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MILITARY SPECIFICATION

AIRBORNE STORES, SUSPENSION EQUIPMENT AND AIRCRAFT-STORE INTERFACE (CARRIAGE PHASE); GENERAL DESIGN CRITERIA FOR

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

1. SCOPE

1.1 Scope. This specification sets forth general structural and mechanical design criteria to which airborne stores, suspension equipment and their associated interfaces shall be designed. Provisions are included to promote cross-utilization and servicing capability among military aircraft of all services of the Department of Defense and various NATO country aircraft. Guidance is provided for design, analysis, test, and documentation of airborne stores, suspension equipment and the aircraft-store interface during captive operations. Acquisition of airborne stores and related suspension and release equipment shall be covered by a detail specification or drawing to be prepared by the contractor or acquiring activity.

1.2 Extent. This specification contains general criteria that shall be used to design, analyze, test and document the development 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 specification. These are gravity launched torpedoes and tow targets. For the detailed requirements not stated in this document, the acquiring activity should specify such.

1.3 Conforming requirements. Unless otherwise specified, all airborne stores and suspension equipment shall conform to this specification and shall perform in service with minimum possible restriction on the aircraft flight envelope. Unless otherwise specified, all requirements stated herein are applicable to all services of the Department of Defense.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 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 shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Naval Air Engineering Center, Systems Engineering and Standardization Department (Code 53), Lakehurst, NJ 08733-5100, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 15GP

SPECIFICATIONS

MILITARY

MIL-T-7743	Testing, Store Suspension and Release Equipment, General Specification for.
MIL-M-8856	Missile, Guided, Strength and Rigidity, General Specification for.
MIL-A-8860	Airplane Strength and Rigidity, General Specification for.
MIL-A-8868	Airplane Strength and Rigidity, Data and Reports.
MIL-A-8870	Airplane Strength and Rigidity, Vibration, Flutter, and Divergence.

STANDARDS

MILITARY

MIL-STD-210	Climatic Information to Determine Design and Test Requirements for Military Systems and Equipment.
MIL-STD-810	Environmental Test Methods and Engineering Guidelines.
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.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

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

DRAWINGS

NAVAL AIR SYSTEMS COMMAND

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

(Unless otherwise indicated, copies of Naval Air Systems Command drawings are available from the Naval Air Technical Services Facility (NATSF) (Code 3121), 700 Robbins Avenue, Philadelphia, PA 19111-5097.)

NAVAL SEA SYSTEMS COMMAND

3236121	Coordination Data, Torpedo MK 46 Mod 5.
5548694	Torpedo MK 50 Configuration Coordination Drawing.

(Unless otherwise indicated, copies of Naval Sea Systems Command drawings are available from the Naval Ordnance Station (Code 802), Louisville, KY 40214-5001.)

PUBLICATIONS

NORTH ATLANTIC TREATY ORGANIZATION (NATO)

STANAG 3441 AA	Design of Aircraft Stores.
STANAG 3558 AA	Locations for Aircraft Electrical Control Connections for Aircraft Stores.
STANAG 3575 AA	Aircraft Stores Ejector Racks.
STANAG 3726 AA	Bail (Portal) Lugs for the Suspension of Aircraft Stores for Fixed Wing Aircraft and Helicopters.

AIR STANDARDIZATION COORDINATING COMMITTEE (ASCC)

AIR STD 20/10	Ejector Racks for Conventional Munitions.
AIR STD 20/13	Suspension Lug Wells, Reinforced Areas, and Design Load Criteria for Droppable Aircraft Stores.
AIR STD 20/15	Suspension Lugs for 1000 Pound Class and 2000 to 5,500 Pound Class Stores.
AIR STD 20/17	Mechanical Arming Wire Connections Between Airborne Armament Stores and Associated Suspension Equipment.

(Unless otherwise indicated, copies of STANAGs and AIR STDs are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Non-Government publications. The following document forms a part of this document to the extent specified herein. Unless otherwise specified, the issue of the document which is DOD adopted is that listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issue of document not listed in the DODISS is the issue of the document cited in the solicitation.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Y10.7	American Standard Letter Symbols for Aeronautical Sciences.

(Application for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York, NY 10018.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated detail specifications, specification sheets or MS standards), 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. REQUIREMENTS

3.1 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 the related basic airplane design specification MIL-A-8860 or as specified in the contract documents by the acquiring activity. Definitions and symbols shall be in accordance with 6.3.

3.2 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 3.11). For limit, yield, and ultimate conditions, stress analysis and tests shall demonstrate that allowable stresses are not exceeded. The service life of the structure must equal or exceed the specified life required in the applicable contractual document.

3.2.1 Limit loads. Unless otherwise specified, the maximum loads expected in normal operation of stores and suspension equipment, including sway brace and lug loads during captive carriage, designated herein as the limit loads, are used in this specification and referenced specifications and formulas.

3.2.2 Yield loads. Unless specific yield loads are delineated, yield loads are obtained herein by multiplying limit loads by 1.15, which is denoted the yield factor of safety (yield factor of safety is 1.0 for Army applications). The effects of deformation remaining after application and removal of yield loads shall not exceed those prohibited in 3.3.

3.2.3 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) are 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 is constituted by 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.

3.3 Deformation. The permanent deformations resulting from flight or structural test articles being loaded statically, cyclically, or dynamically with yield loads shall be combined with any thermal deformation due to application of design temperature. If the thermal deformation should be in a manner which would relieve the yield deformation, the more critical deformation shall be considered. The deformation considered 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, suspension equipment or the carriage aircraft.

c. Require repair or replacement of parts.

3.4 Design loads. The design loads shall include thermal effects and aeroelastic structural deformation. Magnitudes and distribution of loads shall also include effects of structural dynamic response resulting from transient or suddenly applied loads, such as armament dynamic hang fire loads as defined by the acquiring agency or derived by the contractor in a rational manner acceptable to the acquiring agency.

3.4.1 Hang fire condition, Army and Navy requirement. The structural requirement for a hang fire condition is that the weapon shall stay attached to the support structure during a hang fire condition. The design criteria is stated below.

(1) Limit load = thrust x dynamic load factor (DLF)

(2) Ultimate load = limit load x 1.5

The contractor should provide a DLF by analysis or test. If the DLF is unavailable, then a DLF of two is to be used.

3.4.2 Hang fire condition, Air Force requirement. Air Force requirement shall be specified by the Air Force.

3.5 Store classification. This specification shall be used for both ejected stores and rail launched stores. Detailed characteristics of each of these stores are given in the following paragraphs, which are not applicable to torpedoes and tow targets.

3.5.1 Ejected stores. The maximum gross weights of ejected stores shall include all disposable items. This actual 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.

3.5.2 Rail launched stores. The maximum gross weight and other characteristics of rail launched stores are listed in Table II. Each class has unique hanger/rail mechanical interfaces. Table III illustrates the typical hanger configuration for each class of rail launched stores. Generally the hangers are either an internal T-shaped hanger (Figure 10) or an external U-shaped shoe (Figure 11).

TABLE I. Approved lug configuration for aircraft stores.

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

1/ Stores in this weight category may require 14-inch or 30-inch spacing, or both. The decision as to which spacing will be required will be found in the store detail specification and will 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 30-inch spacing.

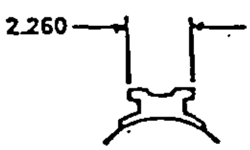
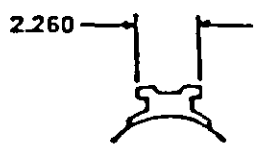
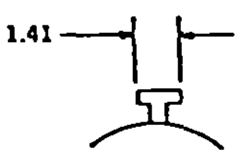
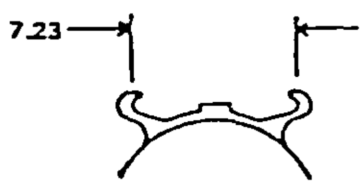
Only Figure 2 lugs shall be used for 14-inch spacing.

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

TABLE II. Typical rail launched store characteristics.

Weight class	Weight (lb)	Diameter (in.)	Type	Range	Launch type
300	< 300	< 7	Air-to-air	Short	Rail
600	300	< 10	Air-to-air	Medium	Rail/eject
600	1000	> 10	Air-to-surface	Medium	Rail/eject

TABLE III. Rail launched store configurations.

Weight class	Forward hanger 1/	Aft hanger 1/
LAU 7 300		
LAU 118 600		

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

3.5.3 Gravity launched torpedoes. Information on torpedoes is contained in interface Drawings 3236121 for the MK 46 MOD 5 and 5548694 for the MK 50. If additional information is required, contact the Naval Sea Systems Command (NAVSEA), code 63Y, for the MK 46 or Project Manager Ships-406 (PMS) for the MK 50, or the Naval Ocean Systems Center (NOSC), code 61.

3.5.4 Towed targets. Detailed requirements shall be specified by the acquiring activity.

3.5.5 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 3.5.1 and 3.5.2, 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 that produce critical loadings shall be examined.

3.6 Thermal criteria. The design of the store and suspension equipment shall provide for the cumulative heating effects from the internal and external thermal environments as defined in 3.6.1 and 3.6.2.

3.6.1 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.

3.6.2 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 MIL-STD-210, or the system specification.

3.7 Service life. Service life shall be defined. 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. Appropriate durability and damage tolerance analyses shall be performed to document that the required service life is satisfied for the planned operational use. A qualification test program shall be conducted which shall adequately demonstrate such analyses.

3.8 Suspension design criteria. This section defines the interface requirements for ejected stores.

3.8.1 Suspension lugs. Suspension lugs shall conform to drawings listed in Figures 1, 2, and 3 and shall be applicable to the weight class shown in Table I.

3.8.1.1 Lug strength. The minimum strength of suspension lugs shall be as specified in Figures 1, 2, and 3. The weight class, as determined in accordance with 3.5, 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 3.11.

3.8.1.2 Lug number and location. Tandem two-lug suspension shall be the minimum lug configuration. Any other means of suspension shall require that the acquiring activity designate or approve a 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 acquiring activity. All lug locations, dimensions, and allowable tolerances are specified in Figures 4, 5, 6, and 7.

3.8.1.3 Lug well details. The lug wells for the 1000 and 2000 pound class stores shall conform to the requirements specified in Figures 8 and 9 respectively. The lug well axis shall be within the store reinforced areas (see 3.9) and perpendicular to the longitudinal axis of the store within a tolerance of ± 0.5 degree.

3.8.1.4 Design acceptance. Appropriate 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 acquiring 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, and 3726 AA and AIR STDS 20/10, 20/13, 20/15, and 20/17 (see 6.5).

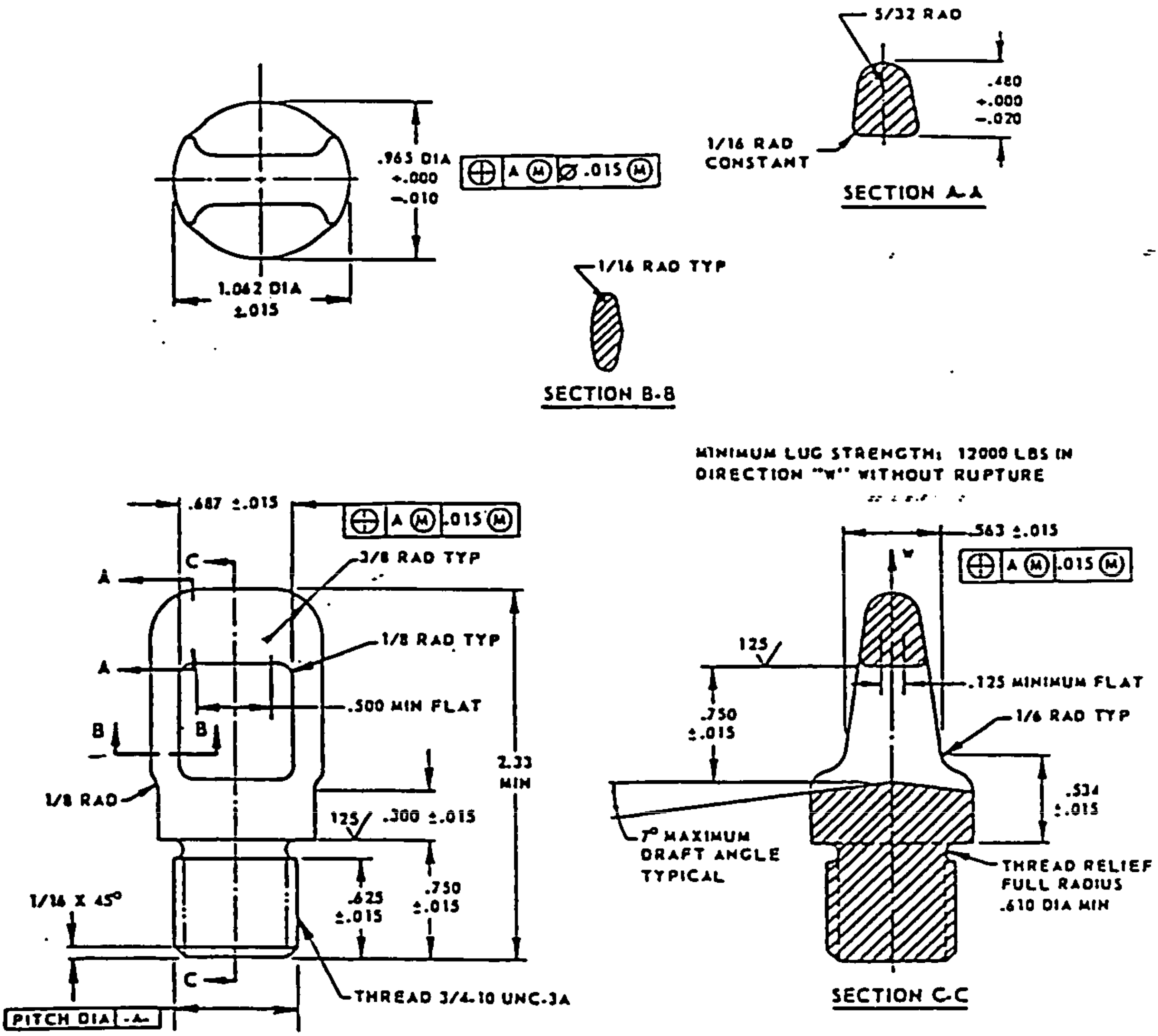
3.8.2 Rail launched hangers. Two types of hangers are used to support rail launched stores. These are either an internal T-shaped hanger or an external U-shaped shoe. Figures 10 and 11 illustrate the general configuration of each. Detail dimensions and material types shall be provided by the acquiring activity.

3.9 Store-to-aircraft interface areas. Store-to-aircraft interface areas shall conform to the dimension and location requirements of 3.9.1, 3.9.2, 3.9.3, and 3.9.5. Strength requirements shall conform to 3.9.4.

3.9.1 Sway brace areas. The sway brace area for stores with 14-inch lug spacing shall be as specified in Figures 4 and 5; for stores with 30-inch spacing shall be as specified in Figure 6; and for heavy stores shall be as specified in Figure 7.

3.9.2 Ejector areas. Both internal and external carriage stores shall have ejector areas as specified in Figures 4, 5, 6, and 7. 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 detail specification or by the acquiring activity.

3.9.3 Cradling and handling areas. As a minimum, all stores shall have cradling and handling area(s) of the size specified in Figures 4, 5, and 6 for the applicable store category. The store in Figure 7 shall sustain cradling and handling loads on any parts of the skin beneath the strongback region.

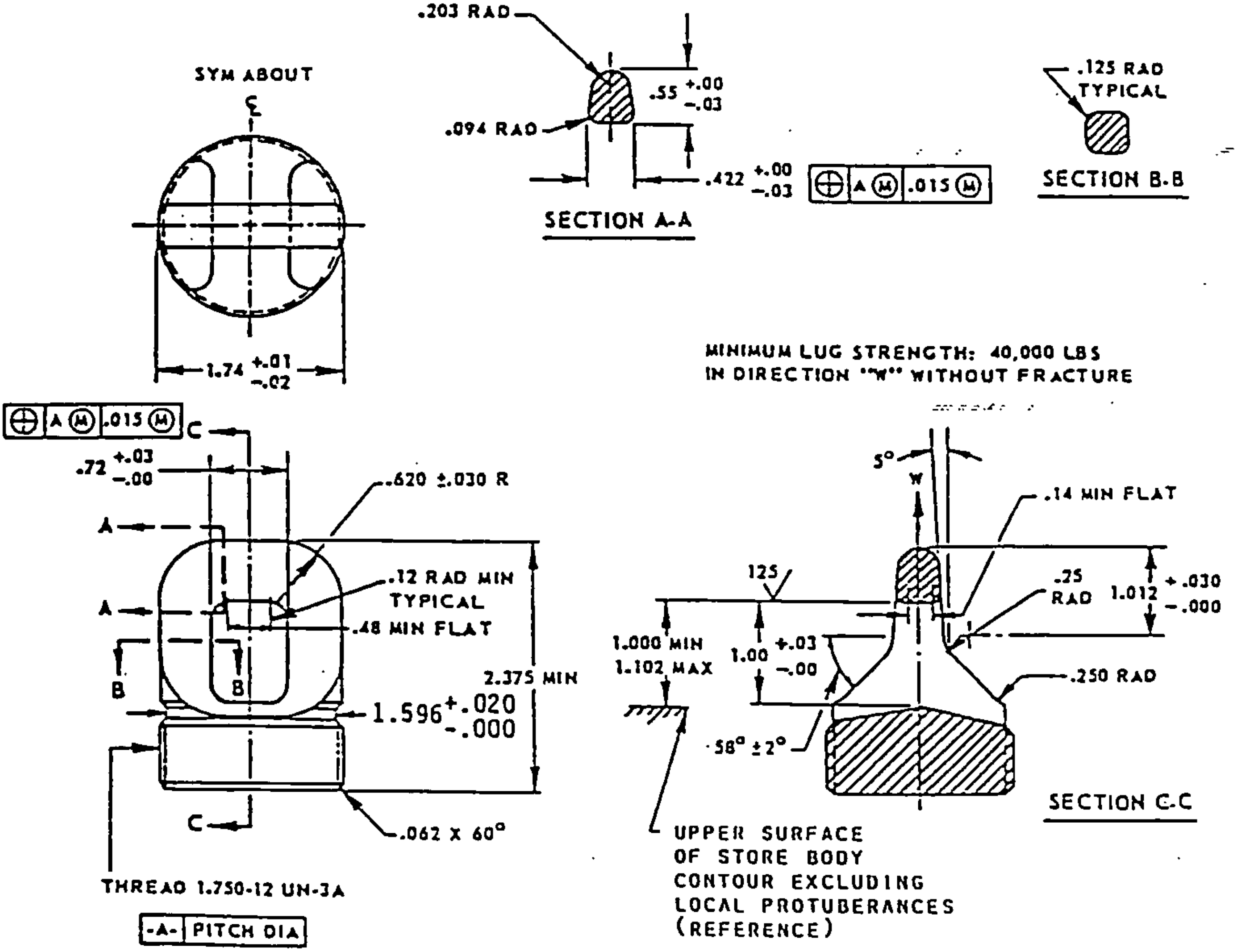


NOTES:

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 1. Lugs for stores in 100-lb weight class.

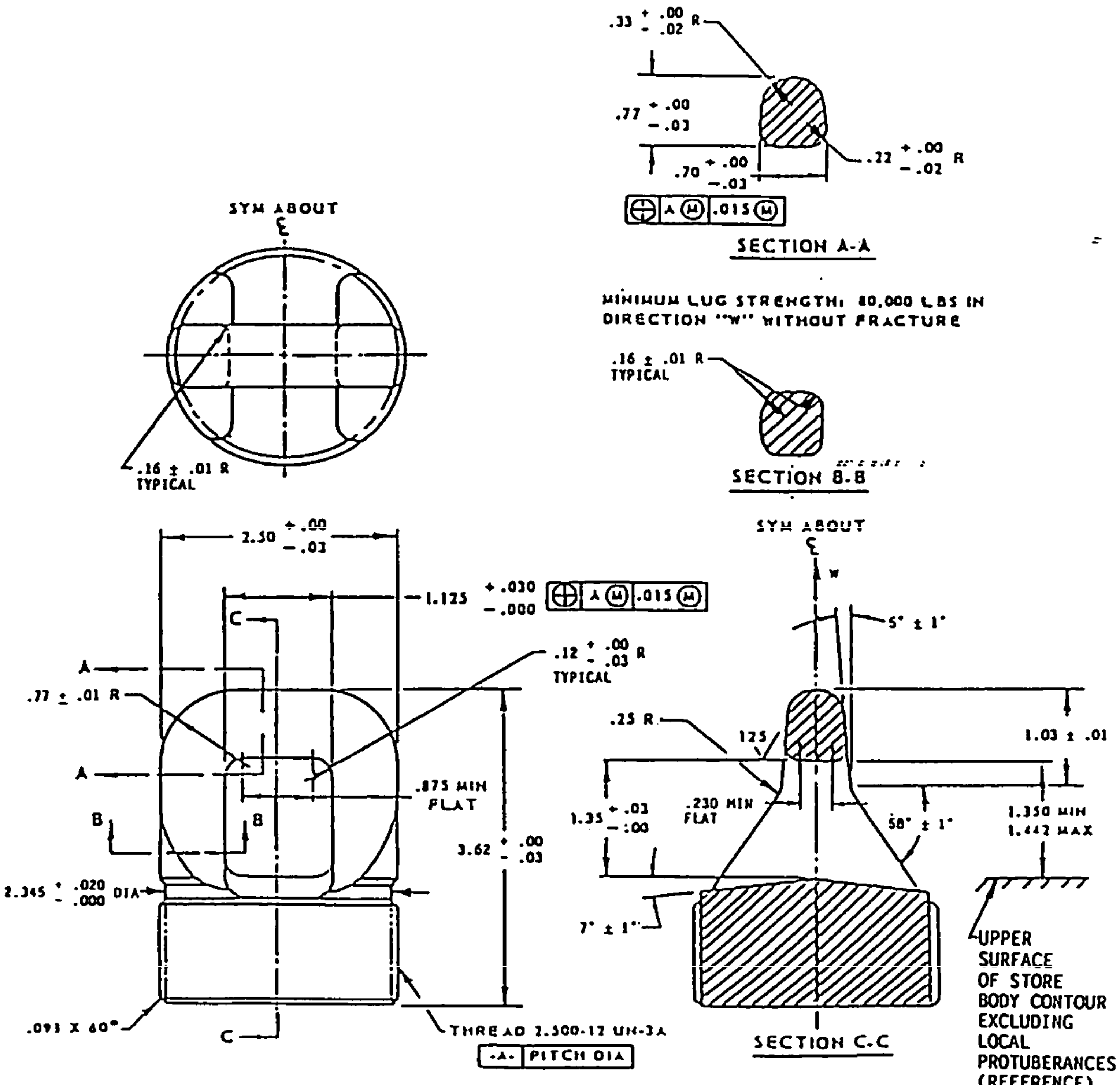


NOTES:

1. For design purposes, MS3314, Lug, Suspension, shall be used on the 1000-lb class bomb lug. The data in the above figure are provided as information only.

2. Dimensions are in inches.

FIGURE 2. 14-inch spaced lugs for stores in 1000-lb weight class.

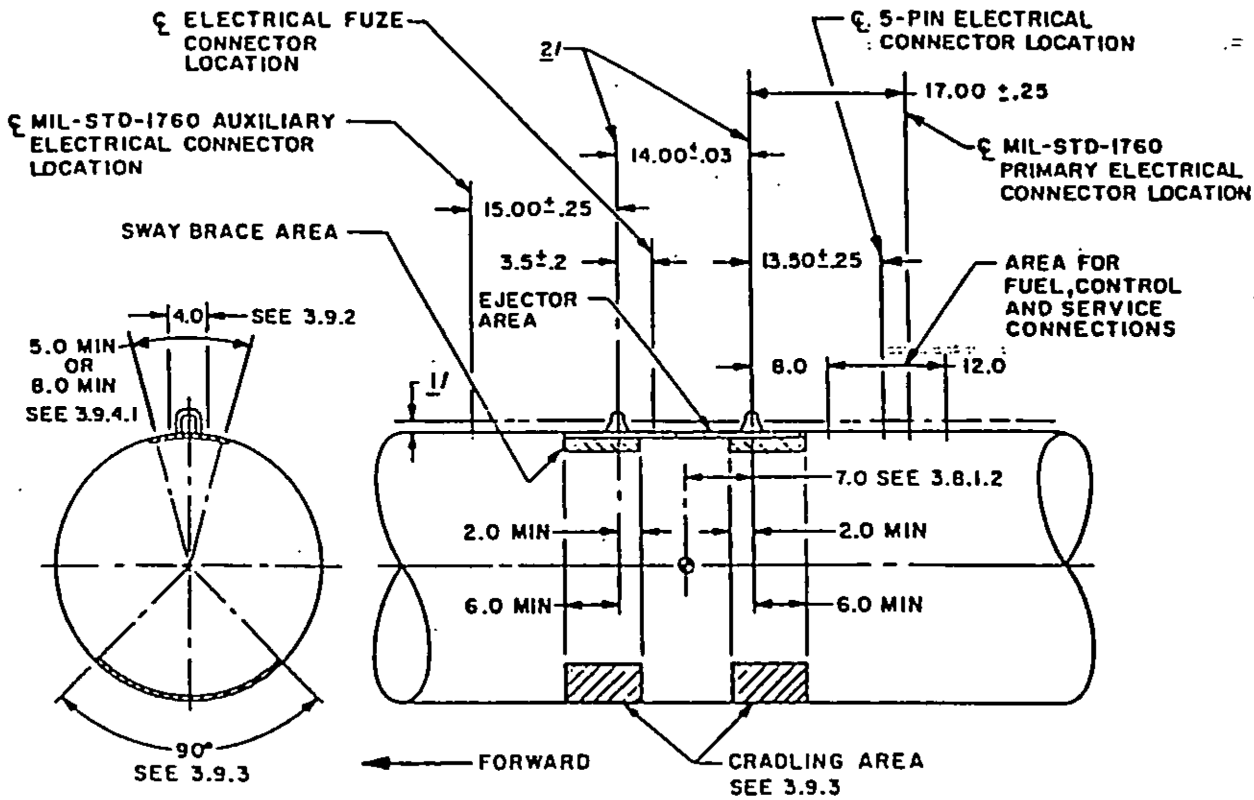


NOTES:

1. For design purposes, NAVAIR Drawing 1380540, MK 3 MOD 0 Lug, shall be used on the 2000-lb class bomb lug. The data in the above figure are provided as information only.

2. Dimensions are in inches.

FIGURE 3. 30-inch spaced lugs for stores up to 2,000-lb weight class.



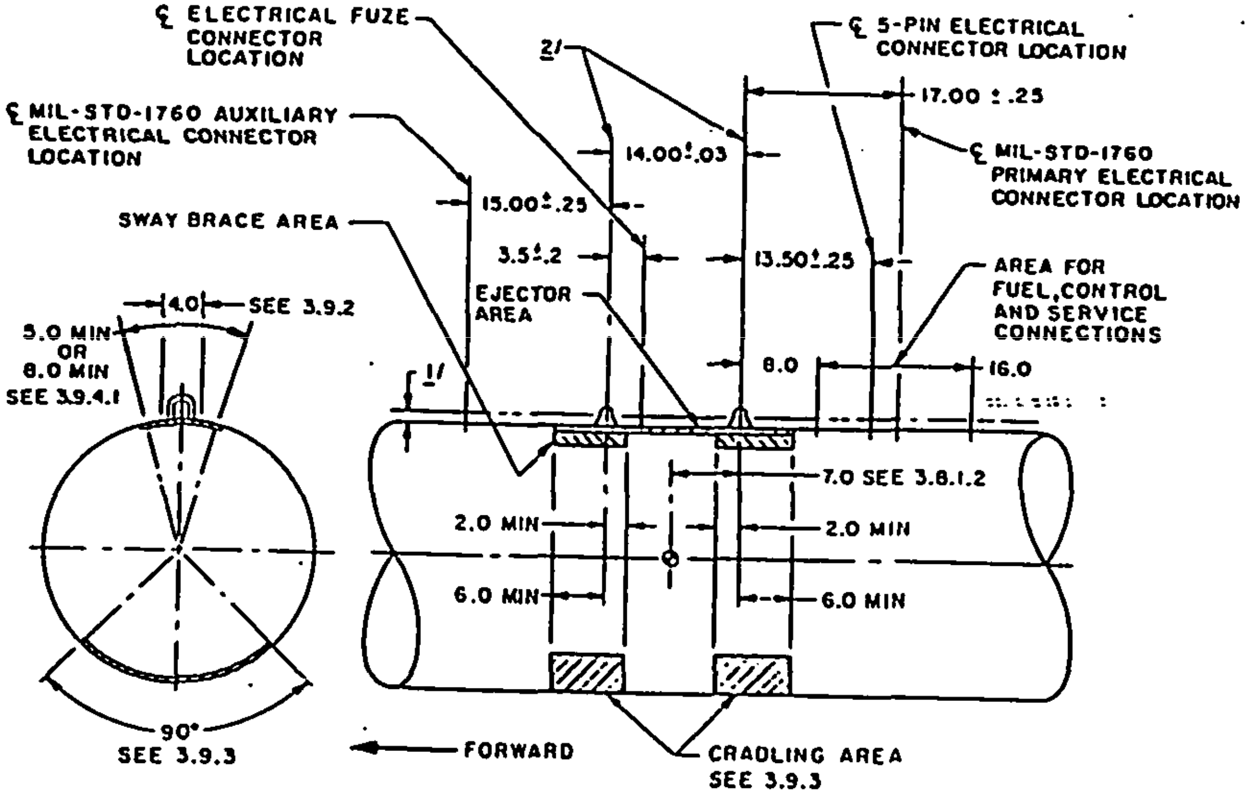
1/ A minimum 0.625 inch clearance shall be provided between the rack lower surface and the store upper surface. This clearance shall not apply to rack hooks, braces, ejectors, store lugs, or service connections.

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°.

NOTES:

1. Dimensions are in inches.

FIGURE 4. Location of store case components, 14-inch lug stores, for carriage on 14-inch lug racks.



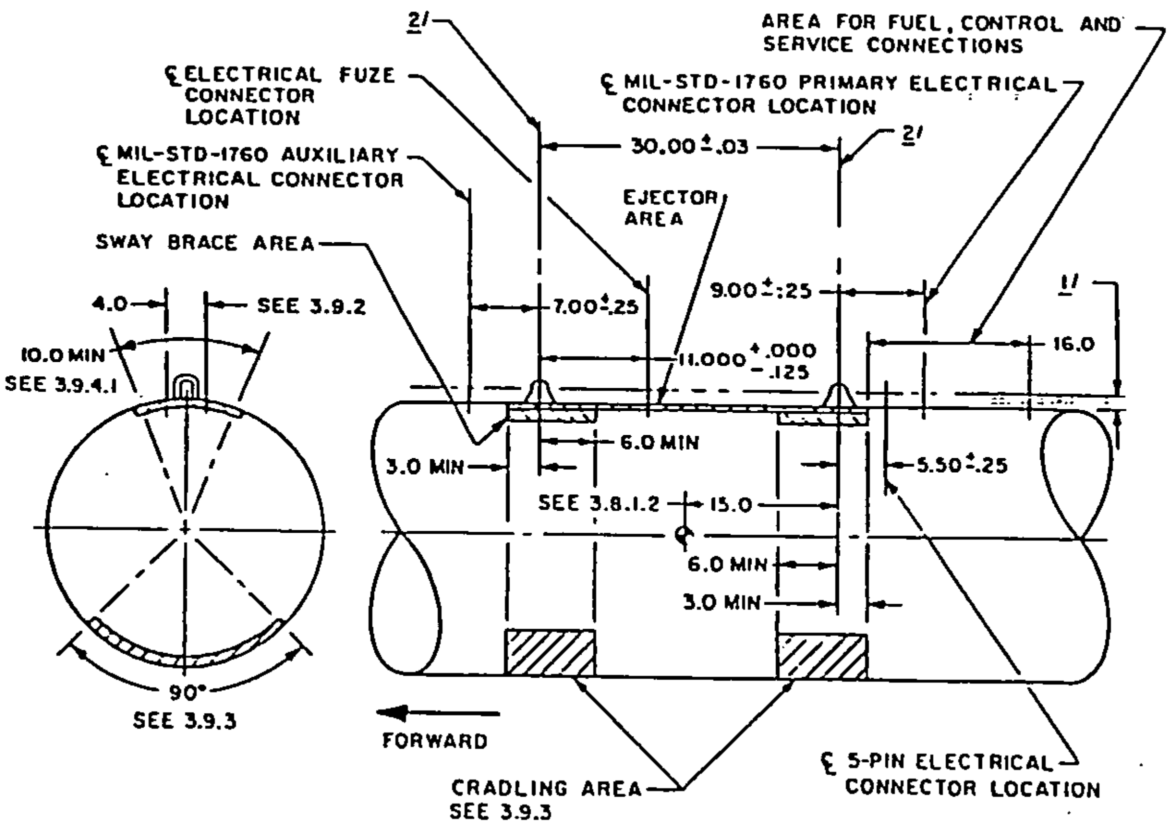
1/ A minimum 0.625 inch clearance shall be provided between the rack lower surface and the store upper surface. This clearance shall not apply to rack hooks, braces, ejectors, store lugs, or service connections.

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°.

NOTES:

1. Dimensions are in inches.

FIGURE 5. Location of store case components, 14-inch lug stores, for carriage on 14 or 30-inch lug racks.



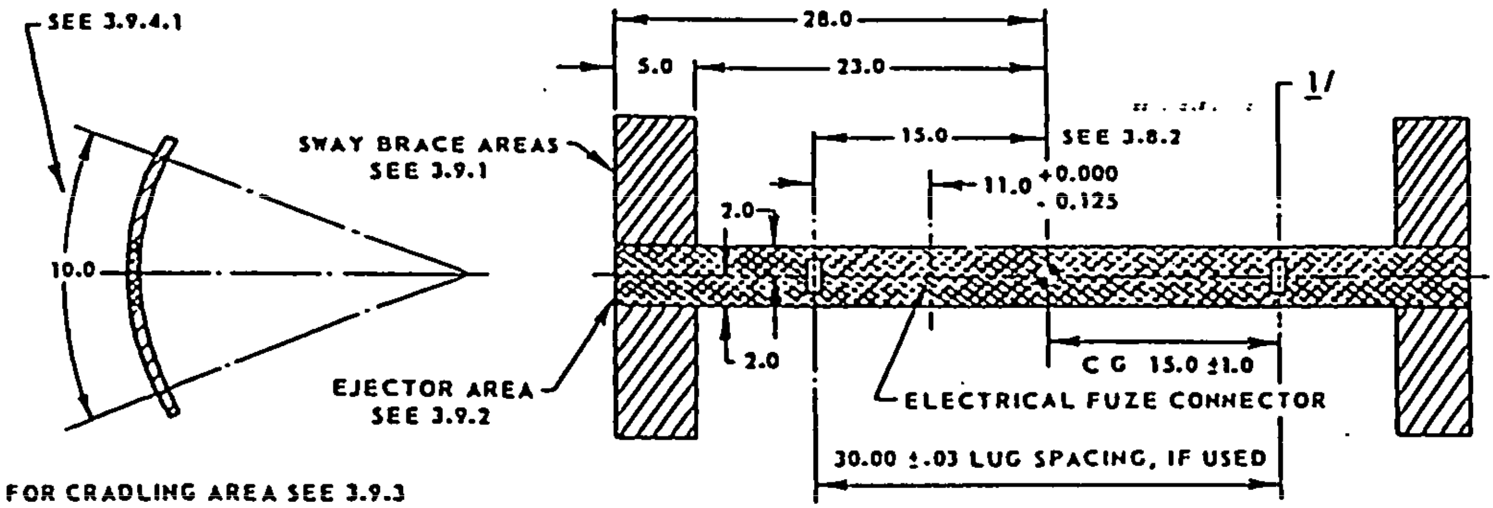
1/ A minimum 0.625 inch clearance shall be provided between the rack lower surface and the store upper surface. This clearance shall not apply to rack hooks, braces, ejectors, store lugs, or umbilical connections.

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

NOTES:

1. Dimensions are in inches.

FIGURE 6. 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 7. Sway brace and ejector areas for heavy stores (ref Table I).

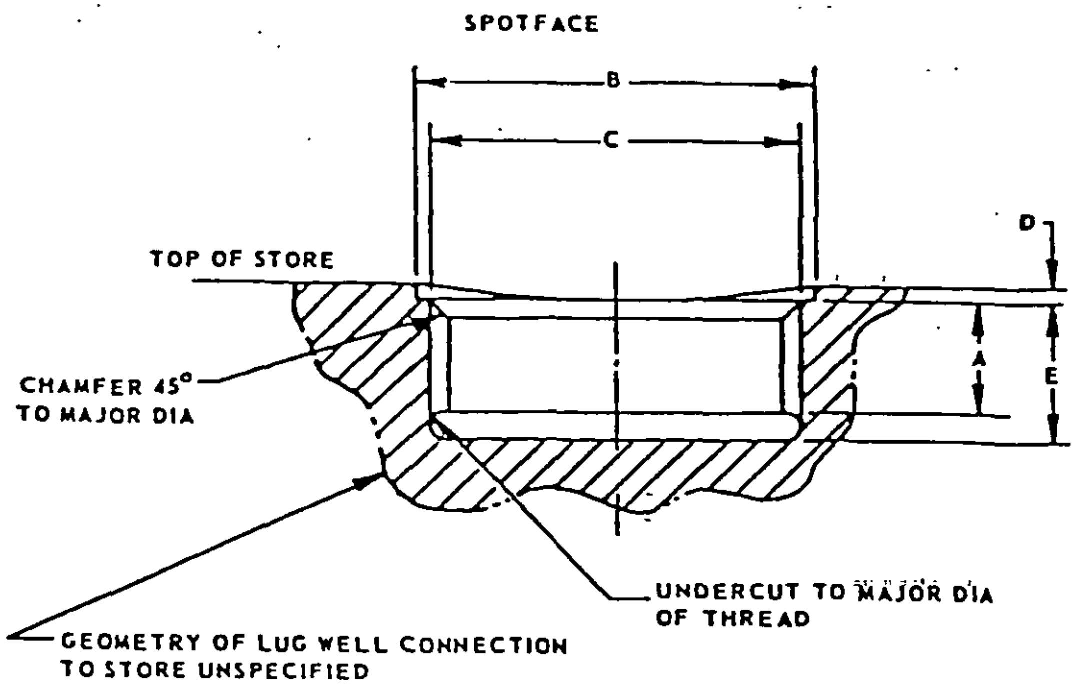


	TABLE OF DIMENSIONS	
1/	A	0.624 in. minimum full thread
	B	1.870 D in.
	C	1.750 in. 12 UN-2B Thread
1/	D	0.177 +0.010 -0.010 in.
1/	E	0.749 +0.141 -0.000 in.

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

FIGURE 8. Threaded lug well for 1000 lb class stores.

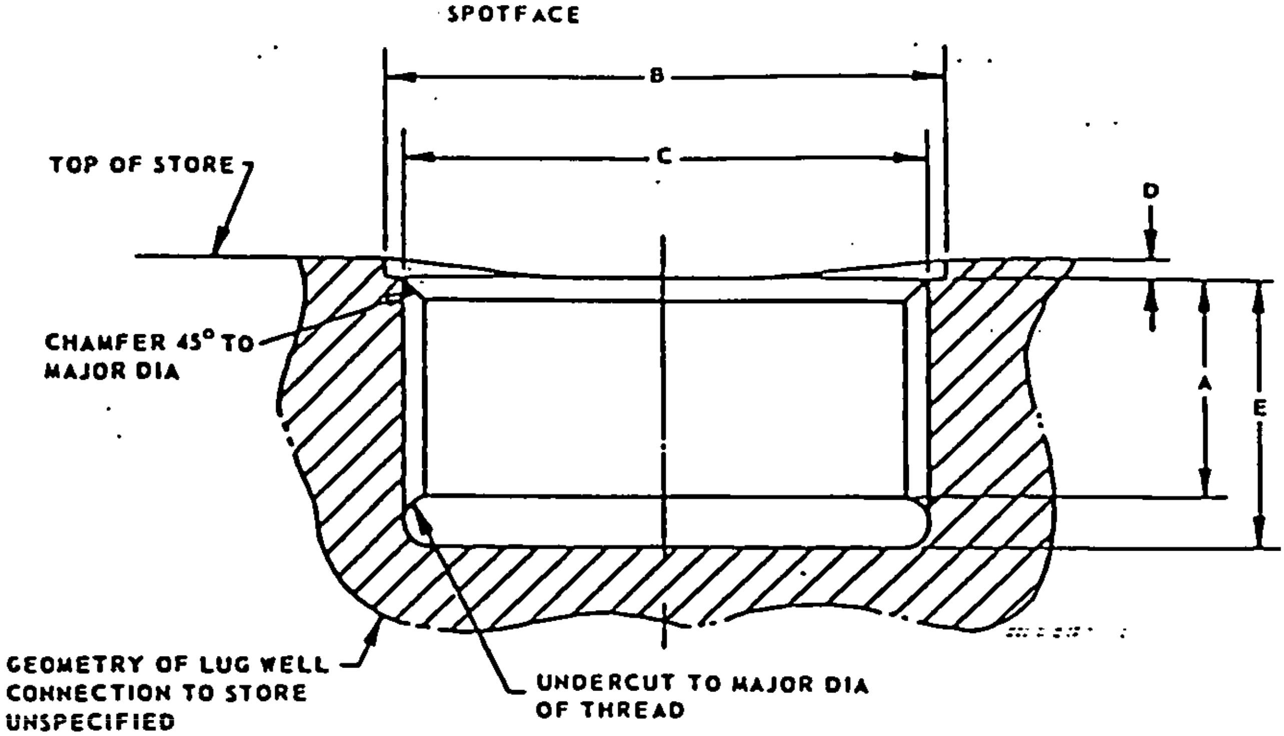


	TABLE OF DIMENSIONS	
1/	A	1.14 in. minimum full thread
	B	2.620 D in.
	C	2.500 in. 12 UN-2B Thread
1/	D	0.210 +0.010 -0.010 in.
1/	E	1.350 +0.000 -0.020 in.

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

FIGURE 9. Threaded lug well for 2000 lb class stores.

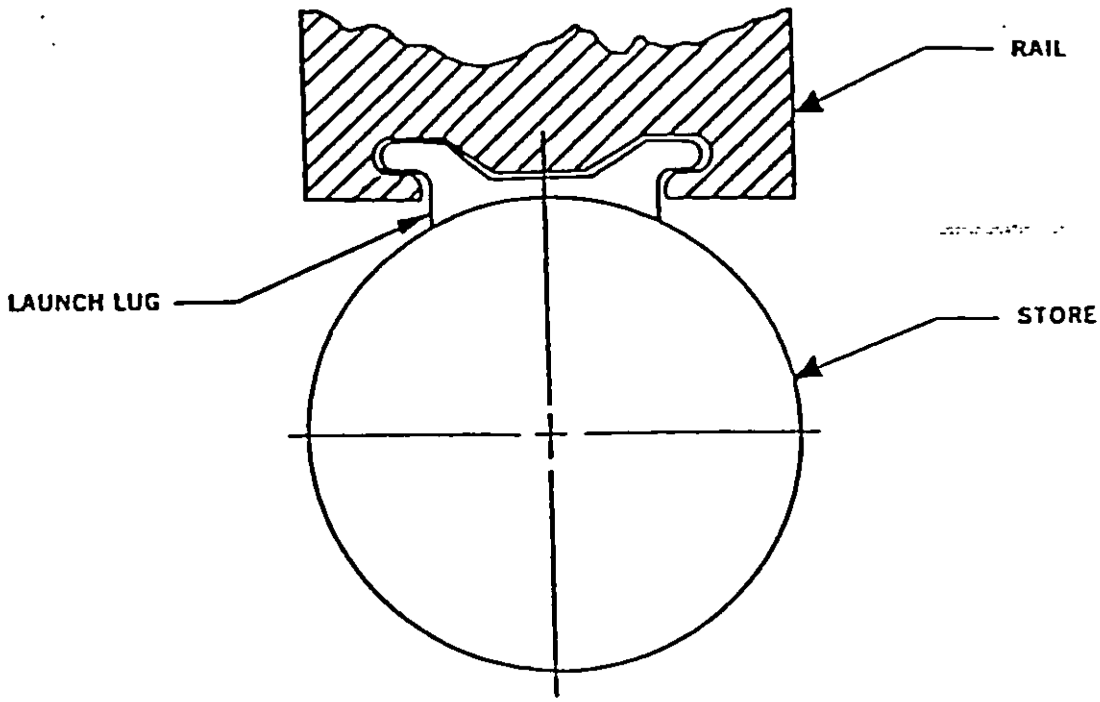


FIGURE 10. Example of internal T-shaped hanger.

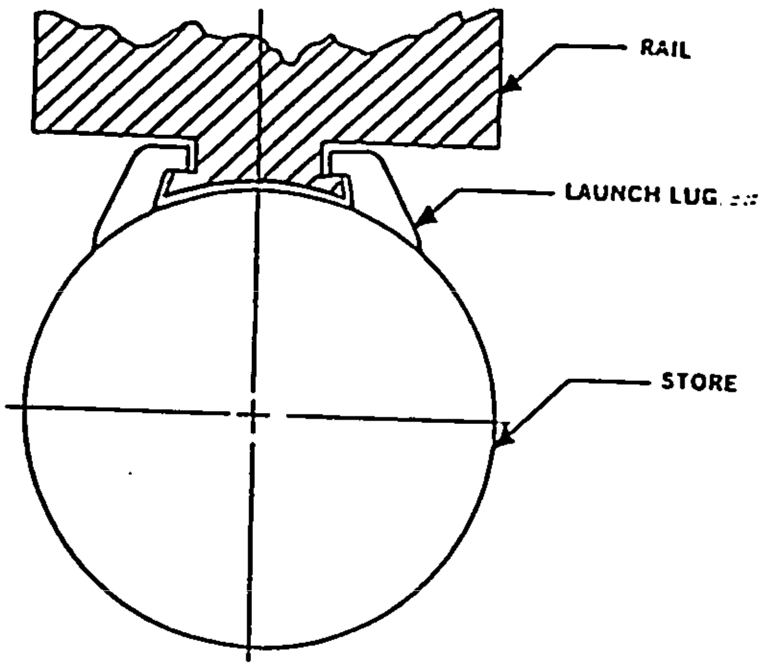


FIGURE 11. Example of external U-shaped shoe.

3.9.4 Reinforced area strength. Unless otherwise specified by the acquiring activity, stores with reinforced areas described in 3.9 shall be capable of withstanding the loads specified in 3.11 without failure.

3.9.4.1 Sway brace pad areas and span. Reinforced sway brace 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 4 through 7).

3.9.4.2 Cradling and handling area strength. The strong area on the bottom of the store shall be capable of withstanding loads equal to three times the weight of the store without permanent deformation (see 3.11.7.3).

3.9.5 Electrical connector locations. Locations are specified in Figures 4, 5, and 6 for the following electrical connectors:

a. Connector(s) specified in MIL-STD-1760.

b. 5-pin connector used for rocket launchers and dispenser type stores.

c. Connector for electrical fuze.

3.10 Store/suspension equipment interface design. This specification defines procedures for use in developing loads for the design of stores and associated suspension equipment. When this specification 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 specification to determine loads generated at the store/suspension equipment interface. This step should 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.

3.10.1 Ejector foot areas. For design purposes, each ejector foot area must be capable of withstanding a minimum of 15,000 psi.

3.10.2 Sway brace pad areas. For store design purposes, it shall be assumed that suspension equipment design shall provide a minimum area of 2 square inches per sway brace pad. Sway brace pad areas for 100-pound class stores are an exception to this rule, however, and suspension equipment design shall be as specified by the acquiring activity.

3.11 Carriage design limit load. Design data for weapon carriage is to 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. Procedure A shall be used unless one of the alternate procedures is approved by the acquiring activity. A method of calculating the maximum reaction forces at the hooks/lugs and sway braces of a store/suspension equipment configuration is given in Appendix D. These calculated loads may be used as a starting point in the early stage of the design of a store/suspension equipment configuration. After the design reaches the point that load paths can be defined, more sophisticated methods, approved by the acquiring activity, should be used.

3.11.1 Procedure descriptions. The following paragraphs 3.11.1.1 and 3.11.1.2 delineate the general and specific cases for fixed wing aircraft and 3.11.1.3 for helicopter aircraft.

3.11.1.1 Procedure A - carriage design limit loads - general case. This procedure, defined in 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 flow field data is not available and the provisions of other procedures do not apply. Since the actual aircraft aerodynamic characteristics are not available, procedures outlined in Appendix A shall be used to calculate store angles of attack and side slip.

3.11.1.2 Procedure B - carriage design limit loads - stores carried on a specific aircraft. This procedure, defined in Appendix B, is intended to provide conservative loads that are representative of the actual loads the store will encounter on specific aircraft, excluding helicopter aircraft which are covered in Procedure 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 defined in Procedure A. Stores that are designed using Procedure B are not intended for application on several classes of aircraft, since this procedure will generally produce less conservative loads than Procedure A.

3.11.1.3 Procedure C - carriage design limit loads - stores carried on helicopter aircraft. This procedure, defined in Appendix C, is intended to provide the methodology for determining the carriage loads on stores mounted on helicopter aircraft only. When stores may be carried on both helicopter and fixed-winged aircraft, it shall be necessary to evaluate the fixed-winged aircraft loads using Procedure A or B, as well as determining the helicopter aircraft loads as defined in Procedure C.

3.11.2 Installation preloads. The preloads imposed by the sway braces shall be included in the calculation of the total design loads. However, it is possible that under certain conditions of high vertical loading, the sway braces 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 sway brace torquing procedures and present this to the acquiring activity for approval.

3.11.3 Dynamic magnification.

3.11.3.1 Dynamic magnification factors. Allowances for dynamic magnification of accelerations imposed on the non-released 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 should be evaluated on an individual basis. The following paragraphs address many of the usual specific dynamic load requirements and are provided for general guidance. There may be additional dynamic loads that occur for specific store/aircraft combinations that are not included here, but must be developed in concurrence with the acquiring activity.

3.11.3.2 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 in Figure 12.

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

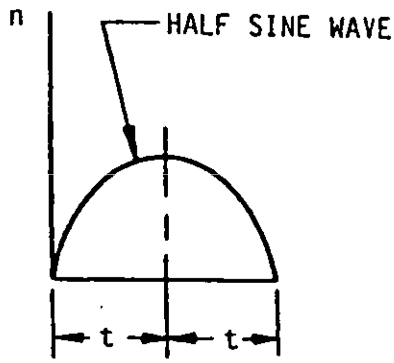


FIGURE 12. Time-load factor curve.

3.11.3.3 Adjacent store loads due to release, ejection, or launch. Loads environment shall be established at the support attach points of parent store stations (eg, pylons, bomb racks, and missile launchers) to define the structural requirements for the retention of non-released stores during all types of release modes, such as salvo, single, and ripple. In lieu of analytical data, appropriate flight measured values may be used. This analytically derived or measured environment shall supplement the inertia load factors developed using Procedure A, B, or C. The resulting load cases shall be the limit load conditions.

3.11.4 Vibratory loads. The vibration environment to which a store and its internal equipment shall be designed is defined in MIL-STD-810, (Methods 514.3 and 515.3). The vibration environment to which the suspension and release equipment shall be designed, will be measured vibration data or as defined 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 acquiring activity. When specific aircraft are designated for the application, the equipment designer and aircraft contractor(s), with approval of the acquiring agency, shall coordinate the definition of the vibration criteria to be used in the design. For stores intended for carriage on helicopters, refer to Appendix C.

3.11.5 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 which subsequently shall be used to estimate fatigue strength in the design. When specific carriage-aircraft are designated, and the forces described above are known, these forces, with a scatter factor of two, shall be used for analyses and testing. If no carriage aircraft are specified, nor a broad spectrum of aircraft designated, and the forces defined above are not known, values shall be estimated and used after acceptance by the acquiring activity. See 3.7 for comments that also apply.

3.11.6 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.

3.11.7 Shock loads.

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

3.11.7.2 Shipping loads. Strength shall be provided to withstand the shipping environmental loads specified by MIL-STD-810 or as designated by the acquiring activity.

3.11.7.3 Cradling and handling loads. Sufficient strength shall be provided at the designated support points to withstand loads equal to 3.0 times the weight of the store (in both directions of the three major axes depicted in Figure 13) without unacceptable deformation (see 3.3).

3.12 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 of MIL-M-8856. The store designer, the suspension equipment contractor and the designated carriage-aircraft contractor shall coordinate with each other, as appropriate, and in accordance with acquiring 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 in accordance with MIL-A-8870.

3.13 Recycled, virgin and reclaimed materials. There is no exclusion to the use of recycled or reclaimed materials and no mandate for the use of virgin materials provided it meets the requirements of this specification.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of section 3. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.2 Test procedures. Design verification test procedure requirements for store design, operational structural capability, and employment characteristics shall be as specified in detail by the acquiring activity or by reference to applicable parts of the designated related specifications. Quality conformance and qualification testing for store and store-mounted equipment shall be in accordance with appropriate MIL-STD-810 requirements. The requirements in these documents shall be as defined in the equipment detail specifications. The acquiring 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 herein or in the contract. Additionally, in cases of suspension and release equipment with nuclear store capability, the qualification test procedures shall, as a minimum, be approved by the Air Force Weapons Laboratory to ensure nuclear safety certification.

4.3 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 acquiring activity in the contract, purchase order, or other applicable contractual document. For Air Force applications, unless otherwise directed, static testing is required if margins of safety are less than 0.20 for forged components and 0.33 for cast components. This requirement does not supersede any requirements of MIL-M-8856.

4.4 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 acquiring activity in the contract, purchase order, or other applicable contractual document.

4.5 Design data. The structural reports and design data required to substantiate the strength and rigidity of the store design shall be specified by the acquiring activity in appropriate contractual documents. The form and extent of information required for design, analysis, test data, and reports shall be equivalent to such appropriate and applicable parts of airplane design specifications, MIL-A-8868 and MIL-A-8870, as they relate to the store. Data schedules shall be as proposed by the contractor and accepted by the acquiring activity.

4.5.1 Symbols and axes systems. Except as otherwise specified herein, the symbols, axes systems designations, signs and angular relationships required for the structural reports, shall be those outlined in ANSI Y10.7.

5. PACKAGING

This section is not applicable to this specification.

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 requirements of this specification shall be used for the design of entire stores and suspension systems. The primary purpose of this specification 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 3.11. These diagrams are then used for detailed design of the store or its components.

6.2 Data.

6.2.1 Data requirements. For the information of contractors and contracting officers, the data to be furnished hereunder shall be listed on DD Form 1423 (Contractor Data Requirements List), which shall be attached to and made a part of the contract or order.

6.2.2 Store certification data. For the information of contractors, contracting officers, program managers, project officers, and project engineers in stores and suspension equipment, U.S. Navy certification and data requirements are set forth in NAVAIRINST 13034.1. For the U.S. Air Force, these requirements are contained in AFR 80-54. These requirements shall be met prior to authorizing stores/suspension equipment to be carried on an aircraft.

6.3 Definitions and symbols.

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

6.3.2 Carriage. The conveying of a store or suspension equipment by an aircraft under all flight and ground conditions including taxi, takeoff, and landing including catapult launch and arrested landing if applicable, or vertical takeoff and landing. The store or suspension equipment may be located either external or internal to the aircraft. Carriage shall include time in flight up to the point of complete separation of the store or suspension equipment from the aircraft.

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

6.3.4 Ejection launcher. A launcher which provides an initial source of energy to adequately displace the missile from the aircraft prior to the initiation of the missile's self-propulsion system.

6.3.5 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.

6.3.6 Jettison.

6.3.6.1 Emergency jettison. The intentional simultaneous or nearly simultaneous separation of all stores or suspension equipment from the aircraft in a pre-set, programmed sequence and normally in the safe condition.

6.3.6.2 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.

6.3.7 Missile launcher. An item rigidly attached to an aircraft to carry, service, launch and jettison air-launched missiles.

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

6.3.9 Rail launcher. A launcher containing rails on which the missile is carried, and along which the missile travels after initiation of the missile's self-propulsion system.

6.3.10 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 shall include the parting of items or submunitions from a dispenser.

6.3.11 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, nuclear weapons, mines, torpedos, pyrotechnic devices, detachable fuel and spray tanks, line-source disseminators, dispensers, pods (refueling, thrust augmentation, gun, and electronic-countermeasures), targets, cargo drop containers and drones.

6.3.12 Suspension equipment. All airborne devices used for carriage, suspension, employment and jettison of stores, such as racks, adapters, launchers and pylons.

6.3.13 Sway bracing. That mechanism within the physical triaxial restraint system which partially or totally reacts to store yaw and pitching moment in addition to lateral store loads.

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

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

W_A - Aircraft basic flight design gross weight, pounds

W_S - Store weight, including all disposable items, pounds

I_{xx}, I_{yy}, I_{zz} - Store moments of inertia, slug-ft^2, at store cg

I_{xy}, I_{xz}, I_{yz} - Store products of inertia, slug-ft^2, at store cg

cg - Center of gravity

S_A - Aircraft reference area, ft^2

S_S - Store reference area, ft^2

ℓ - Store reference length, ft

g - Acceleration of gravity - 32.17 ft/sec^2

q - Dynamic pressure, lbs/ft^2 = $1/2\rho V^2$

ρ - Air density, slugs/ft^3

V - Aircraft forward velocity, ft/sec

V_L - Limiting aircraft speed, ft/sec

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

a_x - Aircraft axial acceleration, g's

a_y - Aircraft side acceleration, g's

a_z - Aircraft normal acceleration, g's

n_x - Fore and aft load factor (+ aft)

n_y - Side load factor (+ right looking forward)

n_z - Normal load factor (+ up)

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

M - Mach number

C_x - Store airload axial force coefficient

C_y - Store airload side force coefficient

C_z - Store airload normal force coefficient

C_ℓ - Store airload roll moment coefficient

C_m - Store airload pitch moment coefficient

C_n - Store airload yaw moment coefficient

C_{L_α} - Aircraft lift curve slope, $\frac{1}{\text{degree}}$

C_{Y_β} - Aircraft side force curve slope, $\frac{1}{\text{degree}}$

P_x - Store air, inertia, or net axial force

P_y - Store air, inertia, or net side force

P_z - Store air, inertia, or net normal force

M_x - Store air, inertia, or net roll moment

M_y - Store air, inertia, or net pitch moment

M_z - Store air, inertia, or net yaw moment

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

X - Aircraft fuselage station, ft

Y - Aircraft butt line, ft

Z - Aircraft waterline, ft

6.3.16 Sign convention. The reference axes for the aircraft or store are shown in Figure 13. 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.

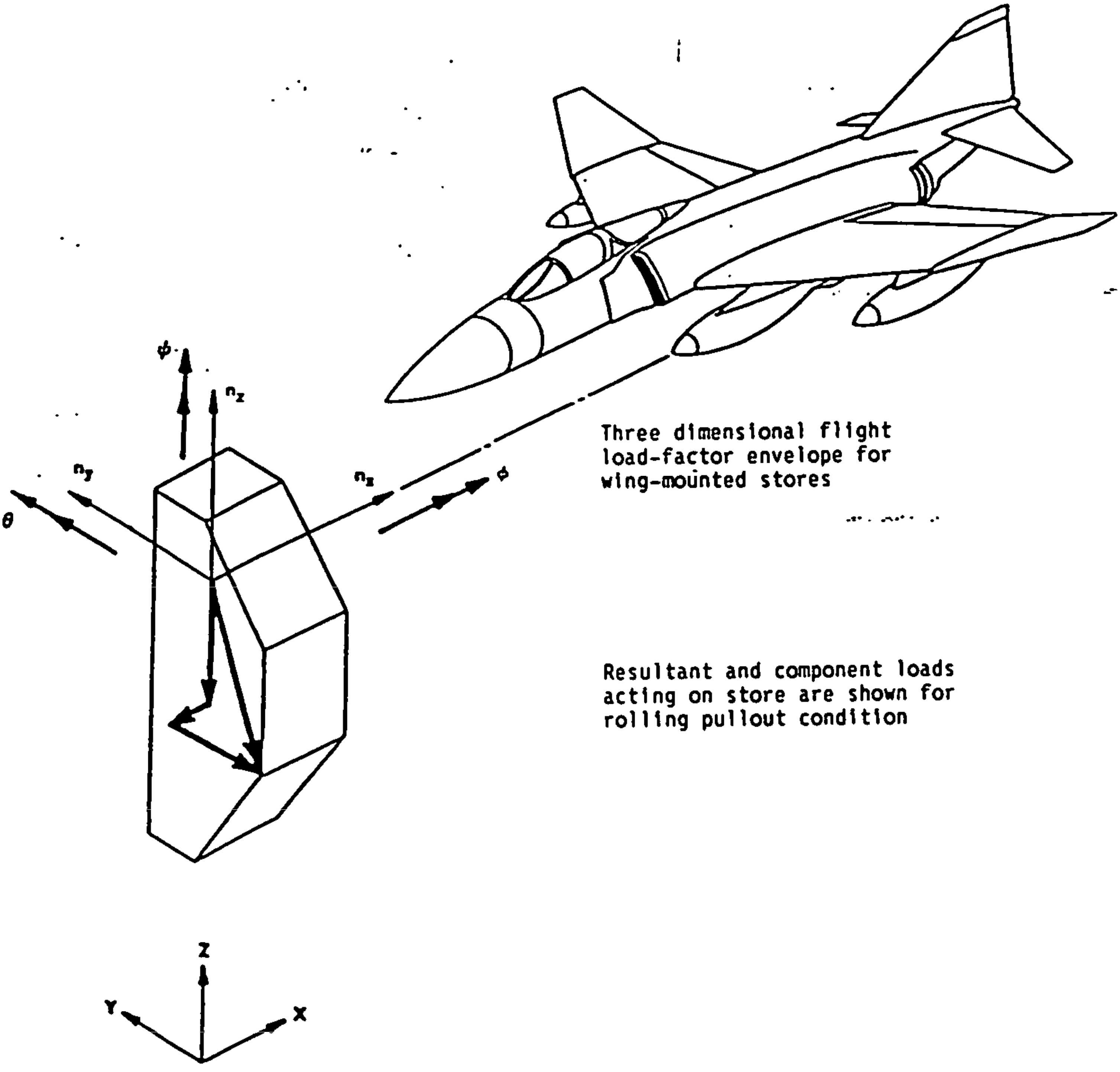


FIGURE 13. Coordinate system, sign convention, and a typical load factor envelope.

6.4 Subject term (key word) listing.

Carriage design limit loads
Ejector areas
Store angles of attack and sideslip
Sway brace areas

6.5 International standardization agreements. Certain provisions of this specification are the subject of the following international standardization agreements; STANAGs 3441 AA, 3558 AA, 3726 AA, and portions of STANAG 3575 AA and AIR STD 20/13, 20/15 and parts of AIR STD 20/10 and 20/17 (see 3.8.1.4). When amendment, revision, or cancellation of this specification is proposed that will modify the international agreement concerned, the preparing activity will take appropriate action through international standardization channels, including departmental standardization offices, to change the agreement or make other appropriate accommodations.

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

APPENDIX A

PROCEDURE A

CARRIAGE DESIGN LIMIT LOADS, GENERAL CASE

10. SCOPE

10.1 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 the specification. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. DESIGN LOADS

30.1 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 in Figure A-1. Corresponding angles of attack and sideslip to be used for calculation of airloads on fuselage-mounted stores are shown in 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. This information shall be furnished by the acquiring activity.

30.2 Inertia loads.

30.2.1 Limit inertia load factors. The limit inertia flight load factor diagram for wing or sponson-mounted stores is shown in Figure A-3. The corresponding diagram for fuselage-mounted stores is shown in Figure A-4. These load factor envelopes shall be applied at the store cg.

30.2.2 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 in Figure A-3. The corresponding diagram for fuselage-mounted stores is shown in Figure A-4.

30.3 General loads. The store/suspension configuration shall be designed to withstand the most critical combination of external loads, included inertia, aerodynamic, blast pressure, recoil of weapon firing, launch or jettison, and temperature effects.

APPENDIX A

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 given below:

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):

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

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

Point (6) (rolling pullout):

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

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

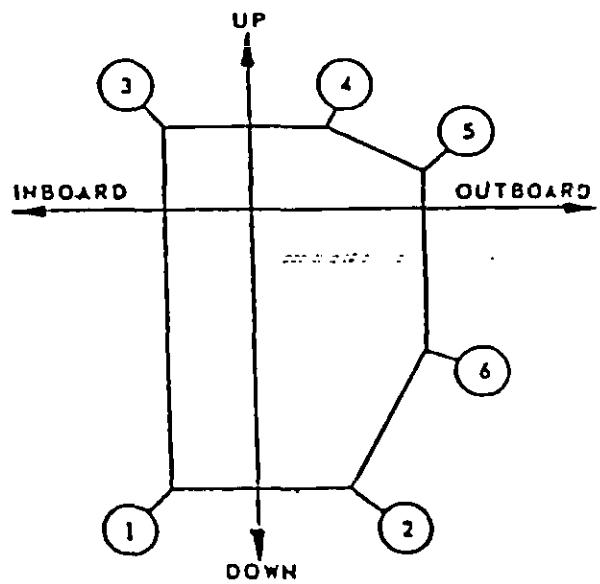


FIGURE A-1. Store angles of attack and sideslip at specific load envelope points for wing or sponson-mounted stores.

APPENDIX A

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 given below:

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

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

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

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

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

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

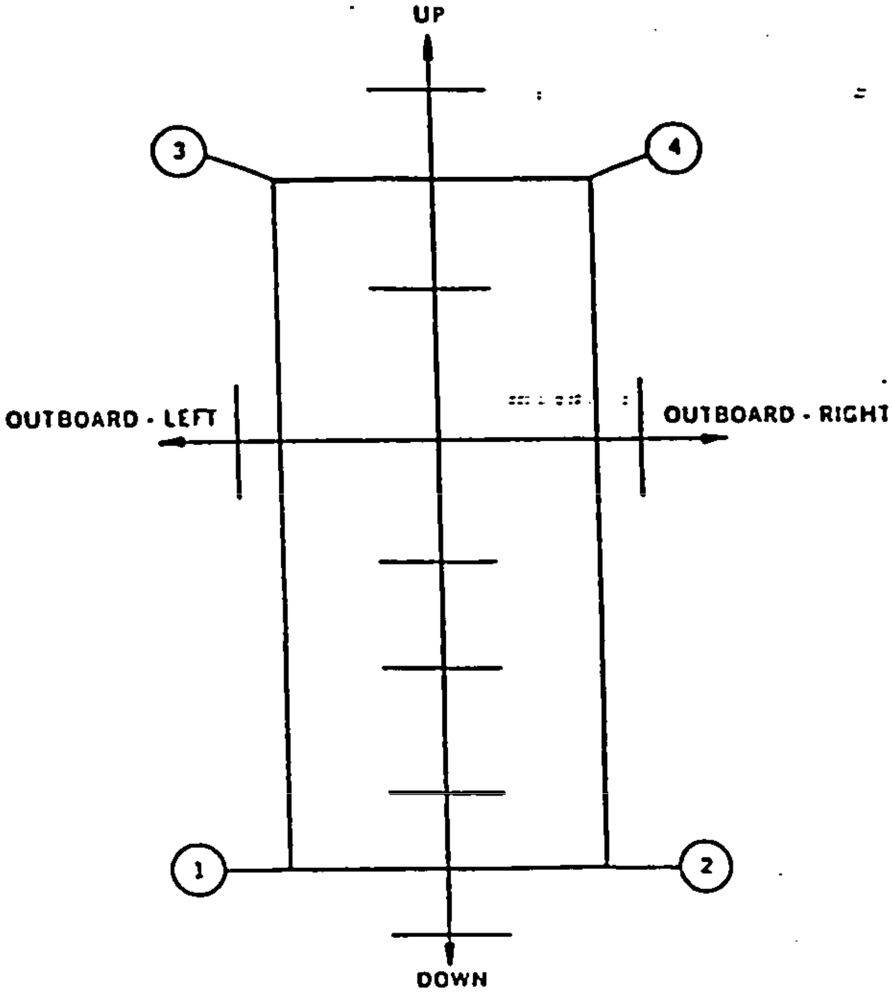


FIGURE A-2. Store angles of attack and sideslip at specific load envelope points for fuselage-mounted stores.

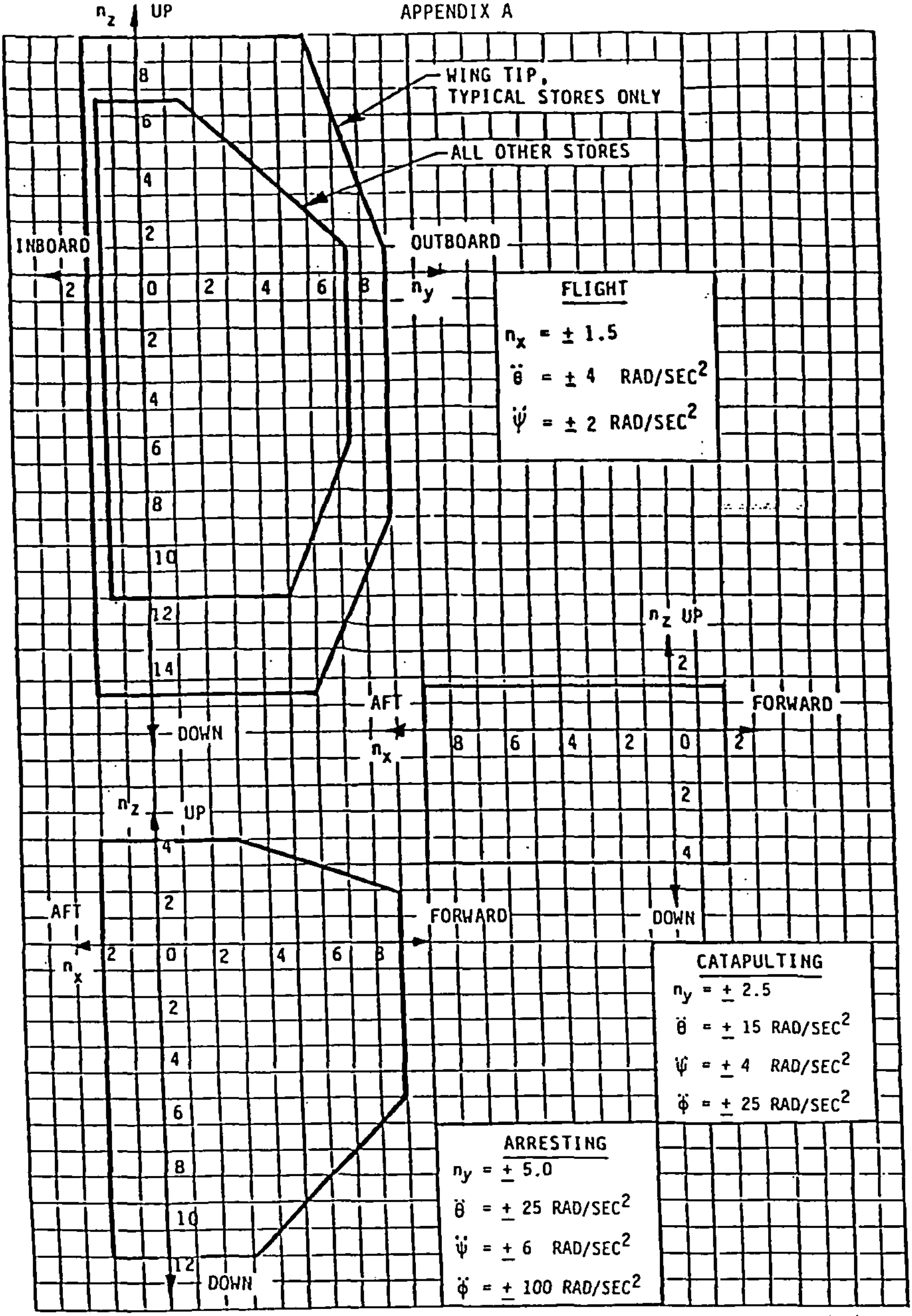


FIGURE A-3. Design inertia limit load factors for wing or sponson-mounted stores. (Data applies at the store center of gravity.)

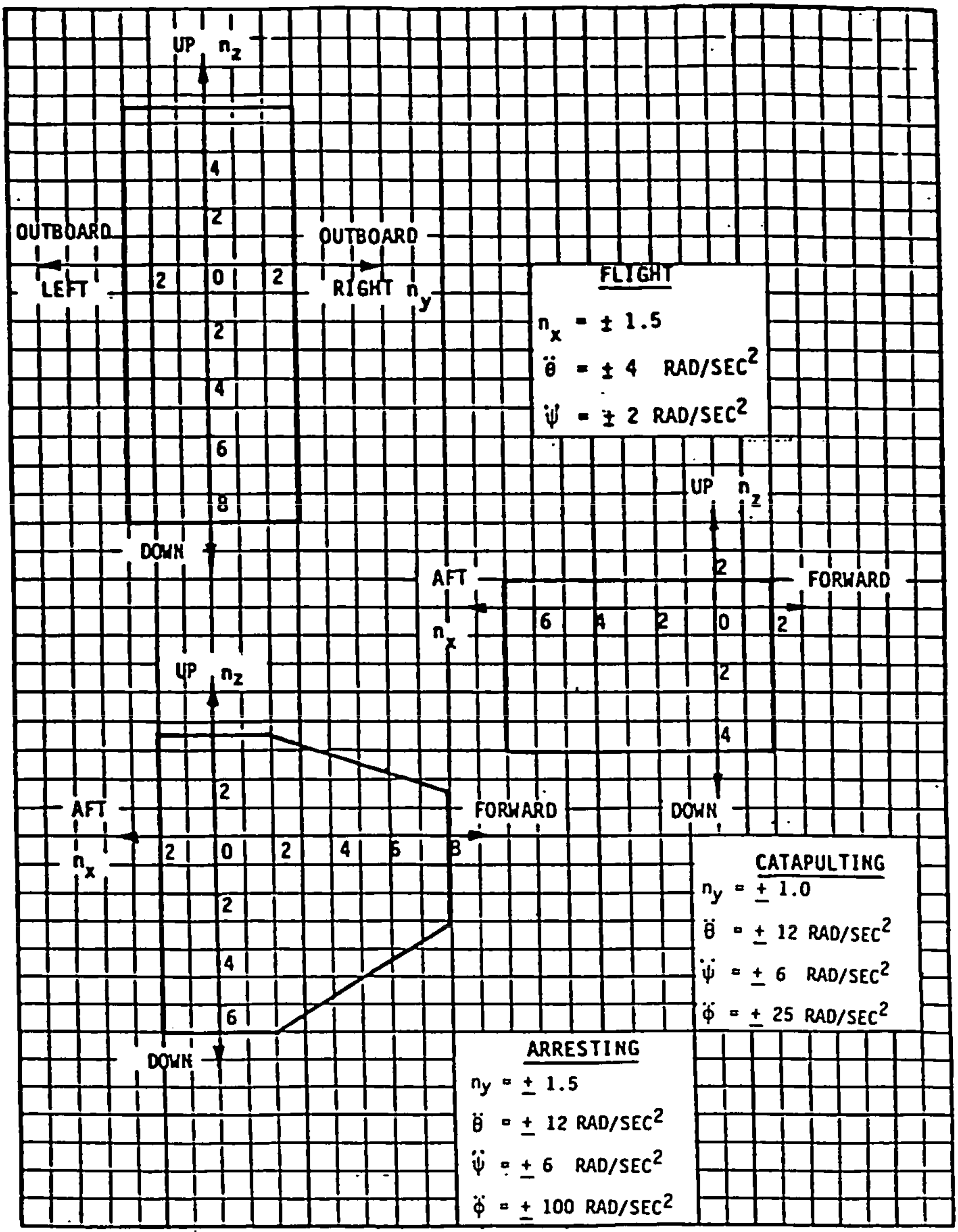


FIGURE A-4. Design inertia limit load factors for fuselage-mounted stores. (Data applies at the store center of gravity.)

APPENDIX B

PROCEDURE B

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

10. SCOPE

10.1 Scope. Appendix B details procedures to be used when specific aircraft, except helicopters, are designated for carriage. This procedure 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. 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 the specification. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS

20.1 Government documents.

20.1.1 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 shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

SPECIFICATIONS

MILITARY

MIL-A-8861	Airplane Strength and Rigidity Flight Loads.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

30. DESIGN LOADS

30.1 Aerodynamic loads. The aerodynamic loading on the store shall be determined assuming the flow field 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 two 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 that is to be used shall be approved by the acquiring activity.

APPENDIX B

30.1.1 Method of Appendix A. 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 is unavailable, analytical or empirical methods may be used to obtain the load coefficients for the store in a uniform onset flow.

30.1.2 Method using aircraft angles. An approximate method based on aircraft aerodynamic characteristics shall be used to calculate store loads. 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 actual aircraft aerodynamic characteristics are unavailable, representative values for the type of aircraft may be obtained from Table B-1. The store angles of attack and sideslip shall be assumed to be the same as the aircraft angles, except for an incidence angle correction which shall be made in accordance with the notes on Figures B-1 and B-2. 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 is unavailable, analytical or empirical methods may be used to obtain the load coefficients for the store in a uniform flow. This method does not take account of the variations in flow field along the store length and its influence on the store load distribution. The flow field will be disturbed by other stores on the aircraft such as fuel tanks and pods. If a specific aircraft is known, use the worst case aerodynamic configuration for the determination of carriage design limit loads.

TABLE B-1. 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	8.00	1.0	4.70	0.05	0.010
Antisubmarine, Patrol	3.00	1.0	1.60	0.10	0.017

APPENDIX B

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 given below:

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):

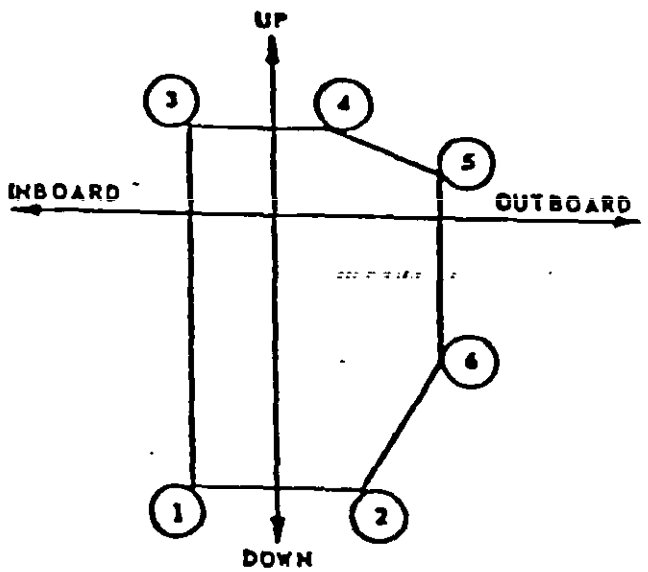
$\alpha_A = +\ \alpha_R$ to $-\ (0.4\ \alpha_{MAX} + \alpha_R)$ degrees

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

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

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

APPENDIX B

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 given below:

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:

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

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

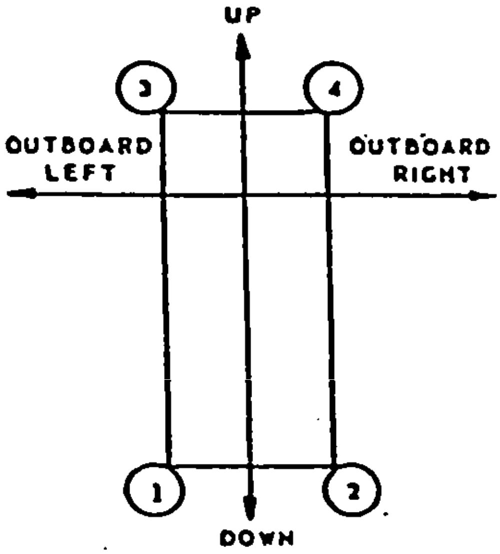


FIGURE B-2. Aircraft angles of attack and sideslip at specific load envelope points for fuselage-mounted stores.

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30.1.3 Method using flow field data. Appropriate interference flow field data shall be used from wind tunnel tests or flight tests. These flow field data shall be combined with velocity to obtain the local flow field distribution over the length of the store. If the parent aircraft is undergoing angular rates in pitch, yaw or roll, the induced flow field due to the aircraft rates shall be combined with the measured interference flow field and velocity to obtain the local flow distribution along the store. The resulting flow field 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.

30.1.4 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 flow field. The methods shall be capable of including angular rates and predicting disturbances in the flow field 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.

30.1.5 Method for low speed carriage. For aircraft with a maximum carriage speed of 350 knots equivalent air speed (KEAS) or less, airloads shall be developed using store angles of attack and sideslip computed in accordance with the equations of 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 is not available, analytical or empirical methods may be used to obtain the load coefficients for the store in a uniform flow.

30.2 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 g's experienced by the store, during a particular maneuver.

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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 given below:

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

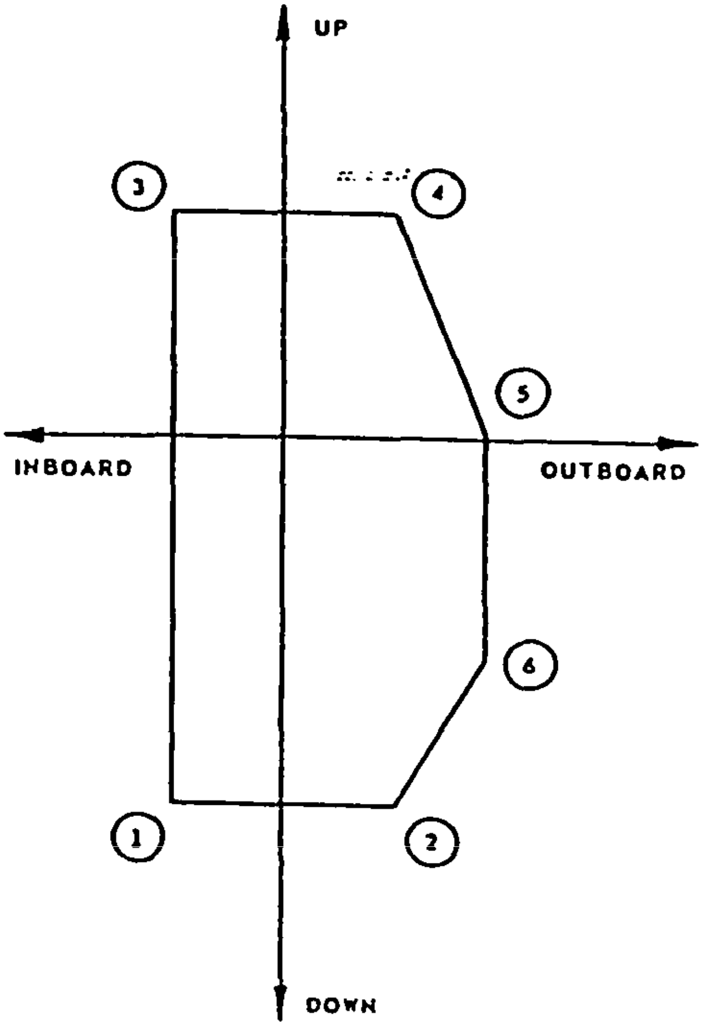

FIGURE B-3. Store angles of attack and sideslip at specific load envelope points for wing or sponson-mounted stores (low speed aircraft).

APPENDIX B

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 given below:

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

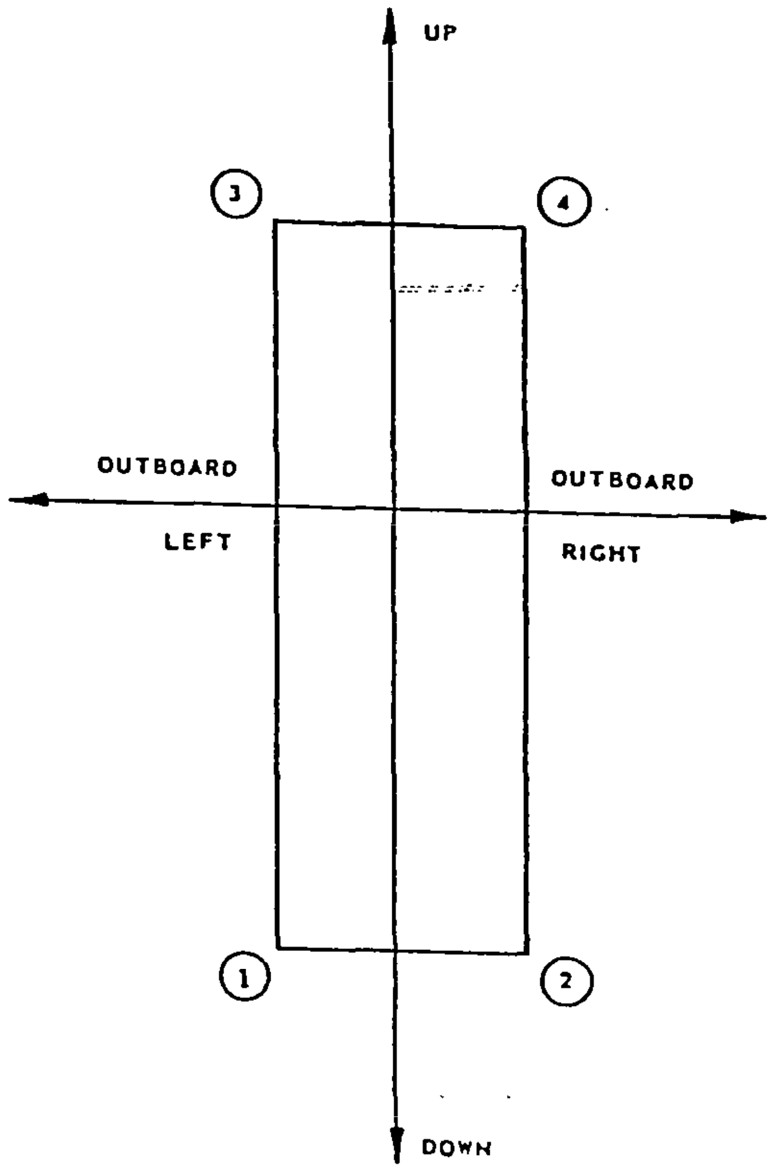

FIGURE B-4. Store angles of attack and sideslip at specific load envelope points for fuselage-mounted stores (low speed aircraft).

APPENDIX B

30.2.1 Load factor calculations. The load factors shall be computed using the relations given below.

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

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

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

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

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

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

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

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

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

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

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

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

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

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30.2.3 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 in Figure B-6.

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

30.2.5 Wingtip mounted air-to-air missiles. For air-to-air missiles mounted at wingtip locations (outboard of the wing pylon stations) on high performance (fighter/attack type) aircraft, the inertia loads shall be determined from the aircraft flight conditions given in Table B-2 if specific aircraft data is not available.

30.2.6 Forces of interaction. The forces of interaction between the store and aircraft may be computed by various means. For stores with unusual or unique configurations, finite-element models utilizing flexible beam-type elements may be necessary to obtain a proper set of store loads. For this situation, a computer code, such as NASTRAN, may be used to obtain not only the forces of interaction, but also the distributed moments and shears along the store. Procedures employed for these interaction force calculations shall be approved by the acquiring activity.

30.3 General loads. The store/suspension configuration shall be designed to withstand the most critical combination of external loads, included inertia, aerodynamic, blast pressure, recoil of weapon firing, launch or jettison, and temperature effects.

30.4 Coordinate system and sign convention. The airplane reference axes are shown in Figure 13. Loads, load factors and dimensions are positive when acting aft, to the right (looking forward), and up. Moments, angular accelerations, and angular velocities about axes parallel to the airplane reference axes follow the right-hand rule.

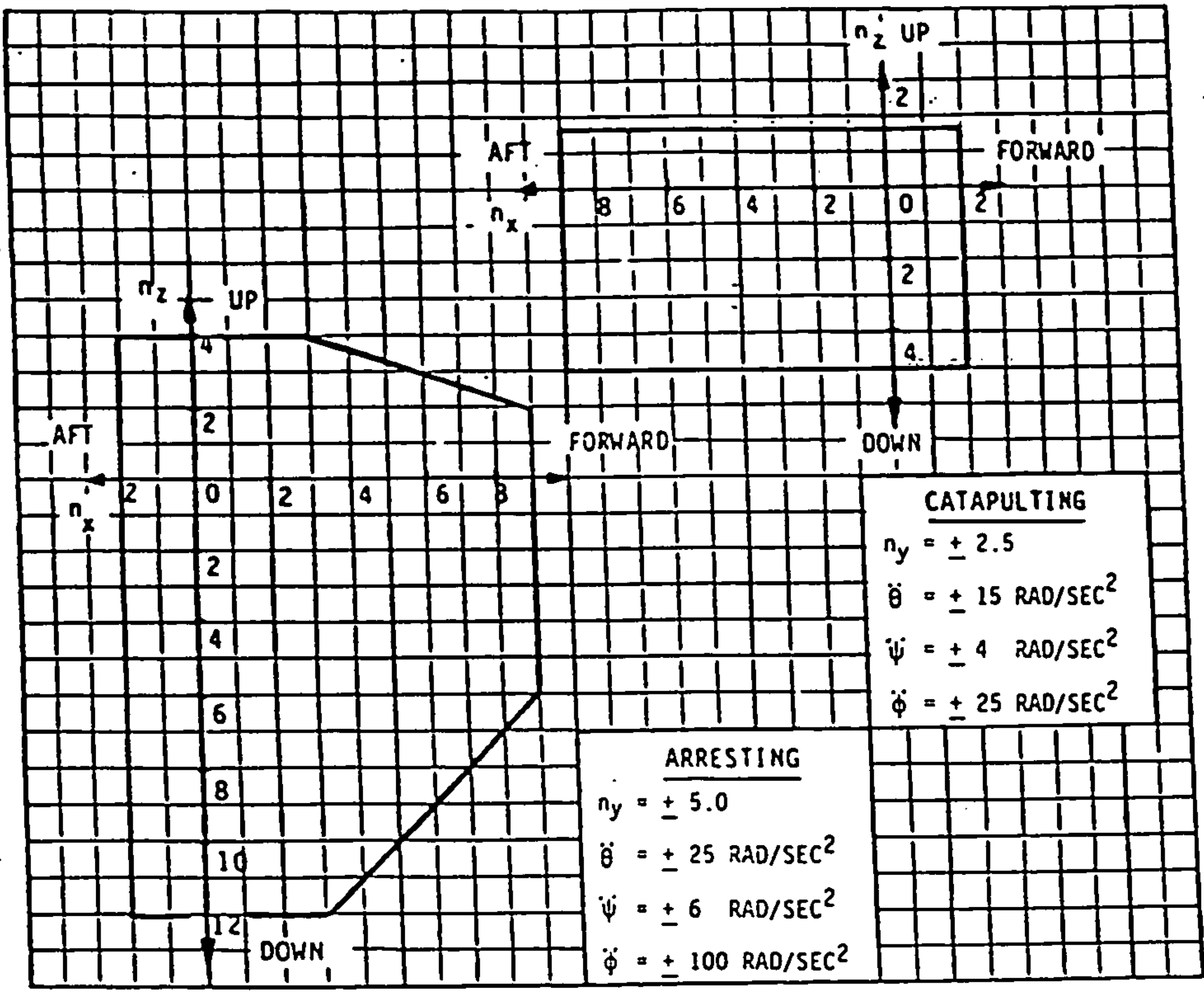


FIGURE B-5. Catapult and arrested landing inertial limit load factors for wing or sponson-mounted stores.

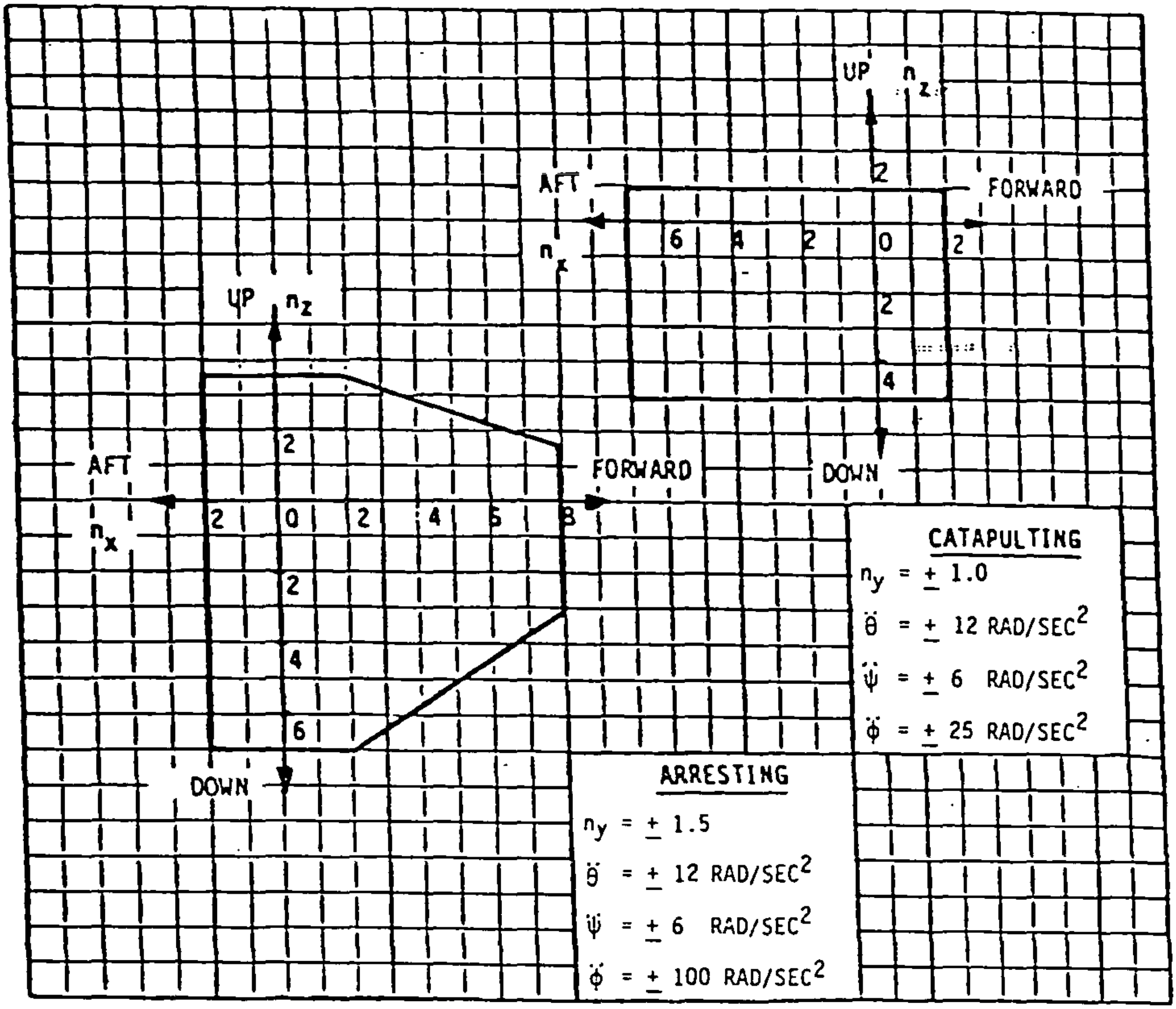
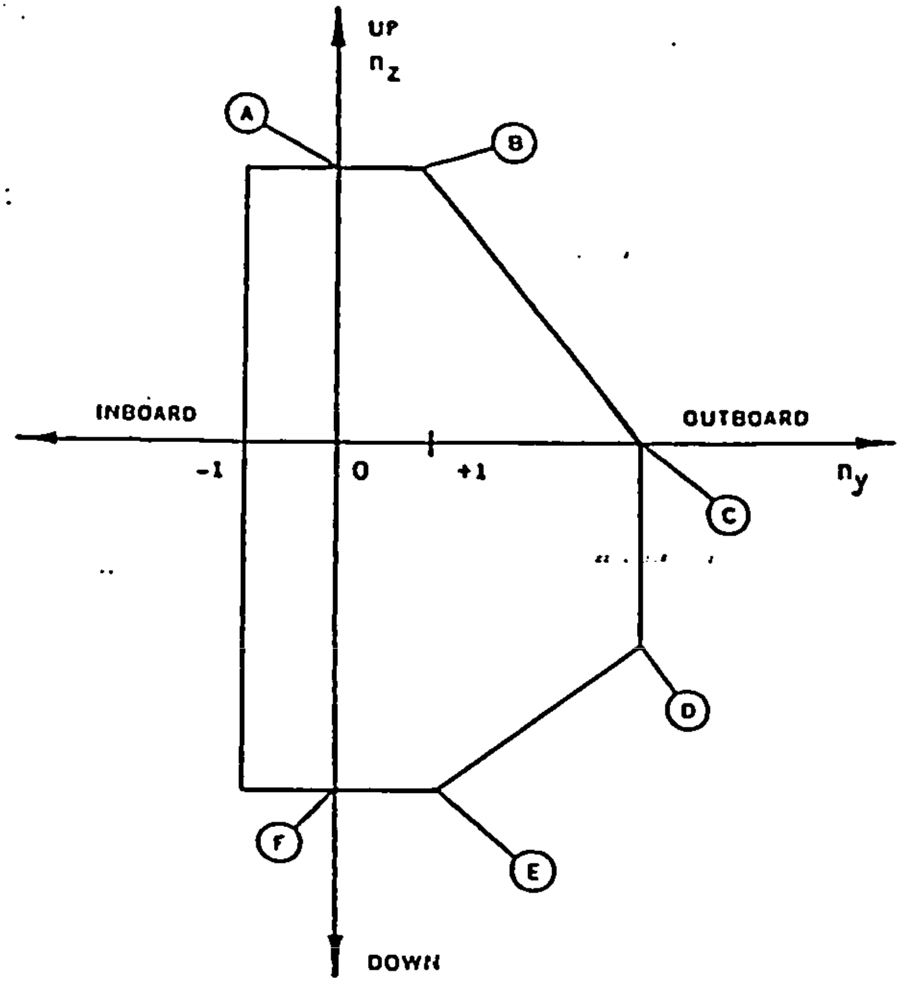


FIGURE B-6. Catapult and arrested landing inertia limit load factors for fuselage-mounted stores.

$n_x = \pm 1.0$

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

$\ddot{\psi} = \pm 2$ rad/sec^2



WHERE:

(A) Has a value of $n_y = 0$, $n_z = 1.5$ x 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 $n_z = 0$, $n_y = 1.5$ x max g as read in cockpit, which can be attained during unsymmetric maneuver.

(D) Has a value of $n_z = n_y = 1.5$ x max g as read in cockpit, which can be obtained 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 $n_y = 0$, $n_z = 1.5$ x 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).

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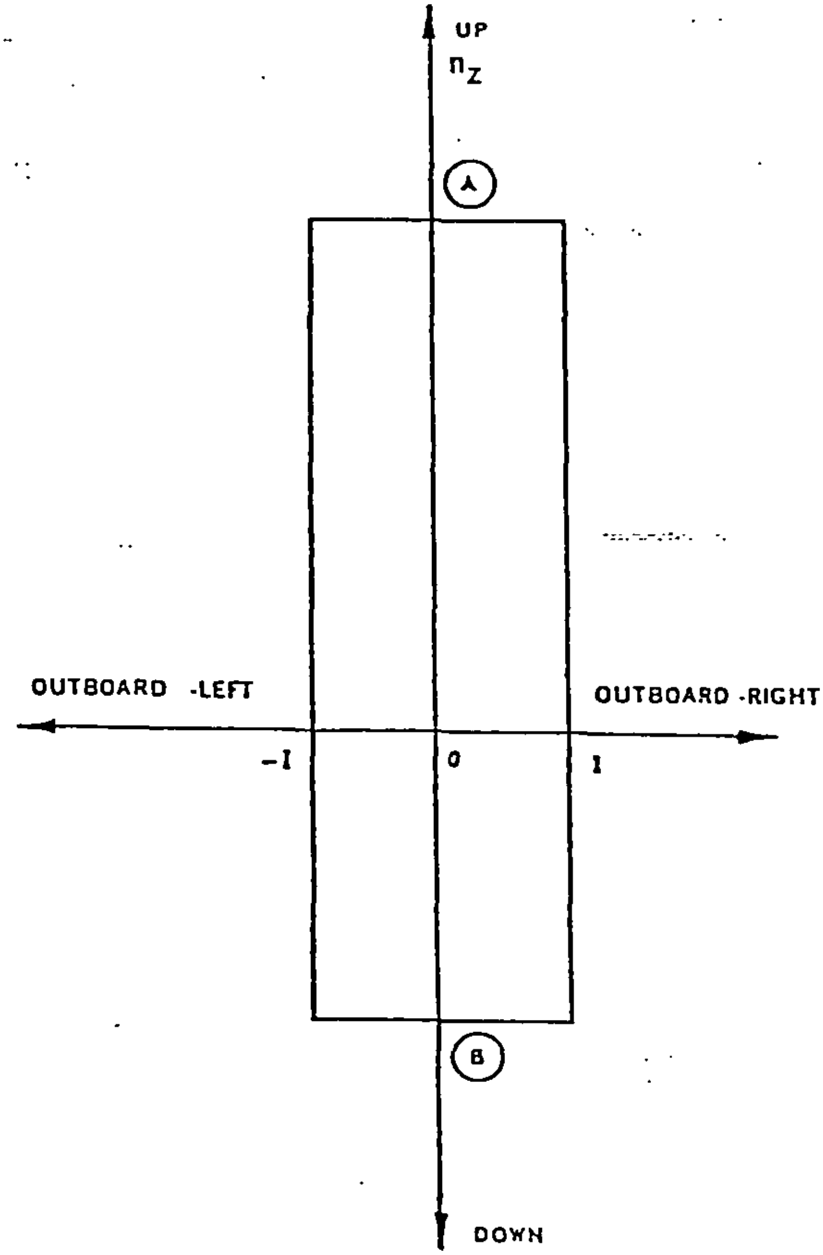
$n_x = \pm 1.0$

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

$\ddot{\psi} = \pm 2$ rad/sec^2



(A) Has a value of $n_y = 0$, $n_z = 1.5$ x max negative g which clean aircraft can attain (n_z must be at least 1.0 up).

(B) Has a value of $n_y = 0$, $n_z = 1.5$ x max positive g which clean aircraft can attain.

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

TABLE B-2 Aircraft flight conditions for design of stores on high performance aircraft (limit loads).

Condition	Dynamic pressure (psf) q	Aircraft angles(deg)		Linear accelerations (g's)			Peak angle rates 1/ (rad/sec)			Peak angular 1/ accelerations (rad/sec²)		
		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
14.Spins 2/												
A. Engines on fuselage												
a.	...	...	...	0	0	+4.25	+3.5	±1.5	+5.0	0	0	0
b.	...	...	...	0	0	-2.5	-3.5	±1.0	+5.0	0	0	0
c.	...	...	...	0	0	+4.25	-3.5	±1.5	+5.0	0	0	0
d.	...	...	...	0	0	-2.5	+3.5	±1.0	+5.0	0	0	0
B. Engines on wing												
a.	...	...	...	0	0	+1.0	+1.5	0	+3.5	0	0	0
b.	...	...	...	0	0	-1.0	-1.5	0	+3.5	0	0	0
c.	...	...	...	0	0	+1.0	-1.5	0	+3.5	0	0	0
d.	...	...	...	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.

APPENDIX C

PROCEDURE C

GENERAL DESIGN CRITERIA FOR HELICOPTERS

10. SCOPE

10.1 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. The requirements set forth herein shall be used except where additional or differing criteria are specified by the acquiring activity.

This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. DESIGN REQUIREMENTS

30.1 General 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 the basic aircraft 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. Where critical to successful projectile/missile launch and target capture (seeker lock-on), the design shall provide acceptable launch tip-off attitudes and rates. Evaluation of these system integration requirements shall be accomplished as specified by the acquiring activity and made available to the store contractor as necessary.

30.2 Loads.

30.2.1 Aerodynamic loads. A general method for determination of aerodynamic loads on a store, similar to Appendix A, is not presented. The detail store loads shall be computed by one of the methods described below and approved by the acquiring activity.

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

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

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c. Analytical force and moment data computed by an appropriate three-dimensional flow field 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.

d. Forces and moments calculated using non-dimensional aerodynamic co-efficients determined by appropriate analytical methods and conditions of dynamic pressure, angle of attack, and sideslip approved by the acquiring activity.

30.2.2 Inertia loading. Methods for calculating store load factors associated with flight and landing are presented here.

30.2.2.1 Flight load factors. The methods for calculating load factors are:

a. When the helicopter performance parameters and the specific location and weight of the store are known, the equations presented in 30.2.1 and 30.2.2 of Appendix B shall be used to calculate flight inertia load factors and store inertia loads, respectively.

b. When the helicopter performance parameters are not known, the limit load factors, angular velocities and accelerations at the aircraft cg presented in 30.2.2.4 of this appendix, shall be used with the equations presented in 30.2.1 and 30.2.2 of Appendix B. If the location and weight of the store are unknown, reasonable estimates of these parameters shall be made based upon knowledge obtained from similar store configurations. Estimated data shall be approved by the acquiring activity.

30.2.2.2 Landing load factors. Methods for calculating landing inertia load factors are the same as those presented in 30.2.2.1a and 30.2.2.1b of this appendix. Landing loads shall not be combined with aerodynamic loads.

30.2.2.3 Crash. Load factors presented in Table C-1 shall be used to determine store loads associated only with Navy helicopter crash conditions. These factors are not additive and are to be applied separately at the store center of gravity. For 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-1. Navy helicopter store ultimate crash load factors (at store cg).

n_{x_s}	n_{y_s}	n_{z_s}
-9.00	± 3.75	-9.0
+2.25	. . .	+4.5

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30.2.2.4 Aircraft parameters. The aircraft parameters shall be as specified in Table C-2.

TABLE C-2. Aircraft 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

30.2.3 Dynamic loading. The store shall be designed for all dynamic loads including those resulting from ground, airborne, weapons and countermeasures firing, weapons jettison and rotor excitation conditions in combination with the appropriate inertial and aerodynamic loads. The store contractor and the designated carriage-aircraft contractor shall coordinate with each other as appropriate and in accordance with acquiring activity direction, to exchange dynamic and vibration data and information. These dynamic characteristics, associated with the specific helicopter(s), shall be accounted for in the design of the aircraft/store system, to preclude adverse response characteristics that would degrade the basic helicopter handling qualities, riding comfort, and aircraft component fatigue lives.

30.2.4 Fatigue loading. Steady state and oscillatory loads which are imposed on the stores installation shall be determined for the full range of the operating environment of the specified helicopter. Fatigue life substantiation shall be accomplished using these loads and a flight spectrum approved by the acquiring activity.

30.3 Dynamic requirements. The vibratory response characteristics of the store, suspension equipment, or store/interface system, shall be calculated or measured for all conditions below. The frequency response shall range from 1/rev of the main rotor through 4b/rev of the main rotor or 2b/rev of the tail rotor, whichever is higher (b = number of blades). 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. Resonances are defined as amplification of the input level by greater than 2:1. Therefore, design consideration shall include, but not necessarily be limited to, the following conditions:

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a. Ground operations including handling and taxiing.

b. Airborne flight including hover IGE and OGE, level flight, normal maneuvers, tactical maneuvers and autorotation.

c. Weapon and countermeasure firing from small and large caliber guns, rockets, missiles, grenades, chaff dispensers and flares.

d. Take off and landing.

e. Stores jettison.

30.3.1 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 resonances within the normal power-on and power-off speeds at all gross weights, centers of gravity, and aircraft loadings, and for all applicable stores loading and dispensing configurations, including that of other store locations. Freedom from nb/rev resonance (n = an integer) 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. Margins from 1/rev and b/rev of 0.25/rev shall be observed, or alternately, it shall be conservatively demonstrated that the combined static and dynamic loadings are acceptable.

30.3.2 Frequency placement. The following structural and dynamic factors 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 or launcher structural flexibility.

e. Sway brace stiffness.

f. Coupling of system modes in close proximity.

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

a. Strength of the rotor wake impinging on the stores and stores support structure, and the resulting harmonic excitation.

b. Magnitude of forcing functions at the rotor hub.

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c. Proximity of natural frequencies to rotor excitation frequencies and weapon firing rates.

d. Transmissibility from rotor to support structure as a result of modal response distributions.

e. Amplification or attenuation of stores relative to support structure (suspension/stores dynamics).

f. Modal coupling.

g. System and local damping.

h. Free play in suspension/release mechanisms.

i. Effective damping of stores, such as fuel.

30.4 Flutter and divergence. The requirements of 3.12 shall be met.

30.5 Mechanical instability. The total weapons system shall be free of mechanical instability with the required margin of safety at all rotor speeds during all ground and flight operating conditions. The store designer, the suspension equipment contractor, and the designated carriage-aircraft contractor shall coordinate with each other, as appropriate, and in accordance with acquiring activity direction, to exchange pertinent inertia, dynamic, and other data necessary to define, by analytical or test methods, the aircraft/store mechanical instability characteristics.

30.6 Store/aircraft interface. The interaction forces between the store and the aircraft shall be determined by a method approved by the acquiring activity. Finite-element models utilizing flexible beam-type elements may be necessary to obtain a proper set of store loads. For this situation, a computer code, such as NASTRAN, may be used to obtain not only forces of interaction, but also the distributed moments and shears along the store.

APPENDIX D

LOAD ANALYSIS
OF A STORE/SUSPENSION EQUIPMENT CONFIGURATION

10. SCOPE

10.1 Scope. Appendix D presents a simplified method for calculation of the reaction forces at the sway braces (SB)/store SB pads and hooks/lugs of a suspension equipment (SE)/store configuration. The SE/store assembly is a flexible statically indeterminate structure. The flexibility of a future structure is not known and the load paths cannot be analytically or experimentally determined for an exact solution. Therefore, a rigid structure was considered and assumption made on the conservative side to reduce the redundant reactions. The SB's/store SB pads take compressive loads only. The hooks/lugs take only tensile loads in the vertical direction. Therefore, general equations based on the positive direction of the loads are not considered practical. Since the four SB's/store SB pads and the two hooks/lugs are designed to withstand their respective maximum forces, only the combination of the external loads that results in these maximum reaction forces at each SB/store SB pad and each hook/lug, as shown in Table D-1, were considered for the derivation of the equations. This appendix is not a mandatory part of the specification.

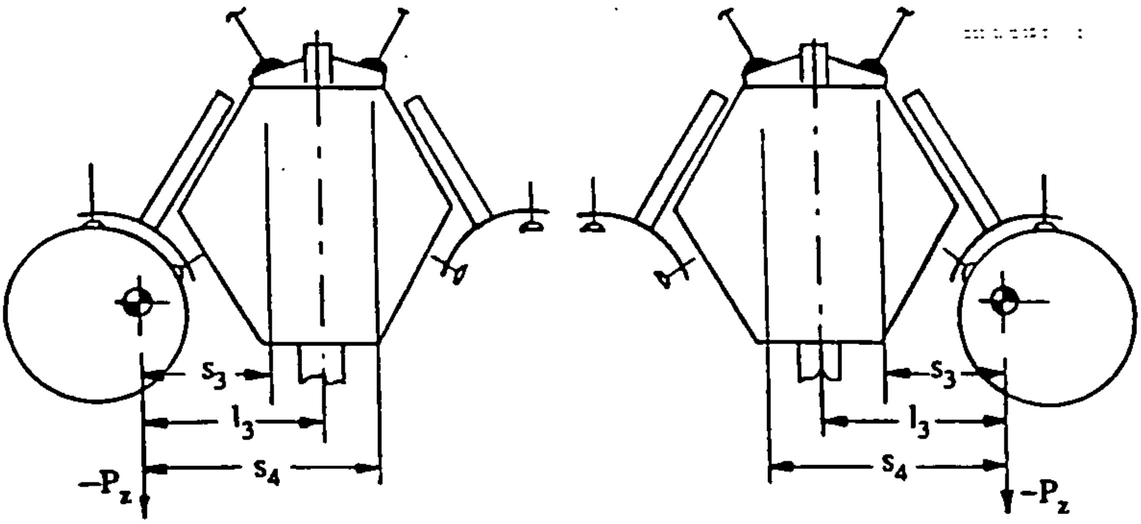
20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

TABLE D-1. Direction of external loads and moments for maximum reaction forces at the SB's/store SB pads and hooks/lugs.

Loads	SB/store SB pad				Hook/Lug	
	Fwd		Aft			
	L	R	L	R	F	A
P_x	-	-	+	+	+	-
P_y	-	+	-	+	±	±
P_z	+(1)	+(1)	+(1)	+(1)	-	-
M_x	-	+	-	+	±	±
M_y	+	+	-	-	-	±
M_z	+	-	-	+	±	±

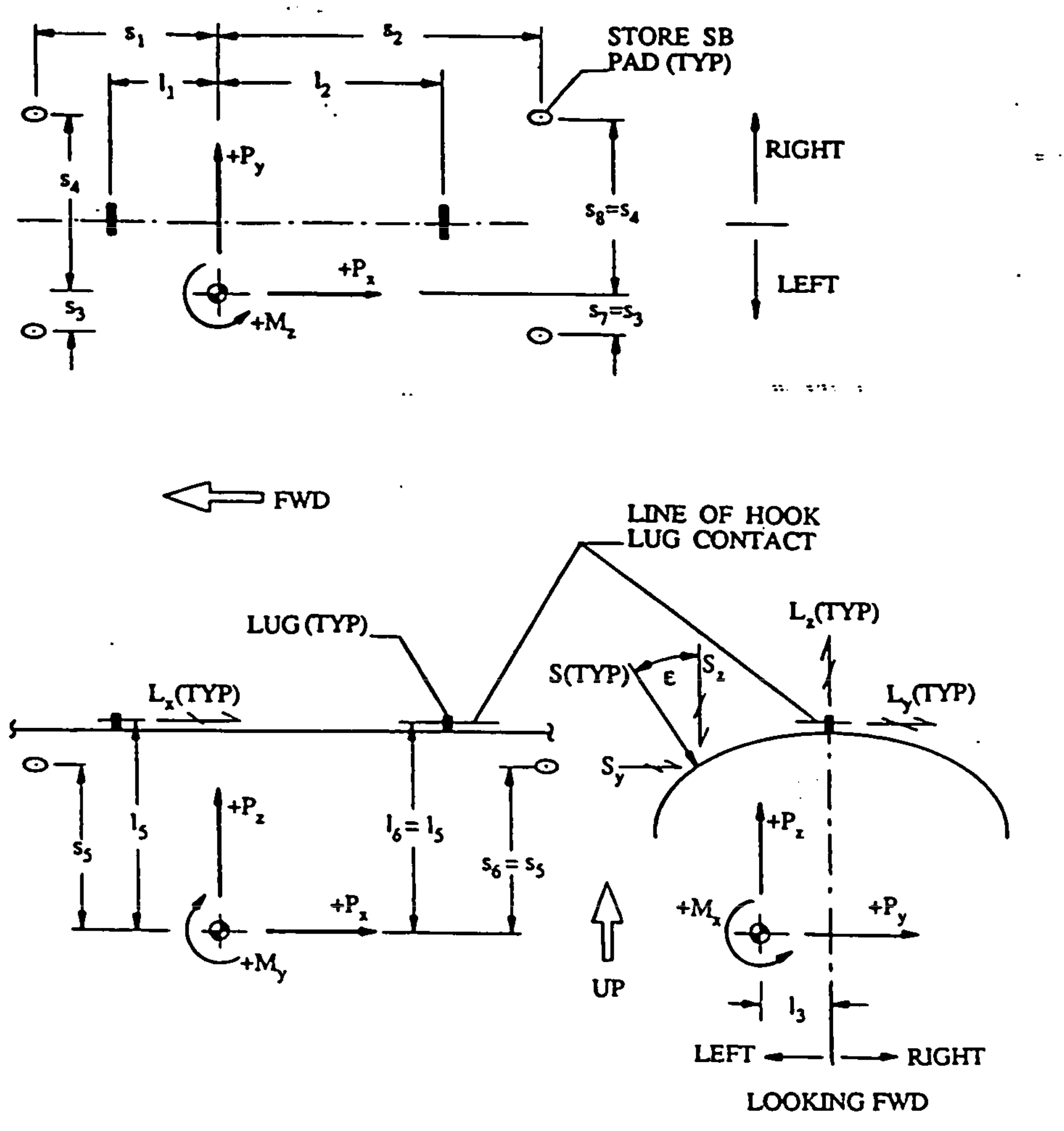
NOTE: (1) If the CG of the store is located laterally outside of the SB's, a negative vertical load (P_z, down) may be critical and should be investigated.



30. SYSTEM OF COORDINATES

30.1 System of coordinates. Figure D-1 defines the system of coordinates and sign convention.

APPENDIX D



Approximations: $l_6 = l_5$, $s_6 = s_5$, $s_7 = s_3$ and $s_8 = s_4$

FIGURE D-1. System of coordinates.

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40. NOMENCLATURE

l Distance between lugs

s Longitudinal distance between forward and aft store SB pads

l_i Distance between CG and lugs

s_i Distance between CG and store SB pads

$i=1, 2, \ldots\ldots, 6$

L_j Reaction forces at lugs

S_j Reaction forces at store SB pads

P_j External loads

M_j External moments

$j=x, y, z$

ε Angle between the direction of the store radius of curvature at the point of contact of the SB and the Z direction.

γ Angle between the SB bolt and the perpendicular to the store, S.

δ_i Angles between the store and aircraft axes of coordinates, $(i=1,2,3)$

50. ASSUMPTIONS

50.1 Assumptions. The following assumptions were made in the derivation of the equations.

a. The store upper surface, where the SB's touch, is symmetrical about the X-Z plane.

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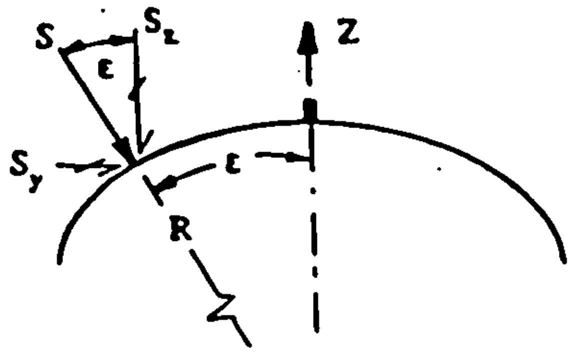
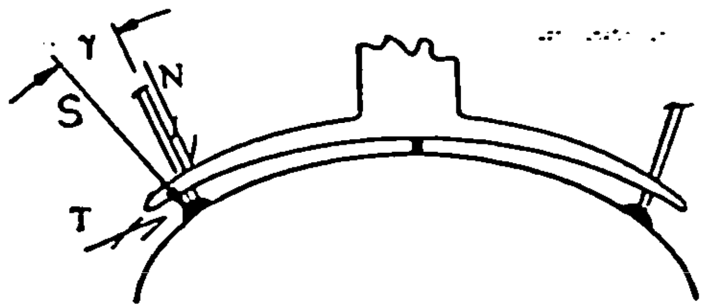
b. The direction of the store SB pad resultant reaction force, S, is perpendicular to the store surface, so that $S_y = S_z \tan\epsilon$. Where ϵ is the angle between the radius of curvature, R, and the direction of the Z axis at the contact point of the SB and the store.



If the SB bolt makes an angle γ with the S direction, the reaction at the SB can be resolved into a normal component $N = S\cos\gamma$ and a transverse component $T = S\sin\gamma$.



c. The yaw moment, M_Z, is reacted laterally by the SB's/SB store pads and induces vertical reaction forces at the hooks/lugs. Since each hook/lug is designed to withstand the entire longitudinal force, P_X, the lateral reaction due to the fraction of the moment M_Z that reacted by the hooks/lugs can be neglected.

60. DERIVATION OF REACTION FORCES

60.1 Approach. Using the relations of static equilibrium

$\Sigma F_i = 0$ and $\Sigma M_i = 0$, $(i = x, y, z)$

in all three planes, X-Y, Y-Z, and X-Z, the principle of superposition and the combinations of the loads and moments of Table D-1, the following equations were derived:

a. Equations for the forward left or right SB/store SB pad.

b. Equations for the aft left or right SB/store SB pad.

c. Equations for the forward hook/lug.

d. Equations for the aft hook/lug.

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Since the loads P_y, M_x, and M_z have the same maximum value in the positive or negative direction and the SE/store can be carried on the port or starboard side of the aircraft, the equations derived for the forward and aft SB's/store SB pads are valid for both the left or the right side. The directions of the reaction forces shown in this appendix are for the store SB pads and lugs. The directions of the reaction forces at the SB's and hooks of a SE are opposite. These equations are valid for SE's/store's with the SB's/store SB pads outside or inside the hooks/lugs or for one pair of SB's/store SB pads outside and the other pair inside the hooks/lugs. The CG can be laterally and/or longitudinally inside or outside of the SB's/store SB pads as in multiple stores laterally or longitudinally unbalanced.

70. EQUATIONS

70.1 Fwd left or right SB/store SB pad.

$S_y = S_z \tan\epsilon$

$S_z = AP_x + BP_y + CP_z + DM_x + EM_y + FM_z$

$S = S_z/\cos\epsilon$ (1)

Where:
$A = l_5/2(s_1+l_2)+l_3/s\tan\epsilon$, $B = s_2 l_5/sK$,
$C = (s_2/s)(0.5+l_3/K)$,
$D = s_2/sK$, $E = 0.5/(s_1+l_2)$, $F = 1/s\tan\epsilon$, $H = (l_5-s_5)\tan\epsilon$,
$K = H+(l_3+s_3)$

For a store with CG location laterally outside the store SB pads [see note (1) of Table D-I], the coefficient C is:

$C = l_2 l_3/[l(H+s_4-l_3)]$

For a store with CG in front of the forward store SB pads the coefficient C is:

$C = [l_2/(l_2-s_1)](0.5+l_3/K)$

For a store with CG location laterally outside the store SB pads and in front of the forward store SB pads, the coefficient C is:

$C = l_2 l_3/[(l_2-s_1)(H+s_4-l_3)]$

70.2 Aft left or right SB/store SB pad.

$S_y = S_z \tan\epsilon$

$S_z = AP_x+BP_y+CP_z+DM_x+EM_y+FM_z$

$S = S_z/\cos\epsilon$ (2)

Where:
$A = l_5/2(s_2+l_1)+l_3/s\tan\epsilon$, $B = s_1 l_5/sK$,
$C = (s_1/s)(0.5+l_3/K)$
$D = s_1/sK$, $E = 0.5/(s_2+l_1)$, $F = 1/s\tan\epsilon$

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For a store with CG location laterally outside the store SB pads [see note (1) of Table D-1], the coefficient C is:

$C=l_1 l_3/[l(H+s_4-l_3)]$

For a store with CG aft the rear store SB pads, the coefficient C is:

$C=[l_1(l_1-s_2)](0.5+l_3/K)$

For a store with CG location laterally outside the store SB pads and longitudinally aft the rear store SB pads, the coefficient C is:

$C=l_1 l_3/[(l_1-s_2)(H+s_4-l_3)]$

70.3 Fwd hook/lug.

$L_x=P_x$

$$L_y=B_yP_y+C_yP_z+D_yM_x, \quad A_y=E_y=F_y=0 \tag{3}$$

Where:

$B_y=(s_2/s)[(l_5\tan\varepsilon/K)-1], \quad C_y=l_2 l_3\tan\varepsilon/[l(H+s_4-l_3)],$
$D_y=s_2\tan\varepsilon/sK$

$$L_z=A_zP_x+B_zP_y+C_zP_z+D_zM_x+E_zM_y+F_zM_z \tag{4}$$

Where:

$A_z=l_5/(s_2+l_1)+l_3/s\tan\varepsilon, \quad B_z=s_2 l_5/sK,$
$C_z=(l_2/l)[l_3/(H+s_4-l_3)+1] \quad D_z=s_2/sK,$
$E_z=1/(s_2+l_1), \quad F_z=1/s\tan\varepsilon$

For a store with CG location in front of the forward lug and/or laterally outside the store SB pads

$L_y=B_yP_y+C_yP_z+D_yM_x$

In this equation all the coefficients are the same as in equation (3) except

$C_y=(s_2 l_3\tan\varepsilon)/[(s_2-l_1)(H+s_4-l_3)]$

$L_z=A_zP_x+B_zP_y+C_zP_z+D_zM_x+E_zM_y+F_zM_z$

In this equation all the coefficients are the same as in equation (4) except:

$C_z=[s_2/(s_2-l_1)][l_3/(H+s_4-l_3)+1]$

70.4 Aft hook/lug.

$L_x=P_x$

$$L_y=B_yP_y+C_yP_z+D_yM_x, \quad A_y=E_y=F_y=0 \tag{5}$$

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Where:

$B_y=(s_1/s)[(l_5\tan\varepsilon/K)-1]$,
$C_y=l_1l_3\tan\varepsilon/[l(H+s_4-l_3)]$, $D_y=s_1\tan\varepsilon/sK$
$L_z=A_zP_x+B_zP_y+C_zP_z+D_zM_x+E_zM_y+F_zM_z$ (6)

Where:

$A_z=l_5/(s_1+l_2)+l_3/s\tan\varepsilon$, $B_z=s_1l_5/sK$,
$C_z=(l_1/l)[l_3/(H+s_4-l_3)+1]$ $D_z=s_1/sK$,
$E_z=1/(s_1+l_2)$, $F_z=1/s\tan\varepsilon$

For a store with CG location aft the rear lug and/or laterally outside the store SB pads

$L_y=B_yP_y+C_yP_z+D_yM_x$

In this equation all the coefficients are the same as in equation (5) except

$C_y=(s_1l_3\tan\varepsilon)/[(s_1-l_2)(H+s_4-l_3)]$

$L_z=A_zP_x+B_zP_y+C_zP_z+D_zM_x+E_zM_y+F_zM_z$

In this equation all the coefficients are the same as in equation (6) except

$C_z=[s_1/(s_1-l_2)][l_3/(H+s_4-l_3)+1]$

70.5 Notes. The loads P_j and the moments M_j ($j=x,y,z$) in these equations include the inertia and aerodynamic forces. These forces and moments are applied at the store CG. The equations for the resultant moments due to translation of the aerodynamic forces from the center of pressure (CP) to the store CG are given in section 100. If the angles between the X, Y, and Z axes of the store system of coordinates and the X', Y', and Z' axes of the aircraft system of coordinates are δ_1, δ_2, and δ_3 respectively, the loads P_x, P_y, and P_z and the moments M_x, M_y, and M_z in the X, Y, and Z axes may be calculated from the equations in section 110. The loads P_j and the moments M_j in these equations are taken as positive numbers. The signs of Table D-1 are used only to identify the critical combinations of loads and moments for each equation. All the distances s_i and l_i and the angle ε are positive numbers. All coefficients are positive numbers except the coefficient B_y for the hooks/lugs which can be positive or negative as shown in Figure D-2. The tensile force on the lug/hook is L_z. The lateral force is $L=\sqrt{L_x^2+L_y^2}$. The design limit loads, S_d and L_{dz}, should include the preloads, S_p and L_p, due to the SB torque. The direction of the store SB pad preload is the same as S. The preload S_p on the SE SB should be resolved into two components, $S_p\cos\gamma$ and $S_p\sin\gamma$, and added to the forces N and T respectively.

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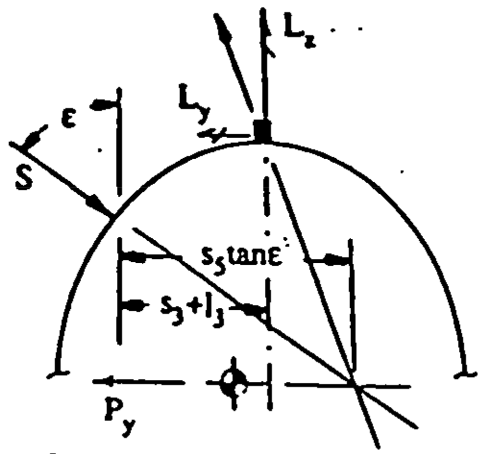
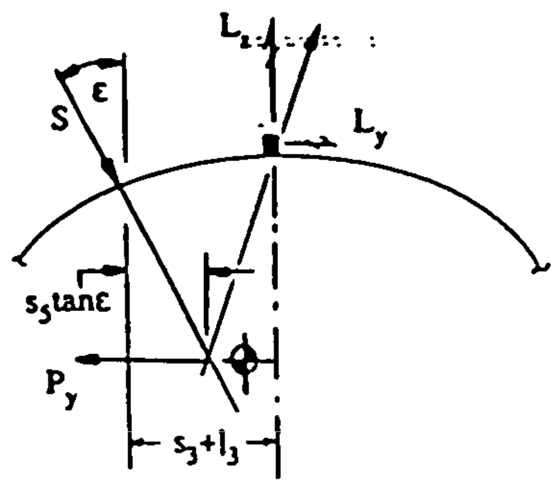
$B_y = (s_2/sK)[s_5\tan\varepsilon - (s_3 + l_3)]$

If $s_5\tan\varepsilon > (s_3+l_3)$, L_y has the same direction as P_y..$B_y > 0$



If $s_5\tan\varepsilon < (s_3+l_3)$, L_y has the opposite direction than P_y..$B_y < 0$.



If $s_5\tan\varepsilon = (s_3+l_3)$, $L_y = 0$. $B_y = 0$

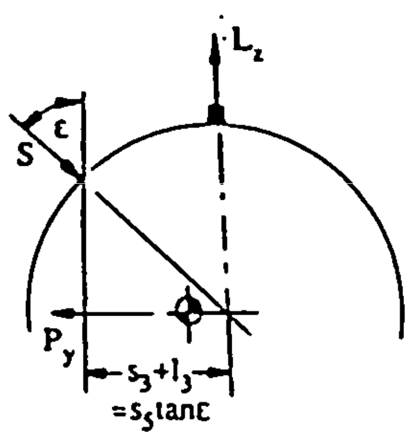


FIGURE D-2. Hook/lug coefficient B_y.

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80. PROCEDURES FOR CALCULATING REACTION FORCES

80.1 Procedures.

a. From Figures A-3, A-4 (Appendix A), B-5 or B-6 (Appendix B), the linear load factors n_j and angular accelerations $\ddot{\omega}_j$, (j=x,y,z) for each equation are determined from Table D-1. The corresponding loads and moments are calculated for the following relations:

$P_{ij}=|Wn_j|$ and $M_{ij}=|I_j \ddot{\omega}_j|$ (absolute values)

Where:

W=Store weight.

I_j=Mass moment of inertia around the X, Y, or Z axes.

b. The aerodynamic loads and moments P_{aj} and M_{aj} are added to the inertia loads, $P_j=P_{ij}+P_{aj}$ and $M_j=M_{ij}+M_{aj}$. The moments M_{aj} include the moments due to translation of the aerodynamic forces from the CP to the store CG.

c. The loads P_j and the moments M_j are substituted in the applicable equations and the limit loads S, L, and L_z are calculated. The preloads, S_p and L_p due to the SB torque, should be added to the loads S and L_z. The resultant yield and ultimate design loads are:

Store SB pad/SB yield force: $1.15S_d$. Where ($S_d=S+S_p$)

Store SB pad/SB ultimate force: $1.5S_d$

Lug/hook yield forces: $1.15L_{dz}$. Where ($L_{dz}=L_z+L_p$) and 1.15L, where: ($L=\sqrt{L_x^2+L_y^2}$)

Lug/hook ultimate forces: $1.5L_{dz}$ and 1.5L

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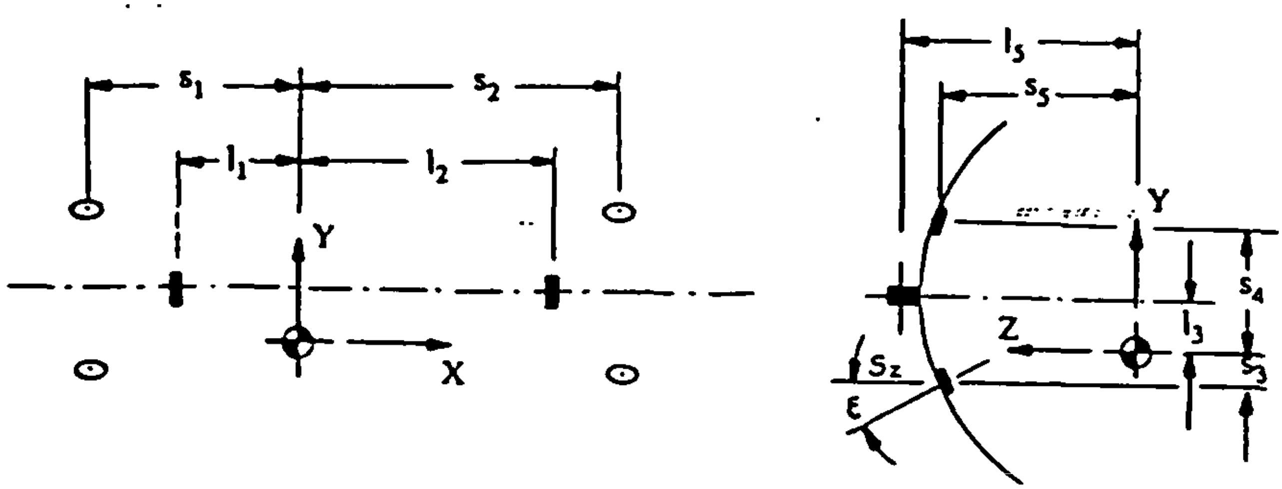
90. EXAMPLE

90.1 Reaction forces. Calculate the maximum reaction forces at the store SB pads and lugs for aircraft carrier suitability operations for the following store mounted on the outboard pylon of an aircraft.

Weight, $W=2{,}000$ lb.

Moments of Inertia around the Y or Z axis, $I_y=I_z=4{,}350$ lb-in-sec^2.



$l=30$ in., $l_1=12$ in., $l_2=18$ in., $l_3=3.5$ in., $l_5=10$ in.

$s=20$ in., $s_1=7$ in., $s_2=13$ in., $s_3=1$ in., $s_4=8$ in., $s_5=8$ in.

$\varepsilon=29.35$ degrees, $\tan\varepsilon=0.562$, $\cos\varepsilon=0.872$.

$H=(10-2)(0.562)=1.124$, $k=1.124+(3.5+1)=5.624$

90.2 Store fwd SB pad.

$S_z=AP_x+BP_y+CP_z+DM_x+EM_y+FM_z$

$A=10/[(2)(7+18)]+3.5/(20)(0.562)=0.511$

$B=(13)(10)/(20)(5.624)=1.156$

$C=(13/20)(0.5+3.5/5.624)=0.730$

$E=0.5/(7+18)=0.020$

$F=1/(20)(0.562)=0.089$

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From Table D-1, the direction of the loads for maximum reaction forces at the store SB pad were found to be:

$-P_x$, $-P_y$, $+P_z$, $-M_x$, $+M_y$, $+M_z$

From Figure A-3 (Appendix A), the critical load factors were found to be:

	n_x	n_y	n_z	$\ddot{\theta}(\dot{\omega}_y)$	$\ddot{\psi}(\dot{\omega}_z)$
Case 1	-9	-5	+2	+25	+6
Case 2	-3	-5	+4	+25	+6

Since all load factors are the same except n_x and n_z and

Case 1: $A(9)+C(2)=(0.511)(9)+(0.730)(2)=6.059$

Case 2: $A(3)+C(4)=(0.511)(3)+(0.730)(4)=4.453$

the critical case is No. 1

$S_z=[6.059+(1.156)(5)]W+[(0.020)(25)+(0.080)(6)]I$

$S_z=(11.839)W+(1.034)I$

90.3 Store aft SB pad.

$S_z=AP_x+BP_y+CP_z+DM_x+EM_y+FM_z$

$A=10/[2(13+12)]+3.5/(20)(0.562)=0.511$

$B=(7)(10)/(20)(5.624)=1.156$

$C=(7/20)(0.5+3.5/5.624)=0.393$

$E=0.5/(13+12)=0.020$

$F=1/(20)(0.562)=0.089$

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From Table D-1, the direction of the loads for maximum reaction forces at the store SB pad were found to be:

$+P_x$, $-P_y$, $+P_z$, $-M_x$, $-M_y$, $-M_z$

From Figure A-3 (Appendix A), the critical load factors were found to be:

	n_x	n_y	n_z	$\ddot{\theta}(\dot{\omega}_y)$	$\ddot{\psi}(\dot{\omega}_z)$
Case 3	+9	-2.5	+1.5	-15	-4
Case 4	+2	-5	+4	-25	-6

Case 3:
$S_z=[(0.511)(9)+(0.622)(2.5)+(0.393)(1.5)]W+[(0.020)(15)+(0.089)(4)]I$

$S_z=(6.744)W+(0.656)I$

Case 4: $S_z=[(0.511)(2)+(0.622)(5)+(0.393)(4)]W+[(0.020)(25)+(0.089)(6)]I$

$S_z=(5.704)W+(1.034)I$

The critical case is No. 1

$S_z=(11.839)(2000)+(1.034)(4350)=28,176$ lb. and

$S=S_z\cos c=(28176)(0.866)=32,319$ lb.

The design limit load for the store SB pads is $S_d=32319+S_p$ (where S_p is the preload due to SB torque).

90.4 Store fwd lug.

$L_x=P_x$

$L_y=B_yP_y+C_yP_z+D_yM_x$, $A_y=E_y=F_y=0$

$B_y=(13/20)[(10)(0.562)/(5.624)-1]=-0.0005$

$C_y=(18)(3.5)(0.562)/[30(1.124+8-3.5)]=0.210$

$L_z=A_zP_x+B_zP_y+C_zP_z+D_zM_x+E_zM_y+F_zM_z$

$A_z=10/(13+12)+3.5/(20)(0.562)=0.711$

$B_z=(13)(10)/(20)(0.562)=1.156$

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$C_z=(18/30)[3.5/(1.124+8-3.5)+1]=0.973$

$E_z=1/(13+12)=0.040$

$F_z=1/(20)(0.562)=0.089$

From Table D-1 and Figure A-3 (Appendix A), the critical load factors were found to be:

	n_x	n_y	n_z	$\ddot{\theta}(\dot{\omega}_y)$	$\ddot{\psi}(\dot{\omega}_z)$
Case 1	+2	-5	-12	-25	-6
Case 2	+9	-2.5	-5	-15	-4

Case 1= $L_x=2W$, $L_y=[(-0.0005)(5)+(0.210)(12)]W=2.518W$

$L_z=[(0.711)(2)+(1.156)(5)+(0.973)(12)]W+[(0.040)(25)+(0.089)(6)]I$

$L_z=(18.878)W+(1.534)I$

Case 2: $L_x=9W$, $L_y=[(-0.0005)(2.5)+(0.210)(5)]W=1.049W$

$L_z=[(0.711)(9)+(1.156)(2.5)+(0.973)(5)]W+[(0.040)(15)+(0.089)(4)]I$

$L_z=(14.154)W+(0.956)\ I$

90.5 Store aft lug.

$L_x=P_x$

$L_y=B_yP_y+C_yP_z+D_yM_x$, $A_y=E_y=F_y=0$

$B_y=(7/20)[(10)(0.562)/(5.624)-1]=-0.0003$

$C_y=(12)(3.5)(0.562)/[30(1.124+8-3.5)]=0.140$

$L_z=A_zP_x+B_zP_y+C_zP_z+D_zM_x+E_zM_y+F_zM_z$

$A_z=10/(7+18)+3.5/(20)(0.562)=0.711$

$B_z=(7)(10)/(20)(0.562)=0.622$

$C_z=(12/30)[3.5/(1.124+8-3.5)+1]=0.64$

$E_z=1/(7+18)=0.040$

$F_z=1/(20)(0.562)=0.089$

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From Table D-1 and Figure A-3 (Appendix A), the critical load factors were found to be:

	n_x	n_y	n_z	$\dot{\theta}(\dot{\omega}_y)$	$\dot{\psi}(\dot{\omega}_z)$
Case 3	-9	-5	-6	+25	-6
Case 4	-3	-5	-12	+25	-6

Case 3: $L_x=9W$, $L_y=[(-0.0003)(5)+(0.140)(6)]W=0.0839W$

$L_z=[(0.711)(9)+(0.622)(5)+(0.649)(12)]W+[(0.040)(25)+(0.089)(6)]I$

$L_z=(13.403)W+(1.534)I$

Case 4: $L_x=3W$, $L_y=[(-0.0003)(5)+(0.140)(12)]W=1.679W$

$L_z=[(0.711)(3)+(0.622)(5)+(0.649)(12)]W+[(0.040)(25)+(0.089)(6)]I$

$L_z=(13.031)W+(1.534)I$

Case	L_x	L_y (lb)	$L=\sqrt{L_x^2+L_y^2}$	L_z
1	4,000	5,036	6,431	44,385
2	18,000	2,098	18,122	32,457
3	18,000	1,678	18,078	33,479
4	6,000	3,358	6,875	32,735

Critical cases are Nos. 1 and 3. The design limit loads for the lugs are:

$L=18,078$ lb. and $L_{dz}=(44,385+L_p)$ lb. Where L_p is the preload due to SB torque.

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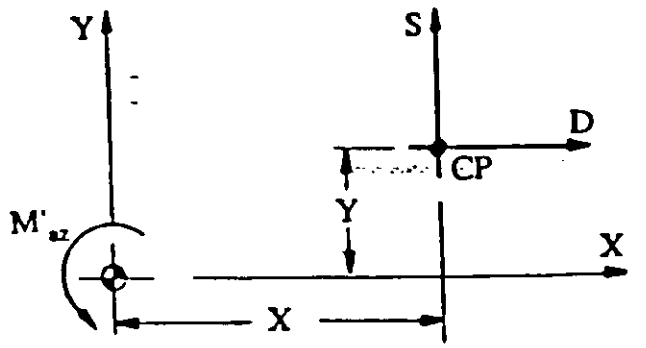
100. EQUATIONS FOR THE RESULTANT MOMENTS DUE TO TRANSLATION OF THE AERODYAMIC FORCES.

100.1 Definitions. X, Y, and Z are the distances measured from the CG to the center of pressure (CP) of the store. Positive directions are in accordance with the system of coordinates of Figure D-1.

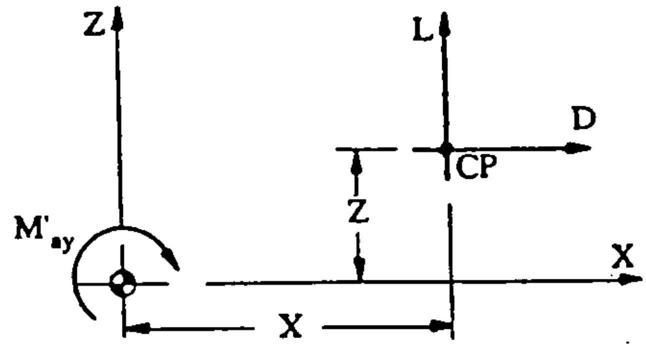
100.1.1 Forces. D=drag, S=side force and L=lift force.

100.1.2 Aerodynamic moments. M_{ax}, M_{ay}, and M_{az}, are aerodynamic moments with respect to X, Y, and Z axes respectively.

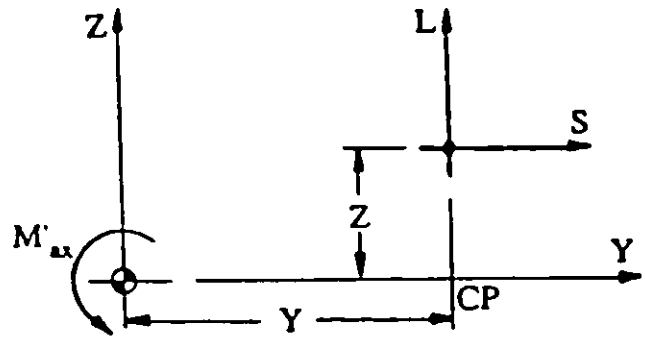
$$M'_{az} + SX - DY = 0$$



$$M'_{ay} + DZ - LX = 0$$



$$M'_{ax} + LY - SZ = 0$$



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100.2 Equations. The resultant moments due to translation of the aerodynamic forces from the CP to the store CG can be computed from the following equations.

$$\begin{bmatrix} M'_{ax} \\ M'_{ay} \\ M'_{az} \end{bmatrix} = \begin{bmatrix} 0 & Z & -X \\ -Z & 0 & X \\ Y & -X & 0 \end{bmatrix} \begin{bmatrix} D \\ S \\ L \end{bmatrix}$$

These moments are added to the aerodynamic roll, pitch, and yaw moments, M''_{ax}, M''_{ay}, and M''_{az}, respectively.

The total aerodynamic moments are:

$$M_{ax} = M'_{ax} + M''_{ax}$$

$$M_{ay} = M'_{ay} + M''_{ay}$$

$$M_{az} = M'_{az} + M''_{az}$$

110. EQUATIONS FOR LOADS AND MOMENTS DUE TO ROTATION OF THE STORE SYSTEM OF COORDINATES

110.1 Definitions.

110.1.1 Loads. P'_i and P_i are the loads in the i direction of the aircraft and store system of coordinates respectively, (i=x,y,z).

110.1.2 Moments. M'_i and M_i are the moments around the i axis of the aircraft and store system of coordinates respectively.

110.1.3 Angles. δ_1, δ_2, and δ_3 are the angles of rotation around the X, Y, and Z axes respectively.

110.2 Equations. The resultant forces and moments due to rotation of coordinates can be computed from the following equations.

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110.2.1 <u>Rotation around the X-axis (for stores mounted at a roll angle, δ_1)</u>.

$P_y = P'_y\cos\delta_1 + P'_z\sin\delta_1$

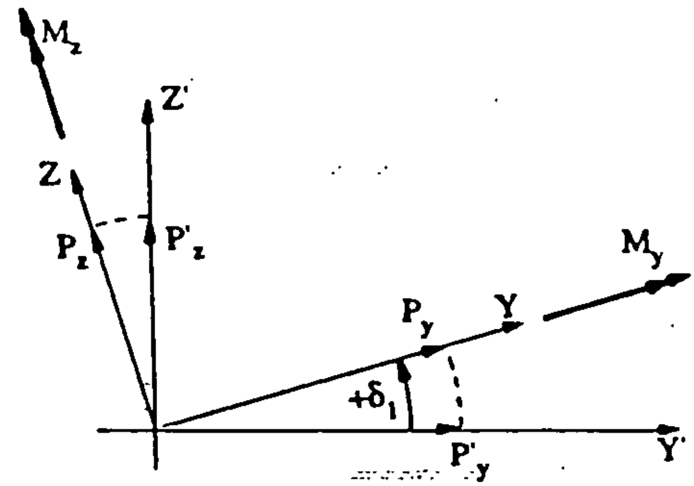
$P_z = P'_z\cos\delta_1 - P'_y\sin\delta_1$

Max $P_z = P'_z\cos\delta_1 + P'_y\sin\delta_1$, for $-P'_y$

$M_y = M'_y\cos\delta_1 + M'_z\sin\delta_1$

$M_z = M'_z\cos\delta_1 - M'_y\sin\delta_1$

Max $M_z = M'_z\cos\delta_1 + M'_y\sin\delta_1$, for $-M'_y$



110.2.2 <u>Rotation around the Y-axis (for stores mounted at a pitch angle, δ_2)</u>.

$P_x = P'_x\cos\delta_2 + P'_z\sin\delta_2$

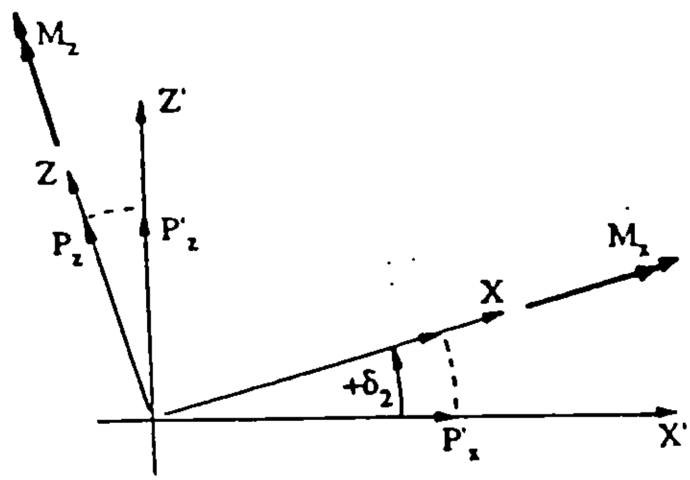
$P_z = P'_z\cos\delta_2 - P'_x\sin\delta_2$

Max $P_z = P'_z\cos\delta_2 + P'_x\sin\delta_2$, for $-P'_x$

$M_x = M'_x\cos\delta_2 + M'_z\sin\delta_2$

$M_z = M'_z\cos\delta_2 - M'_x\sin\delta_2$

Max $M_z = M'_z\cos\delta_2 + M'_x\sin\delta_2$, for $-M'_x$



APPENDIX D

110.2.3 Rotation around the Z-axis (for stores mounted at a yaw angle, δ_3).

$P_x = P'_x \cos\delta_3 + P'_y \sin\delta_3$

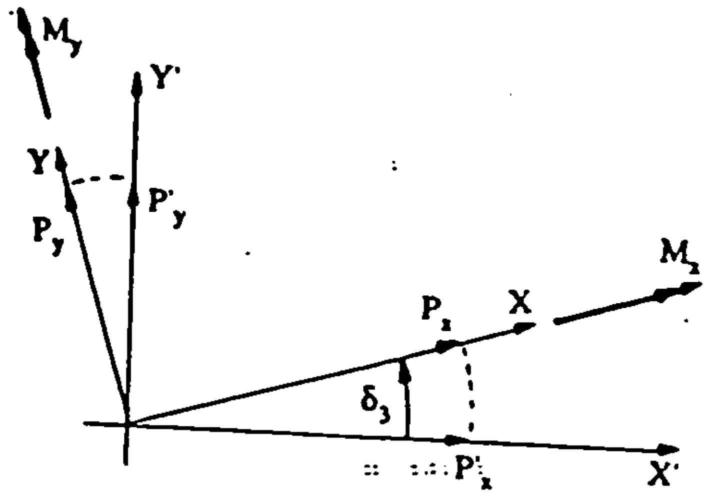
$P_z = P'_y \cos\delta_3 - P'_x \sin\delta_3$

Max $P_z = P'_y \cos\delta_3 + P'_x \sin\delta_3$, for $-P'_x$

$M_x = M'_x \cos\delta_3 + M'_y \sin\delta_3$

$M_y = M'_y \cos\delta_3 - M'_x \sin\delta_3$

Max $M_y = M'_y \cos\delta_3 + M'_x \sin\delta_3$, for $-M'_x$



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Applicable International Organizations:
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Navy - AS
(Project No. 15GP-0074)

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3. DOCUMENT TITLE
AIRBORNE STORES, SUSPENSION EQUIPMENT AND AIRCRAFT-STORE INTERFACE (CARRIAGE PHASE)

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

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