



<b>AEROSPACE STANDARD</b>	<b>AS1988™</b>	<b>REV. B</b>
	Issued 1990-08 Revised 2016-02 Reaffirmed 2023-10  Superseding AS1988A	
<b>Air Cargo Pallet Extensions</b>		

**RATIONALE**

Revised to reflect the pallet extensions standard sizes classification system and associated information agreed by IATA within ULD Regulations Standard Specification 60/1. The title was editorially adjusted to take into account the commonest designation.

AS1988B has been reaffirmed to comply with the SAE Five-Year Review policy.

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## 1. SCOPE

This SAE Aerospace Standard (AS) establishes the dimensional and operational requirements for pallet extension devices. It provides support for items of cargo beyond either the short or the long sides of a pallet, allowing increased volume to be achieved in conjunction with pallets meeting the requirements of AS1491 plus additional pallet sizes usable with extensions.

### 1.1 Purpose

This document defines the minimum requirements for pallet extensions for use in the lower deck of wide-bodied aircraft as well as of standard-bodied aircraft. Extensions can have either of two airworthiness statuses, as follows.

#### 1.1.1 Non-certified

Such extensions are non-certified pallet accessories and do not require airworthiness approval. Regulatory restraint remains ensured by a standard certified pallet and net attached to it, the airworthiness approval requirements and limitations of which (maximum gross weight, maximum C.G. deviation for the whole pallet load) shall be complied with.

Pallet extensions design and strength requirements shall meet the present Aerospace Standard.

The pallet, of which one or both extensions may be removed or re-installed at will, remains designated by the IATA ID Code first letter 'P', whether or not it is fitted with extensions, and its net compatibility is not affected.

#### 1.1.2 Certified

Where a special pallet net is attached to the extension itself, the whole unit is to be airworthiness approved to guarantee it transmits the net's ultimate certification loads to the pallet, and extensions constitute together with the net parts of an approved restraint system. Approval is not within the scope of this Aerospace Standard.

The airworthiness approval parameters for the integrated pallet and extensions assembly are those of NAS 3610 Rev.10 or AS36100 [TSO C90]. In addition, the extensions design and strength requirements shall meet the present Aerospace Standard.

Such pallets with integrated extensions, also known as "winged pallets", are designated by the IATA ID Code first letter 'B' and not 'P'.

Extensions may be removed, providing the pallet remains fitted all around with track, and was approved for compatibility with standard full contour pallet nets. But their re-installation constitutes an airworthiness equipment intervention, to be handled and controlled same as a certified ULD repair.

### 1.2 Standard Sizes

This document defines the requirements for standard pallet extensions sizes, as were agreed by IATA in order to facilitate manufacturing, inventory control, and in-service interchangeability. See 3.2 hereafter.

Nothing, however, prevents from building extensions of different sizes, that shall meet design and strength requirements of this Aerospace Standard, but building and operating the defined standard sizes is encouraged.

## 2. 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 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), [www.sae.org](http://www.sae.org).

AS1491 Interline Air Cargo Pallets

AS1677 General Requirements for Noncertified Cargo/Baggage Containers

AS33601 Track and Stud Fitting for Cargo Transport Aircraft, Standard Dimensions for

AS36100 Air Cargo Unit Load Devices – Performance Requirements and Test Parameters

## 2.2 IATA Publications

Available from International Air Transport Association, Publications Assistant, 800 Place Victoria, P.O. Box 113, Montreal, Quebec H4Z 1M1, Canada, Tel: 1-514-874-0202, [www.iata.org](http://www.iata.org).

IATA ULD Regulations, Standard Specification 50/0 Attachment E, Standard ULD Contours

IATA ULD Regulations, Standard Specification 60/1, Pallet Extensions

## 2.3 NAS Publications

Available from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, Tel: 703-358-1000, [www.aia-aerospace.org](http://www.aia-aerospace.org).

NAS 3610 Cargo Unit Load Devices - Specification for cargo unit load devices to be installed in certificated aircraft

## 2.4 FAR Publications

Available from [www.acquisition.gov/far](http://www.acquisition.gov/far).

14 CFR Part 25, United States Department of Transportation

## 3. GENERAL

Each extension consists of a panel or shelf extending upwards and outwards within a load envelope (see Figure 4).

The panel or shelf is secured in this position by means of chains, cables or structural members attached to the adjacent pallet edge rails.

3.1 The extension shall be used in conjunction with pallets meeting the requirements of AS1491, or equivalent requirements, for the pallet sizes shown in Table 1:

Table 1 - Pallets used in conjunction

TABLE 1			PALLET DIMENSIONS		Extension Contour along Pallet Length / Width							
Pallet Size Code			mm	inch	1 side extension				2 sides extension			
1)	2)	3)	Length x Width	Length x Width	C	E	E3 4)	G	U	F	F3 5)	H
A			2235 × 3175	88 × 125	L	L	W	—	L	L	W	—
L			1534 × 3175	60.4 × 125	L	L	—	—	L	L	—	—
M			2438 × 3175	96 × 125	L	L	W	—	L	L	W	—
K			1534 × 1562	60.4 × 61.5	L	L	L	L	—	—	—	L
	N		1562 × 2438	61.5 × 96	L	L	W	—	—	—	W	—
		P	1198 × 1534	47 × 60.4	L	L	W	—	—	—	—	—
		Q	1534 × 2438	60.4 × 96	—	—	L	—	—	—	L	—
S			1562 × 2235	61.5 × 88	L	L	W	—	—	—	W	—

- 1) In IATA, AS1491 and NAS3610 / AS36100
- 2) In IATA Size N = AS1491 Size III / AS36100  
Size S = AS36100
- 3) In IATA Size P = Base size LD2  
Size Q = Base size LD4/LD8
- 4) E-3 = LD-2 contour } see AS1677
- 5) F-3 = LD-8 contour }

Note:  
Contour code according to  
IATA ULDR SS 50/0

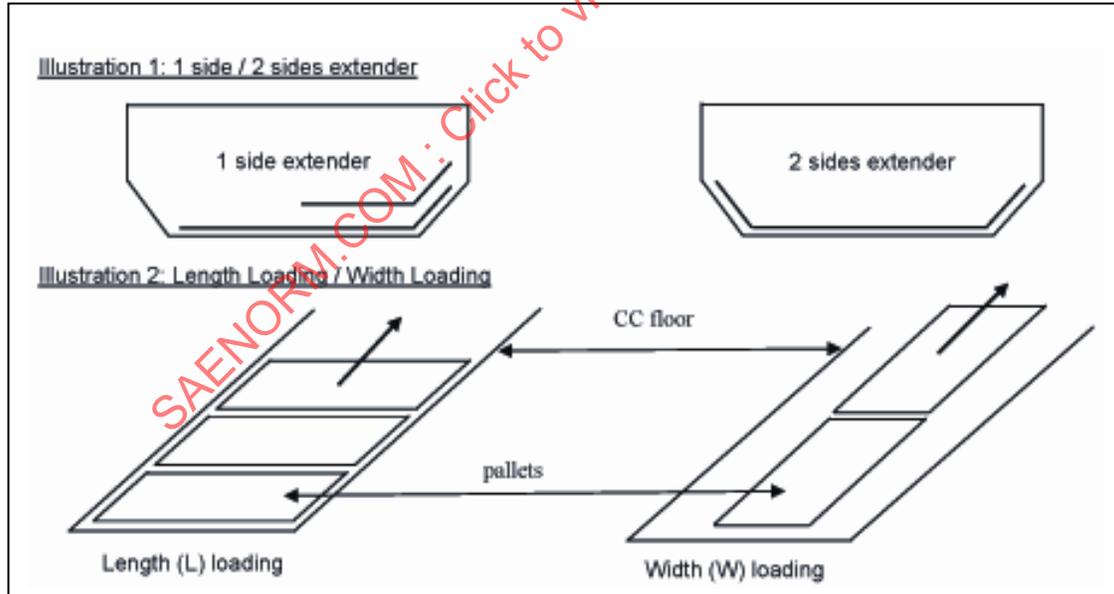


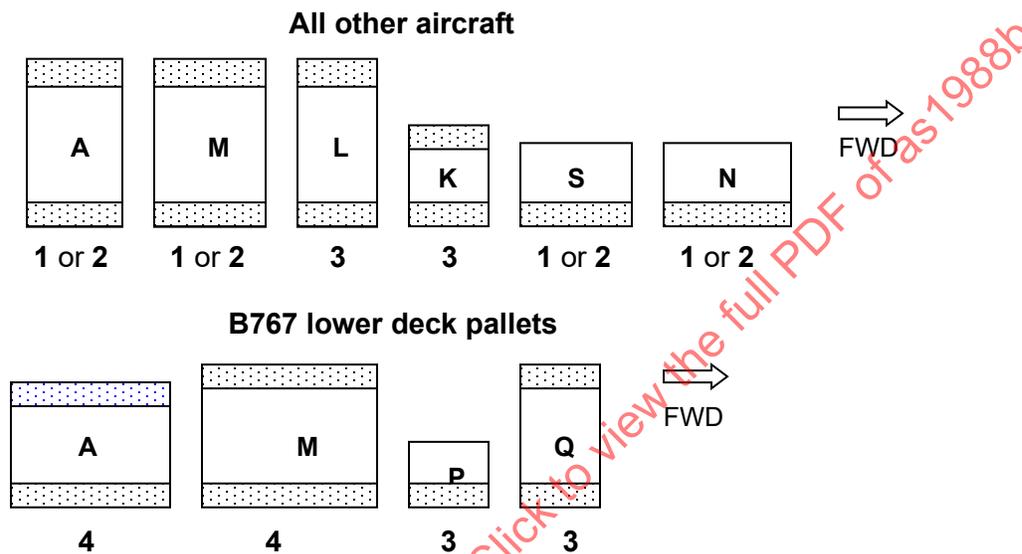
Figure 1

### 3.2 Extension Sizes Standardization

Extensions built for size A pallets should be capable of also being used on size M pallets. Extensions for sizes K, L, P, or Q are identical with each other. Thus four standard extension sizes are recommended:

- size 1: fitting sizes A and M pallets short sides, or sizes N and S long sides, to IATA standard contour **F**
- size 2: fitting sizes A and M pallets short sides, or sizes N and S long sides, to IATA standard contour **U**
- size 3: fitting sizes K, L, P or Q pallets to IATA standard contours **E, F or H**
- size 4: fitting sizes A and M pallets long side to IATA standard contour **F** (for B767 aircraft only)

Utilization of these four standard extension sizes is outlined in Figure 2.



**Figure 2 - Use of standard extension sizes**

3.3 There are two types of extensions actually in use (see Figure 6A):

3.3.1 The contour extensions: a panel attached to the pallet at approximately 45 degrees.

3.3.2 The horizontal extensions: a shelf attached to the pallet with a horizontal load-platform.

An adequate pallet net encloses both extension types together with the pallet load. This net is attached as required either to the pallet edge rail (see 4.4.1) or to the extension itself (see 1.1.2 and 4.4.2).

Due to the different aircraft lower deck contours, the related IATA load contours, the different pallet sizes and thus extension dimensions and/or multi use combinations, several configurations are feasible/advantageous.

NOTE: IATA load contours: C, E, G, and U, F, H and the LD2-LD8 related contour herein called E-3 and F-3.

For reference see Tables 2A and 2B and Figures 6A and 6B.

3.4 It shall be possible to rotate extensions to come to a rest on top of the pallet, to facilitate handling and storage of empty units, or to use the units as pallets only.

- 3.5 For loading of non-stackable goods, without using the additional volume beyond the pallet, it should be possible to secure the extensions in the vertical position.
- 3.6 The extensions shall be designed to be operated with minimum effort by one person without requiring any tools.

#### 4. DESIGN AND CONSTRUCTION

- 4.1 The extension shall be constructed to withstand normal cargo handling, to require only a minimum of maintenance and to provide a maximum service life.
- 4.2 Each extension shall be designed for quick attachment and rapid removal from the pallet by one person without the use of special tools.
- 4.3 The extensions shall be optimized for minimum weight and maximum durability.
- 4.4 The extensions shall be attached to the pallet edge rail by means of fittings in accordance with AS33601. The number and the design of those fittings shall distribute the load to the pallet edge and base to avoid load concentration.

A vertical clearance of 108 mm (4.25 inches) shall be provided to the extension structure, vertically to the pallet edge rail, to allow approximately 102 mm (4 inches) of clearance for the net attachments (see Figure 4).

- 4.4.1 Extension constructions requiring net attachments to the pallet edge rail must provide the space for net attachment points as per NAS3610 / AS36100 / AS1491.
- 4.4.2 Extension constructions requiring net attachments to the extension itself shall meet the requirements of 4.4.

NOTE: In this case, the pallet extension becomes an integral part of the pallet and will require net attachment points on three sides of the extension and thus a specific net or net arrangement.

Such a unit will require airworthiness certification to cover its configuration. See 1.1.2.

- 4.5 Chains, cables or structural members, which support the extension in the extended position shall be equipped with fittings according to AS33601 for attachment to the pallet edge rail.
- 4.6 All edges of the extensions shall be chamfered or rounded to avoid injuries to personnel and damages to aircraft or cargo.
- 4.7 All non-metallic parts which are liquid absorbent shall be sealed or treated to prevent liquid absorption.
- 4.8 All materials used shall comply with the applicable flammability requirements of 14 CFR Part 25, Appendix F Part I (a)(1)(v) and (a)(2)(iv) of the US Federal Regulations: when submitted to the horizontal test defined in Appendix F, Part I (b)(2), they may not have an average burn rate, out of three tested specimens, greater than 100 mm (4.0 inches) per minute when tested horizontally for 15 seconds in a 840 °C (1550 °F) flame.

#### 5. DESIGN LIMITATIONS

- 5.1 Any downward deformation of the extensions (rotation of the extensions by lengthening of cables, chains or structural members or bending of the extensions themselves) shall not exceed the reference ULD contour, or lead to contact with the cargo compartment lining.

Maximum deflection limits correspond to the ultimate load, which is 5.1 times the payload in line with NAS3610 and AS36100 ultimate test loads.

For the applicable values refer to Tables 2A and 2B for the different configurations.

NOTE: This assumes that pallet extensions used exclusively in the lower deck are designed for the above ultimate load in line with NAS3610 and AS36100.

## 6. DESIGN LOADS AND TEST REQUIREMENTS

6.1 Each extension shall be designed and tested to support a share of the maximum total ULD download.

A volumetric share defines the load on a single extension. This share is a percentage of the total ULD load volume at MGW times the gross density variation required to cause a lateral CG shift of 10%.

6.2 Tables 2A and 2B list all data for which each extension shall be designed and tested.

When the pallet is designed and tested for a maximum gross weight which is not covered, the percentage of the maximum nominal download shall be used to establish the test loads.

Three load conditions are to be tested, two of them mandatory.

### 6.2.1 Load Condition N°1 (required)

The test load shall be the share of the ultimate download in line with NAS3610 and AS36100, which includes a safety factor of 1.5 according to 14 CFR 25.303.

The load is thus the extension's payload times a factor of 5.1.

Deflections under this (static) test load shall not exceed the deflection limits for each case, corresponding to the different lower deck cargo compartment contours.

### 6.2.2 Load Condition N°2 (recommended)

The test load shall be the share of the limit load derived from NAS3610 and AS36100.

The load is the extension's payload times a factor of 3.4 (5.1g/1.5 (safety factor)).

Deflections under this (static) test load shall be less than the above deflection limits by at least 25.4 mm (1 inch) [which covers the clearance for the pallet net], in order to prevent any lining damage or loading/unloading problems. No permanent deformation is allowed.

This load condition is not mandatory, provided the results of Load condition N°1 assure that the requirements of Load condition N°2 are met.

### 6.2.3 Load Condition N°3 (required)

The test load shall be the share of the payload the ULD should be qualified for.

Deflections under this (static) test load shall not exceed the deflection limits for each case, corresponding to the reference ULD contour.

6.3 Concentrated loads at the pallet/extension interface when tested per Load condition N°1 must not exceed the structural allowable of the pallet, including a fitting factor of 1.33 and if applicable, an additional casting factor in accordance with 14 CFR 25.621.

6.4 For testing of above load conditions the extender extension shall be restrained as in operation per AS36100. The pallet has to be vertically restrained to prevent upwards bowing.

The static load shall be applied at the load centerline, along a line approximately 13 mm (0.5 inch) wide, extending symmetrically not more than 80% of the length of the extension. In order to represent a uniformly distributed load, a series of unconnected load segments not exceeding 305 mm (12 inches) in length shall be used. Measurements shall be taken/recorded to ensure that deflection limits for each load condition are satisfied.

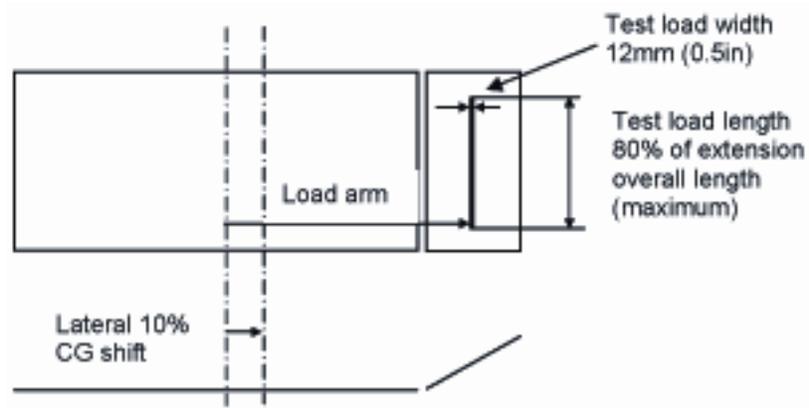


Figure 3 - Test load application

Example of load-arm calculation for an F contour.

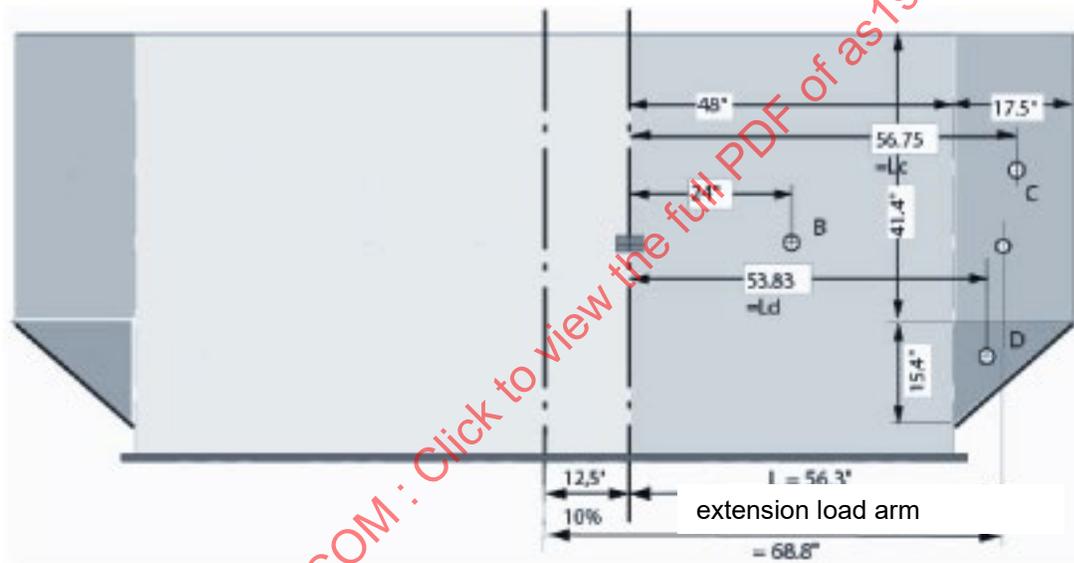


Figure 4 - Load arm calculation

Lc: distance from the shifted center of gravity (CG) to the C area CG

Ld: distance from the shifted CG to the D area CG

L: distance from the shifted CG to the C+D area CG

Sc: surface C

Sc = 724.5 in<sup>2</sup>

Sd surface D

Sd = 134.75 in<sup>2</sup>

$Lc \times Sc + Ld \times Sd = L \times (Sc + Sd)$

$\Rightarrow L = (Lc \times Sc + Ld \times Sd) / (Sc + Sd) = 56.3$  inches

$\Rightarrow$  load arm of the load on the pallet extension

$\Rightarrow = L + 12.5 = \boxed{68.8}$  inches

6.5 In cases an extension is designed and tested for more than one configuration, i.e., more than one ULD contour or pallet size and and/or more than one maximum gross weight, the test conditions shall be the more severe case.

NOTE: Examples are:

- Extensions for A-size pallets also to be used for M-size pallets
- Extensions for E-3/F-3 contours also used for E/F contours
- Extensions for C/U contours also to be used for E/F contours

## 7. OPERATION

7.1 It is recommended, when loading freight on pallets with extensions, to load heavier items on the pallet baseplate.

7.2 It is recommended to load the extensions such as to minimize a longitudinal CG eccentricity.

NOTE: Following these recommendations will minimize overloading the extensions.

## 8. MARKINGS

8.1 Each extension shall be marked with the following information:

1. The name and address of the manufacturer
2. The nominal weight of the extension to the nearest half kilogram and pound
3. The serial number or date of manufacture or both
4. The manufacturer's part number
5. The flammability measurements determined for the extension under 4.8
6. Where applicable, the appropriate airworthiness authority or FAA Supplemental Type Certificate
7. The NAS3610 / AS36100 size code(s) or pallet size(s) the extension is compatible with (only when the net attaches directly to the full periphery of the base pallet and not to the extension)
8. Pallet edge length the extension is compatible with
9. Maximum payload per extension assembly (multiple configurations addressed)

## 9. NOTES

### 9.1 Revision Indicator

A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications nor in documents that contain editorial changes only.

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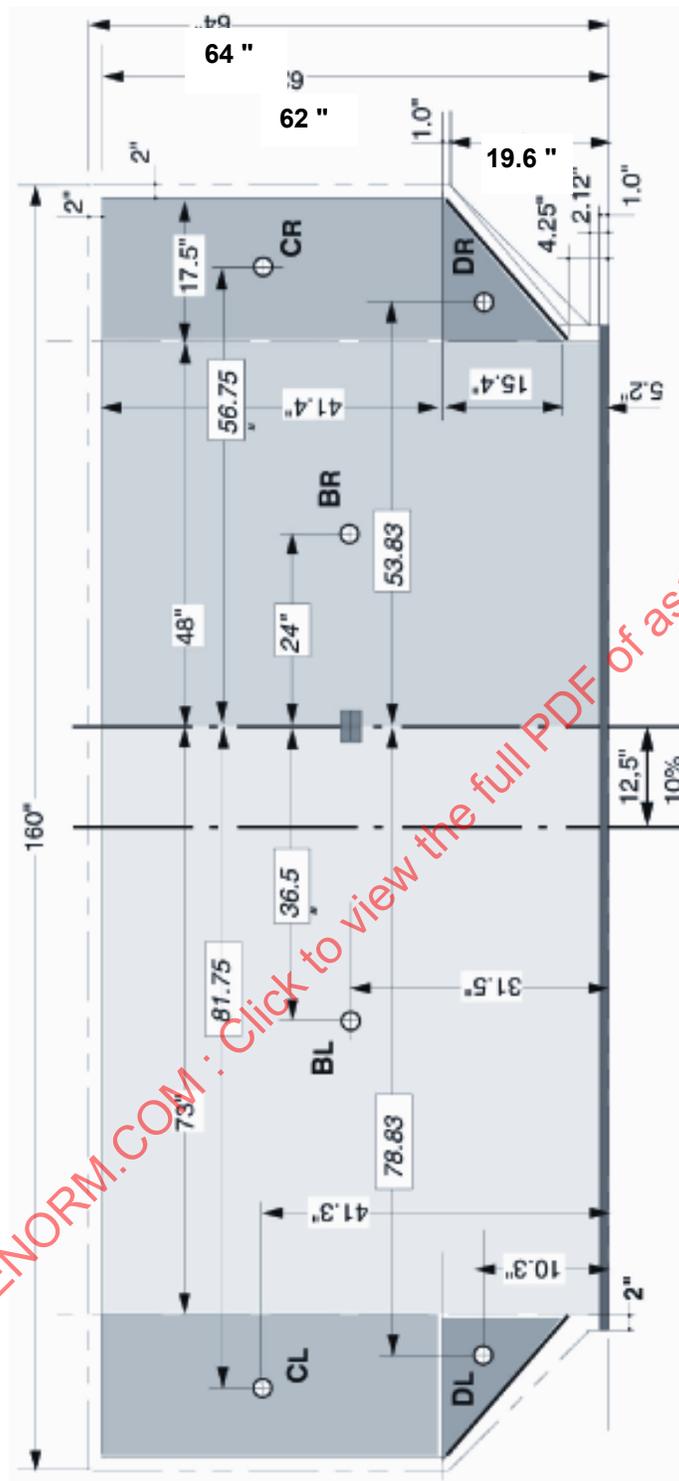


Figure 5 - Example F - Contour dimensions for volume/CG - Shift calculations