

understanding tolerances

What Tolerances Are

Every manufacturing process has limits of accuracy, imposed by technology or economics, which are routinely taken into account in design and production.

Most manufacturers and customers expect to provide, or receive, products whose dimensions are reliable within mutually acceptable deviation limits. Those limits are called tolerances, and a clear agreement on them at the time of ordering benefits both the extrusion supplier and the user. It protects the user by ensuring that the extruded product will be suitable for use and it protects the extruder from having products rejected by a customer with unreasonable expectations.

Where Tolerances Are Applied

The shape of an aluminium extruded product is described by specifying the dimensions of its cross-sectional profile on an engineering drawing, and by specifying the delivered length.

The allowed tolerances are usually expressed in plus-or-minus fractions or percentages of a dimension, applied to zones where the dimensions are to be held within these specified limits.

Unless otherwise specified, standard industry tolerances are applied. Special tolerances may be specified in consultation with the extruder. Extrusion tolerances are applied to a variety of physical dimensions.

Standard tolerances for extruded rod, bar and shapes are applied to cross section/wall thickness, length, straightness, twist, flatness, surface roughness, end cut squareness (vertical and transverse), contour (curved surfaces), corner and fillet radii and angularity.

Extruded tube has standard tolerances for diameter, wall thickness, width and depth for square or rectangular tubes.

Standard Tolerances

The industry's standard tolerances were developed by technical committees of the Australian Aluminium Council, taking into account both the capabilities of extruders and the needs of users.

These Industry Standards are published in Australian Standards AS/NZS1866 and AS/NZS1734. Both publications are updated periodically to reflect improvements in extruder capabilities and changes in user needs.

Standard tolerances are not simple, uniform fractional formulas. There are many different specific numbers of formulas published in tables. The various tolerances are established to match the various degrees of difficulty an extruder faces in controlling different tolerated dimensions. As a result, tolerances vary with cross-sectional size (as measured by the profile's fit within a circumscribing circle), and even with the location of each dimension on a complex shape. Alloy composition and temper also influence certain tolerances, and are reflected in the standard tolerance tables. Because of all these important considerations, tolerancing tables are complex. But their significance is simple and important: under standard tolerances, aluminium extrusions are routinely produced with dimensions accurate within tenths or hundredth of a millimetre. For most purposes, that is a more than ample degree of precision.

Rolled & Imported Extruder Product Tolerances

Unless otherwise stated, tolerances published by the Aluminium Association Inc are applied to materials sold by NALCO.

Special Tolerances

Even tighter tolerances than the Industry Standard can be specified when necessary.

To achieve them, however, requires more involved die corrections, slower extrusion rates, increased inspections, and sometimes a higher rejection rate. All that special care adds up, of course, to higher costs to the extruder and higher prices to the customer.

In rare instances, a desired tolerance may not be possible; but an experienced extrusion supplier such as NALCO may be able to suggest a design change that solves the problem and still meets the purchaser's economic and functional requirements.

The purchaser and the vendor should agree on any special tolerances at the time an order is entered, and should specify them on the order and engineering drawing.

If no special tolerances are ordered, standard tolerances will be applied.

concavity & convexity tolerances

Concavity & Convexity

The function of any particular shape is paramount, and under this provision, negotiation and agreement between customer and extruder is encouraged, particularly at the design stage.

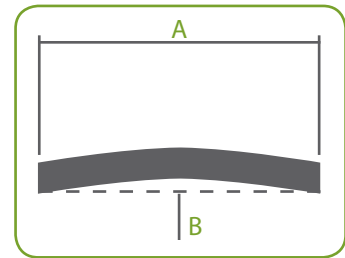
All manufacturing tolerances are subject to review from time to time.

Width (mm)	Tolerance
	Maximum (mm)
25mm	0.125
50mm	0.25
75mm	0.375
100mm	0.5
150mm	0.75
200mm	1
250mm	1.25
300mm	1.5

Dimensional tolerances are rounded down to the nearest 0.05mm, because all callipers used to measure metal dimensions are almost universally graduated at intervals of 0.05mm.

Concavity and Convexity Tolerances:

Over the width (A) of the section, the maximum tolerance on concavity and convexity (B) shall be 0.05mm per 10mm of width.



Bow

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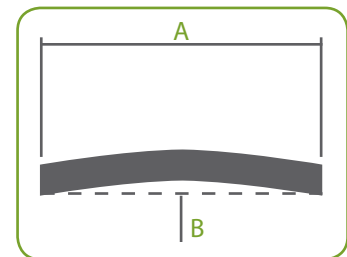
Dimensional tolerances are rounded down to the nearest 0.05mm, because all callipers used to measure metal dimensions are almost universally graduated at intervals of 0.05mm.

Bow Tolerance:

Take the overall length (A) of the section;
the maximum tolerance on bow (B) shall be 1mm per 1000mm of length

Example:

If the length (A) of the section is 5000mm the maximum bow allowable would be

$$5 \times 1 \text{ mm} = 5 \text{ mm}$$


twist tolerances

Twist

The function of any particular shape is paramount, and under this provision, negotiation and agreement between customer and extruder is encouraged, particularly at the design stage.

All manufacturing tolerances are subject to review from time to time.

Length (mm)	Tolerance
	Maximum (mm)
2000mm	2
3200mm	3.2
4400mm	4
5000mm	5
6000mm	6

Twist Tolerance:

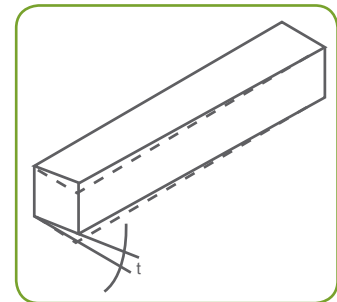
Take the overall length of the section;

the maximum tolerance on twist shall be 1mm per 1000mm of length

Example:

If the length of the section is 5000mm the maximum

twist allowable would be $5 \times 1 \text{ mm}$
= 5mm



Circumscribing Circle Diameter	Angle of Twist (t)	Total Angle of Twist
	per 300mm run	per length
Under 40mm	1°	5°
Between 40mm - 80mm	1/2°	3°
Diameters over 80mm:		
Lengths up to 8000mm	1/4°	2°
Lengths over 8000mm	1/4°	3°

bars & regular section tolerances

Width and Diameter

Diameter, width or width across flats		Tolerance + (mm) - (mm)
Over (mm)	Up to and including (mm)	
	3	0.16
3	10	0.20
10	18	0.26
18	30	0.32
30	40	0.40
40	60	0.45
60	80	0.50
80	100	0.65
100	120	0.80
120	140	0.90
140	160	1.00
160	180	1.10
180	200	1.20
200	240	1.30

Thickness

Width or width across flats		Thickness (mm)													
		Over	1.6	3.0	6	10	18	30	40	60	80	100	120	140	160
Up to and incl. (mm)	Up to & incl.	1.6	3.0	6	10	18	30	40	60	80	100	120	140	160	
-	10	0.16	0.18	0.20	0.22										
10	18	0.18	0.20	0.22	0.24	0.26									
18	30	0.22	0.24	0.26	0.28	0.30	0.32								
30	60	0.24	0.26	0.28	0.30	0.33	0.36	0.40							
60	80	0.28	0.30	0.32	0.34	0.37	0.40	0.43	0.45	0.50					
80	120	0.32	0.34	0.36	0.39	0.42	0.45	0.48	0.52	0.57	0.65	0.80			
120	180		0.36	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.82	0.90	1.00	
180	240			0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.05	

Lengths up to 5000mm (-0 +10mm), over 5000mm (on application).

Tolerances on length provide for out of squareness of cut to the extent of 1°. They are measured at a temperature of 16°C.

hollow section & tubing tolerances

Width, (width across flats & thickness)

Width or width across flats			Thickness (mm)							
Over (mm)	Up to and incl. (mm)	Tolerance ¹ + (mm) - (mm)	Over		1.6	3.0	6	10	18	
			Up to & incl.	1.6	3.0	6	10	18	30	
3	3 10	0.16 0.20	Tolerance + - (mm)							
10 18	18 30	0.26 0.32		0.20 0.26	0.22 0.28	0.32				
30 40	40 60	0.40 0.45		0.32 0.32	0.36 0.36	0.41 0.41	0.48 0.48			
60 80	80 100	0.50 0.65		0.36	0.41 0.48	0.48 0.58	0.58 0.68	0.68 0.82	1.0	
100 120 140	120 140 160	0.80 0.90 1.00			0.48 0.65 0.65	0.58 0.75 0.75	0.68 0.85 0.85	0.82 0.95 0.95	1.0 1.10 1.10	

Diameter of Tubing

Nominal outside diameter		Tolerance on actual diameter ³ + (mm) - (mm)	Tolerance on mean diameter ³ + (mm) - (mm)
Over (mm)	Up to and incl. (mm)		
12 18	18 30	0.25 0.30	0.19 0.23
30 40	40 50	0.36 0.45	0.27 0.34
50 60 80	60 80 150	0.54 0.60 1% of diameter	0.40 0.45 3/4% of diameter

1. Measured at the corners
2. The tolerances apply to non-heat treated sections and tubing of wall thickness not less than 1.6mm or 1/32 of the overall width or outside diameter (whichever is greater), and to heat treated sections and tubing of wall thickness not less than 1.6mm or 1/24 of the overall width or outside diameter (whichever is the greater). The maximum tolerance on concavity and convexity is 0.05mm per 10.0mm of width.
3. In the case of tubing in straight lengths, the tolerance limits are inclusive of ovality.

hollow section & tubing tolerances cont.

Wall Thickness of Tubing

Nominal thickness	Tolerance on mean thickness + (mm) - (mm)	Thickness at any point	
		Max (mm)	Min (mm)
1.6 2.0	0.18 0.20	1.84 2.27	1.36 1.73
2.5 3.0	0.22 0.27	2.80 3.36	2.20 2.64
4.0 5.0	0.31 0.37	4.42 5.49	3.58 4.51
6.0 7.0	0.43 0.51	6.58 7.67	5.42 6.33
8.0 10.0	0.56 0.65	8.76 10.85	7.24 9.15
12.0 14.0	0.77 0.88	13.03 15.24	10.97 12.76

These tolerances on wall thickness do not apply where tolerances on both outside and inside diameter are required. Mean thickness is the average of the wall thickness measured at four equidistant points around the circumference.

open end, channel & i beam tolerances

Open End, Channel & i beam

Overall width of channel (C) in mm		Minimum thickness of web, flange (T ₁ , T ₂)		External (A) or internal (B) tolerance at top of gap for depth (D) in mm												
Between & Incl.		Between & Incl.		Over	10	18	30	40	60	80	100	120				
				Up to & incl.	10	18	30	40	60	80	100	120	140			
0	10	0 1.50 3.00	1.50 3.00 -	Tolerance + - (mm)	0.25 0.23 0.22	0.32 0.28 0.26	0.41 0.34 0.30									
10	18	0 1.50 3.00	1.50 3.00 -		0.31 0.29 0.28	0.38 0.34 0.32	0.47 0.40 0.36	0.56 0.46 0.41	0.70 0.55 0.47							
18	30	0 3.00 6.00	3.00 6.00 -		0.37 0.37 0.35	0.47 0.44 0.41	0.57 0.53 0.48	0.68 0.62 0.55	0.84 0.76 0.64	1.05 0.93 0.78	1.26 1.11 0.91					
30	40	0 3.00 6.00	3.00 6.00 -		0.45 0.45 0.43	0.55 0.52 0.49	0.65 0.61 0.56	0.76 0.70 0.63	0.92 0.84 0.72	1.13 1.01 0.86	1.34 1.19 0.99	1.55 1.36 1.12	1.76 1.54 1.25			
40	60	0 3.00 6.00	3.00 6.00 -			0.60 0.57 0.54	0.70 0.66 0.61	0.81 0.75 0.68	0.97 0.89 0.77	1.18 1.06 0.91	1.39 1.24 1.04	1.60 1.41 1.17	1.81 1.59 1.30			
60	80	0 3.00 6.00	3.00 6.00 -			0.65 0.62 0.59	0.75 0.71 0.66	0.86 0.80 0.73	1.02 0.94 0.82	1.23 1.11 0.96	1.44 1.29 1.09	1.65 1.46 1.22	1.86 1.64 1.35			
80	100	0 6	6 -				0.90 0.86	1.01 0.95	1.17 1.09	1.38 1.26	1.59 1.44	1.80 1.61	2.01 1.79			
100	120	0 6	6 -				1.05 1.01	1.16 1.10	1.32 1.24	1.53 1.41	1.74 1.59	1.95 1.76	2.16 1.94			
120	140	0 6	6 -				1.15 1.11	1.26 1.20	1.42 1.34	1.63 1.51	1.84 1.69	2.05 1.86	2.26 2.04			
140	160	0 6	6 -				1.25 1.21	1.36 1.30	1.52 1.44	1.73 1.61	1.94 1.79	2.15 1.96	2.36 2.14			
160	180	0 6	6 -				1.35 1.31	1.46 1.40	1.62 1.54	1.83 1.71	2.04 1.89	2.25 2.06	2.46 2.24			
180	200	0 6	6 -				1.45 1.41	1.56 1.50	1.72 1.64	1.93 1.81	2.14 1.99	2.35 2.16	2.56 2.34			