NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

January 30, 2015

Group Chairman's Factual Report

STRUCTURES

DCA13MA081

Attachment 1

Telair International Weight and Balance Control and Loading Manual, Report Number 25-55-66 Revision L, Main Deck Cargo Handling System, System Number: 193100-331/-332/-334/-335/-336/-337/-338/-339/-4051/-4053/-4055/-407/-4071, Aircraft: Boeing 747-400SF

These are only selected pages needed for the purposes of conducting the accident investigation. This is not a complete manual and not approved for commercial use.

WEIGHT & BALANCE CONTROL AND LOADING MANUAL

Report Number 25-55-66

Revision L

Main Deck Cargo Handling System

System Number: 193100-331/-332/-334/-335/-336/-337/-338/-339/-4051/-4053/-4055/-407/-4071

Aircraft: Boeing 747-400SF

PREPARED BY:	[redacted]	**15.08.2005** **Date**
CHECKED BY:	[redacted]	**15.08.2005** **Date**
APPROVED BY:	[redacted]	**15.08.2005** **Date**

APPLICABLE CONFIGURATIONS	
ALL	

REVISION HISTORY

REVISION	DESCRIPTION	DATE	PREPARED	APPROVED
-	First Release	15-Aug-2005	[redacted]	[redacted]
A	Tables for missing/inoperative restraints incorporated. Tie down locations at nose section deleted.	27-Oct-2005	[redacted]	[redacted]
B	Chapter “Cargo Tiedowns” updated.	04-Nov-2005	[redacted]	[redacted]
C	In chapter 2.2 A/C serial numbers added. In chapter 12 tables for missing restraints corrected. Chapters 5.1.1, 10.3.7 and 12.12 updated regarding use of Q pallet. Chapter 13.4 updated.	07-Apr-2006	[redacted]	[redacted]
D	In chapter 2.2 A/C serial numbers added.	18-Aug-2006	[redacted]	[redacted]
E	In chapter 4.2.1 was 4.3. Chapter 4.2.2 new introduced. Chapters 6 and 7 marked as ‘Reference only’.	13-Oct-2006	[redacted]	[redacted]
F	In chapter 2.2 A/C serial numbers added.	17-Apr-2007	[redacted]	[redacted]
G	Chapter 2.2 updated and A/C serial numbers added. Center Line Restraint system P/N 193100-4051/-4053/-4055/-407/-4071 added: Chapter 3: Note for Center Line Restraint Systems added. Chapter 5.1.1 Pallets for center line restraint system added. Chapter 11: chapters 11.5, size code F CLR, 11.7, size code G, 11.9, size code M, 11.11 size code R introduced, chapter numbering updated. Chapter 12: chapter 12.2, cargo Center Line Restraint size code F, G, M, R added. Chapter 12.3: Note for CLR added. apter 12.10, size code F, 12.12, size code 12.15, size code M, 12.19, size code R roduced. Numbering of chapter 12 updated.	12-Feb-2008	[redacted]	[redacted]

APPLICABLE CONFIGURATIONS	
ALL	

H	Chapter 11.3: Size Code B capability extended from 31 to 33 ULDs; Comment added how to load the two additional pallets;	31-Jul-2008	[redacted]	[redacted]
J	Chapter 11.3: Table Size Code B centroid balance arms corrected	13-Aug-2008	[redacted]	[redacted]
K	Chapter 11.2: Table Size Code A centroid balance arms corrected (Position T) Chapter 11.8: Table Size Code M centroid balance arms corrected (Position T)	14-Aug-2008	[redacted]	[redacted]
L	Chapter 2.2: Table with converted airplanes updated; BCF MOD Line# column added; Airplanes sorted by BCF MOD LINE#	10-Feb-2009	[redacted]	[redacted]

Table of Content

1. INTRODUCTION

The data presented in this manual are in compliance with Federal Aviation Regulations Part 25, Paragraphs 25.29; 25.471 (b); 25.1519 and 25.1583 (c); and are provided for the purpose of establishing the Model 747-400SF weight and balance requirements and allowables.

This manual presents all the weight and balance information necessary to ensure safe airplane operation. In addition, information is provided to allow the operator to efficiently plan loading procedures in such a manner that maximum payload capability is safely distributed for any type of operation.

The Weight and Balance Manual is organized following the guidelines of the Air Transport Association (ATA) Specification No. 100, “Specification for Manufacturers' Technical Data”. Accordingly, the weight and balance data is presented in two chapters.

1.1. CHAPTER 1 - CONTROL

Control contains all weight and balance data specifically related to the customer aircraft. The data presented in this chapter is modular, with groups of related information provided in discreet subject packages, each of which is uniquely identified by a three element Chapter-Section-Subject number (CHP-SEC-SUB). Major data groupings for the Chapter-Sections are as follows:

CHAPTER -SECTION	MAJOR DATA GROUPING
1-00 through 1-09	General
1-20 through 1-29	Fuel
1-30 through 1-39	Fluids
1-40 through 1-49	Personnel
1-60 through 1-69	Cargo
1-80 through 1-89	Ground Operations
1-90 through 1-99	Examples

The two digit section (SEC) element allows for ten distinct topics within each major group of data (e.g. 20 through 29 for Fuel). The subject (SUB) element is primarily used to uniquely identify topically identical data for varying aircraft configurations. However, in some cases the subject (SUB) element is used to further subdivide topical information.

The Chapter 1 document includes only those topics that apply to the airplanes called out in the “Airplane Configuration” section of the document. The CHP-SEC-SUB number, page numbering, revision date and document number appear on the lower outside corner of each page.

Changes within a revised CHP-SEC-SUB are identified with a solid bar in the outside margin, adjacent to the change. The date for the CHP-SEC-SUB will be revised and the changes will be noted in the revision highlights.

To determine if you have received a complete document, check each section listed in the “Table of Contents” and confirm that the section is included in this document. The total number of pages for each section is specified at the bottom of every page contained within it (e.g. “Page 1 of 4”, where “4” represents the total number of pages in the section).

1.2. MANAGING AIRCRAFT CONFIGURATIONS

In chapter 2 of this document lists all aircraft covered in this document, along with the allowable configurations associated with each aircraft. Restrictions and limitations for each association of a configuration with a specific aircraft serial number are defined in the same section under the heading “Configuration Qualifications”.

The data presented within each chapter apply to the aircraft configuration(s) listed in the “Applicable Configurations” box at the bottom of each page. The word “All” signifies that the data is applicable to all configurations listed in the “Airplane Configuration” section of this document, whereas data that is applicable to specific aircraft configurations will list only the appropriate configuration letter(s) in the “Applicable Configurations” box.

1.3. CHAPTER 2 - AIRCRAFT REPORTS

The Aircraft Report (covered in a separate document) contains weight and balance data specifically related to each delivered aircraft of the customer's fleet. The data includes: make, model, serial number, registration identification, actual weighing data, and inventory list for the delivery configuration of each aircraft.

2. AIRPLANE CONFIGURATION

The engineering and FAA certification provided by this document are applicable and valid only for the airplane in its original Boeing delivery configuration and as modified by the incorporation of FAA approved Boeing Service Bulletins. With respect to any other modifications, it shall be the responsibility of the buyer to obtain appropriate regulatory agency approval of the data provided by this document.

2.1. CONFIGURATION ASSIGNMENT

The table shown below correlates each airplane serial number to the currently allowed configuration(s) for that airplane. Each configuration is designated by a different letter. Configuration qualifications are listed following the table and indicate the change authorization involved for airplanes with multiple allowable configurations. Because there may be multiple configuration letters applicable to any serial number, and also multiple configuration qualifications listed for any configuration letter, care should be exercised when determining the configuration letter which correctly reflects the applicable configuration of the airplane.

LINE NUMBER	SERIAL NUMBER	VARIABLE NUMBER	REGISTRY NUMBER	TELAIR SYSTEM STC No.:	APPLICABLE BOEING WEIGHT & BALANCE MANUAL	CONFIGURATION
-440	94740	XX440	SMX440	STXXX	D043U542-XXX1	X

2.2. CONFIGURATION QUALIFICATIONS

PRODUCTION LINE NUMBER	BCF MOD LINE# (Ref)	SERIAL NUMBER	VARIABLE NUMBER	REGISTRY NUMBER (Reference)	TELAIR SYSTEM STC No.:	APPLICABLE BOEING WEIGHT & BALANCE MANUAL	CONFIG.
834	1	24925	RT456	B-HOU	ST00459LA	D043U544-CAT1	A
929	2	26344	RT655	JA8902	ST00459LA	D043U544-JAL1	A
831	3	24227	RT508	B-HKH	ST00459LA	D043U544-CAT1	A
739	4	24199	RT572	HL7606	ST00459LA	D043U544-KAL1	A
861	5	25152	RT782	B-HUS	ST00459LA	D043U544-CAT1	A
852	6	25068	RT510	B-KAE	ST00459LA	D043U544-DRG1	A
717	7	24061	RT501	PH-MPP	ST00459LA	D043U544-GPR1	A
980	8	26353	RT657	JA8909	ST00459LA	D043U544-JAL1	A
921	9	26547	RT513	B-KAF	ST00459LA	D043U544-DGR1	A
748	10	24200	RT573	HL7412	ST00459LA	D043U544-KAL1	A
827	11	24976	RT781	B-HUR	ST00459LA	D043U544-CAT1	A
838	12	24975	RT509	PH-MPQ	ST00459LA	D043U544-GPR1	A
961	13	26350	RT656	JA8906	ST00459LA	D043U544-JAL1	A

PRODUCTION LINE NUMBER	BCF MOD LINE# (Ref)	SERIAL NUMBER	VARIABLE NUMBER	REGISTRY NUMBER (Reference)	TELAIR SYSTEM STC No.:	APPLICABLE BOEING WEIGHT & BALANCE MANUAL	CONFIG.
990	14	27137	RT520	B-2430	ST00459LA	D043U544-GPR1	A
830	15	24621	RT574	HL7608	ST00459LA	D043U544-KAL1	A
962	16	27133	RT518	B-HKJ	ST00459LA	D043U544-CAT1	A
872	17	25238	RT071	F-GISA	ST00459LA	D043U544-AFA1	A
1049	18	27070	RT528	B-HKS	ST00459LA	D043U544-CAT1	A
805	19	24801	RT751	F-GISF	ST00459LA	D043U544-AID1	A
953	20	27067	RT516	B-KAG	ST00459LA	D043U544-DRG1	A
884	21	25302	RT072	F-GISB	ST00459LA	D043U544-AFA1	A
809	22	24226	RT507	PH-MPR	ST00459LA	D043U544-GPR1	A
1026	23	26356	RT967	JA8911	ST00459LA	D043U544-JAL1	A
960	24	25630	RT075	F-GISE	ST00459LA	D043U544-AFA1	A
1023	25	27217	RT524	B-KAI	ST00459LA	D043U544-DRG1	A
853	26	25205	RT575	HL7482	ST00459LA	D043U544-KAL1	A
745	27	24405	RT022	N472JD	ST00459LA	D043U544-GPR1	A
1188	28	26361	RM128	JA8915	ST00459LA	D043U544-JAL1	A
791	29	24066	RT506	PH-MPS	ST00459LA	D043U544-GPR1	A
874	30	25275	RT576	HL7483	ST00459LA	D043U544-KAL1	A
738	31	24315	RT021	N471JD	ST00459LA	D043U544-GPR1	A
994	32	27154	RT161	B-16461	ST00459LA	D043U544-UPS1	A
812	33	24833	RT752	JA8095	ST00459LA	D043U544-TLS1	A
981	34	27134	RT519	9V-SPS	ST00459LA	D043U544-DRG1	A
925	35	25871	RT461	B-HOZ	ST00459LA	D043U544-CAT1	A
1016	36	26062	RT164	B-16465	ST00459LA	D043U544-UPS1	A
743	37	24346	RT031	B-2456	ST00459LA	D043U544-CGC1	A
775	38	24347	RT032	B-2458	ST00459LA	D043U544-CGC1	A
760	39	24424	RT642	JA8072	ST00459LA	D043U544-JAL1	A
792	40	24348	RT033	B-2460	ST00459LA	D043U544-CGC1	A
1101	41	26557	RT837	9V-SPL	ST00459LA	D043U544-CAT1	A
1040	42	26550	RT526	9V-SPA	ST00459LA	D043U544-SIA1	A
832	43	24920	RT776	JA8096	ST00459LA	D043U544-ANA1	A
893	[1]	26392	RT577	HL7484	ST00459LA	D043U544-KAL1	A
922	[1]	26395	RT578	HL7485	ST00459LA	D043U544-KAL1	A
1241	[1]	29950	RM041	9V-SPM	ST00459LA	D043U544-SIA1	A
951	[1]	26396	RT579	HL7489	ST00459LA	D043U544-KAL1	A
863	[1]	25135	RT777	JA8097	ST00459LA	D043U544-ANA1	A
1070	[1]	26554	RT530	9V-SPE	ST00459LA	D043U544-SIA1	A
1153	[1]	26359	RM126	JA8913	ST00459LA	D043U544-JAL1	A
1234	[1]	27650	RM130	JA8918	ST00459LA	D043U544-JAL1	A

APPLICABLE CONFIGURATIONS	
ALL	

PRODUCTION LINE NUMBER	BCF MOD LINE# (Ref)	SERIAL NUMBER	VARIABLE NUMBER	REGISTRY NUMBER (Reference)	TELAIR SYSTEM STC No.:	APPLICABLE BOEING WEIGHT & BALANCE MANUAL	CONFIG.
1202	[1]	26362	RM129	JA8916	ST00459LA	D043U544-JAL1	A
[1] to be assigned							

3. GENERAL INFORMATION

The purpose of this customer manual is to provide specific weight and balance control and loading information which apply to the customer airplanes listed in chapter 2. This supplementary information included in this manual will enable airline personnel to update their balance analyses and prepare actual operational weight and balance procedures.

Actual weighting data for each airplane is contained in the applicable airplane manual which is identified by Boeing as D043U5xx-XXX1.

This supplementary Weight & Balance and Loading Control Manual always has to be read in conjunction with the applicable Boeing Weight & Balance Manual for the airplanes listed in chapter 2.

Note:

All data provided in this document are based upon Boeing Weight & Balance Manual D043U524. Refer to the applicable Boeing Weight & Balance Manual for aircraft's listed in chapter 2, for any further restrictions in load carrying capability of the Main Deck Cargo Compartment.

Note:

The Center Line Restraint Systems P/N 193100-4051, -4053, -4055, -407 and -4071 are sub-systems which enable center line loading and restraining on the main deck. The Center Line Restraint Systems P/N 193100-4055 and -4071 are add-on systems only, which can not be used for center line loading solely. The P/N 193100-4053 Center Line Restraint System can be extended with P/N 193100-4055 to the P/N 193100-4051 configuration. The Center Line Restraint System P/N 193100-4071 is an add on system with guiding functionality only, which simplifies the loading process for the -407 system.

Note: For position G3 (Ref. 11.7, 12.2; Center Line Restraint System P/N 193100-4051 / 4053) the use of pallets with side slots and massive floor plate sides is prohibited.

3.1. WEIGHT AND BALANCE DEFINITIONS

The following definitions are provided to assist operators in having a better understanding of the terms used throughout the Weight and Balance Manual.

3.2. General Terms and Acronyms

General Terms and Acronyms	
Balance Arm (B.A.)	A true measure of distance from forward to aft, in inches, from a fixed datum. The fixed datum is selected by the airplane manufacturer. Balance Arms are used in weight and balance calculations. To see the relationship between B.A. and B.S., refer to chapter 3 of this manual.
Body Station (B.S.)	A manufacturing location on the airplane. For first of an airplane model, B.S. are continuous from the front to the aft of the airplane. For later versions that are either stretched (i.e. fuselage inserts added) or shrunk (i.e. fuselage sections removed), B.S. becomes discontinuous, for manufacturing reasons. To see the relationship between B.A. and B.S., refer to chapter 3 of this manual.
Layout of Passenger Arrangement (LOPA)	A Boeing internal drawing the depicts the interior layout.
Layout of Passenger Systems (LOPS)	A Boeing internal drawing that depicts the interior layout.

Weight Terms	
Basic Empty Weight (BEW)	Standard Basic Empty Weight plus or minus weight of standard item variations.
Delivery Empty Weight (DEW)	Manufacturer's Empty Weight, less any shortages, plus those standard items and operational items in aircraft at time of delivery.
Fleet Empty Weight (FEW)	Average Basic Empty Weight used for a fleet or group of aircraft of the same model and configuration. (The weight of any fleet member shall not vary more than the tolerance established by government regulations.)
Guaranteed Weight	Weight the manufacturer clearly defines and guarantees, subject to contractual tolerances and adjustments.
Manufacturer's Empty Weight (MEW)	Weight of structure, powerplant, furnishings, systems and other items of equipment that are an integral part of a particular aircraft configuration. (It is essentially a “dry” weight, including only those fluids contained in closed systems.)
Maximum Payload	Maximum Zero Fuel Weight minus Operational Empty Weight.
Operational Empty Weight (OEW)	Basic Empty Weight or Fleet Empty Weight plus operational items.
Operational Items	Personnel, equipment and supplies necessary for a particular oper-ation but not included in Basic Empty Weight. These items may vary for a particular aircraft and may include, but are not limited to, the following: • Crew and Baggage • Manuals and navigational equipment • Removable service equipment for cabin, galley and bar • Food and beverage, including liquor • Usable fluids other than those in useful load • Life rafts, life vests and emergency transmitters • Aircraft unit load devices
Operational Landing Weight (OLW)	Maximum authorized weight for landing. (It is subject to airport, operational and related restrictions. It must not exceed maximum certified landing weight.)
Operational Takeoff Weight (OTOW)	Maximum authorized weight for takeoff. (It is subject to airport, oper-ational and related restrictions. This is the weight at start of takeoff run and must not exceed maximum certified takeoff weight.)
Payload	Weight of the passengers, cargo and baggage. (These may be reve-nue and/or nonrevenue.)

Standard Basic Empty Weight (SBEW)	Manufacturer's Empty Weight plus standard items.
Standard Items	Equipment and fluids not considered an integral part of a particular aircraft and not a variation for the same type of aircraft. These items may include, but are not limited to, the following: • Unusable fuel and other unusable fluids • Engine oil • Toilet fluid and chemical • Fire extinguishers, pyrotechnics and emergency oxygen equipment • Structure in galley, buffet and bar • Supplementary electronic equipment
Useful Load	Difference between takeoff weight and Operational Empty Weight. (It includes payload, usable fuel and other usable fluids not included as operational items.)
Zero Fuel Weight	Operational Empty Weight plus payload. (This weight must not exceed Maximum Zero Fuel Weight.)
Weight Limitation Term	
Maximum Fuel Transfer Weight (MFTW)	The weight above which Reserve Tanks 2 and 3 must be full.
Maximum Landing Weight (MLW)	Maximum weight for landing as limited by aircraft strength and air-worthiness requirements.
Maximum Takeoff Weight (MTOW)	Maximum weight at brake release as limited by aircraft strength and airworthiness requirements.
Maximum Taxi Weight (MTW)	Maximum weight for ground maneuver as limited by aircraft strength and airworthiness requirements. (It includes weight of taxi and runup fuel.)
Maximum Zero Fuel Weight (MZFW)	Maximum weight allowed before usable fuel must be loaded in the aircraft as limited by strength and airworthiness requirements.
Minimum Flight Weight (MFW)	Minimum weight for flight as limited by aircraft strength and airwor-thiness requirements.
Fuel Terms	
Unusable Fuel	Fuel remaining after a fuel runout test has been completed in accor-dance with government regulations. (It includes drainable unusable fuel plus unusable portion of trapped fuel.)
Drainable Unusable Fuel	Unusable fuel minus unusable portion of trapped fuel.

Trapped Unusable Fuel	Unusable fuel remaining when aircraft is defueled by normal means using the procedures and attitudes specified for draining the tanks.
Usable Fuel	Fuel available for aircraft propulsion.
Drainable Usable Fuel	Usable fuel that can be drained from the aircraft by normal means using the procedures and attitudes specified for draining the tanks.
Trapped Usable Fuel	Usable fuel remaining in the fuel feed and engine lines after stan-dard tank defueling.

Curtailments

Cargo Location Variation	Operational margin placed within the certified center of gravity limits to compensate for the effect of reasonable variations in cargo loca-tion when partially unrestricted cargo placement is permitted.
Fuel Density Variation	Operational margin placed within the certified center of gravity limits to compensate for the effect of fuel density variation.
Fuel Usage	Operational margin placed within the certified center of gravity limits to compensate for the effect of fuel management during the critical portions of flight.
In-flight Movement	Operational margin placed within the certified center of gravity limits to compensate for the effect of reasonable passenger, crew, and cart movement during flight.
Loading Schedule	A hardcopy or computerized form used to record the aircraft's weight, load distribution and other appropriate information; to calculate and check the weight and balance conditions of the aircraft against operational limitations; and to establish the stabilizer trim setting for takeoff.
Operational Empty Weight Variation	Operational margin placed within the certified center of gravity limits to compensate for the known variations in the standard and operational items.
Passenger Seating Variation	Operational margin placed within the certified center of gravity limits to compensate for the effect of reasonable variations in passenger center of gravity when unrestricted seating is permitted.

Balance Terms

Fleet Center-of-Gravity	Average Basic Empty Weight center of gravity used for a fleet or group of aircraft of the same model and configuration. (The center of gravity of any fleet member shall not vary more than the maximum tolerance established by government regulations.)
Lateral Imbalance	The offset of the airplane center of gravity from the airplane centerline. It is usually expressed as a moment (LB-IN. or KG-IN.) about the airplane centerline.

Cargo Terms and Definitions

Approved ULD	A unit load device that has been manufactured in accordance to and received approval by the appropriate governmental airworthiness authority indicating the airplane ULD meets their safety requirements.
Container	A rigid structure that performs the function of a ULD without the use of a restraining net.
Frangible Cargo	Cargo consisting of items which will progressively conform to the airplane contour when subjected to loads up to limit load.
G	The expression used to show the magnitude of a force in terms of the standard earth gravitational unit.
Igloo	A bottomless rigid shell made of fiberglass, metal or other suitable material. Its shape conforms to the contours of cargo aircraft envelopes. It covers the maximum usable area of an aircraft pallet to which it is secured during flight.
Limit Loads	Limit loads are the maximum loads to be expected in service. Limit loads must be supported without detrimental permanent deformation or interference with safe operation.
NAS3610	A document which defines test conditions for approval of ULDs per TSO-C90c.
Non-Approved ULD	A unit load device that has not received approval by the appropriate governmental airworthiness authority indicating the airplane ULD meets their safety requirements.
Pallet	An item of equipment consisting of a flat platform with a flat undersurface of standard dimensions on which goods are assembled and secured before being loaded as a unit onto the airplane.
Rigid Cargo	Cargo consisting of an item or items which will not progressively conform to the airplane contour when subjected to loads up to limit load. Examples include machine tools, pipes, large motors or generators, etc.

Tiedown Fitting	An attachment device designed to transfer forces between a load bearing device (typically a net, strap, rope or bar) and a cargo track.
TSO-C90c	Technical Standard Order for the approval of ULDs. NAS 3610 is the minimum performance standard.
ULD	Unit Load Device. An assembly of components comprising either of the following: • aircraft pallet and pallet net, straps, igloo • aircraft container. The purpose of the unit load device is to enable individual pieces of cargo to be assembled into a standardized sized unit to facilitate rapid loading/unloading onto aircraft having compatible handling and restraint systems which interface directly with the unit.
ULD Position	A volume in the cargo compartment which is designated and equipped to be occupied, during flight, by a ULD of specified type.
Ultimate Load	Ultimate loads are limit loads multiplied by prescribed factors of safety.

3.3. ABBREVIATIONS

The following terms, when necessary, will be abbreviated as shown below.

UNIT	ABBREVIATION	UNIT	ABBREVIATION
Pounds	LB	Inches	IN.
Kilograms	KG	Feet	FT
U. S. Gallons	U.S. GAL.	Square Feet	SQ FT
Liters	L	Cubic Feet	CU FT
Number	NO.	Inboard	INBD
Forward	FWD	Outboard	OUTBD
Balance Arm	B.A.	Mean Aerodynamic Chord	MAC
Body Buttock Line	B.B.L.	Leading Edge of the MAC	LEMAC
Water Line	W.L.	Center of Gravity	C.G.

3.4. CONVERSION FACTORS

The data in this manual is provided in both English and Metric units. Unless otherwise stated, the conversions listed below are used throughout this manual.

MULTIPLY	BY	TO OBTAIN
Pounds	0.45359237	Kilograms
U. S. Gallons	3.78541180	Liters

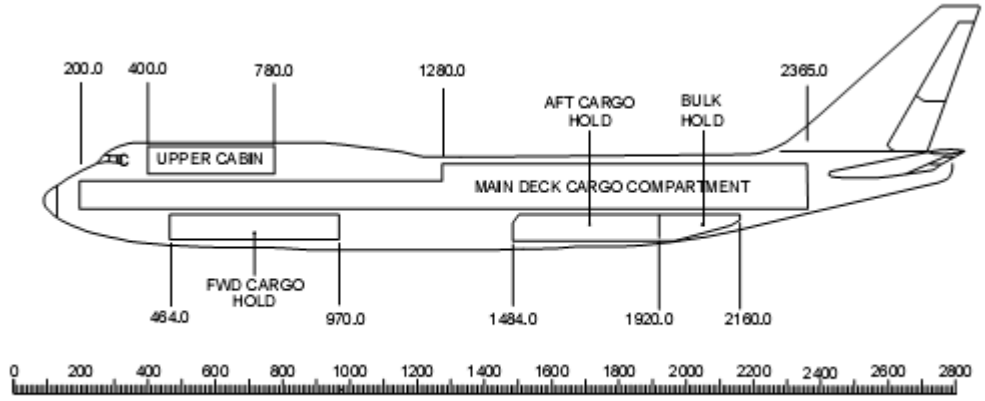
When totals or summations are required the English values are summed separately from the metric values. Differences may occur when comparing the English totals with the metric totals due to round off.

All metric values are converted from English values. When using the conversion factors in this manual, all resultants will be rounded except when the value is a weight limitation. For minimum or maximum weight limitations the resultant metric values will be rounded up or truncated, whichever is more conservative.

4. CARGO COMPARTMENT LOAD LIMITS

4.1. MAXIMUM ALLOWABLE WEIGHTS

This section provides main deck and lower deck cargo compartment loading. These values are the maximum allowable weights that can be sustained by the basic monocoque structure. The following illustration shows the configuration of the cargo compartments.



Five basic structural limitations that must be observed when loading payload are compartment, linear loading, floor loading, cargo net loading, combined load limits, and cumulative load limitations. Cumulative load limitations are discussed in chapter 4.

4.2. CARGO COMPARTMENT LOAD LIMITS

Maximum allowable compartment weights, and maximum allowable linear and floor loading are provided in the following table:

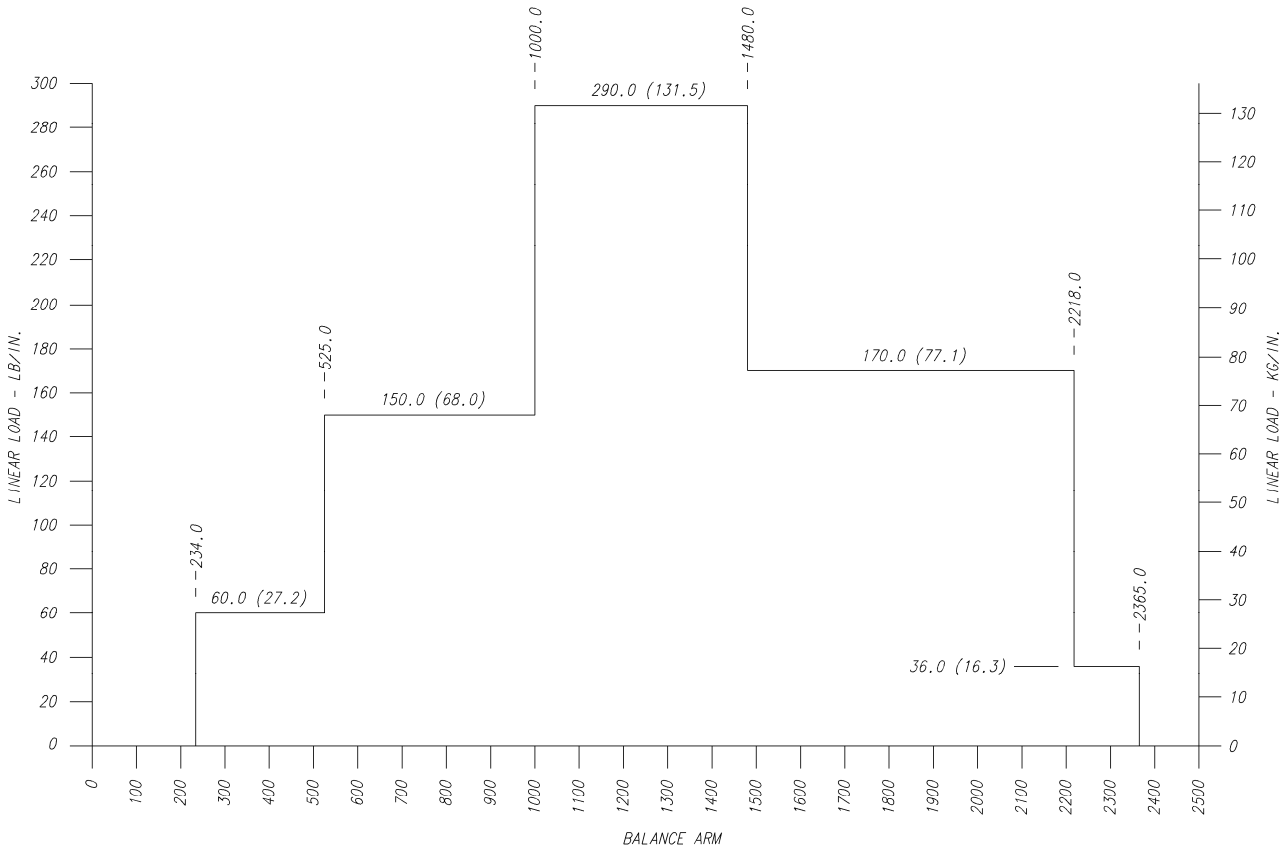
MAXIMUM ALLOWABLE WEIGHT							
	COMPARTMENT	TOTAL WEIGHT		FLOOR LOADING			
		LB	KG	LB/IN.	KG/IN.	LB/ SQ FT	KG/ SQ FT
	Upper Cabin B.A. 140.0 to B.A. 2360.0			31.8[a]	14.4[a]	100.0	45.3
	Main Deck Cargo[b]						
	B.A. 228.0 to B.A. 525.0	17280	7838	60,0	27,2	100,0	45,3
	B.A. 525.0 to B.A. 1000.0	71250	32318	150,0	68,0	200,0	90,7
	B.A. 1000.0 to B.A. 1480.0	115200	52281	290,0	131,5	400,0	181,4
	B.A. 1480.0 to B.A. 2218.1	125460	56907	170,0	77,1	400,0	181,4
	B.A. 2218.0 to B.A. 2365.0	4500	2041	36,0	16,3	100,0	45,3

[a] The upper cabin allowable load includes the weight of supernumeraries, supernumeraries seats, and supernumeraries carryon baggage stowed under the seats.
[b] The main deck limitations include the weight of cargo and the unit load devices (ULDs).

CAUTION:
THESE LOADS MAY BE FURTHER LIMITED BY CUMULATIVE LOAD LIMITATIONS.

4.2.1. MAXIMUM MAIN DECK LINEAR LOAD LIMITS

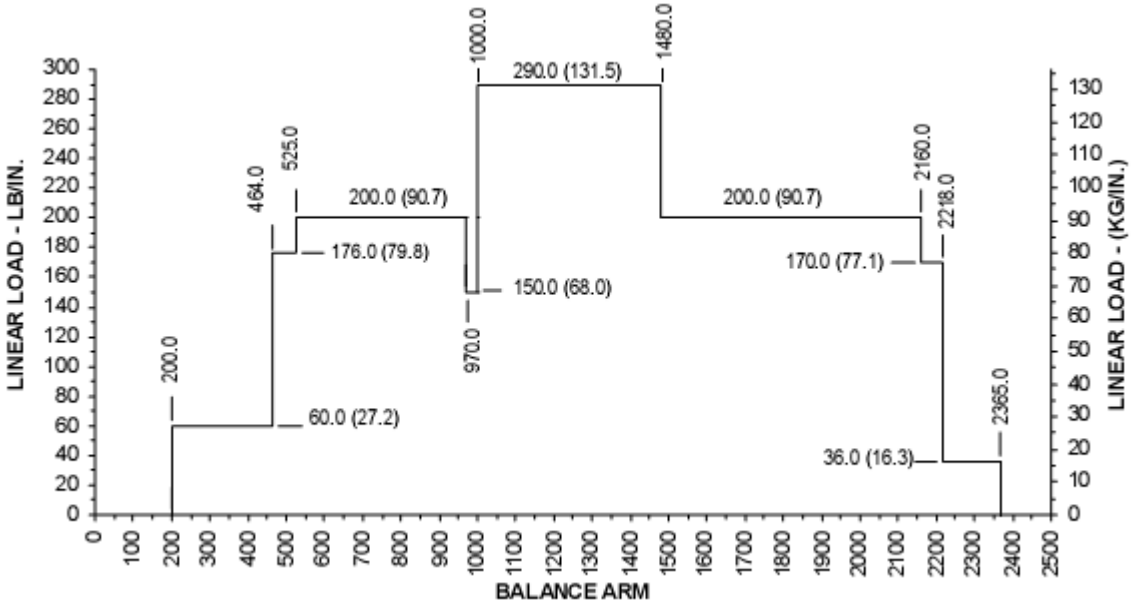
Total loading for the main deck cargo must not exceed the linear loading limits shown in the following diagram:



NOTE:
Combined linear loads and cumulative loads are typically more restrictive than main deck linear loads. For more information see Boeing manual D043U544-XXX1.

4.2.2. MAXIMUM COMBINED LINEAR LOAD LIMITS (REFERENCE ONLY)

Total loading for the main deck and lower deck cargo must not exceed the combined linear loading limits shown in the following diagram:

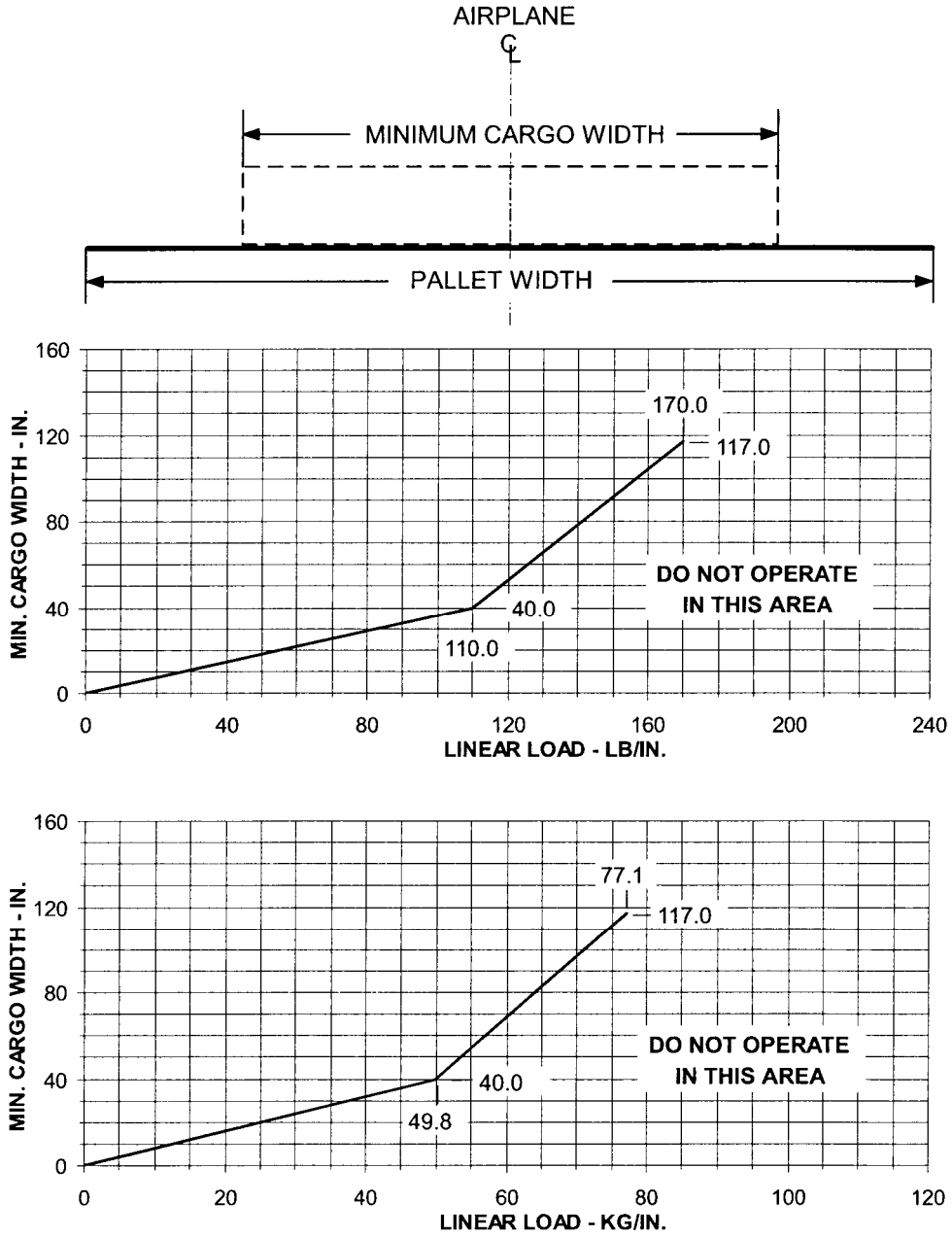


NOTE:
Cumulative loads are typically more restrictive than combined linear loads.

NOTE:
Shown for reference only. For more information see Boeing manual D043U544-XXX1.

4.4. MAIN DECK CENTERLINE LOAD LIMITS

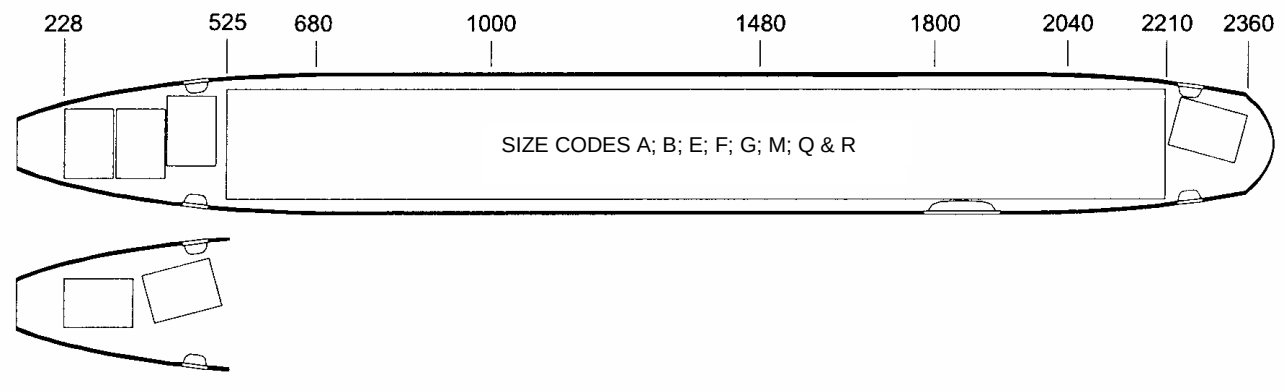
Cargo loaded on unit load devices located along the main deck centerline of the airplane between B.A. 525.0 to B.A. 1000.0 and B.A. 1480.0 to B.A. 2218.0 must meet the minimum cargo width requirements shown in the figure below. Between B.A. 1000.0 to B.A. 1480.0 the limitation is 290 LB/IN. (131.5 KG/IN.), provided the area load limit of 400 LB/SQ. FT. (181.4 KG/SQ. FT.) is not exceeded.



5. CERTIFIED UNIT LOAD DEVICE WEIGHTS BY POSITION

5.1. UNIT LOAD DEVICE POSITIONS - MAIN DECK

The following diagram illustrates the unit load device positions:



Certified unit load device (ULD) weights represent the maximum weight of the ULD, including tare. The allowable weight for a ULD may be further restricted by other factors; refer to the following subjects for additional information:

- See chapter 6 and 7 for forward and aft body cumulative loads, respectively
- See chapter 11 for allowable unit load device locations
- See chapter 12 for missing/inoperative restraint data and other loading considerations
- See chapter 13 for tiedown requirements

5.1.1. Main Deck Pallets

Certified weights for unit load devices loaded on the main deck, in pounds, are provided in the following table:

DESIGNATION			CERTIFIED WEIGHT (LB) MAIN DECK BALANCE ARM –IN.								
SIZE CODE	IATA (COMMON CODE)	NAS 3610 ULD BASE TYPE	228 to 380	380 to 525	525 to 680	680 to 1000	1000 to 1480	1480 to 1800	1800 to 2040	2040 to 2218	2218 to 2365
A	AA Lateral (M3)	1A1P[a] 1A2P[a] 1A3P 2A1P 2A2P 2A3P 2A4P 2A5P 2A6P	5280	5280							
	AA Lateral (M1A)		5280	5280							
	AA (M3)		7500	7500	11875	11875	16667	16667	13500	13793	4500
	PA (M1A)		7500	7500	11875	11875	16667	16667	13500	13793	4500
	PA		7500	7500	11875	11875	16667	16667	13500	13793	4500
B	PB	1B1P 1B2P 1B3P 1B5P 2B1P 2B2P 2B3P 2B5P	6480	6480	10000	10000	10000	10000	9375	8276	3888
	PB (463L)	1B6P	6480	6480	10260	10260	12500	12500	11664	10345	3888
E	PEB	2E1P							2586		
F	AF (M1)	2F1P			11186	11186	15625	15625	12717	12931	4239
	PF				11186	11186	15625	15625	12717	12931	4239
	PF (M1H)				11186	11186	15625	15625	12717	12931	4239
	PF[2]							15300			

DESIGNATION			CERTIFIED WEIGHT (LB) MAIN DECK BALANCE ARM –IN.								
SIZE CODE	IATA (COMMON CODE)	NAS 3610 ULD BASE TYPE	228 to 380	380 to 525	525 to 680	680 to 1000	1000 to 1480	1480 to 1800	1800 to 2040	2040 to 2218	2218 to 2365
G	AG (M2)	2G1P			22658	22658	31250	31250	25758	25862	
	PG				22658	22658	31250	31250	25758	25862	
	PG Left Side (M6)				22658	22658	31250	31250	25758	25862	
	PG Right Side(M6)				22658	22658	31250	31250	25758	25862	
	PG[2]							31250	25862[3]		
M	AM Lateral (M1)	2M1P 2M2P 2M3P	5760	5760							
	PM Lateral (M1)		5760	5760							
	AM (M1)		7500	7500	11875	11875	18750	18125	13500	15517	4500
	PM (M1)		7500	7500	11875	11875	18750	18125	13500	15517	4500
	AM (M1H, M5)		7500	7500	11875	11875	18750	18125	13500	15517	4500
	PM (M1H)		7500	7500	11875	11875	18750	18125	13500	15517	4500
	PM[2]							12500			
Q	PYB								TBD[1]		
R	PR Lateral	2R1P			14400	14400	27840	16320	16320	16320	
	PR				18620	18620	31250	28420	21168	21168	
	PR Left Side				18620	18620	31250	28420	21168	21168	
	PR Right Side				18620	18620	31250	28420	21168	21168	
	PR[2]							31250	25862		

[1] This pallet is not specified according to NAS3610. Allowable pallet weight depends on ultimate load criteria listed in applicable pallet specification of used pallet. It's the airliner's responsibility to determine the allowable weight.
[2] Data for Pallet loaded longitudinally with Center Line Restraint System P/N 193100-4051/-4053/-4055/-407/-4071.
[3] Note: For position G3 (Ref. 11.7, 12.2; Center Line Restraint System P/N 193100-4051 / 4053) the use of pallets with side slots and massive floor plate sides is prohibited.

APPLICABLE CONFIGURATIONS	
ALL	

Certified weights for unit load devices loaded on the main deck, in kilograms, are provided in the following table:

DESIGNATION			CERTIFIED WEIGHT (KG) MAIN DECK BALANCE ARM –IN.								
SIZE CODE	IATA (COMMON CODE)	NAS 3610 ULD BASE TYPE	228 to 380	380 to 525	525 to 680	680 to 1000	1000 to 1480	1480 to 1800	1800 to 2040	2040 to 2218	2218 to 2365
A	AA Lateral (M3)	1A1P[a] 1A2P[a] 1A3P 2A1P 2A2P 2A3P 2A4P 2A5P 2A6P	2395	2395							
	AA Lateral (M1A)		2395	2395							
	AA (M3)		3402	3402	5386	5386	7560	7560	6123	6256	2041
	PA (M1A)		3402	3402	5386	5386	7560	7560	6123	6256	2041
	PA		3402	3402	5386	5386	7560	7560	6123	6256	2041
B	PB	1B1P 1B2P 1B3P 1B5P 2B1P 2B2P 2B3P 2B5P	2939	2939	4536	4536	4536	4536	4252	3754	1764
	PB (463L)	1B6P	2939	2939	4654	4654	5670	5670	5291	4692	1764
E	PEB	2E1P							1173		
F	AF (M1)	2F1P			5074	5074	7087	7087	5768	5865	1923
	PF				5074	5074	7087	7087	5768	5865	1923
	PF (M1H)				5074	5074	7087	7087	5768	5865	1923
	PF[2]							6939			
G	AG (M2)	2G1P			10277	10277	14175	14175	11684	11731	
	PG				10277	10277	14175	14175	11684	11731	
	PG Left Side (M6)				10277	10277	14175	14175	11684	11731	
	PG Right Side(M6)				10277	10277	14175	14175	11684	11731	
	PG[2]							14174	11730[3]		

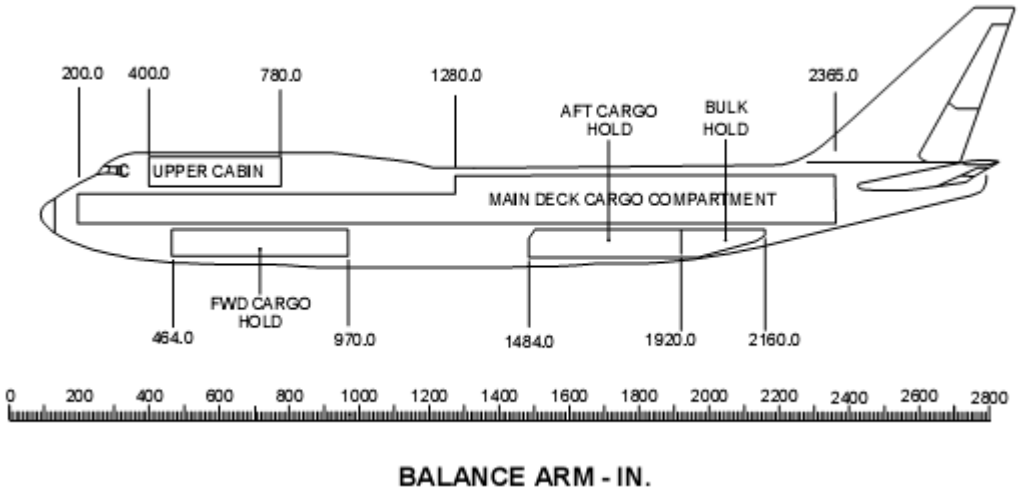
DESIGNATION			CERTIFIED WEIGHT (KG) MAIN DECK BALANCE ARM –IN.								
SIZE CODE	IATA (COMMON CODE)	NAS 3610 ULD BASE TYPE	228 to 380	380 to 525	525 to 680	680 to 1000	1000 to 1480	1480 to 1800	1800 to 2040	2040 to 2218	2218 to 2365
M	AM Lateral (M1)	2M1P 2M2P 2M3P	2613	2613							
	PM Lateral (M1)		2613	2613							
	AM (M1)		3402	3402	5386	5386	8505	8221	6123	7038	2041
	PM (M1)		3402	3402	5386	5386	8505	8221	6123	7038	2041
	AM (M1H, M5)		3402	3402	5386	5386	8505	8221	6123	7038	2041
	PM (M1H)		3402	3402	5386	5386	8505	8221	6123	7038	2041
	PM[2]							5670			
Q	PYB								TBD[1]		
R	PR Lateral	2R1P			6532	6532	12628	7403	7403	7403	
	PR				8446	8446	14175	12891	9602	9602	
	PR Left Side				8446	8446	14175	12891	9602	9602	
	PR Right Side				8446	8446	14175	12891	9602	9602	
	PR[2]							14174	11730		

[1] This pallet is not specified according to NAS3610. Allowable pallet weight depends on ultimate load criteria listed in applicable pallet specification of used pallet. It's the airliner's responsibility to determine the allowable weight.
[2] Data for Pallet loaded longitudinally with Center Line Restraint System P/N 193100-4051/-4053/-4055/-407/-4071.
[3] Note: For position G3 (Ref. 11.7, 12.2; Center Line Restraint System P/N 193100-4051 / 4053) the use of pallets with side slots and massive floor plate sides is prohibited.

8. CARGO COMPARTMENTS

8.1. GENERAL LOCATION AND ARRANGEMENT

The following airplane profile illustrates cargo compartment locations.



The following table provides the main deck cargo compartment location, usable volume and the corresponding volumetric centroid arm.

CARGO COMPARTMENT	LOCATION -B.A.		USABLE VOLUME - CU FT	B. A. IN.
	FROM	TO		
Main Deck	228.0	2365.0	26000	1250.0

The following table provides cargo compartment locations, usable volumes and the corresponding volumetric centroid arms with the net installed at B.A. 1920.0.

CARGO COMPARTMENT	LOCATION -B.A.		USABLE VOLUME - CU FT	B. A. IN.
	FROM	TO		
Forward	464.0	987.0	3523	725.5
Aft	1484.0	1920.0 [a]	2882	1702.0
Bulk	1920.0	2160.0	920	2014.6
[a] Location of net.				

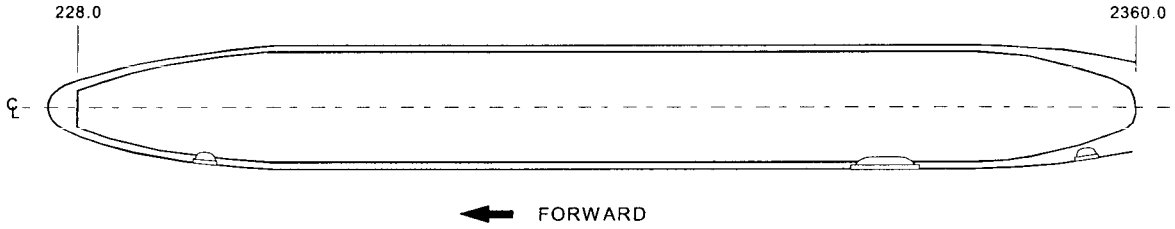
The following table provides cargo compartment locations, usable volumes and the corresponding volumetric centroid arms with the net installed at B.A. 1980.0.

CARGO COMPARTMENT	LOCATION -B.A.		USABLE VOLUME - CU FT	B. A. IN.
	FROM	TO		
Forward	464.0	987.0	3523	725.5
Aft	1484.0	1980.0 [a]	3300	1732.0
Bulk	1980.0	2160.0	520	2064.2
[a] Location of net.				

9. MAIN DECK CARGO COMPARTMENT

9.1. MAIN DECK CARGO COMPARTMENT VOLUME

The following figure shows the main deck cargo hold compartment boundaries.



Total volume and the volumetric centroid for the above figure are provided in the following table.

CARGO COMPARTMENT	LOCATION -B.A.		USABLE VOLUME - CU FT	B. A. IN.
	FROM	TO		
Main Deck Compartment	228.0	2365.0	26000	1250.0

9.2. MAIN DECK CARGO DOOR DIMENSIONS AND ALLOWABLE PACKAGE SIZES

This section provides dimensions of the maximum package sizes which will pass through the main deck cargo door openings.

Package sizes are approximate. Tilting, twisting, bending and/or rotating packages through door openings will allow additional lengths in many cases, but should be determined for each situation. A trial loading is recommended for packages with dimensions close to maximum dimensions indicated in the tables.

The height dimensions do not include allowances for items increasing package height such as fork lift tyne thicknesses, pallet depths, skid tub heights, etc.

Any such devices must be accounted for in the total height. Bulk cargo can be carried on the main deck provided the cargo is tied down. Refer to chapter 13 for tiedown information.

10. UNIT LOAD DEVICES - MAIN DECK

10.1. SIZE CODES A, B, E, F, G, M, Q & R

A Unit Load Device (ULD) is a device for grouping and retaining cargo for transit. The ULD can refer to a pallet and net, a pallet and net over an igloo, or a container. This Chapter-Section-Subject provides volume, center of gravity limits, dimensions, and lateral positions for Size Code A, B, E, F, G, M, Q & R unit load devices. Size Code A, B, E, F, G, M, Q & R certified ULDs conform to the National Aerospace Standards (NAS) 3610.

10.2. VOLUMES AND CENTER OF GRAVITY LIMITS

The design capacities of the support fittings and structure have been established within an allowable center of gravity range as shown in the table below.

DESIGNATION			DIMENSIONS		VOLUME CU FT	ALLOWABLE CENTER OF GRAVITY RANGE -IN.		
SIZE CODE	IATA (COMMON CODE)	NAS 3610 ULD BASE TYPE	BASE IN.	HEIGHT IN.		VERT. [a]	LAT. [b]	LONG. [c]
A	AA (M3)	1A1P[d] 1A2P[d] 1A3P 2A1P 2A2P 2A3P 2A4P 2A5P 2A6P	88.0 x 125.0	96.0	572	0 -48.0	± 8.8	± 12.5
	PA (M1A)			96.0	572	0 -48.0	± 8.8	± 12.5
	PA			118.0	673	0 -48.0	± 8.8	± 12.5
	AA Lateral (M3)		125.0 x 88.0	96.0	572	0 -48.0	± 12.5	± 8.8
	AA Lateral (M1A)			96.0	572	0 -48.0	± 12.5	± 8.8
B	PB	1B1P 1B2P 1B3P 1B5P 2B1P 2B2P 2B3P 2B5	88.0 x 108.0	96.0	482	0 -48.0	± 8.8	± 10.8
	PB			118.0	567	0 -48.0	± 8.8	± 10.8
	PB (463L)	1B6P		96.0	482	0 -48.0	± 8.8	± 10.8
	PB (463L)			118.0	567	0 -48.0	± 8.8	± 10.8
E	PE	2E1P	53.0 x 88.0	96.0	259	0 -48.0	± 5.3	± 8.8
F	AF (M1)	2F1P	96.0 x 117.75	96.0	572	0 -48.0	± 9.6	± 5.8
	PF			96.0	572	0 -48.0	± 9.6	± 5.8

DESIGNATION			DIMENSIONS		VOLUME CU FT	ALLOWABLE CENTER OF GRAVITY RANGE -IN.		
SIZE CODE	IATA (COMMON CODE)	NAS 3610 ULD BASE TYPE	BASE IN.	HEIGHT IN.		VERT. [a]	LAT. [b]	LONG. [c]
	PF (M1H)			118.0	689	0 -48.0	± 9.6	± 5.8
G	AG (M2)	2G1P	96.0 x 238.5	96.0	1190	0 -48.0	± 9.6	± 11.9
	PG			96.0	1190	0 -48.0	± 9.6	± 11.9
	PG Left Side (M6)			118.0	1400	0 -48.0	± 9.6	± 11.9
	PG Right Side (M6)			118.0	1400	0 -48.0	± 9.6	± 11.9
M	AM Lateral (M1)	2M1P 2M2P 2M3P	125.0 x 96.0	96.0	623	0 -48.0	± 12.5	± 9.6
	PM Lateral (M1)			96.0	613	0 -48.0	± 12.5	± 9.6
	M1(AM)		96.0 x 125.0	96.0	623	0 -48.0	± 9.6	± 12.5
	M1 (PM)			96.0	613	0 -48.0	± 9.6	± 12.5
	AM (M1H)			118.0	750	0 -48.0	± 9.6	± 12.5
	PM (M1H, M5)			118.0	740	0 -48.0	± 9.6	± 12.5
Q	PYB	N/A	96.0 x 55.0	118.0	258	0 - 48.0	± 12.5	± 9.6
R	PR Lateral	2R1P	196.0 x 96.0	96.0	974	0 -48.0	± 9.8	± 9.6
	PR Lateral			118.0	1173	0 -48.0	± 9.8	± 9.6
	PR		96.0 x 196.0	96.0	974	0 -48.0	± 9.6	± 9.8
	PR Left Side			118.0	1152	0 -48.0	± 9.6	± 9.8
	PR Right Side			118.0	1088	0 -48.0	± 9.6	± 9.8

[a] Vertical
[b] Lateral
[c] Longitudinal
[d] Cannot be loaded laterally.

The allowable center of gravity range is based on the geometric center of the unit load device base dimension. The vertical center of gravity is measured from the base of the container. Good judgement must be used in distributing the load within the unit load device. Use of ULD's that are not specified in this manual requires tiedowns for the ULD's gross weight and the specified load factors.

CAUTION:

UNIT LOAD DEVICES WHICH DO NOT SATISFY THE PRECEDING REQUIREMENTS OR CONTAIN CARGO OF SUCH SHAPE OR DENSITY AS TO POSE A HAZARD TO THE AIRPLANE STRUCTURE MUST BE RESTRAINED BY TIEDOWNS AS SPECIFIED IN CHAPTER 13 AND 14.

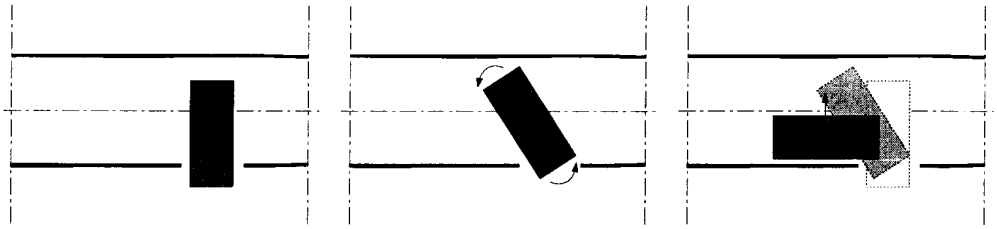
11. MAIN DECK UNIT LOAD DEVICE LOCATIONS

11.1. LOADING CONSIDERATIONS

11.1.1. Side Cargo Door

The following considerations should be observed when loading cargo through the side cargo door:

- ULDs are limited to 118 inches in height and must be positioned in the airplane aft of B.A. 777.
- ULDs longer than 240 inches (no larger than a size code G) cannot be loaded through the side cargo door because they cannot be rotated through the side cargo door.
- When positioned in the side cargo door area, ULDs are limited to 113 inches in height to allow for actuator movement.
- Size codes G and R ULDs greater than 96 inches in height have profile restrictions to allow rotation through the side cargo door (see below).



11.1.2. General

The following considerations should be observed when loading cargo on the main deck:

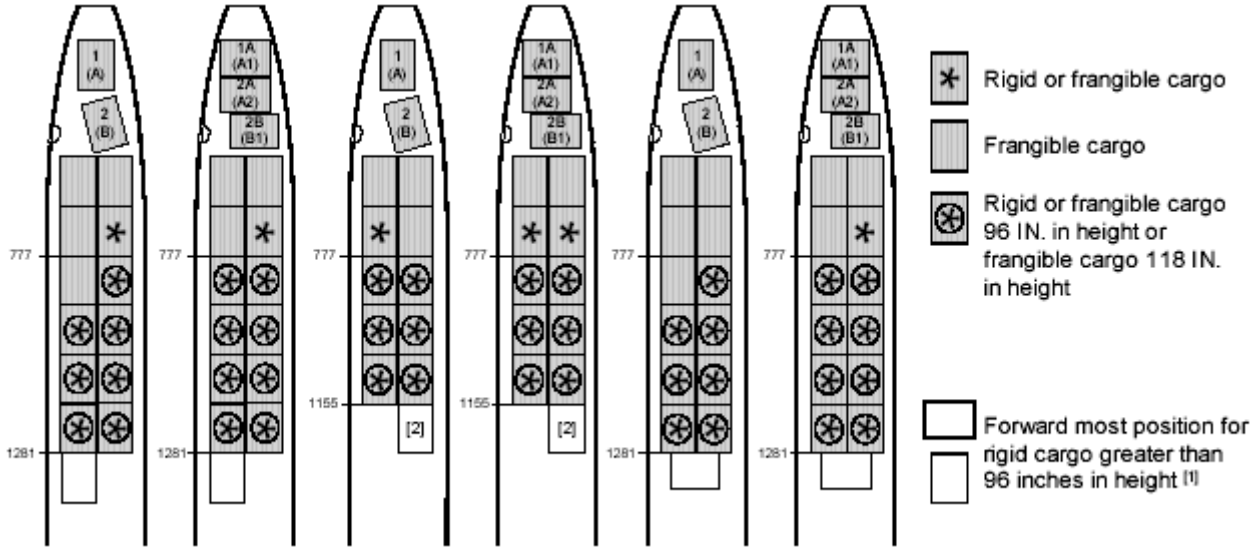
- Only size code A and M pallets can be loaded laterally forward of B.A. 525.
- Only size code A, B, and M pallets can be loaded longitudinally forward of B.A. 525.
- Only size code A, B, F, and M pallets can be loaded aft of B.A. 2218.
- ULDs forward of B.A. 777 are limited to 96 inches in height to ensure at least a 2 inch clearance between the top of the ULD and the ceiling. This clearance is required to allow air flow around ULDs for decompression and smoke detection.
- An object is considered to be frangible if it will readily separate and conform to the airplane contour when subjected to a 9G forward load. Rigid cargo consist of items which will not separate nor conform to the airplane contour. Jet engines, wheeled vehicles, tugs and dollies are examples of rigid cargo.
- Unit load devices greater than 96 inches in height are restricted to positions aft of B.A. 777.
- Rigid cargo over 96 inches in height have the following additional loading restrictions:
    - The most forward rigid loaded device must be loaded aft of B.A. 1160 right side, aft of B.A. 1220 left side, or aft of B.A. 1220 center loaded. [1]
    - There must be a minimum of the equivalent of seven 125 inch long loaded unit load devices positioned directly forward of the rigid cargo greater than 96 inches in height[1].
    - Carriage of an empty ULD cannot be counted as an occupied ULD position.[1]

- Cargo loads which may cut or pass through the upper deck barrier net must be restrained to a 9G forward condition or be placed aft of loads (subject to the restrictions above) which will not penetrate or damage the barrier net.
- In all cases the most forward 4 pallet positions forward of the rigid device must be loaded with frangible cargo. [1]

NOTE:
When rigid cargo is carried on the right side of the airplane, any one or all of the ULD positions 1, 1A, 2, 2A, and 2B count towards the frangible ULD positions discussed in the above restrictions (See illustration below).

NOTE:
When rigid cargo is carried on the left side of the airplane, any one or all of the ULD positions 1, 1A, and 2A only count towards the frangible ULD positions discussed in the above restrictions (See illustration below).

The following graphic illustrates the loading restrictions described above. All pallets shown forward of the rigid cargo are assumed to be loaded on size code M pallets (96 IN. x 125 IN.).



When loading other than size code M pallets (96 IN. X 125 IN.), the forward most position for rigid cargo greater than 96 inches in height is still B.A. 1160 right side, or B.A. 1220 center loaded. Furthermore, the mass of the cargo forward of the rigid cargo must be a minimum of the equivalent of seven size code M pallets shown in the illustration above.

[1] This restriction does not apply if the ULD with rigid cargo over 96 IN. in height, and all ULD positions aft of it, are restrained to a 9G forward load factor.

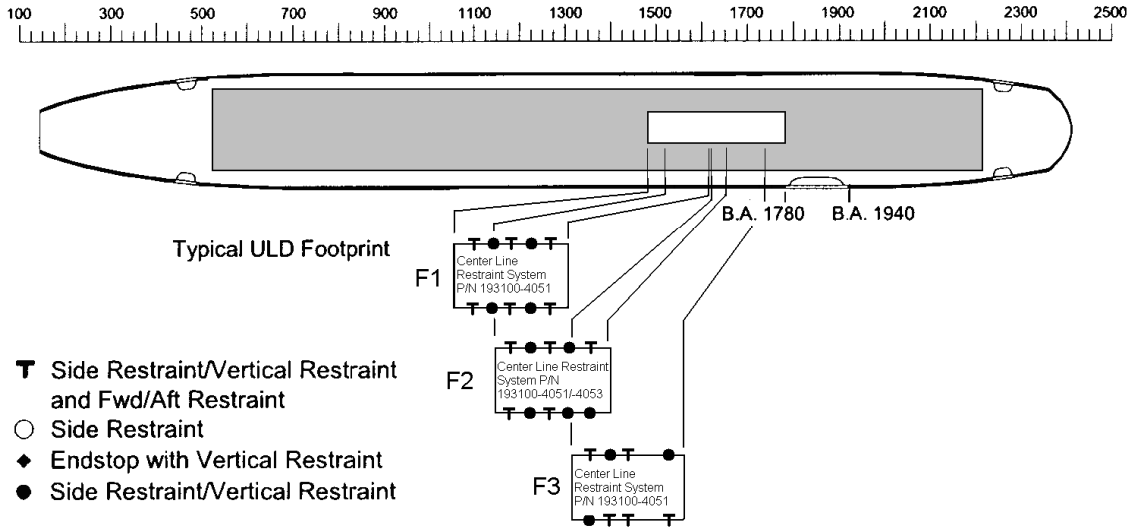
[2] Rigid cargo must be aft of B.A. 1160 on this pallet.

12.2. CARGO CENTER LINE RESTRAINT SYSTEM - SIZE CODES F, G, M & R

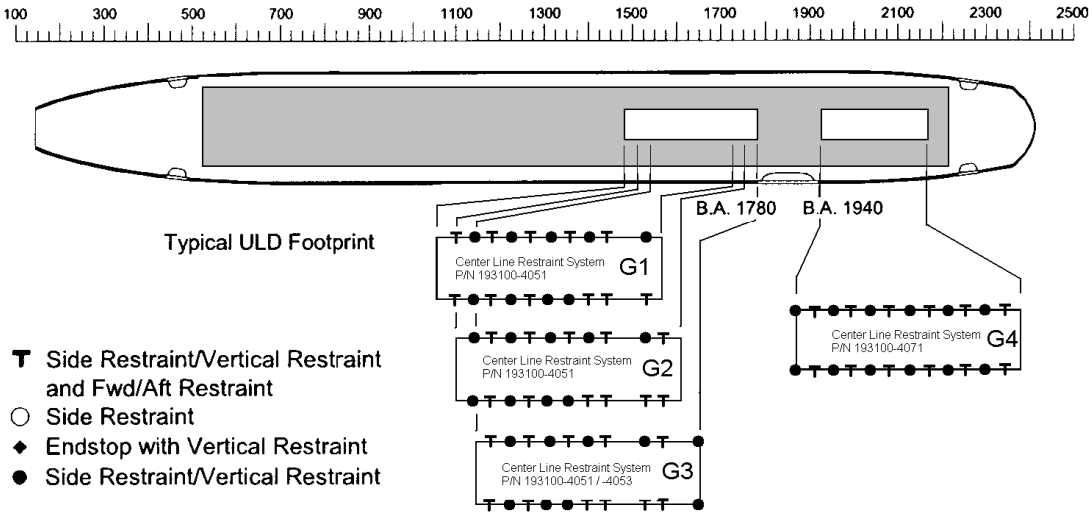
The illustrations below identify the locations of the stops / locks / guides and the associated pallet positions for size codes F, G, M & R.

The locations below show the pallet positions for the Center Line Restraint System (sub-system) configuration. With the Center Line Restraint System pallets are loaded longitudinally.

MAIN DECK COMPARTMENT
CENTER LINE LOADING SYSTEM CONFIGURATION (SIZE CODE F)

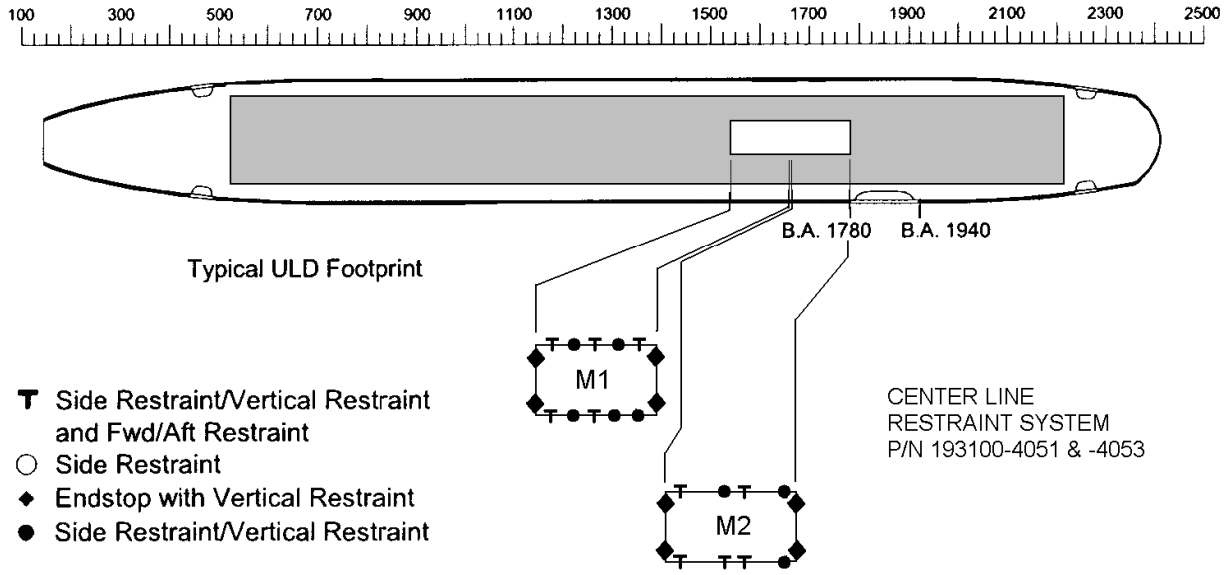


MAIN DECK COMPARTMENT
CENTER LINE LOADING SYSTEM CONFIGURATION (SIZE CODE G)

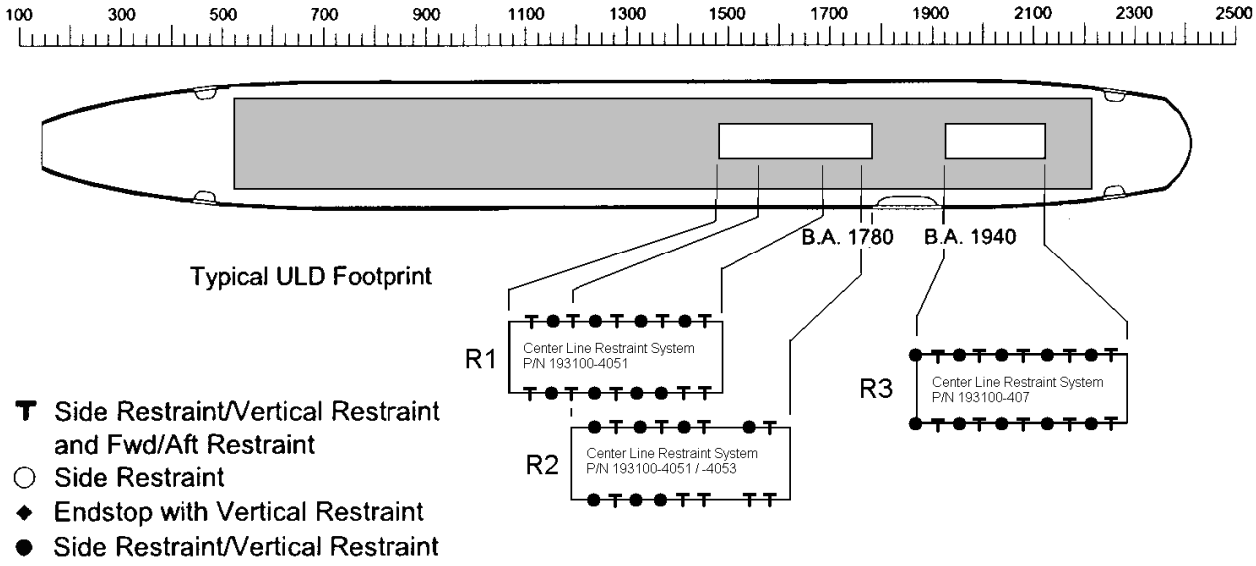


Note: For position G3 (Center Line Restraint systems P/N 193100-4051 / -4053) the use of pallets with side slots and massive floor plate sides is prohibited.

MAIN DECK COMPARTMENT
CENTER LINE LOADING SYSTEM CONFIGURATION (SIZE CODE M)



MAIN DECK COMPARTMENT
CENTER LINE RESTRAINT SYSTEM CONFIGURATION (SIZE CODE R)



13. CARGO TIEDOWNS - MAIN DECK

13.1. GENERAL INFORMATION

Cargo loaded on or in a unit load device or under a certified net installation will not require additional tiedowns unless one of the following conditions exist:

- For non-approved unit load devices.
- For approved unit load devices that contain cargo of such shape and/or densities as to pose a hazard to the airplane structure, the entire weight must be restrained by use of tiedowns.
- For approved unit load devices that are limited either by restraint configurations or by missing / inoperative restraints, the weight in excess of the lock hardware capability must be restrained by use of tiedowns.
- For unit load devices which do not satisfy the center of gravity limitations in chapter 10, the entire weight must be restrained by the use of tiedowns.
- The use of unit load devices that are not specified in this manual requires tiedowns for the unit load device's gross weight and specified load factors.
- Good judgment must be used in selecting the location and number of tiedowns to give sufficient safety margin for uneven strap and net stretch, strap and cargo slippage, and for varying allowables of rings used
- in combination. To prevent overloading of hardware, ring loops should be correctly oriented as closely as possible to the strap direction.

CAUTION:
DO NOT MIX DIFFERENT STIFFNESSES OF TIEDOWN STRAPS (FOR EXAMPLE, KEVLAR AND NYLON WEBS) WHEN RESTRAINING CARGO. MIXING STRAP STIFFNESSES MAY CAUSE PREMATURE FAILURE OF THE STIFFER STRAP. THE USE OF CHAINS FOR TIEDOWNS IS NOT RECOMMENDED.

CAUTION:
TIEDOWN ON THE MAIN DECK IS LIMITED TO THE TIEDOWN LOCATIONS IDENTIFIED IN CHAPTER 14. TIEDOWN TO ANY OTHER POINT IS NOT ALLOWED.

CAUTION:
NO TIE DOWN LOADS (EXCEPT SEAT TRACKS) ARE ALLOWED AT SOME AREAS OF THE MAIN DECK. SEE CHAPTER 13.5 FOR MORE INFORMATION.

CAUTION:
ONLY DOUBLE STUD FITTINGS ARE ALLOWED FOR PALLET LOCKS, END STOPS AND CENTER GUIDES.

13.2. TIEDOWN ALLOWABLES

The following sections describe the basic tiedown requirements and provide the tiedown fitting allowables.

13.2.1. Tiedown Load Components

The allowables given in the following tables take into account the ring, hardware, local structure load carrying capability, floor and side wall strap angles and the load factors that can be experienced in the airplane. The following limit load values were obtained from the following equations.

$$\text{FWD} = \frac{(\text{COSINE FLOOR ANGLE}) \times (\text{COSINE SIDE WALL ANGLE}) \times (\text{ALLOWABLE LOAD AT RING})}{\text{LOAD FACTOR}}$$

$$\text{SIDE} = \frac{(\text{COSINE FLOOR ANGLE}) \times (\text{SINE SIDE WALL ANGLE}) \times (\text{ALLOWABLE LOAD AT RING})}{\text{LOAD FACTOR}}$$

$$\text{UP} = \frac{(\text{SINE FLOOR ANGLE}) \times (\text{ALLOWABLE LOAD AT RING})}{\text{LOAD FACTOR}}$$

In these equations the allowable load at ring value can be obtained from the forward, side and up allowables in the tables using the following equation.

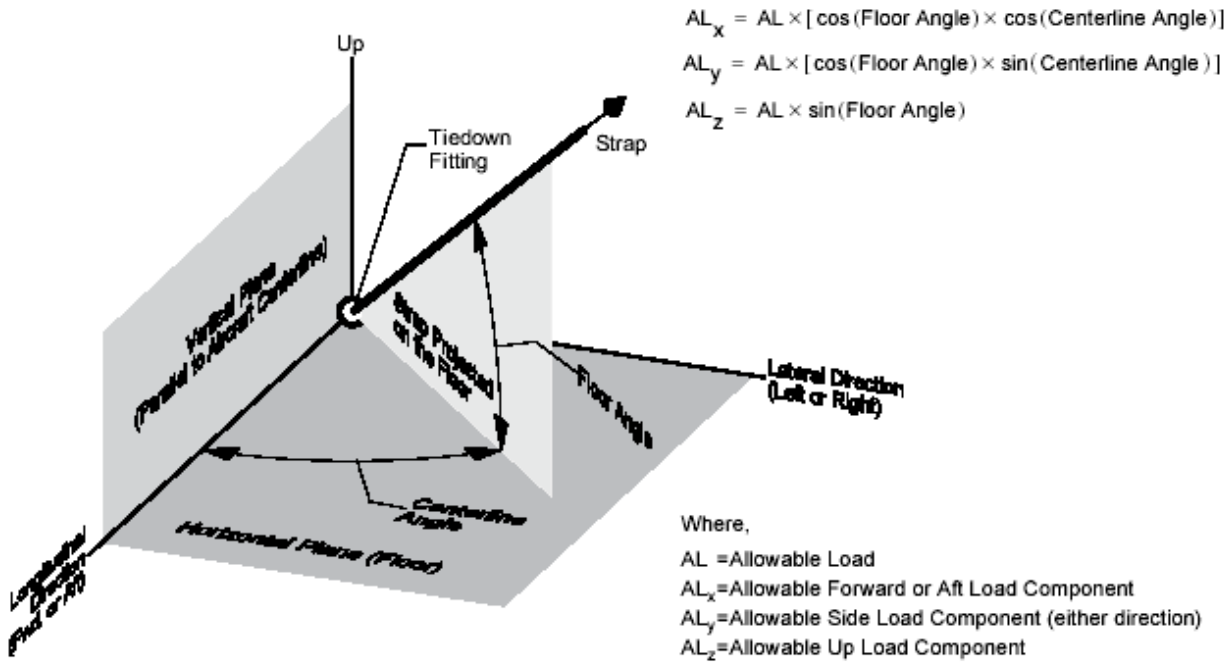
$$\text{ULTIMATE ALLOWABLE LOAD AT RING} = (A^2 + B^2 + C^2)^{1/2}$$

A=Forward Load Allowable x Load Factor

B=Side Load Allowable x Load Factor

C=Up Load Allowable x Load Factor

The following diagram defines the floor and centerline angles used in the equations and tables.



13.2.2. Load Factors

The most critical load factors are given in the following table.

TIEDOWN LOCATION	BODY STATION		ULTIMATE LOAD FACTOR			
	FROM	TO	FORWAR	AFT	SIDE	UP
Center Guide, and Side Guide Main Deck End Lock, End Stop	228	500	1.5	0.75	1.45	1.5
	500	1000			0.78	1.5
	1000	1480				1.5
	1480	2365			1.76	2.34

To achieve common allowables for fittings in various places in the airplane and reduce the number of working tables the following ultimate load factors were used to calculate the allowables.

TIEDOWN LOCATION	LOAD FACTOR			
	FORWARD	AFT	SIDE	UP
Center Guide, Side Guide, End Lock, End Stop	1.5	0.75	1.76	2.34

NOTE: For locations forward of B.A. 1480 use 1/2 of the load factor shown for side load factors.

The minimum strap rating, when using the following tables is 5000 LB. (2267 KG.). Double stud fittings are limited to one strap per fitting.

13.2.3. Tiedown Strap and Fitting Requirements

Each strap must have a minimum rating of 5000 LB (2268 KG).
Each single stud fitting must be a Brownline fitting P/N 10730 or P/N 11251 or equivalent or stronger.
Each double stud fitting must be a Brownline fitting P/N 21035-54 or equivalent or stronger. Fitting limited to single strap hook-up only.

13.2.4. Tiedown Fitting Allowables

The following tables describe the basic tiedown requirements and provide the tiedown fitting allowables.

DESCRIPTION	LOCATION[a]	MINIMUM SPACING BETWEEN TIEDOWNS (IN.)	TABLE CHAPTER NUMBER
Pallet Lock – Tie Down Ring (STA 500-2365)	All	N/A	13.2.5
Pallet Lock – Tie Down Ring (STA 240-500)	All	N/A	13.2.6
Side Guide - Single Stud Fitting	All	N/A	13.2.7
Side Guide - Double Stud Fitting	All	N/A	13.2.8
End Stops - Double Stud Fitting (STA 525 & 2218)	All	N/A	13.2.9
End Stops - Double Stud Fitting (STA 234)	All	N/A	13.2.10
Center Guides - Double Stud Fitting	All	N/A	13.2.11
Crew Baggage	Anchor Plates B.A. 440 - 520 Seat Tracks (LBL 34) B.A. 472 - 520 Seat Track (LBL 62.6) B.A. 445	N/A	Refer to Boeing WBM
Seat Tracks - Stud Fitting	B.A. 240 - 520 B.A. 520 - 1480 B.A. 1480 - 2300	20	Refer to Boeing WBM
Seat Tracks - Double Stud Fitting	B.A. 240 - 520 B.A. 520 - 1480 B.A. 1480 - 2300	20	Refer to Boeing WBM
[a] See Boeing Weight & Balance Manual for exact locations.			

13.2.5. Pallet Lock – Tie Down Ring (STA 500-2365)

The following table summarizes tiedown fitting allowable loads for the pallet locks with ring tiedowns.

RESTRAINT DIRECTION	FLOOR ANGLE (DEGREES)	CENTERLINE ANGLE (DEGREES)							
		0°		30°		60°		90°	
		ALLOWABLE LOAD							
		LB	KG	LB	KG	LB	KG	LB	KG
Forward	0° (Horizontal)	5000	2268	N/A	N/A	N/A	N/A	N/A	N/A
	30°	4330	1964	N/A	N/A	N/A	N/A	N/A	N/A
	60°	2500	1134	N/A	N/A	N/A	N/A	N/A	N/A
	90° (Vertical)	0	0	N/A	N/A	N/A	N/A	N/A	N/A
Side	0° (Horizontal)	0	0	250	113	433	196	500	227
	30°	0	0	217	98	375	170	433	196
	60°	0	0	125	57	217	98	250	113
	90° (Vertical)	0	0	0	0	0	0	0	0
Up	0° (Horizontal)	0	0	0	0	0	0	0	0
	30°	2500	1134	N/A	N/A	N/A	N/A	N/A	N/A
	60°	4330	1964	N/A	N/A	N/A	N/A	N/A	N/A
	90° (Vertical)	5000	2268	N/A	N/A	N/A	N/A	N/A	N/A
Aft	0° (Horizontal)	5000	2268	N/A	N/A	N/A	N/A	N/A	N/A
	30°	4330	1964	N/A	N/A	N/A	N/A	N/A	N/A
	60°	2500	1134	N/A	N/A	N/A	N/A	N/A	N/A
	90° (Vertical)	0	0	0	0	0	0	0	0

Values marked with N/A are not applicable, because this would cause other values to exceed the allowables.
Max. allowed center line angle +/- 3.2°for FWD/AFT and UP load.

See also chapter 13.5 for tiedown restrictions.

13.2.6. Pallet Lock – Tie Down Ring (STA 240-500)

The following table summarizes tiedown fitting allowable loads for the pallet locks with ring tiedowns.

RESTRAINT DIRECTION	FLOOR ANGLE (DEGREES)	CENTERLINE ANGLE (DEGREES)							
		0°		30°		60°		90°	
		ALLOWABLE LOAD							
		LB	KG	LB	KG	LB	KG	LB	KG
Forward	0°(Horizontal)	2900	1315	N/A	N/A	N/A	N/A	N/A	N/A
	30°	2511	1139	N/A	N/A	N/A	N/A	N/A	N/A
	60°	1450	658	N/A	N/A	N/A	N/A	N/A	N/A
	90°(Vertical)	0	0	N/A	N/A	N/A	N/A	N/A	N/A
Side	0°(Horizontal)	0	0	0	0	0	0	0	0
	30°	0	0	0	0	0	0	0	0
	60°	0	0	0	0	0	0	0	0
	90°(Vertical)	0	0	0	0	0	0	0	0
Up	0°(Horizontal)	0	0	N/A	N/A	N/A	N/A	N/A	N/A
	30°	1450	658	N/A	N/A	N/A	N/A	N/A	N/A
	60°	2511	1139	N/A	N/A	N/A	N/A	N/A	N/A
	90°(Vertical)	2900	1315	N/A	N/A	N/A	N/A	N/A	N/A
Aft	0°(Horizontal)	2900	1315	N/A	N/A	N/A	N/A	N/A	N/A
	30°	2511	1139	N/A	N/A	N/A	N/A	N/A	N/A
	60°	1450	658	N/A	N/A	N/A	N/A	N/A	N/A
	90°(Vertical)	0	0	N/A	N/A	N/A	N/A	N/A	N/A

Values marked with N/A are not applicable, because this would cause other values to exceed the allowables.
Max. allowed center line angle +/- 3.2°for FWD/AFT and UP load.

See also chapter 13.5 for tiedown restrictions.

13.2.7. Side Guide - Single Stud Fitting

The following table summarizes tiedown fitting allowable loads for side guide - single stud fittings.

RESTRAINT DIRECTION	FLOOR ANGLE (DEGREES)	CENTERLINE ANGLE (DEGREES)							
		0°		30°		60°		90°	
		ALLOWABLE LOAD							
		LB	KG	LB	KG	LB	KG	LB	KG
Forward	0° (Horizontal)	1300	590	1126	511	650	295	0	0
	30°	1126	511	975	442	563	255	0	0
	60°	650	295	563	255	325	147	0	0
	90° (Vertical)	0	0	0	0	0	0	0	0
Side	0° (Horizontal)	0	0	650	295	1126	511	1300	590
	30°	0	0	563	255	975	442	1126	511
	60°	0	0	325	147	563	255	650	295
	90° (Vertical)	0	0	0	0	0	0	0	0
Up	0° (Horizontal)	0	0	0	0	0	0	0	0
	30°	950	431	950	431	950	431	950	431
	60°	1645	746	1645	746	1645	746	1645	746
	90° (Vertical)	1900	862	1900	862	1900	862	1900	862
Aft	0° (Horizontal)	1300	590	1126	511	650	295	0	0
	30°	1126	511	975	442	563	255	0	0
	60°	650	295	563	255	325	147	0	0
	90° (Vertical)	0	0	0	0	0	0	0	0

13.2.8. Side Guide - Double Stud Fitting

The following table summarizes tiedown fitting allowable loads for side guide - double stud fittings.

RESTRAINT DIRECTION	FLOOR ANGLE (DEGREES)	CENTERLINE ANGLE (DEGREES)							
		0°		30°		60°		90°	
		ALLOWABLE LOAD							
		LB	KG	LB	KG	LB	KG	LB	KG
Forward	0° (Horizontal)	2750	1247	2382	1080	1375	624	0	0
	30°	2382	1080	2063	936	1191	540	0	0
	60°	1375	624	1191	540	688	312	0	0
	90° (Vertical)	0	0	0	0	0	0	0	0
Side	0° (Horizontal)	0	0	1000	454	1732	786	2000	907
	30°	0	0	866	393	1500	680	1732	786
	60°	0	0	500	227	866	393	1000	454
	90° (Vertical)	0	0	0	0	0	0	0	0
Up	0° (Horizontal)	0	0	0	0	0	0	0	0
	30°	1675	760	1675	760	1675	760	1675	760
	60°	2901	1316	2901	1316	2901	1316	2901	1316
	90° (Vertical)	3350	1520	3350	1520	3350	1520	3350	1520
Aft	0° (Horizontal)	2750	1247	2382	1080	1375	624	0	0
	30°	2382	1080	2063	936	1191	540	0	0
	60°	1375	624	1191	540	688	312	0	0
	90° (Vertical)	0	0	0	0	0	0	0	0

13.2.9. End Stops - Double Stud Fitting (STA 525 & 2218)

The following table summarizes tiedown fitting allowable loads for End Stops - double stud fittings.

RESTRAINT DIRECTION	FLOOR ANGLE (DEGREES)	CENTERLINE ANGLE (DEGREES)							
		0°		30°		60°		90°	
		ALLOWABLE LOAD							
		LB	KG	LB	KG	LB	KG	LB	KG
Forward	0° (Horizontal)	2750	1247	2382	1080	1375	624	0	0
	30°	2382	1080	2063	936	1191	540	0	0
	60°	1375	624	1191	540	688	312	0	0
	90° (Vertical)	0	0	0	0	0	0	0	0
Side	0° (Horizontal)	0	0	1000	454	1732	786	2000	907
	30°	0	0	866	393	1500	680	1732	786
	60°	0	0	500	227	866	393	1000	454
	90° (Vertical)	0	0	0	0	0	0	0	0
Up	0° (Horizontal)	0	0	0	0	0	0	0	0
	30°	1675	760	1675	760	1675	760	1675	760
	60°	2901	1316	2901	1316	2901	1316	2901	1316
	90° (Vertical)	3350	1520	3350	1520	3350	1520	3350	1520
Aft	0° (Horizontal)	2750	1247	2382	1080	1375	624	0	0
	30°	2382	1080	2063	936	1191	540	0	0
	60°	1375	624	1191	540	688	312	0	0
	90° (Vertical)	0	0	0	0	0	0	0	0

13.2.10. End Stops - Double Stud Fitting (STA 234)

The following table summarizes tiedown fitting allowable loads for End Stops - double stud fittings.

RESTRAINT DIRECTION	FLOOR ANGLE (DEGREES)	CENTERLINE ANGLE (DEGREES)							
		0°		30°		60°		90°	
		ALLOWABLE LOAD							
		LB	KG	LB	KG	LB	KG	LB	KG
Forward	0° (Horizontal)	2750	1247	N/A	N/A	N/A	N/A	N/A	N/A
	30°	2382	1080	N/A	N/A	N/A	N/A	N/A	N/A
	60°	1375	624	N/A	N/A	N/A	N/A	N/A	N/A
	90° (Vertical)	0	0	N/A	N/A	N/A	N/A	N/A	N/A
Side	0° (Horizontal)	0	0	0	0	0	0	0	0
	30°	0	0	0	0	0	0	0	0
	60°	0	0	0	0	0	0	0	0
	90° (Vertical)	0	0	0	0	0	0	0	0
Up	0° (Horizontal)	0	0	N/A	N/A	N/A	N/A	N/A	N/A
	30°	1450	658	N/A	N/A	N/A	N/A	N/A	N/A
	60°	2511	1139	N/A	N/A	N/A	N/A	N/A	N/A
	90° (Vertical)	2900	1315	N/A	N/A	N/A	N/A	N/A	N/A
Aft	0° (Horizontal)	2750	1247	N/A	N/A	N/A	N/A	N/A	N/A
	30°	2382	1080	N/A	N/A	N/A	N/A	N/A	N/A
	60°	1375	624	N/A	N/A	N/A	N/A	N/A	N/A
	90° (Vertical)	0	0	N/A	N/A	N/A	N/A	N/A	N/A

Values marked with N/A are not applicable, because this would cause other values to exceed the allowables.
Max. allowed center line angle +/- 3.2°for FWD/AFT and UP load.

13.2.11. Center Guides - Double Stud Fitting

The following table summarizes tiedown fitting allowable loads for Center Guides - double stud fittings.

RESTRAINT DIRECTION	FLOOR ANGLE (DEGREES)	CENTERLINE ANGLE (DEGREES)							
		0°		30°		60°		90°	
		ALLOWABLE LOAD							
		LB	KG	LB	KG	LB	KG	LB	KG
Forward	0° (Horizontal)	3000	1361	2598	1178	1500	680	0	0
	30°	2598	1178	2250	1021	1299	589	0	0
	60°	1500	680	1299	589	750	340	0	0
	90° (Vertical)	0	0	0	0	0	0	0	0
Side	0° (Horizontal)	0	0	1000	454	1732	786	2000	907
	30°	0	0	866	393	1500	680	1732	786
	60°	0	0	500	227	866	393	1000	454
	90° (Vertical)	0	0	0	0	0	0	0	0
Up	0° (Horizontal)	0	0	0	0	0	0	0	0
	30°	1500	680	1500	680	1500	680	1500	680
	60°	2598	1178	2598	1178	2598	1178	2598	1178
	90° (Vertical)	3000	1361	3000	1361	3000	1361	3000	1361
Aft	0° (Horizontal)	3000	1361	2598	1178	1500	680	0	0
	30°	2598	1178	2250	1021	1299	589	0	0
	60°	1500	680	1299	589	750	340	0	0
	90° (Vertical)	0	0	0	0	0	0	0	0

13.3. TIEDOWN CALCULATION

The following sections provide the methodology for determining the number of tiedown straps required for each of the basic restraint directions.

Calculation Procedure

The number of tiedowns required must be determined for each of the five basic restraint directions (forward, aft, side-left, side-right, and up). The operator is responsible to ensure that the strap tension rating and the strap attachment rating are each equal to or greater than the load limits of the airplane tiedown fittings used with the strap. Minimum allowable strap tension and strap attachment ratings of 5000 LB (2268 KG) are required.

The following steps outline the procedure for determining the number of tiedown straps required for a single restraint direction:

1.) Determine the weight of the cargo to be restrained in consideration of the load factors for tiedowns taken from chapter 13.2.2.

2.) Create a table similar to the following worksheet:

DIRECTION	TIEDOWN LOCATION	FLOOR ANGLE (DEGREES)	CENTERLINE ANGLE (DEGREES)	NUMBER OF TIEDOWN FITTINGS	TIEDOWN ALLOWABLE LB
Forward					
Aft					
Side-Left					
Side-Right					
Up					

3.) Select the tiedown location to be used from the available tiedown locations in chapter 13.2.2. The B.A. and B.B.L. of these tiedown locations are listed in chapter 14. Only straps that contact the face of the cargo to be restrained are considered to restrain cargo in that direction (for example: a strap must contact the forward face to be considered effective in restraining the cargo in the forward direction. A strap over the top of the cargo does restrain in the up direction but yields no restraint in the forward, aft, or side directions).

4.) Establish the floor and centerline angles (to the nearest 30 degree increment for each tiedown selected).

5.) Use the tables in chapter 13.2.5 to 13.2.8 to determine the tiedown allowable.

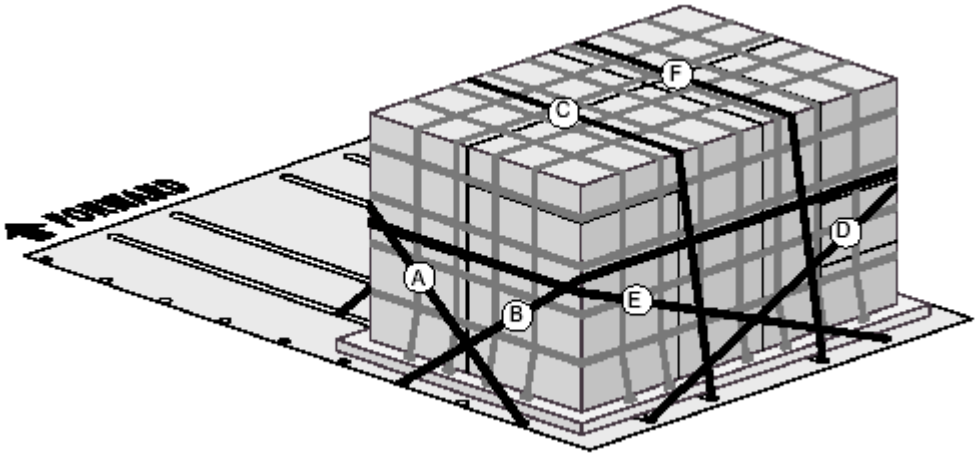
6.) Multiply the tiedown allowable by the number of tiedown fittings to get the total tiedown allowable.

7.) If the total tiedown allowable is equal to or exceeds the weight of cargo to be restrained, then the tiedown scheme is acceptable in that direction. If the total tiedown down allowable is less than the weight of cargo to be restrained, then additional straps are required in that direction.

13.4. TIEDOWN EXAMPLE

In the following example, a package weighs 3200 LB (1452 KG), and will be carried in between B.A. 710 and B.A. 1000 on the main deck. Refer to chapter 4 for compartment capabilities. The package is to be restrained completely by the use of tie downs rated at 5000 LB (2267 KG). The mass is evenly distributed.

A proposed tiedown scheme is shown below. The proposed scheme shows 6 straps, which is the minimum number of straps required for tiedown (one strap each in the forward, aft, side-left, and side-right directions and two straps in the up direction).



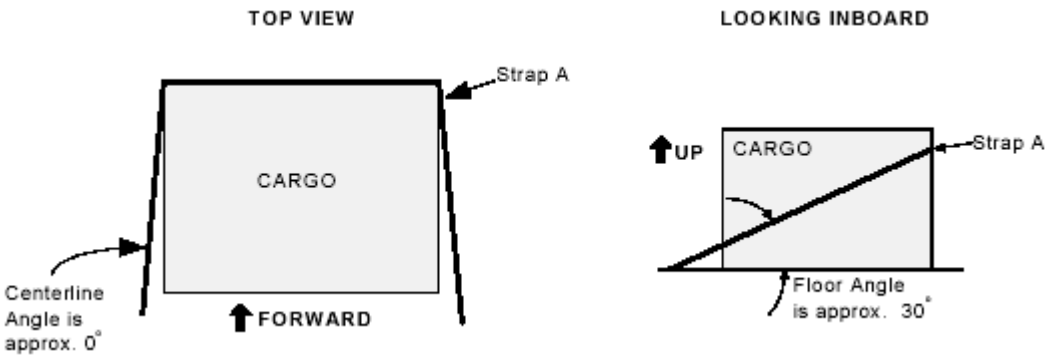
13.4.1. Forward Restraint

1.) Determine the weight of the cargo to be restrained in consideration of the load factors for tiedowns taken from chapter 13.2.2. The weight to be restrained in forward direction is 3200 LB x 1.5 = 4800 LB (2177 KG).

2.) Create a table similar to the following worksheet. The data from Steps 3 through 5 have been added to the worksheet.

3.) Select the tiedown location to be used from the choices in chapter 14. The side guide with single stud fittings was used in the example and this data was added to the table in Step 2. Only Strap A will restrain in the forward direction because only this strap contacts the forward face of the cargo to be restrained. Due to the reason, that Strap A is attached to fittings on side guide and center guide, the lower value is chosen from the tables in chapter 13.2.8 and 13.2.11.

DIRECTION	TIEDOWN LOCATION	FLOOR ANGLE (DEGREES)	CENTERLINE ANGLE (DEGREES)	NUMBER OF TIEDOWN FITTINGS	TIEDOWN ALLOWABLE LB
Forward	Center Guide / Side Guide Double Stud Fitting [a]	30°	0°	2	2382 (1080) [a]
[a] From chapter 13.2.8 and 13.2.11					



4.) Establish the floor and centerline angles (to the nearest 30 degree increment for each tiedown selected). The floor angle is 30 degrees and the centerline angle is 0 degrees in the example and this data was added to the table in Step 2. There are two tiedown fittings, one at each end of the strap.

5.) Use the tables in chapter 13.2.5 to 13.2.11 to determine the tiedown allowable. The tiedown allowable is 2382 LB (1080 KG) from the table in chapter 13.2.8 the example and this data was added to the table in Step 2.

6.) Multiply the tiedown allowable by the number of tiedown fittings to get the total tiedown allowable. The total tiedown allowable is:

(2382 LB) x (2 tiedowns) = 4764 LB
(1080 KG) x (2 tiedowns) = 2160KG

7.) If the total tiedown allowable is equal to or exceeds the weight of cargo to be restrained, then the tiedown scheme is acceptable in that direction. If the total tiedown allowable is less than the weight of cargo to be restrained, then additional tiedowns are required in that direction.

Since the tiedown allowable is 4764 LB (2161 KG) and the weight of the cargo is 4800 LB (2177 KG), another strap is required in the forward direction. Let's add another strap, similar to the first strap and then repeat Steps 2 through 5 and create a new table as follows:

DIRECTION	TIEDOWN LOCATION	FLOOR ANGLE (DEGREES)	CENTERLINE ANGLE (DEGREES)	NUMBER OF TIEDOWN FITTINGS	TIEDOWN ALLOWABLE LB
Forward	Center Guide / Side Guide Double Stud Fitting [a]	30°	0°	4	2382 (1080.5) [a]
[a] From chapter 13.2.8 and 13.2.11					

6A). Multiply the tiedown allowable by the number of tiedown fittings to get the total tiedown allowable. The total tiedown allowable is:

(2382 LB) x (4 tiedowns) = 9528 LB
(1080 KG) x (4 tiedowns) = 4320 KG

7A.) If the total tiedown allowable is equal to or exceeds the weight of cargo to be restrained, then the tiedown scheme is acceptable in that direction. If the total tiedown down allowable is less than the weight of cargo to be restrained, then additional tiedowns are required in that direction.

Since the tiedown allowable is now 9528 LB (4320 KG) and the weight of the cargo is 4800 LB (2177 KG), the two straps are sufficient to restraint the cargo in the forward direction.

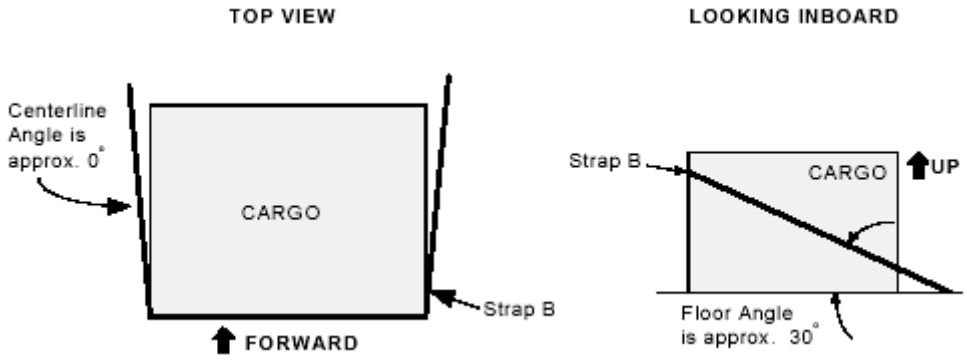
13.4.2. Aft Restraint

1.) Determine the weight of the cargo to be restrained in consideration of the load factors for tiedowns taken from chapter 13.2.2. The weight to be restrained in aft direction is 3200 x 0.75 = 2400 LB (1089 KG).

2.) Create a table similar to the following worksheet. The data from Steps 3 through 5 have been added to the worksheet.

DIRECTION	TIEDOWN LOCATION	FLOOR ANGLE (DEGREES)	CENTERLINE ANGLE (DEGREES)	NUMBER OF TIEDOWN FITTINGS	TIEDOWN ALLOWABLE LB
Aft	Center Guide / Side Guide Double Stud Fitting [a]	30°	0°	2	2382 (1080) [a]
[a] From chapter 13.2.8 and 13.2.11					

3.) Select the tiedown location to be used from the choices in chapter 14**Fehler! Verweisquelle konnte nicht gefunden werden.**. The side guide with double stud fittings was used in the example and these data were added to the table in Step 2. Only Strap B will restrain in the aft direction because only this strap contacts the aft face of the cargo to be restrained.



4.) Establish the floor and centerline angles (to the nearest 30 degree increment for each tiedown selected). The floor angle is 30 degrees and the centerline angle is 0 degrees in the example and this data was added to the table in Step 2. There are two tiedown fittings, one at each end of the strap.

5.) Use the tables in chapter 13.2.5 to 13.2.11 to determine the tiedown allowable. The tiedown allowable is 2382 LB (1080 KG) from the table in chapter 13.2.8 in the example and this data was added to the table in Step 2. Due to the reason, that Strap B is attached to fittings on side guide and center guide, the lower value is chosen from the tables in chapter 13.2.8 and 13.2.11.

6.) Multiply the tiedown allowable by the number of tiedown fittings to get the total tiedown allowable. The total tiedown allowable is:

(2382 LB) x (2 tiedowns) = 4764 LB
(1080 KG) x (2 tiedowns) = 2160 KG

7.) If the total tiedown allowable is equal to or exceeds the weight of cargo to be restrained, then the tiedown scheme is acceptable in that direction. If the total tiedown allowable is less than the weight of cargo to be restrained, then additional tiedowns are required in that direction.

Since the tiedown allowable is 4764 LB (2161 KG) and the weight of the cargo is 2400 LB (1089 KG), the Strap B is sufficient to restrain the cargo in the aft direction.

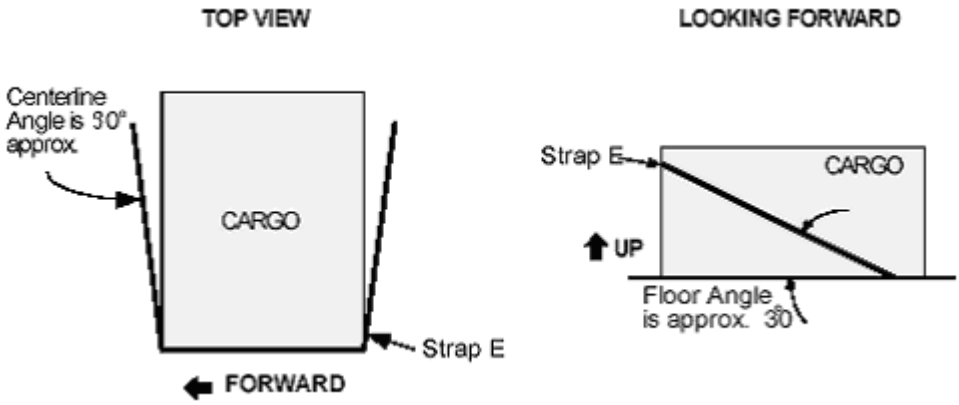
13.4.3. Side-Left Restraint

1.) Determine the weight of the cargo to be restrained in consideration of the load factors for tiedowns taken from chapter 13.2.2. The weight to be restrained in side-left direction is 3200 x 1.76 = 5632 LB (2555 KG).

2.) Create a table similar to the following worksheet. The data from Steps 3 through 5 have been added to the worksheet.

DIRECTION	TIEDOWN LOCATION	FLOOR ANGLE (DEGREES)	CENTERLINE ANGLE (DEGREES)	NUMBER OF TIEDOWN FITTINGS	TIEDOWN ALLOWABLE LB
Side-Left	Side Guide Double Stud Fitting [a]	30°	90°	2	1732 (786) [a]
[a] From chapter 13.2.8					

3.) Select the tiedown location to be used from the choices in chapter 14. The side guide was used in the example and this data was added to the table in Step 2. Only Strap E will restrain in the side-left direction because only this strap contacts the side-left face of the cargo to be restrained.



4.) Establish the floor and centerline angles (to the nearest 30 degree increment for each tiedown selected). The floor angle is 30 degrees and the centerline angle is 90 degrees in the example and this data was added to the table in Step 2. There are two tiedown fittings, one at each end of the strap.

5.) Use the table in chapter 13.2.5 to 13.2.11 to determine the tiedown allowable. The tiedown allowable is 1732 LB (786 KG) from the table in chapter 13.2.8 in the example and this data was added to the table in Step 2.

6.) Multiply the tiedown allowable by the number of tiedown fittings to get the total tiedown allowable. The total tiedown allowable is:

(1732 LB) x (2 tiedowns) = 3464 LB
(786 LB) x (2 tiedowns) = 1572 KG

7.) If the total tiedown allowable is equal to or exceeds the weight of cargo to be restrained, then the tiedown scheme is acceptable in that direction. If the total tiedown allowable is less than the weight of cargo to be restrained, then additional tiedowns are required in that direction.

Since the tiedown allowable is 3464 LB (1572 KG) and the weight of the cargo is 5632 LB (2555 KG), another strap is required in the side-left direction. Let's add another strap, similar to the first strap and then repeat Steps 2 through 5 and create a new table as follows:

DIRECTION	TIEDOWN LOCATION	FLOOR ANGLE (DEGREES)	CENTERLINE ANGLE (DEGREES)	NUMBER OF TIEDOWN FITTINGS	TIEDOWN ALLOWABLE LB
Side-Left	Side Guide Double Stud Fitting [a]	30°	90°	4	1732 (786) [a]
[a] From chapter 13.2.8					

6A). Multiply the tiedown allowable by the number of tiedown fittings to get the total tiedown allowable. The total tiedown allowable is:

(1732 LB) x (4 tiedowns) = 6928 LB
(786 KG) x (4 tiedowns) = 3144 KG

7A.) If the total tiedown allowable is equal to or exceeds the weight of cargo to be restrained, then the tiedown scheme is acceptable in that direction. If the total tiedown down allowable is less than the weight of cargo to be restrained, then additional tiedowns are required in that direction.

Since the tiedown allowable is now 6928 LB (3144 KG) and the weight of the cargo is 5632 LB (2555 KG), the two straps are sufficient to restraint the cargo in the side-left direction.

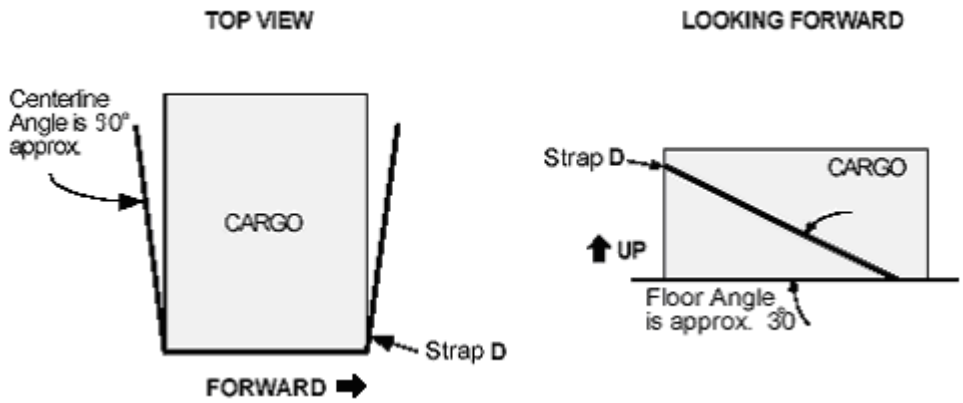
13.4.4. Side-Right Restraint

1.) Determine the weight of the cargo to be restrained in consideration of the load factors for tiedowns taken from chapter 13.2.2. The weight to be restrained in side-right direction is 3200 x 1.76 = 5632 LB (2555 KG).

2.) Create a table similar to the following worksheet. The data from Steps 3 through 5 have been added to the worksheet.

DIRECTION	TIEDOWN LOCATION	FLOOR ANGLE (DEGREES)	CENTERLINE ANGLE (DEGREES)	NUMBER OF TIEDOWN FITTINGS	TIEDOWN ALLOWABLE LB
Side-Right	Center Guide Double Stud Fitting [a]	30°	90°	2	1732 (786) [a]
[a] From chapter 13.2.11					

3.) Select the tiedown location to be used from the choices in chapter 14. The center guide was used in the example and this data was added to the table in Step 2. Only Strap D will restrain in the side-right direction because only this strap contacts the side-right face of the cargo to be restrained.



4.) Establish the floor and centerline angles (to the nearest 30 degree increment for each tiedown selected). The floor angle is 30 degrees and the centerline angle is 90 degrees in the example and this data was added to the table in Step 2. There are two tiedown fittings, one at each end of the strap.

5.) Use the table in chapter 13.2.5 to 13.2.11 to determine the tiedown allowable. The tiedown allowable is 1732 LB (786 KG) from the table in chapter 13.2.11 in the example and this data was added to the table in Step 2.

6.) Multiply the tiedown allowable by the number of tiedown fittings to get the total tiedown allowable. The total tiedown allowable is:

(1732 LB) x (2 tiedowns) = 3464 LB
(786 LB) x (2 tiedowns) = 1572 KG

7.) If the total tiedown allowable is equal to or exceeds the weight of cargo to be restrained, then the tiedown scheme is acceptable in that direction. If the total tiedown allowable is less than the weight of cargo to be restrained, then additional tiedowns are required in that direction.

Since the tiedown allowable is 3464 LB (1572 KG) and the weight of the cargo is 5632 LB (2555 KG), another strap is required in the side-right direction. Let's add another strap, similar to the first strap and then repeat Steps 2 through 5 and create a new table as follows:

DIRECTION	TIEDOWN LOCATION	FLOOR ANGLE (DEGREES)	CENTERLINE ANGLE (DEGREES)	NUMBER OF TIEDOWN FITTINGS	TIEDOWN ALLOWABLE LB
Side-Right	Center Guide Double Stud Fitting [a]	30°	90°	4	1732 (786) [a]
[a] From chapter 13.2.11					

6A). Multiply the tiedown allowable by the number of tiedown fittings to get the total tiedown allowable. The total tiedown allowable is:

(1732 LB) x (4 tiedowns) = 6928 LB
(786 KG) x (4 tiedowns) = 3144 KG

7A.) If the total tiedown allowable is equal to or exceeds the weight of cargo to be restrained, then the tiedown scheme is acceptable in that direction. If the total tiedown down allowable is less than the weight of cargo to be restrained, then additional tiedowns are required in that direction.

Since the tiedown allowable is now 6928 LB (3144 KG) and the weight of the cargo is 5632 LB (2555 KG), the two straps are sufficient to restraint the cargo in the side-right direction.

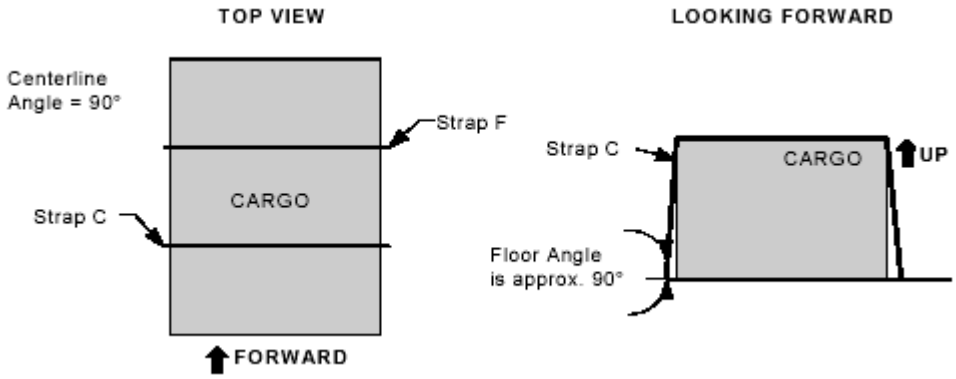
13.4.5. Up Restraint

1.) Determine the weight of the cargo to be restrained in consideration of the load factors for tiedowns taken from chapter 13.2.2. The weight to be restrained is 3200 x 2.34 = 7488 LB (3396 KG).

2.) Create a table similar to the following worksheet. The data from Steps 3 through 5 have been added to the worksheet.

DIRECTION	TIEDOWN LOCATION	FLOOR ANGLE (DEGREES)	CENTERLINE ANGLE (DEGREES)	NUMBER OF TIEDOWN FITTINGS	TIEDOWN ALLOWABLE LB
Up	Pallet Lock - Tiedown Ring [a]	90°	0°	4	5000 (2268) [a]
[a] From chapter 13.2.5					

3.) Select the tiedown location to be used from the choices in chapter 14. The pallet lock with tiedown ring was used in the example and this data was added to the table in Step 2. Only Straps C and F will restrain in the up direction because only these straps contact the top face of the cargo to be restrained.



4.) Establish the floor and centerline angles (to the nearest 30 degree increment for each tiedown selected). The floor angle is 90 degrees and the centerline angle is 0 degrees in the example and this data was added to the table in Step 2. There are two tiedown fittings, one at each end of the strap.

5.) Use the table in chapter 13.2.5 to 13.2.11 to determine the tiedown allowable. The tiedown allowable is 5000 LB (2268 KG) from the table on in chapter 13.2.5 in the example and this data was added to the table in Step 2.

6.) Multiply the tiedown allowable by the number of tiedown fittings to get the total tiedown allowable. The total tiedown allowable is:

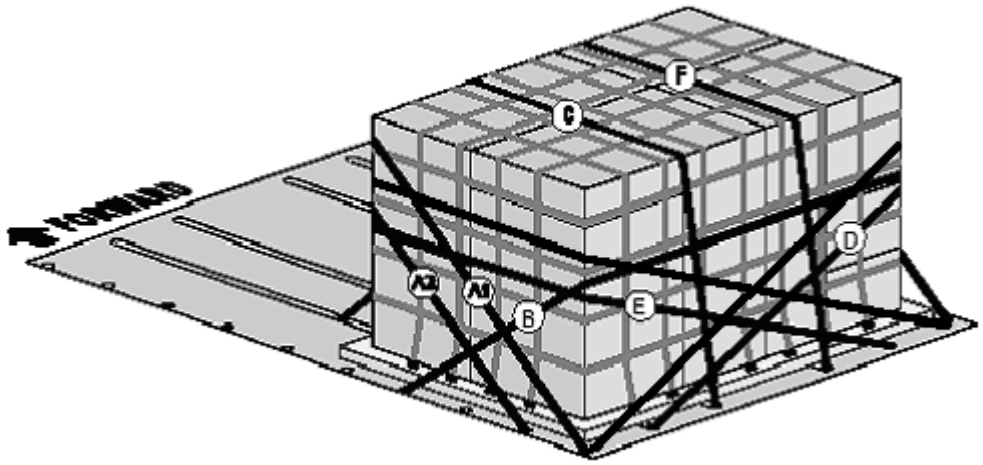
(5000 LB) x (4 tiedowns) = 20000 LB
(2268 LB) x (4 tiedowns) = 9072 KG

7.) If the total tiedown down allowable is equal to or exceeds the weight of cargo to be restrained, then the tiedown scheme is acceptable in that direction. If the total tiedown allowable is less than the weight of cargo to be restrained, then additional tiedowns are required in that direction.

Since the tiedown allowable is 20000 LB (9072 KG) and the weight of the cargo is 7488 LB (3396 KG), the two Straps C and F are sufficient to restrain the cargo in the up direction.

13.4.6. Conclusion

The proposed tiedown will require additional straps to restrain cargo in the forward and the side directions. With this added straps, the tiedown is acceptable for restraining a 3200 LB (1452 KG) package on the main deck. A final restraint scheme is shown below.



13.5. Tiedown Restrictions

Due to the fact that the TELAIR system provides twice the tie-down fitting quantity between STA 520 – 1000 and STA 1480 – 2220, as well as due to some differences between the BOEING System and the TELAIR system, the following tie-down restrictions apply:

The following restrictions apply to the Telair mechanical cargo loading system for the 747-400 special freighter airplane:

Restrictions to Side Guide Rail Tie-Down Locations

F-Code ULD's - No side guide rail tie downs adjacent to an engaged flipper or blade may be used. In the case of missing restraints a tie down adjacent to a broken or missing flipper or blade may be used.

R-Code ULD's - Installed with 4 or 5 blades engaged - tie downs are restricted to 2500 lb. fwd, 4500 lb. up and 5000 lb. INBD. These limits are ultimate and singular. See the following table for allowable ultimate tie down strap tension load at various angles.

Ultimate Tie Down Strap Tension Load for Side Locked R-Code Longitudinal Pallet

APPLICABLE CONFIGURATIONS	
ALL	

	Side Wall Angle, phi				
Floor Angle, Theta Degrees	0	30	45	60	90
0	2500	3549	5000	5000	5000
30	2211	2174	2339	2678	3549
45	2304	2271	2416	2705	5000
60	2589	2560	2689	2935	5000
90	4500	4500	4500	4500	4500

Phi = angle measured INBD from plane parallel to airplane BL

Theta = angle measured up from a plane parallel to the airplane WL.

No tie down restriction for the G pallets - Acceptable by comparison to the R-Pallet with 5 blades engaged. The applied loads due to G pallets are less than those due to R pallet with 5 blades engaged. No restriction for end locked pallets: A, B, M or endlocked F.

Tiedowns adjacent to a missing or inoperative rail support fitting may not be used.

Restrictions to Tie-Down Locations at Nose Area STA240 - 525

No tiedowns locations are allowed on Side Guide Rails between STA 240 and STA 525.

Allowable tiedown loads on lock trays & pallet locks are restricted to 2400 lbs (1088 kg) for the hole unit. If several tiedown locations at one lock tray or pallet lock are used, tiedown loads for each tiedown locations are reduced to make sure that the maximum allowed load the the loack tray or pallet is not exceeded.

Restrictions to Side Guide Rail Tie-Down Locations RH-Side P-29

The 2 additional tie downs at STA 2260 and 2320 common to the R/H side guide rail 290100-28 cannot be used in order to ensure interface loads equivalent to existing Boeing hardware.

Restrictions to Tie-Down Locations at Constant Section STA 2218

The Tiedowns common to the 288100-1 and 289100-1/-3 will be restricted to 4250 lbs fwd, 1780 lbs side and 5000 lbs up in order to ensure interface loads equivalent to existing Boeing hardware.

The tie down common to 288100-1 cannot be used to restrain cargo loaded in P29.

288100-1 Endlock is located at STA 2216, RBL 55.50

289100-1 and -3 Endlocks are located at STA 2216, LBL 30.75, 55.50 and 80.25

Note: Loads are restricted so that Telair interface loads will be no greater than Boeing interface loads. The unrestricted loads in the Boeing systems are 5000 lbs FDW, AFT, UP and 2000 lbs SIDE.

14. TIEDOWN FITTING LOCATIONS - MAIN DECK

NOTE: The above figures are only intended to show a typical cargo tiedown fitting configuration. Tiedown fitting equipment, arrangement and location may vary from what is shown.

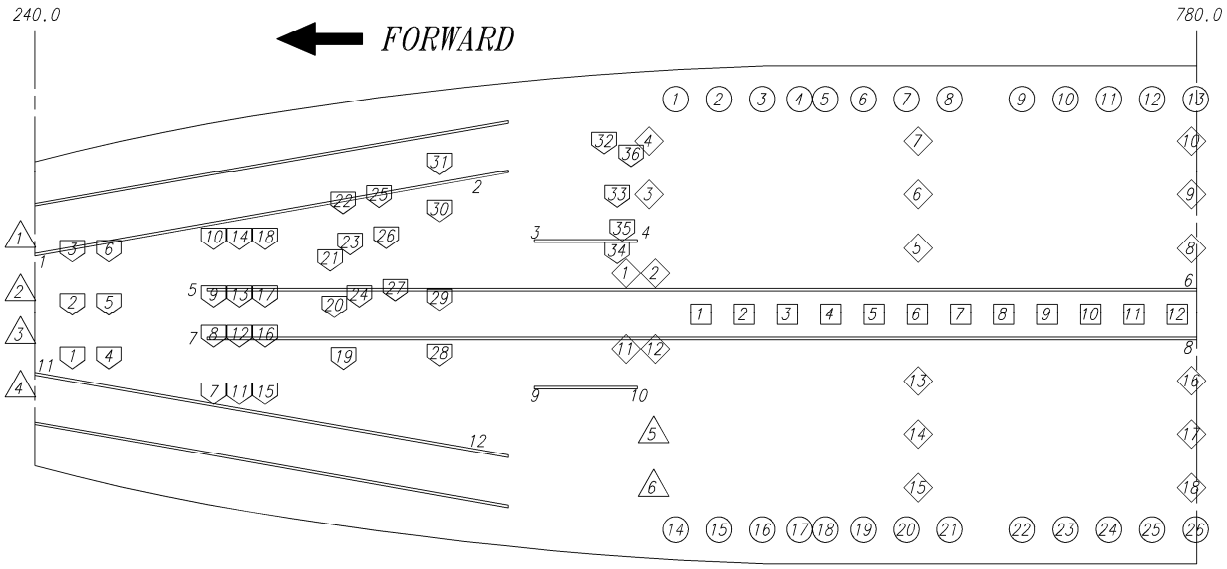
NOTE: The tiedown locations on the pallet locks and endstops may vary in an 1.00 inch increment up and down the whole aircraft length between B.A. 525 – 2280 depending where they are installed within the lock trays at RBL 30.75, 55.50, 80.25 and LBL 30.75, 55.50, 80.25.

NOTE: Tiedowns must not obstruct use of the crew ladder or electrical floor access hatch.

NOTE: For Seattrack and Crew Baggage tiedown allowables and locations, refer to the Boeing Weight and Balance Manual applicable for airplanes listed in chapter 2.
Show Seat Track and related tiedown locations are for reference only.

14.1. FITTING LOCATIONS

The following illustration shows the layout of pivoting shackles, anchor plates, and tiedown fittings on the main deck between B.A. 240.0 and B.A. 780.0.



The following tables provide the locations for each tiedown fitting on the main deck between B.A. 240.0 and B.A. 780.0.

△	NO.	B.A. IN.	B.B.L. IN.
End Stops	1	234	35,34
	2	234	9,27
	3	234	-9,33
	4	234	-34,62
	5	526,2	-55,5
	6	526,2	-80,3

	NO.	B.A. IN.	B.B.L. IN.
Structure Mounted Pallet Locks	1	256,9	-19,3
	2	256,9	5,5
	3	256,9	30,3
	4	273,9	-19,3
	5	273,9	5,5
	6	273,9	30,3
	7	322,5	-35,7
	8	322,5	-9,2
	9	322,5	9,2
	10	322,5	36,0
	11	330,5	-35,7
	12	330,5	-9,2
	13	330,5	9,2
	14	330,5	36,0
	15	338,5	-35,7
	16	338,5	-9,2
	17	338,5	9,2
	18	338,5	36,0
	19	382,9	-19,5
	20	382,9	4,3
	21	382,9	29,4
	22	382,9	52,5
	23	386,0	33,5
	24	390,3	9,2
	25	399,4	55,4
	26	402,7	36,5
	27	407,0	12,1
	28	427,5	-17,9
	29	427,5	7,6
	30	427,5	48,7
	31	427,5	70,5
	32	505,7	80,3
	33	510,1	55,5
	34	514,6	29,5
	35	516,5	35,6
	36	516,5	74,2

◇	NO.	B.A. IN.	B.B.L. IN.
Tray Mounted Pallet Locks	1	516,5	20,8
	2	524,5	20,8
	3	524,4	55,5
	4	524,4	80,3
	5	649,4	30,8
	6	649,4	55,5
	7	649,4	80,3
	8	776,4	30,6
	9	776,4	55,5
	10	776,4	80,3
	11	516,5	-16,0
	12	524,5	-16,0
	13	649,4	-30,7
	14	649,4	-55,5
	15	649,4	-80,2
	16	776,4	-30,6
	17	776,4	-55,5
	18	776,4	-80,2

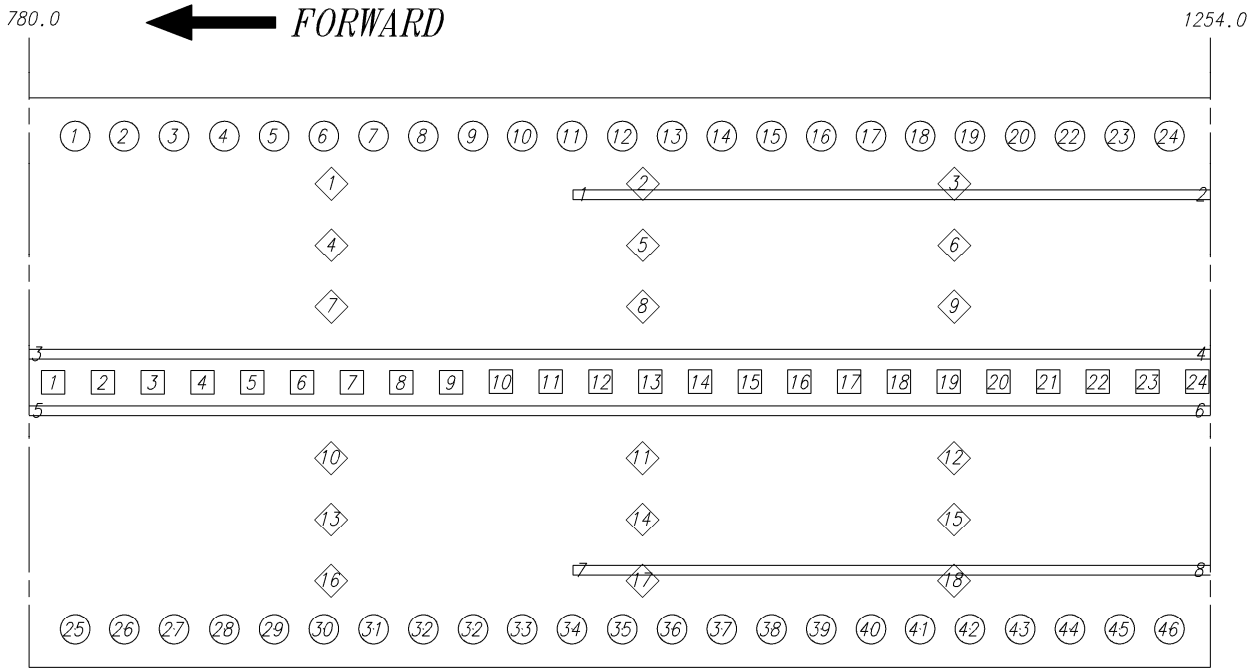
	NO.	B.A. IN.	B.B.L. IN.
Side Guides	1	537,0	99,7
	2	557,1	99,7
	3	577,3	99,7
	4	597,4	99,7
	5	604,3	99,7
	6	624,3	99,7
	7	644,3	99,7
	8	664,3	99,7
	9	698,0	99,7
	10	718,1	99,7
	11	738,3	99,7
	12	758,4	99,7
	13	778,6	99,7
	14	537,0	-99,7
	15	557,1	-99,7
	16	577,3	-99,7
	17	597,4	-99,7
	18	604,3	-99,7
	19	624,3	-99,7
	20	644,3	-99,7
	21	664,3	-99,7
	22	698,0	-99,7
	23	718,1	-99,7
	24	738,3	-99,7
	25	758,4	-99,7
	26	778,6	-99,7

	NO.	B.A. IN.	B.B.L. IN.
Center Guides	1	547.3	0.0
	2	567.5	0.0
	3	587.6	0.0
	4	607.7	0.0
	5	627.8	0.0
	6	648.0	0.0
	7	668.1	0.0
	8	688.2	0.0
	9	708.3	0.0
	10	728.5	0.0

	NO.	NODE [a]	B.A. IN.	B.B.L. IN.
Seat Tracks	1	First	240.0	+27.3
	2	Last	445.0	+62.2
	3	First	472.0	+34.0
	4	Last	520.0	+34.0
	5	First	320.0	+11.3
	6	Last	780.0	+11.3
	7	First	320.0	-11.3
	8	Last	780.0	-11.3
	9	First	472.0	-34.0
	10	Last	520.0	-34.0
	11	First	240.0	-27.3
	12	Last	445.0	-62.6
[a] Nodes are 1 IN. apart				

NOTE:
Crew Baggage tiedown locations are defined as follows:
- The anchor plates between B.A. 440 and 520
- Seat tracks at LBL 34 between B.A. 472 and 520
- Seat track at LBL 62.6 and B.A. 445

The following illustration shows the layout of pivoting shackles and tiedown fittings on the main deck between B.A. 780.0 and B.A. 1254.0.



The following tables provide the locations for each tiedown fitting on the main deck deck between B.A. 780.0 and B.A. 1254.0.

	NO.	B.A. IN.	B.B.L. IN.
Side Guides	1	798.6	99.8
	2	818.5	99.8
	3	838.6	99.8
	4	859	99.8
	5	879.1	99.8
	6	899.3	99.8
	7	919.4	99.8
	8	939.5	99.8
	9	959.6	99.8
	10	979.5	99.8
	11	999.6	99.8
	12	1020	99.8
	13	1040.1	99.8

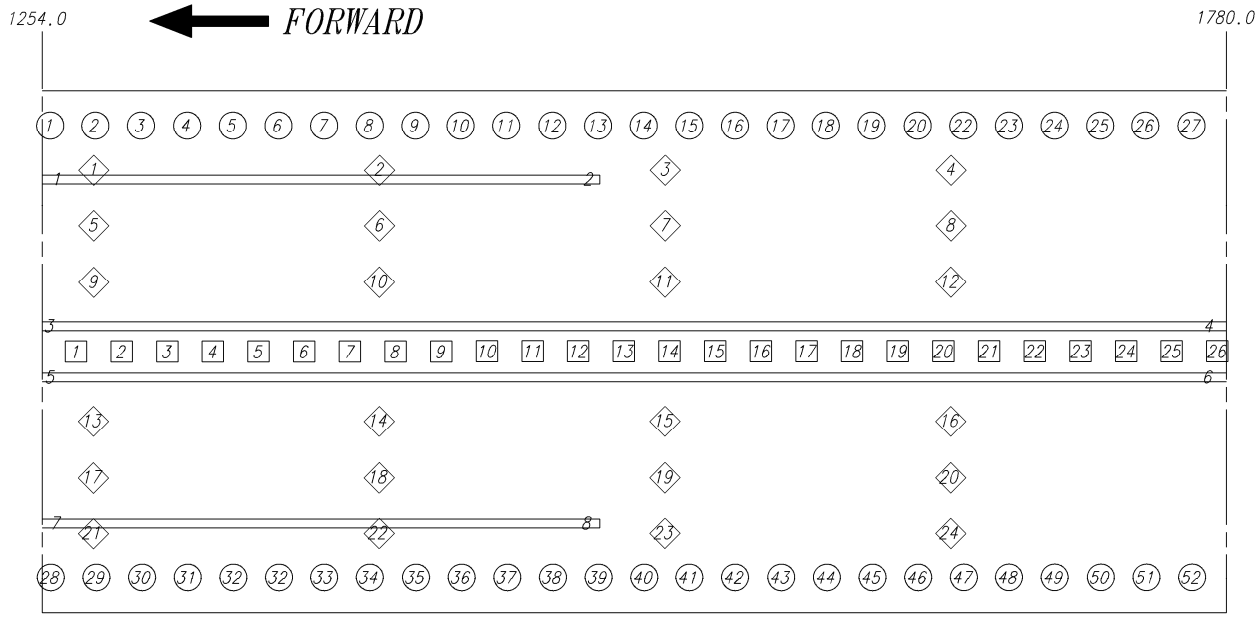
	NO.	B.A. IN.	B.B.L. IN.
	14	1060.3	99.8
	15	1080.4	99.8
	16	1100.5	99.8
	17	1120.6	99.8
	18	1140.5	99.8
	19	1160.6	99.8
	20	1181	99.8
	21	1201.1	99.8
	22	1221.3	99.8
	23	1241.4	99.8
	24	1241.4	-99.8
	25	1221.3	-99.8
	26	1201.1	-99.8
	27	1181	-99.8
	28	1160.6	-99.8
	29	1140.5	-99.8
	30	1120.6	-99.8
	31	1100.5	-99.8
	32	1080.4	-99.8
	33	1060.3	-99.8
	34	1040.1	-99.8
	35	1020	-99.8
	36	999.6	-99.8
	37	979.5	-99.8
	38	959.6	-99.8
	39	939.5	-99.8
	40	919.4	-99.8
	41	899.3	-99.8
	42	879.1	-99.8
	43	859	-99.8
	44	838.6	-99.8
	45	818.5	-99.8
	46	798.6	-99.8

◆	NO.	B.A. IN.	B.B.L. IN.
End Locks/Stops	1	902.5	80.3
	2	1028.5	80.3
	3	1154.5	80.3
	4	902.5	55.5
	5	1028.5	55.5
	6	1154.5	55.5
	7	902.5	30.8
	8	1028.5	30.8
	9	1154.5	30.8
	10	902.5	-30.8
	11	1028.5	-30.8
	12	1154.5	-30.8
	13	902.5	-55.5
	14	1028.5	-55.5
	15	1154.5	-55.5
	16	902.5	-80.3
	17	1028.5	-80.3
	18	1154.5	-80.3

	NO.	B.A. IN.	B.B.L. IN.
Center Guides	1	788.8	0.0
	2	809.0	0.0
	3	829.1	0.0
	4	849.2	0.0
	5	869.3	0.0
	6	889.5	0.0
	7	909.6	0.0
	8	929.7	0.0
	9	949.8	0.0
	10	970.0	0.0
	11	990.1	0.0
	12	1010.2	0.0
	13	1030.3	0.0
	14	1048.0	0.0
	15	1068.1	0.0
	16	1088.2	0.0
	17	1108.4	0.0
	18	1128.5	0.0
	19	1148.6	0.0
	20	1168.7	0.0
	21	1188.9	0.0
	22	1209.0	0.0
	23	1229.1	0.0
	24	1249.2	0.0

	NO.	NODE [a]	B.A. IN.	B.B.L. IN.
Seat Tracks	1	First	1000.0	+75.9
	2	Last	1254.0	+75.9
	3	First	780.0	+11.3
	4	Last	1254.0	+11.3
	5	First	780.0	-11.3
	6	Last	1254.0	-11.3
	7	First	1000.0	-75.9
	8	Last	1254.0	-75.9
[a] Nodes are 1 IN. apart				

The following illustration shows the layout of pivoting shackles and tiedown fittings on the main deck between B.A. 1254.0 and B.A. 1780.0.



The following tables provide the locations for each tiedown fitting on the main deck deck between B.A. 1254.0 and B.A. 1780.0.

	NO.	B.A. IN.	B.B.L. IN.
Side Guides	1	1257,5	99,8
	2	1277,6	99,8
	3	1297,5	99,8
	4	1317,6	99,8
	5	1338	99,8
	6	1358,1	99,8
	7	1378,3	99,8
	8	1398,4	99,8
	9	1418,5	99,8
	10	1438,6	99,8
	11	1458,5	99,8
	12	1478,6	99,8
	13	1499	99,8
	14	1519,1	99,8
	15	1539,3	99,8
	16	1559,4	99,8
	17	1579,5	99,8

	NO.	B.A. IN.	B.B.L. IN.
	18	1599,6	99,8
	19	1619,5	99,8
	20	1639,6	99,8
	21	1660	99,8
	22	1680,1	99,8
	23	1700,2	99,9
	24	1720,4	99,8
	25	1740,5	99,8
	26	1760,6	99,8
	27	1257,5	-99,8
	28	1277,6	-99,8
	29	1297,5	-99,8
	30	1317,6	-99,8
	31	1338	-99,8
	32	1358,1	-99,8
	33	1378,3	-99,8
	34	1398,4	-99,8
	35	1418,5	-99,8
	36	1438,6	-99,8
	37	1458,5	-99,8
	38	1478,6	-99,8
	39	1499	-99,8
	40	1519,1	-99,8
	41	1539,3	-99,8
	42	1559,4	-99,8
	43	1579,5	-99,8
	44	1599,6	-99,8
	45	1619,5	-99,8
	46	1639,6	-99,8
	47	1660	-99,8
	48	1680,1	-99,8
	49	1700,2	-99,8
	50	1720,4	-99,8
	51	1740,5	-99,8
	52	1760,6	-99,8

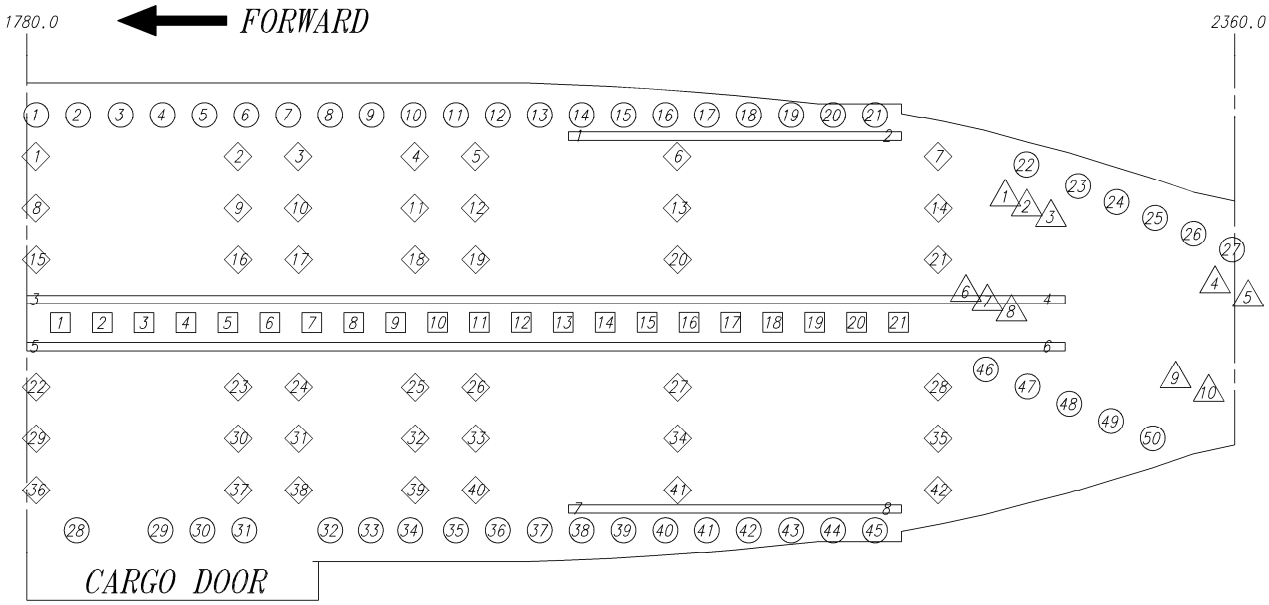
	NO.	B.A. IN.	B.B.L. IN.
End Locks/Stops	1	1280.5	80.3
	2	1406.5	80.3
	3	1532.5	80.3
	4	1658.5	80.3
	5	1280.5	55.5
	6	1406.5	55.5
	7	1532.5	55.5
	8	1658.5	55.5
	9	1280.5	30.8
	10	1406.5	30.8
	11	1532.5	30.8
	12	1658.5	30.8
	13	1280.5	-30.8
	14	1406.5	-30.8
	15	1532.5	-30.8
	16	1658.5	-30.8
	17	1280.5	-55.5
	18	1406.5	-55.5
	19	1532.5	-55.5
	20	1658.5	-55.5
	21	1280.5	-80.3
	22	1406.5	-80.3
	23	1532.5	-80.3
	24	1658.5	-80.3

	NO.	B.A. IN.	B.B.L. IN.
Center Guides	1	1269.4	0.0
	2	1289.5	0.0
	3	1309.6	0.0
	4	1329.7	0.0
	5	1349.9	0.0
	6	1370.0	0.0
	7	1390.1	0.0
	8	1410.2	0.0
	9	1430.4	0.0
	10	1453.0	0.0
	11	1473.1	0.0
	12	1493.2	0.0
	13	1513.3	0.0

	14	1533.5	0.0
	15	1553.6	0.0
	16	1573.7	0.0
	17	1593.8	0.0
	18	1614.0	0.0
	19	1634.1	0.0
	20	1654.2	0.0
	21	1674.3	0.0
	22	1694.5	0.0
	23	1714.6	0.0
	24	1734.7	0.0
	25	1754.8	0.0
	26	1775.0	0.0

	NO.	NODE [a]	B.A. IN.	B.B.L. IN.
Seat Tracks	1	First	1254.0	+75.9
	2	Last	1480.0	+75.9
	3	First	1254.0	+11.3
	4	Last	1780.0	+11.3
	5	First	1254.0	-11.3
	6	Last	1780.0	-11.3
	7	First	1254.0	-75.9
	8	Last	1480.0	-75.9
[a] Nodes are 1 IN. apart				

The following illustration shows the layout of pivoting shackles and tiedown fittings on the main deck between B.A. 1780.0 and B.A. 2360.0.



The following tables provide the locations for each tiedown fitting on the main deck between B.A. 1780.0 and B.A. 2360.0.

	NO.	B.A. IN.	B.B.L. IN.
Side Guides	1	1784.5	99.8
	2	1804.6	99.8
	3	1825.0	99.8
	4	1845.1	99.8
	5	1865.3	99.8
	6	1885.4	99.8
	7	1905.5	99.8
	8	1925.6	99.8
	9	1945.5	99.8
	10	1965.6	99.8
	11	1986.0	99.8
	12	2006.1	99.8
	13	2026.3	99.8
	14	2046.4	99.8

	NO.	B.A. IN.	B.B.L. IN.
	15	2066.5	99.8
	16	2086.6	99.8
	17	2106.5	99.8
	18	2126.6	99.8
	19	2147.0	99.8
	20	2167.1	99.8
	21	2187.3	99.8
	22	2260.0	76.3
	23	2284.8	66.0
	24	2303.3	58.4
	25	2321.8	50.7
	26	2340.2	43.0
	27	2358.7	35.4
	28	1803.9	-99.8
	29	1844.1	-99.8
	30	1864.3	-99.8
	31	1884.4	-99.8
	32	1925.6	-99.8
	33	1945.1	-99.8
	34	1964.1	-99.8
	35	1986.0	-99.8
	36	2006.1	-99.8
	37	2026.3	-99.8
	38	2046.4	-99.8
	39	2066.5	-99.8
	40	2086.6	-99.8
	41	2106.5	-99.8
	42	2126.6	-99.8
	43	2147.0	-99.8
	44	2167.1	-99.8
	45	2187.3	-99.8
	46	2240.5	-22.3
	47	2260.5	-30.6
	48	2280.6	-38.9
	49	2300.6	-47.2
	50	2320.6	-55.5

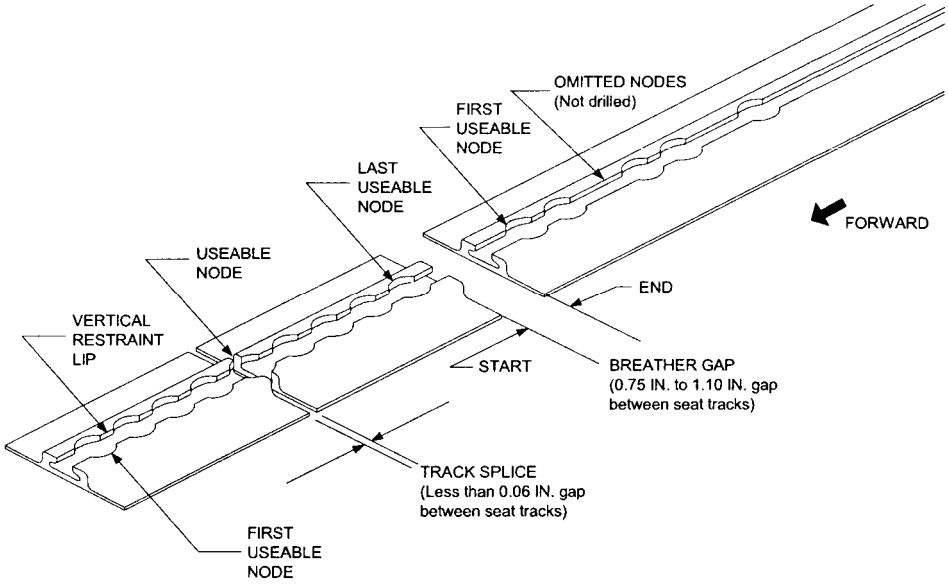
◇	NO.	B.A. IN.	B.B.L. IN.
End Locks/Stops	1	1807.4	80.3
	2	1904.4	80.3
	3	1933.4	80.3
	4	1989.4	80.3
	5	2018.4	80.3
	6	2115.4	80.3
	7	2240.5	80.3
	8	1807.4	55.5
	9	1904.4	55.5
	10	1933.4	55.5
	11	1989.4	55.5
	12	2018.4	55.5
	13	2115.4	55.5
	14	2240.5	55.5
	15	2240.5	30.8
	16	1807.4	30.8
	17	1904.4	30.8
	18	1933.4	30.8
	19	1989.4	30.8
	20	2018.4	30.8
	21	2115.4	30.8
	22	1807.4	-30.8
	23	1904.4	-30.8
	24	1933.4	-30.8
	25	1989.4	-30.8
	26	2018.4	-30.8
	27	2115.4	-30.8
	28	2240.5	-30.8
	29	1807.4	-55.5
	30	1904.4	-55.5
	31	1933.4	-55.5
	32	1989.4	-55.5
	33	2018.4	-55.5
	34	2115.4	-55.5
	35	2240.5	-55.5
	36	1807.4	-80.3
	37	1904.4	-80.3
	38	1933.4	-80.3
	39	1989.4	-80.3
	40	2018.4	-80.3
	41	2115.4	-80.3
	42	2240.5	-80.3

	NO.	B.A. IN.	B.B.L. IN.
Center Guides	1	1796.0	0.0
	2	1816.1	0.0
	3	1836.3	0.0
	4	1856.4	0.0
	5	1876.5	0.0
	6	1896.6	0.0
	7	1916.8	0.0
	8	1936.9	0.0
	9	1957.0	0.0
	10	1977.1	0.0
	11	1997.3	0.0
	12	2017.4	0.0
	13	2037.5	0.0
	14	2057.6	0.0
	15	2077.8	0.0
	16	2097.9	0.0
	17	2118.0	0.0
	18	2138.1	0.0
	19	2158.3	0.0
	20	2178.4	0.0
	21	2198.5	0.0

	NO.	B.A. IN.	B.B.L. IN.
Lock Trays	1	2249.7	60.9
	2	2256.4	58.1
	3	2265.4	54.4
	4	2350.4	19.2
	5	2230.7	15.1
	6	2366.3	12.6
	7	2237.4	12.4
	8	2246.4	8.6
	9	2331.4	-26.6
	10	2347.3	-33.1

	NO.	NODE [a]	B.A. IN.	B.B.L. IN.
Seat Tracks	1	First	2040.0	+89.7
	2	Last	2220.0	+89.7
	3	First	1780.0	+11.3
	4	Last	2300.0	+11.3
	5	First	1780.0	-11.3
	6	Last	2300.0	-11.3
	7	First	2040.0	-89.7
	8	Last	2220.0	-89.7

The following illustration shows a typical section of seat track located on the main deck.



NOTE:
Some locations may be unavailable due to cargo handling hardware, breather gaps between seat tracks, and ommited nodes.

NOTE:
Do not use vertical restraint lips immediately adjacent to the breather gaps.

NOTE:
Illustration for reference only. For further information refer to Boeing weight & Balance Manual.