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21 August 1974

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8 AUGUST 1968

MILITARY STANDARD

ITEM CHARACTERISTICS AFFECTING
TRANSPORTABILITY
AND
PACKAGING AND HANDLING
EQUIPMENT DESIGN



FSC 8140

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DEPARTMENT OF DEFENSE

Washington, D. C.

Item Characteristics Affecting Transportability
and Packaging and Handling Equipment Design

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1. This standard is approved for use by all Departments and Agencies of the Department of Defense.
2. Recommended corrections, additions, or deletions should be addressed to the Commanding Officer, Naval Ordnance Station, Standardization Division, Indian Head, Maryland 20640.

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FOREWORD

In designing packages and handling equipment, the interface between the package and the handling equipment and the item to be packaged or handled must be defined. Further, where the item is a transportability problem item (as defined herein), the interface between the item (packaged or not) and the transportation system must be defined. These interface definitions need to be kept current to assure proper equipment design and transportability analysis (where required). The item characteristics identified herein are those required to define these interfaces. Availability of these data is an essential prerequisite to container and handling equipment design.

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ITEM CHARACTERISTICS AFFECTING TRANSPORTABILITY AND PACKAGING AND HANDLING EQUIPMENT DESIGN

1. SCOPE

1.1 This standard identifies the item characteristics affecting design and development of packaging and handling equipment as well as the item characteristics affecting transportability (see 6.1 and 6.2).

2. REFERENCED DOCUMENTS

2.1 The issue of the following documents in effect on the date of invitation for bids form a part of this standard to the extent specified herein.

STANDARDS

Military

MIL-STD-444	Definitions in the Ammunition Area
MIL-STD-648	General Design Criteria for Systems Shipping Containers
MIL-STD-1365	General Design Criteria for Systems Handling Equipment Associated With Weapons and Weapon Systems
MIL-STD-1366	Definition of Transportation and Delivery Mode Dimensional Constraints
MIL-STD-1367	Packaging, Handling, Storage and Transportability Program Requirements (For System and Equipments)
MS 35858	Diagram, Equipment, Composite, Railway, Freight, 56-1/2 Gage, Domestic Service

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(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

OTHER PUBLICATIONS

Department of Transportation Regulations

49 CFR 170-189 Department of Transportation (DOT) Regulations
for the Transportation of Explosives and Other
Dangerous Articles by Land and Water

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, D. C. 20402. Orders for the publication should cite "The latest issue and supplements thereto.")

3. DEFINITIONS

3.1 Transportability. The inherent capability of material to be moved by towing, by self-propulsion, or by carrier via railways, highways, inland waterways, oceans, and airways.

3.2 Transportability problem item. An item in its shipping configuration which exceeds the dimensions given in MIL-STD-1366; any item or material defined as hazardous in the Department of Transportation regulations; any item so sensitive to shock, vibration, or climatic environment that specialized conveyances are essential to its movement; any item requiring special security procedures or technical escort while in transit; any item requiring external power source during transit and storage; any item requiring special radiation shielding (electromagnetic or radioactive); any wheeled or tracked vehicle, or; any item requiring special procedures or unusual material handling equipment while in transit (see 6.2.1).

4. GENERAL REQUIREMENTS

4.1 Not applicable.

5. DETAILED REQUIREMENTS

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5.1 Report submittal. Data accumulated pursuant to this standard shall be submitted to the Government only when specified in the applicable contract DD Form 1423 (see 6.3).

5.1.1 Submittal timing. When a report submittal is required, it is normally required to be submitted early in the contract to define potential transportability problem items, when any significant changes occur, and just prior to design freeze. A significant change occurs when an item change forces redirection of packaging or handling equipment design or whenever status as a transportability problem item changes. The specific time frame for submittal of preliminary, final, and amended reports shall be in accordance with the requirements of the applicable DD Form 1423.

5.2 Source information. Sources for item characteristics shall include, but not be limited to, the following:

- (a) Technical development plans
- (b) Specific operational requirements or qualitative material requirements
- (c) System and item specifications
- (d) Test reports
- (e) Vibration and shock analyses
- (f) Stress analyses
- (g) Correlation or coordination drawings
- (h) Integrated logistic support plans for the system and its major components.

It is not anticipated that all of these data will be available at the start of a program. For example, environmental test reports would not be ready until well into the engineering development phase of a system. When available, however, these data should be carefully screened to determine whether prescribed minimum environmental performance values are being exceeded, and by how much. If so, packaging design problems and transportability problems may be drastically reduced with concomitant reduction of system costs.

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5.2.1 Traceability. The contractor shall insure that the interface control data accumulated as a result hereof are traceable to valid controlling documents or test reports.

5.3 Basic product characteristics. The characteristics delineated in the subparagraphs which follow are concerned with the item, preserved as necessary, and with all blank-off covers, protective cages or other packaging materials attached to the item itself but excluding all containers, associated cushioning, tie-down devices, or purely in-plant handling devices. Although characteristics are presented separately, combination is not thereby discouraged; see Figure 1.

5.3.1 Item geometry.

5.3.1.1 Shape. Envelope shape, preferably supported by dimensioned sketch or drawing, see Figure 2.

5.3.1.2 Dimensions. Overall length, width and height, see Figure 2.

5.3.1.3 Weight. Weight of the item.

5.3.1.4 Center of gravity. Location of center of gravity of the item with respect to its own coordinate system.

5.3.1.5 Projections. Any unusually projecting characteristic affecting development of packaging, handling, or transportability; for example, antennas of relatively small cross section projecting from any part of a missile.

5.3.1.6 Surface finish. Unusual surface finish maintenance criteria such as: surface finish of 125 shall be preserved in areas indicated.

5.3.2 Item dynamic characteristics.

5.3.2.1 Radii of gyration. Radii of gyration in the three major Cartesian coordinate axes with respect to the center of gravity.

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COMPONENT SECTION	NET WEIGHT (POUNDS)	LENGTH (INCHES)	DIAMETER (INCHES)	CG MISSILE STATION	RADI OF GYRATION (INCHES)	
					ROLL	PITCH AND YAW
GUIDANCE SECTION	161.62	39.00	14.00	52.86	7.56	12.63
ARMAMENT SECTION	175.00	18.50	13.87	72.6	9.81	11.23
MOTOR SECTION	462.62	65.37	14.00	131.06	9.90	37.89
CONTROL SECTION	126.20	16.37	14.00	175.6	9.90	10.08
FINS (4)	69.36	72.50	5-3/8 H x 2-1/2 W	N/A	3.41	10.44
CONTROL SURFACES (4)	16.18	13.50	14-1/2 H x 1-1/2 W	N/A	5.62	5.43
COMPLETE MISSILE DATA	1010.98	158.85	Var.	119.78	9.93	91.81

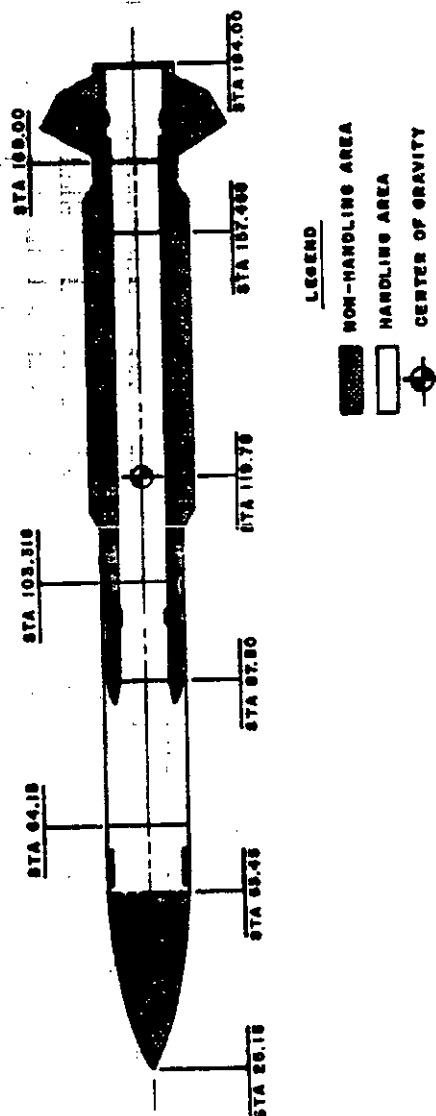


Figure 1. Typical Tabulation of Weapon Characteristics

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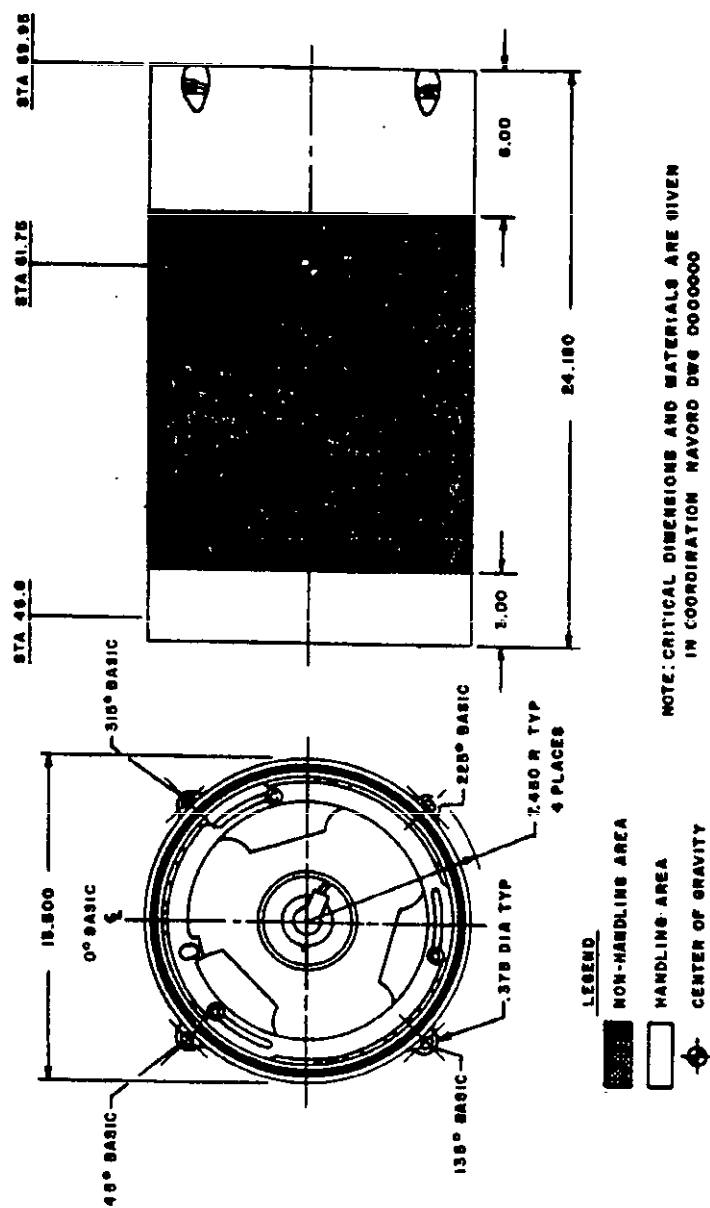


Figure 2. Typical Component Dimensional Data

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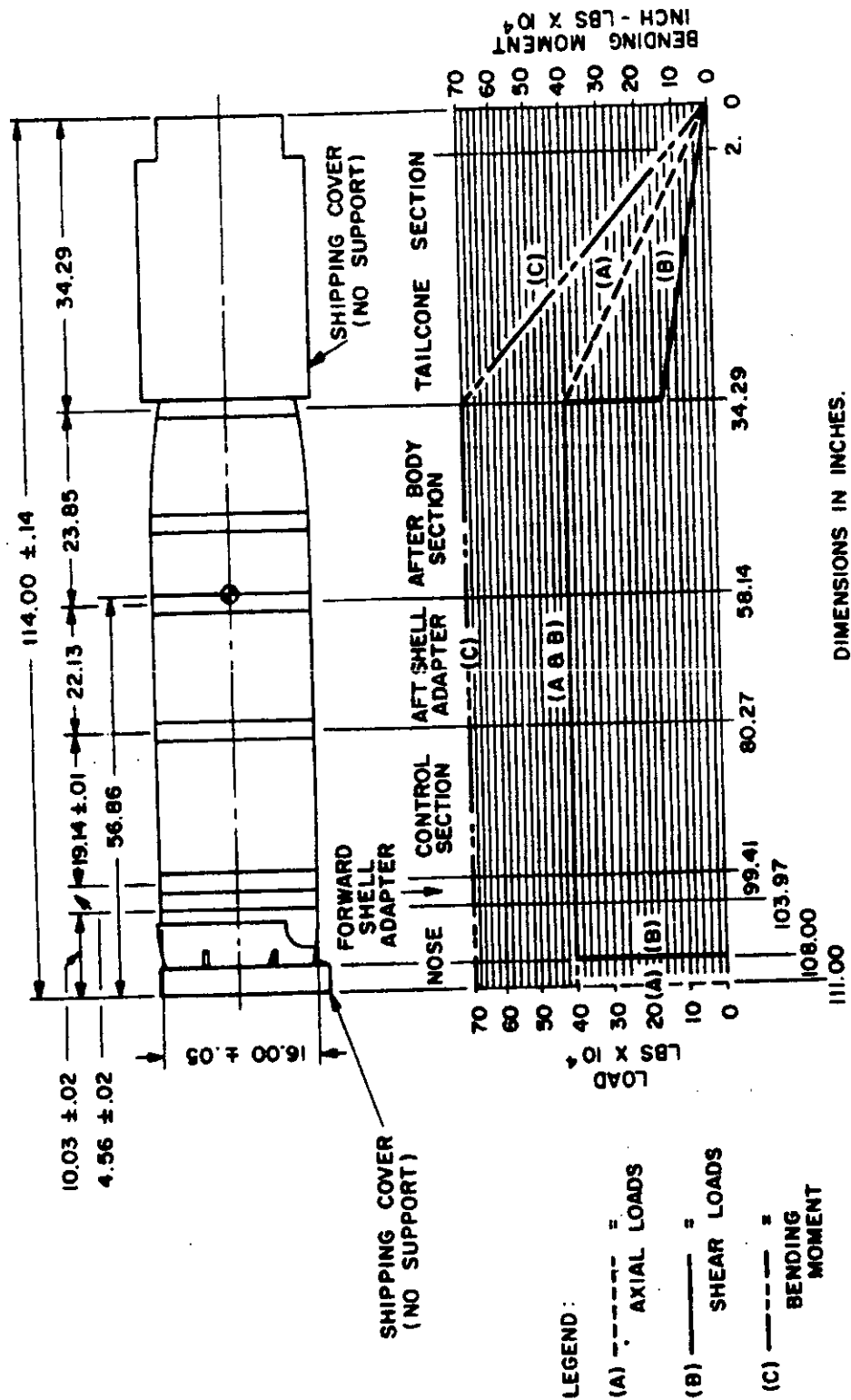


Figure 3. Typical Loading and Bending Moment Diagram

ments. Bending moments in plane(s) of each logical
r long slender items (slender items are items having
thickness or diameter of 5:1 or greater), see

transient forces. Allowable transient forces,
terms of multiples of the acceleration of gravity,
time and associated pulse shape along each of the
dinate axes.

s. Critical resonant or maximum transmissibility
uencies in the plane of each logical shipping atti-

sure. Maximum allowable static skin pressures,
olddown features are not available. Figure 4 is
ure diagram usable where skin pressure varies.

features. Dimensions and locations (see Figure 2)
ing features which may be used to secure the item
shipping skid, handling device or shipping conveyance.
namic stress of these features is also required to

Maximum allowable solid, liquid, or gaseous emis-
rates.

pressure. Vapor pressure at 70° Fahrenheit (F) and
and semiliquid products. Associated outage or
irements shall be identified.

onmental limitations.

ure. Specific limits on allowable high and low tem-

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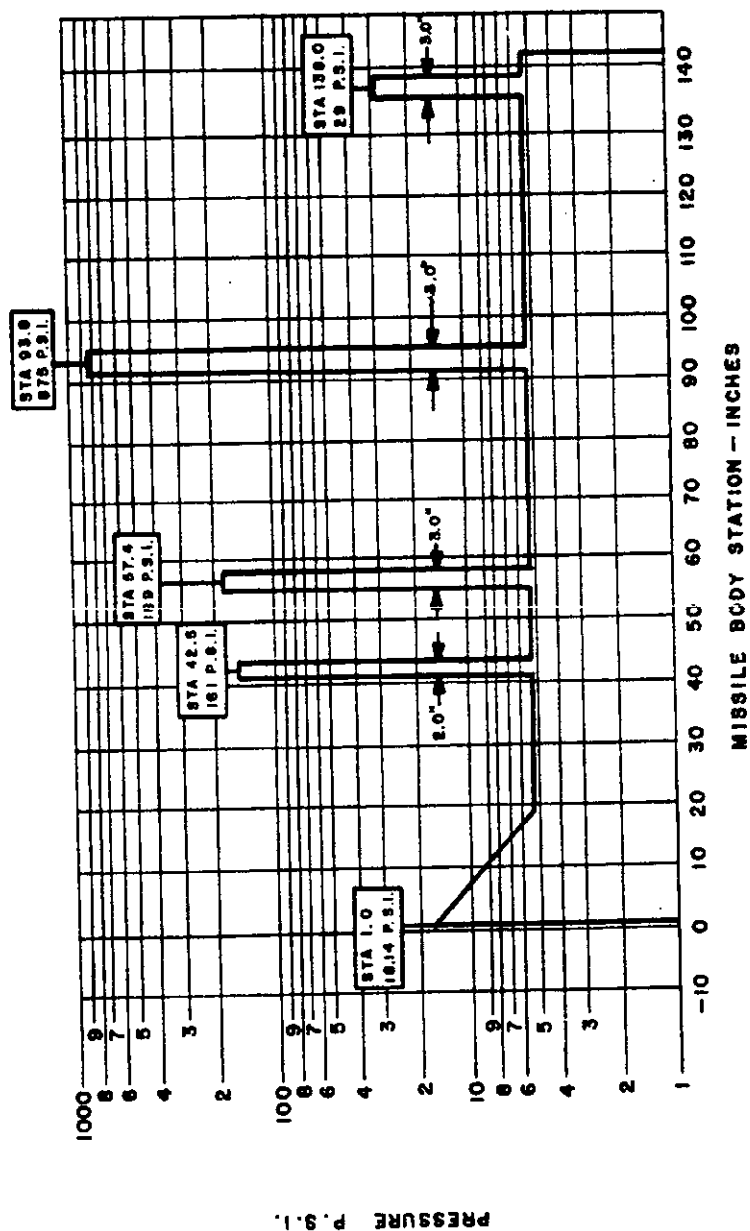


Figure 4. Typical Skin Pressure Diagram

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5.3.3.2 Pressure. Specific limits on allowable ambient pressures. Particular attention shall be paid to items or materials incapable of withstanding a pressure altitude of 5000 feet, standard atmosphere. (See also 5.3.2.7.1.)

5.3.3.3 Humidity. Specific limits on allowable humidity exposure and time associated with the high and low extremes. Humidity may be expressed as absolute humidity or as relative humidity with associated temperatures.

5.3.3.4 Cleanliness and sterilization. Items requiring clean room or sterile processing shall be identified. Criteria for special filters, etc., to maintain cleanliness or sterility during transportation and storage shall be stated.

5.3.3.5 Shelf life. Shelf life data of nonmetallic components of the item are required.

5.3.4 Hazard characteristics.

5.3.4.1 Explosive and explosive-loaded items.

5.3.4.1.1 Net explosive content. Net weight of explosive to be included in the device or anticipated shipping container, and quantities of each, if more than one, shall be defined. Trade names of explosives shall not be used..

5.3.4.1.2 Nomenclature. Official military designation of explosive composition(s) and Department of Transportation classification of the item, insofar as it can be estimated in advance of container design.

5.3.4.1.3 Storage requirements. Known or anticipated quantity-distance and storage/stowage compatibility restrictions applicable to the end item.

5.3.4.2 Occupational safety. Occupational safety hazards (health, flammability, and reactivity). Need for and types of special protective clothing.

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5.3.4.3 Electrostatic. Grounding or shorting requirements to prevent unwanted action initiated by static electricity.

5.3.4.4 Radiation. Protection required from or by radioactive radiation or magnetic flux. Location of and effects on external dimensions of shields, shorting plugs, etc.

5.3.4.5 Disaster response. Force requirements for response to a disaster during transportation or storage, including, but not limited to, security, fire fighting, and medical.

5.4 Derived characteristics. The following characteristics are derived, in iterative fashion, from the basic product characteristics. They are basic ingredients in any transportability analysis which may be required. The derived characteristics specifically refer to the item as prepared for shipment.

5.4.1 Items in containers or on skids.

5.4.1.1 Type of container. The type of container; for example, fully reusable metal, open crate, or skid.

5.4.1.2 Dimensions. Overall dimensions, including gross weight of the item in its shipping container (see 6.2.2). Where stacking height and overall height are not the same, both dimensions are pertinent.

5.4.1.3 Handling fittings. Locations and dimensions of tie-down fittings, lifting rings, forklift pockets, and other container fittings.

5.4.1.4 Center of gravity location. Location of center of gravity with respect to a reference common to locations of handling fittings.

5.4.1.5 Natural frequency. For shock isolated items, vertical translational natural frequency, in hertz, or frequency of maximum transmissibility of isolation system.

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5.4.1.6 Footprint. Footprint dimensions and total area of skids (on container or of shipping skid) and type of skid material (wood or metal).

5.4.1.7 Special handling equipment. Identification of special slings or lifting rigs required to move material into, onto, or out of transportation conveyances, or into or out of container.

5.4.2 Items on wheels or tracks. The following characteristics are required in addition to the dimensional data required for an item in a container:

- (a) Footprint data (plan view, showing length and width of actual area in contact with the ground)
- (b) Dimensions indicating relative positions of the areas in contact with the ground
- (c) Number of tires, size, locations, and inflation pressure
- (d) Pressure of track on surface (track pressure in pounds per square inch)
- (e) Individual axle loads (empty and loaded) and spacing
- (f) Front and rear overhang data by dimensional sketch
- (g) Wheelbase
- (h) Distance from ground to the lowest part of chassis or equipment
- (i) Turning radius
- (j) Speed range
- (k) Statement of compliance with State and Federal regulatory requirements when applicable.

5.4.3 Shipping condition drawing. Final values of the characteristics prescribed above may be lumped into a shipping condition drawing, when submittal of such a drawing is required (see 6.4).

5.5 Transport conveyance characteristics.

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5.5.1 Proposed conveyances. Need for heavy duty, or drop center rail cars, or special low bed trailers is a transportability consideration.

5.5.2 Special services. Need for special services such as power, heat, or refrigeration during transport or by the receiving activity is a transportability consideration.

5.5.3 Blocking and bracing. Methods of blocking and bracing, particularly for oversize equipment moving on open top conveyances and for ammunition and explosives, is a transportability consideration.

5.5.4 Vehicle loading configuration. Final values of the characteristics prescribed above may be lumped into a vehicle loading configuration drawing, or equivalent, when submittal of such data is required (see 6.4).

5.6 Routings. Where the item conveyance combination is such as to indicate the probability of special routings being required (see, for example, MS 35858), then the following traffic characteristics are a transportability consideration:

- (a) Contemplated origins of shipments
- (b) Contemplated destinations; for example, storage sites, installation activities, or ports.

6. NOTES

6.1 Intended use. This standard is intended to be used in contracts for major systems and equipment to define the interface between the equipment and its packaging and handling equipment and the interface between the item prepared for shipment and the transportation system.

6.2 Engineering for transportability. The overall scope of the engineering for transportability program is contained in Joint Regulation: DSAR 4500.25; AR 70-44; OPNAVINST 4600.22A; AFR 80-18; MCO 4610.14B.

6.2.1 Transportability problem item. The definition of transportability problem item given here does not include a category contained in the cited joint regulation. This category is an item which does not

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meet the transportability characteristics specifically imposed by the contract work statement, or the system specification or the item development specification. Since this is a matter of contract performance, it need not be addressed here.

6.2.2 Estimating tare weight and cube. An answer to the question of whether or not an item is a transportability problem item on the basis of dimensions requires estimating container tare weight and cube before the container is designed. A useful approximation technique is given in Appendix A.

6.3 Contract data requirements. Reports conforming to DI-L-2123, "Report Transportability Problem Item" or DI-L-1408, "Transportability Design Data Sheets," may be required for delivery in connection with this standard. When so required, such data will be specified for delivery on a DD Form 1423 included in the contract.

6.4 Shipping condition drawing and vehicle loading configuration. Shipping condition drawings and vehicle loading configurations are not normally data items procured in accordance with this standard. They may be called for by other specifications or standards referenced in the applicable contract; for example, MIL-STD-1367.

Custodians:

Navy - OS
Army - MT
Air Force - 69

Preparing activity:

Navy - OS
(Project No. 8140-0063)

Review activities:

Army - AV, MI, ME, GL, MU, PA, WC, SG, SM, TE
Navy - AS, MC, SA, SH, YD
Air Force - 10, 11, 13, 15, 16, 17, 18, 19, 70, 71
Other - DH, DS

User interest:

Army - AT, AD

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Appendix A

A FIRST APPROXIMATION TECHNIQUE FOR ESTIMATING CONTAINER DIMENSIONS AND ASSOCIATED TARE WEIGHT

10.1 SCOPE

10.1.1 This appendix contains a simplified method of estimating the dimensions of a large crated or skidded item (over 1000 pounds) based upon the item dimensions and for estimating the weight of the resulting crate or skid. It is emphasized that, as in all design operations, iteration is required. What follows is the first step in this iteration; no more.

10.2 REFERENCED DOCUMENTS

10.2.1 The issue of the following document in effect on the date of invitation for bids forms a part of this appendix to this standard to the extent specified herein.

HANDBOOK

MIL-HDBK-701	Blocking, Bracing and Skidding of Industrial Plant Equipment
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10.3 NOTATION

10.3.1 Let:

L_1	= length of item to be packed, feet
L_2	= overall length of item after packing, feet
W_1	= width of item to be packed, feet
W_2	= overall width of item after packing, feet
H_1	= height of item to be packed, feet
H_2	= overall height of item after packing, feet
K_1, K_2	= constants defined in the pertinent equations
W_n	= weight in pounds of item to be packed divided by 1000
$W(t)$	= tare weight, pounds.

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10.4 OVERALL LINEAR DIMENSIONS

10.4.1 Limit of accuracy. The procedures which follow are useful for estimating overall linear dimensions within plus or minus one half foot.

10.4.2 Formulas. Given L_1 , W_1 , and H_1 , and all dimensions in feet, then:

$$L_2 = L_1 + 1$$

$$W_2 = W_1 + 1/2$$

$$H_2 = H_1 + 1$$

10.5 TARE WEIGHT

10.5.1 General. The first step is to make an estimate concerning whether the item can be shipped in a sheathed crate, an open crate, or skidded. Such decision is not within the scope of this appendix.

10.5.2 Sheathed crates. First approximation of tare weight, $W(t)$, in pounds, of a sheathed crate may be estimated from

$$W(t) = K_1(L_2H_2 + W_2H_2 + W_2L_2),$$

where K_1 is an empirical constant depending upon the value of W_2H_2 such that

$$\begin{aligned} K_1 &= 6.4 \text{ if } W_2H_2 \leq 20, \\ K_1 &= 8.0 \text{ if } 20 < W_2H_2 \leq 40, \\ K_1 &= 9.6 \text{ if } 40 < W_2H_2 \leq 70, \text{ and} \\ K_1 &= 11.2 \text{ if } W_2H_2 > 70. \end{aligned}$$

10.5.2.1 Reduction factors. The above tare weight may be reduced 10 percent if the contents weigh less than 6000 pounds. The above tare weight may also, and independently, be reduced 10 percent if plywood sheathing can be substituted for lumber sheathing.

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10.5.2.2 Example. Assume an object that weighs 7000 pounds and application of the sizing rule has forecast a crate 16 feet long, 6 feet wide, and 5-1/2 feet high. Accordingly, the value of W_2H_2 is 6×5.5 or 33.0 and the value of K_1 to use thus becomes 8.0. Following the formula produces an estimated crate tare weight of

$$W(t) = 8.0[(16)(5.5) + 33.0 + (6)(16)] \approx 1740 \text{ pounds.}$$

The total weight is on the order of 8700 pounds and the item is not, therefore, a potential transportability problem item on the basis of dimensions.

10.5.3 Open crates. Open crate tare weight can be estimated from the formula:

$$W(t) = K_2(L_2H_2 + W_2H_2 + W_2L_2),$$

where

$$K_2 = 5.0 + 0.2[(W_{t1} - 5) + (W_2 - 4)].$$

Minimum value of K_2 is 5.0.

10.5.3.1 Example. Using the same dimensions as in the previous example, we find that

$$K_2 = 5.0 + 0.2[(7 - 5) + (6 - 4)] = 5.8.$$

Substituting in the basic formula produces

$$W(t) = 5.8(217) \approx 1260 \text{ pounds.}$$

Thus, the total estimated shipping weight is approximately 8300 pounds.

10.5.4 Skids. There is no short cut formula for estimating weight of skids. A convenient first approximation method is to use the skid requirement tables of MIL-HDBK-701 and to assume solid nominal 2-inch

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planking for floor boards throughout the length of the skid. The volume of lumber is then computed and converted to tare weight on the basis of 35 pounds per cubic foot.

10.5.4.1 Example. Assuming the same plan for dimensions from previous examples and, in this case, determining that the supported load is similar to a flush base machine tool for beam selection purposes, table V of the handbook is consulted. It is found that three nominal 6 x 6 timbers will support the load. The estimated lumber bill of materials, to slide rule accuracy, is as follows:

<u>Members</u>	<u>Computation</u>	<u>Cubic inch</u>
Runners	Three $(5-1/2 \times 5-1/2 \times 16 \times 12)$	17,400
Headers	Two $(5-1/2 \times 5-1/2 \times 6 \times 12)$	4,360
Flooring	$(16 \times 6 \times 144) \times 1-3/4$	<u>24,400</u>
	Total	46,160

$$W(t) = \frac{46160 \times 35}{1728} = 940 \text{ pounds.}$$