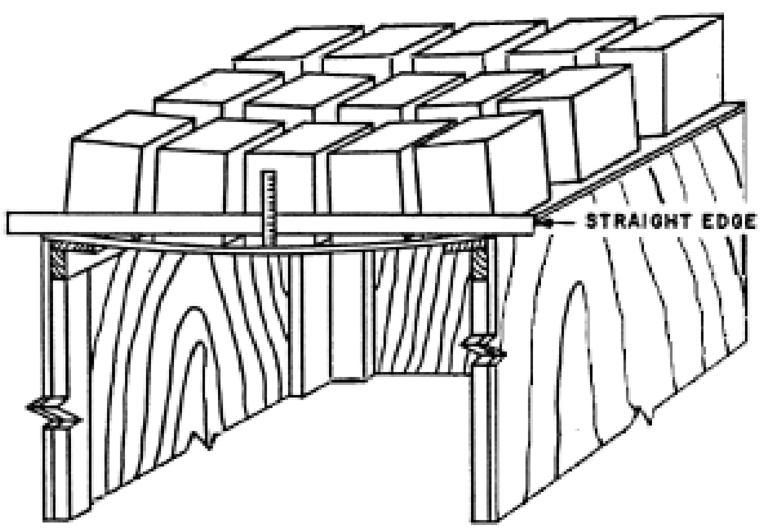


FIGURE E-1. Top superimposed-load test (uniformly distributed, without dunnage).

VIBRATION (REPETITIVE SHOCK) TEST

F.1 SCOPE

F.1.1 Scope. This appendix provides procedures intended to indicate whether or not a package is adequate to prevent damage to either the packaging or the contents when the package is tested unattached on the platform of a package vibration testing machine at frequencies below 5 hertz. Either the package bounces on the platform, and receives repetitive shocks and vibration of an indiscrete and variable nature; or the package does not leave the platform. Shocks applied to the package excite each component at its own natural frequency, but when the package 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.

F.2 DEFINITIONS

F.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.)

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

F.3 APPARATUS

F.3.1 Platform. A platform of suitable size and weight-carrying capacity supported on a mechanism that shall 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 F.6.

F.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.

F.4 SPECIMENS

F.4.1 Contents of container. One container and its contents shall constitute a single specimen. The container 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. 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, shall be determined by appropriate methods to establish the extent of damage suffered in the test.

b. 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.

F.5 CONDITIONING

F.5.1 Test specimen. Unless otherwise specified in the CIDS, no special conditioning of the test specimen shall be necessary. The condition of the specimen and any tests performed prior to the vibration test shall be recorded.

F.6 PROCEDURE

a. The specimen shall be placed on but not fastened to the platform. If the specimen might be shipped in other than an upright orientation, the test shall be interrupted and the orientation changed so that the specimen is tested for equal periods of time in each reasonable shipping orientation. If the specimen rocks during testing, in any orientation, then midway through the test period for that orientation, the specimen shall be rotated 180 degrees. Unless failure occurs, the total time of vibration shall be 2 hours if the specimen is tested in one orientation; and if tested in more than one orientation, the total time shall be 3 hours.

b. 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 orientation, about ½ inch, in any horizontal direction.

c. With the specimen in one orientation, the platform shall be vibrated at ½-inch amplitude (1-inch double amplitude) starting at a frequency of about three cycles per second. The frequency shall be steadily increased until the package leaves the platform (i.e., until a 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 container leaves the table not less than 0.1875 inch on each cycle. This test is normally conducted at an ambient temperature. While observing to detect development of any failure, vibration shall continue at such frequency until the total time of vibration in the orientation is completed. Whether or not the specimen leaves the platform and the frequency maintained shall be observed and recorded.

d. If the specimen is to be tested in more than one orientation, F.6.c shall be repeated for each orientation.

e. After the total period of vibration is complete, the packaging and the contents shall be inspected for evidence of damage. Appropriate functional or other tests shall be made to establish whether or not the item suffered damage.

FREE-FALL DROP TEST

G.1 SCOPE

G.1.1 Scope. This appendix provides procedures for determining the ability of containers to withstand impacts and the ability of packaging and packing methods to protect the contents when the pack is subjected to free-fall drops. This procedure is appropriate for use with all containers weighing up to 150 pounds, except those with skids or those having any edge or diameter over 60 inches. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

G.2 APPARATUS

Any suitable apparatus may be used that conforms to the following requirements:

a. Permits the container to be placed in a position prior to release that will assure free, unobstructed fall to impact the container at the orientation and in the direction required.

b. Permits accurate and convenient control of the height of drop.

c. Utilizes lifting devices that shall not damage the containers, reinforce the container during impact, nor cushion the impact by falling between impact surfaces during the drop.

d. Provides an instantaneous release mechanism that does not impart rotational or sidewise forces to the test container.

e. Provides a rigid and level steel surface not less than ½ inch thick, integral with a solid mass of concrete, steel, or stone sufficient to absorb all shock without displacement.

f. Provides, when required by the CIDS, an additional and properly positioned hazard to test a container's ability to protect a specific point of critical vulnerability of its contents. This hazard will consist of a straight block of oak or other relatively heavy hard wood 4 by 4 by at least 24 inches long with the edges rounded to a radius of $\frac{1}{4} \pm \frac{1}{16}$ inch. The detail specifications will include any further description of the impacting object, the attitude, the point of impact, height, and number of drops.

G.3 SPECIMEN

G.3.1 Contents of container. One container and its contents shall constitute a single specimen. The container 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 with weight, rigidity, shape, and CG position in the container. The contents, or dummy load, shall be blocked, braced, and cushioned in place, as for shipment, and appropriately instrumented to record shock forces or deflections during the test.

G.4 CONDITIONING

G.4.1 Test specimen. All tests shall be conducted at room temperature (ambient) except as noted below. The container test specimen shall be closed and prepared as for shipment, prior to any pretest conditioning. Closure mechanisms may not be adjusted (loosened or tightened) to compensate for changes during the conditioning period.

G.5 PROCEDURE

G.5.1 Bags. Unless otherwise specified in the CIDS, each bag specimen shall be dropped once on the filling end and once flatwise (seams horizontal) from a height of 48 inches.

G.5.2 Cylindrical containers. Unless otherwise specified in the CIDS, cylindrical containers, barrels, pails, etc. shall be subjected to one of the procedures described below. The container shall be dropped, once flatwise, on each end. The top and bottom rim or chime drops shall be made wherein the container CG is directly above the striking point at the instant of release. A plumb line aligned with the center point of the drop table (see figure G-1) may be used to position the container. The rim drop shall be made in pairs: one on the top rim and one on the bottom rim. For the two drops of each pair, the container shall strike on diagonally opposite quadrants of the top and bottom rims. If a total of more than four rim drops is specified, the additional drops shall be on sections not previously dropped upon.

Procedure A. One drop on each end (two drops).

Procedure B. One drop on each half of the top and bottom rims (four drops).

Procedure C. One drop on each quadrant of the top and bottom rims (eight drops).

Procedure D. One drop on each half of the top and bottom rims, one drop on each end, and two drops on the cylindrical side of the container at 90 degrees to each other (eight drops).

G.5.3 Rectangular containers. Unless otherwise specified in the CIDS, rectangular containers shall be subjected to one or more of the following procedures, as described below, but dropped not more than once on any flat face, edge, or corner. For edgewise drops, the striking edge of the package shall be parallel with the dropping surface at the instant of release. For edgewise and cornerwise drops, the package CG shall be directly above the striking edge or corner of the package at the instant of release (see figure G-1).

Procedure A. One drop on each flat face, edge and corner (26 drops).

Procedure B. One drop on each flat face (6 drops).

Procedure C. One cornerwise drop followed by one edgewise drop on each of the three edges radiating from the struck corner (4 drops).

Procedure D. One cornerwise drop on each of the four bottom corners (4 drops).

Procedure E. One cornerwise drop on each of the eight corners (8 drops).

Procedure F. One drop on each edge (12 drops).

Procedure G. One cornerwise drop on each of two sets of diagonally opposite corners; followed by one flat drop on the bottom, top, and two adjacent sides (8 drops).

If the test specimen contains materials which are significantly affected by temperature, the test shall be conducted at the specified temperature extremes. Unless otherwise specified in the CIDS, half of the drops indicated by the above procedures shall be made at a stabilized temperature of -20±5 °F and half shall be made at a temperature of 120±5 °F.

G.5.4 Drop height. All package drops shall be made so that the package falls freely through the specified vertical free-fall distance (see table G-I).

G.6 NOTES

This method specifically describes only the free-fall drop test procedure. If other tests on the container, such as a preceding exposure test or a subsequent leakage test are desired, then such tests and their sequence should be specified. In this free-fall drop test procedure, details are given with the qualification "unless otherwise specified" in paragraphs regarding:

a. Conditioning of specimens (see G.4.1).
b. Height of drop, number of drops, points of impact (see G.5.1, G.5.2, and G.5.3).

This test is meant to simulate the impacts of accidentally dropping a container on its edges, corners, or flat surfaces.

TABLE G-I. Height of free-fall drops for containers of various sizes and weights.

Gross weight (within range limits)	Dimension of any edge, height, or diameter (within range limits)	Height of free-fall drop on corners or edges or flat faces	
Pounds	**Inches**	**Level A inches**	**Level B inches**
0 - 15	0 - 30	36	27
16 - 30	31 - 33	30	22
31 - 50	34 - 37	25	19
51 - 75	38 - 42	21	17
76 - 110	43 - 50	19	15
111 - 150	51 - 60	18	14

NOTES:

1. Use the lowest drop height indicated by either gross weight or dimension. (For example, a container having a gross weight of 36 pounds and a maximum edge dimension of 42⅝ inches will be dropped 19 inches for Level A or 15 inches for Level B.)
2. Containers with gross weight or any one dimension exceeding 150 pounds or 60 inches, respectively, should not be tested by the free-fall method unless warranted by exceptional package design or intended use. (See the cornerwise- and edgewise-drop test impacts and tipover test [Appendix H, I, and J, respectively].)
3. As a guideline for normal handling and transportation mishaps by non-U.S. Navy logistics of non-person portable containers for Level A protection, 15 inches is an acceptable height, while for Level B protection, 12 inches is an acceptable height regardless of overall gross weight or dimensional size.
4. Weight and dimensions to be rounded to the nearest full number (e.g., 15.4 to 15, 30.6 to 31, etc.).

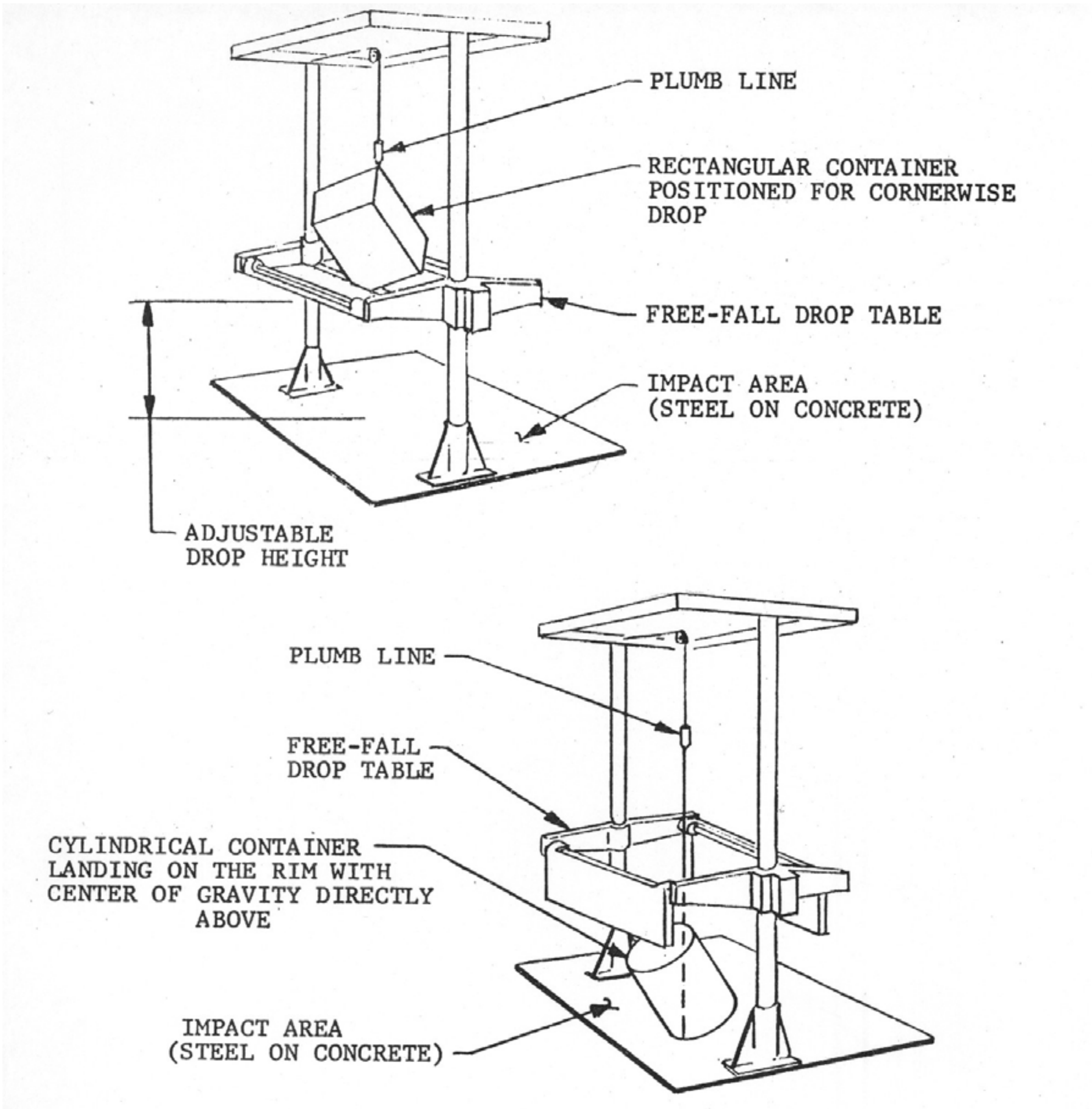


FIGURE G-1. Free-fall drop test.

CORNERWISE-DROP (ROTATIONAL) TEST

H.1 SCOPE

H.1.1 Scope. This appendix provides procedures for determining the ability of large shipping containers to resist the impacts of being dropped on their corners and for determining the ability of 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.

H.2 DEFINITIONS

H.2.1 Large shipping containers. For the purpose of this test, a large shipping container may be a box, case, crate, other container constructed of wood, metal, or other material, or any combination of these for which the free-fall drop test is not considered practical or adequate. Large containers are considered those having:

a. Gross weight over 150 pounds,

b. Length of any edge over 60 inches, or

c. Gross weight under 150 pounds and the container is equipped with skids.

H.3 APPARATUS

H.3.1 Cornerwise-drop test. In conducting the cornerwise-drop test, the container 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.

H.4 SPECIMEN

H.4.1 Contents of container. One container and its contents shall constitute a single specimen. The container 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 CG 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.

H.5 CONDITIONING

H.5.1 Test specimen. All tests shall be conducted at room temperature (ambient) except as noted below. The container test specimen shall be closed and prepared as for shipment, prior to any pretest conditioning. Closure mechanisms shall not be adjusted (loosened or tightened) to compensate for changes during the conditioning period.

H.6 PROCEDURE

H.6.1 Number and height of drops. The specimen shall be placed on its bottom base down in the normal shipping condition. One corner of the base of the container 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 container 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 container when dropping takes place, but should not be high enough to cause the container to slide on the supports when the drop end is raised for the drop. The unsupported end of the container 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 H-1). Unless otherwise specified in 5.2.4, the height of drop for Levels A and B protection shall conform to table H-I; the maximum heights shall not exceed 36 inches and 27 inches, respectively. Unless otherwise specified in the container CIDS, there shall be one drop on each corner of the container base (four drops). If the test specimen contains materials which are significantly affected by temperature, the test shall be conducted while the container 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 120±5 °F. Thus, a total of four drops constitutes a complete test.

H.7 NOTES

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

(1) Definition of large container (see H.2.1).

(2) Conditioning of specimen (see H.5.1).

(3) Number and height of drops (see H.6.1).

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 container was designed.

TABLE H-I. Height of rotational drops for containers of various sizes and weights.

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
251 - 400	67 - 72	32	24
401 - 600	73 - 80	28	21
601 - 1000	81 - 95	24	18
1001 - 1500	96 - 114	20	16
1501 - 2000	115 - 144	17	14
2001 - 3000	Above 144	15	12
Above 3000		12	9

NOTES:

1. Use the lowest drop height indicated by either gross weight or dimension. (For example, a container having a gross weight of 440 pounds and a maximum edge dimension of 95⅝ inches will be dropped 20 inches for Level A tests or 16 inches for Level B tests.)
2. As a guideline for normal handling and transportation mishaps by non-U.S. Navy logistics of non-person portable containers for Level A protection, 15 inches is an acceptable height, while for Level B protection, 12 inches is an acceptable height regardless of overall gross weight or dimensional size.
3. Weight and dimensions to be rounded to the nearest full number (e.g., 15.4 to 15, 30.6 to 31, etc.).

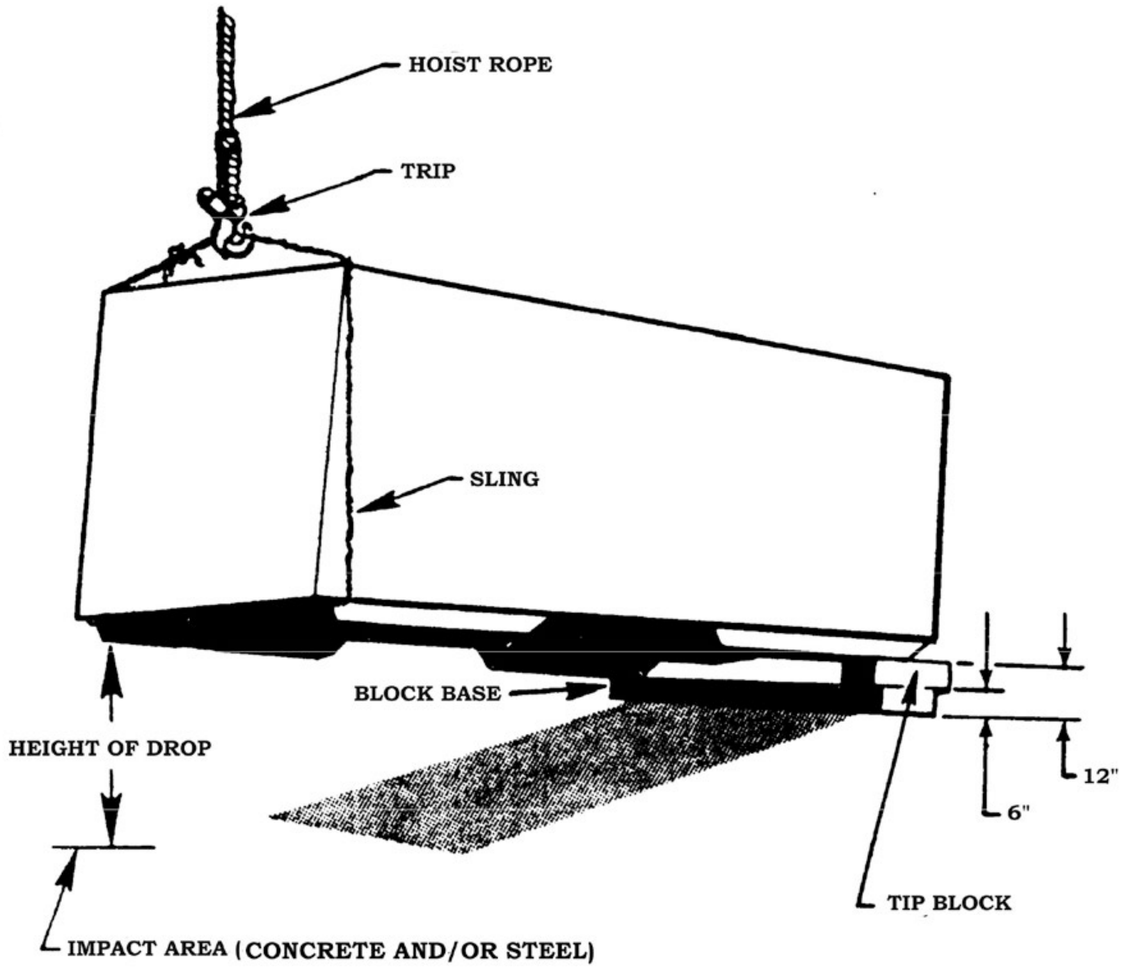


FIGURE H-1. Cornerwise drop (rotational).

EDGEWISE-DROP (ROTATIONAL) TEST

I.1 SCOPE

I.1.1 Scope. This appendix provides procedures for determining the ability of large shipping containers 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 pack is dropped on its edges. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

I.2 DEFINITIONS

I.2.1 Large shipping containers. For the purpose of this test, a large shipping container may be a box, case, crate, or other container constructed of wood, metal, or other material, or any combination of these for which the free-fall drop test is not considered practical or adequate. Large containers are considered those having:

a. Gross weight over 150 pounds,

b. Length of any edge over 60 inches, or

c. Gross weight under 150 pounds and the container is equipped with skids.

I.3 APPARATUS

I.3.1 Edgewise-drop test. In conducting the edgewise-drop test, the container 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.

I.4 SPECIMEN

I.4.1 Contents of container. One container and its contents shall constitute a single specimen. The container 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 CG 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.

I.5 CONDITIONING

I.5.1 Test specimen. All tests shall be conducted at room temperature (ambient) except as noted below. The container test specimen shall be closed and prepared as for shipment prior to any pretest conditioning. Closure mechanisms shall not be adjusted (loosened or tightened) to compensate for changes during the conditioning period.

I.6 PROCEDURE

I.6.1 Number and height of drops. The specimen shall be placed on its bottom with one end of the base of the container 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 container when dropping takes place, but should not be high enough to cause the container to slide on the supports when the drop end is raised for the drop. The unsupported end of the container shall then be raised and allowed to fall freely to the concrete surface or similarly unyielding surface from a prescribed height (see figure I-1). Unless otherwise specified in 5.2.5, the height of drop for Levels A and B protection shall conform to table I-I. The maximum heights shall not exceed 36 inches for Level A and 27 inches for Level B protection. Unless otherwise specified in 5.2.5, a total of four drops constitute a complete test. If the size of the container and the location of the CG are such that the drop cannot be made from the prescribed height, the height of the sill shall be increased. Rectangular containers shall be dropped once on each edge of the container base. Cylindrical containers shall be dropped on the top and bottom rims at diagonally opposite quadrants and shall not require corner drops. 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 container is stabilized at the extremes of temperature. Unless otherwise specified in the container CIDS, half the total number of drops shall be made at -20±5 °F and half will be made at 120±5 °F.

I.7 NOTES

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

(1) Definition of large container (see I.2.1).

(2) Conditioning of specimens (see I.5.1).

(3) Number and height of drops (see I.6.1).

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 container was designed.

TABLE I-I. Height of rotational drops for containers of various sizes and weights.

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
251 - 400	67 - 72	32	24
401 - 600	73 - 80	28	21
601 - 1000	81 - 95	24	18
1001 - 1500	96 - 114	20	16
1501 - 2000	115 - 144	17	14
2001 - 3000	Above 144	15	12
Above 3000		12	9

NOTES:

1. Use the lowest drop height indicated by either gross weight or dimension. (For example, a container having a gross weight of 440 pounds and a maximum edge dimension of 95⅝ inches will be dropped 20 inches for Level A tests or 16 inches for Level B tests.)
2. As a guideline for normal handling and transportation mishaps by non-US Navy logistics of non-person portable containers for Level A protection, 15 inches is an acceptable height, while for Level B protection, 12 inches is an acceptable height regardless of overall gross weight or dimensional size.
3. Weight and dimensions to be rounded to the nearest full number (e.g., 15.4 to 15, 30.6 to 31, etc.).

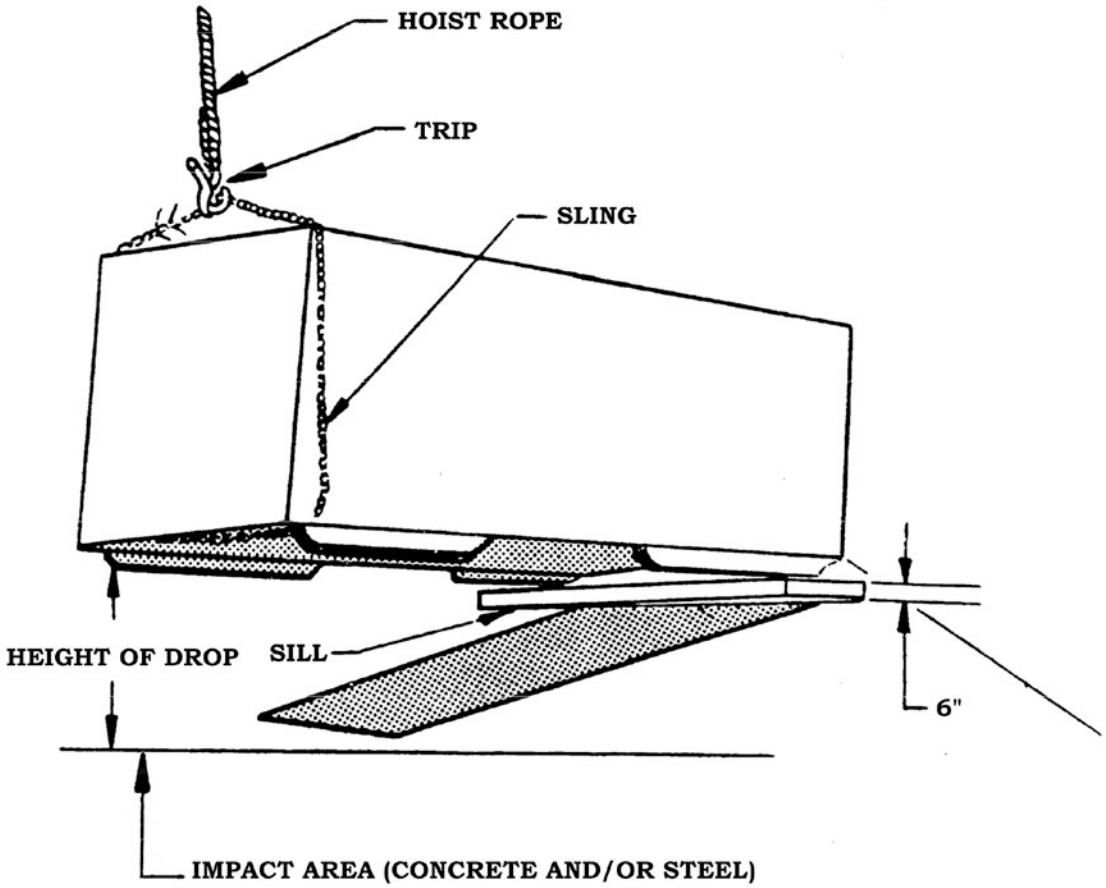


FIGURE I-1. Edgewise drop (rotational).

TIPOVER TEST

J.1 SCOPE

J.1.1 Scope. This appendix provides procedures for determining the ability of large shipping containers to resist the impacts of being tipped over, and for determining the ability of the packaging and packing methods to provide protection to the contents when the pack is tipped over. Unless otherwise specified in the CIDS, only containers whose weight and balance are such that the container will tip over when an edge or corner is raised sufficiently for the base to form a 20-degree angle with the floor will be tested in this manner. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

J.2 DEFINITION

J.2.1 Large shipping containers. For the purpose of this test, a large shipping container may be a box, case, crate, or other container constructed of wood, metal, or other material, or any combination of these for which ordinary box tests are not considered practical or adequate. Unless otherwise specified in the CIDS, large containers are considered those having:

a. Gross weight over 150 pounds,

b. Length of any edge over 60 inches, or

c. Gross weight under 150 pounds and the container is equipped with skids.

J.3 APPARATUS

J.3.1 Tipover test. In making the tipover test, the container 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.

J.4 SPECIMEN

J.4.1 Contents of container. One container and its contents shall constitute a single specimen. The container 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.

J.5 CONDITIONING

J.5.1 Test specimen. Unless otherwise specified in the CIDS, no special conditioning of the test specimen shall be necessary.

J.6 PROCEDURE

J.6.1 Number and direction of tipover. The specimen shall be placed on its bottom and tipped until it falls freely (by its own weight) on its side to a smooth, level, concrete slab or similarly unyielding surface. Unless otherwise specified in the CIDS, 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 container, 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.

J.7 NOTES

a. This test is meant to simulate the impacts of accidentally tipping over a container. It is intended that the tipover test be used only on containers that are susceptible to accidental tipovers. Details are given with the qualification "unless otherwise specified" in paragraphs regarding:

(1) Scope – excluded containers (see J.1.1).

(2) Definition of large containers (see J.2.1).

(3) Conditioning of specimens (see J.5.1).

(4) Number and direction of tipover (see J.6.1).

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 pack was designed.

ROLLOVER TEST

K.1 SCOPE

K.1.1 Scope. This appendix provides procedures for indicating the ability of a package to withstand rolling completely over from base to one side, to top, to other side, and onto the base again. This procedure is applicable to packages too large for testing in the revolving drum apparatus, but light enough, or of proportions, so that the package might possibly be rolled over during rough handling. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

K.2 APPARATUS

The following shall be required for the rollover test:

a. A sufficient area of level, rigid pavement or similarly unyielding surface.

b. A forklift truck, or sufficient manpower, to topple the package for each impact.

K.3 SPECIMEN

K.3.1 Contents of container. One container and its contents shall constitute a single specimen. The container 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.

K.4 CONDITIONING

K.4.1 Test specimen. Unless otherwise specified in the CIDS, no special conditioning of the test specimen shall be necessary.

K.5 PROCEDURE

a. The specimen shall be placed in its normal upright position on the pavement. The specimen shall then be slowly tipped toward one side until it topples and falls by its own weight onto the side. The specimen shall then be toppled so that it falls onto its top. Again, the specimen shall be toppled so it falls onto its other side and, finally, toppled so it falls onto its base. The container shall be observed and any evidence of inadequacies or damage that would impair serviceability of the container shall be recorded.

b. The container shall be opened and the blocking, bracing, cushioning, and preservation shall be examined. Any evidence of inadequacies or damage that would impair serviceability of the package shall be recorded.

c. If the specimen included the item for which the package was designed, whether or not the item sustained damage shall be determined and recorded, any damage shall be described, and any apparent reasons why damage occurred shall be recorded.

K.6 NOTES

a. Details are given with the qualification “unless otherwise specified” in the paragraph regarding conditioning (see K.4.1).

b. This procedure should not be used for items too heavy to anticipate rollover in handling. For relatively high, narrow packages, the tipover test (see Appendix J) may be more appropriate than this rollover test.

INCLINE-IMPACT TEST

L.1 SCOPE

L.1.1 Scope. This appendix provides procedures for determining the ability of large shipping containers to resist impacts on their surfaces or edges, and for determining the ability of the packaging and packing methods to provide protection to the contents when the pack is impacted on its surfaces or edges. This test may be applied also to unitized loads. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

L.2 DEFINITION

L.2.1 Incline impact tester. For the purpose of this test, an incline-impact tester will consist of a two-rail steel track inclined 10 degrees from the horizontal, a rolling carriage or dolly, and a rigid bumper (see L.3 and figure L-1).

L.3 APPARATUS

L.3.1 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 or steel. 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 projections, such as bolts or nail heads, 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.

L.4 SPECIMEN

L.4.1 Contents of container. One container and its contents shall constitute a single specimen. The container 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.

L.5 CONDITIONING

L.5.1 Test specimen. Unless otherwise specified in the CIDS, no special conditioning of the test specimen shall be necessary.

L.6 PROCEDURE

a. 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. If it is desired to concentrate the impact at any particular position on the container, a 4- by 4-inch timber or 8- by 8-inch steel may be 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 container 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. Unless otherwise specified in the CIDS and when the test is conducted to determine satisfactory performance of a container or pack, the specimen shall be subjected to one impact on each surface that has each dimension less than 9.5 feet. Unless otherwise specified in the CIDS, the velocity at time of impact (which may be assumed equal to twice the average velocity) shall be 7 feet per second.

b. A record shall be made of each impact to show velocity at impact and any changes or breaks in the container, 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.

L.7 NOTES

This test is meant to simulate railroad humping, switching, or other accidental handling impacts. It is intended that the incline-impact test be used only on containers that are susceptible to such accidental impacts. Details are given with the qualification "unless otherwise specified" in paragraphs regarding:

a. Conditioning of specimens (see L.5.1).

b. Number and velocity of impacts (see L.6.a).

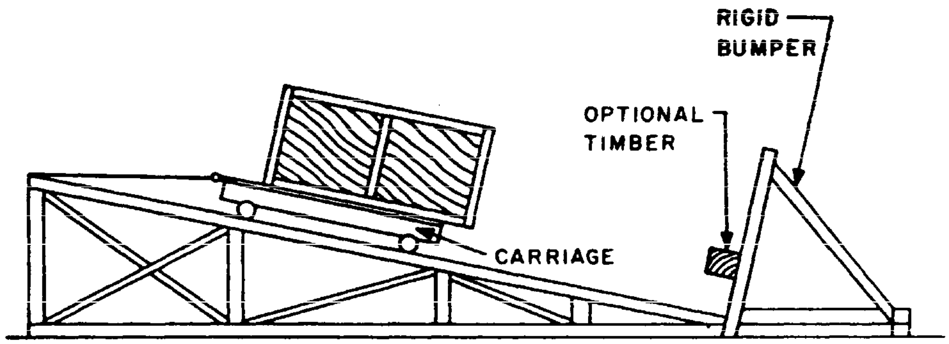


FIGURE L-1. Incline-impact test.

PENDULUM-IMPACT TEST

M.1 SCOPE

M.1.1 Scope. This appendix provides procedures for determining the ability of large shipping containers to resist horizontal impacts and for determining the ability of the packaging and packing methods to provide protection to the contents when the pack is impacted. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

M.2 DEFINITION

M.2.1 Large shipping containers. For the purpose of this test, a large shipping container may be a box, case, crate or other container constructed of wood, metal or other material, or any combination of these for which ordinary box tests are not considered practical or adequate. Unless otherwise specified in the CIDS, large containers will be considered as those which measure more than 60 inches on any edge or diameter, or those when loaded, have gross weights in excess of 150 pounds.

M.3 APPARATUS

M.3.1 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 container end, 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, if used, shall be large enough to support the container or pack, and when hanging free, shall have its top surface approximately 9 inches above the floor. 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. If the platform is not utilized, suspension chains will interface directly with container lift features (see figure M-1).

M.4 SPECIMEN

M.4.1 Contents of container. One container and its contents shall constitute a single specimen. The container 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.

M.5 CONDITIONING

M.5.1 Test specimen. Unless otherwise specified in the CIDS, no special conditioning of the test specimen shall be necessary.

M.6 PROCEDURE

a. 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 CG of the pack is raised to the prescribed height, and then shall be released to swing freely so that the surface of the container impacts against the bumper (see figure M-2). Unless otherwise specified in the CIDS and when the test is conducted to determine satisfactory performance of a container or pack, 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 in the CIDS, the vertical height of drop shall be 9 inches, which results in a velocity of 7 feet per second at impact.

b. A record shall be made of any changes or breaks in the container, 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.

M.7 NOTES

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

(1) Definition of large containers (see M.2.1).

(2) Conditioning of specimens (see M.5.1).

(3) Number and height of drops (see M.6.a).

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 pack was designed.

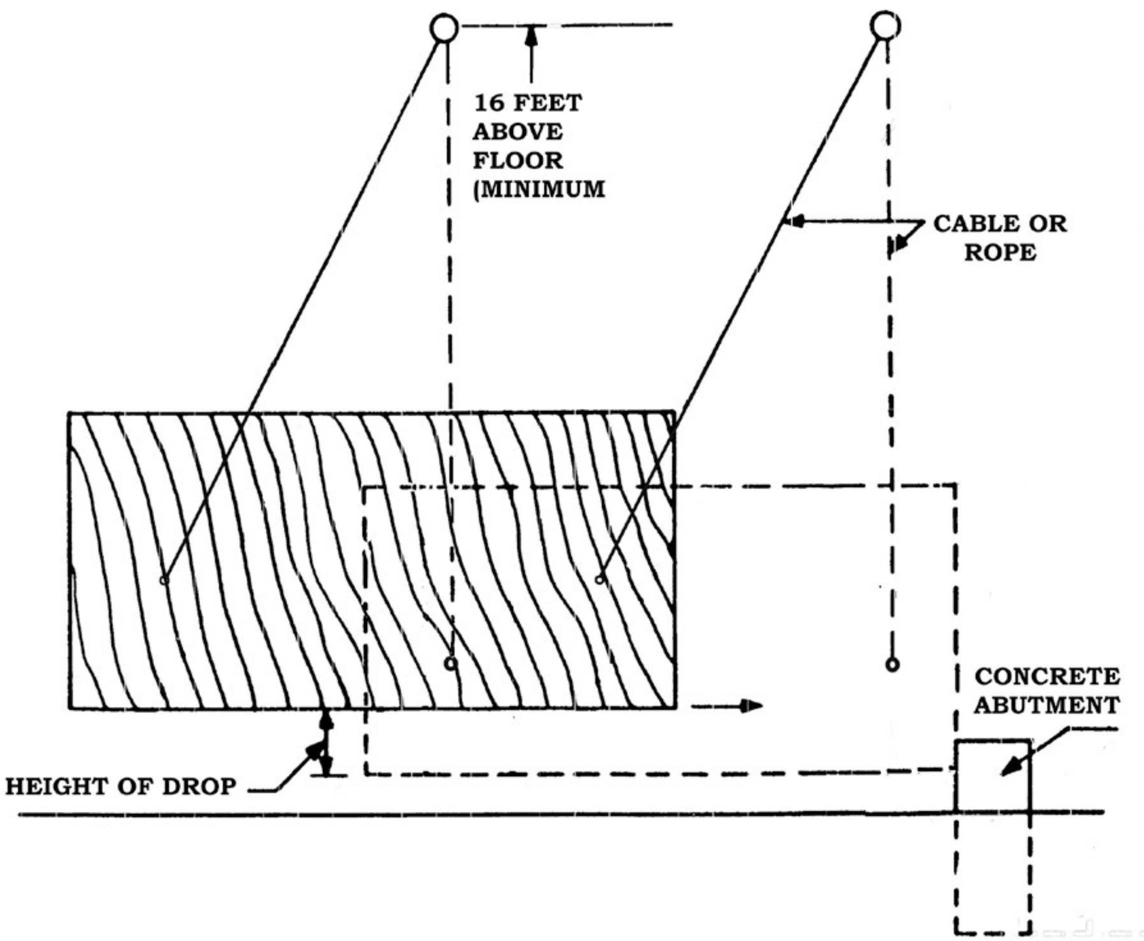


FIGURE M-1. Pendulum-impact test without platform.

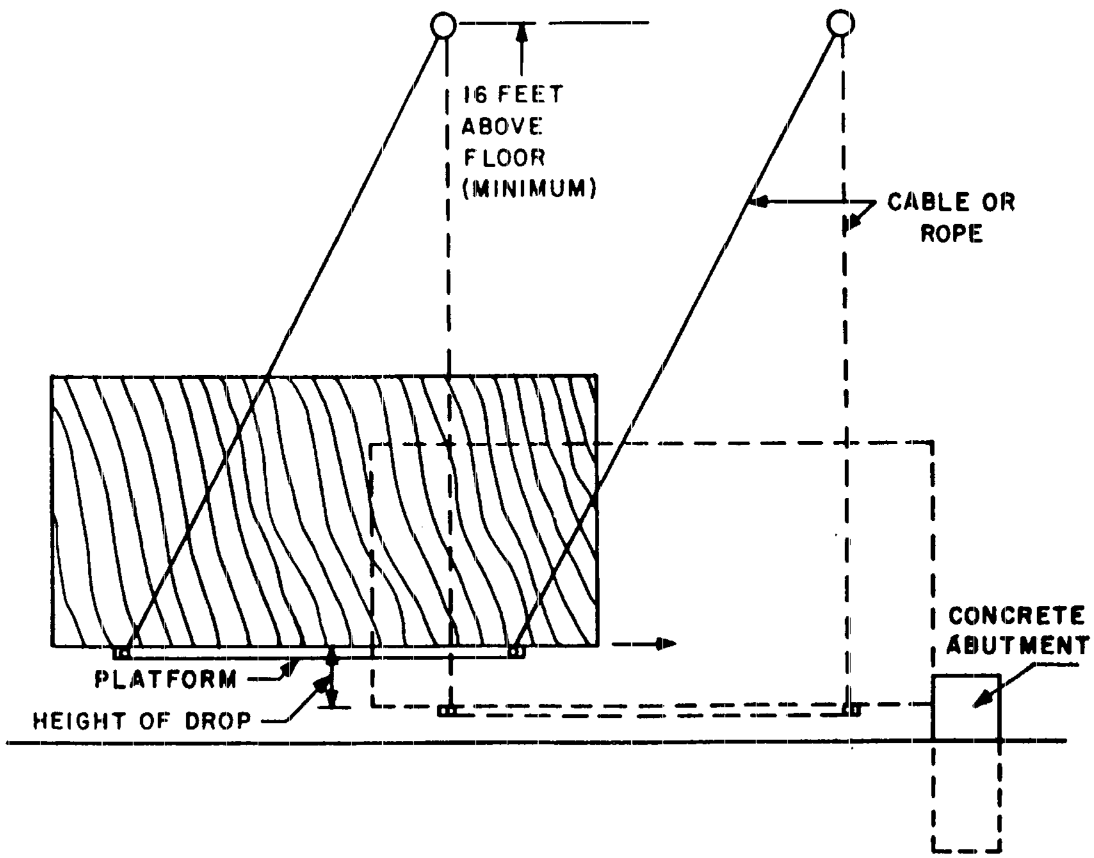


FIGURE M-2. Pendulum-impact test with platform.

VIBRATION (SINUSOIDAL MOTION) TEST

N.1 SCOPE

N.1.1 Scope. This appendix provides procedures for testing packages containing items that might be susceptible to vibration encountered during shipment by common carrier. In particular, the method simulates application of the rectilinear components of the probable shipping vibration environment to packages that are tied down to the floor of the carrier in transit. By testing according to this procedure, it will be possible to determine (1) the probability of the packaging to withstand this kind of shipping vibration environment and (2) the probable adequacy of the packaging to protect the item from shipping vibration. To serve this function, the actual item should be used rather than a dummy load, and functional tests before and after vibration should be performed. The test method is intended for packages that contain susceptible items which will be tied down to the floor of the carrier (both, not either). This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

N.2 DEFINITION

N.2.1 Octave. A change in frequency by a factor of either 2 or 0.5.

N.3 APPARATUS

N.3.1 Platform. A platform of suitable size and weight-carrying capacity supported on a mechanism(s) that shall maintain the surface, essentially horizontal, as it vibrates the platform vertically in linear motion. For this motion, the relationship between displacement and time shall be approximately a sine wave. Controls of the motion shall be capable of producing the test envelope in N.6.b.

N.3.2 Fixture. A fixture to anchor the specimen to the platform. Neither the fixture nor the platform should have a natural frequency within the range specified in N.6.b. If unavoidable, the natural frequencies shall be recorded and the test data at these frequencies shall be interpreted with appropriate reservations.

N.3.3 Instrumentation. Instrumentation shall have a flat (±5 percent) response within the frequency range specified in N.6.b.

N.4 SPECIMENS

N.4.1 Contents of container. One container and its contents shall constitute a single specimen. The container 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. If the intended contents or a fully representative dynamically similar dummy load, such as a reject item, are to be used in the package, their condition before and after the vibration test shall be determined by appropriate methods to establish the extent of damage suffered during the vibration test.

b. If a dummy load is to be used, unless it is fully representative of the intended contents, the ability of the packaging to prevent damage can be estimated by indirect methods, such as comparison of accelerations measured on the dummy load and fragility factors for the intended contents, or other indirect comparisons.

N.5 CONDITIONING

N.5.1 Test specimen. Unless otherwise specified in the CIDS, no special conditioning of the test specimen shall be necessary. The condition of the specimen and any tests performed prior to the vibration test shall be recorded.

N.6 PROCEDURE

a. The specimen shall be attached securely on the platform so that no point can lift off the platform during vibration. If the specimens might be shipped in other than an upright position, the specimen shall be in such a position; and if more than one position is reasonable, the test shall be extended and the position changed so that the specimen shall be tested in each reasonable shipping position. Electric resistance type strain gages, accelerometers, or other sensors shall be attached to strategic areas of the specimen, as appropriate, for the purpose of the test.

b. Unless otherwise specified in the CIDS, the apparatus shall be operated for 7.5 minutes by vibrating in the vertical axis with a sinusoidal profile from 5 to 50 hertz; with a constant 0.125-inch double amplitude input displacement from 5 to 12.5 hertz, switching to a constant 1 g input from 12.5 to 50 hertz.

(1) During operation of the apparatus, the output of the sensors on the apparatus and on the specimen shall be either recorded or monitored. Any indications of resonance shall be recorded.

c. Unless otherwise specified in the CIDS, when resonance is indicated in N.6.b, the specimen shall be tested an additional 30 minutes at the maximum resonant frequency. The frequency shall start at resonance and shall be adjusted, if necessary, to maintain resonance.

d. The specimen shall be inspected (packaging and contents) and any evidence of damage shall be recorded. Appropriate functional or other tests shall be made and results to establish whether or not the item suffered damage during the vibration test shall be recorded.

LEAKS IN CONTAINERS

O.1 SCOPE

O.1.1 Scope. This appendix provides nine common techniques for detecting leaks in containers. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

a. For the leakage of air, the following techniques are included:

(1) Vacuum retention technique. Technique in which air is evacuated from the container and is vacuum-sealed. Leakage is indicated by a loss of vacuum (see O.6.1).

(2) Vacuum chamber technique. The container is sealed at ambient conditions as for shipment, and then observed in a vacuum chamber to detect leaks (see O.6.2).

(3) Pneumatic pressure technique. The air in the container is pressurized and then the container is observed to detect leaks (see O.6.3). Leaks may be located by one of the methods in O.6.3.d.

(4) Squeeze technique. A flexible container is sealed containing air at ambient conditions as for shipment, and then is squeezed to increase the internal air pressure as the container is observed to detect leaks (see O.6.4).

(5) Hot water technique. A container is sealed containing air at ambient conditions as for shipment, and then immersed in hot water so that the rise in internal air temperature will produce a rise in air pressure as the container is observed for leaks (see O.6.5).

b. For the leakage of water, or other contents indicated, the following techniques are included:

(1) Submersion technique. The sealed container is submerged in various positions under water and subsequently opened and inspected for leakage (see O.6.6). A variation is the “immersion technique” in which an open top container is inspected while immersed to a required depth.

(2) Simulated rainfall technique. The container closed as for shipment, is subjected to water spray and subsequently opened and inspected for leakage (see O.6.7).

(3) Hydraulic pressure technique. Internal pressure is utilized to force water or other liquids through any leaks and the container is inspected for such leakage (see O.6.8).

(4) Static leak test. The container is filled with water, or other contents, and observed at rest in various positions to detect leakage of such contents (see O.6.9).

O.2 DEFINITIONS

O.2.1 Leak. Any opening in a container which contrary to intention, either allows contents to escape or permits substances to enter.

O.2.2 Leakage. That which passes through a leak.

O.3 APPARATUS

a. Tests for air leaks shall require the following apparatus with the different techniques:

(1) Vacuum retention. A vacuum pump and pressure gage, such as a manometer.

(2) Vacuum chamber. A vacuum chamber with pressure controls and a vessel in which the specimen can be submerged in water.

(3) Pneumatic pressure. A supply of compressed air, pressure gage, and either a vessel in which the specimen can be submerged in water or a quantity of bubble-supporting liquid.

(4) Squeeze. Either a vessel in which the specimen can be submerged in water or a quantity of bubble-supporting liquid.

(5) Hot water. A vessel of hot water in which the specimen can be submerged and a means of maintaining the water temperature.

b. Tests for water leaks, or leaks of other contents, shall require the following apparatus with the different techniques:

(1) Submersion (or immersion). A vessel of water in which the specimen may be submerged or immersed.

(2) Simulated rainfall. Adjustable spray nozzles and a level area that will not tap standing water.

(3) Hydraulic pressure. A source of hydraulic or pneumatic pressure with gage and pressure regulator.

(4) Static leakage. Blocking, as necessary, to support the specimen in the various positions required.

c. Tests in which the specimen is submerged and for water tests other than simulated rainfall, the water used in the test may be a diluted colored solution prepared in the following proportions:

(1) 1 gram (g) of Aerosol OT (or approved substantial equal),

(2) 1 g of Erythrosin B (or approved substantial equal), and

(3) 98 milliliters of water.

The solution may be mixed and allowed to stand with occasional shaking for not less than 4 hours. One part of this solution may be diluted with four parts of water before use.

O.4 SPECIMEN

O.4.1 Contents of container. Unless otherwise specified in the CIDS, a specimen shall be one container (bag, envelope, pouch, can, drum, box, or other) and its intended contents or simulated contents packed and sealed as for shipment (see O.6).

O.5 CONDITIONING

O.5.1 Test specimen. Unless otherwise specified in the CIDS, no special conditioning of the test specimen shall be necessary and it shall be at equilibrium with normal room conditions (ambient).

O.6 PROCEDURE

O.6.1 Vacuum retention technique.

a. During the preparation of the specimen, provision shall be made for connecting a tube to evacuate air from the specimen and to connect with a gage that will indicate any loss in vacuum pressure. Such provision may be a tube sealed into an opening at one end of a seam in a flexible barrier, a drilled and tapped plug, a valve stem incorporated in a container, or other acceptable device that can be either sealed or removed so that the container can be reclosed or resealed upon completion of the test without adverse effect upon its serviceability.

b. The vacuum pump shall be connected to the specimen and the air shall be evacuated until the specimen vacuum is attained. Unless otherwise specified in the CIDS, the vacuum pressure shall be 9±1 millimeters of mercury or 5±½ inches of water. The required vacuum may be drawn more than once to ensure that equilibrium within the specimen is reached.

CAUTION: Vacuum pressure may cause damage to a flexible specimen or its contents, so use of this technique may be inappropriate for some designs.

c. When the specimen is evacuated to a constant specified pressure, the evacuation of air shall stop and the vacuum pressure gage reading shall be recorded.

d. Ten minutes, unless otherwise specified in the CIDS, after the initial vacuum pressure reading, the final pressure reading shall be read and recorded. The loss in vacuum pressure shall be computed and recorded.

O.6.2 Vacuum chamber technique.

a. The specimen shall be submerged in water contained in the vessel within the vacuum chamber. The uppermost surface of the specimen shall be covered by not more than 1 inch of water.

b. The chamber shall be evacuated to the specified vacuum pressure. Unless otherwise specified in the CIDS, the vacuum pressure (P) shall be calculated equal to the specified strength of the barrier seam (S) times pi (π) divided by the sum of the two smaller dimensions (d1 and d2) of the package.

$$P = \frac{S \times \pi}{(d1 + d2)}$$

(For example, to test a package 10 by 6 by 4 inches enclosed in MIL-PRF-131 barrier material, the vacuum pressure shall be the specified strength of MIL-PRF-131 barrier seam (3½ pounds/inches) times pi (3.14) divided by the sum of the smaller dimensions (6+4 inches); that is, the vacuum pressure will be $^{11}/_{10}$ or 1.1 pound/square inch. For other sizes, other pressures shall be calculated in a similar manner or read from an appropriate curve.)

c. The vacuum shall be held for 30 seconds while observing the submerged specimen for leakage.

d. The specimen shall be inverted and O.6.2.a, O.6.2.b, and O.6.2.c shall be repeated.

e. Locations of leaks or "no leaks" shall be recorded.

O.6.3 Pneumatic pressure technique.

a. During preparation of the specimen, provisions shall be made for connecting a tube or clamp-in valve to the specimen. The container shall be prepared by sealing or removing all breathing devices and installing suitable pressurizing fittings and gauges.

b. The specimen shall be pressurized with air from compressed air supply to 1.00+0.25/-0.0 psig above the required positive reseal pressure or a minimum of 1.50+0.50/-0.00 psig (after corrections for variations in air temperature and ambient pressure). After temperature stabilization, the internal pressure shall be monitored for a period of 1 hour. Any pressure loss over the test period shall be recorded.

CAUTION: Pneumatic pressure may cause explosive failure of weak specimens. The applied pressure shall not exceed the requirement of 5.5.2.1.

c. If any loss in pressure is detected, the leaks can be located by means of ultrasonic detector, submersion, or bubble-supporting film methods; and repaired, as required, to seal the container.

d. An ultrasonic translator detector finds areas where leakage occurs. This technique can be used on all types and sizes of pressurized containers as a rapid means of "pinpointing" the source of leak.

e. If a water tank is available and the containers are relatively small, the specimens may be submerged 1 to 2 inches under water and observed for leakage with the specimen upright and with the specimen inverted. If the tank is not available or the container is too large, leakage can be detected by coating joints, castings connections, and other likely points with a bubble-supporting film, and observed for leakage.

O.6.4 Squeeze technique. (Applicable only to flexible specimens, such as bags, envelopes, etc.).

a. During sealing of the specimen, as much air as possible shall be entrapped within the specimen.

b. The specimen shall either be submerged 1 to 2 inches under water and, while squeezing the specimen to force air to the area under observation, all seams and surface shall be observed for leakage; or all seams, joints, or other areas likely to leak shall be coated with a bubble-supporting film and each shall be observed for leaks while squeezing the specimen to force air to the area under observation. Locations of leaks or "no leaks" shall be recorded.

O.6.5 Hot water technique.

a. Any wax-dipped specimens shall be cooled to equilibrium at an initial temperature between 50 and 60 °F.

b. Unless otherwise specified in the CIDS, the specimen shall be submerged in water heated to a temperature at least 50 °F above the initial temperature of the specimen (not over 110 °F for wax-dipped specimens). While holding the specimen submerged with the uppermost surface covered by not more than 1 inch of water, the specimen shall be observed for at least 15 seconds to detect leakage. The specimen shall be rotated and observed repeatedly until the entire specimen has been examined. Total time in hot water should not exceed 8 minutes. The locations of any leaks or "no leaks" shall be recorded.

O.6.6 Submersion (or immersion) techniques.

a. Unless otherwise specified in the CIDS, the specimen shall be submerged so that the uppermost surface is beneath the water surface not less than 1 inch or more than 2 inches for 1 hour or longer in water maintained at a temperature of not less than 40 °F below the temperature at which the specimen is sealed. After submersion and before opening the specimen, the outside of the specimen where the opening will be made shall be carefully dried. Then the specimen shall be opened.

b. When immersion of an open top container is required, the container shall be positioned in the water at the depth specified and held in such position for the period of time specified (see O.7.1).

c. The inside shall be inspected for leakage. Whether or not the specimen leaked and, if possible, the locations of leaks shall be recorded.

O.6.7 Simulated rainfall technique.

a. Unless otherwise specified in the CIDS, the specimen shall be placed upright on the level area and the nozzles arranged above so that water droplets will fall vertically in a uniform distribution onto the top of the specimen and the pavement around the specimen at a rate such that 4±1 inches of water per hour will accumulate in open top cylindrical cans positioned upright anywhere on the top of the container. The specimen shall be sprayed for a period of 4 hours. Several specimens may be sprayed simultaneously if they are spaced not less than 6 inches apart.

b. Before opening the specimen, the outside of the specimen where the opening will be made shall be carefully dried. The specimen shall be opened and the inside, particularly any joints, connectors, and seams shall be inspected for leakage, or any adverse effect of spraying. Whether or not the specimen leaked or suffered from spraying and, if possible, the locations of any leaks shall be recorded.

O.6.8 Hydraulic pressure technique.

a. Before filling and sealing the specimen, a suitable leak-proof connection for a pressure line shall be installed in the specimen.

b. Unless otherwise specified in the CIDS, the specimen shall be filled with colored water (see O.3.c), and either an air or water pressure line shall be connected to the specimen.

c. The pressure shall be increased uniformly over a 10-second period to the test pressure and maintained for the period of time specified. Unless otherwise specified in the CIDS, the pressure shall be 15 psi and the period shall be 5 minutes. The exterior of the specimen shall be inspected for leakage, particularly around joints and fastenings.

d. Whether or not leakage was observed shall be recorded and the locations of the leaks shall be described.

O.6.9 Static technique.

a. If the intended contents of the specimen are not fluid, unless otherwise specified in the CIDS, the colored water (see O.3.c) shall be used instead of the intended contents to fill the specimen and close it as for shipment.

b. Unless otherwise specified in the CIDS, the specimen shall be placed in each of the following positions and left in each for a period of 15 minutes:

(1) Upright.

(2) Upside down.

(3) On one side (or one quadrant).

(4) On one end (or second quadrant).

(5) On other side (or third quadrant).

(6) On other side (or fourth quadrant).

c. The specimen shall be examined after each period and location of any leakage or “no leakage” shall be recorded.

O.7 NOTES

O.7.1 Selection of technique. The most appropriate technique will depend principally upon the construction, size, and weight of the specimen and the information needed. If the specimen has removable caps or plugs or an air valve, a pressure technique is appropriate to locate leaks. (The pneumatic pressure technique (see O.6.3) might reveal smaller leaks than the hydraulic pressure technique (see O.6.8), but hydraulic pressure is less hazardous than pneumatic pressure.) The vacuum chamber technique (see O.6.2) is appropriate to locate leaks in all small specimens that do not contain liquids mixable with water. For such specimens too large for the vacuum chamber available, the hot water technique (see O.6.5) is appropriate; or the squeeze technique (see O.6.4) is appropriate for specimens constructed of flexible materials, such as plastic film. The vacuum retention technique (see O.6.1) does not specifically locate leaks and may not indicate the existence of tiny leaks in a large specimen. The submersion (or immersion) technique (see O.6.6) for detecting water leakage is not as sensitive as the air leakage tests but it is appropriate to reveal whether or not water might leak into the specimen and, depending upon the duration of the test, gives some indication of the extent to which the materials used in the specimen are waterproof (remain unaffected by water). The simulated rainfall technique (see O.6.7) is appropriate for the same purposes, but under other conditions particularly appropriate for very large specimens. The static technique (see O.6.9) merely determines whether or not the contents of the specimen will leak out when the specimen rests in various positions, and may be appropriately used as a final test after all other tests on a specimen.

Details are given with the qualification “unless otherwise specified” in the paragraphs regarding:

a. Specimen (see O.4.1).

b. Conditioning (see O.5.1).

c. Techniques:

(1) Vacuum retention (see O.6.1), Pressure (see O.6.1.b), Duration (see O.6.1.d).

(2) Vacuum chamber (see O.6.2), Pressure (see O.6.2.b).

(3) Pneumatic pressure (see O.6.3), Pressure (see O.6.3.b).

(4) Squeeze technique (see O.6.4).

(5) Hot water (see O.6.5), Temperature (see O.6.5.b).

(6) Submersion (or immersion) (see O.6.6), Time, depth, and temperature (see O.6.6.a).

(7) Simulated rainfall (see O.6.7), Specimen position, spray rate, period, and spacing of multiple specimens (see O.6.7.a).

(8) Hydraulic pressure (see O.6.8), Specimen contents (see O.6.8.b), Pressure and period (see O.6.8.c).

(9) Static (see O.6.9), Specimen contents (see O.6.9.a), Position and period (see O.6.9.b).

MECHANICAL HANDLING TEST

P.1 SCOPE

P.1.1 Scope. This appendix provides tests for determining the ability of a package or container to withstand handling by mechanical handling equipment. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

a. This test provides independent procedures for each of the following paragraphs:

(1) Lifting and transporting by forklift truck (see P.5.2).

(2) Hoisting with slings (see P.5.5).

(3) Hoisting with grabs (see P.5.6).

(4) Pushing (see P.5.3).

(5) Towing (see P.5.4).

(6) Conveying (see P.5.7).

b. These procedures do not include every conceivable mechanical handling hazard to a package. If the package shall withstand other known hazards not represented by these procedures, other tests should be used. Conversely, any of these procedures not appropriate for a specific package should not be applied.

P.2 APPARATUS

P.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 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.

P.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 P.5.5).

P.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 container and prevent slipping.)

P.2.4 Pushing.

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

P.2.5 Towing.

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

b. A towline of sufficient strength.

P.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.

P.3 SPECIMEN

P.3.1 Contents of container. One container and its contents shall constitute a single specimen. The container 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 container. The contents, or dummy load, shall be blocked, braced, and cushioned in place as for shipment.

P.4 CONDITIONING

P.4.1 Test specimen. Unless otherwise specified in the CIDS, no special conditioning of the test specimen shall be necessary.

P.5 PROCEDURE

P.5.1 Handling provisions. Unless otherwise specified in the CIDS, handling provisions shall be tested as follows in the sequence given.

P.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. Consideration shall be given to partially loaded containers with offset CG to ensure container is lifted high enough to avoid end contact with ground. Parallel pairs of 1-inch boards spaced 54 inches apart shall be laid flat wise 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 shall attain either a height not less than 80 inches or a weight not less than 1000 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 1200 pounds, which is not less than 1000, 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. If the test specimen weighs 6000 pounds or more, a soft tire forklift truck shall be used. 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. Containers with offset side forklift openings shall be picked up from the opposite container side and a second pass over the course shall be performed. 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. The specimen shall be observed, particularly in the vicinity of the ends of the forks, and observations shall be recorded. If the specimen can thus be lifted clear of the floor, it shall be transported on the forks over the same 100-foot course and observations shall be recorded. If it cannot be thus lifted, the length of forks used shall be reported and it shall be stated that the specimen could not be carried on the forklift truck at either end.

P.5.3 Pushing test (flat). For ordnance containers, the pushing test shall be conducted on empty containers only. Non-ordnance containers shall be tested with contents. The vehicle shall be positioned 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. The truck shall be operated 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. Observations shall be recorded. The vehicle shall be moved to abut the side of the specimen near the floor and the specimen shall be moved sidewise over the same distance. Observations shall be recorded.

P.5.3.1 Pushing test (lifted). When specified in the CIDS, the pushing test shall be repeated with one end of the container lifted off the ground about 6 inches by the tips of the forks inserted between the skids. The test shall not be conducted if no openings exist for the fork tines. The strength of the container structure, as well as the skids, shall survive the test without failure or permanent deformation.

P.5.4 Towing. For ordnance containers, the towing test shall be conducted on empty containers only. Non-ordnance containers shall be tested with contents. A sling shall be attached to the towline attachment fittings at one end, and connected with a towing vehicle at a height not greater than the fittings. If no fittings are provided, a sling or gravity-type grabs shall be used at the base of the specimen for attaching the towline, or some other feasible arrangement may be devised. The vehicle shall be operated 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. Observations and the method of attaching the towline shall be recorded. Then the towline shall be reattached and the specimen shall be towed sidewise over the same distance. Observations shall be recorded.

P.5.4.1 Additional towing test. When specified in the CIDS, the towing test shall be repeated with one end of the container lifted off the ground about 6 inches by the tips of the forks inserted between the skids. For ordnance containers, this test shall be conducted on empty containers only. Non-ordnance containers shall be tested with contents. The strength of the container structure, as well as the skids, shall survive the test without failure or permanent deformation.

P.5.5 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 1000 pounds (see P.5.2 for examples). Such superimposed load shall not contact the slings or lend reinforcement to the top structure of the package.

P.5.5.1 Undersling handling (see figure P-1). Two slings without spreaders shall be placed around the specimen, each passing beneath the specimen, one near each end where indicated on the package and bought to a common point above the center of balance for attachment to the hoist. When no indication is provided, slings shall be located at outside end of rubbing strips, if possible. If not possible, slings shall be located about midway between the center of balance and the ends. The specimen and any superimposed load shall be lifted, and held suspended for not less than 2 minutes. Any indications of inadequacies shall be carefully observed and the specimen shall be let down again. Observations shall be recorded.

P.5.5.2 Sling handling with attachments.

a. Slings shall be attached to two hoisting attachment provisions (lift rings, eyes, lugs, or other devices), one on each side or each end, so that the specimen remains upright when hoisted. The length of the slings shall be such that when lifting, they form angles between 20 and 25 degrees with a horizontal plane (see figure P-2). The specimen shall be lifted clear of the floor and held suspended for not less than 2 minutes. Any indications of inadequacies of the specimen shall be carefully observed. Observations shall be recorded and the specimen shall be let down again. This procedure shall be repeated with other hoisting attachment provisions until each has been tested. If the specimen has only one attachment provision, only one sling shall be attached to hold the specimen suspended for 2 minutes.

b. If more than one attachment point is provided, the superimposed load, if any, shall be removed from the specimen. One sling shall be attached to one lifting attachment provision, and the specimen shall be lifted clear of the ground (see figure P-2). Any indications of inadequacies of the specimen shall be observed. Observations shall be recorded and the specimen shall be lowered to the ground. This procedure shall be repeated with each lifting attachment point provided on the specimen.

P.5.6 Hoisting with grabs (see figure P-3). The grabs shall be aligned on opposite sides or ends of the specimen above its center of balance. The grab operating chain or cable shall be adjusted so that while the specimen is suspended, the grab pressure normal to the surface of the container shall 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, then horizontally to a pulley on the other grab and then upward to the hoist attachment, the required pressure shall 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 shall result when the inclined portions of the line form angles of 22½ degrees [±2½ degrees] with a horizontal plane.) The hoist shall be connected to the lifting point of the grab operating line and slowly lifted. If the specimen tilts excessively upon lifting, it shall be lowered and the grabs and the lifting point shall be relocated, if necessary, to align with the CG of the specimen. The specimen shall be hoisted clear of the floor, held suspended for 2 minutes, and returned to the floor. Any evidence of inadequacy or damage to the container, or deflection of the container that might cause damage or displacement of contents shall be observed. A record shall be made of observations.

P.5.7 Conveying.

a. The specimen shall be placed lengthwise on the conveyor, and conveyed back and forth until the specified distance lengthwise is accumulated. Each movement shall be not less than the length of the container. The specimen shall be placed crosswise on the conveyor and conveyed back and forth until the specified distance crosswise is accumulated. Any damage to the package or conveyor shall be observed and recorded and any difficulties in conveying the specimen shall be recorded.

b. Unless otherwise specified in the CIDS, the total conveyed distance shall be 1000 feet lengthwise and another 1000 feet crosswise.

P.5.8 Inspection after handling. The specimen shall be opened and the inner surfaces of the container shall be examined and the contents shall be inspected for evidence of inadequacies or damage. Observations shall be recorded.

P.6 NOTES

P.6.1 Test procedure. This test procedure is intended to demonstrate the effects of handling a package 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 package may be accepted. (For example, a container may have no lifting eyes or lugs for the attachment of slings; so only P.5.5.1, which is a test for handling with an encircling sling, should be applied and P.5.5.2, which is a test for sling attachment, should be accepted.) References to this standard should list any of the methods of handling (see P.5.2, P.5.5, P.5.6, P.5.3, P.5.4, and P.5.7) that are to be excluded from the test procedures.

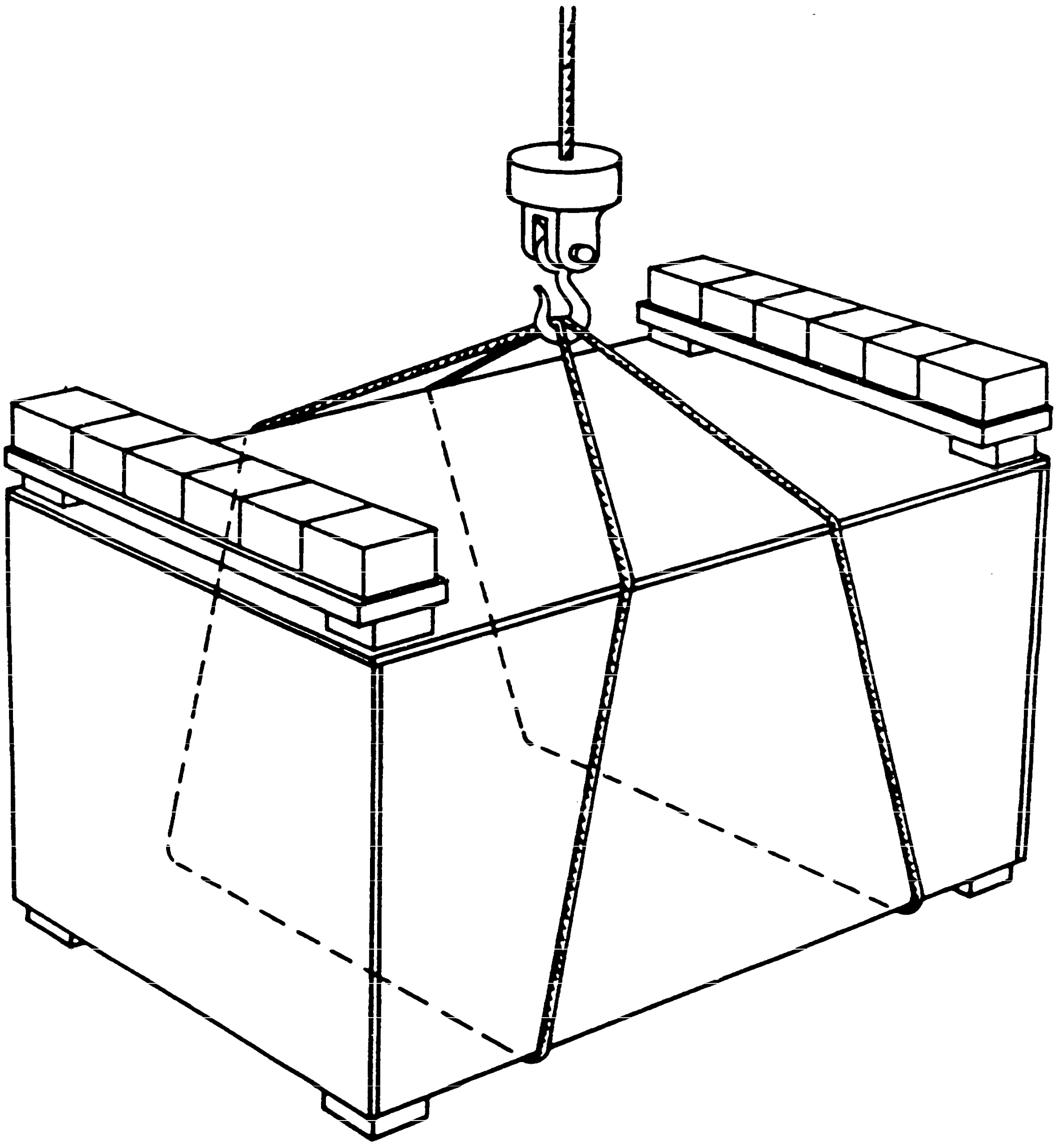


FIGURE P-1. Slings placed around specimen with load superimposed.

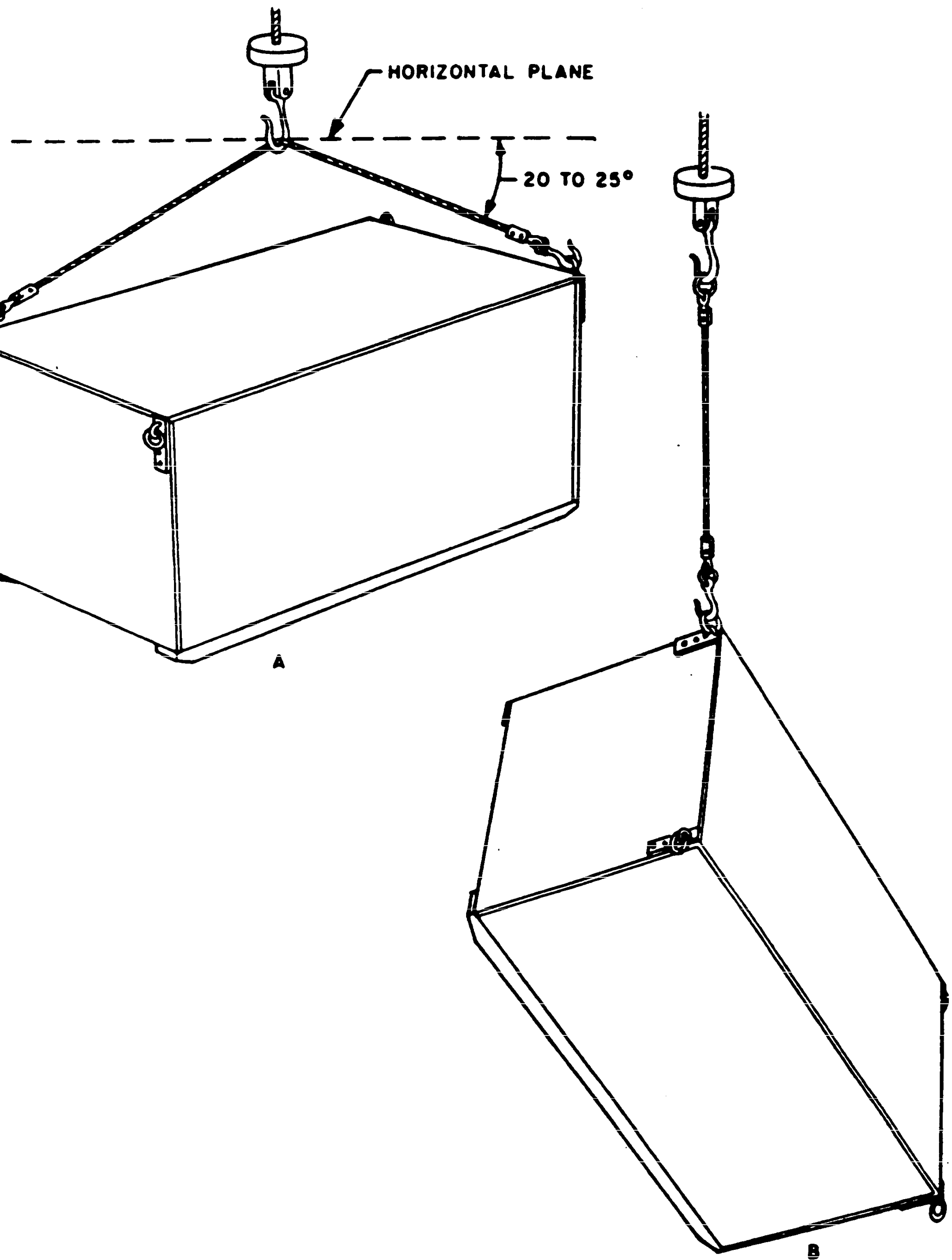


FIGURE P-2. Hoisting with sling attachment provisions.

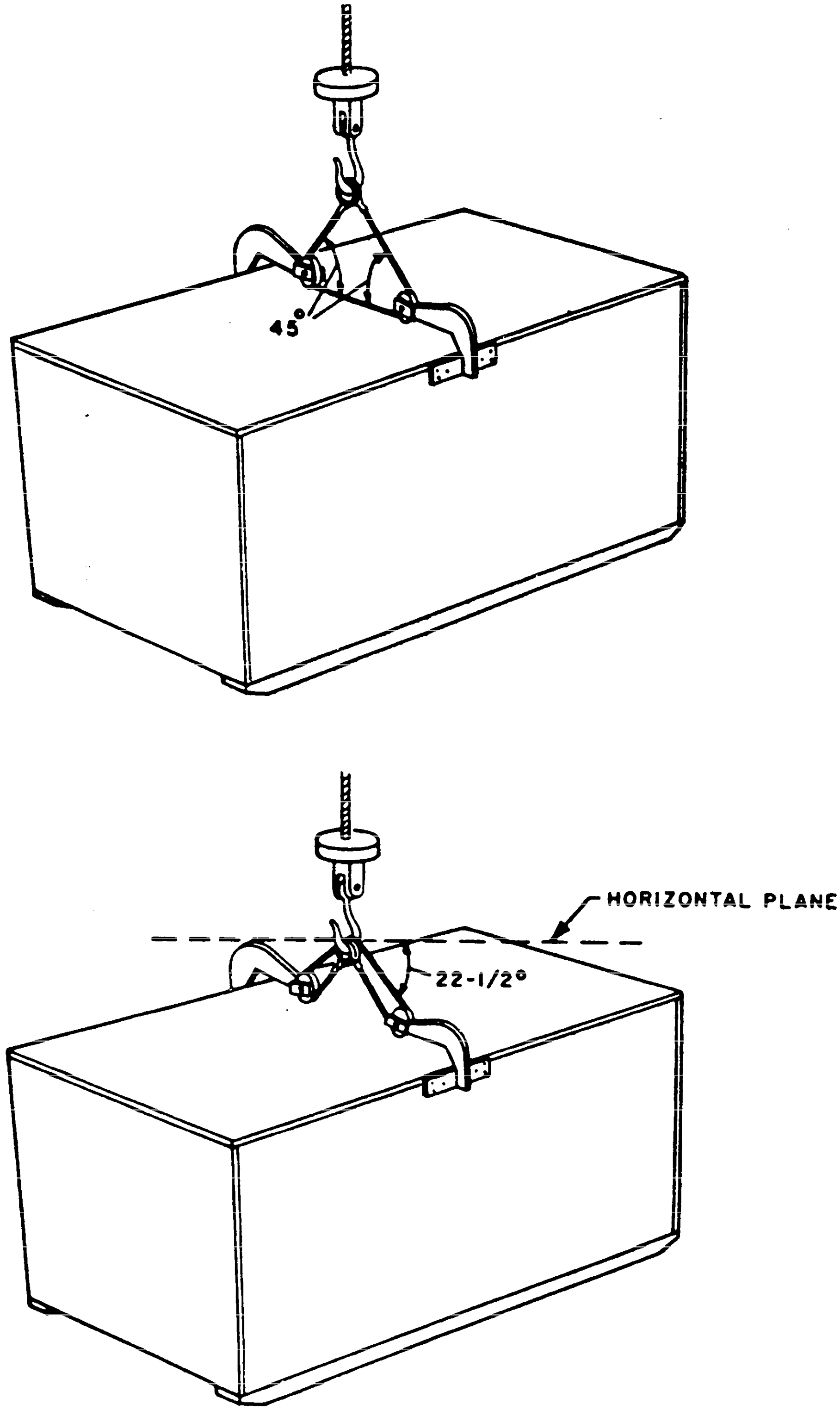


FIGURE P-3. Hoisting with grabs.

MINIMIZATION OF HYDROGEN EMBRITTLEMENT IN PH 17-4/7 H900 COUPLED WITH ALUMINUM IN PHST CENTER DESIGNED EQUIPMENT

Q.1 SCOPE

Q.1.1 Scope. This appendix provides a minimization of hydrogen embrittlement in PH-17-4/7 H900 coupled with aluminum in PHST Center designed equipment. This appendix is not a mandatory part of the standard. The information contained herein is intended for guidance only.

NSWC INDIAN HEAD DIVISION
DETACHMENT EARLE
PHST CENTER
TECHNICAL MEMORANDUM

TECH MEMO NO: PHST-30-99

DATE: 28 JULY 1999

SUBJECT: MINIMIZATION OF HYDROGEN EMBRITTLEMENT IN PH 17-4/7 H900 COUPLED WITH AL IN PHST CENTER DESIGNED EQUIPMENT

PREPARED BY: Joseph A. Raevis Mark A. Heinrichs **J. RAEVIS & M. HEINRICHS** **DESIGN BRANCH (CODE 7142)**	**SYSTEMS APPROVAL:** [signature] **AIR WARFARE BRANCH (CODE 711)**
DESIGN BRANCH: Joseph A. Raevis **J. RAEVIS (CODE 7142)**	**ENGINEERING DEVELOPMENT DIVISION APPROVAL:** [signature] **R. SMITH (CODE 714)**

DISTRIBUTION:

INFORMATION:

NAVORDCEN	**N71**
NAVSEASYSCOM	**SEA - 03M**

K. H. Zimms
K. H. ZIMMS
DIRECTOR, PHST CENTER

Tech Memo PHST 30-99

1. INTRODUCTION

1-1. One of the most significant limitations in the use of high strength steel components is hydrogen embrittlement cracking (HEC). Hydrogen, in atomic form, can enter metals from many sources: (1) cathodic protection (2) galvanic corrosion, (3) plating processes, (4) steel making and (5) welding. It can produce a range of deterioration resulting in reduced ductility to brittle fracture. HEC occurs at the atomic level, within a metallic material; therefore, there are no visible, exterior signs of potential failure of a part, product or structure. Consequences of hydrogen embrittlement and stress corrosion cracking are much more devastating than corrosion, because failures are unexpected. They occur with no warning, because the crack initiates at the atomic level, within the metal, below the surface. With time in service under stress, subsurface hydrogen cracks initiate and grow until a time-dependent catastrophic failure occurs. Only by indirect methods can the problem be detected and monitored.

1-2. HEC is not completely understood; however, it is generally agreed that only atomic hydrogen will enter and diffuse through steel during corrosion while under stress. Whether absorbed hydrogen causes cracking or not is a complex interaction of material strength, external stresses and temperature. At high strength (180KSI/1241MPa and above) or hardness (40 HRC and above) levels; only a few PPM of dissolved hydrogen can cause cracking.

1-3. This Technical memorandum details rationale for our preventative actions to eliminate HEC in Naval PHST Center designed stainless steel components.

2. BACKGROUND

2-1. The March 1999 edition of ASTM's STANDARDIZATION NEWS contained an article titled, "The Enemy Within: Hydrogen Embrittlement". Early in the article was the following; "Hydrogen embrittlement problems seem to be omnipresent. PH 17-4 stainless steel clips on aluminum piston or PH 17-4 bolts in a flange of an aluminum spacecraft valve can experience a service-induced hydrogen embrittlement failure." Since the Center had recently migrated from plated steel container components to PH 17-4 stainless components that are in intimate contact with aluminum, we felt it prudent to initiate an in-depth study for safety reasons.

2-2. To start the investigation we contacted the author of the article, Louis Raymond, Ph.D. (LRA Technology Center). He shared a great deal of information with us during the initial telephone conversation. This resulted in our sending a designer to the following seminar, "Hydrogen Embrittlement: Process Control and Failure Analysis of Plated or Coated Parts." The seminar was held in Jacksonville, FL., on April 18, 1999. It was run by LRA and RSL™ Technology Centers. The following month we had Dr. J. Barton Boodey (RSL™ Technology Center) visit the Center to assist us in determining the best course of action to prevent failure of Naval PHST Center designed stainless steel components.

Tech Memo PHST 30-99

3. DISCUSSION

3-1. To minimize replacement of corroded metallic components on Naval PHST Center's designed commodities; plated steel components are being replaced with stainless steel components. The latest generation lift rings, shackle pins and latches are all manufactured out of PH 17-4 and 17-7 stainless steels.

3-2. Finite Element Analysis (FEA) is performed on each stressed component before fabrication of the test program's prototype. Qualification tests are then performed on each new component to verify their ability to withstand the rigors of naval use. Once the new stainless components pass physical prototype testing, as FEA modeling had predicted, release for production is authorized.

3-3. With the newly discovered concern of HEC of PH 17-4, a technical meeting was hosted here at the center. FEA analysis and logistics of use for lift rings and shackle pins were reviewed in-depth by the Center's designers and Dr. Boodey. It was agreed that there was a remote possibility that our design was a candidate for HEC. This was due to the galvanic coupling of PH 17-4 stainless steel with aluminum combined with exposure to water while under stress.

3-4. As discovered by LRA and RSL™ the combination of PH 17-4 stainless steel, aluminum, stress and moisture is a formula for possible failure. To nearly eliminate the possibility of failure, it was jointly agreed that a barrier coating needs to be applied in the area of dissimilar metal contact along with a secondary heat treatment process. The combination of these two processes will virtually eliminate any chance of HEC. For components already in service, it was jointly agreed that by only applying a barrier coating in the area of dissimilar metal contact, the possibility of HEC ever occurring will be minimized. In either event, the barrier coating is only to be applied during initial assembly; no periodic application is necessary.

3-5. As a side note, LRA Labs, under an Army contract from Milt Levy at Watertown from 1988 to 1990, studied hydrogen embrittlement from plating of high-strength steels and later under a Small Business Innovative Research contract from 1990 to 1993 under Dr. Alexis I. Kaznoff at Naval Sea Systems Command in Washington, D.C., developed an accelerated hydrogen embrittlement test method for welded HY-130 steels. From this program, a commercially available test machine specifically designed to conduct tests in accordance with ASTM F 1624 was developed and is known as the Rising Step Load™ (RSL™) testing system. The RSL™ testing system will be investigated as a possible secondary test method for the Center's stainless steel components.

4. CONCLUSION

4-1. When designing high strength, stressed stainless steel components for use in contact with aluminum the following preventative measures shall be taken:

- ☑ A barrier coating shall be used to coat all stainless steel components in the aluminum contact zone during initial assembly only. It shall be MIL-G-21164: Grease, Molybdenum Disulfide, for low and high temperature, NATO code number G-353.

- ☑ A careful selection of materials of construction shall be adhered to. This includes the specifying of lower strength (hardness) or high resistance alloys, coupled with a secondary heat treatment process. Specifically, all PH 17-4 stainless steel components shall be aged for 4 hours at 950^{o}F to substantially reduce its susceptibility to hydrogen embrittlement. This aging process will reduce the tensile strength of the material by 10 to 15%, but will almost double the toughness.

5. KEY PERSONNEL

5-1. Dr. Louis Raymond, President and Director of Technical Operations of LRA has served as a consultant to fastener manufacturers and users. In addition to performing failure analyses for Aerospace and Airline companies and DOD agencies, he has worked with the automotive, ship, offshore platforms and building industries. Dr. Raymond is a Fellow of ASTM and currently Chairman of ASTM F7 on Aerospace & Aircraft and ASTM F7.04 on Hydrogen Embrittlement, for whom he has edited two ASTM STP's on "Test Methods for Hydrogen Embrittlement" and "Hydrogen Embrittlement: Prevention and Control", for which he received the 1993 ASTM Dudley Award. He holds the patent on the RSL™ accelerated hydrogen embrittlement testing system for which he received the Institute for the Advancement of Engineering (IAE), 1994 "George Washington Engineer of the Year" Award.

5-2. Dr. J. Barton Boodey, President and Technical Director of RSL™ Technology Center served as a materials engineer for 16 years at the Naval Air Warfare Center in Warminster, Pa. While with the Navy, Dr. Boodey specialized in hydrogen interaction with materials, corrosion science and directed the operational chemicals laboratory. He is a consultant to aerospace and automotive companies and their suppliers conducting failure analyses, plating process evaluations and material hydrogen susceptibility determinations.

CONCLUDING MATERIAL

Custodians:
Army – SM
Navy – OS
Air Force – 69

Preparing activity:
Navy – OS
(Project PACK-2016-004)

Review activities:
Army – AR, AT, AV, CR, MI, MT, TE, TM
Navy – AS, MC, SA, SH, YD
Air Force – 11, 13, 99
DLA – DH

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 https://assist.dla.mil.