INCH-POUND

MIL-STD-8591
12 December 2005
SUPERSEDING
MIL-A-8591H(1)
30 June 1994

DEPARTMENT OF DEFENSE DESIGN CRITERIA STANDARD

AIRBORNE STORES, SUSPENSION EQUIPMENT AND AIRCRAFT-STORE INTERFACE (CARRIAGE PHASE)

AMSC N/A　　　　FSC 15GP

FOREWORD

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

2. Military specification, MIL-A-8591, Airborne Stores, Suspension Equipment and Aircraft-Store Interface (Carriage Phase), has been changed to a Design Criteria Standard, MIL-STD-8591 of the same title.

3. Comments, suggestions, or questions on this document should be addressed to: Commander, Naval Air Warfare Center Aircraft Division, Code 491000B120-3, Highway 547, Lakehurst, NJ 08733-5100 or emailed to thomas.omara@navy.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil.

CONTENTS

CONTENTS

CONTENTS

PARAGRAPH PAGE

CONTENTS

CONTENTS

CONTENTS

PARAGRAPH PAGE

FIGURE

CONTENTS

PARAGRAPH PAGE

1. SCOPE

1.1 Scope. This standard sets forth general structural and mechanical design criteria for airborne stores, suspension equipment and their associated interfaces. Provisions are included to promote interoperability among military aircraft of all Services of the Department of Defense and NATO members' aircraft. Requirements are provided for design, analysis, and testing of airborne stores, suspension equipment and the aircraft-store interface during captive operations.

1.2 Extent. This standard contains general criteria for the design, analysis, and testing of airborne stores, suspension equipment and other details of the interface between the store and the aircraft suspension equipment.

1.2.1 Unique stores. Certain types of stores possess unique characteristics which negate the strict adherence to many of the requirements listed in this standard. These include practice bombs, gravity-force dropped torpedoes and tow targets. For the detailed requirements not stated in this document, the procuring activity should specify such.

1.3 Conforming requirements. Unless otherwise specified by the procuring activity, all airborne stores and suspension equipment are to conform to this standard and should perform in service with minimum possible restriction on the aircraft flight envelope.

2. APPLICABLE DOCUMENTS

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

2.2 Government documents.

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

INTERNATIONAL STANDARDIZATION AGREEMENTS

STANAG-3441	-	Design of Aircraft Stores.
STANAG-3558	-	Location of Electrical Connectors for Aircraft Stores.
STANAG-3575	-	Aircraft Stores Ejector Racks.
STANAG-3605	-	Compatibility of Arming Systems and Expendable Aircraft Stores.
STANAG-3726	-	Bail (Portal) Lugs for the Suspension of Aircraft Stores.
STANAG-3842	-	Rail Launched Missile/Launcher Mechanical Interface

AIR STANDARDIZATION COORDINATING COMMITTEE (ASCC) PUBLICATIONS

AIR-STD-20/10	-	Ejector Release Units for Aircraft Stores.
AIR-STD-20/13	-	Design of Aircraft Stores.
AIR-STD-20/14	-	Location of Electrical Connectors for Aircraft Stores.
AIR-STD-20/15	-	Suspension Lugs for 1,000 lb Class and 2,000 lb Class Stores.
AIR-STD-20/17	-	Mechanical Connectors Between Stores and Suspension Equipment for Arming and Associated Functions of Stores.

(Copies of the above STANAGs and AIR-STDs are under controlled distribution. Information may be obtained from the Air Force International Standardization Office, Directorate of Operational Requirements, HQ USAF/XORD-ISO, 1815 North Fort Myer Drive, Suite 400, Arlington, VA 22209-1809 or email to: asccmcus@pentagon.af.mil.)

DEPARTMENT OF DEFENSE SPECIFICATIONS

JSSG-2006	-	Aircraft Structures.
MIL-T-7743	-	Testing, Store Suspension and Release Equipment, General Specification for.
MIL-M-8856	-	Missiles, Guided, Structural Integrity, General Specification for.
MIL-A-8860	-	Airplane Strength and Rigidity, General Specification for.
MIL-A-8870	-	Airplane Strength and Rigidity, Vibration, Flutter, and Divergence.

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-810	-	Environmental Engineering Considerations and Laboratory Tests.
MIL-STD-1760	-	Aircraft/Store Electrical Interconnection System.
MIL-STD-2088	-	Bomb Rack Unit (BRU), Aircraft, General Design Criteria for.
MS3314	-	Lug, Suspension, (1000 Pound Class) Airborne Equipment.

DEPARTMENT OF DEFENSE HANDBOOKS

MIL-HDBK-310	-	Global Climatic Data for Developing Military Products.

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

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

NAVAL AIR SYSTEMS COMMAND DRAWINGS

1380540	-	MK 3 Mod 0 Lug.
1555268	-	MK 14 Mod 0 Lug.

(Copies of the above drawings are available from the Naval Air Technical Data and Engineering Service Command (NATEC), P.O. Box 357031, NASNI, Bldg. 90, San Diego, CA 92135-7031 or email to: nani_governmentdrawings@navy.mil.).

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

3. DEFINITIONS AND SYMBOLS

3.1 Aircraft. Any vehicle designed to be supported by air, being borne up either by the dynamic action of the air upon the surfaces of the vehicle, or by its own buoyancy. Aircraft includes fixed and rotary wing aircraft, gliders, and airships, but exclude missiles, target drones, and flying bombs. Applicability to unmanned air vehicles is determined by the procuring activity.

3.2 Air-launched missile. A guided, self-propelled store designed to be launched from an airborne vehicle and whose target is either airborne, on the ground, or under the water surface.

3.3 Bomb rack. An item attached to the pylon or aircraft structure for suspending and releasing stores. The designs of bomb racks vary but usually fall within one or two general categories: single suspension (store suspended by single lug) or double suspension (store suspended by two lugs, as described herein). Bomb racks contain an integral release mechanism and are rigidly attached to the aircraft structure and are not readily removable.

3.4 Carriage. The conveying of a store or suspension equipment by an aircraft under all flight and ground conditions including taxi, normal and vertical takeoff and landing, catapult launch and arrested landing. The store or suspension equipment may be located either external or internal to the aircraft. Carriage includes all aircraft evolutions such as taxi, takeoff, landing, and time in-flight up to the point of complete separation of the store or suspension equipment from the aircraft.

3.5 Ejection. Separation of a store with the assistance of a force imparted from a device, either external or internal to the store.

3.6 Ejection launcher. A launcher which provides an initial source of energy to adequately displace the missile from the aircraft.

3.7 Employment. The use of a store for the purpose and in the manner for which it was designed, such as releasing a bomb, launching a missile, firing a gun, or dispensing submunitions.

3.8 Hang fire. Any store (or stores) which does not separate from the aircraft or launcher when activated for employment or jettison.

3.9 Hook/lug reference line. The line through the contact area where the front hook and front lug make contact, and the aft hook and aft lug make contact.

3.10 Interface. The physical contact point(s) between items or systems. This standard deals specifically with the interface between the store and the store suspension and release equipment.

3.11 Interoperability. The ability of systems, units or forces to provide services to, and accept services from, other systems, units or forces, and to use the services so exchanged to enable them to operate effectively together.

3.12 Jettison.

3.12.1 Emergency jettison. The intentional simultaneous or nearly simultaneous separation of all stores or suspension equipment from the aircraft in a preset, programmed sequence, and normally, in the fuze-safe (unarmed) condition.

3.12.2 Selective jettison. The intentional separation of stores or suspension equipment, or portions thereof (such as expended rocket pods), no longer required for the performance of the mission in which the aircraft is engaged.

3.13 Margin of safety. The margin of safety is a relative measure of the material allowable capability to the maximum working condition, as specified by the procuring activity.

3.14 Missile launcher. Equipment rigidly attached to an aircraft to carry, service, launch, and jettison air-launched missiles.

3.15 Pylon. A suspension device externally attachable on the wing or fuselage of an aircraft, with provisions for attaching stores.

3.16 Rail launcher. A launcher containing rails on which the store is carried, and along which the store travels after initiation of its propulsion system.

3.17 Separation. The terminating of all physical contact between a store or suspension equipment, or portions thereof, and an aircraft; or between a store, or portions thereof, and suspension equipment. This includes the parting of items or submunitions from a dispenser.

3.18 Store. Any device intended for internal or external carriage and mounted on aircraft suspension and release equipment, whether or not the item is intended to be separated in flight from the aircraft. Stores include missiles, rockets, bombs, mines, torpedoes, fuel tanks, and all types of pods and dispensers; for example, refueling, gun, electronic, cargo, bomblet, chaff, flare, chemical spray, aerial target. Items dispensed from pods and dispensers are part of the store and are subject to the applicable portions of the requirements herein. Aircraft thrust augmentation devices such as Jet Assisted Takeoff units or auxiliary engines are not included. Specific equipment items mounted outside aircraft mold lines may be included by the procuring activity; for example, in the PAVE PENNY and LANTIRN programs, which are mounted to special pylons not incorporating store suspension equipment.

3.18.1 Ejected stores. Stores released and pushed away from the aircraft laterally or downwardly, typically by the action of a cartridge-activated ejector.

3.18.2 Expendable store. A store normally separated from the aircraft in flight, such as a missile, rocket, bomb, mine, torpedo, pyrotechnic device, sonobuoy, signal underwater sound device, cargo drop container, drone and other similar items.

3.18.3 Non-expendable store. A store which is not normally separated from the aircraft in flight, such as a tank (fuel and spray), pod (refueling, thrust augmentation, gun, electronic countermeasure, data link), multiple rack, target and other similar items.

3.18.4 Rail-launched stores. Stores which slide off a rail, typically accelerating longitudinally from the aircraft under power of a rocket motor.

3.19 Store suspension and release equipment. Equipment which provides structural, electrical and environmental connection between the store and the aircraft. This includes bomb racks, launchers and similar devices. It may include pylons and similar items which are usable on more than one aircraft and which interface directly with stores. It does not include cargo hooks.

3.20 Swaybrace. That mechanism within the physical triaxial restraint system which partially or totally reacts to the store moments in addition to the store loads.

3.21 Weight class. The designation given stores within a specified weight range, used herein in table I for ejectable stores and table II for rail-launched stores, which is a nominal weight within that range. The nominal weight is not necessarily a mid-range or extreme range value.

3.22 Symbols. This section provides a partial list of symbols for use with this standard. Additional symbols are defined in the individual appendices as required.

a_X - Aircraft axial acceleration, g's

a_Y - Aircraft side acceleration, g's

a_Z - Aircraft normal acceleration, g's

b – Number of blades per rotor

cg - Center of gravity

C_ℓ - Store airload roll moment coefficient

C_{L_α} - Aircraft lift curve slope, 1/degree

C_m - Store airload pitch moment coefficient

C_n - Store airload yaw moment coefficient

C_X - Store airload axial force coefficient

C_Y - Store airload side force coefficient

C_{Y_β} - Aircraft side force curve slope, 1/degree

C_Z - Store airload normal force coefficient

g - Acceleration due to gravity - 32.17 ft/sec^2

I_{XX}, I_{YY}, I_{ZZ} - Store moments of inertia, slugs-ft^2, at store cg

I_{XY}, I_{XZ}, I_{YZ} - Store products of inertia, slugs-ft^2, at store cg

ℓ - Store reference length, ft

M - Mach number

M_X - Store air, inertia, or net roll moment (+ roll, to left)

M_Y - Store air, inertia, or net pitch moment (+ pitch, nose up)

M_Z - Store air, inertia, or net yaw moment (+ yaw, nose left)

n_X - Fore and aft load factor (+ aft)

n_Y - Side load factor (+ right looking forward)

n_Z - Normal load factor (+ up)

P_X - Store air, inertia, or net axial force (+ aft)

P_Y - Store air, inertia, or net side force (+ right looking forward)

P_Z - Store air, inertia, or net normal force (+ up)

q - Dynamic pressure, lbs/ft^2 ($0.5\rho V^2$)

R - Distance from aircraft roll center to aircraft store station, inches

Rev – Revolution

S_A - Aircraft reference area, ft^2

S_S - Store reference area, ft^2

V - True airspeed, ft/sec

V_L - Limiting aircraft speed, ft/sec

W_A - Aircraft basic flight design gross weight, pounds

W_S - Store weight, including all disposable items, pounds

X - Aircraft fuselage station, ft

Y - Aircraft butt line, ft

Z - Aircraft waterline, ft

α_A - Aircraft angle of attack, degrees

α_R - Store local angle of attack due to aircraft roll rate, degrees

α_S - Store local angle of attack, degrees

β_A - Aircraft angle of sideslip, degrees

β_S - Store local angle of sideslip, degrees

ρ - Air density slugs/ft^3

φ - Roll attitude, degrees

θ - Pitch attitude, degrees

ψ - Yaw attitude, degrees

$\dot{\phi}$, $\dot{\omega}_x$ - Roll rate, rad/sec

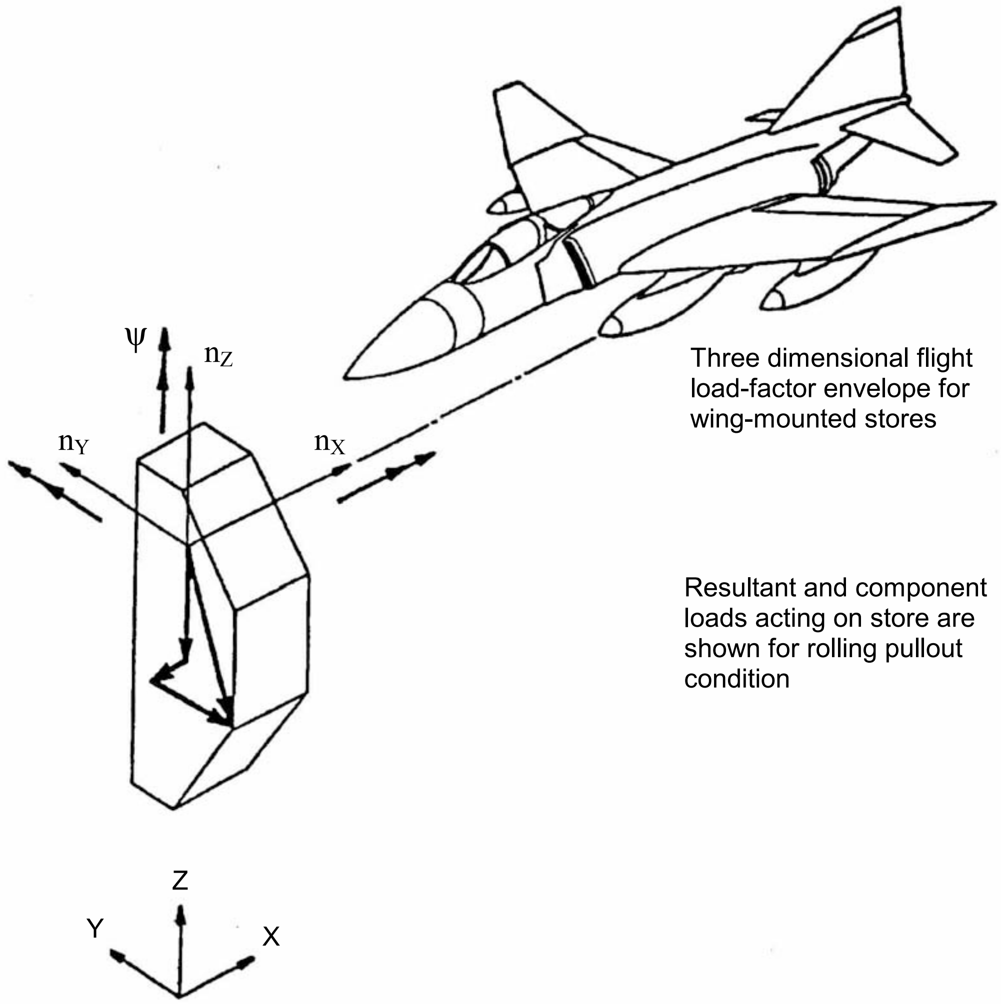
$\dot{\theta}$, $\dot{\omega}_y$ - Pitch rate, rad/sec

$\dot{\psi}$, $\dot{\omega}_z$ - Yaw rate, rad/sec

$\ddot{\phi}$, $\ddot{\omega}_X$ - Roll acceleration, rad/sec^2

$\ddot{\theta}$, $\ddot{\omega}_Y$ - Pitch acceleration, rad/sec^2

$\ddot{\psi}$, $\ddot{\omega}_Z$ - Yaw acceleration, rad/sec^2



NOTE: Loads, load factors, and dimensions are positive when acting aft, to the right (looking forward) and up. Angles, moments, angular accelerations and angular velocities about axes parallel to the reference axes follow the right-hand rule.

FIGURE 1. Coordinate system, sign convention, and a typical load factor envelope.

4. GENERAL REQUIREMENTS

4.1 Terms and nomenclatures. U. S. Standard Atmosphere, normal atmospheric property variations, design analysis, test, and reporting nomenclatures to be used shall be those equivalent to appropriate and applicable terms and nomenclature used in MIL-A-8860 or JSSG- 2006 or shall be as specified in the contract documents by the procuring activity. Definitions and symbols shall be in accordance with section 3.

4.2 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.

4.3 Design verification. Design verification for store design, operational structural capability, and employment characteristics shall be as specified in detail by the procuring activity or by reference to applicable parts of the designated related specifications. Quality conformance testing for store and store-mounted equipment shall be in accordance with MIL-STD-810 requirements. The requirements shall be as defined in the equipment detail specifications. The procuring activity shall approve the test plans and reserves the right to modify the tests, revise the limit values, or specify the degree of testing, if considered necessary to determine compliance with the requirements specified herein or in the contract. Additionally, in cases of suspension and release equipment with nuclear store capability, verification shall, as a minimum, be approved by the Director of Special Weapons to ensure nuclear safety certification.

4.4 Ground tests. A program of static, dynamic, repeated load, environmental, wind tunnel, and other ground tests required for proof of structural and operational design shall be performed as specified by the procuring activity in the contract, purchase order, or other applicable contractual document. Unless otherwise directed, static testing shall be required if ultimate margins of safety are less than 0.33. The margin of safety shall not supersede any requirements of MIL-M-8856.

4.5 Flight tests. Operational flight tests, including carrier or shipboard suitability testing, if applicable, to demonstrate the structural and functional adequacy of the store shall be performed as specified by the procuring activity in the contract, purchase order, or other applicable contractual document.

4.6 Design data. The structural reports and design data required to substantiate the strength and rigidity of the store design shall be specified by the procuring activity in appropriate contractual documents. The form and extent of information required for design, analysis, test data, and reports shall be specified in MIL-A-8870 as they relate to the store. Data schedules shall be as proposed by the contractor and accepted by the procuring activity.

5.0 DETAILED REQUIREMENTS

5.1 Design strength. The airborne store and associated suspension equipment shall have the strength and rigidity to support the forces and moments resulting from the loading conditions specified herein (see 5.10). For limit, yield, and ultimate conditions, stress analysis and tests shall demonstrate that allowable stresses are not exceeded. The service life of the structure shall meet or be greater than the specified list required in the applicable contractual document.

5.1.1 Limit loads. The limits loads shall be the maximum and most critical combination of loads which can result from authorized ground and flight use of the air vehicle. This includes maintenance activity, system failures from which recovery is expected, a lifetime usage of the store, and all loads whose frequency of occurrence is greater than or equal to $1x10^{-7}$ occurrences per flight. All loads resulting from the requirements of this specification are limit loads unless otherwise specified.

5.1.2 Yield loads. Unless specific yield loads are delineated, yield loads shall be obtained herein by multiplying limit loads by 1.15, which is the yield factor of safety. The yield factor of safety is 1.0 for Army applications. The effects of deformation remaining after application and removal of yield loads shall be not greater than those prohibited in 5.2.

5.1.3 Ultimate loads. Except when specific ultimate loads are delineated, ultimate loads for suspension equipment or airborne stores while in the captive phase (store is within the sphere of influence of the aircraft) shall be obtained by multiplying the limit loads by 1.50, which is the ultimate factor of safety for the captive phase. The airborne store or associated suspension equipment shall not fail during application of ultimate loads. Failure includes unintended separation of the store from the suspension equipment, separation of any part of the store or suspension equipment at ultimate or lower loads, or a material fracture of the store or suspension equipment.

5.2 Deformation. The permanent deformations from loads and other induced structural deformations/deflections resulting from flight or structural test articles being loaded statically, cyclically, or dynamically from any authorized use and maintenance with yield loads shall be combined with any thermal deformation due to application of design temperature. If the thermal deformation should relieve the yield deformation, the more critical deformation shall be considered. Deformation shall not:

a. Inhibit or degrade the mechanical operation of the store or suspension equipment, or of the carriage aircraft.

b. Adversely affect the aerodynamic characteristics of the store or suspension equipment of the carriage aircraft.

c. Require repair or replacement of parts.

d. Reduce the clearances between movable parts of the control system and adjacent structures or equipment to values less than the minimum permitted for safe flight.

e. Result in significant changes to the distribution of external or internal loads without due consideration thereof.

f. Result in detrimental deformation, delamination, detrimental buckling, or surpass the yield point of any part, component or assembly which would result in subsequent maintenance actions.

5.3 Design loads. The airframe operational and maintenance capability shall be in accordance with the following structural loading conditions. These realistic conditions shall consider both required and expected-to-be-encountered critical combinations of configurations, gross weights, centers of gravity, thrust or power, altitudes, speeds, and type of atmosphere and shall be used in the design of the airframe. The design loads shall also include thermal effects and aeroelastic structural deformation. The dynamic response of the air vehicle resulting from the transient or sudden application of loads shall be included in the determination of design loads. The dynamic response of the air vehicle resulting from ground operations and transient or sudden application of loads shall be included in the determination of design loads. In addition, the air vehicle shall be free from any static or dynamic instabilities. The airframe strength shall be adequate to provide the operational and maintenance capability required commensurate with the general parameters of 5.9 and 5.10, without detrimental deformations, at 115 percent of the limit or specified loads, and without structural failure at ultimate loads. Magnitudes and distribution of loads shall also include effects of structural dynamic response resulting from armament dynamic hang fire (see 3.8) loads as defined by the procuring activity or derived by the contractor and approved by the procuring activity.

5.3.1 Hang fire condition, Army and Navy requirement. The structural requirement shall be that the weapon shall stay attached to the support structure during a hang fire condition. The design criteria shall be:

a. Limit load = thrust x dynamic load factor (DLF)

b. Ultimate load = limit load x 1.5

The contractor shall provide a DLF by analysis or test. If the DLF is unavailable, then a DLF of 2.0 shall be used.

5.3.2 Hang fire condition, Air Force. The Air Force hang fire condition shall be specified by the Air Force.

5.4 Store classification. This standard shall be used for both ejected stores and rail-launched stores. Detailed characteristics of each of these stores that follow are not applicable to torpedoes and tow targets.

5.4.1 Ejected stores. The maximum gross weights of ejected stores shall include all disposable items. This weight, and any attainable lesser weight, shall be used in the determination of design loads and establishment of the store weight class for selection of suspension lugs. Store weight classes, approved lug types, and spacing for each class are listed in table I.

5.4.2 Rail-launched stores. The maximum gross weight and other characteristics of rail-launched stores are listed in table II. Each class has unique hangar/rail mechanical interfaces. Table III illustrates the typical hangar configuration for each class of rail-launched stores. Generally the hangars are either an internal T-shaped hangar or an external U-shaped shoe (see 5.7.2).

5.4.3 Torpedoes. Information on torpedoes shall be referred to Naval Sea Systems Command.

TABLE I. Ejected store weight classes and lug configurations.

Weight class (lb)	Weight range (lb)	Number of lugs	Spacing (in)	Lug figures	Remarks
100	20 to 100	2	14 (see figure 5)	2	-
1,000	101 to 1,450	2	14 or 30, or both (see figures 5, 6, or 7)	3 or 4	1/
2,000	1,451 to 3,500	2	30 (see figure 7)	4	-
12,000	3,501 to 12,500	-	(see figure 8)	-	2/
Over 12,500	12,501 and up	-	(see figure 8)	-	2/

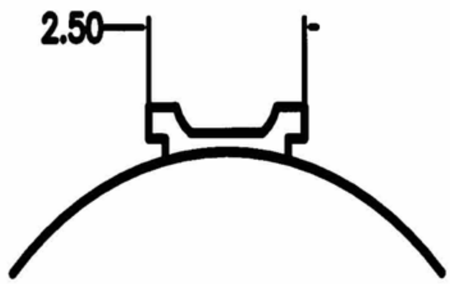
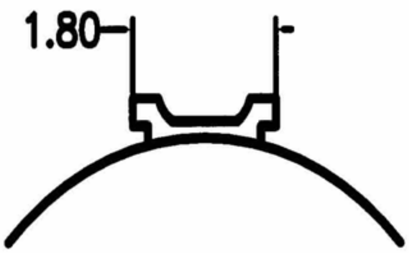
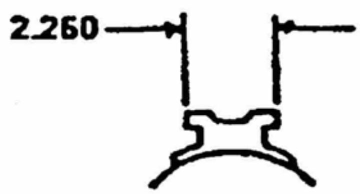
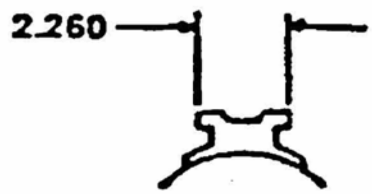
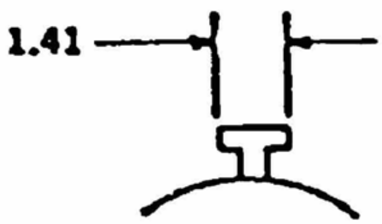
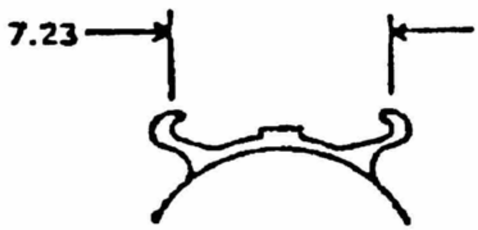
1/ Stores in this weight category may require 14-inch or 30-inch spacing or both. The decision as to which spacing shall be required will be found in the store detail specification and shall be a function of store weight, length, diameter, moments of inertia, and types of aircraft on which it will be carried. Only figure 3 lugs shall be used for 14-inch spacing. Only figure 4 lugs shall be used for 30-inch spacing.

2/ In most instances, stores in this weight category will be sling-suspended in bomb bays.

TABLE II. Rail-launched store weight classes.

Weight Class (lb)	Weight Range (lb)	Typical Diameter (in)
150	<150	<7
300	150 - 300	< 7
600	300-600	< 10
1000	>600	> 10

TABLE III. Typical rail-launched store hanger configurations.

Weight class (lb)	Forward hangar 1/	Aft hangar 1/
Example: Hellfire Missile 150		
Example: LAU 7 300		
Example: LAU 118 600/1000		

1/ Dimensions are in inches and are for reference only.

5.4.4 Towed targets. Detailed requirements shall be specified by the procuring activity.

5.4.5 Center of gravity. The center of gravity (cg) positions to be considered for design shall be the maximum forward and aft positions for the gross weights of ejected and rail-launched stores, including all distributions of mass items for the store during ground use, captive flight, and operational conditions. Additional center of gravity positions within this range which produce critical loadings shall be examined.

5.5 Thermal criteria. The design of the store and suspension equipment shall provide for the cumulative heating effects from the internal and external environments specified as follows:

5.5.1 Internal. Heating effects shall be considered for internal thermal environmental areas of the store and suspension equipment caused by, but not limited to, operation of electronic systems and ejection cartridges prior to, during, and after separation.

5.5.2 External. The external thermal environment shall be considered which results from cooling and heating effects on external areas of the store and suspension equipment caused by, but not limited to, aerodynamic heating and operation in ambient atmospheres consistent with both the cold and hot atmospheres prevalent at the specified operational altitudes as covered in the system specification. Guidance may be obtained from MIL-HDBK-310.

5.6 Service life. Service life design shall be a function of external loads resulting from pressure, oscillatory forces, shock and transient loadings, temperature effects, transportation, and storage consistent with the specified or intended operational use. Durability and damage tolerance analyses shall be performed to document that the required service life is met for the usage spectrum approved by the procuring activity. A test program shall be conducted which shall demonstrate such analyses.

5.6.1 Repeated loads sources. All sources of repeated loads shall be considered and included in the development of the service loads spectra and shall not detract from the store's service life. The following operational and maintenance conditions shall be included as sources of repeated loads:

a. Maneuvers.

b. Vibration and aeroacoustics.

c. Takeoffs.

d. Landings.

e. Buffet. All static and dynamic sources including the following:

(1) Buffet due to non-linear flow during high angle of attack operations

(2) Buffet due to transonic shock instabilities

f. Other ground loads. These include taxi, braking, brake release, pivoting, turning, towing, and miscellaneous ground loads spectra.

g. Pressurization. The total number of pressurization cycles are based on the number of flights and ground pressure checks.

h. Repeated operation of movable structures. These include impact, operational, and residual loads occurring from the normal operation of movable structures.

5.7 Suspension design criteria. This section specifies the interface requirements for stores attached to suspension and release equipment.

5.7.1 Suspension lugs. Suspension lugs shall conform to drawings listed on figures 2, 3, and 4 and shall be applicable to the weight class shown in table I.

5.7.1.1 Lug strength. The minimum strength of suspension lugs shall be as specified on figures 2, 3, and 4. The weight class, as determined in accordance with 5.4, shall be used for selection of the type of suspension lugs to be used on the store. Other suspension lug designs shall comply with the load requirements specified in 5.10.

5.7.1.2 Lug number and location. Tandem two-lug suspension shall be the minimum lug configuration. Any other means of suspension shall require that the procuring activity approve the suspension configuration. The number of suspension lugs and the spacing, by weight class, shall be as specified in table I. Lug location with respect to the store cg shall be the most practical location consistent with the characteristics of the airborne store carriage aircraft, and separation and handling requirements. The store cg shall be centered on the lugs within ±3.0 inches unless otherwise approved by the procuring activity. All lug locations, dimensions, and allowable tolerances are specified on figures 5, 6, 7, and 8.

5.7.1.3 Lug well details. The lug wells for the 1,000 and 2,000-pound class stores shall conform to the requirements specified on figures 9 and 10 respectively. The lug well axis shall be within the store reinforced areas (see 5.8) and perpendicular to the longitudinal axis of the store within a tolerance of ±0.5 degree.

5.7.1.4 Design acceptance. Drawings, illustrations, proposed store designs, and data describing and substantiating the use of suspension lug dimensions, strengths, and locations specified herein shall be submitted to the procuring activity for acceptance prior to incorporating the lugs in stores for use on standard suspension equipment. The design shall not conflict with NATO STANAGs 3441 AA, 3558 AA, 3575 AA, 3605 AA, and 3726 AA; and ASCC AIR-STDs 20/10, 20/13, 20/14, 20/15, and 20/17 (see 6.4).

5.7.2 Rail-launched hangers. Two types of hangars shall be used to support rail-launched stores. These shall be either an internal T-shaped hangar or an external U-shaped shoe. Figures 11 and 12 illustrate the general configuration of each. Detail dimensions and material types shall be provided by the procuring activity.

5.8 Store-to-aircraft interface areas. Store-to-aircraft interface areas shall conform to the dimension and location requirements of 5.8.1, 5.8.2, 5.8.3, and 5.8.5. Strength requirements shall conform to 5.8.4.

5.8.1 Swaybrace areas. The swaybrace area for stores with 14-inch lug spacing shall be as specified on figures 5 and 6; for stores with 30-inch spacing the area shall be as specified on figure 7; and for heavy stores the area shall be as specified on figure 8.

5.8.2 Ejector areas. Both internal and external carriage stores shall have ejector areas as specified on figures 5, 6, 7, and 8. The store ejection velocities, store attitude control, and the load time histories on the ejector area of the store shall be as specified in the bomb rack and/or suspension equipment specification or by the procuring activity.

5.8.3 Cradling and handling area. As a minimum, all stores shall have cradling and handling area(s) of the size specified on figures 5, 6, and 7 for the applicable store category. The store on figure 8 shall sustain cradling and handling loads on any parts of the skin beneath the strongback region.

5.8.4 Reinforced area strength. Unless otherwise specified by the procuring activity, stores with reinforced areas specified in 5.8 shall withstand the loads specified in 5.10 without failure.

5.8.4.1 Swaybrace pad areas and span. Reinforced swaybrace pad areas shall be provided in the store design for a minimum of 2.5 inches circumferentially on either side of the lug centerline for 100-pound weight class stores, a minimum of 4.0 inches circumferentially on either side of the lug centerline for 1000-pound weight class stores, and a minimum of 5.0 inches circumferentially on either side of the lug centerline for heavier weight class stores (see figures 5 through 8).

5.8.4.2 Cradling and handling area strength. The strong area on the bottom of the store shall withstand loads equal to three times the weight of the store without permanent deformation (see 5.10.7.3).

5.8.5 Electrical connector locations. Locations shall be as specified on figures 5, 6, 7, and 13 for the following electrical connectors:

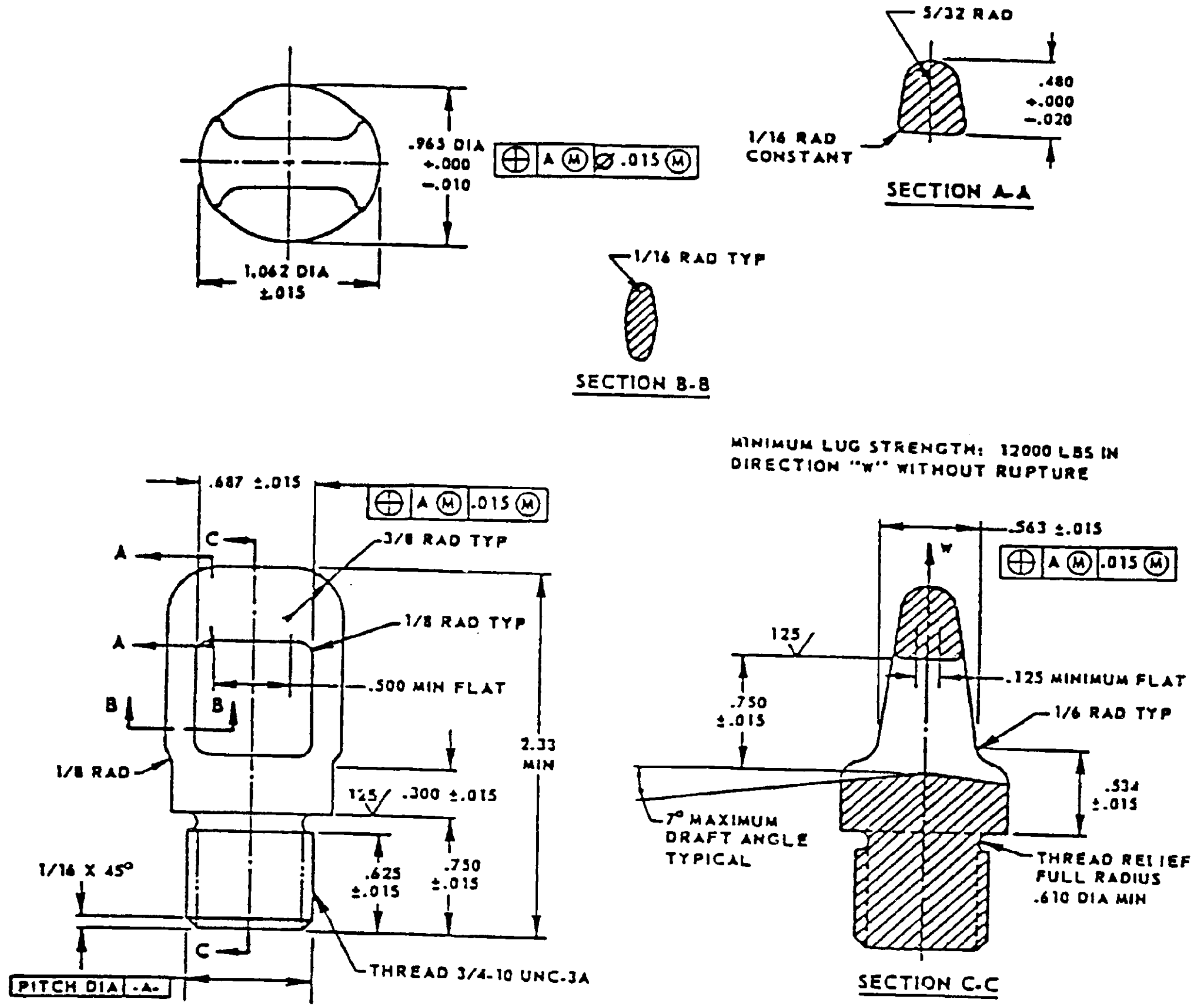
a. Type 1 connector(s) specified in MIL-STD-1760 are shown on figures 5, 6, and 7.

b. The Type 2 connector in MIL-STD-1760 is shown on figures 5, 6, and 7 for blind mate eject launch applications and figure 13 for rail-launch application.

c. 5-pin connector used for rocket launchers and dispenser type stores is shown on figures 5, 6, and 7.

d. Connector for electrical fuse is shown on figure 8.

Other locations shall be approved by the procuring activity.

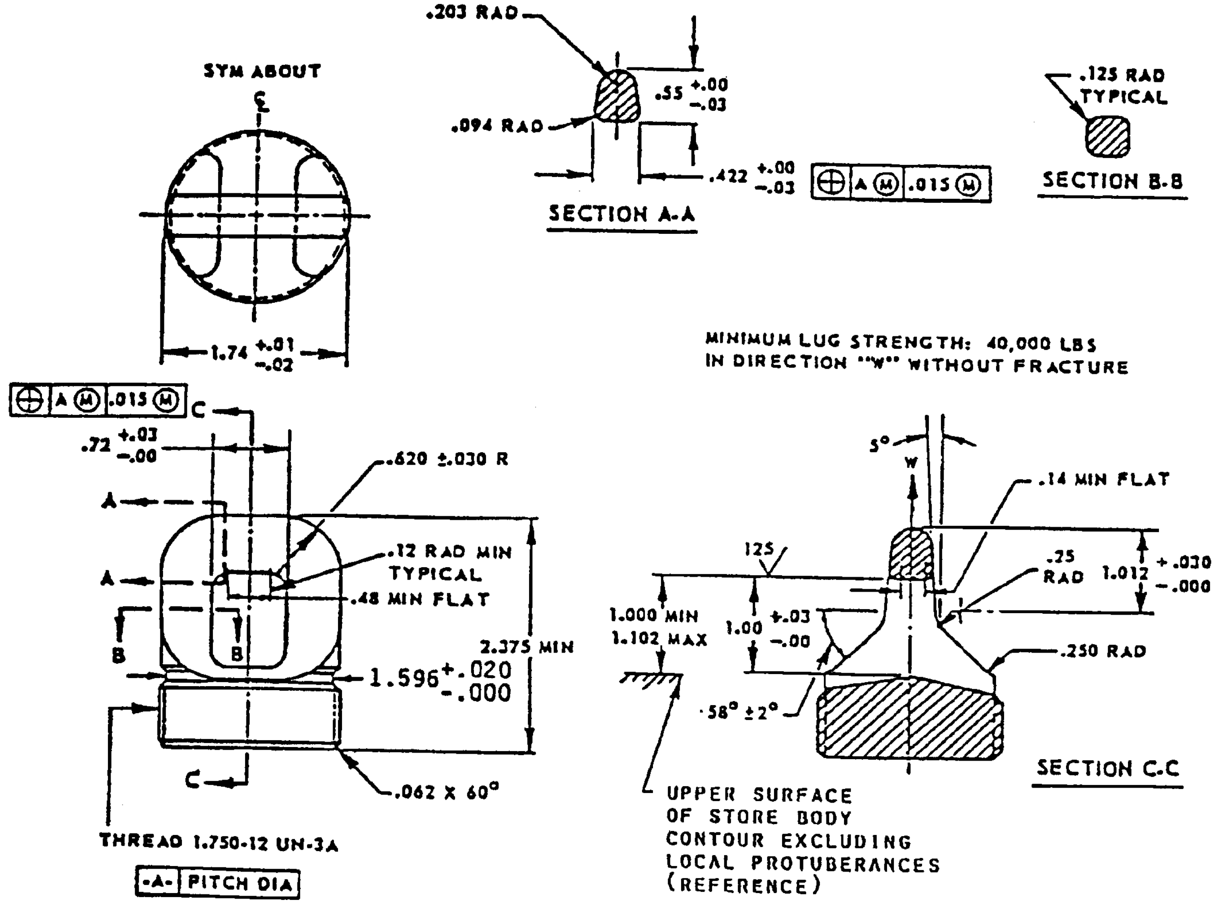


NOTES:

1. For design purposes, NAVAIR Drawing 1555268, MK 14 MOD 0 Lug, shall be used on the 100-lb class bomb lug. The data in the above figure are provided as information only.

2. Dimensions are in inches.

FIGURE 2. Lugs for stores in 100-lb weight class.

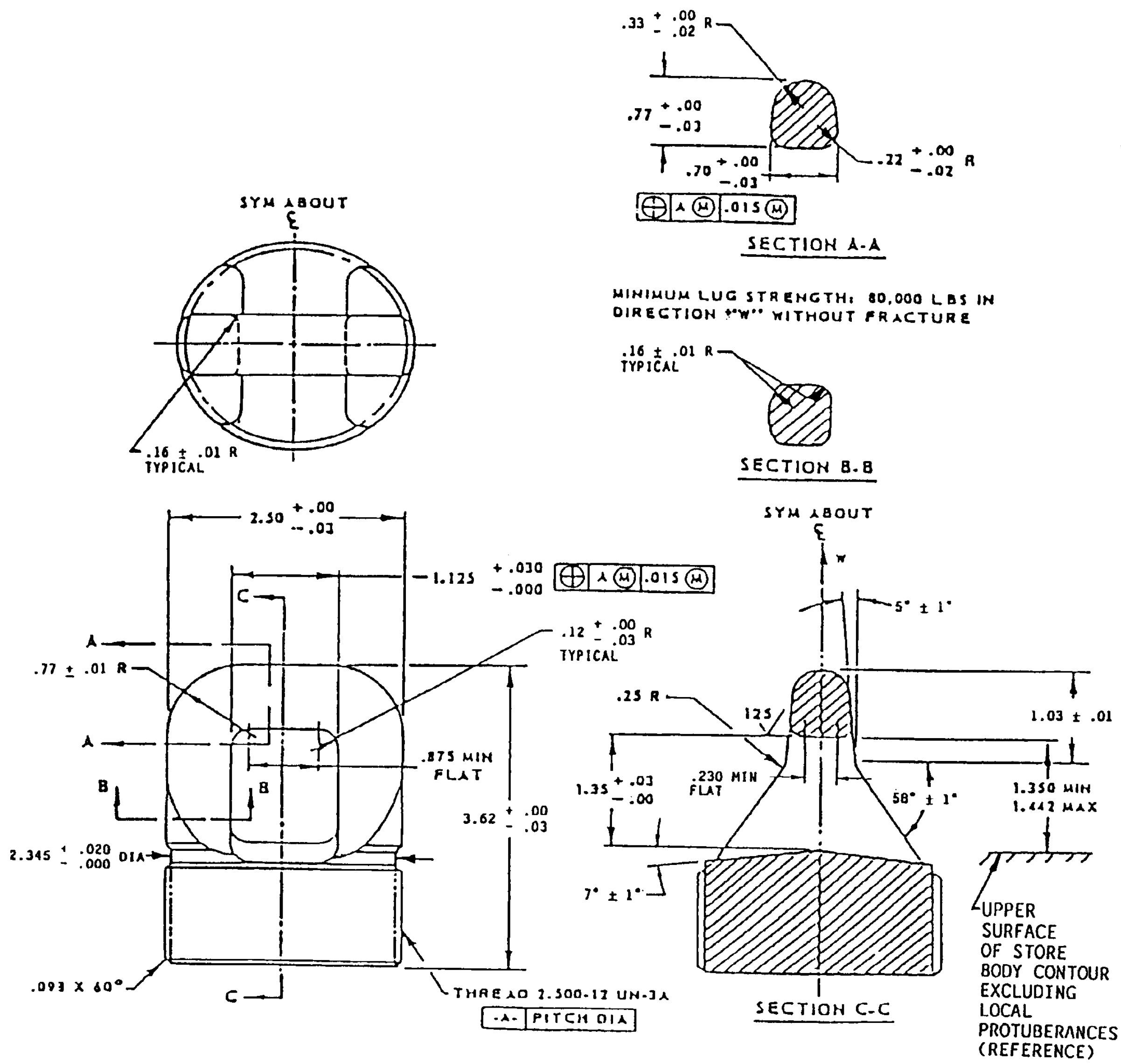


NOTES:

1. For design purposes, MS3314, Lug, Suspension, shall be used on the 1,000-lb class bomb lug. The data in the above figure are provided as information only.

2. Dimensions are in inches.

FIGURE 3. 14-inch spaced lugs for stores in 1,000-lb weight class.

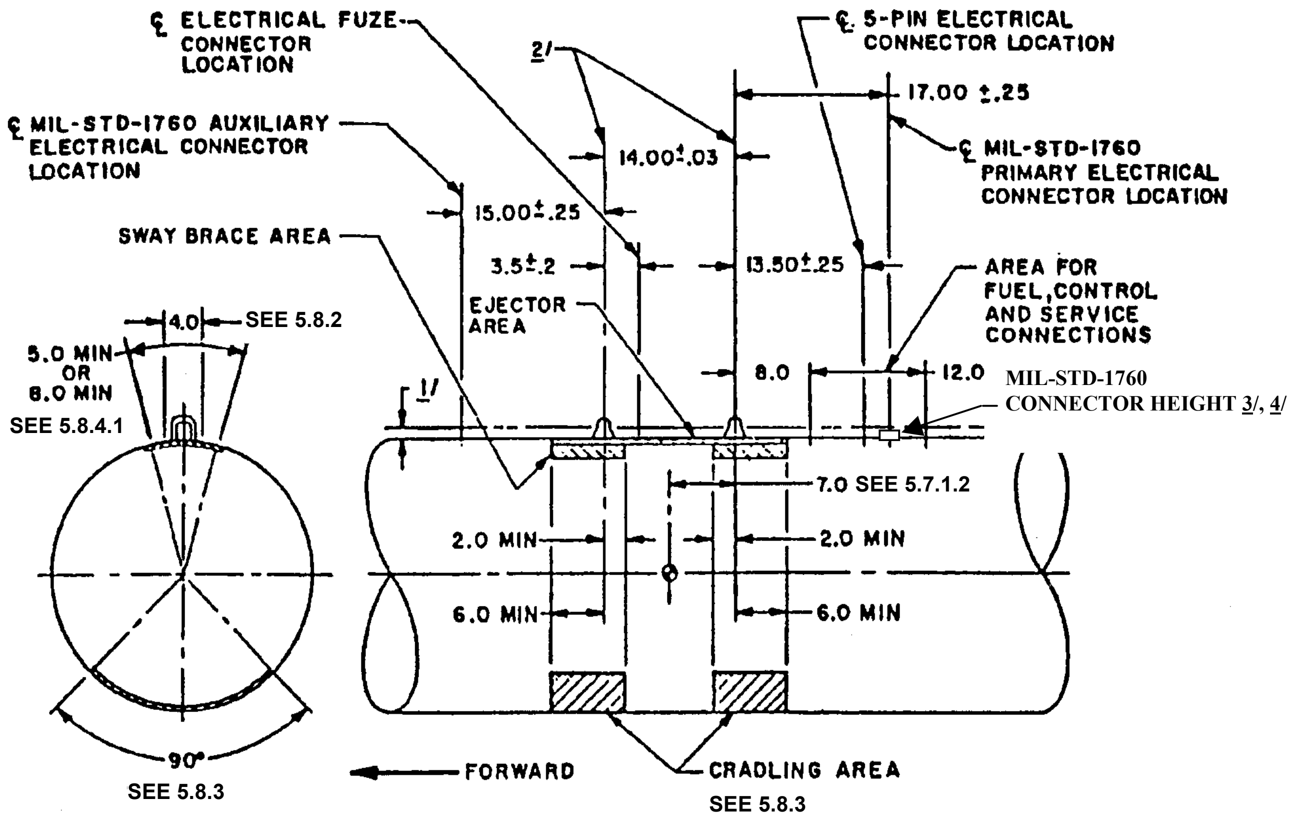


NOTES:

1. For design purposes, NAVAIR Drawing 1380540, MK 3 MOD 0 Lug, shall be used on the 2,000-lb class bomb lug. The data in the above figure are provided as information only.

2. Dimensions are in inches.

FIGURE 4. 30-inch spaced lugs for stores up to 2,000-lb weight class.



1/ A minimum 0.625-inch clearance shall be provided between the rack lower surface and the store upper surface. This clearance shall not apply to rack hooks, braces, ejectors, store lugs, or service connections.

2/ Lug and lug well axes shall be normal to the store longitudinal axis within ±1/2° and in the same plane within ±1/2°.

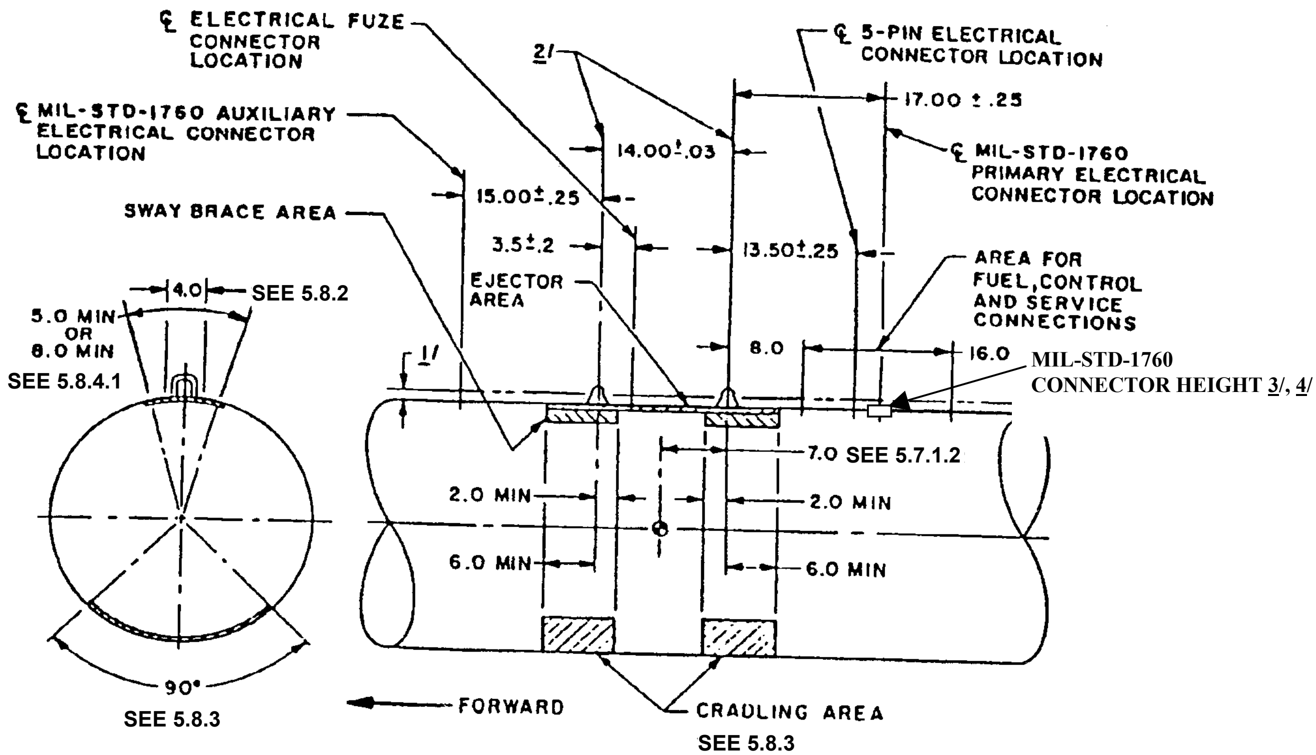
3/ The top surface of the MIL-STD-1760 connector shall be between 1.9 inches and 2.4 inches below the hook/lug reference line. If this cannot be met, and if store design permits connector repositioning in selected locations as far as 2.5 inches aft of the standard location, the height range may extend from 0 inches to 2.4 inches below the hook/lug reference line.

4/ The vertical axis of the MIL-STD-1760 connector shall be perpendicular to the hook/lug reference line within ± 2 degrees.

NOTES:

1. Dimensions are in inches.

FIGURE 5. Location of store case components, 14-inch lug stores, for carriage on 14-inch lug racks.



1/ A minimum 0.625-inch clearance shall be provided between the rack lower surface and the store upper surface. This clearance shall not apply to rack hooks, braces, ejectors, store lugs, or service connections.

2/ Lug and lug well axes shall be normal to the store longitudinal axis within ±1/2° and in the same plane within ±1/2°.

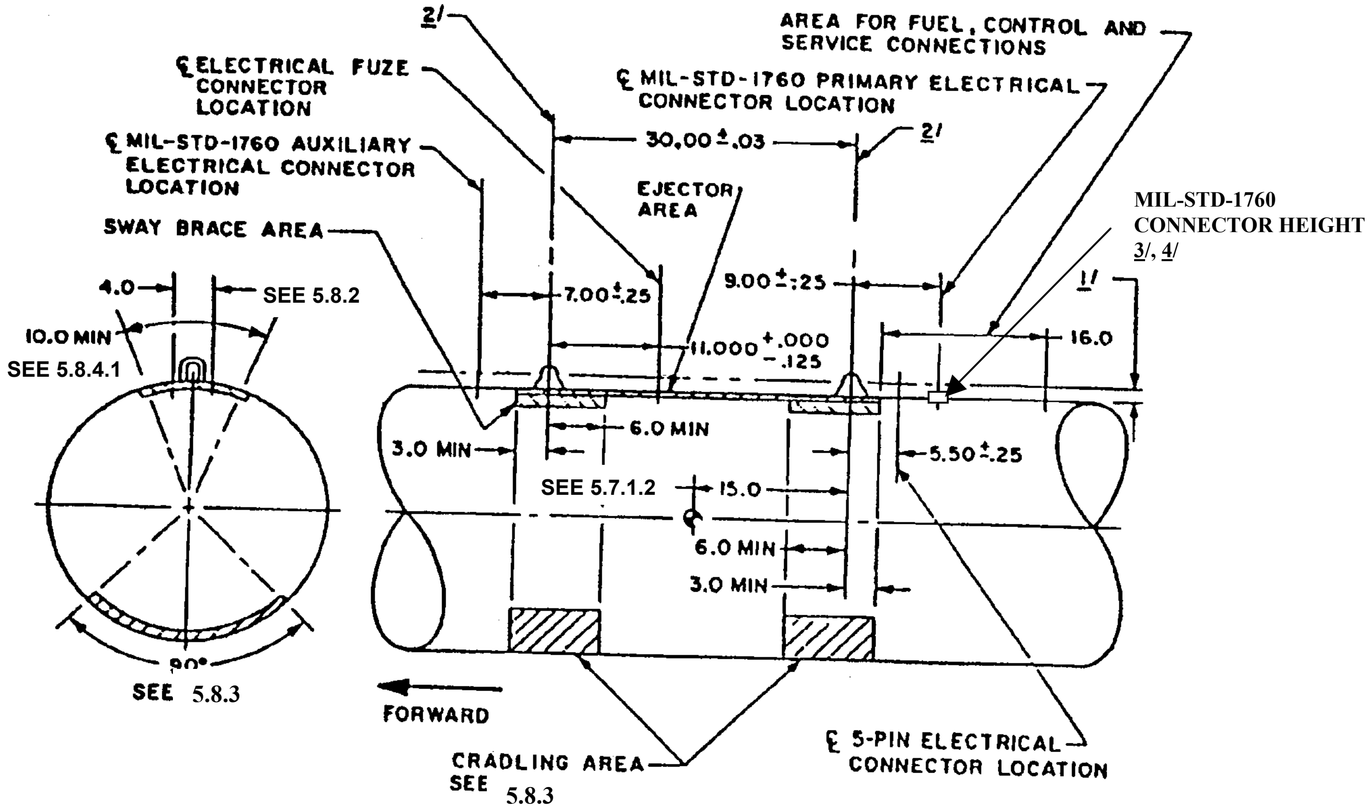
3/ The top surface of the MIL-STD-1760 connector shall be between 1.9 inches and 2.4 inches below the hook/lug reference line. If this cannot be met, and if the store design permits connector repositioning in selected locations as far as 2.5 inches aft of the standard location, the height range may extend from 0 inches to 2.4 inches below the hook/lug reference line.

4/ The vertical axis of the MIL-STD-1760 connector shall be perpendicular to the hook/lug reference line within ± 2 degrees.

NOTES:

1. Dimensions are in inches.

FIGURE 6. Location of store case components, 14-inch lug stores, for carriage on 14- or 30-inch lug racks.



1/ A minimum 0.625-inch clearance shall be provided between the rack lower surface and the store upper surface. This clearance shall not apply to rack hooks, braces, ejectors, store lugs, or umbilical connections.

2/ Lug and lug well axes shall be normal to the store longitudinal axis within $\pm 1/2^{\circ}$ and in the same plane within $\pm 1/2^{\circ}$.

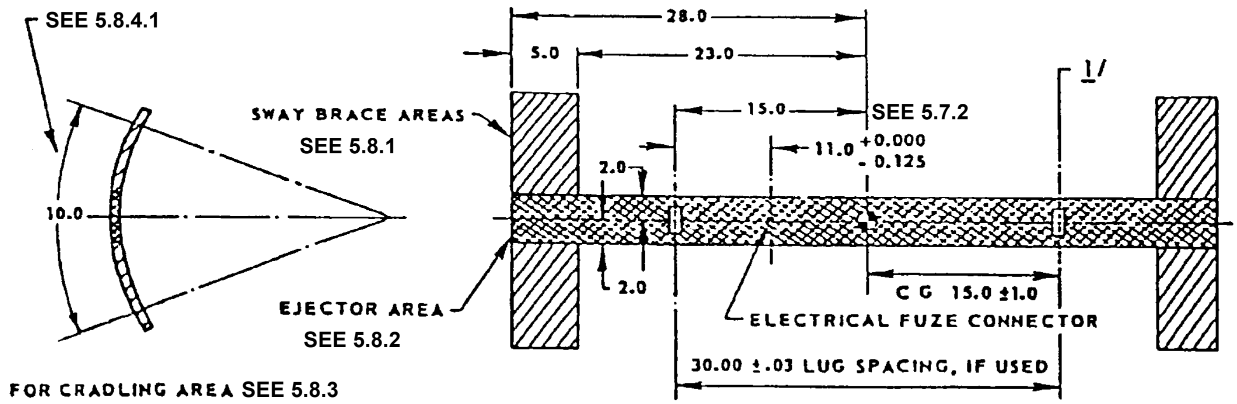
3/ The top surface of the MIL-STD-1760 connector shall be between 1.9 inches and 2.4 inches below the hook/lug reference line. If this cannot be met, and if store design permits connector repositioning in selected locations as far as 2.5 inches aft of the standard location, the height range may extend from 0 inches to 2.4 inches below the hook/lug reference line.

4/ The vertical axis of the MIL-STD-1760 connector shall be perpendicular to the hook/lug reference line within ± 2 degrees.

NOTES:

1. Dimensions are in inches.

FIGURE 7. Location of store case components, 30-inch lug stores, for carriage on 30-inch lug racks.



1/ If used, lug and lug well axes shall be normal to the store longitudinal axis within ±1/2° and in the same plane within ±1/2°.

NOTES:

1. Dimensions are in inches.

FIGURE 8. Swaybrace and ejector areas for heavy stores (ref table I).

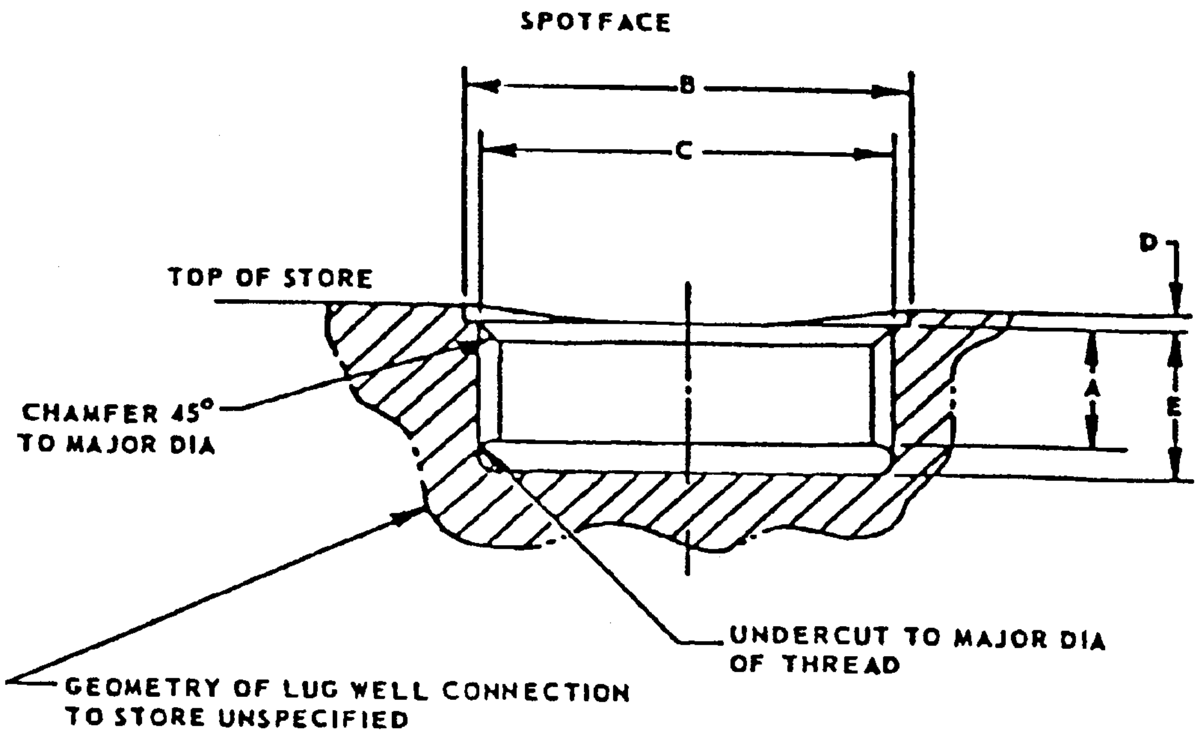


	TABLE OF DIMENSIONS	
1/	A	0.624 in. minimum full thread
	B	1.870 D in.
	C	1.750 in. 12 UN-2B Thread
1/	D	0.177 +0.010 in. -0.010
1/	E	0.749 +0.141 in. -0.000

1/ These dimensions are mandatory for the U.S., and advisory for other participating nations that have agreed to STANAG-3441 AA and AIR-STD-20/13.

FIGURE 9. Threaded lug well for 1000-lb class stores.

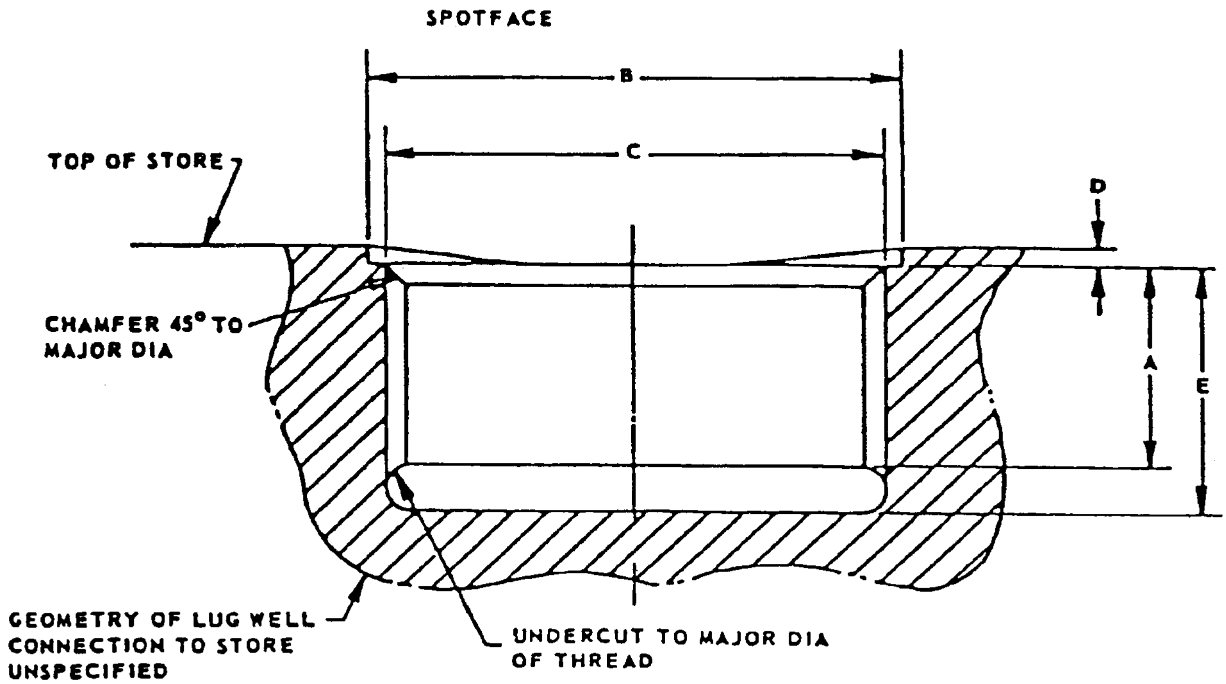


	TABLE OF DIMENSIONS	
1/	A	1.14 in. minimum full thread
	B	2.620 D in.
	C	2.500 in. 12 UN-2B Thread
1/	D	0.210 +0.010 -0.010 in.
1/	E	1.350 +0.000 -0.020 in.

1/ These dimensions are mandatory for the U.S., and advisory for other participating nations that have agreed to STANAG-3441 AA and AIR-STD-20/13.

FIGURE 10. Threaded lug well for 2000-lb class stores.

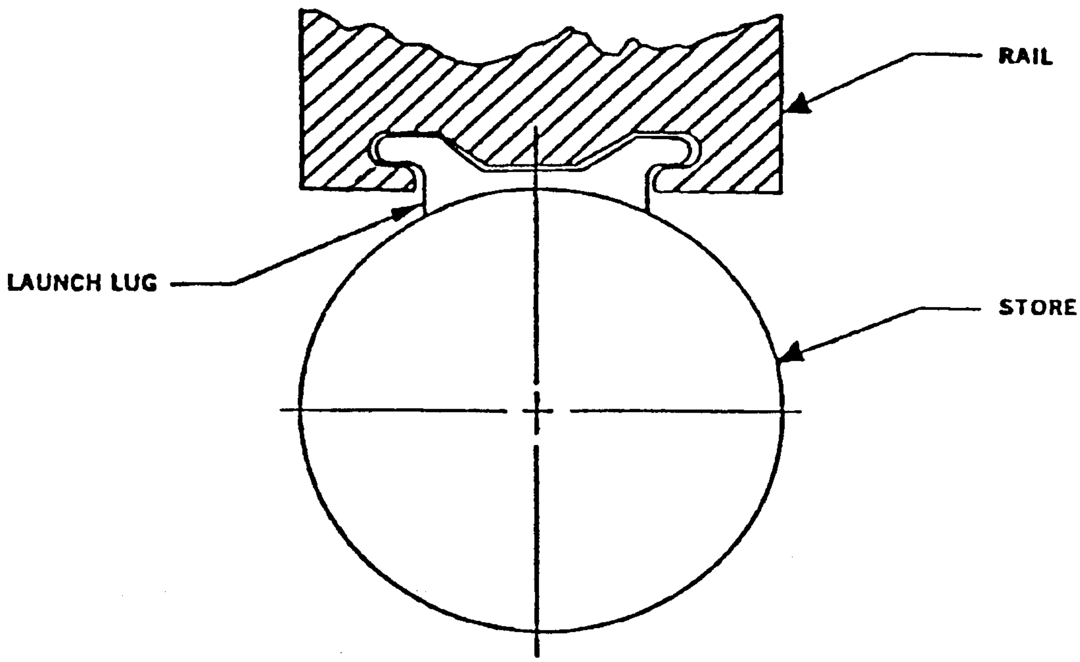


FIGURE 11. Example of internal T-shaped hangar.

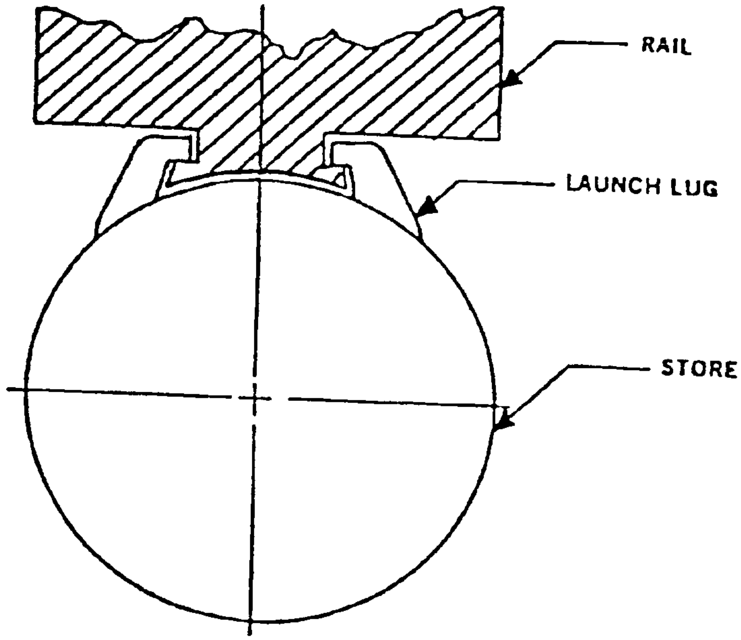
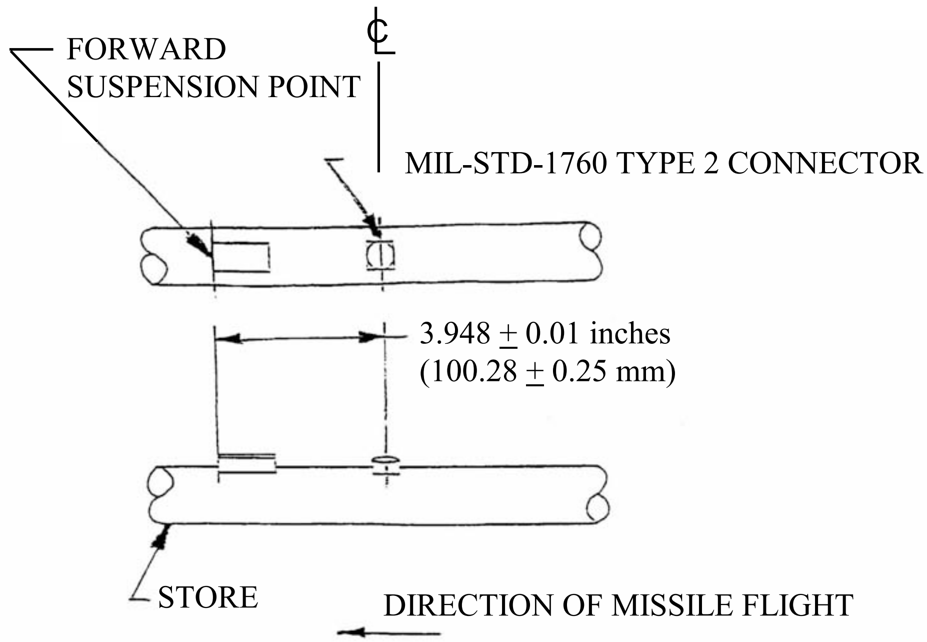


FIGURE 12. Example of external U-shaped shoe.



NOTES:

1. Drawing is not to scale.

FIGURE 13. Location of connector on rail launched store.

5.9 Store/suspension equipment interface design. This standard defines procedures for use in developing loads for the design of stores and associated suspension equipment. When this standard is used for the design of suspension and release equipment, it shall be applied in conjunction with the appropriate design specifications/standards for bomb racks (see MIL-STD-2088), launchers, and pylons. The following method of application shall be followed for suspension equipment design.

a. Use appropriate appendices given in this standard to determine loads generated at the store/suspension equipment interface. This step shall consider all stores scheduled for carriage on the new suspension equipment.

b. If the suspension equipment being designed is a multiple-store type, the worst case loads shall be examined to determine maximum shear/moment conditions for various critical design structural points within the suspension equipment.

c. Use the loads generated at the store/suspension equipment interface to perform stress analysis of the new suspension equipment.

5.9.1 Ejector foot areas. For design purposes, each ejector foot area shall withstand a minimum of 15,000 psi.

5.9.2 Swaybrace pad areas. For store design purposes, it shall be assumed that suspension equipment design shall provide a minimum area of two square inches per swaybrace pad. Swaybrace pad areas for 100-pound class stores are an exception to this rule, however, and suspension equipment design shall be as specified by the procuring activity.

5.10 Carriage design limit load. Design data for weapon carriage shall be generated by one of three procedures. These procedures have been developed to cover a variety of aircraft/store situations; including high and low speed fixed wing aircraft; helicopter aircraft; stores mounted at fuselage, wing pylon and wing-tip station; rack-mounted and rail-mounted stores. A summary of the various procedures and their applications are given in the following paragraphs. Detailed descriptions of these procedures are contained in Appendices A, B, and C. The procedure described in Appendix A shall be used unless one of the alternate procedures is approved by the procuring activity. At the discretion of the procuring activity, final checks or additions to these loads may be made that include carriage aircraft specific loads that exceed the loads developed using the procedures listed in this standard.

5.10.1 Procedure descriptions. The following procedures delineate the general and specific cases for fixed wing aircraft and helicopter aircraft.

5.10.1.1 Appendix A - carriage design limit loads - general case. Appendix A includes the use of general inertial load factor envelopes along with free stream aerodynamic data to develop conservative design loads for application to a broad spectrum of aircraft. It shall be employed when flowfield data is not available and the provisions of other procedures do not apply. Since the actual aircraft aerodynamic characteristics are not available, Appendix A shall be used to calculate store angles of attack and sideslip.

5.10.1.2 Appendix B - carriage design limit loads - stores carried on a specific aircraft. Appendix B provides conservative loads that are representative of the actual loads the store will encounter on specific aircraft, excluding helicopter aircraft, which are covered in Appendix C. Alternative methodologies are presented to allow the proper combination of aerodynamic loads and inertial loads to represent particular flight conditions, rather than following the more general approach in Appendix A. Stores that are designed using Appendix B are not intended for application on several classes of aircraft since this procedure will generally produce less conservative loads than Appendix A.

5.10.1.3 Appendix C - carriage design limit loads - stores carried on helicopter aircraft. Appendix C provides the methodology for determining the carriage loads on stores mounted on helicopter aircraft only. When stores may be carried on both helicopter and fixed-wing aircraft, it shall be necessary to evaluate the fixed-wing aircraft loads using Appendices A or B, as well as determining the helicopter aircraft loads in Appendix C.

5.10.2 Installation preloads. The preloads imposed by the swaybraces shall be included in the calculation of the total design loads. However, it is possible that under certain conditions of high vertical loading, the swaybraces will cease to touch the store, thereby reducing the preload effect to zero. For the specific installation being considered, the contractor shall determine an appropriate distribution of preloads by swaybrace torquing procedures and present this to the procuring activity for approval.

5.10.3 Dynamic magnification.

5.10.3.1 Dynamic magnification factors. Allowances for dynamic magnification of accelerations imposed on the nonreleased stores by aircraft catapult, arrested landings, and ejections of adjacent stores are not adequately defined for all aircraft in the load factor envelopes of Appendices A, B, and C. Magnifications of the inertial loads arise due to structural flexibilities of individual aircraft, pylons, and suspension equipment. These conditions shall be evaluated on an individual basis. The following address many of the usual specific dynamic load requirements. There may be additional dynamic loads that occur for specific store/aircraft combinations that are not included here, and these shall be developed in conjunction with the procuring activity.

5.10.3.2 Time rates. For those cases where the functioning of store and suspension equipment internal components may be affected by the dynamic application of load, and when specific data are not available, the time histories of application of critical combinations of load factors and rotational accelerations shall be as shown on figure 14.

5.10.3.3 Adjacent store loads due to release, ejection, or launch. Load environment shall be established at the support attach points of parent store stations; e.g., pylons, bomb racks, and missile launchers, to define the structural requirements for the retention of nonreleased stores during all types of release modes, such as salvo, single, and ripple. In lieu of analytical data, flight measured values shall be used. This analytically derived or measured environment shall supplement the inertia load factors developed using Appendices A, B, or C. The resulting load cases shall be the limit load conditions.

For flight:	t = 0.20 sec to 1.0 sec
For arrested landing: (with longitudinal load factors up to ± 2.0)	t = 0.03 sec to 0.10 sec
For arrested landing: (with longitudinal load factors above 2.0)	t = 0.15 sec to 0.50 sec
For catapulting:	t = 0.02 sec to 0.40 sec
For non-arrested landings:	t = 0.03 sec to 1.0 sec
For all cases above:	n = load factor

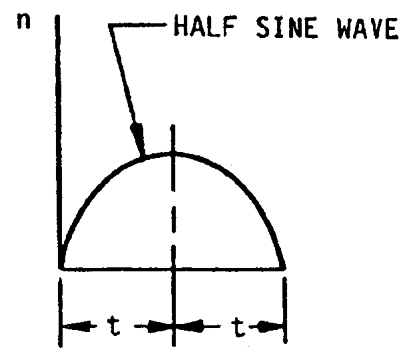


FIGURE 14. Time-load factor curve.

5.10.4 Vibratory loads. The vibration environment to which a store and its internal equipment shall be designed as specified in MIL-STD-810, Methods 514.5 and 515.5. The vibration environment to which the suspension and release equipment shall be designed, shall be measured vibration data or as specified in MIL-T-7743, whichever is more severe. If actual measured vibration environments are available, these may be used by the store designer, provided such use is approved by the procuring activity. When specific aircraft are designated for the application, the equipment designer and aircraft contractor(s), with approval of the procuring activity, shall coordinate the vibration criteria to be used in the design. For stores intended for carriage on helicopters, refer to Appendix C.

5.10.5 Fatigue strength. Oscillatory forces associated with pressures and load spectra representative of excitations which include turbulent airflow, inlet hammershock, radiated jet engine exhaust noises, boundary layers, wakes, and similar sources, shall be considered in identifying and analyzing resonant vibratory stresses. The oscillatory forces shall subsequently be used to estimate fatigue strength in the design. When specific carriage aircraft are designated and the loads are known, a scatter factor of 4.0 on life shall be used for analysis, and a scatter factor of 2.0 on life shall be used for test. If no carriage aircraft are specified, nor a broad spectrum of aircraft designated, and the oscillatory forces defined above are not known, values shall be estimated and used after acceptance by the procuring activity. For comments that also apply to service life, see 5.6.

5.10.6 Liquid-slosh loads. If the store contains liquids, strength shall be provided for the pressures and dynamic response associated with liquid-slosh and liquid-surge loads. Strength shall be provided for all capacities of varying-capacity stores.

5.10.7 Shock loads.

5.10.7.1 Employment loads. Strength shall be provided for transient loading occurring during employment by ejection, jettisoning, and firing.

5.10.7.2 Shipping loads. Strength shall be provided to withstand the shipping environmental loads specified by MIL-STD-810, Part Two, Various Test Methods or as designated by the procuring activity.

5.10.7.3 Cradling and handling loads. Sufficient strength shall be provided at the designated support point to withstand loads equal to 3.0 times the weight of the store (in both directions of the three major axes depicted on figure 1 without unacceptable deformation (see 5.2).

5.11 Flutter and divergence. Flutter, buzz or other related dynamic instabilities of any or all of the store, the suspension equipment, the weapon station, the related aircraft structures and components, shall be accounted for in accordance with the flutter and divergence specified in MIL-M-8856. The store designer, the suspension equipment contractor and the designated carriage-aircraft contractor shall coordinate with each other and in conjunction with procuring activity direction, to exchange pertinent inertia, dynamic, and other data necessary to define, by analytical and test methods, the aircraft/store flutter and divergence characteristics. These data shall be used to establish test requirements for the store during carriage and separation conditions.

6. NOTES

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

6.1 Intended use. The criteria of this standard are for the design of the entire stores and suspension systems. The primary purpose of this standard is for the design of the total store and its components, not merely the generation of interface loads. Design of store components usually requires generation of distributed shear and moment diagrams using the information provided in 5.10. These diagrams are then used for detailed design of the store or its components.

6.2 Acquisition requirements. Acquisition documents should specify the following:

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

6.3 Subject term (key word) listing.

Carriage loads
Ejector
Inertial envelope
Interface reaction
Lug
Store
Store angles of attack and sideslip
Swaybrace

6.4 International standardization agreement implementation. This standard implements NATO STANAGs 3441 AA (Design of Aircraft Stores), 3558 AA (Location of Aircraft Electrical Connectors for Aircraft Stores), 3605 AA (Compatibility of Arming Systems and

Expendable Aircraft Stores), 3726 AA (Bail (Portal) Lugs for the Suspension of Aircraft Stores), and portions of STANAG-3575 AA (Aircraft Stores Ejector Racks) and ASCC AIR-STD 20/13 (Design of Aircraft Stores), 20/14 (Location of Electrical Connectors for Aircraft Stores), 20/15 (Suspension Lugs for 1,000 lb Class and 2,000 lb Class Stores), and parts of AIR-STD 20/10 (Ejector Release Units for Aircraft Stores) and 20/17 (Mechanical Connectors between Stores and Suspension Equipment for Arming and Associated Functions of Stores) (see 5.7.1.4). When changes to, revision, or cancellation of this standard are proposed, the preparing activity must coordinate the action with the U.S. National Point of Contact for the international standardization agreement, as identified in the ASSIST database at http://assist.daps.dla.mil.

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

`

CARRIAGE DESIGN LIMIT LOADS, GENERAL CASE

A.1 SCOPE

A.1.1 Scope. Appendix A details procedures for either of the following conditions:

a. When no individual carriage aircraft is specified
b. When a broad spectrum of carriage aircraft is being considered.

This appendix is a mandatory part of this standard. The information contained herein is intended for compliance.

A.2 DETAILED REQUIREMENTS

A.2.1 Aerodynamic loads. The airloads to be used for wing or sponson-mounted stores shall be developed from store free stream aerodynamic data using the angles of attack and sideslip computed in accordance with the equations shown on figure A-1. Corresponding angles of attack and sideslip to be used for calculation of airloads on fuselage-mounted stores are shown on figure A-2. Values of dynamic pressure, q, shall be determined for all critical conditions of velocity, V, to which the store is intended to be subjected. Note that the worst case aerodynamic loads may not occur at maximum angles of attack and/or sideslip. This information shall be furnished by the procuring activity. All airloads shall be added to the inertial load component.

A.2.1.1 Aerodynamic distribution. The airloads specified in appendix A only develop the total airload on the store. Methods shall be developed with the approval of the procuring activity to develop distributed and component level airloads to be used in the analysis of the store. These methods shall include the following or a combination of the following:

a. Classic analytical derivation
b. Wind tunnel measured pressures
c. Wind tunnel measured, calibrated control surface loads
d. Computational Fluid Dynamics (CFD) derived distribution, corrected and correlated to wind tunnel and/or flight test data.

A.2.2 Inertia loads.

A.2.2.1 Limit inertia flight load factors. The limit inertia flight load factor diagram for wing or sponson-mounted stores is shown on figure A-3 . The corresponding diagram for fuselage-mounted stores is shown on figure A-5. These load factor envelopes shall be applied at the store center of gravity (cg).

A.2.2.2 Limit inertia catapult and arrested landing load factors. The limit inertia catapult and arrested landing load factor diagram for wing or sponson-mounted stores is shown on figure A-4. The corresponding diagram for fuselage-mounted stores is shown on figure A-5.

A.2.2.3 Limit inertia adjacent-store-release load factors. The limit inertia adjacent-store-release load factor diagram for wing or sponson-mounted stores is shown on figure A-3. These load factor envelopes shall be applied at the store cg.

A.2.3 General loads. The store/suspension configuration shall be designed to withstand the most critical combination of external loads, including inertia, aerodynamic, interface preload, blast pressure, recoil of weapon firing, launch or jettison, and temperature effects. Loads applied individually or in combination may produce the critical condition.

A.2.4 Forces of interaction. The forces of interaction between the store and aircraft may be computed by various means. Procedures employed for these interaction force calculations shall be approved by the procuring activity.

Points (1) and (2) (symmetric pullup):

$$\alpha_S = 0 \text{ to } + \frac{38000}{q} \text{ degrees}$$

$$\beta_S = \pm \frac{3000}{q} \text{ degrees}$$

Points (3) and (4) (symmetric pushover):

$$\alpha_S = 0 \text{ to } - \frac{22800}{q} \text{ degrees}$$

$$\beta_S = \pm \frac{3000}{q} \text{ degrees}$$

Point (5) (rolling pushover):

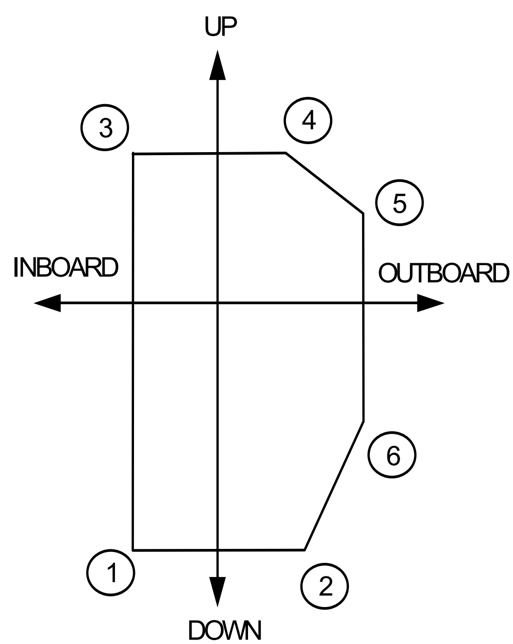
$$\alpha_S = 0 + \frac{100}{q^{1/2}} \text{ to } - \frac{15200 + (100)(q^{1/2})}{q} \text{ degrees}$$

$$\beta_S = \pm \frac{13000}{q} \text{ degrees}$$

Point (6) (rolling pullout):

$$\alpha_S = 0 \text{ to } + \frac{30400 + (100)(q^{1/2})}{q} \text{ degrees}$$

$$\beta_S = \pm \frac{13000}{q} \text{ degrees}$$



Note: For all points, the stores shall be considered to be mounted at incidence angles of 0 or -3 degrees, whichever is more critical in each case, to be added to the values of α_S. Maximum values for angles derived from the procedure shall not exceed 30 degrees.

FIGURE A-1. Store angles of attack and sideslip at specific load envelope points for wing or sponson-mounted stores.

Points (1) and (2) (pull up):

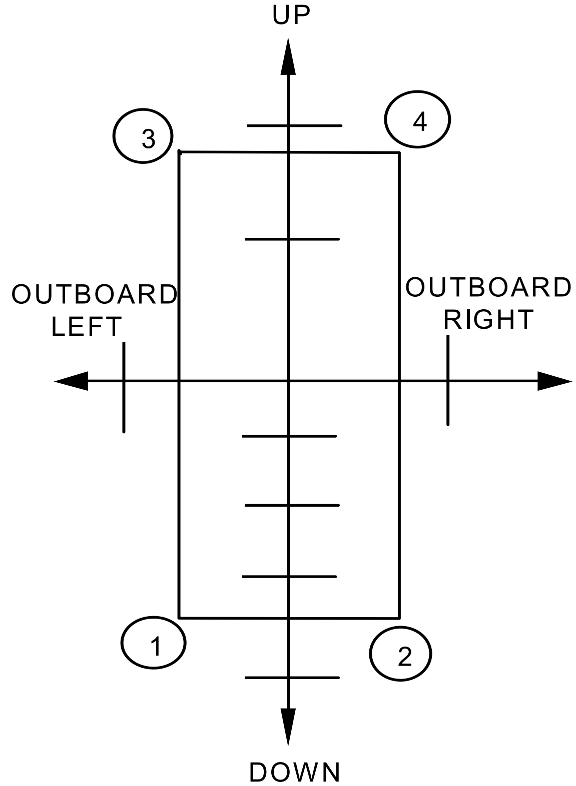
$\alpha_S = 0 \text{ to } +\frac{38000}{q}$ degrees

$\beta_S = \pm\frac{13000}{q}$ degrees

Points (3) and (4) (pushover):

$\alpha_S = 0 \text{ to } -\frac{30400}{q}$ degrees

$\beta_S = \pm\frac{13000}{q}$ degrees



Note: For all points, the stores shall be considered to be mounted at incidence angles of 0 or -3 degrees, whichever is more critical in each case, to be added to the values of α_S. Maximum values for angles derived from the procedure shall not exceed 30 degrees.

FIGURE A-2. Store angles of attack and sideslip at specific load envelope points for fuselage-mounted stores.

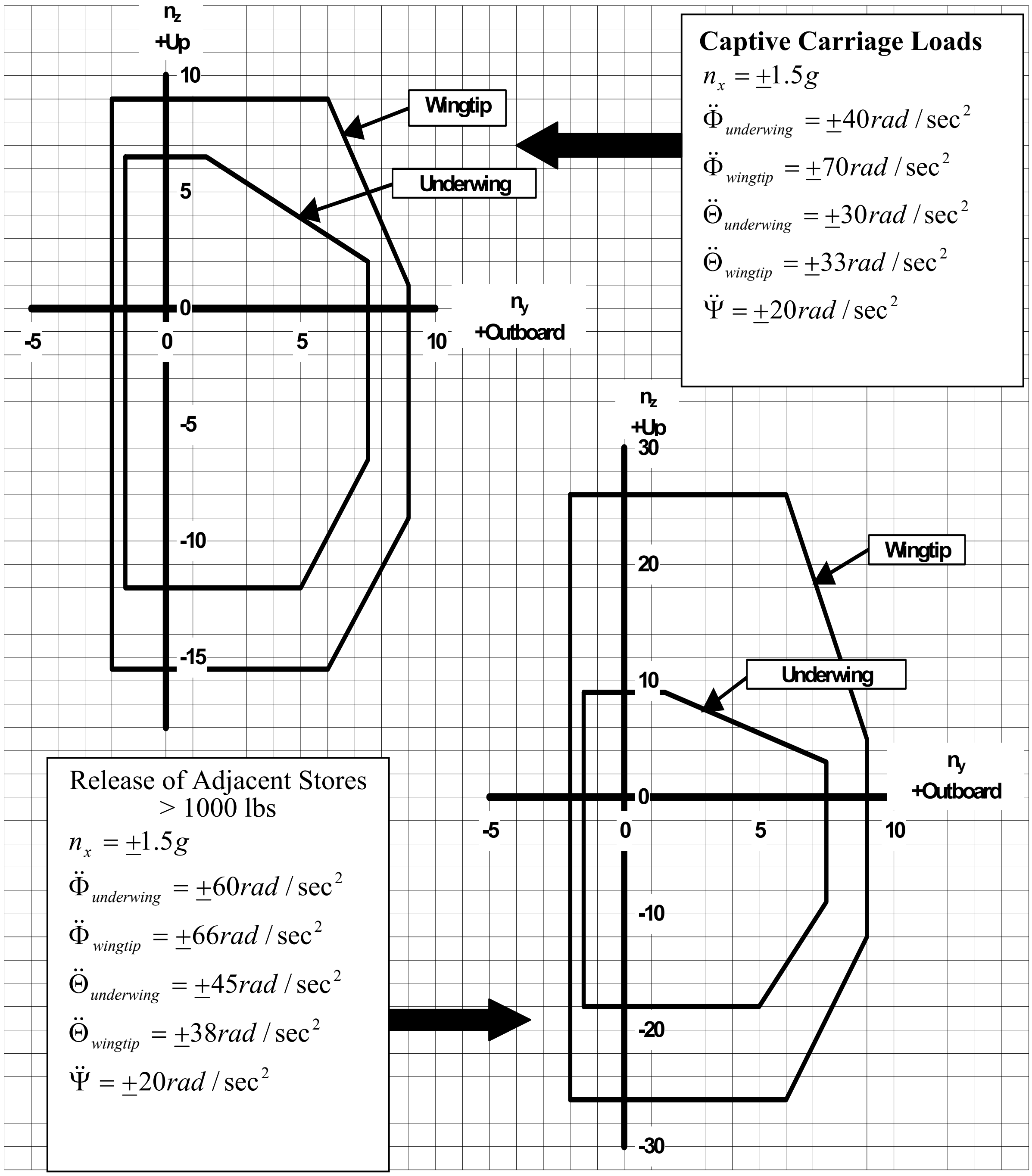


FIGURE A-3. Design flight inertia limit load factors for wing or sponson-mounted stores. Data applies at the store center of gravity (cg).

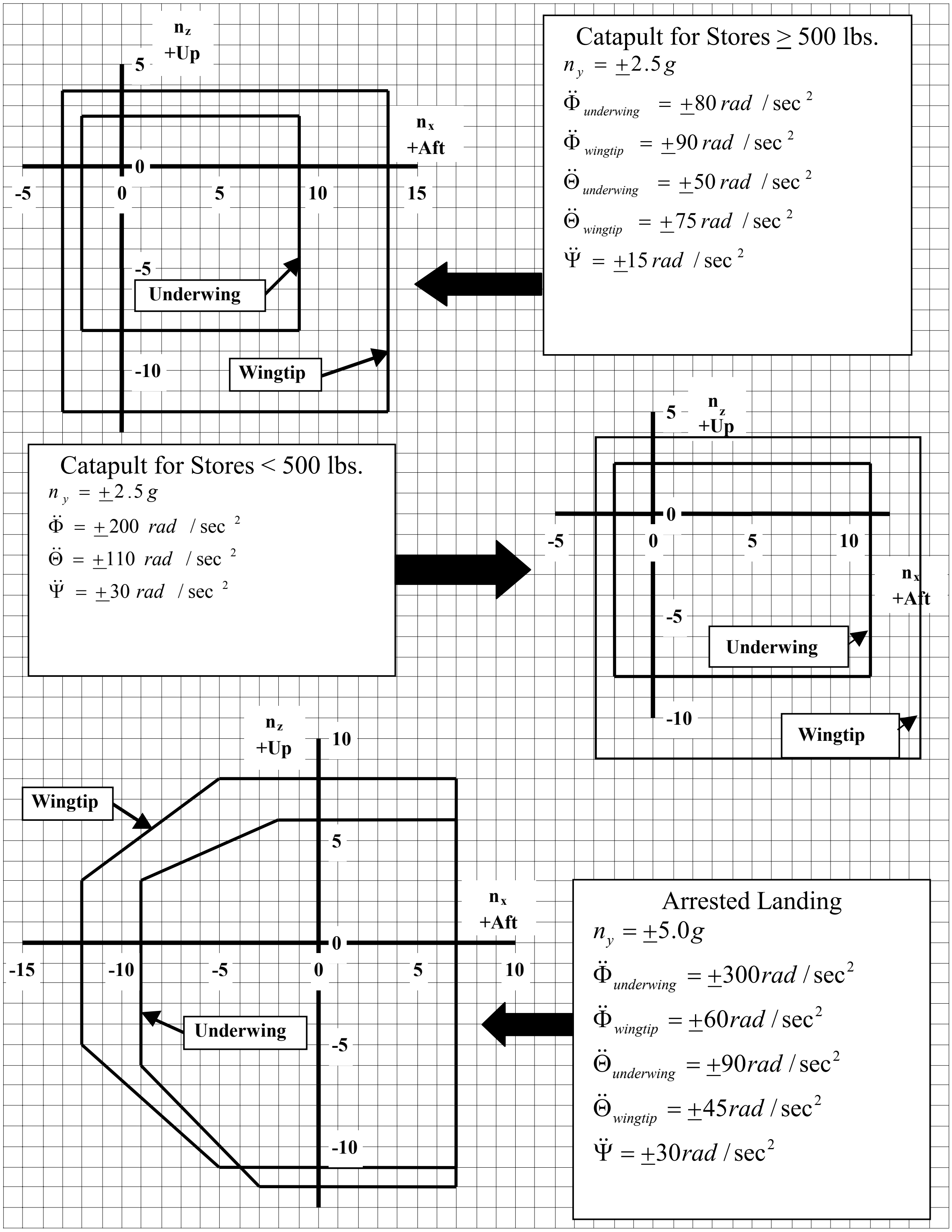


FIGURE A-4. Design takeoff and landing inertia limit load factors for wing or sponson-mounted stores. Data applies at the store center of gravity (cg).

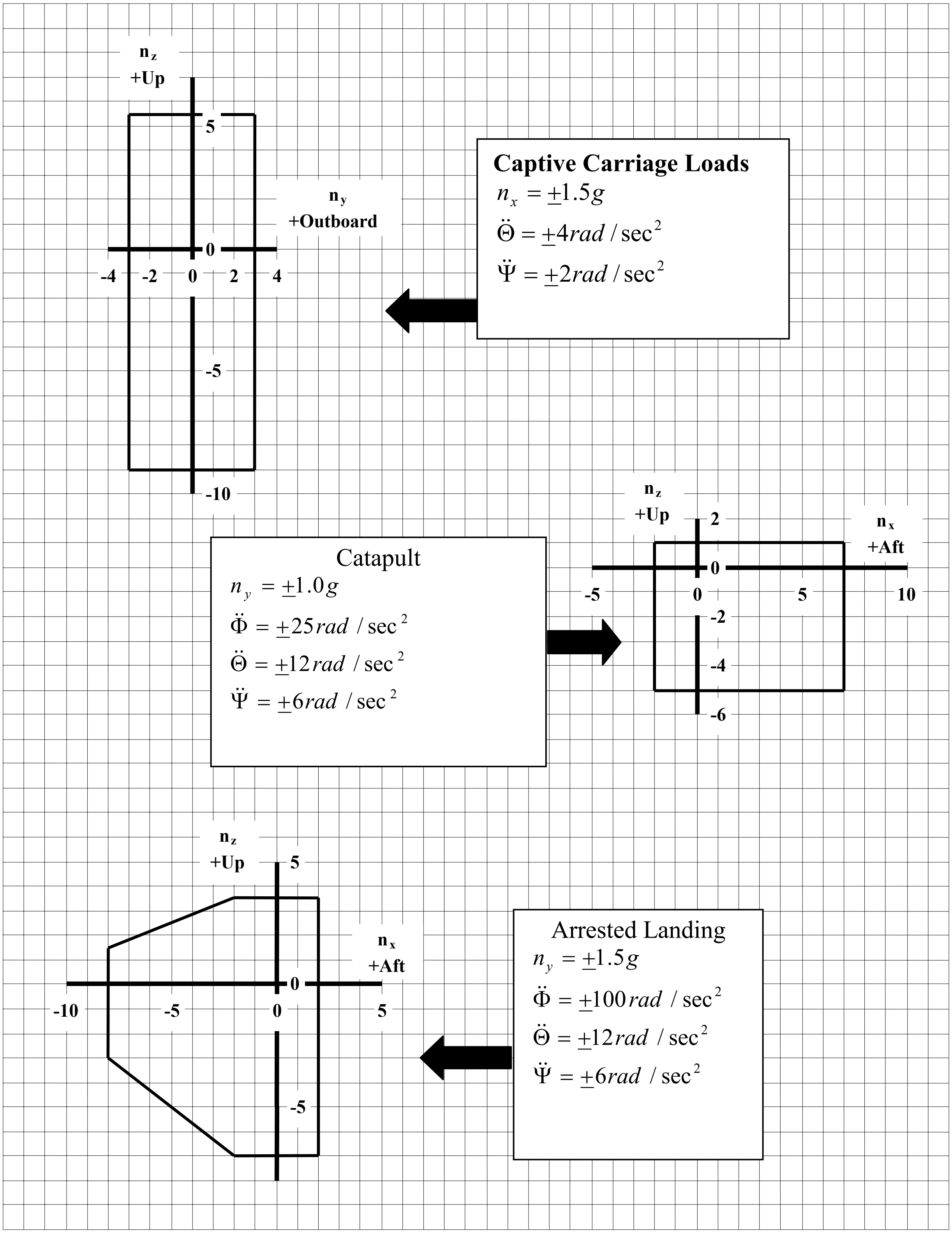


FIGURE A-5. Design inertia limit load factors for fuselage-mounted stores. Data applies at the store center of gravity (cg).

CARRIAGE DESIGN LIMIT LOADS, STORES CARRIED ON SPECIFIC AIRCRAFT, A GROUP OR CLASS OF AIRCRAFT

B.1 SCOPE

B.1.1 Scope. This Appendix details procedures to be used when specific aircraft, except helicopters, are designated for carriage. It defines analysis methods that may be used as an alternative to Appendix A for cases where consideration is being given to specific aircraft/store combinations for which detailed information is available, including wing tip mounted stores, heavy stores, and low performance aircraft carriage. The procedures herein are intended to provide loads that are conservative, but as close as possible to the actual loads the store will encounter. Aerodynamic loads for a particular flight condition shall be combined with inertia loads representing the same flight condition. Aerodynamic loads shall be added to inertial loads. Alternative methodologies are included because the type and amount of data available for a specific aircraft cannot be predicted. This appendix is a mandatory part of this standard. The information contained herein is intended for compliance.

B.2 DETAILED REQUIREMENTS

B.2.1 General loads. The store/suspension configuration shall be designed to withstand the most critical combination of external loads, including inertia, aerodynamic, interface pre-load, blast pressure, recoil of weapons firing, launch or jettison, and temperature effects. Loads applied individually or in combination may produce the critical condition.

B.2.2 Aerodynamic loads. The aerodynamic loading on the store shall be determined assuming the flowfield to be quasi-static at the instant that the inertia loading is being applied. Actual test data for store aerodynamic loads may be used for airloads, otherwise, the method to be used may be selected from those described below. The first three methods involve free stream aerodynamic data and uniform flow angles; whereas, the latter two methods involve the utilization of local flow effects and distributed angles. The actual method to be used shall be approved by the procuring activity.

B.2.2.1 Method of Appendix A. When the actual aircraft aerodynamic characteristics are unavailable and the aircraft cannot be categorized into either type aircraft of table B-I, the method of Appendix A shall be used to determine the store angles of attack and sideslip. These angles shall be used with wind tunnel data for the store alone in a uniform flow, together with q, to obtain aerodynamic loads. If appropriate store aerodynamic coefficient data are unavailable, analytical or empirical methods shall be used to obtain the load coefficients for the store in a uniform onset flow.

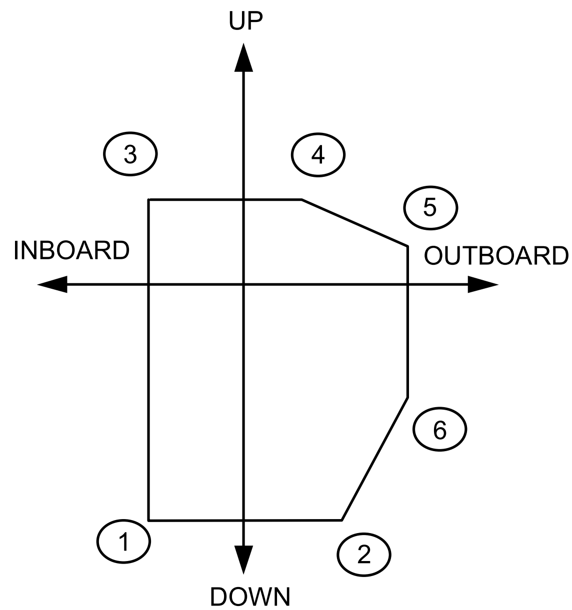
B.2.2.2 Method using aircraft angles for low and high speed carriage. An approximate method based on aircraft aerodynamic characteristics shall be used to calculate store loads. If the actual aircraft aerodynamic characteristics are unavailable, representative values for the type of aircraft shall be obtained from table B-I.

TABLE B- I. Representative values for parameters of figures B-1 and B-2.

Type of aircraft	n_z	n_y	$\dot{\phi}$	C_{L_α}	C_{Y_β}
Fighter, attack	9.00	1.0	4.70	0.05	0.010
Antisubmarine, patrol	3.00	1.0	1.60	0.10	0.017

This method is only valid when source data for aerodynamic loads is derived from carriage loads data. Freestream store data is not valid with this method. For wing or sponson-mounted stores, use figure B-1 to compute the aircraft static angles of attack and sideslip. For fuselage-mounted stores, use figure B-2 to compute the aircraft static angles. If the aircraft motion includes angular rates, incremental angles of attack and sideslip shall be calculated using the products of angular rate and distance of the store from the aircraft center of rotation and added to the store angles. The overall store loads shall be calculated assuming the store to be in a uniform onset flow by using the store angles of attack and sideslip determined above with wind tunnel data for the store in a uniform onset flow. If appropriate store aerodynamic coefficient data are unavailable, analytical or empirical methods shall be used to obtain the load coefficients for the store in a uniform flow. This method does not take account of the variations in flowfield along the store length and its influence on the store load distribution. The flowfield will be disturbed by other stores on the aircraft such as fuel tanks and pods. If a specific aircraft is known, the worst-case aerodynamic configuration shall be used for the determination of carriage design limit loads.

:



Points (1) and (2) (symmetric pullup):

$\alpha_A = 0$ to α_{MAX} degrees

$\beta_A = \pm 0.2\ \beta_{MAX}$ degrees

Points (3) and (4) (symmetric pushover):

$\alpha_A = 0$ to $-0.6\ \alpha_{MAX}$ degrees

$\beta_A = \pm 0.2\ \beta_{MAX}$ degrees

Point (5) (rolling pushover):

$\alpha_A = +\ \alpha_R$ to $-(0.4\ \alpha_{MAX} + \alpha_R)$ degrees

$\beta_A = \pm\ \beta_{MAX}$ degrees

Point (6) (rolling pullout):

$\alpha_A = 0$ to $(0.8\ \alpha_{max} + \alpha_R)$ degrees

$\beta_A = \pm\ \beta_{MAX}$ degrees

Where:

$\alpha_{MAX} = n_z\ (W_A/S_A)\,(1/C_{L_\alpha} q)$

$\alpha_R = (1.98\ R\ \dot{\phi})/q^{1/2}$ (In this equation, R is in feet)

$\beta_{MAX} = n_y\ (W_A/S_A)(1/C_{Y_\beta} q)$

Note:
1. For all points, the stores shall be considered to be mounted at incidence angles of 0 or -3 degrees, whichever is more critical in each case, to be added to the values of α_A .
2. Table B-I should be used only if specific aircraft data are not available.

FIGURE B-1. Aircraft angles of attack and sideslip at specific load envelope points for wing or sponson-mounted stores.

Point (1) (pullup):

$\alpha_A = 0$ to α_{MAX} degrees

$\beta_A = \pm 0.2\ \beta_{MAX}$ degrees

Point (2) (pullup):

$\alpha_A = 0$ to $0.8\ \alpha_{MAX}$ degrees

$\beta_A = \pm \beta_{MAX}$ degrees

Point (3) (pushover):

$\alpha_A = 0$ to $-0.6\ \alpha_{MAX}$ degrees

$\beta_A = \pm 0.2\ \beta_{MAX}$ degrees

Point (4) (pushover):

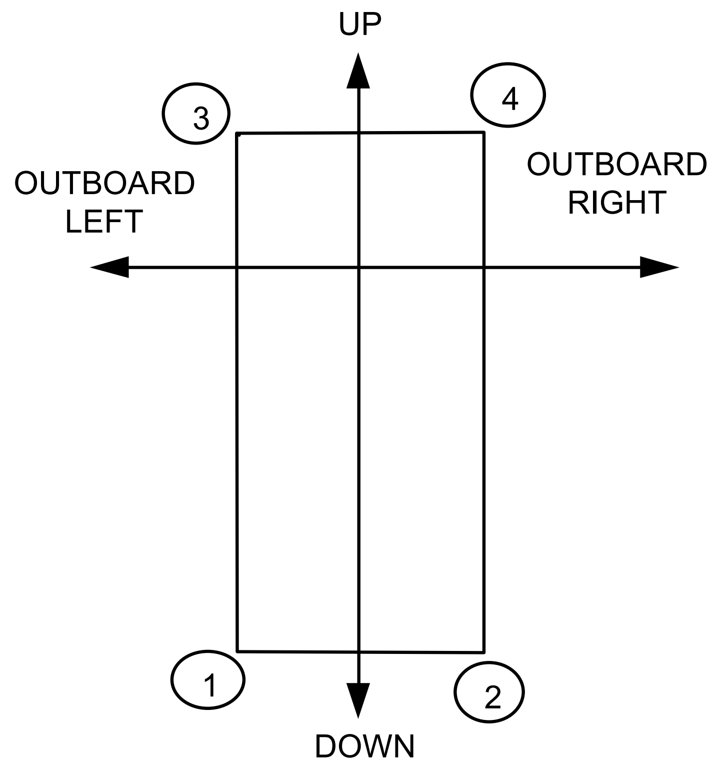
$\alpha_A = 0$ to $-0.4\ \alpha_{MAX}$ degrees

$\beta_A = \pm \beta_{MAX}$ degrees

Where:

$\alpha_{MAX} = n_z(W_A/S_A)(1/C_{L\alpha}q)$

$\beta_{MAX} = n_y\,(W_A/S_A)(1/C_{Y_\beta}q)$



Note:
1. For all points, the stores shall be considered to be mounted at incidence angles of 0 or -3 degrees, whichever is more critical in each case, to be added to the values of α_A.
2. Table B-I should be used only if specific aircraft data are not available.

FIGURE B-2. Aircraft angles of attack and sideslip at specific load envelope points for fuselage-mounted stores.

B.2.2.3 Method using aircraft angles - low speed carriage only. For aircraft with a maximum carriage speed of 350 knots equivalent airspeed (KEAS) or less, airloads shall be developed using store angles of attack and sideslip computed with the equations on figure B-3 (wing or sponson-mounted stores) or figure B-4 (fuselage-mounted stores). The store overall loads shall be determined using the store angles with wind tunnel data for the store in a uniform onset flow. If appropriate store aerodynamic coefficient data are unavailable, analytical or empirical methods shall be used to obtain the load coefficients for the store in a uniform flow.

B.2.2.4 Method using flowfield data. Appropriate interference flowfield data shall be used from wind tunnel tests or flight tests. These flowfield data shall be combined with velocity to obtain the local flowfield distribution over the length of the store. If the parent aircraft is undergoing angular rates in pitch, yaw, or roll, the induced flowfield due to the aircraft rates shall be combined with the measured interference flowfield and velocity to obtain the local flow distribution along the store. The resulting flowfield shall then be used with appropriate load distribution methods to obtain the force distribution acting along the length of the store. The force distribution shall then be summed to obtain the overall store aerodynamic loads.

B.2.2.5 Analytical method. Analytical prediction methods shall be used to calculate the overall aerodynamic loads on the store when the store is under the influence of the aircraft flowfield. The methods shall include angular rates and predict disturbances in the flowfield due to the aircraft components, including, but not limited to, the fuselage, wing, pylon, rack, and adjacent stores, and shall predict the influence of these disturbances on the load distribution along the length of the store.

Points (1) and (2) (symmetric pullup):

$\alpha_S = 0$ to $\frac{15000}{q}$ degrees

$\beta_S = \pm \frac{500}{q}$ degrees

Points (3) and (4) (symmetric pushover):

$\alpha_S = 0$ to $-\frac{9000}{q}$ degrees

$\beta_S = \pm \frac{500}{q}$ degrees

Point (5) (rolling pushover):

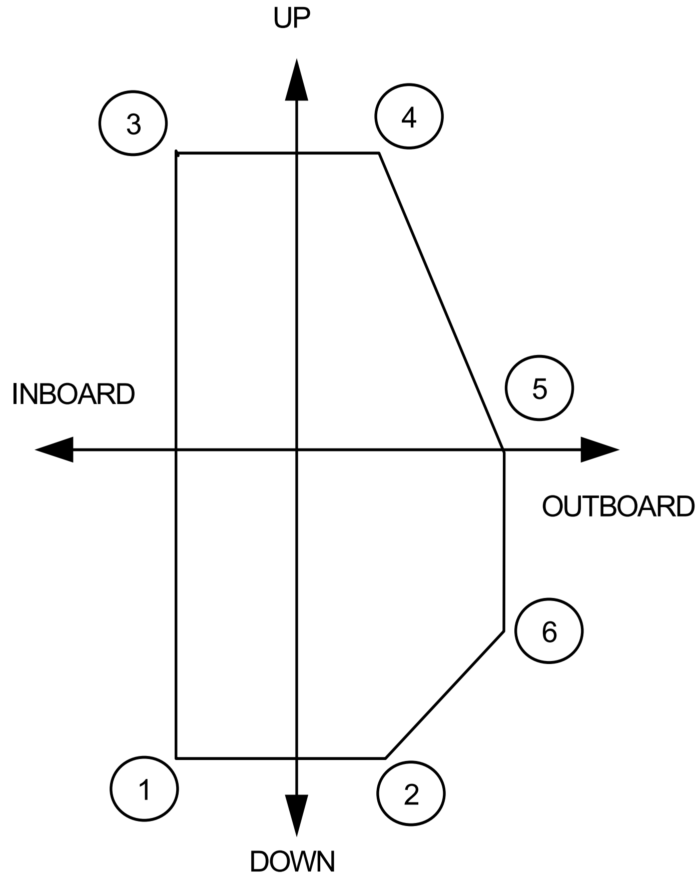
$\alpha_S = \pm \frac{600}{q}$ to $-\frac{8000}{q}$ degrees

$\beta_S = \pm \frac{6000}{q}$ degrees

Point (6) (rolling pullout):

$\alpha_S = 0$ to $\frac{15000}{q}$ degrees

$\beta_S = \pm \frac{6000}{q}$ degrees



Note:
For all points, the stores shall be considered to be mounted at incidence angles of 0 or -3 degrees, whichever is more critical in each case, to be added to the values of α_s .

FIGURE B-3. Store angles of attack and sideslip at specific load envelope points for wing or sponson-mounted stores (low speed aircraft).

Points (1) and (2) (pullup):

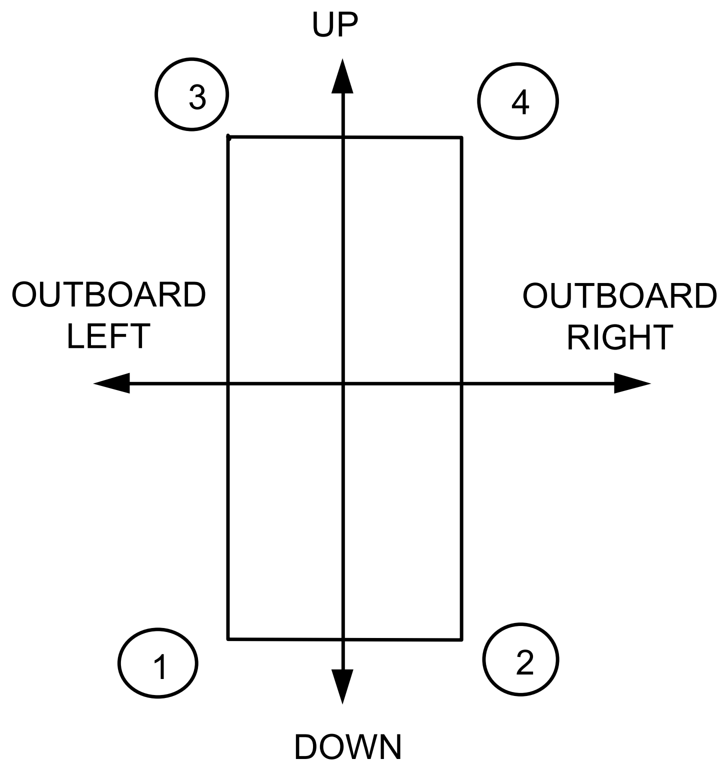
$\alpha_S = 0 \text{ to } \frac{1600}{q}$ degrees

$\beta_S = \pm \frac{6000}{q}$ degrees

Points (3) and (4) (pushover):

$\alpha_S = 0 \text{ to } -\frac{1500}{q}$ degrees

$\beta_S = \pm \frac{6000}{q}$ degrees



Note:
For all points, the stores shall be considered to be mounted at incidence angles of 0 or -3 degrees, whichever is more critical in each case, to be added to the values of α_S.

FIGURE B-4. Store angles of attack and sideslip at specific load envelope points for fuselage-mounted stores (low speed aircraft).

B.2.3 Inertia loads. Inertia loads shall be determined from a knowledge of the aircraft performance capabilities and the location of the store on the aircraft. Each combination of aircraft and carriage location defined by the acquiring activity shall be considered in determining the critical loads. When the performance capability of the aircraft is affected by the presence of the store, the performance with the store present shall be used. These load factor envelopes shall be applied at the store cg. It shall be noted that the store load factors are equal in magnitude, but opposite in direction to the accelerations in units of gravity (g's) experienced by the store during a particular maneuver.

B.2.3.1 Load factor calculations. The load factors shall be computed using the relations given below:

$$n_{x_s} = -a_x + \frac{1}{g}[\ddot{\omega}_z \Delta Y - \ddot{\omega}_y \Delta Z + (\dot{\omega}_y{}^2 + \dot{\omega}_z{}^2)\,\Delta X - \dot{\omega}_x \dot{\omega}_y \Delta Y - \dot{\omega}_x \dot{\omega}_z \Delta Z]$$

$$n_{y_s} = -a_y + \frac{1}{g}[\ddot{\omega}_x \Delta Z - \ddot{\omega}_z \Delta X + (\dot{\omega}_x{}^2 + \dot{\omega}_z{}^2)\,\Delta Y - \dot{\omega}_x \dot{\omega}_y \Delta X - \dot{\omega}_y \dot{\omega}_z \Delta Z]$$

$$n_{z_s} = -a_z + \frac{1}{g}[\ddot{\omega}_y \Delta X - \ddot{\omega}_x \Delta Y + (\dot{\omega}_y{}^2 + \dot{\omega}_x{}^2)\,\Delta Z - \dot{\omega}_x \dot{\omega}_z \Delta X - \dot{\omega}_y \dot{\omega}_z \Delta Y]$$

$$\Delta X = X_{\text{store cg}} - X_{\text{aircraft cg}}$$

$$\Delta Y = Y_{\text{store cg}} - Y_{\text{aircraft cg}}$$

$$\Delta Z = Z_{\text{store cg}} - Z_{\text{aircraft cg}}$$

For high performance (fighter/attack type) aircraft (with wing tip mounted stores), the inertia loads shall be determined from the aircraft flight conditions given in table B-II, if specific aircraft data are not available.

TABLE B-II. Aircraft flight conditions for design of stores on high performance aircraft (limit loads).

Condition	Dynamic pressure q (psf)	Aircraft angles (deg)		Linear acceleration (g)			Peak angle rates 1/ (rad/sec)			Peak angular accelerations 1/ (rad/sec^2)		
		Attack α_A	Sideslip β_A	a_x	a_y	a_z	$\dot{\omega}_x$	$\dot{\omega}_y$	$\dot{\omega}_z$	$\ddot{\omega}_x$	$\ddot{\omega}_y$	$\ddot{\omega}_z$
1. Pullout	2500	5	0	±1.5	±1.0	+7.0				±0.25	±0.5	0
2. Pullout	1000	13	0	±1.5	±1.0	+8.5				±0.5	±0.5	0
3. Pullout	500	25	0	±1.5	±1.0	+10.0				±0.5	±0.5	0
4. Rolling-pullout	650	6	±2	±1.5	±0.5	+7.0	±5.0			±11.0	±3.0	±2.0
5. Rolling-pullout	2500	3	±1	±1.5	±0.25	+6.5	±4.5			±13.0	±1.0	±1.0
6. Rolling-pullout	2500	2	±1	±1.5	±0.25	+6.0	±4.5			±17.0	±1.0	±1.0
7. Barrier engagement (land)	150	0	0	-4.0	±1.0	+2.0				0	±6.0	±4.0
8. Max sink rate landing	150	0	0	-1.0	±1.0	+4.0				0	±4.0	±2.0
9. Bank-to-bank roll	2500	3	±1	±1.5	±1.0	+6.0				±13.0	±0.5	±1.0
10. Rudder-kick release (1g)	400	2	±10	±1.5	±1.5	+1.0				±1.0	0	±1.5
11. Pushover	2500	-2	0	±1.5	±1.0	-1.0				0	0	0
12. Pushover	1800	-4	0	±1.5	±1.0	-3.0				0	0	0
13. Pushover	1000	-6	0	±1.5	±1.0	-6.0				±0.5	0	0

TABLE B-II. Aircraft flight conditions for design of stores on high performance aircraft (limit loads). (Continued)

Condition	Dynamic pressure q (psf)	Aircraft angles (deg)		Linear acceleration (g)			Peak angle rates 1/ (rad/sec)			Peak angular accelerations 1/ (rad/sec^2)		
		Attack α_A	Sideslip β_A	a_x	a_y	a_z	$\dot{\omega}_x$	$\dot{\omega}_y$	$\dot{\omega}_z$	$\ddot{\omega}_x$	$\ddot{\omega}_y$	$\ddot{\omega}_z$
14. Spins 2/												
a. Engines on fuselage												
(1)				0	0	+4.25	+3.5	±1.5	+5.0	0	0	0
(2)				0	0	-2.5	-3.5	±1.0	+5.0	0	0	0
(3)				0	0	+4.25	-3.5	±1.5	+5.0	0	0	0
(4)				0	0	-2.5	+3.5	±1.0	+5.0	0	0	0
b. Engines on wing												
(1)				0	0	+1.0	+1.5	0	+3.5	0	0	0
(2)				0	0	-1.0	-1.5	0	+3.5	0	0	0
(3)				0	0	+1.0	-1.5	0	+3.5	0	0	0
(4)				0	0	-1.0	+1.5	0	+3.5	0	0	0

1/ Note that these values are peak values and do not occur simultaneously.
2/ Derived from MIL-A-8861

B.2.3.2 Total inertia loads at store cg. The total inertial loads at the store cg shall be computed from the following relations:

$$P_{x_{inertia}} = n_{x_s} W_s$$

$$P_{y_{inertia}} = n_{y_s} W_s$$

$$P_{z_{inertia}} = n_{z_s} W_s$$

$$M_{x_{inertia}} = -I_{xx}\ddot{\omega}_x + (I_{yy} - I_{zz})\dot{\omega}_y\dot{\omega}_z + I_{yz}(\dot{\omega}_y{}^2 - \dot{\omega}_z{}^2) + I_{xz}(\ddot{\omega}_z + \dot{\omega}_x\dot{\omega}_y) + I_{xy}(\ddot{\omega}_y - \dot{\omega}_z\dot{\omega}_x)$$

$$M_{y_{inertia}} = -I_{yy}\ddot{\omega}_y + (I_{zz} - I_{xx})\dot{\omega}_z\dot{\omega}_x + I_{xz}(\dot{\omega}_z{}^2 - \dot{\omega}_x{}^2) + I_{xy}(\ddot{\omega}_x + \dot{\omega}_y\dot{\omega}_z) + I_{yz}(\ddot{\omega}_z - \dot{\omega}_x\dot{\omega}_y)$$

$$M_{z_{inertia}} = -I_{zz}\ddot{\omega}_z + (I_{xx} - I_{yy})\dot{\omega}_x\dot{\omega}_y + I_{xy}(\dot{\omega}_x{}^2 - \dot{\omega}_y{}^2) + I_{yz}(\ddot{\omega}_y + \dot{\omega}_x\dot{\omega}_z) + I_{xz}(\ddot{\omega}_x - \dot{\omega}_y\dot{\omega}_z)$$

B.2.3.3 Limit inertia-release load factors adjacent store. The limit inertia adjacent-store-release load factors shall be determined for each specific aircraft-store combination.

B.2.3.4 Catapult and arrested landing load factors. For wing or sponson-mounted stores on carrier-based aircraft, use figure B-5 for catapult and arrested landing load factors. The corresponding diagram for fuselage-mounted stores is shown on figure B-6.

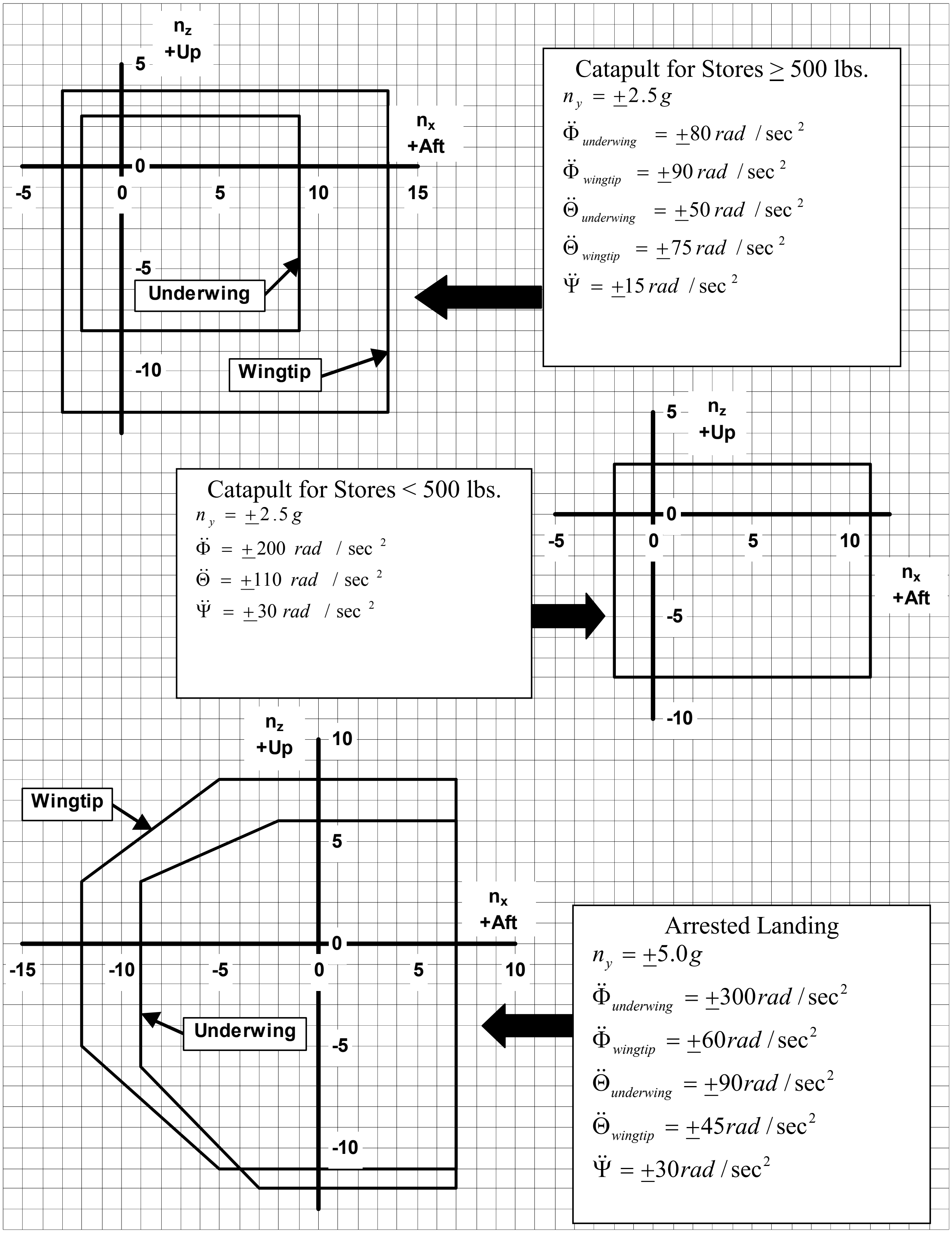


FIGURE B-5. Catapult and arrested landing inertia limit load factors for wing or sponson-mounted stores.

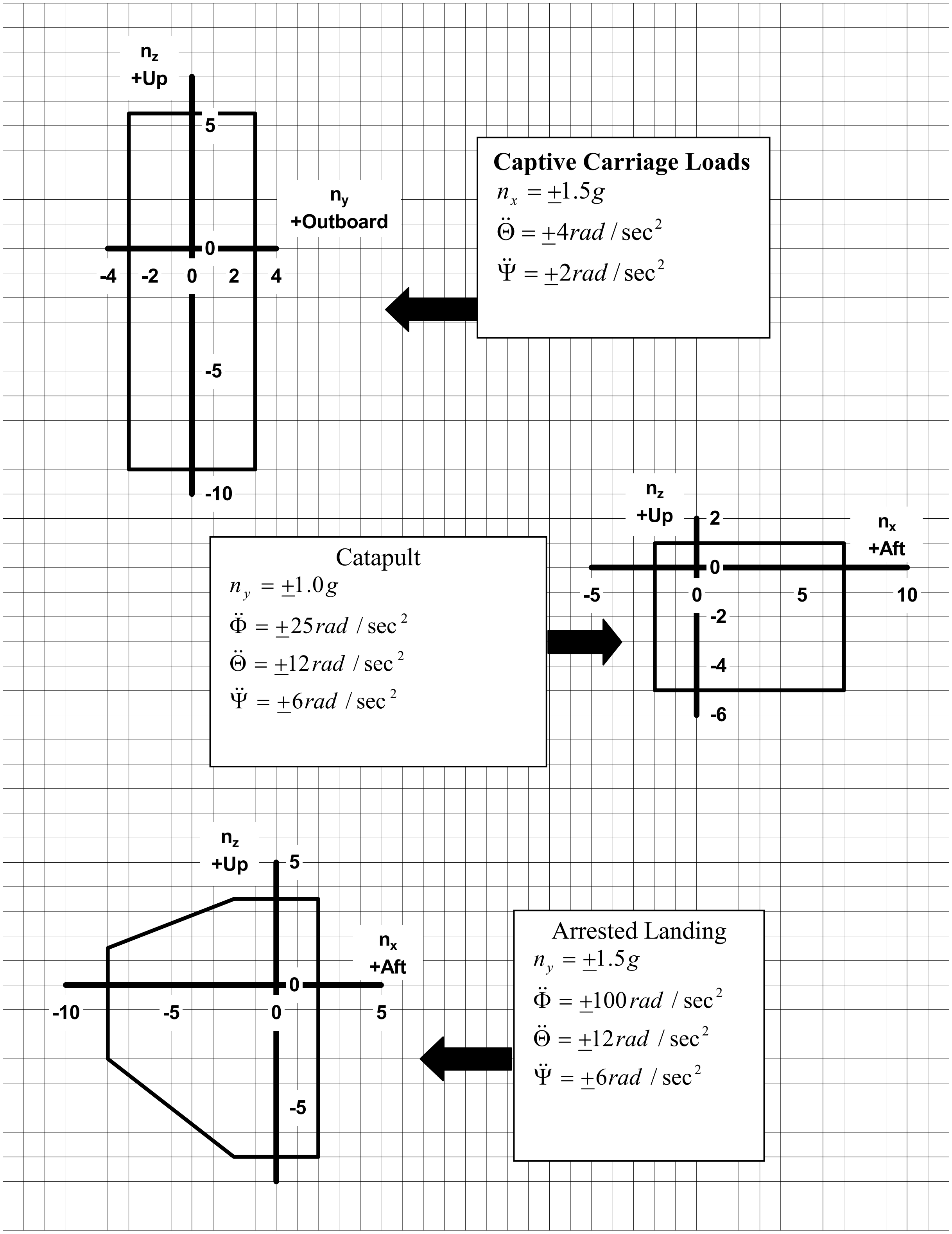
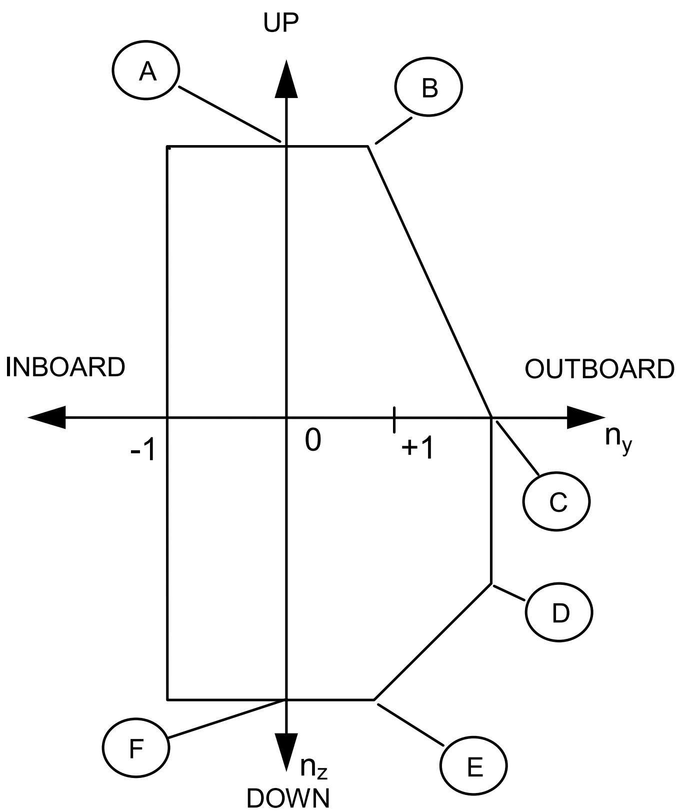


FIGURE B-6. Catapult and arrested landing inertia limit load factors for fuselage-mounted stores.

B.2.3.5 Low-speed fixed wing aircraft. For aircraft with a maximum carriage speed of 350 KEAS or less, inertia load factors shall be taken from figure B-7 (wing mounted stores) or figure B-8 (fuselage mounted stores).

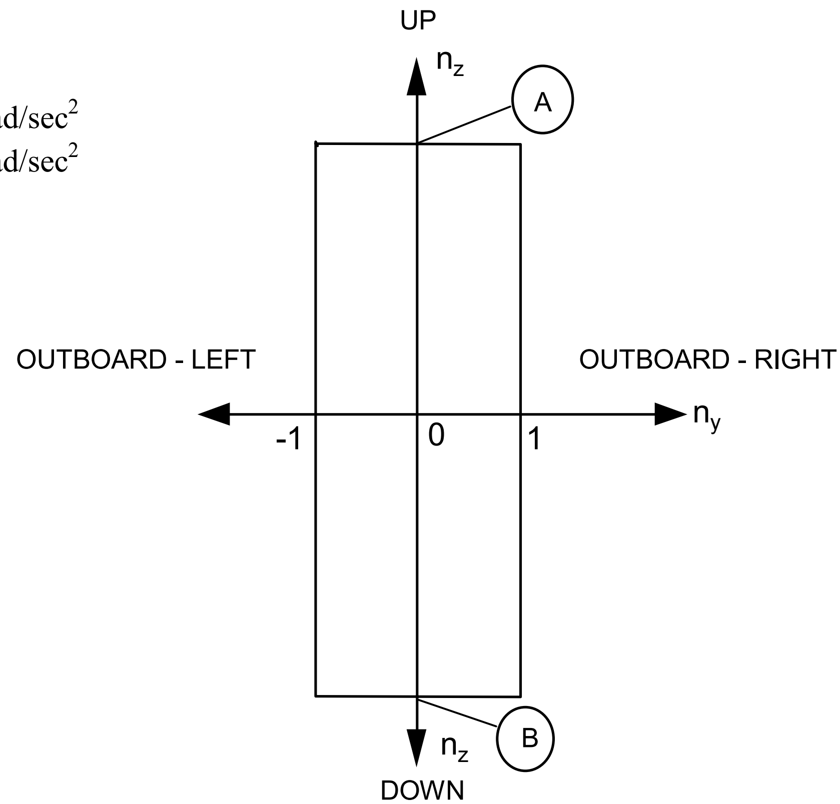
$n_x = \pm 1.0$
$\ddot{\theta} = \pm 4$ rad/sec^2
$\ddot{\psi} = \pm 2$ rad/sec^2



WHERE:
A: has a value of $n_y = 0$, $n_z = 1.5$ times max negative g which clean aircraft can attain (n_z must be at least 1.0 up).
B: has a value of $n_z = n_z$ at Point (A), $n_y = 1.0$.
C: has a value of $n_z = 0$, $n_y = 1.5$ times max g as read in cockpit, which can be attained during unsymmetric maneuver.
D: has a value of $n_z = n_y = 1.5$ times max g as read in cockpit, which can be attained during an unsymmetric maneuver.
E: has a value of $n_z = n_z$ at Point (F), $n_y = 1.0$.
F: has a value of $n_y = 0$, $n_z = 1.5$ times max positive g which the clean aircraft can attain.

FIGURE B-7. Design inertia limit load factors for wing or sponson-mounted stores (low speed aircraft).

$n_x = \pm 1.0$
$\ddot{\theta} = \pm 4$ rad/sec^2
$\ddot{\psi} = \pm 2$ rad/sec^2



WHERE:
A: has a value of $n_y = 0$, n_z =1.5 times max negative g which clean aircraft can attain (n_z shall be at least 1.0 up).
B: has a value of $n_y = 0$, n_z = 1.5 times max positive g which clean aircraft can attain.

FIGURE B-8. Design inertia limit load factors for fuselage-mounted stores (low speed aircraft).

B.2.4 Forces of interaction. The forces of interaction between the store and aircraft may be computed by various means. Procedures employed for these interaction force calculations shall be approved by the procuring activity.

CARRIAGE DESIGN LIMIT LOADS - STORES CARRIED ON HELICOPTERS

C.1 SCOPE

C.1.1 Scope. Appendix C sets forth general and specific criteria to which airborne stores and related suspension and release equipment, intended for use on helicopters, shall be designed. This appendix is a mandatory part of this standard. The information contained herein is intended for compliance.

C.2 DETAILED REQUIREMENTS

C.2.1 Design requirements. External stores, suspension and release equipment, and the associated interfacing hardware, shall be designed to withstand the most critical combinations of aerodynamic, dynamic, and inertial loadings occurring in any specified aircraft configuration. All applicable combinations of external store/suspension, ground or flight conditions (rotor speeds, altitudes and temperatures), and the effects of blast pressure and recoil during weapon firing, launch, or jettison shall be considered. The dynamic interaction or coupling of the combined stores/suspension/aircraft and any possible resonant amplification shall be investigated. There shall be no degradation of basic aircraft performance with regard to ground and air resonance phenomena or the occurrence of dynamic instabilities, including flutter and divergence, within the prescribed margins which define the operating envelope of the aircraft. Evaluation of these system integration requirements shall be accomplished as specified by the procuring activity and made available to the store contractor as necessary.

C.2.2 Aerodynamic loads. The detail store loads shall be computed by one of the methods described below and approved by the procuring activity.

C.2.2.1 Measured force and moment data. Measured force and moment data from wind tunnel or flight tests properly scaled with respect to dynamic pressure or size shall be used.

C.2.2.2 Analytical force and moment data from simulation. Analytical force and moment data shall be computed by an appropriate rotorcraft flight simulation program during maneuvers performed in accordance with the applicable structural specification.

C.2.2.3 Analytical force and moment data from flowfield modeling. Analytical force and moment data shall be computed by an appropriate three-dimensional flowfield program modeling either the complete airframe and store or only the store and those portions of the airframe in the immediate vicinity of the store.

C.2.2.4 Calculated forces and moments. Forces and moments shall be calculated using non-dimensional aerodynamic coefficients determined by appropriate analytical methods and conditions of dynamic pressure and angles of attack and sideslip.

C.2.3 Flight load factors.

C.2.3.1 Known helicopter performance parameters. When the helicopter performance parameters and the specific location and weight of the store are known, the equations presented in B.2.3.1 and B.2.3.2 shall be used to calculate flight inertia load factors and store inertia loads, respectively.

C.2.3.2 Unknown helicopter performance parameters. When the helicopter performance parameters are not known, the limit load factors, angular velocities and accelerations at the aircraft cg presented in C.2.6 of this appendix shall be used with the equations presented in B.2.3.1 and B.2.3.2. If the location and weight of the store are unknown, reasonable estimates of these parameters shall be made based on knowledge obtained from similar store configurations. Estimated data shall be approved by the procuring activity.

C.2.4 Landing load factors. Methods for calculating landing inertia load factors are the same as those presented in C.2.3.1 and C.2.3.2 of this appendix. Landing loads shall not be combined with aerodynamic loads.

C.2.5 Crash conditions. Load factors presented in table C-I shall be used to determine store loads associated only with U.S. Navy helicopter crash conditions. These factors are not additive and are to be applied separately at the store cg. For stores judged to pose a possible aircrew hazard in the event of store or store components separating during a crash, the crash loads shall be obtained from the procuring activity. For U.S. Army helicopters, the store and store support structure, as a minimum, shall be designed to separate from the aircraft prior to failure of the primary structure.

TABLE C-I. U.S. Navy helicopter store ultimate crash load factors (at store cg).

n_{xs}	n_{ys}	n_{zs}
-9.00	$\pm$3.75	-9.0
+2.25	…	+4.5

C.2.6 Helicopter parameters. The helicopter parameters shall be as specified in Table C-II.

TABLE C-II. Helicopter parameters.

Condition	a_x	a_y	a_z	$\dot{\omega}_x$	$\dot{\omega}_y$	$\dot{\omega}_z$	$\ddot{\omega}_x$	$\ddot{\omega}_y$	$\ddot{\omega}_z$
Symmetrical flight	±1.0	±0.2	3.5	±1.0	±1.0	±0.1	±1.0	±4.0	±0.5
Unsymmetrical flight	±0.5	±0.5	2.8	±1.0	±1.0	±0.9	±8.0	±1.5	±2.5
Landing with roll	±0.5	0	1.8	-	-	-	±12.0	±2.5	±1.5
Landing with pitch	±0.5	±0.5	2.2	-	-	-	±7.0	±5.5	±0.3

C.2.7 Dynamic loading. The store shall be designed for all dynamic loads in combination with the appropriate inertial and aerodynamic loads. Dynamic loads include but are not limited to:

a. Ground operations including handling and taxiing.
b. Airborne flight including hover in ground effect and out of ground effect, level flight, normal maneuvers, tactical maneuvers and auto-rotation.
c. Weapon and countermeasure firing from small and large caliber guns, rockets, missiles, grenades, chaff dispensers and flares.
d. Takeoff and landing.
e. Stores separation.

C.2.8 Dynamic requirements. The vibratory response characteristics of the store, suspension equipment, or store/interface system, shall be calculated or measured for all conditions listed in C.2.7. The frequency response shall range from one blade per revolution (1b/rev) of the main rotor through 4b/rev or 2b/rev of the tail rotor, whichever is higher. For weapons firing conditions, the frequency range shall extend from the fundamental firing frequency through the 10th harmonic. In addition to excitations at frequencies producing highest loads or accelerations, other rotor and weapons-fire harmonics shall be considered when their frequency is within ± 10 percent of a known component resonance (resonance being the amplification of the input level by greater than 2 to 1). The store dynamic characteristics, associated with the specific helicopter(s), shall be accounted for in the design of the aircraft/store interface to preclude adverse response characteristics.

C.2.8.1 Rotor induced harmonic excitation. Main and tail rotor induced vibrations are the significant sources of dynamic loading for helicopters. The coupled dynamic response of the rotor(s), fuselage, wing (if applicable), suspension equipment, and stores induced either aerodynamically or through the structure, shall be determined. As a goal the system shall be designed to avoid main and tail rotor resonance within the normal power-on and power-off speeds at all gross weights, centers of gravity, aircraft loadings, and for all applicable stores loading and dispensing configurations including that of other store locations. Freedom from nb/rev resonance (nb = number of blades, a whole number) is highly desirable. Where more than one store is mounted on the same suspension hardware, or where more than one store/suspension combination is located on a structure(s) cantilevered from the fuselage, then all specified loading combinations shall be considered. Resonance within 1/rev ± 0.25/rev and b/rev ± 0.25/rev shall be avoided. Alternately, it shall be demonstrated that the combined static and dynamic loadings are acceptable.

C.2.8.2 Frequency placement. The following structural characteristics which control frequency placements shall be considered:

a. Fuselage attachment and supporting structure including wings or other cantilevered structure for support of external stores.
b. Wing or cantilevered structural stiffness.
c. Flexibility of suspension and release equipment.
d. Stores structural flexibility.
e. Swaybrace stiffness.
f. Coupling of system modes in close proximity.

C.2.8.3 Store response. Factors affecting the prediction of store response magnitude shall include, but not necessarily be limited to, the following:

a. Rotor wake impingement on the stores and stores support structure and the resulting harmonic excitation.
b. Magnitude of forcing functions at the rotor hub.
c. Proximity of natural frequencies to rotor excitation frequencies and weapon firing rates.
d. Transmissibility from rotor to support structure and support structure to store as a result of modal response distributions.
e. Overall system modal coupling.
f. System and local damping.
g. Free play in suspension/release mechanisms and stores.
h. Effective damping of stores, such as fuel.

C.2.9 Flutter and divergence. The requirements of 5.11 of this standard shall be met.

C.2.10 Mechanical instability. The total weapons system shall be free of mechanical instability with the required margin of safety specified by the procuring activity at all rotor speeds during all ground and flight operating conditions.

C.2.11 Forces of interaction. The forces of interaction between the store and helicopter may be computed by various means. Procedures employed for these interaction force calculations shall be approved by the procuring activity.

CONCLUDING MATERIAL

Custodians:
Army-AV
Navy - AS
Air Force - 11

Preparing activity:
Navy - AS

(Project 15GP-2005-004)

Review activity:
Air Force - 19, 22, 99

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