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Superseding AIR4899

Cargo Compartments Maximum Package Size Calculation Methodology

RATIONALE

The SAE AGE-2A committee determined that the technology/practice defined in this standard has reached a level of maturity such that it is unlikely to change in the foreseeable future; therefore, it does not require regular 5-year reviews by the committee and it is appropriate for it to be stabilized.

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INTRODUCTION

For a given aircraft and each cargo compartment, the maximum package size tables determine the maximum size of rectangular shaped package that can be accommodated, due to cargo door and compartment geometry and sizes.

Published by each airframe manufacturer for information, these data are verified and adapted by the individual airline in line with loading methods practiced and training provided. They serve to accept such loads for air cargo transport.

When such a package is received and checked, the reliability of the maximum package size table data and pertaining assumptions are the basis for further considerations, i.e. weight, manpower, multiple packages, loading and restraint, to realize a smooth loading operation.

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1. SCOPE:

The methodology for maximum package size loading is based on a mathematical method allowing the calculation of maximum package size tables.

This method does not in principal differentiate between bulk loading and cargo system loading.

However, some restrictions have to be considered:

- Some cargo systems generate pre-determined pallet trajectories. Envelope curves depending on the pallet size and the possible trajectories have to be determined first.
- Door geometric limitations (with or without cargo loading system)
- Turning limitations due to weight, load geometry and conveyance capability
- Securing requirements

This document is not intended for airline operational use. It should be used by engineers performing calculations or developing computer programs to produce Maximum Package Size tables specified in AS1825.

1.1 Purpose:

The purpose of this document is to provide mathematical support to establish and verify max. package loadability and max. package size tables for given cargo hold dimensions.

This standardized methodology shall be:

- applicable for any given aircraft and each compartment
- based on a defined and practicable loading procedure
- exact for the range of maximum size packages within a rectangular contour envelope
- referenced as basic methodology, to identify geometrical variants

2. REFERENCES:

2.1 Applicable Documents:

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AS1825	Methodology of Calculating Aircraft Volumes
ARP5595	Cargo Restraint Straps - Utilization Guidelines

2.1.2 IATA Publications:

Orders from North, Central, South America, Asia, Australasia and the Pacific: International Air Transport Association, 800 Place Victoria, P.O. Box 113, MONTREAL, Quebec, Canada H4Z1M1.

Orders from Europe, Africa and the Middle East: International Air Transport Association, IATA Centre, 33 route de l'aéroport, P.O. Box 672, CH-1215 GENEVA 15 Airport, Switzerland.

IATA - AHM 671	securing of loads
IATA - AHM 673	bulk compartment load limitations
IATA - AHM 676	handling / bulk loading of HEAVY items
IATA - AHM 677	handling and loading of BIG OVERHANG items

of the IATA AIRPORT HANDLING MANUAL, latest edition

2.2 Definitions:

RECTANGULAR COMPARTMENT: In this document and for practical reasons, a cargo compartment with a constant cross section and a rectangular horizontal section will be called rectangular compartment.

TAPERED SHAPE COMPARTMENT: In this document and for practical reasons, a cargo compartment with a variable cross section and/or a tapered horizontal section will be called tapered compartment.

2.3 Abbreviations:

A/D: Aircraft Datum Line
CC: Cargo Compartment
MPS: Maximum Package Size

3. METHODOLOGY:

3.1 Method of Loading:

Loading a maximum size rectangle shaped package follows on both ends simultaneously the guideline (A) and the intersection line (B) of the cargo compartment floor/lining, passing the corner (C) when manipulated in contact with the floor at a critical angle (the maximum height is the one of the lower deck, all clearances respected).

When lifted by the distance L parallel to the floor, B_L and C_L apply. The package length might be then significantly larger but the maximum height reduced by L .

NOTE: The load is positioned at the cargo compartment door sill, perpendicular to the aircraft datum line (A/D).

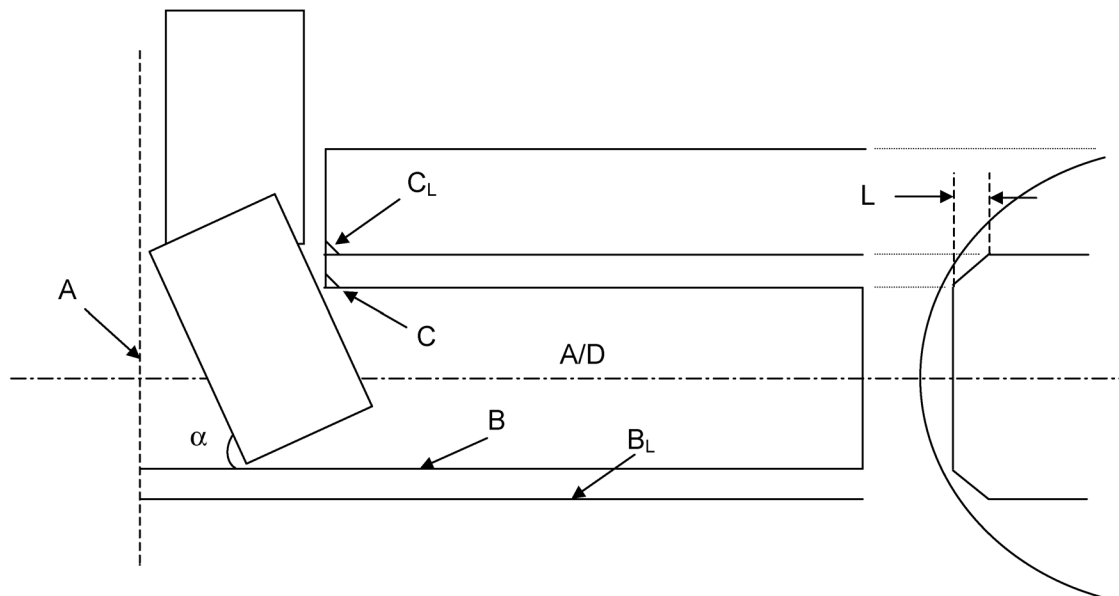


FIGURE 1

3.2 Loading Parameters:

3.2.1 For bulk loading and manipulation with floor contact, the following has to be used:

- Door width minus 50.8 mm (2 in) clearance on both sides (= maximum width)
- Floor width minus 50.8 mm (2 in) clearance on both sides
- Compartment height minus 50.8 mm (2 in) clearance on top (= maximum height)
- Package length (at defined package width):
 - defined by the door-/floor width dimensions
 - at corner C - see 3.1
 - above standard clearances considered

3.2.2 For bulk loading and manipulation with the packages lifted parallel to the floor, the following has to be used:

- Compartment width replaces floor width
- Package length (at defined package width):
 - defined by the door-/compartment width dimensions
 - at corner C_L - see 3.1
 - above standard clearances considered

3.2.3 For containerised/palletised compartments, manipulation with floor contact.

- 3.2.1 applies
- However cargo loading system components i.e.:
 - guides
 - latches (Z-restraint),
 - Power Drive Units,
 - etc.and possible trajectories plus adequate clearances have to be taken into account.
- This could be waived, when i.e. the package is loaded with auxiliary equipment, to pass above those cargo loading system components, which reduce the usable height.

3.2.4 For containerised/palletised compartments, manipulation with packages lifted parallel to floor.

- 3.2.2 applies

3.2.5 The package length can be limited by the compartment length, clearances to bulkheads of 50.8 mm (2 in) accounted for.

NOTE: The Maximum Package Size tables are assuming loading/positioning parallel to A/D.

3.2.6 Constraints which have to be considered for practical loading are:

- Weight,
- Possible trajectories and turning limitations,
- Manpower,
- Weight distributions,
- Securing requirements,
- Conveyance capability,
- Access and restraints especially when loading multiple packages

3.3 Mathematical Solution:

3.3.1 Introduction: For the mathematical purpose, it is assumed that a rectangular package is to be loaded into a room through an opening located at the longitudinal side. Heights of package and loading room (i.e., the third dimension) are not considered. Loading is done by pushing the package without any tilting or lifting (rectangular movement).

The mathematical theory is provided in the annexes.

3.3.2 "Rectangular compartment" (constant cross section + rectangular horizontal section)

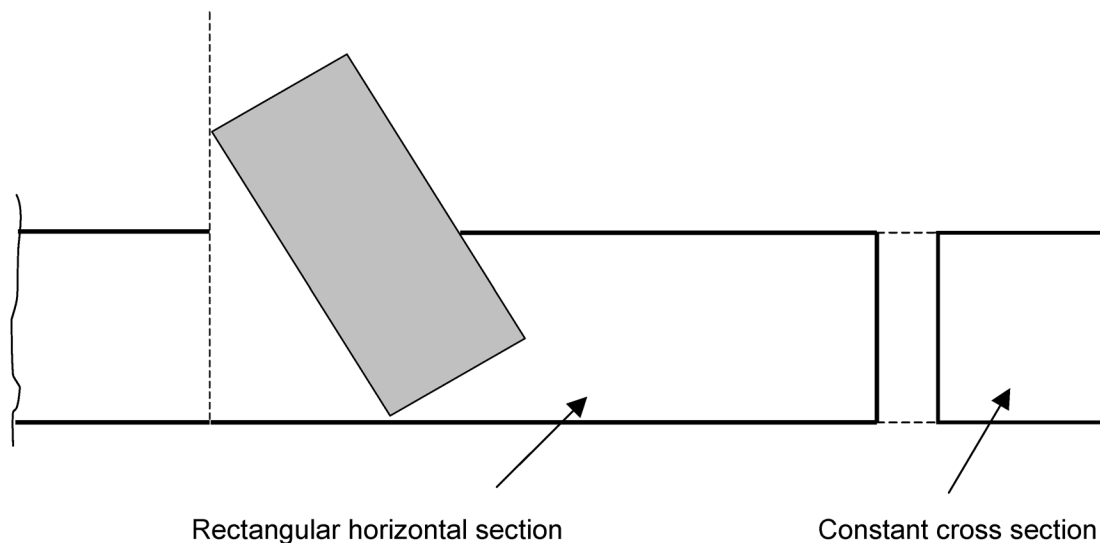


FIGURE 2

The method using the "rectangular compartments" does not necessarily apply to a perfect rectangular horizontal section. In fact, the rectangular section has to be inscribed in the dimensions of the compartment.

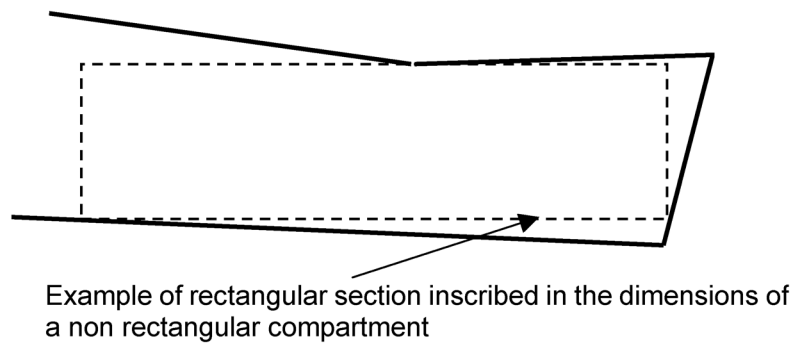


FIGURE 3

3.3.3 "Tapered shape Compartment" (variable cross section + tapered horizontal section)

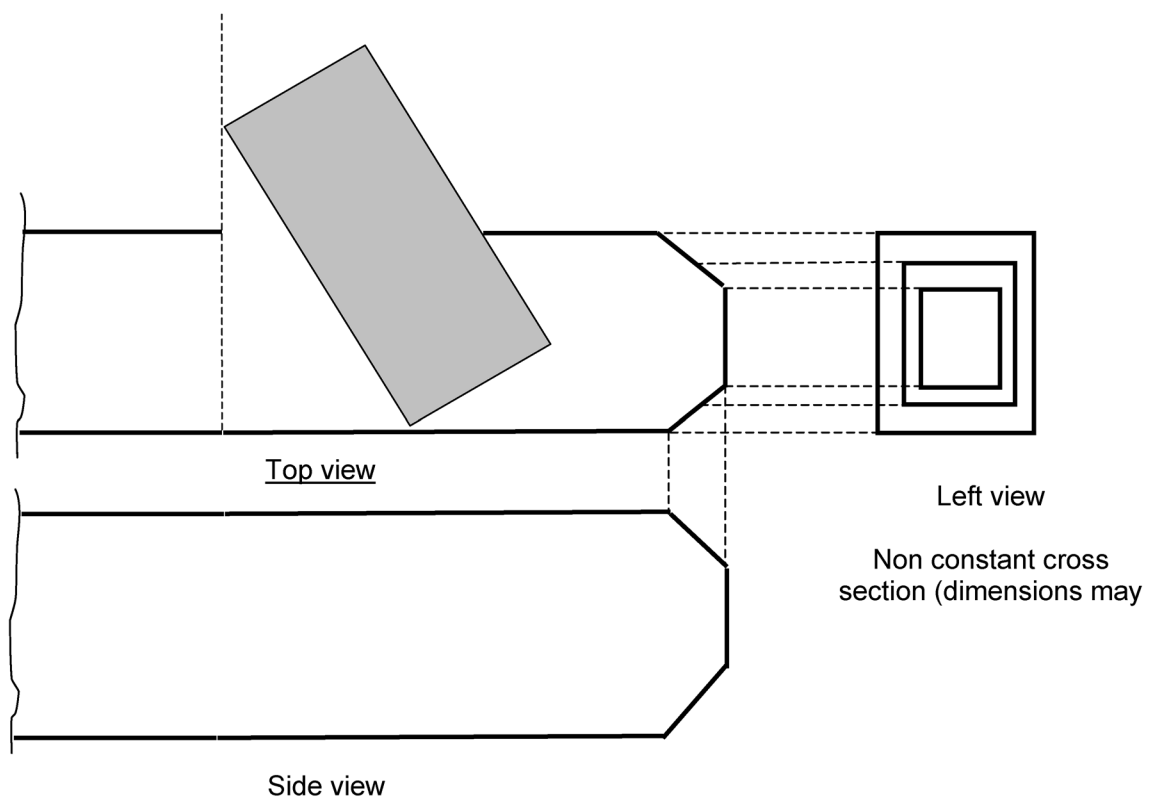


FIGURE 4

The method using the tapered cargo compartment refers to a cross section that may change from frame to frame. Therefore, the cross section dimensions have to be given if necessary for each frame.

3.4 Influences of Compartment Width:

The main factor for all cargo compartment max. package size calculations is the floor width:

The floor width cannot be exceeded by the package bearing base width.

3.5 Influences of Modified Clearances:

Modifying clearances results in new Door-/Floor width proportions that can be recalculated.

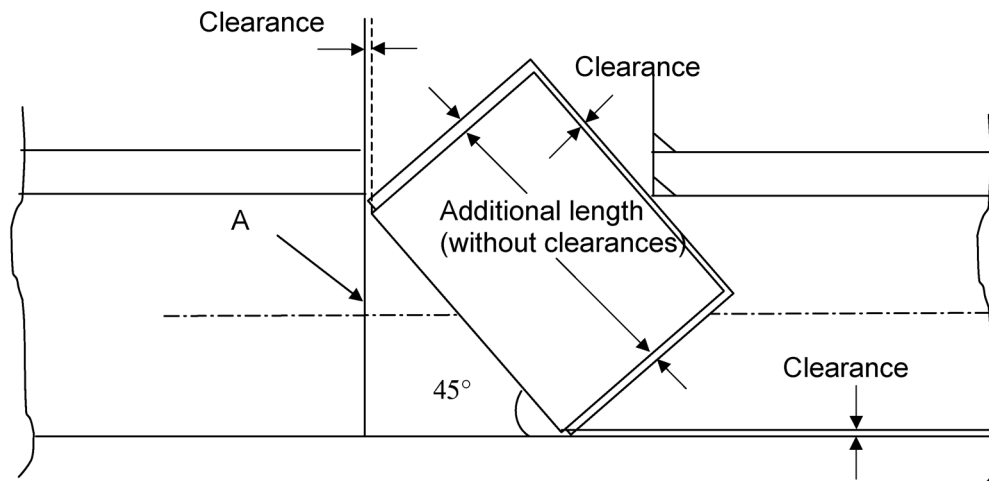


FIGURE 5

4. RECTANGULAR CARGO COMPARTMENT EXAMPLE:

4.1 Rectangular Cargo Compartment Dimensions:

The maximum dimensions of the packages that are loadable into the rectangular cargo compartments are shown in the tables below. The following dimensions are approximate and referring to rectangular package sizes.

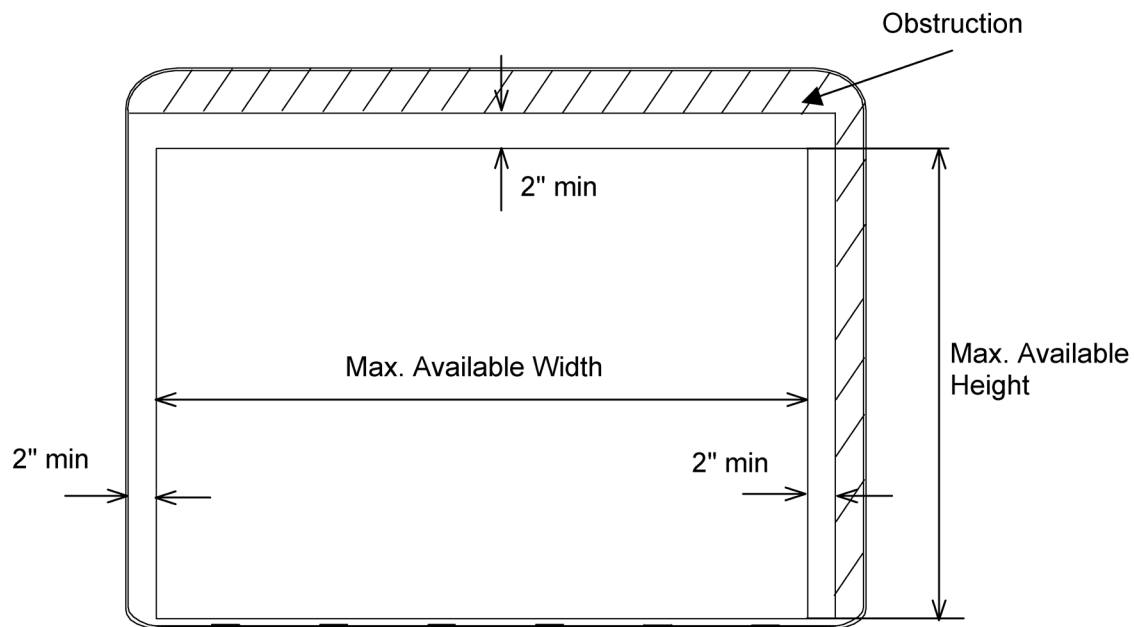


FIGURE 6

Cargo Compartment, usable length 7984 mm

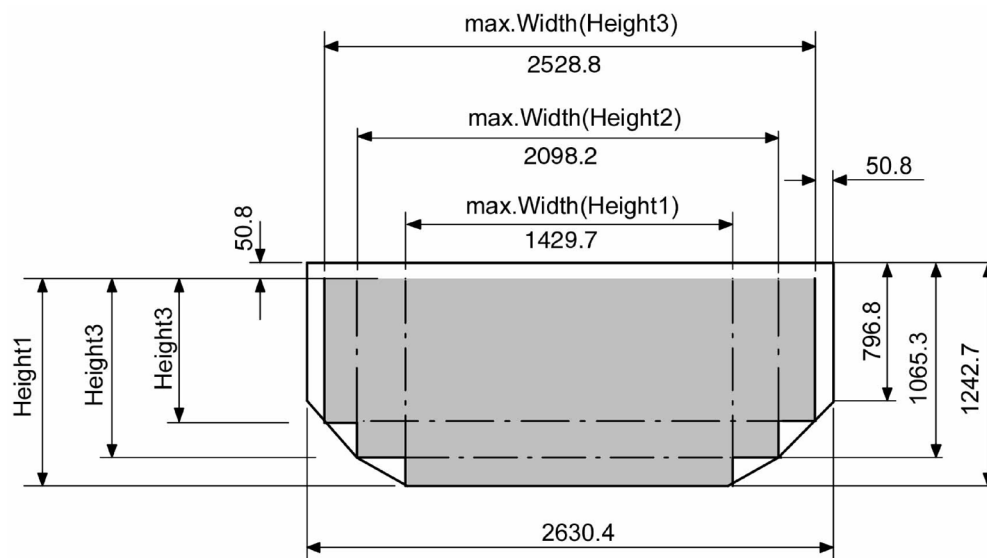


FIGURE 7

4.2 Rectangular Cargo Compartment MPS Tables:

	RANGE 1		RANGE 2		RANGE 3	
PACK HEIGHT MAX (mm)	1184.8		1014.5		746	
FLOOR WIDTH MAX (mm)	1430		2098		2529	
DOOR WIDTH MAX (mm)	1651		1651		1651	
FLOOR LENGTH (mm)	7984		7984		7984	
PACK WIDTH	PACK LENGTH	ANGLE	PACK LENGTH	ANGLE	PACK LENGTH	ANGLE
0	4353	43.6	5290	47.3	5867	49.1
100	4153	43.5	5089	47.4	5665	49.3
200	3953	43.4	4888	47.5	5463	49.5
300	3752	43.3	4687	47.7	5260	49.7
400	3552	43.2	4486	47.9	5057	50.0
500	3351	43.0	4285	48.1	4854	50.3
600	3151	42.8	4084	48.3	4650	50.6
700	2950	42.6	3883	48.5	4446	51.0
800	2749	42.3	3681	48.9	4241	51.5
900	2548	41.9	3479	49.2	4036	52.0
1000	2347	41.4	3277	49.7	3829	52.6
1100	2145	40.7	3074	50.2	3621	53.4
1200	1942	39.7	2870	50.9	3411	54.3
1300	1738	38.0	2665	51.8	3198	55.5
1400	1651	0.0	2458	53.1	2982	57.2
1500			2247	55.1	2758	59.6
1600			2098	90.0	2529	90.0

FIGURE 8

4.3 Rectangular Cargo Compartment MPS Curves:

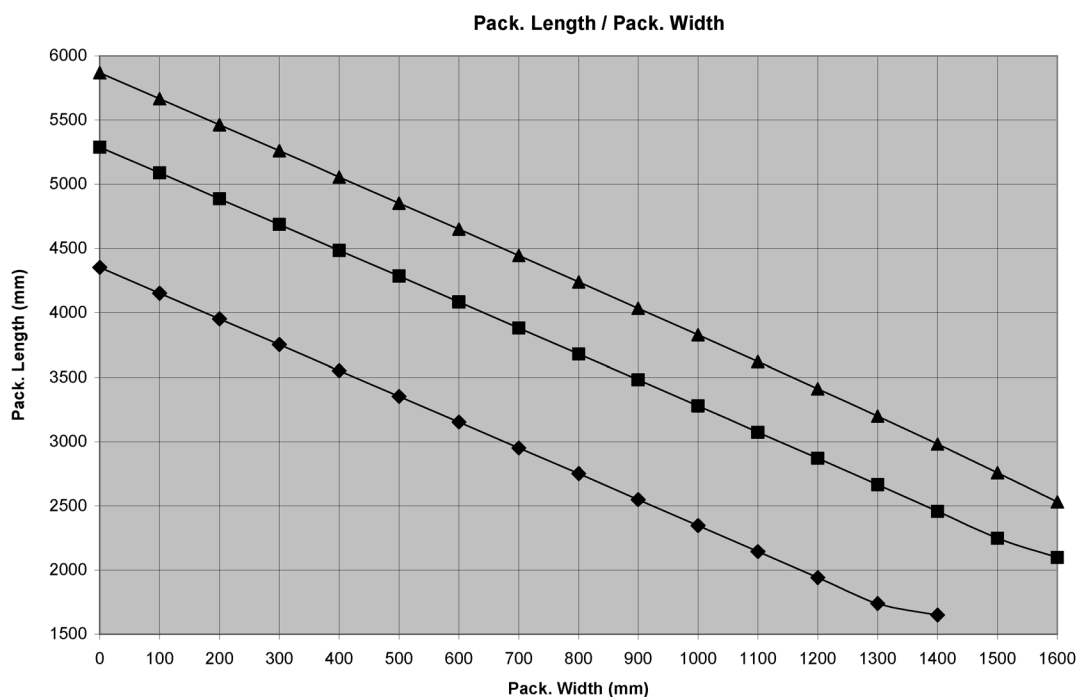
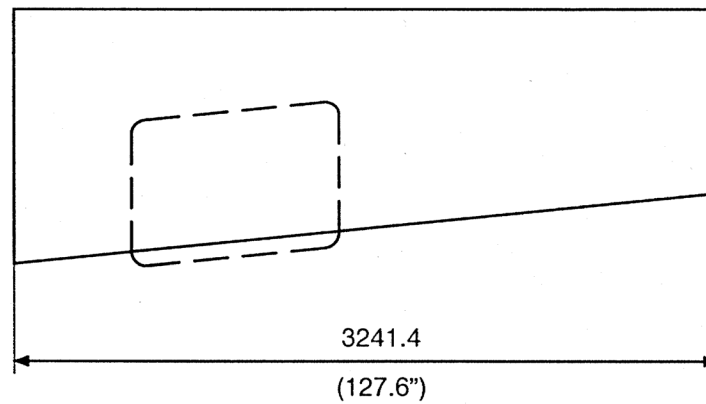


FIGURE 9

5. TAPERED CARGO COMPARTMENT EXAMPLE:

5.1 Tapered Compartment Dimensions:



Cargo Door Example

FIGURE 10