|INCH POUND|
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MILITARY SPECIFICATION

TIE-DOWNS, AIRFRAME DESIGN, REQUIREMENTS FOR

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

1. SCOPE

1. Scope. This specification defines the design and construction requirements for Naval Aircraft Tie-Down Fittings, Attachment Points, and the associated aircraft carry-through structures.

2. APPLICABLE DOCUMENTS

2.1 Government documents

* 2.1.1 Specifications and standards. The following specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATION

Military

MIL-A-8860	Airplane strength and Rigidity General Specification for
MIL-A-8867	Airplane Strength and Rigidity Ground Tests
MIL-A-8868	Airplane Strength and Rigidity Data and Reports

STANDARDS

Military

DOD-STD-100	Engineering Drawing Practices
MIL-STD-805	Towing Fitting and provisions for Military Aircraft

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

2.1.2 Other Government drawings and publications. The following other Government 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 Sea Systems Command

805-1916300	- Aircraft Securing and Engine Run-up Fittings

Naval Air Systems Command

993AS100	- Aircraft Run-up Fitting Assembly Type XIII-Land-based
1540AS100	- Tie-down, aircraft, type TD-1B
1540AS102	- Hook

PUBLICATIONS

Naval Air Systems Command

SD-24	- General Specification for Design and Construction of Aircraft Weapon Systems
SD-8706	- Design Examination, Engineering, Aircraft Weapon Systems
NAVAIR 17-1-537	- Tie-Down, Aircraft, Equipment and Procedures
BULLETIN NO. 1	- Air Capable Ship Aviation Facilities

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

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

3. REQUIREMENTS

3.1 Purpose of tie-down fittings. Tie-down fittings shall be provided on the aircraft to permit securing the aircraft on the flight deck, hangar deck, or a land-based apron. They shall be so located that, without reliance upon wheel chocks, the installed tie-down lines will hold the aircraft in its intended position under the loads of 3.6.

3.2 Design criteria. The tie-down fittings, attachments and their carry-through structures shall be capable of supporting, without failure, the critical combinations of ultimate loads resulting from the load conditions and ultimate factor of safety specified herein. These structures shall be so designed and constructed that structural tests in accordance with MIL-A-8867 will demonstrate the structural reliability and systems effectiveness for the planned service life of the aircraft. Permanent deformations that would adversely affect the operation and structural integrity of the aircraft shall not result from the ultimate loads specified herein.

3.3 Load definition.

3.3.1 Limit loads. The loads, load factors, and load formulas in this specification and the reference specifications of 2.1 represent limit loads.

3.3.2 Ultimate loads. The ultimate loads are obtained by multiplying the limit loads by a factor of safety of 1.50.

3.4 Deformations. The effects of deformation of the aircraft tie-down fittings, attachment points, and the carry-through structure shall be included in the determination of the magnitude and distribution of the limit and ultimate loads. However, for the derivation of loads using strain energy methods the assumption of the aircraft as a rigid body may be used if appropriate.

3.5 Design allowables.

3.5.1 Design data and allowable materials properties. Design data, properties of materials, allowable stress values, and material strengths shall be in accordance with MIL-A-8660.

3.5.2 Magnesium alloys. Magnesium-base-alloy parts shall not be used.

3.6 Design load determination.

3.6.1 Design limits loads. Design limit loads shall be derived from inertial forces caused by ship's motion, wind forces on the aircraft, rotor lift, and engine thrust. Additionally, their derivation shall include the following:

a. The aircraft shall be oriented at all angles with respect to the tie-down pattern and the longitudinal axis of the ship. The winds specified in Tables I and II shall be acting from all horizontal directions. The inertia load of Table I or Table II, as applicable, shall act independently and in combinations.

b. Under any possible combination of loads and conditions described herein, the maximum individual tie-down line load shall not exceed 10,000 pounds. For the determination tie-down reactions in cases where their magnitude is not statically determinate, the reactions should be determined by rational or conservative methods.

c. The ship's motion inertial loads may be deleted from the derivation of limit loads in the determination of securing patterns for land-based tie-down conditions.

d. The forces required for equilibrium of tied down aircraft, in combination with the loads resulting from each of the weather conditions of Table I or Table II, as applicable, shall be the reactions at the main and auxiliary wheels acting normal to the ground or deck, and the tension loads in the securing lines attached to the normal weather, moderate weather, and heavy weather securing points provided. Horizontal loads shall not be reacted at the wheels. The critical combinations of loads resulting from wind, propulsion forces, lift forces, and inertial forces shall be distributed through only those tie-down lines which can react to these combinations of loads.

e. For normal weather and moderate weather conditions, the foldable portions of wings, tails, rotors and other aircraft components that can be folded, shall be assumed in the folded positions and alternately in the extended positions.

f. For heavy weather conditions, all control surfaces shall be secured with battens or locks that are provided for securing purposes. Jury struts, if provided for securing, shall be installed, and the rotor blades shall be secured.

g. For normal weather conditions defined in Table I or Table II, as applicable, rotary wing aircraft shall be secured to the normal weather tie-down fittings with rotor blades in the secured position, and alternately with engines assumed operating and rotor blades turning at all RPM's under all combinations of cyclic control varying from 0 to 25 percent, and pitch control varying from 0 to 50 percent, of the maximum available values of control. For shipboard operations, rotor blade inertial loads and inertial loads caused by ship's motion shall be combined with wind and lift loads.

3.6.1.1 Ship's motion inertial loads. Ship's motion loads are defined:

$$P_{xm} = \pm N_x W$$

$$P_{ym} = \pm N_y W$$

$$P_{zm} = + N_z W$$

Where:

$P_{xm} = \pm N_x W$ Forward inertial load, parallel to ship's deck, positive aft.

$P_{ym} = \pm N_y W$ lateral inertial load, parallel to ship's deck, positive to port.

$P_{zm} = + N_z W$ total vertical inertial load applied at aircraft's center of gravity, perpendicular to ship's deck, positive down.

W = all weights from the maximum design gross weight down to the minimum flying gross weight except that the maximum design gross weight may be reduced by an amount equal to personnel weight for which provisions are allowed for all requirement specified herein except for the requirements of 3.6.1g and 3.6.1.3. The definitions of maximum design gross weight and minimum flying gross weight shall be as specified in MIL-A-8860.

N_x, N_y, and N_z = ship's motion inertial load factors shown in Table I or Table II, as applicable.

TABLE I. DESIGN PARAMETERS FOR AIRCRAFT RESTRICTED TO OPERATE FROM AVIATION SHIPS OR AMPHIBIOUS AVIATION SHIPS

Weather Conditions	Wind Speeds (knots)	Ship's Motion Inertial Load Factors			
		$\pm N_x$	$\pm N_y$	$+N_z$	
				Min.	Max.
Heavy Weather	100	0.30	0.80	Ø	1.70
Moderate Weather	60	0.10	0.40	0.70	1.30
Normal Weather	45	0.05	0.15	0.90	1.10

TABLE II. DESIGN PARAMETERS FOR AIRCRAFT ABLE TO OPERATE FROM AIR CAPABLE SHIPS

Weather Conditions	Wind Speeds (knots)	Ship's Motion Inertial Load Factors			
		$\pm N_x$	$\pm N_y$	$+N_z$	
				Min.	Max.
Heavy Weather	100	0.30	1.00	Ø	2.00
Moderate Weather	60	0.15	0.65	0.55	1.45
Normal Weather	45	0.10	0.25	0.85	1.15

3.6.1.2 Wind loads. The wind lift and drag loads shall be those caused by the wind speeds of Table I and II acting from all horizontal directions. These loads shall be determined from actual test data, except that wind-drag loads may be determined from:

$$F_d = 35A \left(\frac{V}{100}\right)^2$$

Where:

F_d = resultant force (pounds)acting through the centroid of area "A", and parallel to the wind direction.

A = aircraft's projected area (sq ft) on a plane normal to the wind direction.

V = wind speed (knots).

3.6.1.3 Engine run-up thrust loads. Critical loads derived from 110 percent maximum symmetrical and unsymmetrical thrust shall be combined with the ship's motion inertial loads, wind drag loads, and wind lift loads (for normal weather condition only).

3.6.1.3.1 Engine run-up restraints. Securing the aircraft during engine run-up operations may require the use of an engine run-up chain assembly or catapult holdback hardware in addition to, or instead of the standard aircraft tie-downs. Full power engine run-up tie-down assemblies are described in NAVAIR 17-1-537 and Naval Air Systems Command Drawing 916AS100. These assemblies are used with an adapter that shall be furnished by the contractor for Attachment to the aircraft catapult holdback fitting assembly.

3.6.1.4 Land-based on shipboard deck tie-down fittings. NAVAIR 17-1-537 describes various deck fitting types used for securing aircraft and for restraining aircraft during engine run-up operations. Also, drawings of fittings are contained in Naval Sea Systems command Drawing 805-1916300 and Naval Air Systems Command Drawing 993AS100. Aircraft tie-down arrangements shall not allow conditions that would cause the maximum working load of the applicable deck tie-down fitting to be exceeded.

3.6.2 Tie-down for jacking. For normal weather conditions defined in Table I or Table II, as applicable, when aircraft are on jacks for such purposes as functional checks and maintenance of landing gear, the aircraft shall be secured symmetrically by using available tie-down fittings on wings and fuselage. The forces required for equilibrium of tied down aircraft on jacks, in combination with the loads resulting from the normal weather condition of Table I or Table II, as applicable, shall be the reactions at the jacks acting normal to the ground or deck, and the tension loads in the appropriate securing lines attached to available wing and fuselage tie-down fittings. Horizontal loads shall not be reacted at the jacks. The critical combinations of loads resulting from wind and inertial forces, as applicable, shall be distributed through only those tie-down lines which can react these combinations of loads.

3.7 Aircraft fitting design and construction.

* 3.7.1 Aircraft fitting compatibility. The aircraft tie-down fitting installations shall be so designed and constructed that they are compatible with government furnished tie-down equipment conforming to 1540AS100 and with equipment and procedures specified in NAVAIR 17-1-537. The aircraft tie-down fittings attachments to the landing gear shall permit removal of damaged fittings and installation of new fittings with no impairment of structural reliability and systems effectiveness of landing gear structures.

3.7.1.1 Size. The fittings shall meet the following size requirements:

a. The minimum area of clear opening in the lug or ring shall be 3.20 square inches. Additionally, each opening shall be of sufficient size to permit use of the number of tie-down lines required for adequately securing the aircraft in accordance with 3.7.5.

b. The minimum width of clear opening in the lug or ring (minor axis of opening) shall be 1.0 inch, except where used as an aircraft towing point. In this event, the minimum minor axis requirements of MIL-STD-805 shall govern.

c. Stock cross section shall be essentially circular and shall be compatible with the tie-down hook specified in NAVAIR dwg. 1540AS102.

d. Sharp corners shall be avoided.

3.7.2 Number and location of tie-downs. The minimum number of tie-down fittings to be provided for each aircraft are as follows:

3.7.2.1 Fixed-wing aircraft.

a. Inboard on the upper main gear or inboard on the upper main gear structure (2).

b. Outboard on the upper main gear or outboard on the upper main gear structure (2).

c. Wing (2).

d. Aft fuselage or arresting hook.

e. Upper nose gear or bottom section of the forward fuselage; location of nose gear tie-down fittings shall permit attachment of the tow bar without requiring removal of tie-down lines.

f. Lower main gear (2); (Note towing requirements of MIL-STD-805).

3.7.2.2 Rotary-wing aircraft.

a. Upper main gear or upper main gear structure (2).

b. Upper auxiliary gear or upper auxiliary gear structure.

c. Outboard on the main wheel axles.

d. Aft fuselage.

e. Forward fuselage.

f. Additional tie-down fitting (s) as necessary to comply with rotary-wing aircraft requirement of 3.6.1.

3.7.3 Recessed fittings. For aerodynamic considerations requiring that the fittings on the aircraft be recessed and covered by a door, the following requirements shall be met:

a. The door or adjacent structure shall be properly labeled.

b. A quick-release fastener shall be employed to provide access with a minimum of effort.

c. The door shall be secured, when in the open position, to prevent damage to the aircraft and eliminate a personnel hazard.

d. The door in the open position shall not interfere with tie-down lines when they are extended within the desired angles to pull-off.

e. The door installation shall be such that the door can be secured in both the open and the closed position by only one crewman.

f. The door shall be operable by a crewman during 60-knot winds either wearing or not wearing gloves needed for protection during cold weather.

g. The door shall be capable of withstanding 100-knot winds from any direction while in the open position.

3.7.4 Fitting accessibility. The aircraft tie-down fittings shall be easily accessible to the crewman and shall clear the deck and ground in accordance with requirements of SD-24. Wing tie-down fittings shall be accessible when the wings are either folded and extended.

3.7.5 Aircraft tie-down patterns. Tie-down patterns for the aircraft shall be developed and presented pictorially in the Handbook of maintenance Instructions, showing the recommended location, allowable angular direction of pull-off, and number of tie-down lines required to secure an aircraft in the specified weather conditions. Aircraft tie-down patterns shall meet the following general requirements.

a. Figures 1, 2 and 3 show basic recommended tie-down patterns for fixed-wing aircraft. Similar patterns shall be shown for rotary-wing aircraft. The procuring activity shall be informed as early as possible of any tie-down pattern that requires more than 18 individual tie-down assemblies.

b. The aircraft tie-down patterns shall enable a simple, rapid securing of the aircraft.

c. The aircraft tie-down patterns shall not interfere with maintenance operations which may be required while the aircraft is secured.

d. The aircraft tie-down patterns shall not interfere with the operation of aircraft access doors.

e. The aircraft tie-down patterns shall be compatible with existing tie-down and deck equipment and conforming to the procedures in NAVAIR 17-1-537.

f. The tie-down assembly shall be easily attached to and removed from the fitting without contacting the aircraft and external stores.

g. The use of the tie-down line assemblies in series or in parallel should be avoided where possible. If the tie-down pattern should contain tie-down line assemblies in series or in parallel, then the procuring activity shall be notified as soon as possible.

3.8 Structural analysis and design data. Design, construction, analysis, and test data and information shall be prepared to verify the strength, rigidity, systems effectiveness, and reliability of tie-down components, attachments, and carry-through structures to retain the aircraft in position when subject to the loads of 3.6. These data shall be prepared in accordance with MIL-A-8868 and SD-8706.

3.9 Data and information requirements relating to arrangement and usage.

3.9.1 Tie-down arrangement drawing. Arrangement drawings, conforming to DoD-STD-100 and similar to figure 4, shall be prepared showing the tie-down arrangements for the weather conditions of Table I or Table II, as applicable. These drawings shall consist of a 1/20 scale three-view presentation of the aircraft in the static attitude. A deck and ground fitting pattern similar to that shown in figure 5 shall be shown superimposed on the three-view drawing. The tie-down lines shall be shown connecting the aircraft tie-down fittings to the deck and ground fittings, and all aircraft tie-down fittings and deck and ground fittings shall be shown. Clearances between the tie-down lines and the aircraft (including external stores) shall be provided in accordancw with 4.3.3 "High Point" securing, which may require hangar bulkhead fitting installations in some cases, shall be clearly described in the appropriate arrangement drawing in accordance with Naval Air Systems Command Air Capable Ship Aviation Facilities Bulletin No. 1

3.9.2 Tie-down demonstration drawings. It shall be demonstrated by use of overlay type drawings that the aircraft can be secured for random placement of the aircraft on deck tie-down fitting patterns as noted in Table III. All aircraft that are capable of operating on air-capable type ships shall also be able to adapt to a 42 inch by 42 inch deck fitting pattern spacing. Tie-down patterns for land-based operations shall be in accordance with NAVAIR 17-1-537.

3.10 Tie-down procedure report. A tie-down procedure report shall be submitted to the naval Air Systems Command for acceptance. The report shall include step by step tie-down procedures and requirements, using NAVAIR 17-1-537 as a guide. The procedures report shall include drawings which indicate, for all tie-down fittings, the coordinates of the aircraft fitting location similar to Figure 6, and the limitations in angular pulloff. The reasons for the limitations shall be clearly stated in the text. Any tie-down lines that are used in parallel should be clearly

noted. Clearance, as shown in Figure 7, shall be indicated by that portion of the base of a cone generated by a tie-down chain of either 118" or 136" maximum length in which a deck or ground fitting may be located without creating interference between the aircraft (including external stores) and a line from the deck. The structural clearance drawing and the tie-down arrangement drawings shall be compatible in that the tie-down lines on the tie-down arrangement drawing shall be shown only in those areas where interference will not occur.

3.10.1 Special procedures. Special tie-down procedures, necessary to prevent mechanical instability of rotary wing aircraft which are tied down with rotors turning, shall be clearly stated in the tie-down line adjustment, to avoid overload in aircraft tie-down fittings, attachments, and carry-through structures shall be included.

4. QUALITY ASSURANCE PROVISIONS

(This section is not applicable to this specification)

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. This specification establishes the design and construction of aircraft tie-down fittings, attachment points, and associated aircraft carry-through structure.

* 6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number, and date of the specification.

b. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1).

* 6.3 Consideration of data requirements. The following data requirements should be considered when this specification is applied on a contract. The applicable Data Item Descriptions (DID's) should be reviewed in conjunction with the specific acquisition to ensure that only essential data re requested/provided and that the DID's are tailored to reflect the requirements of the specific acquisition. To ensure correct contractual application of the data requirements, a Contract Data Requirements List (DD Form 1423) must be prepared to obtain the data, except where DOD FAR Supplement 27.475-1 exempts the requirement for a DD Form 1423.

Reference Paragraph	DID Number	DID Title	Suggested Tailoring
3.8	DI-S-30588	Structural Analysis and Design Data	Whenever possible use the contractors test report Format
3.9.1 & 3.9.2	DI-E-7031	Drawing, Engineering and Associated Lists	
3.10	UDI-S-20444	Procedure Report	

The above DID's were those cleared as of the date of this specification. The current issue of DOD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL), must be research to ensure that only current, cleared DID's are cited on the DD Form 1423.

* 6.4 Subject Term (Key Word) Listing.

Aircraft Securing, Carrier Flight Deck
Carrier Flight Deck, Aircraft Mooring
Chains, Aircraft Mooring
Aircraft, Carrier Flight Deck
Securing Aircraft, Carrier Flight Deck

* 6.5 Changes from previous issue. The margins of this specification are marked with asterisks to indicate where changes (additions, modifications, corrections, deletions) from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Preparing Activity:
Navy - AS
(Project No. 15GP-0099)

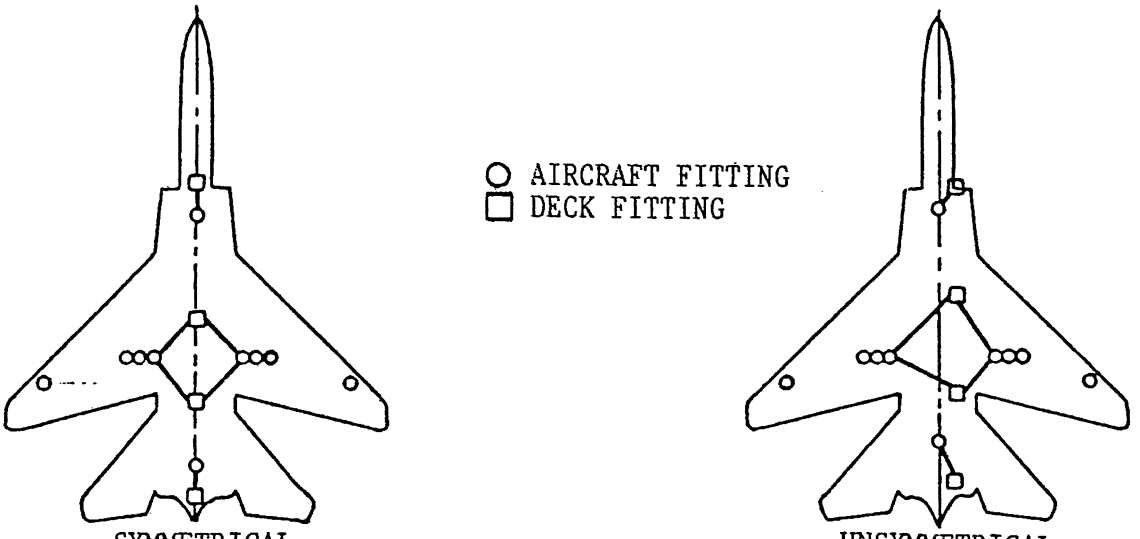


FIGURE 1. 6-line, normal weather tie-down.

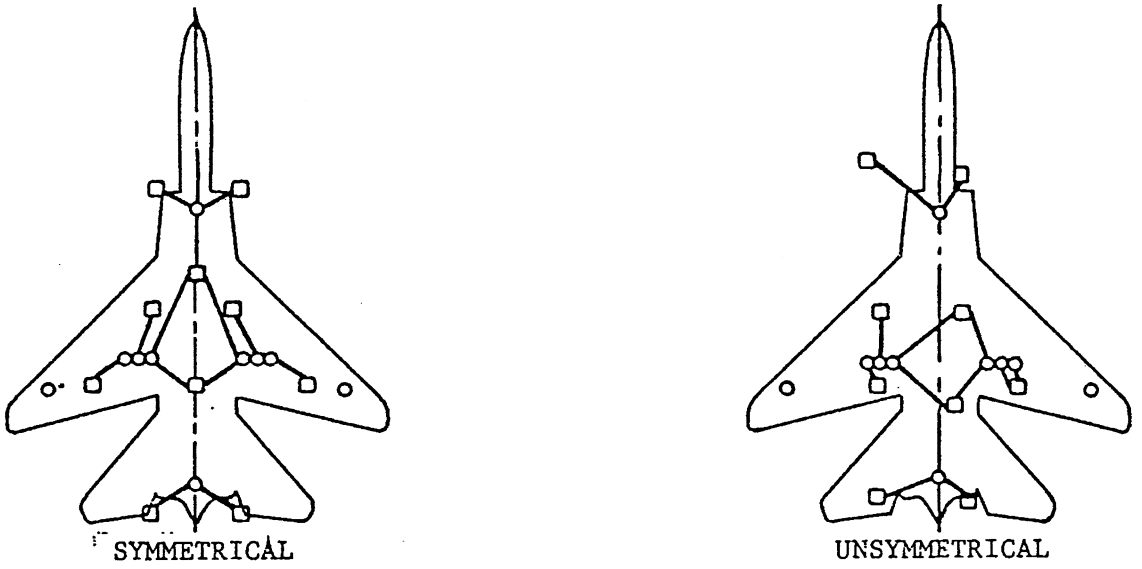


FIGURE 2. 12-line, moderate weather tie-down.

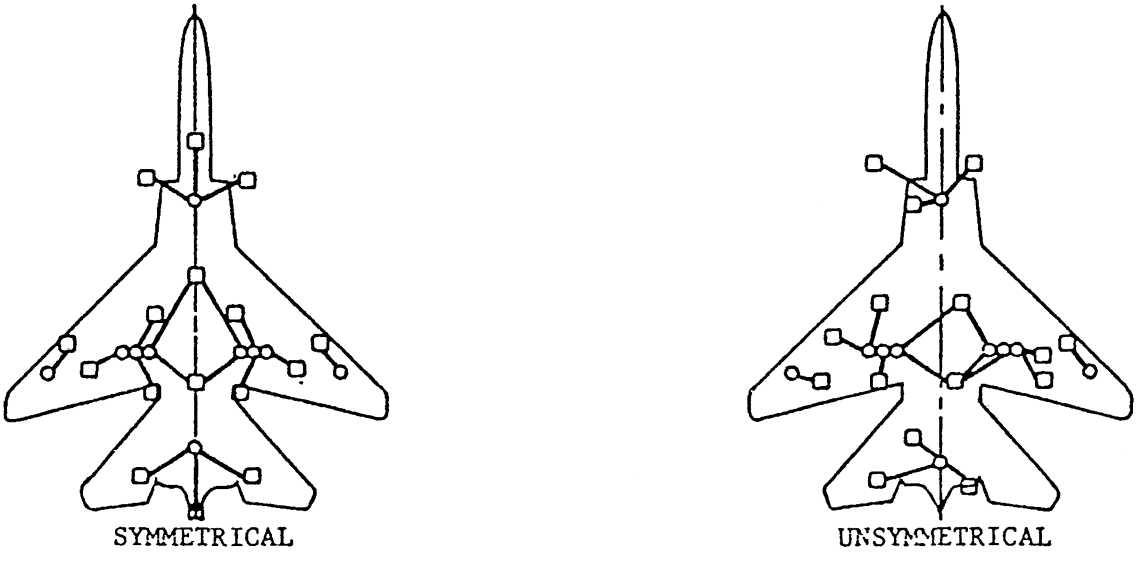
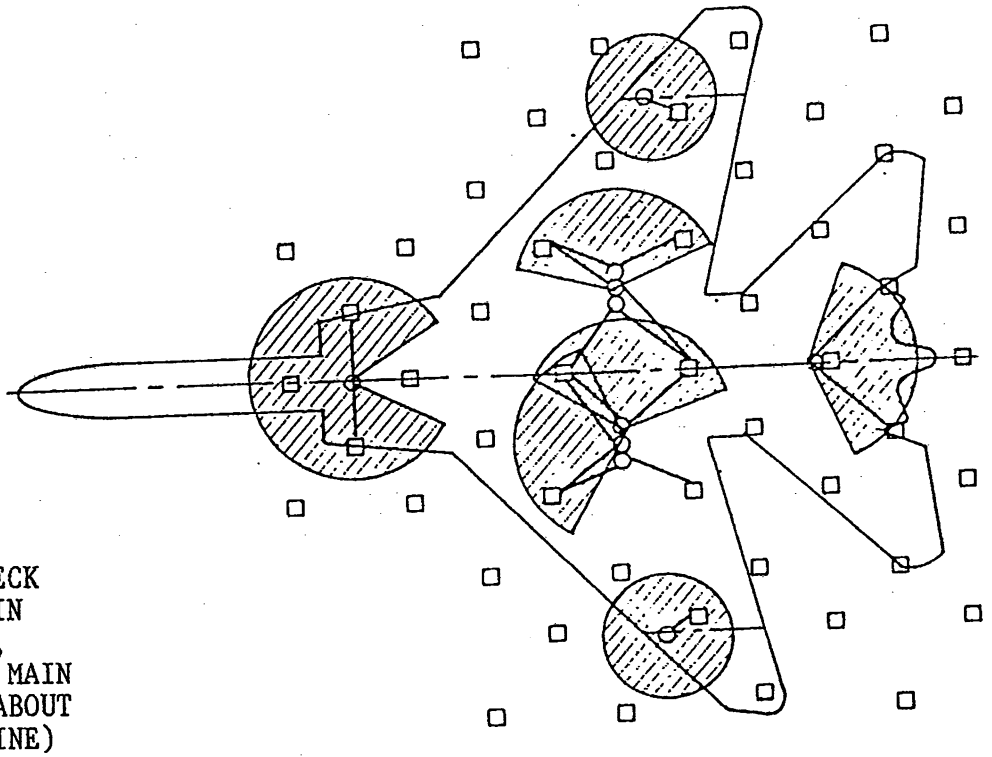
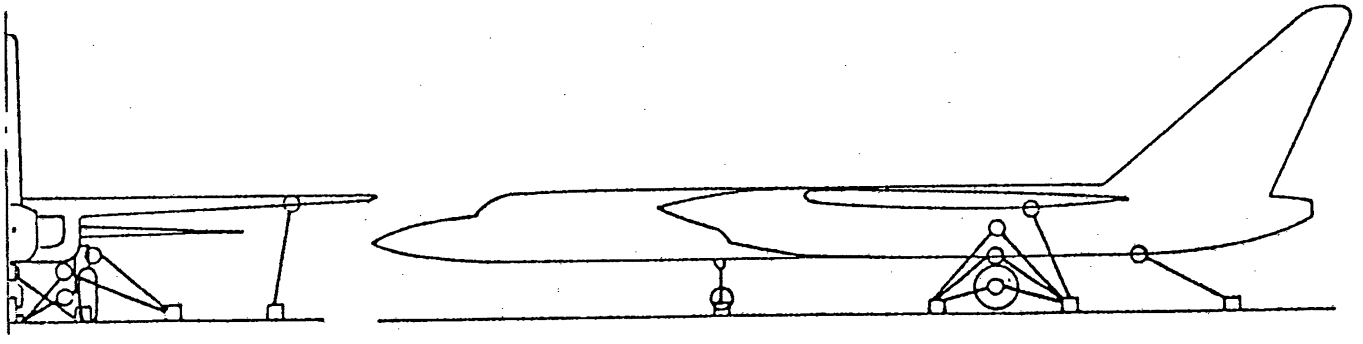


FIGURE 3. 18-line, heavy weather tie-down.

○ AIRCRAFT FITTING
□ DECK FITTING



NOTE:
ATTACH LINES TO DECK FITTINGS LOCATED IN SHADED AREAS ONLY, (SHADED AREAS FOR MAIN GEAR SYMMETRICAL ABOUT AIRCRAFT CENTER LINE)



AIRCRAFT RECOMMEND HEAVY WEATHER TIE-DOWN PATTERN

FIGURE 4. Tie-down arrangement drawing.

○ AIRCRAFT FITTING
□ DECK FITTING

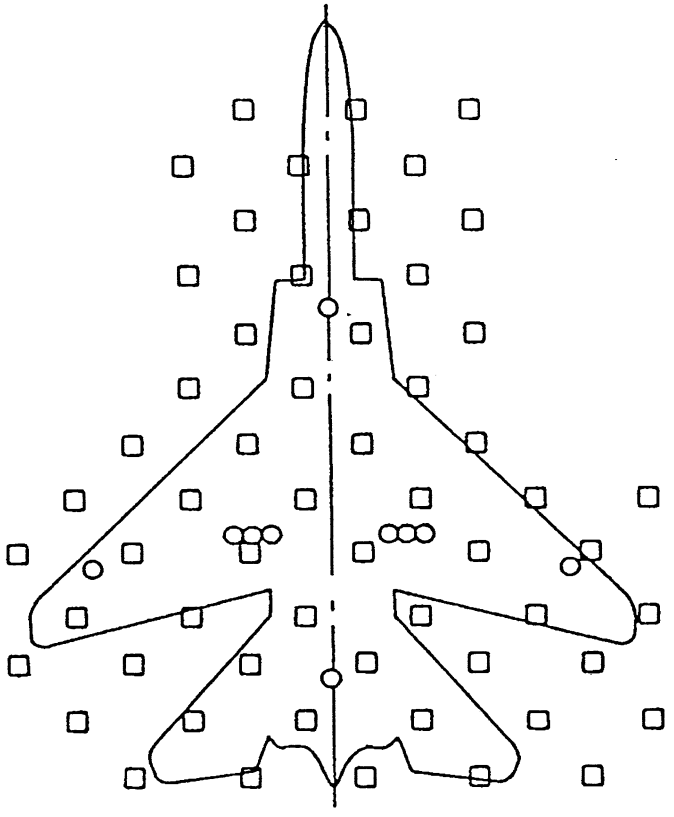
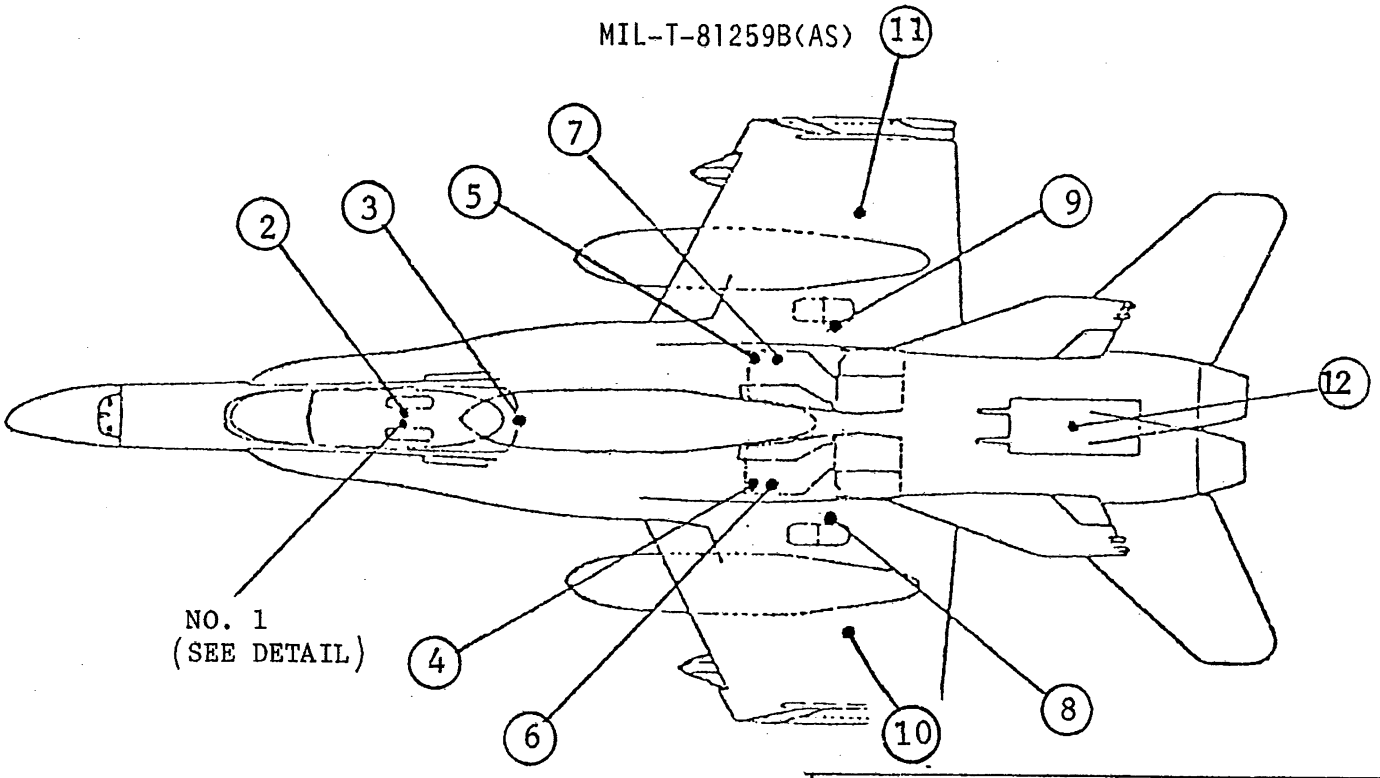
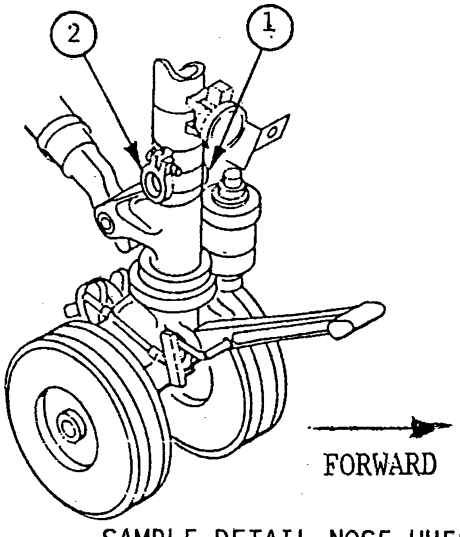


FIGURE 5. Spotting position for tie-down patterns.





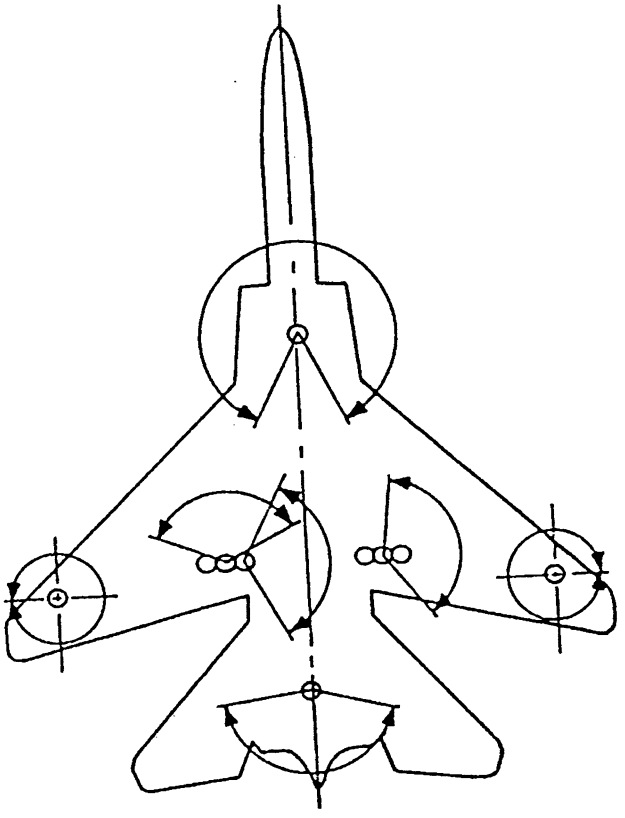
SAMPLE DETAIL-NOSE WHEEL

(SPECIFIC LOCATION OF EACH TIE-DOWN FITTING SHALL BE ILLUSTRATED)

TIE-DOWN FITTING DESCRIPTION	LOC. NO.	COORDINATES X	Y	Z
NOSE GEAR	1 2			
FWD FUSELAGE	3			
MAIN LANDING GEAR	4 5 6 7 8 9			
WING	10 11			
AFT FUSELAGE	12			

FIGURE 6. Tie-down Fitting Locations.

○ AIRCRAFT FITTING



Arrows show that portion of the base of a cone generated by a tie-down chain of either 118" or 236" Maximum length.

These tie-down chains shall be secured to the deck fittings without interfering with structure.

FIGURE 7. Tie-down clearance area.

TABLE III. Deck tie-down fitting pattern.

Ship Type	Flight Deck		Hangar Deck	
	A (See Figure 8)	B (See Figure 8)	A (See Figure 8)	B (See Figure 8)
Aviation Ships (CV/CVN)	5'0"	5'0"	5'0"	5'0"
Amphibious] LHA	4'6"	7'0"	3'6"	5'0"
Aviation] Ships] LPH	5'0"	4'0"	5'0"	4'0"
Air Capable Ships	3'6"	3'6"	3'6"	3'6"

☐ DECK FITTING

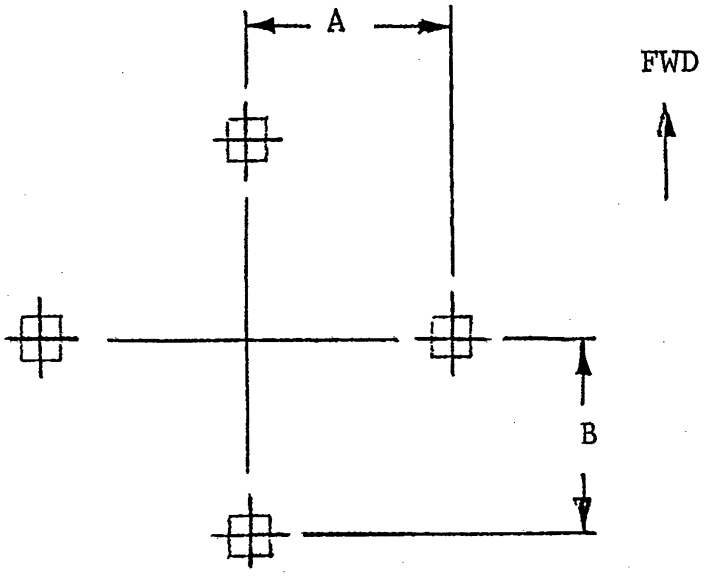


FIGURE 8. Deck Fitting Pattern Spacing.