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MIL-STD-1365C
17 May 2010

SUPERSEDING
MIL-STD-1365B
30 September 1997

DEPARTMENT OF DEFENSE
DESIGN CRITERIA STANDARD

GENERAL DESIGN CRITERIA FOR HANDLING EQUIPMENT ASSOCIATED WITH WEAPONS AND RELATED ITEMS

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FOREWORD

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

2. This revision has resulted in many changes to standard format, but the most significant one is the addition of design criteria for lifting equipment developed for use in a constrained space environment.

3. 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.daps.dla.mil.

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1. SCOPE

1.1 Scope. This design standard contains the general design criteria and applicable tests for beams, bands, strongbacks, cradles, assembly stands, slings, dollies, bomb loaders, trailers and hoists (used as an integral component of an ordnance handling device) associated with handling weapons and related items. This standard is not intended to be used directly for acquisition of related equipment, but is to be used as the basis to prepare appropriate development specifications from which the equipment is to be designed and procured.

2. APPLICABLE DOCUMENTS

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

COMMERCIAL ITEM DESCRIPTIONS

A-A-50469	-	Hook, Regular Eye, Latch Type
A-A-52428	-	Reflector, Indicating, Clearance

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-S-901	-	Shock Tests, H.I. (High Impact) Shipboard Machinery, Equipment and Systems, Requirements for
MIL-S-8512	-	Support Equipment, Aeronautical, Special, General Specification for the Design of

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-130	-	Identification Marking of U.S. Military Property
MIL-STD-167-1	-	Mechanical Vibrations of Shipboard Equipment (Type I - Environmental and Type II - Internally Excited)
MIL-STD-209	-	Lifting and Tiedown Provisions
MIL-STD-461	-	Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment
MIL-STD-740	-	Airborne and Structureborne Noise Measurements and Acceptance Criteria of Shipboard Equipment
MIL-STD-810	-	Environmental Engineering Considerations and Laboratory Tests
MIL-STD-814	-	Requirements for Tiedown, Suspension and Extraction Provisions on Military Material for Airdrop
MIL-STD-882	-	Standard Practice for System Safety

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MIL-STD-913	-	Requirements for the Certification of Sling Loaded Military Equipment for External Transportation by Department of Defense Helicopters
MIL-STD-1310	-	Shipboard Bonding, Grounding, and Other Techniques for Electromagnetic Compatibility and Safety
MIL-STD-1366	-	Transportability Criteria
MIL-STD-1399-300	-	Electric Power, Alternating Current
MIL-STD-1474	-	Noise Limits

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

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

DEPARTMENT OF AGRICULTURE STANDARDS

5100-1A	-	Spark Arrestors for Internal Combustion Engines

(Copies of this document are available from the National Interagency Fire Center, 3833 S. Development Avenue, Boise, ID 83705.)

DEPARTMENT OF DEFENSE MANUALS

DOD 4145.26	-	DOD Contractors' Safety Manual for Ammunition and Explosives

(Copies of this document are available from the National Center for Standards and Certification Information, Global Standards and Information Group, National Institute of Standards and Technology, 100 Bureau Drive, Stop 2100, Gaithersburg, MD 20899-2100 or online at http://www.dtic.mil/whs/directives/.)

DEPARTMENT OF THE ARMY MANUALS

FM 5-430-00-1	-	Planning and Design of Roads, Airfields, and Heliports in Theater of Operations, Volume 1
FM 5-430-00-2	-	Planning and Design of Roads, Airfields, and Heliports in Theater of Operations, Volume 2

(Copies of these documents are available from Commander, USA PPC, ATTN: SAIS-PRP-L, 2461 Eisenhower Ave., Alexandria, VA 22331-0302.)

NAVAL AIR SYSTEMS COMMAND (NAVAIR) INSTRUCTIONS AND NOTICES

NAWCADLKE-MISC-482600-0039	-	General Design Guidelines and Tips for Designing Airborne Stores Support Equipment and Designing for Support Equipment Compatability

(Copies of this document are available from Commander, Naval Air Warfare Center Aircraft Division, Hwy 547, Lakehurst, NJ 08733-5033.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA) DRAWINGS (53711)

NAVSEA 6213972	-	Swaged Sleeve Endings for Wire Rope Slings (Flemish Eye)
NAVSEA 6213973	-	Swaged Sleeve Endings for Wire Rope Slings (Turnback Eye)

(Copies of these documents are available from the Director, Naval Surface Warfare Center, Crane Detachment, ATTN: Code 3J10, 160 Rochester, 160 Rochester Drive, Louisville, KY 40214-5001.)

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NAVAL SEA SYSTEMS COMMAND (NAVSEA) PUBLICATIONS

NAVSEA OP 3565/NAVAIR 16-1-529	-	Electromagnetic Radiation Hazards (U) Hazards to Personnel, Fuel and Other Flammable Material, Volume 1
NAVSEA OP 3565/NAVAIR 16-1-529	-	Electromagnetic Radiation Hazards (U) (Hazards to Ordnance) (U) Volume 2

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

OPNAV INSTRUCTIONS

OPNAVINST 3500.39	-	Operational Risk Management (ORM)
OPNAVINST 9072.2	-	Shock Hardening of Surface Ships

(Copies of these documents are available from the Department of the Navy Issuances, SECNAV/OPNAV Directives Control Office (DNS-5), Washington Navy Yard, Bldg. 36, 720 Kennon Street, SE Rm. 203, Washington Navy Yard, DC 20374-5074 or online at http://doni.daps.dla.mil/default.aspx.)

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 NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B30	-	Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings
ANSI S1.1	-	Acoustical Terminology

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

ASTM INTERNATIONAL

ASTM D996	-	Standard Terminology of Packaging and Distribution Environments
ASTM F1166	-	Standard Practice for Human Engineering Design for Marine Systems, Equipment, and Facilities

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

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS

IEEE C63.14	-	American National Standard Dictionary for Technologies of Electromagnetic Compatibility (EMC), Electromagnetic Pulse (EMP) and Electrostatic Discharge (ESD)

(Copies of this document are available from the Institute of Electrical and Electronics Engineers, Inc., 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331 or online at www.ieee.org.)

NATIONAL FIRE PROTECTION ASSOCIATION

NFPA No. 70	-	National Electrical Code

(Copies of this document are available from NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471 or online at www.nfpa.org.)

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SAE INTERNATIONAL

SAE-J561	-	Electrical Terminals, Eyelet and Spade Type
SAE-AS8090	-	Mobility, Towed Aerospace Ground Equipment, General Requirements for
SAE-AS50861	-	Wire, Electric, Polyvinyl Chloride Insulated, Copper or Copper Alloy

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

UNDERWRITERS LABORATORY

UL 558	-	Standard for Industrial Trucks, Internal Combustion Engine-Powered
UL 583	-	Standard for Electric-Battery-Powered Industrial Trucks

(Copies of these documents are available from COMM 2000, 1414 Brook Drive, Downers Grove, IL 60515 or online at www.ul.com.)

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 following terms are used throughout this standard, and their interpretation are in accordance with the following definitions. Except as otherwise indicated, definitions for shock and vibration are in accordance with ANSI S1.1. Definitions for packaging terms are in accordance with ASTM D996.

3.1.1 AEODA. Acronym denoting ammunition, explosives, and other dangerous articles.

3.1.2 Capacity. The maximum static load (expressed in pounds or kilograms) which can be lifted or handled by a piece of handling equipment. “Capacity”, “rated load”, and “safe working load” are considered to be synonymous.

3.1.3 Connected replenishment-at-sea (CONREP). CONREP is the transfer of material from ship to ship at sea by cable transfer system.

3.1.4 Design load. The load to which a piece of equipment is designed, which is equal to the dynamic load multiplied by an applicable safety factor.

3.1.5 Design proof load. The maximum test load (expressed as the ratio of test load to rated load) which will demonstrate the capability of equipment to perform without permanently deforming or breaking. The design proof load is applicable to prototype equipment only and not production. This test is considered destructive.

3.1.6 Dynamic load. The “capacity” multiplied by an applicable load factor which represents what might be reasonably expected in an operational environment, e.g., dynamics, friction, etc.

3.1.7 End product. A complete, assembled piece of equipment.

3.1.8 Explosive. The term explosive includes any chemical compound or mixture which, when subjected to heat, friction, detonation, or other suitable initiation, undergoes a very rapid chemical change with the evolution of large volumes of highly heated gases which exert pressures in the surrounding medium.

3.1.9 Fail-safe. A fail-safe condition exists when failure does not result in damage to the load or uncontrolled movement of the load or the handling equipment itself, nor jeopardize the safety of personnel. In the event of power failure, the load and the equipment become immobilized by means of a safety device or safety devices.

3.1.10 Handling. Moving material from one place to another within a specific area.

3.1.11 Handling equipment. Equipment designed and used to make handling possible, easier, or more efficient.

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3.1.12 Inert. Lacking in activity, reactivity, or effect.

3.1.13 Load factor. A ratio which considers additional loads or forces above the static weight of an item being handled. Such additional loads or forces may be those dynamically induced by the acceleration during lifting or handling, by friction, suction (such as when a missile is extracted from its canister), or by other sources such as wind or water drag. The load factor is the ratio of the additional forces plus the static weight of the item being handled to the static weight of the item. As an example, if 200 pounds of friction or suction occurs when removing a 1,000-pound missile from a canister, the total force acting on the handling equipment is 1,200 pounds. The load factor is the ratio of the sum of the static weight and friction or suction force (1,200 pounds) divided by the static weight (1,000 pounds), or 1.2. As another example, if the cable of a crane lifting an item accelerates at one-tenth of gravity (0.1 gravity), the handling equipment is subjected to 10 percent greater load than the static weight of the item being lifted. The load factor for this example is 1.1.

3.1.14 Loading equipment. Equipment that is used to load or unload a weapon.

3.1.15 Longitudinal. Pertaining to the lengthwise dimension.

3.1.16 Mobile equipment. Handling equipment that is provided with wheels, tracks, or runners in order to travel over a specified surface, including equipment which requires either human or mechanical power to move. Equipment excluded are fork lift trucks and pallet trucks which are defined by other documents.

3.1.17 Mobility index (MI). A number which results from a consideration of certain vehicle characteristics (see FM 5-430-00-1 and FM 5-430-00-2).

3.1.18 Munitions. Parts of nuclear and nonnuclear explosives in any case or contrivance prepared to form a charge, complete round, or cartridge for cannon, howitzer, mortar, or small arms; or for any other weapon, torpedo, naval mine, land mine, bomb, depth charge, demolition charge, fuse, detonator, projectile, grenade, guided missile, rocket, and the like; signaling and illuminating pyrotechnic materials; explosive-loaded impulse devices such as explosive bolts, squibs, and catapult charges; and dangerous chemical materials.

3.1.19 Nonmobile equipment. Equipment not meeting the definition of mobile equipment. Such equipment may use mechanical or electrical power to perform its intended function, or may not require power. Examples of the latter are slings, storage or stowage racks, and assembly stands.

3.1.20 Nonstandard part. Any part that does not meet the definition of 3.1.33.

3.1.21 Pitch (tilt). The rising and falling motion of the bow of a ship as the craft oscillates about a transverse axis.

3.1.22 Positive control. Physical restraint from uncontrolled movement in all attitudes. The load does not become disengaged from its handling equipment during any phase of a sequential handling operation, and the operation is under complete control of a human operator or operators while in motion.

3.1.23 Ram (heave). A linear travel of the longitudinal axis in the vertical plane.

3.1.24 Rated load. See “capacity”.

3.1.25 Roll. An angular rotation about the center of motion of the athwart ship axis in the vertical plane.

3.1.26 Safe. Freedom from those conditions that can cause injury or death to personnel or damage or loss to equipment or property.

3.1.27 Safe working load. See “capacity”.

3.1.28 Safety factor. The ratio of ultimate breaking strength or yield strength of the material from which a piece of handling equipment is fabricated to the working stress which can result when the equipment is subjected to the working load.

3.1.29 Shipment. Movement using equipment commonly available to or usable by common carriers such as railcars, ships, aircraft, barges, or trucks.

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3.1.30 Shipping configuration. The assemblies of end product(s) in or on a transport vehicle (including ISO container or 463L pallet) together with all blocking, bracing, or other restraining devices.

3.1.31 Shipping container. A structure intended to protect an item of supply or product from the hazards of handling, shipment, and storage.

3.1.32 Shipping skid or cradle. A platform or similar device attached to an end product to make handling, storage, and shipment easier.

3.1.33 Standard part. A part which is considered to be a common item and readily available.

3.1.34 Standard tension replenishment alongside method (STREAM). A method of transferring cargo which is suspended from a trolley that rides on a tensioned wire highline from a transfer station on the delivery ship to the receiving station on a receiving ship.

3.1.35 Underway replenishment (UNREP). Either CONREP, vertical replenishment-at-sea (VERTREP) or a combination of the two.

3.1.36 Vehicle cone index (VCI). The index assigned to a particular vehicle which indicates the minimum soil strength, as identified by the Soil cone index (SCI), required for traversing of said soil (see FM 5-430-00-1 and FM 5-430-00-2).

3.1.37 Vertical replenishment (VERTREP). The external transfer of material from ship to ship at sea by helicopter.

3.1.38 Working stress. The maximum stress which can occur in a piece of equipment when that equipment is subjected to the dynamic load.

3.1.39 Yaw. An angular rotation about the center of motion of the longitudinal axis in the horizontal plane.

4. GENERAL REQUIREMENTS

4.1 General. In designing specific pieces of handling, shipping, and transporting equipment or preparing specifications for developing such equipment, the following basic design goals consistent with the primary objectives of ensuring safety and reliable function shall be met. Appearance shall be dictated only by functional utility; avoid all non-functional embellishments. Requirements for ground support equipment other than weapons handling equipment shall be in accordance with MIL-S-8512. Additional and superseding requirements for submarines are obtained from but not limited to Section 703 of the applicable class specification for building submarines.

4.1.1 Parts selection. Standard parts shall be used to the maximum extent possible.

4.1.2 Toxic chemicals, hazardous substances, and ozone-depleting chemicals. The use of toxic chemicals, hazardous substances, or ozone-depleting chemicals shall be avoided, if feasible.

4.1.3 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible, provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life-cycle costs.

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4.2 Safety.

4.2.1 AEODA safety. Equipment for handling AEODA shall permit safe operation in accordance with DOD 4145.26. Positive control shall be exercised at all times while handling AEODA, such as dead-man controls or braking mechanisms. Positive control shall include elimination of the possibility of dropping or losing a load. Any undue shock imparted on the load such as that caused by shifting, swaying, swinging, or motion of the load on the carrying equipment shall be prevented. Hydraulic systems shall have hydraulically operated “fail-safe” devices such as counterbalance valves in pushing and lifting mechanisms. Emphasis shall be placed on cradling and restraining mechanisms so as not to compromise safety during intermediate transfer of munitions. Systems shall be designed for proper structural load capabilities incorporating fail-safe devices. All powered equipment used for handling AEODA shall be non-spark producing or explosion-proof in accordance with the respective specific requirements of the NFPA No. 70 (for electrical bonding and grounding requirements, see 4.7.6).

4.2.1.1 System safety. Equipment for handling AEODA shall be designed to assure that safety consistent with mission requirements is designed into systems. As specified by the procuring activity, the specification applicable to the equipment being developed shall include a requirement to prepare a system safety program in accordance with MIL-STD-882 (see 6.2).

4.2.2 Personnel safety. Provisions shall be incorporated for the safety of personnel to the maximum extent possible, with all anticipated operating conditions and the capability of operating personnel under these conditions being considered. An operational risk management process shall be performed to identify hazards, assess risks, and implement controls to reduce the risk associated with any operation in accordance with OPNAVINST 3500.39. System components shall be designed so that they are actuated only by the operator.

4.2.2.1 Guards. Suitable guards shall be provided for exposed moving parts such as belts, chains, gears, and linkages with which the operator or other personnel in the area may come in contact during normal operation of equipment. Guards or enclosures shall be provided for otherwise exposed electrical portions of equipment. Guards shall allow for inspection of mechanisms whose failure could cause a hazardous condition.

4.2.2.2 Sharp edges. Sharp edges, projections, and hinged devices with hazardous characteristics that could injure personnel shall be avoided.

4.2.2.3 Electrical shock. Suitable interlocks, grounding means, enclosures, or protective devices in accordance with NFPA No. 70 or equivalent industry standard shall be employed so that danger from electrical shock is avoided.

4.2.2.4 Securing. Parts which may cause a hazardous condition by working loose in service shall be safety wired, or shall have other approved positive locking means applied.

4.2.2.5 Toxic gases. Special design attention shall be paid to those items that emit toxic gases that could be harmful to operators or other personnel in the vicinity so as to eliminate or minimize any adverse effect.

4.2.2.6 Stability. The ability of free-standing equipment to remain stable is a function of platform dimensions relative to center of gravity height. The tipping angle is defined as the point at which stability is lost. The determination of an acceptable tipping angle depends on the application and utilization of the subject equipment. In the absence of specified tipping angle criteria, equipment shall be designed to remain stable at no less than 11 degrees. (For shipboard stability, see 5.1.3.1.)

4.2.3 Noise. The noise level of the equipment shall be designed so as not to exceed 85 dBA at the operator’s position (MIL-STD-740 and MIL-STD-1474 shall be used as applicable).

4.2.4 Reflectors. Reflectors shall be provided in accordance with A-A-52428.

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4.3 Maintenance considerations.

4.3.1 Accessibility. Components requiring frequent inspection shall be made as accessible as possible. Removable covers, access doors, or plates may be used provided these are secured to the item in suitable fashion to prevent loss.

4.3.2 Disassembly provisions. Provisions shall be made for ready replacement of major assemblies which may require replacement, major repair, or overhaul, without requiring removal of other assemblies, or insofar as possible, without requiring draining liquid-filled systems. Connecting and disconnecting features shall be arranged so as to preclude the possibility of incorrect assembly. All disconnect points shall be identified.

4.3.3 Lubrication. Requirements for field lubrication shall be minimized. Maximum use shall be made of pre-lubricated bearings. The number of grease fittings shall be minimized. Grease fittings shall be readily accessible. All fittings should be of the same size on a single piece of equipment, if practicable.

4.3.4 Storage. Where applicable, storage space shall be provided for maintenance tools, equipment, parts, and instruction handbooks which may be necessary to accompany the equipment when in use.

4.3.5 Fasteners, fittings, and connectors. Captive, quick disconnect fasteners with a positive locking means shall be used on component covers and access plates. Self-locking nuts are preferred and should be used on all fasteners in assemblies which are subject to operating vibration in service. Readily attachable and detachable type fittings should be used in hydraulic and pneumatic systems when practicable. Multiple-line connectors, receptacles, and disconnect plugs shall be incorporated in electrical systems. Riveted connections shall be used only in pure shear applications.

4.3.6 Cradles and support rollers. If cradles are used, they shall be faced with a suitable material, well bonded, that will not scratch or otherwise mar the surface of any weapon. If support rollers are used, they shall be free rolling and of a material that will not damage the surface of the weapon. When using cradles or support rollers, they shall be adjustable on or within the full limit of the designated chocking area of any weapon intended to be handled. Contact area between chock or support roller and items being handled shall be sufficient to result in skin pressures not exceeding the maximum permitted values as defined in the applicable specification for the items being handled. In addition, complete latitude of adjustment is necessary to permit proper location of center-of-gravity to ensure stability.

4.4 Structural design.

4.4.1 Design stress safety factors. Weapons handling equipment shall be designed to the minimum safety factors, as specified in table I.

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TABLE I. Acceptable static safety factors and design proof loads. [4/]

	Safety factors			Design proof load		
	Navy	Air Force	Army	Navy	Air Force	Army
Lifting devices (metallic)	5:1 [1/] (yield)	5:1 [1/] (yield)	ANSI B30	5:1	[3/]	ANSI B30
Lifting devices (non-metallic)	5:1 to 10:1 [2/] (ultimate)	5:1 to 10:1 [2/] (ultimate)		5:1 to 10:1	[3/]	
Stands, cradles, adapters, etc. (metallic)	3:1 (yield)	3:1 (yield)		3:1	[3/]	
Stands, cradles, adapters, etc. (non-metallic)	4:1 (ultimate)	4:1 (ultimate)		4:1	[3/]	
Loaders, trailers, etc.	3:1 (yield)	3:1 (yield)		3:1	[3/]	

NOTES:

[1/] Under unique circumstances, where the using environment can be determined and controlled, the 5:1 requirement may be reduced by waiver from the procuring activity. However, under no circumstances shall the requirement be less than specified by ANSI B30 (see 4.4.1.1). For chain, wire rope, and associated fittings (see 4.4.3.3). For further guidance on hoisting, adapters, trolleys, bands, etc., associated with the Single Hoist Ordnance Loading System (SHOLS), see NAWCADLKE-MISC-482600-0039.

[2/] Depending on creep characteristics (see 4.4.3.1).

[3/] Guidance regarding proof-load criteria for USAF equipment may be obtained from MIL-S-8512.

[4/] Above guidelines represent the minimum requirements for all handling equipment, including shipping and handling systems for submarines. Refer to the applicable class specification for building submarines for additional requirements.

4.4.1.1 Load factors. When designing handling equipment, forces which impose loads in excess of the static weight of the item being lifted should be considered. These additional forces can be represented by load factors as defined in 3.1.13. Preparers of development specifications and designers should investigate the unique conditions affecting specific pieces of handling equipment to determine the value of each load factor and the cumulative value to be used in the specification and design. When the overall load factor is established, it is multiplied by the capacity to determine the dynamic load. Since the use of load factors provides a greater awareness of the using environment and the total forces acting on the handling equipment, procuring activities, at their discretion, may reduce the safety factor requirement specified in table I. However, the safety factor requirement specified in table I shall continue to be applied when the using environment cannot be controlled or when load factors are not known. Under no circumstances shall the safety factors be less than specified by ANSI B30.

4.4.1.2 Munitions trailer transportation. Designers must consider the dynamic loading imparted on stores and support equipment by munitions trailers during maximum speed, turns, and braking at maximum gross vehicle weight. For the MHU-110, MHU-141, and MHU-226 trailers, the maximum dynamic loading for design purposes is 0.5G lateral during high speed turns at minimum turn radius, 0.5G longitudinal during maximum braking, and 3.0G vertical on paved roads and the flight line environment at maximum speed. Dynamic loading for other trailers or carrier vehicles must be calculated based on maximum vehicle performance.

4.4.2 Design stresses for handling equipment not involved in lifting or hoisting. Design stresses for all metal devices where the load is being transferred to the ground or deck through the equipment shall have a safety factor of 3:1 based on the yield point of the material. Nonmetallic elements shall have a safety factor of 4:1 based on the ultimate strength of the material. Equipment for which this requirement is applicable includes, but is not limited to, assembly fixtures, dollies, support stands, and cradles.

4.4.3 Design stresses for lifting equipment. Design stresses for lifting equipment such as slings, beams, strongbacks, carriers, or any other equipment which supports a suspended load shall be in accordance with the following:

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4.4.3.1 Nonmetallic materials. Nonmetallic materials shall not produce more than 1 percent permanent deformation when loaded to one and one half times the rated load measured 24 hours after removal of the load. To avoid creep, the design load should be selected in the range of one-tenth to one-fifth of the breaking strength, the former being preferred. In addition, the material shall withstand a load not less than five times the rated load without any sign of failure.

4.4.3.2 Metallic elements. Requirements for metallic elements are as specified in table I and in 4.4.1.1.

4.4.3.3 Wire rope, chain and associated fittings. The dynamic loads shall not exceed 16 percent of the minimum breaking strength. Navy wire rope slings shall have eye splices that are fabricated using Flemish Eye construction method in accordance with NAVSEA Drawing 6213972. Navy slings that utilize a wire rope less than ¼-inch diameter shall have eye splices that are fabricated using turnback eye construction method in accordance with NAVSEA Drawing 6213973. Natural fiber core wire rope shall not be used for lifting equipment developed under this standard. The use of chain in lifting equipment is permissible but not desirable. In selecting materials for lifting equipment, effects of deflection under load and repeated loading shall be considered.

4.4.3.4 Multiple-leg slings. When a sling contains more than one leg, each leg shall be capable of supporting the entire dynamic load.

4.4.4 Weight. Weight limitations shall be as specified by the procuring activity in the applicable specification; however, to the maximum extent possible, consistent with military service requirements, simple construction shall be used to provide the lowest weight possible to comply with human engineering requirements, safety, and reliability. Unless otherwise specified by the procuring activity or the applicable development specification (see 6.2), maximum permissible gross weight of any unit (e.g., missile and transfer dolly) during UNREP is 6,000 pounds with a 4,000 pound maximum preferred,. Simplicity, reliability, safety, or strength shall not be sacrificed to minimize weight. When the weight of an item exceeds 75 pounds, the weight shall be identified on the equipment.

4.4.5 Materials. Materials used for components, which are likely to be subjected to adverse weather conditions, shall be either protected against deterioration or the component made of materials that do not deteriorate under climatic and environmental conditions. The use of protective coatings that will crack, chip, or scale shall be avoided.

4.4.5.1 Dissimilar metals. Dissimilar metals are those which generate an electric current resulting from galvanic action when two specimens are either in contact or are electrically connected in a conductive solution (electrolyte). Since dissimilar metals can be subjected to accelerated corrosion, protection against galvanic action shall be required by providing proper electrical insulation at the dissimilar metal interface or by eliminating the electrolyte where feasible. Further, the choice of dissimilar metals in contact with each other should be made using the Galvanic Series as a guide so as to select combinations having electrical potentials which are similar or near one another. A source for further guidance concerning dissimilar metals may be found in 6.3.

4.4.5.2 Corrosion. Metal parts subject to corrosion shall be protected with commercially available surface treatments and coatings that will prevent such corrosion when the equipment is subjected to the environment specified by the procuring activity or the development specification (see 6.2). Cadmium coating or plating shall not be used. Paint shall be lead and chromate free.

4.4.5.3 Fungus proof materials. Materials that are nutrients for fungi should not be used where it is practical to avoid them. In the event they are used and not hermetically sealed, the item shall be treated with a suitable fungicidal agent (see 4.9.2).

4.4.6 Lifting equipment designed for use in a constrained space environment. Additional forces imposed on lifting equipment as a result of handling AEODA in a constrained space environment shall be accounted for when establishing their capacity. Lifting equipment includes slings, beams, strongbacks, carriers, or any other equipment which supports a suspended load. An example of a constrained space environment would be a launch cell (or tube) where forces such as friction, surface tension, or vacuum act against a missile canister shell during its extraction, causing an increase in tension (over and above the weight of the static load) on the lifting equipment. For purposes of this paragraph, and rigging safety, the applied load experienced in a constrained space environment shall not exceed the safe working load (capacity) of the lifting equipment.

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4.4.7 Human factors engineering (HFE). HFE is the application of the knowledge of human capabilities and characteristics to the development of engineered equipment and systems. By applying this knowledge, human performance, and therefore system performance, can be improved dramatically. Man/machine systems designed with the human as the key element are inherently safer and more reliable than those that are not.

4.4.7.1 HFE design criteria. The designer shall consider safety, comfort, ease of use, and productivity/performance during development of equipment or a system. The methodology presented in ASTM F1166 shall be followed to mitigate potential deficiencies in human/equipment interfaces.

4.5 Hydraulic systems.

4.5.1 General. Hydraulic systems and parts shall be designed to operate satisfactorily under all conditions which the equipment may be expected to encounter. They shall conform to sound design practice with respect to flow constriction, structural design, and strength. Consideration shall be given to baffles, fluid connectors, sumps, drains, vents, filters, inlet filter units, and heat exchangers. Unless otherwise specified in the applicable specification or by the procuring activity (see 6.2), hydraulic systems shall conform to the best commercial practices.

4.5.2 Materials.

4.5.2.1 Metals. Metals shall be compatible with the hydraulic fluid used and intended temperature extremes, and shall conform to the functional, service, and storage conditions to which the components and system will be exposed. Magnesium shall not be used.

4.5.2.2 Plastic parts. Plastic parts shall be used only when allowed by the developmental specification or with the approval of the procuring activity. When used, they shall be suitable for the system environment and the fluid used.

4.5.2.3 Plating. The applicable developmental specification shall define the environment in which the equipment will operate. Metal coatings which have been demonstrated to be satisfactory for commercial applications or by the government shall be used to protect the equipment in the specified environment. When used, aluminum alloys shall be anodized or treated with a chemical coating suitable to resist corrosion. Ferrous alloys shall be internally and externally protected against corrosion. Further, cadmium plating shall not be used, and zinc plating shall not be used for any internal parts or on internal surfaces in contact with hydraulic fluid or exposed to its vapors.

4.5.2.4 Hydraulic fluid. Hydraulic fluids should be selected in accordance with best commercial practice, except that for systems exceeding 600 psi (see 4.5.3.3).

4.5.3 Pressure limitations.

4.5.3.1 Gauges. Red-lined gauges shall be provided to indicate safe limits of operation.

4.5.3.2 Emergency pressure backup. When hydraulic pressure is supplied by a powered primary source, a manual hand pump and check valve circuit shall be provided for emergency pressure backup in the event of a failure to the primary source. The manual system shall be capable of providing sufficient power to operate the lift mechanism to raise or lower the rated load; however, it may be at a reduced rate of motion as specified by the applicable developmental specification. Levers to operate the manual hand pump shall be designed so that the force required by one hand does not exceed 30 pounds. For two-hand operation, the force shall not exceed 50 pounds. Maximum fore-aft displacement of the lever shall not exceed 14 inches.

4.5.3.3 Safety hydraulic fluid. When system pressure is greater than 600 psi, a water-based safety type hydraulic fluid shall be used.

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4.5.4 Other considerations.

4.5.4.1 Hydraulic system. Hydraulic system shall be provided with vent plugs or valves to ensure that the system is full of fluid before putting the system into operation. To vent any accumulation of trapped air in any system, accessible watertraps, filters, and low-point drainage plug(s) shall be provided. Disconnection of lines, loosening of tubing nuts, or the use of external pressure source does not constitute proper system venting.

4.5.4.2 Fail safe mechanisms. Hydraulic systems designed to handle weapons shall have “fail safe” devices such as hydraulic velocity fuses or counter-balance valves in positioning and lifting mechanisms.

4.5.4.3 Function-adjustment screws. Function-adjustment screws, if used, shall be so designed and constructed as to maintain adjustment under all the required vibration and operation. It shall be possible to adjust and lock the adjustable screws with standard tools. Positive locking means such as safety wire, lock nuts, or lock tabs shall be used.

4.5.4.4 Noise and vibration. Noise and vibration, caused by turbulence or cavitation in hydraulic equipment or by unbalanced moving parts shall be minimized. Noise and vibration transmitted from other equipment shall also be minimized by proper selection and design of mountings, couplings, and similar parts. MIL-STD-740 should be referred to for guidance when the equipment is intended for shipboard use.

4.5.4.5 Leakage. The system operating the lifting mechanism shall be designed such that internal leakage when power has been interrupted will only allow 0.5 inch/hour maximum movement of the rated load.

4.6 Pneumatic equipment.

4.6.1 General. Pneumatic components shall be designed in accordance with commercial practices.

4.6.2 Pneumatic system lubrication. The lubricant for pneumatic systems shall be suitable for the application and environment in which it is to be used. Grease conforming to NATO Code Number G 392 is preferred, but an equivalent commercial product is acceptable. No other lubricant or organic compound may be used in the pneumatic system or in any application where contamination of the pneumatic system is possible.

4.7 Electrical systems.

4.7.1 General. Unless otherwise specified herein, or by the applicable development specification or procuring activity (see 6.2), electrical systems shall be designed in accordance with NFPA No. 70.

4.7.2 Power requirements. Both shipboard and shore-based equipment shall operate on Type I, 440-volt, three-phase, 60-Hz power in accordance with MIL-STD-1399-300. If necessary, the alternate voltage of 115 VAC, single phase, may be used.

4.7.3 Main power switch. A main power switch shall be provided which opens and closes all input power leads to the equipment. The main power input to the equipment shall be provided with suitable fuses or circuit breakers on the equipment side of the main power switch, to protect the power source from short-circuits or overloads within the equipment.

4.7.4 Overload protection. Protective devices shall be provided to prevent damage to the equipment caused by overload conditions and subsequent excessive heating of circuit components. Parts which are likely to carry any overload because of circuit malfunction, poor adjustment, or component casualty shall be capable of sustaining such an overload. Where this is impractical, circuit breakers, relays, fuses, or other devices shall be included to protect the affected parts. A minimum number of secondary protective devices consistent with good engineering and safety practices shall be used.

4.7.4.1 Circuit breakers. Where circuit breakers are used, they shall be located in one main panel and be easily accessible to the operator.

4.7.4.2 Fuses. Fuses shall be easily replaceable. Fuse ratings shall correspond closely to the maximum current rating of the parts they protect. Fuses shall open the circuit under short-circuit or overload conditions without emitting flame, molten metal, or vapor. One replacement fuse of each type and rating used shall be attached to the equipment in a convenient location.

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4.7.5 Power plugs and receptacles. Portable equipment requiring external power shall be equipped with plugs and receptacles as indicated in 4.7.5.1.

4.7.5.1 Portable equipment using 115-volt, 60-cycle power. Portable shipboard equipment requiring 115-volt, 60-cycle power shall have a two-bladed plug equipped with a ground pin and shall have a minimum electrical rating of 15 amperes, 125 volts. The plug shall be watertight and shall be compatible with mating receptacles of comparable electrical rating used aboard ship. Shore-based equipment shall be provided with a National Electrical Code approved conventional three-prong ground plug.

4.7.5.2 Portable equipment using other power sources. If power other than 115 volts, 60 cycles is required for the portable equipment, the power supply cord plug shall be colored red, and a tag stating the type of power required shall be permanently attached to the cord. If the equipment will be damaged by power other than that specified, this fact shall be stated on the tag.

4.7.5.3 Portable equipment using receptacles. When receptacles are used in portable equipment, a tag shall be placed on the panel adjacent to the receptacle containing the same information required in 4.7.5.2.

4.7.6 Electrical bonding and grounding. Each piece of equipment used for handling AEODA should be provided with adequate means for electrically bonding the load to the equipment. The continuity of the electrical bond shall be checked by attaching one lead of an accurate low resistance ohmmeter to the outside ground and the other lead to the item. The meter reading should show continuity at a resistance reading of not more than 1.0 ohm. Appropriate ground wire connections for all such portable or nonportable equipment shall be provided. Mobile equipment shall be provided with two replaceable, electrically conductive straps, or conductive wheels and tires which shall serve to discharge static electricity through their contact with the deck or road surface. For electrical bonding and grounding aboard ship, MIL-STD-1310 shall be used for guidance.

4.8 Marking. Mobile and non-mobile equipment shall be marked in accordance with MIL-STD-130. Equipment, except cables and slings, shall be marked by means of a securely attached nameplate.

4.9 Environmental design. Except as noted below, equipment shall conform to MIL-STD-810 environmental conditions or conditions specified in the applicable developmental specification without detrimental effect on subsequent operation. Sand and dust tests, when required, shall be run on the affected components rather than the complete equipment. Salt, fog, and humidity tests shall be run on the complete equipment or representative coupon samples.

4.9.1 Temperature. The Navy operating shipboard temperature requirements shall be between -20 °F (low) and 140 °F (high). For additional temperature requirements, MIL-STD-810 shall be used as specified by the procuring activity (see 6.2).

4.9.2 Fungus resistance. Parts which are susceptible to fungi shall be subjected to a fungus test in accordance with MIL-STD-810, Method 508.6.

4.9.3 Altitude. Unless otherwise specified in the developmental specification, the equipment shall be required to pass the altitude test of MIL-STD-810, Method 500.5, Procedure I.

4.9.4 Sand and dust. The function of operating parts shall not be impaired by exposure to the sand and dust test of MIL-STD-810, Method 510.5.

4.9.5 Salt atmosphere and humidity. Equipment shall function during and after exposure to the salt fog test specified in MIL-STD-810, Method 509.5. Corrosion which affects the performance of the equipment is cause for rejection. Minor corrosion affecting appearance only is not sufficient cause for rejection.

4.9.6 Rain. Equipment shall operate properly after exposure to the rain test specified by MIL-STD-810, Method 506.5. Procedures shall be as specified by the development specification.

4.9.7 Reliability and maintainability (R&M). If specified by the procuring activity (see 6.2), a program for reliability and maintainability shall be developed.

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5. DETAILED REQUIREMENTS

5.1 Requirements for mobile equipment.

5.1.1 General mobility requirements. Mobile equipment shall be designed to meet the mobility requirements and the pertinent tests contained in SAE-AS8090, as modified by this standard.

5.1.1.1 Mobility index (MI) and vehicle cone index (VCI). When required, the mobility index (MI) and vehicle cone index (VCI) shall be derived in accordance with FM 5-430-00-1 and FM 5-430-00-2. The MI shall be as specified in the applicable development specification or by the procuring activity for the specific equipment based on the off-road requirement of the vehicle.

5.1.1.2 Air transportability. When required to be air-transportable, the equipment shall be designed to be compatible with the specific aircraft types intended for such transport. Because of differences in the physical characteristics of weapons handling equipment to be shipped, and the aircraft used to transport them, this design standard cannot define all the requirements which apply. However, users are advised to obtain and utilize guidance referred to in 6.4. If 6.4 is insufficient to define the parameters needed to prepare a development specification, users should contact the United States Air Force Air Transportability Test Loading Agency (email: ATTLA@wpafb.af.mil).

5.1.1.3 Ramp performance. Air-transportable equipment shall be capable of transitioning from a horizontal surface to a ramp inclined 20 degrees and then back to a horizontal surface without interference or bottoming out. Non-air-transportable equipment shall be capable of transitioning a 10-degree ramp without interference or bottoming out.

5.1.2 Navy shore-based requirements. Activities preparing developmental specifications for Navy shore-based equipment are referred to SAE-AS8090 for guidance regarding specific requirements applicable to the equipment.

5.1.3 Shipboard requirements.

5.1.3.1 Stability. Vehicles shall be capable of operating on aircraft carriers under flight deck conditions (simple harmonic motion) of ±11 degrees in roll with an 18-second period and ±2 degrees in pitch with an 8-second period. Other shipboard equipment shall be designed to remain stable on a 26 percent (15 degrees) slope in a loaded operating configuration. This stability requirement applies at any axis relative to the equipment. Stability shall be evaluated by the following procedure:

a. Place the loaded unit on a tiltable platform coated with a slip resistant deck covering having a static coefficient of friction of at least 1.15 dry or 1.00 wet. The longitudinal axis of the equipment shall be parallel to the edge of the platform which will act as a pivot.

b. Raise the opposite edge slowly until it makes an angle of 15 degrees with the horizontal. Observe the results, then lower the platform.

c. Turn the equipment 15 degrees about its vertical axis, and re-raise the platform.

d. Repeat step c until 24 observations, each at a different position of the equipment, have been made.

5.1.3.1.1 Mobile equipment failure. Mobile equipment fails this test when any of the following occurs:

a. Vehicle upsets.

b. Brakes do not hold.

c. Equipment slides on platform.

d. Load slides relative to the equipment.

5.1.3.2 Shock and vibration resistance.

5.1.3.2.1 High-impact shock. When specified (see 6.2), shipboard handling equipment shall meet the Grade A shock requirements of MIL-S-901. For surface ships, applicability of high-impact shock requirements to shipboard handling equipment are as specified in OPNAVINST 9072.2.

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5.1.3.2.2 Rolling shock. Shipboard equipment, when loaded to capacity, shall be designed to roll over a 1-inch vertical rise and fall onto a hard, unyielding surface at 3.5 feet per second for Class 1 mobility as defined by SAE-AS8090 and 7.25 feet per second for Class 2 without damage or permanent deformation. Verification of this requirement shall be as follows:

a. Roll the equipment, loaded to capacity, along a smooth surface at a minimum design speed, i.e., 3.5 feet per second for Class 1 mobility and 7.25 feet per second for Class 2.

b. Roll the complete unit up a 1-inch vertical rise consisting of a hard material.

c. Continue to roll the unit off a 1-inch vertical drop onto a hard surface.

d. Stop the unit and repeat the operation backwards at the required speed without reorienting the unit.

e. Inspect the equipment for any signs of damage or permanent deformation.

5.1.3.2.3 Impact shock. Handling equipment, such as dollies, designed for use in UNREP operations, shall be required to sustain the following impacts when loaded as applicable:

a. Connected replenishment (CONREP).

(1) 18-inch flat drop without damage to equipment or item.

(2) 10 feet per second (minimum) impact against an unyielding surface on all four sides without damage to equipment or contents. (Minor structural damage to “bumpers” will not be cause for rejection.)

b. Vertical replenishment (VERTREP).

(1) 18-inch flat drop without damage to equipment or item.

(2) 7 feet per second (minimum) impact against an unyielding surface on all sides without damage to equipment or weapon. (Minor structural damage to “bumpers” will not be cause for rejection.)

c. Equipment designed for both CONREP and VERTREP shall pass the CONREP tests. Where connected transfer can predictably be confined to the use of the STREAM system and sliding padeye, impact velocity may be reduced to 7 feet per second.

5.1.3.2.3.1 Verification of equipment requirement. Verification of this requirement shall be as follows:

a. Connected replenishment (CONREP).

(1) The equipment shall be loaded to its rated capacity using a simulated weapon and raised to a height of 18 inches above the deck.

(2) The equipment shall then be released and allowed to free fall causing a flat drop to an unyielding surface.

(3) Equipment and simulated weapon shall be inspected. Any evidence of damage or structural failure shall be cause for rejection.

(4) With the equipment loaded as above, the equipment shall be impacted on all four sides at a minimum velocity of 10 feet per second against an unyielding surface.

(5) Equipment and simulated weapon shall be inspected. Any evidence of damage shall be cause for rejection. Minor structural damage to “bumpers” is acceptable.

b. Vertical replenishment (VERTREP).

(1) The equipment shall be loaded to its rated capacity using a simulated weapon and raised to a height of 18 inches above the deck.

(2) The equipment shall then be released and allowed to free fall causing a flat drop to an unyielding surface.

(3) Equipment and simulated weapon shall be inspected. Any evidence of damage shall be cause for rejection.

(4) With the equipment loaded as above, the equipment shall be impacted on all four sides at a minimum velocity of 7 feet per second against an unyielding surface.

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(5) Equipment and simulated weapon shall be inspected. Any evidence of damage shall be cause for rejection. Minor damage to “bumpers” is acceptable.

c. Connected replenishment for equipment used exclusively with STREAM strongback and sliding padeye.

(1) Tests shall be the same as for CONREP above except that the impact velocity against all sides of equipment shall be no less than 7 feet per second.

5.1.3.3 Vibration resistance. Equipment developed for shipboard use shall be capable of withstanding mechanical vibrations encountered in a shipboard environment. The applicable developmental specification shall define the vibration characteristics in accordance with MIL-STD-167-1 which provides guidance concerning mechanical vibrations aboard ship.

5.1.3.4 Brakes. Mobile shipboard equipment shall include brakes designed on the dead-man principle so that the brake must be held off to move the equipment. Brakes shall be provided and must hold the loaded equipment motionless on a 15-degree slope. Brakes shall be capable of bringing the loaded equipment to a full stop within a distance of 12 inches on a dry, level, brush finish, concrete surface, when moving at the design rated speed (3.5 feet per second for Class 1 and 7.25 feet per second for Class 2). In special cases, depending on end use, the procuring service may increase or decrease the 15-degree general requirement and provide definitive design parameters and test and evaluation requirements. Brakes shall operate in a wet and saline atmosphere when tested in accordance with the salt fog test, Method 509.5, of MIL-STD-810, after a 72-hour period. When testing is required by the procuring activity or the applicable development specification, the following applies:

a. The equipment, loaded to its rated capacity, shall be placed on a tiltable platform with a non-skid surface having a coefficient of friction not less than 1.15 dry or 1.00 wet.

b. The brakes shall be applied.

c. Raise the platform to an angle of 15 degrees.

d. Equipment shall be observed for any indication of wheel rotation or skidding for 5 minutes.

e. Any evidence of movement shall be cause for rejection.

f. The equipment, loaded to its rated capacity, shall be caused to move at a velocity of 3.5 feet per second for Class 1 equipment or 7.25 feet per second for Class 2 on a dry, level, brush finish concrete surface.

g. Brakes shall be applied causing the equipment to come to a full stop.

h. The stopping distance shall be measured. A distance greater than 12 inches is cause for rejection.

When specified, the tests shall be performed after the equipment has been subjected to the salt fog test of MIL-STD-810, Method 509.5, for a 72-hour period.

5.1.3.5 Obstacle performance. When the equipment is to be operated on the flight deck of aircraft carriers, the standard 1-inch obstacle height required for Type I mobility shall be increased to 2 inches. Mobile vehicles designed for handling and loading weapons aboard ship shall be capable of traversing ramps to deck edge aircraft elevators and fire door sills on aircraft carriers. The requirement for door sills aboard aircraft carriers is 3 inches of rise with a 4-degree slope on each side of the sill. If required by the developmental specification or procuring activity, conformance with the requirement may be determined by the following test. The equipment, loaded to its rated capacity, shall be operated at any convenient speed over a 2-inch vertical rise. Any damage resulting from traversing the obstacle, or difficulty negotiating the obstacle when using the intended method of propulsion shall be cause for rejection. Tests shall be repeated by operating the loaded equipment up a ramp having a rise of 3 inches and a slope of 4 degrees and back down a second ramp of 4 degrees slope. The up and down ramps shall be back to back. Any damage, contact with the deck (other than the wheels), or difficulty negotiating the obstacle when using the intended method of propulsion shall be cause for rejection.

5.1.4 Special mobility requirements. Three-wheel running gear configurations shall never be used for loaders or trailers. Trailer and loader center of gravity shall be located to optimize wheel ground pressure for steering and traction. Casters may be used for shop and hangar equipment but shall not be utilized for towed flightline equipment.

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5.1.4.1 Power/drive train. Power sources for self-propelled equipment may be electrical or internal combustion. Powered equipment to be used in magazine spaces or ready reserve lockers shall be non-spark producing. Where the equipment is intended to handle bulk high explosives or bag charges, the equipment shall be explosion proof. Powered equipment shall be in accordance with UL 558 and UL 583 commensurate with the intended application as specified in the developmental specification.

5.1.4.1.1 Internal combustion engines. Engines for vehicles may be reciprocating or gas turbine and use shall be selected from military or industrial sources, subject to the approval of the procuring activity. Power requirements for driven parts shall not exceed 75 percent of the available horsepower of the engine at operating RPM. Fuel requirements shall be compatible with the engine type and shall be readily available. Gasoline, diesel oil, and kerosene are acceptable fuels provided they are compatible with the operational environment. Exotic fuels, such as hypergolics, shall not be used. The engine used for munitions handling vehicles shall be qualified by the applicable military specifications. The engines used shall incorporate:

a. A flame arresting intake and exhaust system.

b. Devices to minimize exhaust emission pollutants.

c. An operating time recorder.

d. Sufficient fuel and oil capacity to operate at least four hours without servicing.

5.1.4.1.2 Electric motors. Electric motors shall be state-of-the-art heavy duty, industrial type with a high starting torque. The motors shall be capable of withstanding the current loads expected when the equipment is operated under maximum performance conditions. One or more thermal relay switches shall be provided to interrupt the current to an overheated circuit when the outside surface temperature of the motor exceeds 225 °F. Forward and reverse speed controllers shall give smooth acceleration and shall include automatic means to prevent starting or reversing in other than first (slowest) speed. Motors, controllers, relays, switches, and other electrical accessories that could be expected to arc or produce sparking during operation shall be the totally enclosed type.

5.1.4.1.3 Drive train systems. Drive train systems shall be designed to deliver power to the propelling wheels in a smooth, efficient manner. Drive train components shall be of sufficient strength to transfer the power required to operate the equipment at its rated capacity under the conditions specified in the applicable development specification. Whenever possible, commercial industrial grade automotive components shall be used. Unless otherwise specified by the applicable development specification, power trains shall consist of fully automatic transmissions, coupled to the power source by a torque converter or hydrostatic drive. When a manual transmission is used, it shall be of a fully synchromesh type. Provisions for dispersing excess heat shall be provided, and there shall be no leakage of the drive train lubricant or working fluids from the system under any conditions of operation.

5.1.4.1.4 Other power/drive train considerations.

5.1.4.1.4.1 Structural fuse. To protect the power train, a structural fuse, i.e., a “weak link”, shall be incorporated which will be designed to fail before the weakest part of the power train if excess forces occur. The structural fuse may be a mechanical link that fails, a component which slips, or some other device, but in no way shall it compromise the operation of the equipment. The structural fuse shall be designed and located for easy replacement if necessary.

5.1.4.1.4.2 Clutch. The use of manual clutches is discouraged; however, when such use cannot be avoided, the force required to depress the clutch pedal shall not exceed 40 pounds.

5.1.4.1.4.3 Engine exhaust system. The exhaust system should be of corrosion resistant steel, positioned and protected against entry of rain and shall have adequate drainage to prevent the accumulation of condensed vapors. The exhaust system shall provide for a spark arresting device. The exhaust system shall be mounted such that it will prevent burns to the operator and so that it will emit fumes away from the operator.

5.1.4.1.4.3.1 Muffler. The muffler shall be of corrosion resistant steel construction, conform to commercial industrial standards and be capable of reducing overall exhaust noise to a maximum of 85 decibels (dB) at a radius of 10 feet from the end and 2 feet above the muffler tail pipe with engine operating at rated load and speed.

5.1.4.1.4.3.2 Spark arrestor. The spark arrestor shall conform to the requirements of USDA Forest Service Standard 5100-1A, except for an increase of efficiency to 95 percent.

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5.1.4.2 Electrical system. The electrical system shall be negative ground and shall consist of an alternator and a regulator, 12/24 volt battery, lights, switches, and necessary wiring. The nominal system voltage shall be 15/28 volts. The electrical system shall be adequately protected against overload by discriminate fuses or circuit breakers.

5.1.4.2.1 Alternator and regulator. Heavy duty, commercially available automotive alternators and regulators shall be used whenever possible. The alternator shall be mounted externally on the engine and be capable of delivering more amperage than the system draws. The regulator shall be capable of maintaining voltage levels between 13 and 15 volts for 12-volt systems, and between 26 and 28 volts for 24-volt systems. The alternator and regulator system shall be protected from overload by an automatic disconnect circuit activated when an external power source is applied for emergency starting.

5.1.4.2.2 Battery. Batteries (except for battery powered equipment) shall be of commercial, heavy duty, automotive quality. The battery or battery circuit shall have quick-disconnect capabilities. Batteries designated as non-hazardous for transportation should be used whenever possible.

5.1.4.2.3 Lighting system. The lighting system of the equipment shall consist of running lights, stop and tail lights, blackout lights, and spot or flood lights for loading at night.

5.1.4.2.3.1 Lights. Running lights and directional signaling devices shall be installed on all off-base operated equipment. The incorporation of compatible provisions for equipment operated solely on-base and/or special provisions (spotlights, warning lights, etc.) shall be specifically delineated in the detail specification.

5.1.4.2.3.2 Blackout-running lights. The equipment shall have combination blackout-running lights on each of the four corners. When the blackout lights are in operation, stop and tail lights will not be operable.

5.1.4.2.3.3 Spot/flood light. The equipment shall be equipped with a swivel mounted spot or flood light, which can become portable, to facilitate night loading.

5.1.4.2.4 Switches. Ignition and starter switches shall be either single pole or double pole toggle, as required, of automotive industrial grade quality and environmentally sealed. Light switches shall be of the type used by the automotive industry and shall be waterproof. Electrical characteristics of all switches shall be compatible with voltage and current applicable to the circuit in which used.

5.1.4.2.5 Wiring. Wiring used on loaders and trailers shall be made up in a harness configuration wherever possible. Wires shall be marked so as to identify the circuit in which they are used. Marking may be in the form of molding or stamping, or may consist of bands or adhesive tapes capable of withstanding the using environment. Color Coding of wires may also be used along with a means of associating the color code to the circuit in which the wire is used. Additional guidance regarding marking may be found in 6.5. Wire shall be in accordance with SAE-AS50861. Terminal ends in accordance with SAE-J561 should be used on all wire endings.

5.1.4.2.6 Fuses and circuit breakers. Automotive style fuses or circuit breakers shall be provided for each circuit and shall be matched to the maximum current normally expected in the circuit. Fuses and breakers shall be located together in an easily accessible panel.

5.1.4.2.7 Electromagnetic interference. Electromagnetic interference which is generated by powered and self-propelled equipment shall be avoided or suppressed so as not to cause interference with other electrical/electronic equipment. Guidance regarding electromagnetic interference may be had from MIL-STD-461 and IEEE C63.14. Radiation Hazard (RADHAZ) requirements shall conform to OP3565/NAVAIR 16-1-529 Volumes 1 and 2.

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5.1.4.3 Brakes.

5.1.4.3.1 General requirements. All mobile equipment shall have brakes capable of restraining the handling equipment and its rated load on specified floor or deck conditions. For shore-based equipment, the service brakes shall be of the air-over-hydraulic or electric-hydraulic actuated type. For shipboard applications, mechanical brakes shall be used for skids and transporters, while loaders shall incorporate either mechanical or fluid as required. Except as specified herein, the brake requirements for all mobile equipment shall be in accordance with SAE-AS8090.

5.1.4.3.2 Parking brakes. An automotive type manual parking brake shall be provided. The parking brake shall be capable of holding the equipment, loaded to rated capacity, stationary on an incline of 11.5 degrees. No rolling or skidding shall take place. The force to fully actuate the parking brake shall not exceed 30 pounds if applied by hand or 50 pounds if applied by foot.

5.1.4.3.3 Service brakes. Automotive style service brakes shall be provided and shall be capable of holding the equipment, loaded to rated capacity, stationary on an incline of 11.5 degrees, and stopping the loaded vehicle from a speed of 20 mph when traveling on a dry, level, concrete surface in not more than 30 feet from the point at which the brakes are applied. Force required to operate the brake pedal and lock the brakes shall not exceed 80 pounds.

5.1.4.4 Examination and test conditions.

5.1.4.4.1 Environmental. Unless otherwise specified in the applicable development specification or by the procuring activity (see 6.2), the item shall be tested or examined under the following conditions and in accordance with MIL-STD-1366.

a. Temperature: 77±18 °F

b. Humidity (relative): 90 percent maximum

c. Barometric pressure: Ambient

5.1.4.4.2 Item examination. The item shall be examined for conformance with applicable product specifications and drawings, with respect to performance functions. The product shall be operated with a load and shall demonstrate adherence to the design requirements. In addition, any part of the product which supports or encloses a weapon or component shall be checked to assure that proper contact is achieved between mating surfaces and that there is no slippage, binding or interference.

5.1.4.4.3 Functional.

5.1.4.4.3.1 Rated load. The product shall be tested for not less than 5 minutes carrying the rated load. Equipment not at rest on a horizontal flat surface shall be securely mounted to a stationary apparatus, so that minimal movement is made during testing. After application of the rated load, critical areas of the product shall be inspected to ensure that no overstressing of parts has resulted. In addition, the tests shall conform to the design requirements of 4.4 or as required by the applicable development specification.

5.2 Special requirements - trailers.

5.2.1 Classification of requirements. Trailers designed using this standard shall be subjected to all tests listed with the exception of those tests which do not apply to the trailer as designed (see 6.2). The trailer test requirements shall be classified as follows:

a. Product examination (see 5.2.2)

b. Functional requirement (see 5.2.3)

c. Environmental requirements (see 5.2.4)

Unless otherwise specified in the applicable development specification or by the procuring activity (see 6.2), all testing shall be conducted with rated load.

5.2.2 Product examination. Trailers shall be examined for conformance with applicable trailer specification and drawings, with respect to function and performance. The trailer shall be towed without a load and demonstrate forward and rear mobility including proper steering, brakes, and tow bar functions.

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5.2.3 Functional.

5.2.3.1 Brakes.

5.2.3.1.1 Parking brakes. Trailers and towed vehicles shall be equipped with manually applied parking brakes which shall be capable of locking the wheels so that:

a. When a towing force of sufficient magnitude is applied, the braked wheels of the trailer or towed vehicle shall skid, not roll, on dry level concrete.

b. The fully loaded equipment shall remain motionless on a dry incline of 20 percent (11.5 degrees).

5.2.3.1.2 Service brakes. Trailers and towed equipment shall be equipped with service brakes meeting the following requirements:

a. The brakes shall be capable of stopping the fully loaded vehicle traveling on a level concrete surface at 20 mph within 30 feet after brakes have been applied. The service brake shall operate smoothly and uniformly, and the trailer shall exhibit no tendency to jackknife.

b. The service brakes shall be capable of holding the trailer motionless and control it whether headed up or down a dry incline of 20 percent (11.5 degrees).

c. The service brakes shall be automatically applied in synchronization with the braking action of the towing vehicle.

5.2.3.1.2.1 Breakaway stopping. The brake system shall assure that, in the event the trailer is separated from the towing vehicle, the trailer service brakes will be automatically energized to stop the trailer in not more than 150 percent of tow vehicle/trailer stopping distance at rated load.

5.2.3.1.2.2 Back-up (if required). While the trailer is subjected to a back-up force, the service brakes shall momentarily hold, but with continued force shall release and allow unrestricted rearward travel.

5.2.3.1.3 Surge brakes. A trailer surge brake system, when used, shall provide smooth proportional braking action when the towing vehicle is decelerating on down-grades. The system shall have a bypass provision to permit the trailer to move rearward, with a maximum delay of one second after application of the rearward force.

5.2.3.1.3.1 Breakaway (if required). When equipped with surge brakes, the vehicle shall be capable of meeting the following requirements. On a dry level brushed concrete surface, free of loose material, and with the breakaway lever of the surge brake positioned to apply the brakes, the loaded trailer shall be subjected to a towing force sufficient to move the trailer for a minimum distance of 5 feet to determine that the wheels will skid and not roll.

5.2.3.1.3.2 Inadvertent actuation. The surge brake actuator shall incorporate provisions to prevent premature or intermittent brake action resulting from uneven road surfaces and/or trailer pitching.

5.2.3.2 Towing force. The trailer shall demonstrate capability to roll under a maximum towing force of 2½ percent of its maximum gross weight when tested as follows. A prime mover shall be used to apply a gradual towing force through a dynamometer or other suitable force measuring device placed between the prime mover and the towbar of the vehicle, and the tow force shall be measured to determine compliance with the requirement. This evaluation shall be conducted with the trailer fully loaded on a dry, level, concrete surface free of loose material.

5.2.3.3 Design proof load. The trailer shall be subjected to a test load (see table I) with the trailer supported in such a manner that the load will not be carried by the tires. Evidence of permanent deformation shall be cause for rejection.

5.2.3.4 Mobility. Requirements for mobility shall be as determined by the procuring activity or as defined in the development specification (see 6.2). Guidance regarding mobility concerns may be found in SAE-AS8090.

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5.2.4 Environmental. The trailer shall be subjected to all tests described in 5.3.4 except with the following addition: Equipment designed for fording shall be capable of operating through water deep enough to submerge its running gear for at least 30 minutes with no adverse effect on equipment performance or braking characteristics. Confirmation that the requirement has been achieved shall be determined by towing the trailer at 15 mph and applying the brakes within 2 minutes after the 30-minute submersion. Any unusual towing or braking characteristics, such as yawing, skidding, or other evidence of improper operation, are cause for rejection.

5.3 Special requirements - loader.

5.3.1 Classification of requirements. Loaders designed under this specification shall be subjected to all tests listed with the exception of those tests which do not apply to the loader as designed (see 6.2). The loader test requirements shall be classified as follows:

a. Product examination (see 5.3.2).

b. Functional requirement test (see 5.3.3).

c. Environmental requirement test (see 5.3.4).

Unless otherwise specified in the applicable development specification or by the procuring activity (see 6.2), all testing to satisfy requirements shall be conducted with the rated load.

5.3.2 Product examination. The loader shall be examined for conformance with applicable loader specifications and drawings, with respect to functions and performance. The loader shall be operated with the rated load, and shall demonstrate forward and rear propulsion, steering, brakes, lift and incremental control, azimuth and incremental control, lateral, longitudinal, yaw, pitch, roll, side frame extension, and operation of electrical switches. The boom motions are to be verified to coincide with their design limitations. It shall be determined that the weight of the loader does not exceed the specified maximum. When a turning radius is specified by the applicable development specification, the turning radius shall be measured to determine conformance.

5.3.3 Functional.

5.3.3.1 Lift rate.

5.3.3.1.1 Powered. The lifting mechanism shall be capable of lifting the rated load throughout the entire lift cycle at a controllable rate up to the maximum required as specified in the applicable development specification or by the procuring activity (see 6.2).

5.3.3.1.2 Auxiliary. In case of a prime mover failure, the auxiliary lifting mechanism shall demonstrate a maximum lifting time of 1 minute per every 16 inches of travel.

5.3.3.2 Accumulator (if required). When the loader is so equipped, the accumulator shall demonstrate its capability of being charged to capacity while the power source is running at the required rpm. The time required to fully charge the accumulator shall be specified in the development specification.

5.3.3.3 Fail-safe. The loader fail-safe device for the lifting mechanism shall hold the load in any given attitude during the entire lifting operation in the event of a power failure. Compliance with this requirement shall be determined by simulating a failure in the lifting mechanism as follows. During the lift cycle, the power shall be interrupted and the lift mechanism observed to assure that it remains stationary, within the limits specified herein, in the attitude at which it was when the power was disengaged. Any movement greater than 0.5 inches per hour is unacceptable.

5.3.3.4 Boom lifting and azimuth incremental control. The boom shall be capable of both vertical and horizontal movement in ⅛-inch or less increments. Testing shall be accomplished along selected points of the vertical and horizontal paths to determine compliance.

5.3.3.5 Cycle. The loader shall be subjected to a simulated loading condition comprising all boom and manipulator head movements, thus constituting one cycle. The cycle shall be repeated 250 times with the side rails, if any, fully extended. The tests shall be run at specified loads and at normal operating speed.

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5.3.3.6 Design proof load. The loader shall withstand a design proof load (see table I) applied to the forks with the center of gravity (c.g.) of the load in a normal weapon or store position and held there for 5 minutes. Evidence of yield in any of the components, which could in any manner prevent the loader from meeting operational requirements during service life, shall be reason to consider that the loader has failed this test. Due to the extreme load it is recommended that one axle be blocked at the wheels and the opposite end of the loader be tied down.

5.3.3.7 Mobility.

5.3.3.7.1 Road. The loader(s) shall be subjected to a road test of 50 miles over paved level surfaces, 25 miles loaded (rated load) and 25 miles unloaded. At the end of this test there shall be no evidence of damage or construction deficiencies. During the 25-mile loaded portion, one short stop is permitted to cool down the loader if necessary. The duration of the stop should not exceed 30 minutes.

5.3.3.7.2 Side slope stability. The loader shall be required to demonstrate its ability to remain stable when driven sideways on an 8-percent (4.5-degree) grade. Loader side rails, if any, may be extended during this operation.

5.3.3.7.3 Brakes. The brake test requirements are as follows:

5.3.3.7.3.1 Service brake. The service brake shall be tested for its capability to hold the loader, fully loaded, without slippage on a dry, 20-percent (11.5-degree) grade for shore-based equipment or a 26-percent (15-degree) grade for shipboard equipment. All tests to be done with loader facing both up and down the grade.

5.3.3.7.3.2 Parking brake. The parking brake shall be capable of holding the vehicle motionless on the following slopes, up and down:

a. 20-percent (11.5-degree) slope with rated load for shore-based equipment.

b. 26-percent (15-degree) slope with rated load for shipboard equipment.

5.3.3.7.3.3 Emergency braking. The service brake shall be applied in full force while the loader is traveling at top speed in a loaded condition. The brakes shall be capable of locking all four wheels in this test. Using a time distance recorder, the loader shall be brought to a complete stop from top speed within the distance specified in the applicable development specification after brake application. This test shall be repeated three times. Failure to pass any one of these tests shall be cause for rejection.

5.3.3.8 Ramp negotiation. The loader shall demonstrate its capability of climbing a 10-percent (5.7-degree) grade loaded or a 20-percent (11.5-degree) grade unloaded. No point on the loader other than the wheels shall contact the ground or the ramp. The loader shall negotiate this grade under its own power. Failure to do so shall be cause for rejection.

5.3.3.9 Creep capability. The loader shall demonstrate smooth acceleration from a dead stop to a constant slow speed. Any evidence of surging or leaping shall be cause for rejection.

5.3.3.10 Speed. The loader shall be tested at top speed and must be capable of attaining its designed speed as specified in the applicable development specification. Conformance with this requirement shall be ascertained by a test which shall be performed on a level, hard roadway. The loader shall be accelerated to its top speed which shall be maintained through a measured course of 400 feet. The average top speed shall be determined by measuring the time the loader takes to travel the 400-foot course. The test shall be conducted twice.

5.3.4 Environmental. The general requirements specified in MIL-STD-810, except as noted, shall apply to the environmental tests specified herein.

5.3.4.1 Temperature extremes.

5.3.4.1.1 High temperature. Unless otherwise specified in the applicable development specification or by the procuring activity (see 6.2), the equipment shall be tested in accordance with MIL-STD-810, Method 501.5, Procedure II. The following detail requirements shall apply:

a. Pre-test data shall be required.

b. High storage and operating temperature shall meet the requirements of 4.9.1.

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After tests, operate the equipment at ambient temperature.

5.3.4.1.2 Low temperature. Unless otherwise specified in the applicable development specification or by the procuring activity (see 6.2), the equipment shall be tested in accordance with MIL-STD-810, Method 502.5, Procedure I. The following detail requirements shall apply:

a. Pre-test data shall be required.

b. Low storage and operating temperature shall meet the requirements of 4.9.1.

After tests, operate the equipment at ambient temperature.

5.3.4.2 Humidity. The equipment shall be subjected to a humidity test in accordance with MIL-STD-810, Method 507.5, Procedure I. The following detail requirements and exceptions to the test program shall apply:

a. Pre-test data shall be required.

b. The equipment shall be subjected to a performance check immediately after completion of the tenth cycle, i.e., step 6 of the MIL-STD-810 test procedure shall be eliminated.

After tests, operate the equipment at ambient temperature.

5.3.4.3 Salt fog. The equipment shall be subjected to a salt fog test in accordance with MIL-STD-810, Method 509.5.

5.3.4.4. Sand and dust. The equipment shall be subjected to a dust test in accordance with MIL-STD-810, Method 510.5, Procedure I. Upon completion of test, it shall be demonstrated that equipment performs satisfactorily.

5.3.4.5 Rain. The equipment shall be subjected to a rain test in accordance with MIL-STD-810, Method 506.5. Procedure(s) shall be as specified by the procuring activity (see 6.2). Upon completion of tests, it shall be demonstrated that equipment performs satisfactorily.

5.4 Special requirements - trailers and loaders.

5.4.1 Parking brakes. Parking brakes, when mechanical, shall be designed so that structural deflection of the vehicle caused by rated load dynamic conditions will not actuate them.

5.4.1.1 Adjustment access. Adjustment of the mechanical brakes shall be possible without the removal or disassembly of any associated brake system components/related parts.

5.4.1.2 Force levels. The force levels required to fully energize the mechanical brake system shall not exceed 30 pounds if single hand operated or 50 pounds if foot operated.

5.4.2 Towing provisions. A maximum of four trailers shall be capable of being towed in tandem. The drawbar shall swivel in the vertical plane and shall be equipped with a standard lunette coupler ring having a nominal inside eye diameter of 3 inches. Strength characteristics shall be as specified by the applicable development specification. An associated pintle assembly for towing shall also be provided. The pintle shall have a towing capacity of 18,000 pounds and shall be sized to be compatible with the lunette coupler. Also, it shall be equipped with a manual release and shall be positioned from 14 to 21 inches above the static ground line.

5.4.2.1 Steering. The steering mechanism shall assure minimum differential tire wear. Sufficient mechanical advantage shall be provided through the drawbar to allow one man to manually steer the trailer under static full load conditions.

5.4.2.2 Automotive type steering. Methods shall be included for minute adjustment of parts that become misaligned because of wear. An access provision shall be made for lubrication. Means for adjusting the camber and toe-in of wheels shall be included.

5.4.2.3 Cramping stops. Stops shall be provided on the trailer chassis. They shall restrict the front wheel to a maximum cramping angle of 40 degrees to each side of the center track. However, oversteer designs are acceptable.

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5.4.3 Fenders, mudflaps, and bumpers. Fenders, mudflaps, and bumpers shall not be provided for equipment unless they are essential for protecting the item being handled. For equipment used in UNREP, bumpers shall be provided for weapon protection.

5.4.4 Controls. All controls for energizing armament handling motions shall be designed on the dead-man principle. Handles, switches, etc., shall automatically neutralize in the absence of manual force.

5.4.5 Fuel servicing provisions.

5.4.5.1 Fuel tank construction and mounting. The fuel tank and filler neck shall be constructed to permit mounting in a location where damage from chafing against other equipment parts will not occur. Mounting attachments provided shall be of a type that will not loosen under operational vibration. When mounting straps are furnished, a barrier of fuel resistant material shall be provided to prevent chafing. The tank shall be vented to the outside of the enclosure and shall be able to accept fuel without spill back from a fueling nozzle or a fuel can. Spills or overflows shall be directed overboard without the possibility of trapping or pocketing in or on the enclosure. During refueling, the fuel delivery nozzle or container shall not come in contact with any exposed electrical components of the tank or equipment. Metal fuel tanks shall be metal to metal contact with the frame or incorporate a ground strap to frame permitting discharge of static electricity.

5.4.5.2 Fuel tank components. A cap, chain, filler neck, strainer, shutoff valve, and other necessary fittings shall be provided with each tank. The filler cap should be external to the enclosure to eliminate the necessity for an access door or plate. The cap shall be constructed of a material treated to resist corrosion, or a material inherently corrosion resistant. The cap shall be captive chained to the equipment. The chain shall not be connected to the fuel supply line, and shall be of sufficient size to inhibit loss of the fuel cap. The filler neck shall be constructed of materials treated to resist corrosion, compatible with the fuel tank, and affixed to the tank in a manner compatible with the type of tank construction. The filler strainer shall be removable, constructed of non-corrosive material, 60 mesh screen, and shall be protected to prevent damage caused by contact with the refueling nozzle.

5.4.5.3 Fuel tank marking. The type fuel and fuel tank capacity shall be stenciled on the equipment adjacent to the filler cap. Material used for marking shall be compatible with the type of fuel being used.

5.5 Requirements for non-mobile equipment.

5.5.1 Hoist cable guides. Hoists employing wire rope as the load carrying medium shall incorporate adequate guides, fairleads, and/or feed devices to prevent snarling or entanglement of cable during reeling operations.

5.5.2 Hydraulic lifting or hoisting mechanisms. Mechanical locking capabilities shall be provided on any hydraulic lifting or hoisting mechanism which is intended (or might be used) to hold the load in the raised or extended position for more than 2 minutes.

5.5.3 Positioning and stabilizing load. Where a load must be lifted into close quarters or onto precise mating, provisions shall be made for final adjustment in aligning, mounting, and stabilizing the load. This is especially important for shipboard operations where conditions of roll and pitch must be considered. When testing the complete unit for hoisting safety, these means should be locked out unless their failure would permit the load to fall. When systems handling equipment is operated through the trunk or hatch of a ship, guides shall be provided for lateral restraint when the operations will be conducted under conditions of more than 3 degrees of roll or list.

5.5.4 Hand operated hoist. Hand operated hoist(s) shall be designed such that, when the actuating force is removed, it will automatically stop and hold the load in the raised position.

5.6 Special requirements for boom-type hoists.

5.6.1 Classification of requirements. Hoists designed under this standard shall be subjected to all tests listed with the exception of those tests which do not apply to the hoist as designed (see 6.2). The hoist tests shall be classified as follows:

a. Product examination (see 5.6.2).

b. Functional requirement test (see 5.6.3).

c. Environmental requirement test (see 5.6.4).

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Unless otherwise specified in the applicable development specification or by the procuring activity (see 6.2), all testing shall be conducted with the rated load. Unless otherwise specified in the applicable development specification or by the procuring activity (see 6.2), all tests shall apply to both powered and manual hoists.

5.6.2 Product examination. Each hoist shall be inspected for strict conformance to the pertinent drawings and specifications with respect to function and performance, especially rated capacity, elevation, extension and rotation requirements.

5.6.3 Functional requirements. During testing, the hoist shall be securely mounted either to a vehicle or a stationary apparatus, so that minimal movement is made to the frame.

5.6.3.1 Design proof load. With the hoist securely mounted, a test load (see table I) shall be suspended by the hoist for 5 minutes in the same manner that the rated load is suspended during normal operation. No part of the hoist shall take a permanent set as a result of the test. After completion of the test, remove the test load and apply the rated load. The hoist shall operate satisfactorily under power for 6 cycles and then manually for 1 cycle, raising and lowering the rated load the full distance. Upon completion of this test, destroy the cable and replace with a new cable.

5.6.3.2 Operating speed. The rated load shall be raised and lowered through the entire lift distance at an average speed as specified by the development specification. This test shall be conducted in the following sequence without interruption between sequences:

a. Perform 2 cycles manually, if manual operation is required as an alternate.

b. Perform 12 cycles under power, when the equipment is powered.

c. Perform 10 cycles manually.

No malfunctioning of the hoist, such as skipping or jumping of the cable from the cable grooves or uncontrolled lowering, shall occur during this test. There shall be no evidence of damage after completion of these tests. If manually operated, the effort to raise or lower the designed load shall not exceed 35 pounds (17½ pounds per handcrank) on a radius of 8 inches.

5.6.3.3 Braking. While operating the hoist with the rated load the driving power shall be stopped. The load shall stop positively and smoothly, without slips or jerks, and be held without lowering. Upon resumption of operation, there shall be no interference in any part of the system, or slipping or jerky action due to a clutch, if any. For powered hoists with manual backup, the brake test shall be accomplished two times while operating the hoist manually and six times while operating the hoist under power. For manual hoists only, the brake test shall be accomplished four times.

5.6.3.4 Cycle test. The hoist shall be operated without failure or adjustment of parts through a total of 500 cycles. The rated load shall be raised and lowered the entire lift distance to constitute a cycle. The 500 cycles shall consist of segments of 20 consecutive cycles with a maximum 10-minute period of down time between segments and repeated. After completion of the 500 cycles, the hoist shall be completely disassembled and inspected to determine whether any wear, fretting, scoring, etc., that would affect the operation of the hoist has occurred.

5.6.3.5 Free-wheeling. If a hoist has a clutch or similar mechanism to allow free wheeling of the cable drum to facilitate cable rigging, a maximum and minimum force to extract the cable shall be MIL-STD-1365 specified by the development specification. This force shall be measured to ensure compliance with the design requirements.

5.6.3.6 Safety overload device. The hoist shall have a mechanism by which overloading of the hoist on attaching structures is prevented. The force at which this device is activated (maximum and minimum) shall be specified by the development specification. The mechanism shall be tested to ensure compliance with the design limits.

5.6.4 Environmental. The hoist shall be subjected to all tests described in 5.3.4.

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5.7 Special handling requirements.

5.7.1 Hoisting and tiedown fittings. Equipment weighing more than 150 pounds shall be provided with hoisting and tiedown fittings in accordance with MIL-STD-209. In addition, if the equipment shall be delivered by parachute or touch-and-go, suspension and extraction provisions shall be provided in accordance with MIL-STD-814. For internal air transport by fixed wing aircraft, see 6.4 for an appropriate source of guidance for restraint of cargo. For external airlift by rotary wing aircraft, MIL-STD-913 provides appropriate guidance for the restraint of cargo.

5.7.1.1 Single-point hoisting. Lifting devices shall be designed for single point hoisting, wherever possible. Lifting devices for heavy aircraft ordnance may be multiple-point suspension to ensure compatibility with airplane attachments or to stabilize the load.

5.7.1.2 Location of single-point hoisting eye. The hoisting eye shall be placed directly above the center of gravity of the combined load. Where the unit has variable center of gravity locations, separate, clearly identified locations shall be provided for the hoisting eye. If, while the load is suspended, the center of gravity will be changed by work on the unit, a smooth-acting, simple means shall be provided for adjusting locations of the hoisting eye to level the load. Levelness shall be maintained within ±5 degrees.

5.7.1.3 Size of hoisting eye. The inside diameter of hoisting eyes interfacing with cargo hooks, etc., shall be at least 3½ inches. Hoisting eyes designed to interface with other equipment, such as aircraft or smaller hoists, may be correspondingly smaller or larger in accordance with MIL-STD-209.

5.7.2 Load attachments. All load attachments shall be as simply designed as possible, consistent with safety, and so that positive action is required to disengage them. Positive latches, spring-loaded safety hooks and spring-loaded or self-locking nut-bolt combinations in accordance with A-A-50469 shall be used on clevises.

5.7.3 Spreader bar slings. Spreader bars shall be used, if necessary, either to obtain clearance, or when the load might be damaged by compression induced by angular suspension (particularly applicable to light structures of the type common in missiles). Minimum angle between spreader bar and member, leading to hoisting eye, shall be 30 degrees.

5.7.4 VERTREP slings. VERTREP slings and associated helicopter hookup gear shall be designed to provide a suitable insulator to avert grounding static electricity through hookup personnel. Layed rope is not acceptable. Provisions should be made to secure loose legs of a sling prior to takeoff to eliminate the hazard of entanglement. Chafe protection shall also be applied to nylon lifting eyes of hoisting slings.

5.7.5 Lifting beams. To reduce overhead clearance, consider lifting beams as an alternate to spreader bar slings. Lifting beams shall be designed to hold the load level within ±5 degrees. Further, particular attention shall be given to prevent torsional failure.

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 provide general design criteria and guidance for handling equipment associated with weapons and other items of similar nature and should be used as the basis for preparing development specifications for such equipment. However, this standard should not be substituted for sound engineering judgment with respect to establishing specific requirements for handling equipment needed to solve unique handling situations. The need for sound engineering judgment is further emphasized in light of the elimination of many government reference documents (military specifications, military standards, etc.) from this standard in order to encourage greater use of commercial products wherever possible. The intent of this standard, therefore, is to provide sufficient information and latitude for the use of commercial products, and to define those unique requirements, such as shipboard and aircraft interface criteria, which are not likely to be found in the commercial section and require the use of the documents referenced.

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6.2 Acquisition requirements. Acquisition documents should specify the following:

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

b. System safety program requirement (see 4.2.1.1).

c. When permissible gross weight of any unit (e.g., missile and transfer dolly) during UNREP is other than that specified (see 4.4.4).

d. The environment requirements (see 4.4.5.2).

e. Requirements for hydraulic systems (see 4.5.1).

f. Electrical system requirements other than those specified (see 4.7.1).

g. Temperature requirements other than that specified (see 4.9.1).

h. When development of a program for reliability and maintainability is required (see 4.9.7).

i. Whether high-impact shock requirements are applicable (see 5.1.3.2.1).

j. Environmental test requirements other than those specified (see 5.1.4.4.1).

k. Trailer test load values other than those specified (see 5.2.1).

l. Requirements for mobility (see 5.2.3.4).

m. Loader test load values other than those specified (see 5.3.1).

n. Maximum rated load for the lifting mechanism (see 5.3.3.1.1).

o. High temperature test requirement other than that specified (see 5.3.4.1.1).

p. Low temperature test requirement other than that specified (see 5.3.4.1.2).

q. Procedures for a rain test other than that specified (see 5.3.4.5).

r. Hoist test load values other than those specified (see 5.6.1).

s. Hoist types to be tested other than those specified (see 5.6.1).

6.3 Dissimilar metals. MIL-STD-889 (Dissimilar Metals) may be referred to for information regarding dissimilar metals, the Galvanic Series and means of protecting against corrosion due to galvanic action.

6.4 Air transportability. MIL-HDBK-1791 (Designing for Internal Aerial Delivery in Fixed Wing Aircraft) provides guidance concerning information which must be considered when developing equipment which will be air-delivered in fixed wing cargo aircraft. Such information includes, but is not limited to, size of the equipment, weight, hoisting and tiedown fittings, and compatibility with the type of aircraft to be used for transport.

6.5 Wiring marking. MIL-HDBK-454 (General Guidelines for Electronic Equipment), Guideline 67 provides additional guidance regarding the marking of wiring.

6.6 Subject term (key word) listing.

AEODA

Bomb loaders

CONREP

Explosive

Munitions

6.7 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.

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Custodians:
Army – SM
Navy – OS
Air Force – 69

Preparing activity:
Navy – OS
(Project PACK-2008-003)

Review activities:
Army – AR, MI, MT
Navy – AS, EC, MC, SA, SH
Air Force – 11, 99

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