Technical Information

Updates

Due to continuous product development, some information may have been updated since the time of publishing this manual. Altus reserves the right to amend specifications and make changes to products without prior notice and without incurring any obligation. Altus accepts no responsibility for loss or consequential loss due to inaccuracies at the time of publishing or of subsequent changes made. Altus will keep www.altus.co.nz updated. The manual is subject to copyright by the proprietors, Altus NZ Ltd.

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Technical information

Surface finishing

Anodising

Anodising is available in 12, 15, 20 and 25 micron. Corrosion resistance increases with film thickness. Anodised product comes standard without a colour warranty.

Anodising comes in a standard colour range of Bronze, Silver and Black as defined by the WGANZ Standards.

Anodising finishes are all produced to meet the Window and Glass Association of New Zealand (WGANZ) standards. Specifications are available from the following website: www.wanz.co.nz

We recommend you talk to our experienced Altus Industrial Solutions team for more detailed advice and recommendations about how to achieve the outcome you want.

Anodic film is substantially transparent

Unlike painting, the parent metal surface remains visible through the coating. So the surface of the extruded aluminium surface should be of the best possible quality before anodising.

Anodising does not remove all defects

The cleaning and etching process does not remove defects such as deep die lines, surface abrasions and corrosion. In fact these defects are often exaggerated. So it's important to control damage risks during production, storage, handling and transport of extruded aluminium.

Film thickness affects appearance

As the anodic film becomes thicker, the film also becomes duller and less transparent. For a good match in appearance, particularly with coloured material, its best to avoid mixed film thickness.

Heat joining methods affect colour

Weld filler metal and the heat affected zones of weldments anodise to a different colour than the parent metal. This fact must be taken into account when anodising welded structures.

Temper (hardness) and metal types affect colour

T4 and T5 tempers anodise to a different shade, as do sheet metal and extruded metal. The sheet alloys 5005 and especially 5052 provide the best match with 6060 T5. Cast material is almost impossible to match with wrought metal (sheet or extrusion).

Cleaning products and environmental factors may cause corrosion

The anodic film on aluminium is one of the most corrosion resistant coatings available, but it is not indestructible.

- Strong acid or alkaline material will seriously corrode the coating. In service, it's essential to avoid:
  - Contact with brick or glass cleaners (acid) or alkaline cleaners;
  - Contact with wet building materials such as plaster or cement and unprotected concrete (alkaline);
  - Paint splashes – as attempts to remove them using paint stripper will cause corrosion;
  - Aggressive scouring type cleaners.

We recommend you treat all commercial cleaning products with suspicion and do patch tests before using them extensively on anodised aluminium.

Run off from dissimilar metal building components such as copper guttering or downpipes can also cause serious corrosion.

Dissimilar metal fixings should be properly insulated from anodised aluminium, particularly in a severe environment. Use only good quality, proven sealants.

Reasonably resistant to abrasion

Anodised film is about 4-5 times harder than the aluminium alloy substrate. The greatest hardness is found at the surface of the film, which is capable of marking glass and steel. The aluminium alloy's substrate is not altered by anodic treatment.

Anodic film is therefore quite resistant to abrasion. In fact, specific abrasion tests have found that anodised aluminium is more abrasion resistant than hardened glass. Rubbing type abrasion, particularly with hard scouring material, is more damaging than blast type abrasion – for example, water blasting.

Bending may cause crazing and reduced corrosion resistance

Anodic films cannot be permanently deformed (bent out of shape) without crazing, which also reduces the film's corrosion resistance. We recommend you avoid bending or forming anodised extruded sections, except for sections with very low thickness film.

Powder coating

Altus supplies painting services for the industrial and building product customers.

Our powder coating lines operate under Australian/New Zealand Standards AS/NZS3715 for powder coating applications. Our Hamilton paint line is an approved Q Base, Enduro Colour, Gold Akzo Nobel and registered Orica applicator.

Please Note: The Enduro Colour draws it requirements from the Qualicoat & AS3715 standards. The Akzo Nobel standard powders used by us (D1010) perform according to AS3715, AIMF Qualicoat, BS6496, and AAMA2603-2003 standards. Colour charts are available on request.

Facts and tips

Starting with a smooth metal surface is important.

Paint film is not transparent, so you will not see the parent metal through the finish. But depressions such as die lines or abrasion marks, unless very shallow are not filled in by powder coating. Protrusions such as adherent particles or water corrosion will be 'painted over', leaving raised-type defects. These are aesthetic rather than damaging.

Differences in surface contour such as flow lines may also affect the paints film's reflectivity and make these effects more visible.

Cleaning products and environmental factors may cause corrosion

The bond between paint film and parent metal is very strong. It is enough to prevent corrosion under normal exposure conditions.

However, acid or alkaline cleaners must be avoided, along with:

- Contact with wet building materials such as plaster or cement and unprotected concrete (alkaline);
- Paint splashes – as attempts to remove them using paint stripper will destroy the film;
- Solvents – as these will tend to soften and perhaps dissolve the film.

Care needed to avoid scratching

The paint film on powder coated aluminium has about one tenth of the hardness of the parent metal.

Avoid using any type of scouring pad – whether metallic or synthetic.

Reasonable flexibility

Paint film is flexible enough to allow simple operations like drilling or punching.

Severe bending or powder coated aluminium extrusion is not easy because of the difference in the formability of the paint film and the base metal.

We partner with Dulux and Akzo Nobel (Interpon) for the supply of powder, both are leading global powder suppliers with years of experience. Each brand offers over 36 key colours (including bright colours for that stunning entrance door). You are able to choose from matte, gloss, flat and pearlescent finishes.

Notes: Head banding & colour variation are all to be expected and will not be detrimental to the coating. Thermal expansion and contraction that exhibit crazing when viewed at some angles, are also not detrimental to the coating.

Die design

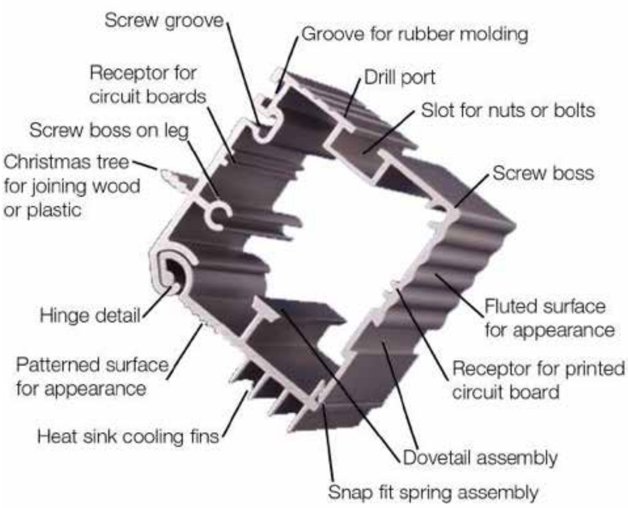
The Altus Die Design team operates closely in conjunction with the Mill Manufacturing Team. Our experienced team have a long successful history of assisting companies with die design and modification to ensure successful results.

Well designed dies enable quality extrusion to be manufactured consistently, resulting in improved Mill performance thus improving delivery to customers.

Aluminium extrusions can be made into an almost limitless variety of shapes. The design flexibility of extrusions allows a great deal of functionality to be incorporated into extruded sections.

This can help improve efficiency by simplifying assembly, and can also help improve the aesthetics of an extrusion. The extrusion shown illustrates some of the functions that are commonly incorporated.

However there are practical limitations to extrusion design. Some designs can be very difficult to extrude, which minor changes to an extrusion design can often yield significant benefits in extruding and cost.



PE coating

Altus stocks a wide range of products with PE coating. For more information on PE Coating services, simply contact the Altus Trade Centre nearest to you or your Account Manager.

Foreward

1. **Synopsis**

   The stocked product catalogue gives metric data for rolled and extruded products that are available from stock. The Mill product catalogue gives metric data for extruded products that are available from the Mill in standard production quantities. This Technical Catalogue provides detailed technical information on the properties of aluminium and its use.

2. **Special alloys and products**

   Altus have supply partnerships with major European, Asian and American manufacturers and distributors. We can usually provide a solution to enquiries for hard to find aluminium materials. Enquiries should be directed to your Account Manager.

3. **Range**

   The range of extrusions available is constantly changing, enquiries for shapes not listed may be made by contacting your Account Manager.

4. **Shape**

   All dimensions are in millimetres. Major dimensions only are shown. Fully dimensioned drawings are available on request via your Account Manager.

5. **Weight**

   Extrusion weights are in kg/m.

6. **Price**

   Prices may be obtained on enquiry to your Account Manager or any Altus Trade Centre.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027725
1027726
1001244
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1006674
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1001243
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Advantages of aluminium

A unique combination of properties makes aluminium and its alloys one of the most versatile engineering and construction materials available today.

Lightweight

Aluminium is one of the lightest available commercial metals with a density approximately one third that of steel or copper.

Its high strength to weight ratio makes it particularly important to transportation industries allowing increased payloads and fuel savings. Catamaran ferries, petroleum tankers and aircraft are good examples of aluminium's use in transport.

Excellent corrosion resistance

Aluminium has excellent resistance to corrosion due to the thin layer of aluminium oxide that forms on the surface of aluminium when it is exposed to air.

In many applications, aluminium can be left in the mill finished condition. Should additional protection or decorative finishes be required, then aluminium can be either anodised or painted.

Strong

Although tensile strength of pure aluminium is not high, mechanical properties can be markedly increased by the addition of alloying elements and tempering. You can choose the alloy with the most suitable characteristics for your application. Typical alloying elements are manganese, silicon, copper and magnesium.

Strong at low temperatures

Where as steel becomes brittle at low temperatures, aluminium increases in tensile strength and retains excellent toughness.

Easy to work

Aluminium can be easily fabricated into various forms such as foil, sheets, geometric shapes, rod, tube and wire. It also displays excellent machinability and plasticity ideal for bending, cutting, spinning, roll forming, hammering, forging and drawing.

Aluminium can be turned, milled or bored readily, using the correct toolage. In fact, most aluminium alloys can be machined speedily and easily. An important factor contributing to the low cost of finished aluminium parts.

Aluminium is a popular choice of material for complex-sectioned hollow extrusions. Almost any method of joining is applicable - riveting, welding, brazing or soldering. A wide variety of mechanical aluminium fasteners simplifies the assembly of many products.

Adhesive bonding of aluminium parts is successfully employed in many applications including aircraft components, car bodies and some building applications.

Good heat conductor

Aluminium is about three times as thermally-conductive as steel. This characteristic is important in heat-exchange applications (whether heating or cooling).

Aluminium is used extensively in cooking utensils, air conditioning, industrial heat exchangers and automotive parts.

High reflectivity

Aluminium is an excellent reflector of radiant energy through the entire range of wave lengths. From ultra-violet through the visible spectrum to infra-red and heat waves, as well as electromagnetic waves such as radio and radar.

Aluminium has a light reflectivity of over 80% which has led to its wide use in lighting fixtures. These reflectivity characteristics also lead to its use as an insulating material. For example, aluminium roofing reflects a high percentage of the sun's heat, promoting a cool interior atmosphere in summer, yet insulating against heat loss in winter.

Good electrical conductor

Aluminium is one of the two common metals having electrical conductivity high enough for use as an electrical conductor. The conductivity of electrical-conductor grade (alloy 1350) is about 62% that of the International Annealed Copper Standard.

However, aluminium is only a third the weight of copper, which means it conducts about twice as much electricity as copper of the same weight.

Aluminium is widely utilised in power-transmission cables, transformers, busbars and bases of electrical bulbs.

Easy surface treatment

For many applications, aluminium requires no protective or decorative coating; the surface supplied is entirely adequate

without further finishing. Mechanical finishes such as polishing, embossing, sand blasting, or wire brushing meet a variety of needs.

Where the plain aluminium surface does not suffice, a wide variety of surface finishes are available to suit.

Chemical, electrochemical and paint finishes are all used.

Above all, anodising treatment can provide excellent corrosion resistance and a wide range of colour variations. Such finishes are widely used for both interior and exterior applications.

Non-magnetic

Aluminium has non-magnetic properties which make it useful for electrical shielding such as busbar or magnetic compass housings. Other applications include computer disks and parabolic antennas.

Non-toxic

The fact that aluminium is essentially non-toxic was discovered in the early days of the industry. It is this characteristic which enables the metal to be used in cooking utensils without any harmful effect on the body. Aluminium with its smooth surface is easily cleaned, promoting a hygienic environment for food processing. Aluminium foil wrapping and containers are used extensively and safely in direct contact with food products.

Easy to recycle

Due to a low melting temperature, it is economically recyclable, requiring only about 5% the energy required for smelting. It is an ideal material in this age of energy and resource saving.

Sound absorbing

Used for ceilings.

Shock absorbing

Due to its low modulus of elasticity, aluminium is used for automobile bumpers and the like.

Non-sparking

Aluminium is void of sparking properties against itself and other non-ferrous metals.

These are the characteristics that give aluminium its extreme versatility

In the majority of applications, two or more of these characteristics come prominently into play:

- For example, lightweight combined with strength in aircraft, railway rolling stock, trucks and other transportation equipment.
- High resistance to corrosion and high thermal conductivity are important for the chemical and petroleum industries; these properties combine with non-toxicity for food processing equipment.
- Attractive appearance together with high resistance to weathering and low maintenance requirements have led to extensive use in buildings of all types.
- High reflectivity, excellent weathering characteristics, and light weight are all important in roofing materials.
- Light weight contributes to low handling and shipping cost whatever the application.

Note: Many applications require the extreme versatility which only aluminium possesses. Almost daily, unique combinations of these properties are being put to work in new ways.

Handling and storing aluminium

Aluminum water stain prevention

When you receive metal

1. **Check for wetness**
   - Is the metal wet? Is the wrapping paper puckered up or wet?
   - If it is wet, note it on all copies of the receiving papers (Endorse freight carrier documents as damaged)
   - Unpack and dry, if stained contact your Account Manager
2. **Check to see if the metal feels cold**

   If it does:

   - Tell your supervisor immediately
   - Leave the metal in a cool indoor area away from drafts to allow it to warm up slowly (If this is not adhered to, and metal is put in a heated warehouse immediately, it may sweat and become water stained)
   - After the metal is reasonably warm (about a day later), move it to the warehouse

When you move metal between areas

Check to see if the temperature in the area the metal will be taken to is higher than the temperature in the area the metal is coming from.

If the difference is more than 11°C (20°F):

a. Only move as much metal as will be used immediately

b. Tell your supervisor

c. Leave the remainder of the metal where it is until ready for use

Note: If you experience any signs of moisture, dampness or water staining on your delivery, please call your local Altus Trade Centre immediately.

Taking care of surface finished extrusions

Maintenance of powder coated extrusions

You can wash the powder coated extrusions with warm water and a mild detergent. DO NOT use a strong solvent cleaner as this will be harmful to the powder coating.

- If the powder coated surface has lost its gloss or is looking chalky, apply a high quality cream polish to the extrusions a soft cloth. We strongly recommend that you read the manufacturer's instructions before you do this (contact Altus if you're not sure). Avoid polishes that contain cutting compounds, again Altus will be able to advise you on the best products to use.
- Powder coating on extrusions that are in sheltered areas will be more at risk of coating degradation. This is because wind-blown salt, grit and grime will stick to the surface. We recommend, therefore, that you check and clean the extrusions in these areas on a more regular basis

Maintenance of anodised extrusions

Anodising provides a tough, hard-wearing finish to your aluminium extrusions. Some deterioration could occur over the years. This can be caused by grime building up on the extrusions, which in turn will trap moisture that can etch away at the anodised surface.

Regular cleaning will prevent build-up of grime and keep your extrusions looking great for years.

- Wash the aluminium with warm water and a suitable wetting agent or mild soap detergent. Use a sponge or a cloth. If you need to loosen dirt or grime, you can use a fine brush, but avoid using anything stiffer or more abrasive as you could end up damaging the surface. DO NOT use acid or alkaline cleaners. These will damage the surface and could even discolour the extrusions.
- You can clean away greasy deposits or really hard to remove grime by using a soft cloth dipped in white spirit, turpentine, kerosene or a mild liquid scourer. Make sure however that these solvents don't come into contact with any other parts of the fabricated units (such as the rubber seal), as they will damage them. Remember to use a rag to dry off the extrusions immediately after cleaning.
- You can provide extra protection for your anodised extrusions by cleaning it with a good quality car wax after each wash. This will also lift the appearance of your extrusions and keep it looking better, longer.

How often should anodised extrusions be cleaned?

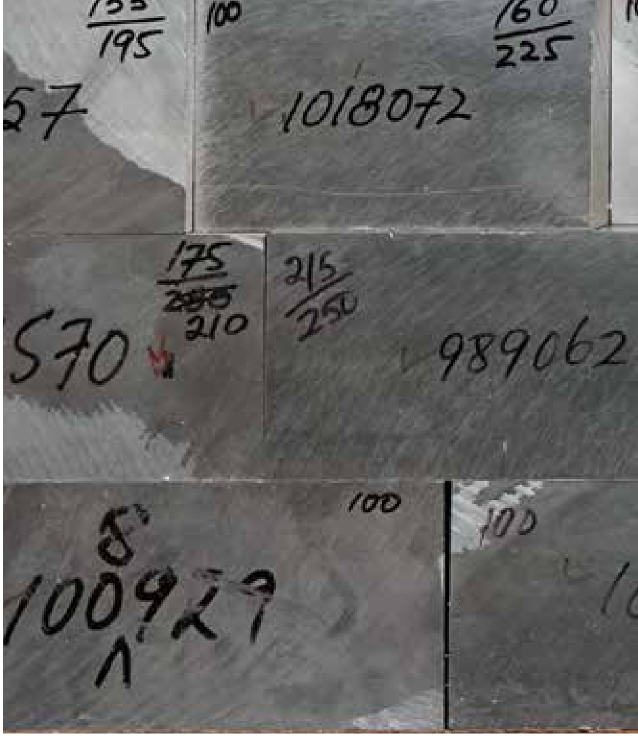
- Rural environments – every six months.
- Urban environments – every three months.
- Industrial and marine environments (or places that are exposed to a lot of salt and sulphur in the air) – every six months, as well as a cold water wash every month.

Special Note: **With both anodising and powder coating exposure to ultra violet light may cause some coating colours to exhibit rapid colour degradation. These colours should not be specified for external use. Check with your Account Manager before specifying.**

Corrosion

A guide to galvanic corrosion effects between aluminium and other metals

<table>
<tr><th>Metal</th><th colspan="2">Galvanic Corrosion Effect When Coupled With Aluminium or an Aluminium Alloy</th></tr>
<tr><td>Gold, Platinum, Silver</td><td>Attack accelerated in most environments</td><td rowspan="8">These metals, and especially those at the top of the list, are generally cathodic to aluminium and its alloys, which are therefore preferentially attacked when corrosion occurs</td></tr>
<tr><td>Copper, Copper Alloys,</td><td>Attack accelerated in most atmospheres and under</td></tr>
<tr><td>Silver Solder</td><td>Conditions of total immersion</td></tr>
<tr><td>Solder Coatings on Steel or Copper</td><td>Attack accelerated at interface in severe or moderate atmospheres and under conditions of total immersion</td></tr>
<tr><td>Nickel and Nickel Alloys</td><td>Attack accelerated in marine or industrial atmospheres and under conditions of total immersion, but not in mild environments</td></tr>
<tr><td>Steel, Cast Iron</td><td>Attack accelerated in marine or industrial atmospheres and under conditions of total immersion, but not in mild environments</td></tr>
<tr><td>Lead, Tin</td><td>Attack accelerated only in severe environments such as marine and some industrial</td></tr>
<tr><td>Tin-Zinc Plating (80-20) on steel</td><td>Attack accelerated only in severe atmospheres and under conditions of total immersion</td></tr>
<tr><td>Pure Aluminium and Aluminium Alloys not containing substantial amounts of copper or zinc</td><td colspan="2">When aluminium is alloyed with appreciable amounts of copper it becomes nobler and when it is alloyed with appreciable amounts of zinc it becomes less noble. In marine or industrial atmospheres, or when totally immersed, an aluminium alloy suffers accelerated attack when in good electrical contact with another aluminium alloy that contains substantial amounts of copper, such as the alloys in the 2000 series</td></tr>
<tr><td>Zinc and Zinc Alloys</td><td>Attack on zinc is accelerated in severe environments such as marine or industrial and under conditions of total immersion</td><td></td></tr>
<tr><td>Magnesium and Magnesium Alloys</td><td>Attack on magnesium is accelerated in severe environment such as marine or industrial and under conditions of total immersion</td><td>Attack on aluminium may also be accelerated</td></tr>
<tr><td>Titanium</td><td>Little data available, but attack on aluminium is known to be accelerated in severe marine or industrial conditions and when immersed in seawater</td><td rowspan="2">These metals form inert protective film that tend to reduce galvanic reaction Where attack occurs, the aluminium base material suffers</td></tr>
<tr><td>Stainless Steel
(18-8, 18-8-2 and 13% Cr)</td><td>No acceleration of attack on aluminium in moderate atmospheres, but attack may be accelerated in severe marine or industrial atmospheres and under conditions of total immersion</td></tr>
<tr><td>Chromium Plate</td><td>No acceleration of attack on aluminium when plating is not less than 0.0025mm thick, except in severe atmospheres</td><td></td></tr>
</table>



The Electro-chemical series

Base Metal		Noble Metal
Magnesium	Bronzes	Platinum
Zinc	Monel Metal	
Aluminium	Silver Solders (70% Ag 30% Cu)	
Cadmium	Nickel	
Mild Steel	Stainless Steel (Type 304)	
Cast Iron	Silver	
Lead	Titanium	
Tin	Graphite	
Brasses	Gold	
Copper		

Pitting

Pitting is the localised form of corrosion that usually occurs at random in the form of small pits or craters (of roughly hemispherical shape). Pits usually become covered with a mound of corrosion product. The rate of penetration of a pit usually diminishes with time, and frequently the pitting can be tolerated if the wall thickness is adequate. The frequency and depth of pitting vary somewhat from one alloy to another.

The depth of pitting is extremely small and the process is known as "weathering". The type and level of pollution will determine general appearance.

Regular maintenance and washing down of aluminium should prevent permanent discolouration from the effects of industrial pollutants. Anodised surfaces retain their original appearance for much longer periods when regular maintenance is provided.

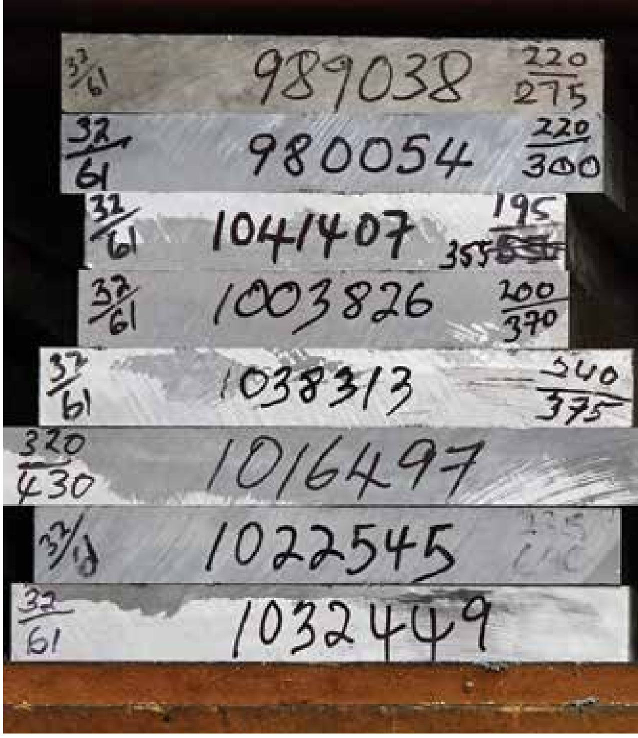
Poultice action

Poultice Action is a form of corrosion that takes place under moist conditions when porous materials such as asbestos, cloth, cork, paper, etc. absorb water and act as a poultice. The corrosive action is the result of differences in oxygen concentration in the water in adjacent areas of the material. It may be increased by corrosive chemicals extracted from the material.

Exposure

Aluminium and its alloys have excellent durability and corrosion resistance, but, like most materials, their behaviour can be influenced by the way in which they are used. Aluminium's natural affinity with oxygen results in the formation of a transparent oxide film when aluminium is exposed to air. This oxide film is generally 5 to 10 microns thick, extremely hard, chemically stable, corrosion resistant and adheres strongly to the parent metal surface. If damaged in anyway, it will reform if enough oxygen is available. The film is removed to facilitate anodising or welding.

In anodising, a thicker, more controlled deposit of oxide film is added. In welding, the oxide film inhibits metal fusion.



Galvanic corrosion

Takes place when dissimilar metals are coupled together in the presence of moisture. The severity of the corrosion depends largely on the circumstances in which the electrolytic couple formed producing a current flow from the less noble metal (anode) to the more noble metal (cathode) and resulting in corrosion of the less noble metal.

Galvanic corrosion may be prevented by insulating dissimilar metals from each other with an electrically inert, non-absorbent barrier.

This type of connection is used between the aluminium superstructure and steel decking on ships.

Simple rules to avoid corrosion

Since the corrosion behaviour of alloyed aluminium is influenced by the physical conditions of the environment, contact with dissimilar metals and by the presence of crevices, the design of equipment made with aluminium can have an appreciable influence on the nature and rate of corrosion.

- Never use aluminium in anaerobic (no oxygen) conditions
- Seal all joints and bolt holes
- Eliminate corners and crevices which are difficult to clean
- Butt weld where possible
- Avoid dissimilar metal contact whenever possible

Contact with materials

Wood

- Dry wood has no reaction to aluminium
- Unseasoned/damp wood should be coated with an aluminium or bituminous paint
- Treated timber may require special consideration and referral to the supplier

Insulation

- Foam, felt, fire retardant may cause corrosion of aluminium if they become wet when in contact with it
- Protect the aluminium by using an inert barrier

Concrete

- No protection under perfectly dry conditions
- As these conditions are rare, all aluminium surfaces in direct contact with concrete should be coated with bituminous paint

Chemicals

- A direct chemical attack of aluminium only occurs to any great extent in strong acid of alkaline conditions
- In some cases the temperature may significantly alter the rate of chemical reaction or be a major factor in initiating chemical attack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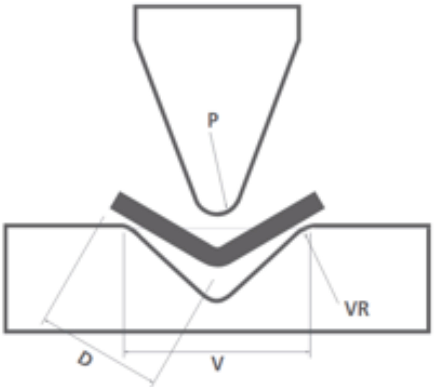
Bending aluminium



Press Brake Die Set Up

P = Inside Bend / Punch Tool Radii mm

D = Smallest Setting Side mm

V = Bottom Die V Gap Width mm

VR = Bottom Die V Shoulder Radii mm

Recommended Press Brake Die Set Up for Cold Forming of Sheet and Plate[1]												
P	1.0	1.3	1.6	2.0	2.7	3.0	3.3	4.0	5.0	5.5	6.5	7.0
D	4.0	6.0	7.0	9.0	11.0	13.0	14.0	17.0	22.0	24.0	28.0	31.0
V	6.0	8.0	10.0	12.0	15.0	18.0	20.0	25.0	30.0	35.0	40.0	45.0
VR	0.8	1.0	1.3	1.6	2.2	2.4	2.6	3.2	3.9	4.2	4.9	5.3
P	8.0	10.0	11.0	13.0	16.0	19.0	21.0	23.0	24.5	26.0	28.0	32.0
D	35.0	42.0	47.0	56.0	70.0	80.0	90.0	100.0	105.0	11.0	130.0	140.0
V	50.0	60.0	70.0	80.0	100.0	120.0	130.0	140.0	150.0	160.0	180.0	200.0
VR	5.6	7.0	7.7	9.1	11.2	12.4	13.7	15.0	15.9	16.9	18.2	20.8

1 To select press brake tooling for a bending application refer to the Recommended Minimum Inside Bend Radii chart for the alloy and thickness of metal to be formed. Make sure the Bottom Die V Gap Width V is not less than that recommended above in conjunction with the Punch Tool Radii P.

Using a wider rather than narrower Bottom Die V Gap Width and tooling that is in good condition will reduce the risk of surface marking and cracking. Surface marking on the sheet from the Bottom Die V will indicate less than an optimal tooling configuration.

Altus recommends that a test bend is made prior to fabrication. Most Press Brake tooling set ups have been designed to bend steel rather than aluminium. Steel has more elongation than aluminium enabling it to be stretched further.

Further technical information can be obtained by contacting your Account Manager.

Bend Radii for 90 Degree Cold Forming

Recommended Minimum Inside Bend Radii for 90 Degree Cold Forming of Sheet and Plate, transverse to the rolling direction 1 2 3 4 5 6 7

Alloys	Tempers	Radii for various thicknesses expressed in terms of thickness							
		0.4mm	0.8mm	1.6mm	3.0mm	4.0mm	6.0mm	10mm	12mm
1100 1200	-0	0	0	0	0	0	½	1	1 ½
	-H12	0	0	0	½	1	1	1 ½	2
	-H14	0	0	0	1	1	1 ½	2	2 ½
	-H16	0	½	1	1 ½				
	-H18	1	1 ½	2	3				
5005 [4]	-0	0	0	0	0	½	1	1	1 ½
	-H12	0	0	0	½	1	1	1 ½	2
	-H14	0	0	0	1	1	1 ½	2	2 ½
	-H16	½	1	1	1 ½				
	-H18	1	1 ½	2	3				
5052 [3,6] 5251	-0	0	0	0	½	1	1	1 ½	1 ½
	-H32	0	0	1	1 ½	1 ½	1 ½	1 ½	2
	-H34	0	1	1 ½	2	2	2 ½	2 ½	3
	-H36	1	1	1 ½	2 ½				
	-H38	1	1 ½	2 ½	3				
5454	-0	0	0	½	1	1	1	1 ½	1 ½
	-H32	0	½	1	1 ½	1 ½	2	2 ½	3 ½
	-H34	½	1	1 ½	2	2 ½	3	3 ½	4
5083 [5]	-0			½	1	1	1	1 ½	1 ½
	-H321		2	2	2	2 ¼	2 ½	3 ½	3 ½
	-H116			2	3	3 ½	4		
6061	-0	0	0	0	1	1	1	1½	2
	-T4	0	½	1	1 ½	2 ½	3	3 ½	4
	-T6	1	1	1 ½	2 ½	3	4	4 ½	5

1 The radii listed are the minimum recommended for bending sheets and plates without fracturing in a standard press brake with air bend dies. Other types of bending operations may require larger radii or permit smaller radii. The minimum permissible radii will also vary with the design and condition of tooling. Refer to the ALTUS Recommended Press Brake Die Set Up Chart for more information.

2 Heat-treatable alloys can be formed over appreciably smaller radii immediately after solution heat treatment.

3 The H12 temper (applicable to non-heat treatable alloys) is supplied in the as-fabricated condition without special property control but usually can be formed over radii applicable to the H14 (or H34) temper.

4 Applicable to 5005 H1X and H3X tempers.

5 Use H116 bend radii if yield strength is over 255 MPa or elongation is less than 16%.

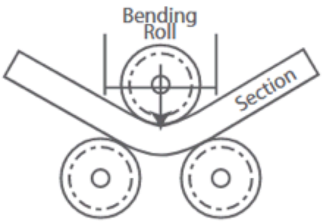
6 All recommended radii refer to bends made transverse to the rolling direction. A larger radii may be required in some materials for bends made longitudinal to the rolling direction.

7 Bend radii for tread plate in temper H112 or H114 should be based on the overall thickness (Including lozenge height) of the metal. Then use the bend radii recommended for H34.

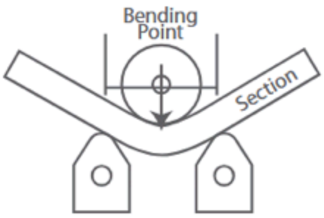
Bending aluminium

There are several types of forming machines suitable for bending aluminium sections. The choice depends upon the class of section, whether solid, open or hollow; the range of support tooling available; the alloy and temper. Tubing is by far the most commonly bent extruded product.

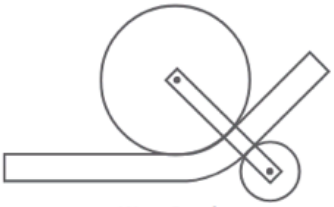
Bending may be carried out by four main methods:

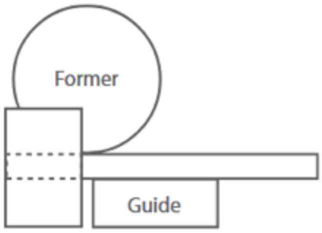


Three Roll Bender

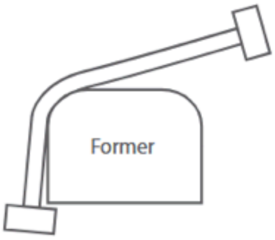


Three Point Bender


Wrap Bender
(Former moves around section)



Draw Mandrel Bender
(Section moves around former)



Stretch bender

The three roll bender has a central moveable roller which is gradually depressed until the desired radius is obtained.

The three point bender has a similar method of operation, the load being either applied gradually or impacted.

The roll and point methods of bending are usually applied to robust sections.

In both wrap and mandrel benders, it is possible to provide formers and other support tools which minimise the amount of buckling and enable tighter radii to be obtained.

The stretch former puts the section into tension and then, moving laterally, wraps it around a former. This method reduces the likelihood of compression failure.

Drawn tube should be specified where tight tolerances are required and where a higher level of mechanical property is necessary than is available in an extruded product. Drawn tube bends more consistently than extruded tube, again, due to the range in the mechanical properties.

Section bending is a specialist procedure and generally the soft tempers should be used, particularly for complex shapes.

Recommended bending Radii for round tube

Recommended minimum inside bending Radii (r) for selected sizes of Round Tube - Mandrel bending

Tube Size		Radii for Various Alloys and Tempers (mm)					
Outside Diameter (mm)	Wall Thickness (mm)	1200-O 1350-O	6106-O 6060-O 6063-O 6061-O 6351-O	6106-T4 6061-T4 6351-T4 6063-T4	6060-T5 6063-T5 & T6 6101-T5 & T6 6106-T6	6005A-T6 6061-T6 6351-T6	6060-T81 6063-T81
10	1.0	12	15	16	18	20	18
	1.6	10	13	14	16	18	16
12	1.0	16	16	18	22	25	28
	1.6	12	15	17	20	23	26
16	1.0	19	22	30	32	35	38
	1.6	17	20	23	26	32	32
20	1.0	25	28	38	40	50	60
	1.6	22	25	32	32	40	40
25	1.2	38	45	50	56	62	70
	1.6	35	45	46	50	56	65
	3.0	30	42	40	45	52	50
28	1.2	45	54	60	68	84	98
	1.6	42	50	54	58	64	75
	3.0	34	40	42	45	50	50
32	1.2	54	62	80	80	100	110
	2.0	42	48	54	60	80	80
	3.0	38	42	46	52	60	70
40	1.6	64	72	90	95	120	140
	2.0	56	64	80	80	100	110
	3.0	48	54	60	70	80	85
50	1.6	90	112	125	140	175	220
	2.0	84	98	110	126	150	190
	3.0	70	80	95	110	125	150
	4.0	68	70	80	90	120	140
60	2.0	110	120	150	170	220	260
	3.0	100	105	120	130	180	220
	4.0	85	90	100	120	150	190
	6.0	70	80	90	100	130	150
80	2.0	165	190	220	240	340	400
	3.0	140	170	185	200	250	320
	4.0	135	150	160	180	220	280
	6.0	120	130	140	160	200	250

It is recommended that a test bend is carried out before a final selection is made.

Alloy specifications

Mechanical property limits - Rolled Product

Tensile Strength (MPa)							
Alloy & Temper	Thickness (mm)		Ultimate		Yield		Elongation % min. in 50mm
	Over	Up to	Min	Max	Min	Max	
5005 H12	0.4	0.63	125	165	95		2
	0.63	1.2	125	165	95		4
	1.2	6.3	125	165	95		6
5005 H34	0.3	0.8	137	180	105		3
	0.8	1.3	137	180	105		4
	1.3	3.0	137	180	105		5
	3.0	4.0	137	180	105		6
	4.0	6.0	137	180	105		7
5052 H32	0.5	1.3	213	263	158		5
	1.3	3.0	213	263	158		7
	3.0	6.0	213	263	158		9
	6.0	12	213	263	158		11
5052 H34	0.5	1.3	234	283	179		4
	1.3	3.0	234	283	179		6
	3.0	6.0	234	283	179		7
	6.0	12.0	234	283	179		8
5052 H36	0.2	0.8	255	304	199		3
	0.8	4.0	255	304	199		4
5052 H38	0.63	3.2	270		220		4
5083 H321	5.0	40.0	303	387	213	297	10
5083 H112	6.3	12.5	275		125		12
	12.5	40.0	275		125		10
	40.0	80.0	270		115		10
5083 H116	3.0	30.0	305		215		10
6061 T651	12.5	40.0	290		240		8
	40.0	80.0	290		240		6
	80.0	100.0	290		240		5
	100.0	150.0	275		240		5
	150.0	175.0	265		230		4

These are the minimum mechanical properties for the alloys listed. (Data obtained from AA and ADC)

Mechanical property limits – Extruded Products

Tensile Strength (MPa)								
Alloy & Temper	**Thickness (mm)**		**Ultimate**		**Yield**		**Elongation % min. in 50mm**	
	Over	**Up to**	**Min**	**Max**	**Min**	**Max**	**5005**	**5050A**
1200 - H112	All		75		20		18	
6101 T5		12	150		110			
6101 T6	3	12	200		170		10	
6060 T5		12.0	150		110		8	
	12.0	25.0	145		105		6	
6063 T5		12	151		110		8	
	12	25	144		103		6	
6063 T6		25	205		170		8	
	25	150.0	185		160		10	
6106 T6		10	235		210		8	
	10.0	25.0	205		170		8	
	25.0	150.0	185		160		10	
6261 T5 or T6		All	295		255		7	
6061 T6		All	262		241		8	
6061 T6511	175.0	All	260		240		10	
6082 T6511	5.0	150	310		260		8	

These are the minimum mechanical properties for the alloys listed. (Data obtained from AA and ADC).

Welding aluminium

Welding uses an intense heat source to cause localised melting and fusion of the parent metal of the joint. Filler metal may or may not be used.

A wide variety of processes are used to weld aluminium, some common, others highly specialised.

Arc Welding

- T.I.G. (Tungsten Inert Gas)
- M.I.G. (Metal Inert Gas)
- Pulse Arc (lower than normal currents)
- Stud (attaching studs and fasteners to metal)
- Atomic Hydrogen (intense heat - rare)
- Carbon Arc (rarely used)
- Metal Arc (not good quality - repairs)

Oxy-Gas Welding

- Standard oxy-fuel techniques (oxy acetylene/oxy hydrogen)

Resistance Welding

- Spot
- Seam
- Flash Butt
- Resistance Butt
- Projection
- Percussion

(Applicable to all aluminium alloys but more particularly to the heat-treatable alloys which are difficult to weld by the fusion process)

Specialised Welding

- Pressure
- Ultrasonic
- Friction
- Thermit
- Electron Beam
- Laser Beam
- Plasma Arc
- Induction and resistance seam

(All applicable to the joining of aluminium but very limited application)

Welding is a widely accepted method of joining aluminium and the techniques are well known in the engineering and manufacturing industries.

The most commonly used basic welding processes are tungsten inert gas (T.I.G.) and metal inert gas (M.I.G.).

As the names suggest, both processes are inert-gas-shielded systems which shroud the weld area from the air to prevent reformation of oxide film.

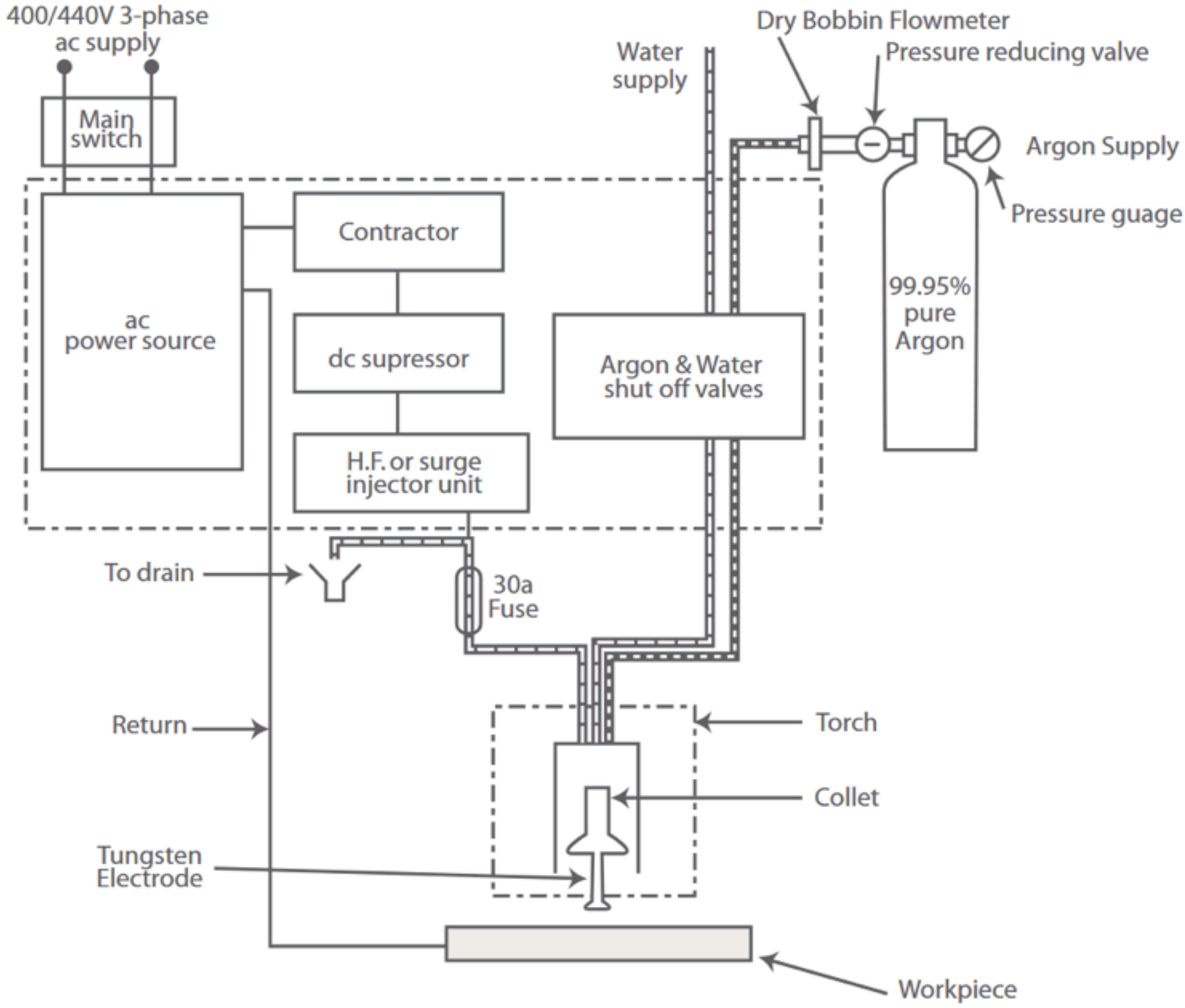
Metal thickness capacity of T.I.G. and M.I.G. Welding Systems

Welding System	Thickness of Parent Metal (mm)		Welding Equipment
	min	max	
T.I.G.	1.2	9.5 [1]	Composite unit (350A) with Transformer (350A), High Frequency or Surge Injector unit, Suppressor and Welding Torches
M.I.G. 0.5kg	1.6	8.0 [2]	Composite unit (250A) with Wire Feed unit and Welding Gun for 0.5kg Spool
M.I.G. 5kg	4.8	None	Composite unit (250A) with Wire Feed unit and Welding Gun for 5kg Spool

1 Although the T.I.G. process can weld thicker material, it is not normally used for aluminium greater than 9.5mm in thickness for economic reasons.

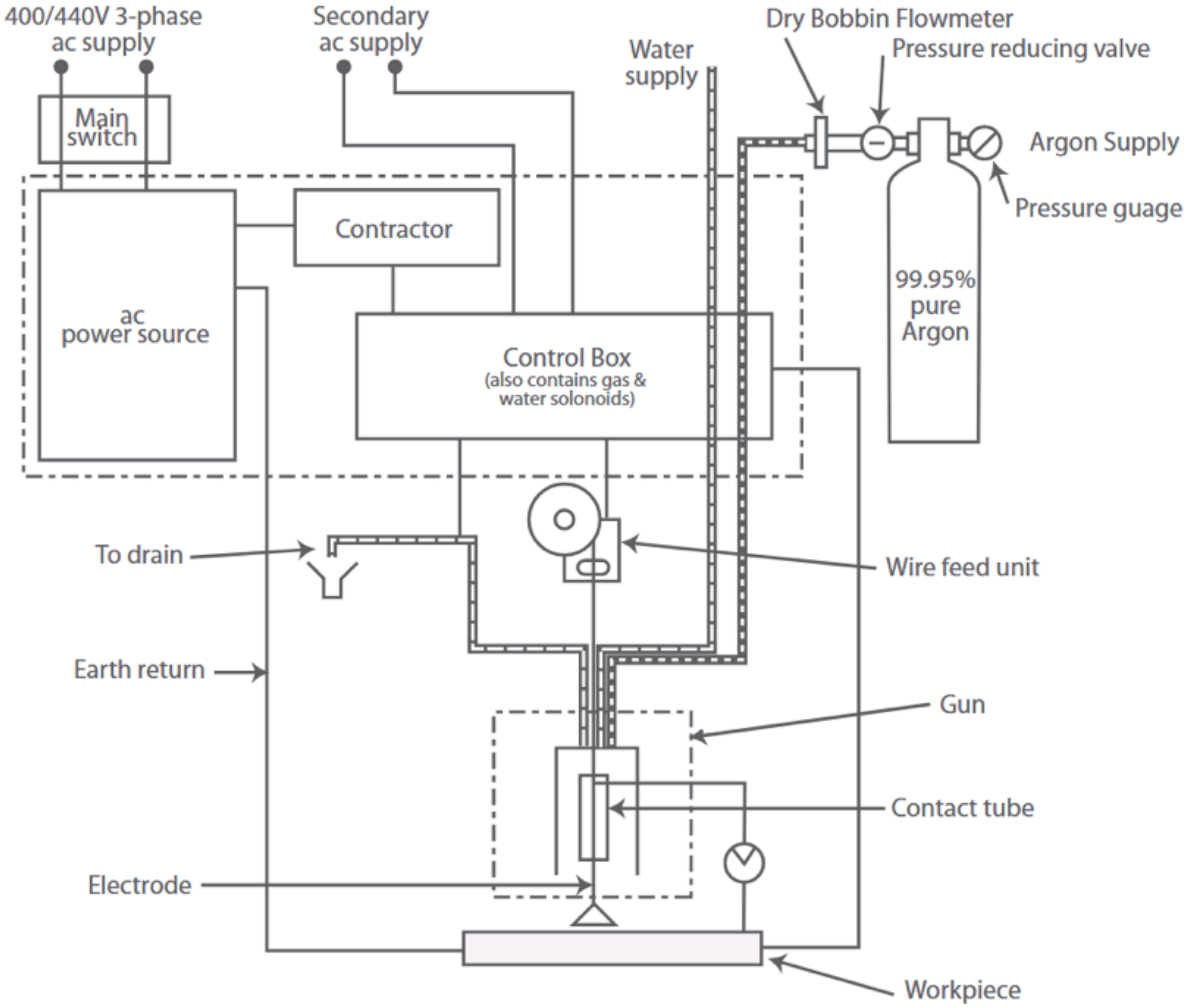
2 In theory there is no upper limit to metal thickness for 0.5kg M.I.G., but it is more economical to use 5kg M.I.G. for aluminium greater than 8.0mm in thickness.

A typical T.I.G. (GTAW) Welding System



Note: **Composite T.I.G. welding units include all the necessary auxiliaries. The argon and water shut off valves are usually controlled by solenoids, but may also be manually operated. The main power cable, fuse and torch can be air or water cooled.**

A typical T.I.G. (GTAW) Welding System



1. The a.c. supply is 110v for 0.5kg MIG and 220v for 5kg M.I.G. welding.
2. Composite M.I.G. welding units have the contactor and control box built in.
3. The filler wire feed unit is integral with the gun in 0.5kg M.I.G. and independent of it in 5kg M.I.G. systems.
4. A voltage pick-up lead is required for 0.5kg M.I.G.
5. The main power cable and gun of 5kg M.I.G. can be water cooled.
6. Arc voltage in M.I.G. welding processes is measured with a voltmeter connected between the contact tube and the workpiece.

Preparation

Cleanliness and removal of the oxide film are most important. The proposed weld area must be degreased using methylated spirits, acetone, etc. Oxides, grease or oil films left on the edges to be joined will cause unsound welds and the mechanical efficiency of the weld will be adversely affected. The joint must be wiped dry.

After degreasing, the joint is cleaned with stainless steel wire brushes, or a chemical etch cleaner to remove the oxide film. Welding should be carried out as soon as possible.

The majority of T.I.G. and M.I.G. welding is done manually; however, they are ideal processes for mechanising. This leads to improvements in terms of increased welding speed, more consistent penetration, bead shape and general appearance and a greater degree of repeatability which is essential for volume production welding work.

The chief differences between the T.I.G. and M.I.G. processes are in the electrodes and the characteristics

of the power used. In T.I.G. welding, the electrode is tungsten (non-consumable), which is used to maintain

the arc; an appropriate aluminium filler material is added separately as required. Argon is fed to the torch through a flexible tube so that the whole of the arc and the weld pool are shrouded with argon, effectively preventing oxidation.

Conventional T.I.G. welding of aluminium is performed with AC current.

In M.I.G. welding, the electrode is aluminium filler wire fed continuously through the gun or torch from

a reel into the weld pool as fast as it is consumed; the arc is struck between the tip of this wire and the metal being welded. For welding aluminium, the gas may be argon, helium, or a mixture of both, which is fed through the torch to provide a protective shroud. The current supply is DC (reverse polarity) with the electrode positive.

The choice of correct fill composition is of fundamental importance when fusion welding the various aluminium alloys. As well as the important consideration of corrosion resistance and the strength required of the weld, the filler metal must be compatible with the alloy to be welded. Weld cracking may result from using incorrect filler alloys.

The correct joint design is important to ensure adequate penetration. Backing strips should be used where feasible; the backing bar may be of steel, stainless steel, copper or aluminium.

For the T.I.G. process, the joint design and root openings required are determined by the thickness of the aluminium to be jointed and the structural requirements of the weldment.

For the M.I.G. process, the square butt joint is satisfactory up to 6mm. For thicker material either a single-vee or double-vee bevel may be necessary.

The four primary conditions which must be correct for a good weld are:

- Volts
- Amps
- Gas Flow
- Arc Travel Speed

Each job requires a particular set of welding conditions depending on the type and position of weld and the thickness of the metal.

Filler Wire

Alloys in the 5000 and 6000 series can be welded readily to a wide range of other aluminium alloys. The table that follows shows the preferred weld filler wire for such combinations of parent metals and, where appropriate, gives an alternative filler wire which can be used when the finished component is to be anodised and a close colour match is required between the weld area and the parent metal. Alloys in the 2000 series are not shown in the table since they are not recommended for fusion welding using the T.I.G. and M.I.G. processes.

Filler metal selection chart for the Welding of Wrought Alloys[1, 2]

The table below is extracted from "Successful Welding of Aluminium" published by WTIA (Welding Technology Institute of Australia) and should be used as a guide only.

First alloy subgroup	Second alloy subgroup						
	Itself (or same subgroup)	7005	6006[3] 6061 6082	5154A 5454	5083 5086	5052 5251	5005 5050A
1050[4]	1100[7]	5356[7]	4043	4043[9]	5356[7]	4043[9]	4043[9]
5005 5050A	4043[8, 9]	5356[9]	4043[6]	5356[6]	5356[9]	4043[9]	4043[9]
5052 5251	5356[5, 6, 7]	5356[9]	5356[6, 7]	5356[6]	5356[9]		
5083	5183[9]	5183[9]	5356[9]	5356[9]			
5086	5356[9]	5356[9]	5356[9]	5356[9]			
5154A	5356[5, 6, 8]	5356[6]	5356[6, 7]	5356[6]	5356[9]		
5383	5183[9]	5183[9]	5356[9]	5356[9]			
5454	5554[7, 9, 11]	5356[6]	5356[6, 7]				
6060[3]							
6061	4043[6]	5356[6, 7]					
6082							
7005	5356[9, 10]						

1 Service conditions such as immersion in fresh or salt water, exposure to specific chemicals, or a sustained high temperature (over 65°C) may limit the choice of filler metals. Filler metals 5356, 5183, 5556 and 5654 are not recommended for sustained temperature service over 65°C.

2 Recommendations in the main body of this table are the preferred choice and apply for most applications.

3 Other alloys in this group include: 6005A, 6101, 6106 and 6261.

4 Other alloys in this group include: 1080A, 1150, 1350 and 3203.

5 5654 filler is used for welding base metal alloys for low-temperature hydrogen peroxide service (less 65°C).

6 5183, 5356, 5554, 5556 and 5654 may be used. 5554 is only 5xxx series filler alloy listed suitable for service temperature over 65°C.

7 4043 may be used.

8 Filler metal with the same analysis as the base metal may be used.

9 5183, 5356 or 5556 may be used.

10 5039 is preferred but not readily available.

11 5554 is only 5xxx series filler alloy listed suitable for service temperatures over 65°C.


AIR PRESSURE
EMERGENCY STOP
AIR COMPRESSORS
SAMSUNG

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 toleranced 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 and imported extruder product tolerances

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

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 Altus 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 and convexity tolerances

Concavity and 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.

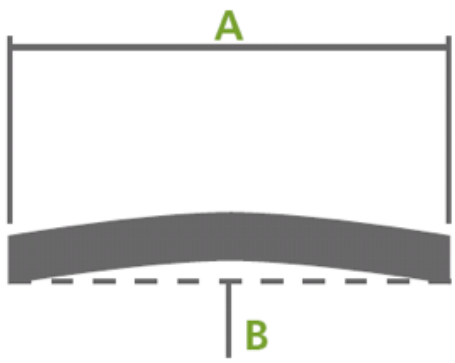
All manufacturing tolerances are subject to review from time to time.

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.

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Bow tolerances

Bow

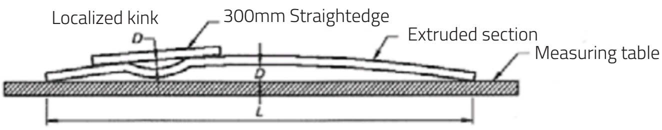
The function of any particular shape is paramount, and under this provision, negotiation and agreement between customer and extruder is encouraged, particularly at the design stage.

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.

Straightness tolerance for extruded products



Alloy and Temper	Allowable Deviation from Straightness, D, mm	
	In any length ≤ 300mm	Maximum (mm)
6101-T5	0.2	0.7 L
6063-T5 & T52	0.2	0.7 L
6060-T5 & T52	0.2	0.7 L
All other alloys and tempers	0.6	2 L

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.

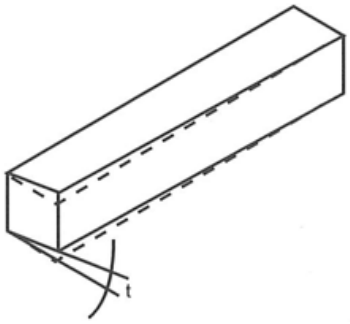
All manufacturing tolerances are subject to review from time to time.

Width (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 5x1mm = 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 800mm	1/4°	2°
Lengths over 8000mm	1/4°	3°

Bars and 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)													
Up to & incl. (mm)		Over		1.6	3.0	6	10	18	30	40	60	80	100	120	140
		Up to & incl.	1.6	3.0	6	10	18	30	40	60	80	100	120	140	160
-	10	Tolerance + - (mm)	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

Hollow section and Tubing tolerances

Width (Width across Flats and 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	0.16							
3	10	0.20							
10	18	0.26	Tolerance + - (mm)	0.20	0.22				
18	30	0.32		0.26	0.28	0.32			
30	40	0.40		0.32	0.36	0.41	0.48		
40	60	0.45		0.32	0.36	0.41	0.48		
60	80	0.50		0.36	0.41	0.48	0.58	0.68	
80	100	0.65			0.48	0.58	0.68	0.82	1.0
100	120	0.80			0.48	0.58	0.68	0.82	1.0
120	140	0.90			0.65	0.75	0.85	0.95	1.10
140	160	1.00			0.65	0.75	0.85	0.95	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	0.25	0.19
18	30	0.30	0.23
30	40	0.36	0.27
40	50	0.45	0.34
50	60	0.54	0.40
60	80	0.60	0.45
80	150	1% of diameter	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.

Wall thickness of Tubing

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

Open End, Channel and I Beam

Overall Width of Channel (C) in mm		Minimum Thickness of Web, Flange (T1 , T2)		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	Tolerance + - (mm)	0.25	0.32	0.41						
		1.50	3.00		0.23	0.28	0.34						
		3.00	-		0.22	0.26	0.30						
10	18	0	1.50		0.31	0.38	0.47	0.56	0.70				
		1.50	3.00		0.29	0.34	0.40	0.46	0.55				
		3.00	-		0.28	0.32	0.36	0.41	0.47				
18	30	0	3.00		0.37	0.47	0.57	0.68	0.84	1.05	1.26		
		3.00	6.00		0.37	0.44	0.53	0.62	0.76	0.93	1.11		
		6.00	-		0.35	0.41	0.48	0.55	0.64	0.78	0.91		
30	40	0	3.00		0.45	0.55	0.65	0.76	0.92	1.13	1.34	1.55	1.76
		3.00	6.00		0.45	0.52	0.61	0.70	0.84	1.01	1.19	1.36	1.54
		6.00	-		0.43	0.49	0.56	0.63	0.72	0.86	0.99	1.12	1.25
40	60	0	3.00			0.60	0.70	0.81	0.97	1.18	1.39	1.60	1.81
		3.00	6.00			0.57	0.66	0.75	0.89	1.06	1.24	1.41	1.59
		6.00	-			0.54	0.61	0.68	0.77	0.91	1.04	1.17	1.30
60	80	0	3.00			0.65	0.75	0.86	1.02	1.23	1.44	1.65	1.86
		3.00	6.00			0.62	0.71	0.80	0.94	1.11	1.29	1.46	1.64
		6.00	-			0.59	0.66	0.73	0.82	0.96	1.09	1.22	1.35
80	100	0	6				0.90	1.01	1.17	1.38	1.59	1.80	2.01
		6	-				0.86	0.95	1.09	1.26	1.44	1.61	1.79
100	120	0	6				1.05	1.16	1.32	1.53	1.74	1.95	2.16
		6	-				1.01	1.10	1.24	1.41	1.59	1.76	1.94
120	140	0	6				1.15	1.26	1.42	1.63	1.84	2.05	2.26
		6	-				1.11	1.20	1.34	1.51	1.69	1.86	2.04
140	160	0	6				1.25	1.36	1.52	1.73	1.94	2.15	2.36
		6	-				1.21	1.30	1.44	1.61	1.79	1.96	2.14
160	180	0	6				1.35	1.46	1.62	1.83	2.04	2.25	2.46
		6	-				1.31	1.40	1.54	1.71	1.89	2.06	2.24
180	200	0	6				1.45	1.56	1.72	1.93	2.14	2.35	2.56
		6	-				1.41	1.50	1.64	1.81	1.99	2.16	2.34


EXIT

Metallurgical aspects

In high purity form, aluminium is soft and ductile. Most commercial users, however, require greater strength than pure aluminium affords. This is achieved in aluminium by the addition of other elements to produce various alloys which alone, or in combination, impart strength to the metal. Further strengthening is possible by means which classify the alloys roughly into two categories, non-heat treatable and heat-treatable.

Non-heat treatable alloys

The initial strength of alloys in this group depends upon the hardening effect of elements such as manganese, silicon, iron and magnesium. The non-heat treatable alloys are therefore usually designated in the 1000, 3000, 4000 and 5000 series.

Since these alloys are able to be workhardened further strengthening is possible with various degrees of cold working, denoted by the H series of tempers. Alloys containing appreciable amounts of magnesium when supplied in strain-hardened tempers are usually given a final elevated-temperature treatment called stabilising to ensure stability of properties.

Heat treatable alloys

The initial strength of alloys in this group is enhanced by the addition of alloying elements which, either between themselves or in conjunction with aluminium, form compounds which show increasing solid solubility in aluminium with increasing temperature. This phenomenon has enabled this group of alloys to be developed so that their strength may be improved by carefully controlled thermal treatment.

The first step, called heat treatment or solution heat treatment, is an elevated temperature process designed to put the soluble element in solid solution. This is followed by rapid quenching, usually in water, which temporarily "stabilises" the structure and for a short time renders the alloy very workable. It is at this stage that some fabricators retain this more workable structure by storing the alloys at sub zero temperatures until they are ready to form them. At room or elevated temperatures, supersaturated solution begins. After a period of several days at room temperature, termed ageing or room temperature precipitation, the alloy is considerably stronger. Many alloys approach a stable condition at room temperature, but some alloys, particularly those containing magnesium and silicon or magnesium and zinc, continue to age-harden for longer periods of time at room temperature.

By heating for a controlled time at slightly elevated temperatures even further strengthening is possible and properties are stabilised. This process is called artificial ageing or precipitation hardening. By the proper combination of solution heat treatment, quenching, artificial ageing, and cold working the highest strengths are obtained.

Alloy characteristics

Rolled Products

Alloy	Typical application (✓)	Forms available				Characteristics					
		Plate	Flat Sheet	Coiled Sheet	Circle Blanks	Corrosion Resistance	Machining	Anodising	Forming	Welding	Heat Treatable
1050	Chemical, process plant and equipment	✓	✓	✓		aa	dc	bb	ad	aa	no
1150	Commercially pure aluminium that has been specially processed to give a reasonably streak free surface when mechanically polished and anodised. Suitable for chemical brightening before anodising. Typical uses saucepan lids, beakers and decorative trim and panels.		✓	✓	✓	aa	dc	aa	ad	bc	no
1200	Commercial pure aluminium. Uses include cooking utensils, packing containers, building components (not stressed) and domestic appliances. Deep drawing quality available.		✓	✓	✓	aa	dc	bb	ac	ba	no
3003	Chemical equipment, sheet metalwork, rigid foil containers, closures		✓	✓		aa	dc	bb	ac	ba	no
3004	Sheet metal work, car bodies, seam welded tubing, roofing sheet		✓	✓		aa	dc	bb	ac	ba	no
3105	Painted sheet products, sheet metal work, closure sheet, finstock.		✓			aa	dc	bb	ac	ba	no
5005	A stronger alloy than 1200. This is a general purpose alloy suitable to welding.	✓	✓	✓	✓	aa	dc	bb	ac	ba	no
5083	Used in high strength structural applications principally in the form of sheet and plate for welded marine applications and road transport vehicles.	✓	✓			ac	cb	cc	ac	ba	no
5251 5052	A medium strength alloy with reasonable ductility-work hardens rapidly. Very suitable for welding with a high corrosion resistance, particularly in marine atmospheres. Uses include boats, panelling and pressing for transport, boxes and containers. Suitable for applications specifying 5052.	✓	✓	✓		aa	cb	cc	ac	ba	no
5454	Welded structures, pressure vessels for use at elevated temperatures, marine applications.	✓	✓	✓		aa	cb	cc	ac	ba	no
6061	Structural applications where corrosion resistance is required. Transport, marine, aircraft landing mats.	✓	✓			bb	bc	bb	ac	ba	yes
7075	High Strength and surface hardness, susceptible to stress corrosion cracking.	✓				cc	bb	dd	dd	bc	yes

Relative ratings in decreasing order of merit = a b c d (where a = most applicable) two ratings: e.g. ac are for annealed and hardest tempers.

Extruded Products

Alloy	Typical Application (✓)	Forms Available				Drawn		Characteristics					
		Rod & Bar	Solid Shapes	Hollow Shapes	Tube	Rod & Bar	Tube	Corrosion Resistance	Machining	Anodising	Forming	Welding	Heat Treatable
2011	Commercial machining alloy.	✓	e			✓		d	aa	d	cd	d	p
3003	Drawn tube for heat exchangers, chemical equipment and hardware.				e		✓	a	dc	b	ac	a	nr
6060 / 6063	Most commonly used extrusion alloy. Architectural and general purpose	✓	✓	✓	✓	✓	✓	a	cc	a	ac	a	p
6061	Structural alloy with medium weld strength and good corrosion resistance.	✓	✓	✓	✓	✓	✓	b	bc	b	ac	a	p
6101	Electrical conductors.	✓	✓	✓	✓	✓	✓	ab	bc	a	ac	a	p
6106	General purpose and light structural.	✓	✓	✓	✓	✓	✓	a	cb	a	ac	a	p
6261	Commercial machining alloy with good anodising.	✓	e	e	✓	✓		b	aa	b	ac	a	p
6082	Heavy duty structures with good corrosion resistance and medium weld strength. Transport, marine etc.	✓	✓	✓	✓			ab	bc	b	ac	a	p
6463A	Trims requiring decorative finishing.	e	e					a	c	a	a	a	p

Relative ratings are in decreasing order of merit = a,b,c,d

e = Special enquiry needed to clarify application

Nr = Not recommended

Where applicable, ratings for both annealed and hardest temper are given, e.g. a,c

Ratings inicates suitability of alloy for decorative quality anodising; all aluminium alloys can be anodised for increased corrosion and wear resistance.

Useful formulae

Sheets

To Calculate the Mass of a Sheet		
Alloy	**Factor**	**Calculation**
5083	0.982	
5251	0.993	
1150	0.996	Length (m) x Width (m) x Thickness (mm) x 2.71 x factor = Kg
5005	0.996	Example: To calculate mass of 5005 sheet 1800 x 763 x 1.2mm thick
1200	1.000	1.8 x 0.763 x 1.2 x 2.71 x 0.996 = 4.448 kg
3105	1.004	
3003	1.007	

Coiled sheet

Coil density (kg per mm of width) = 2.128 (D + d) (D - d) 10-6

D = outside diameter of coil (mm)

d = inside diameter of coil (mm)

Circles

Mass per circle = 2.1^{3} $D^{2}t$ x 10-6 = kg

D = diameter (mm)

t = thickness (mm)

Extrusions

Mass per unit length for Extrusions		
Alloy	Density (kg/m3 x 103)	Conversion Factor
2011	2.77	1.044
3003	2.73	1.007
6060	2.70	0.996
6106	2.70	0.996
6061	2.70	0.996
6082	2.70	0.996

Circles

Mass per metre (kg) = $2.71 \times A \times 10^{-3} \times$ Factor

Tubes

Mass per metre (kg) = $8.51t(D-t) \times 10^{-3} \times$ Factor

Round bar and wire

Mass per metre (kg) = $2.13\ D^2 \times 10^{-3} \times$ Factor

D = outside diameter (mm)

d = inside diameter (mm)

t = thickness

A = cross section area (mm^2)

Gauge conversion chart

Gauge to millimetre conversion chart

Gauge to Millimetre Conversion Chart	
Gauge	**Conversion to mm**
25g	.50
24g	.60
22g	.70
20g	.90
18g	1.20
16g	1.60
14g	2.00
12g	2.80
10g	3.00
3/16	5.00
1/4	6.00

Conversion basics

Linear	
1 inch	25.4mm
1 foot	0.3048m
1mm	0.0394 inches
1m	3.28 feet
Area	
1 sq inch	645 sq mm
1 sq foot	0.0929 sq m
1 sq mm	0.00155 sq in
1 sq m	10.84 sq ft
Volume	
1 cubic inch	16387 cu mm
1 cu mm	0.000061 cu in
Force	
1 pound force	4.45 newtons
1 newton	0.225 pound force
Pressure	
1 lb per sq in	0.00689 MPa
1 MPa	145 lbs per sq in
Weight	
1 Kg	2.204 lb

Linear conversion tables imperial - metric

Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm
1/64	0.3969	33/64	13.0969	1 1/32	26.1938	2 1/32	51.5938	3 1/32	76.9938
1/32	0.7938	17/32	13.4938	1 1/16	26.9875	2 1/16	52.3875	3 1/16	77.7875
3/64	1.1906	35/64	13.8906	1 3/32	27.7813	2 3/32	53.1813	3 3/32	78.5813
1/16	1.5875	9/16	14.2875	1 1/8	28.5750	2 1/8	53.9750	3 1/8	79.3750
5/64	1.9844	37/64	14.6844	1 5/32	29.3688	2 5/32	54.7688	3 5/32	80.1688
3/32	2.3813	19/32	15.0813	1 3/16	30.1625	2 3/16	55.5625	3 3/16	80.9625
7/64	2.7781	39/64	15.4781	1 7/32	30.9563	2 7/32	56.3563	3 7/32	81.7563
1/8	3.1750	5/8	15.8750	1 1/4	31.7500	2 1/4	57.1500	3 1/4	82.5500
9/64	3.5719	41/64	16.2719	1 9/32	32.5438	2 9/32	57.9438	3 9/32	83.3438
5/32	3.9688	21/32	16.6688	1 5/16	33.3375	2 5/16	58.7375	3 5/16	84.1375
11/64	4.3656	43/64	17.0656	1 11/32	34.1313	2 11/32	59.5313	3 11/32	84.9313
3/16	4.7625	11/16	17.4625	1 3/8	34.9250	2 3/8	60.3250	3 3/8	85.7250
13/64	5.1594	45/64	17.8594	1 13/32	35.7188	2 13/32	61.1188	3 13/32	86.5188
7/32	5.5563	23/32	18.2563	1 7/16	36.5125	2 7/16	61.9125	3 7/16	87.3125
15/64	5.9531	47/64	18.6531	1 15/32	37.3063	2 15/32	62.7063	3 15/32	88.1063
1/4	6.3500	3/4	19.0500	1 1/2	38.1000	2 1/2	63.5000	3 1/2	88.9000
17/64	6.7469	49/64	19.4469	1 17/32	38.8938	2 17/32	64.2938	3 17/32	89.6938
9/32	7.1438	25/32	19.8438	1 9/16	39.6875	2 9/16	65.0875	3 9/16	90.4875
19/64	7.5406	51/64	20.2406	1 19/3	40.4813	2 19/32	65.8813	3 19/32	91.2813
5/16	7.9375	13/16	20.6375	1 5/8	41.2750	2 5/8	66.6750	3 5/8	92.0750
21/64	8.3344	53/64	21.0344	1 21/32	42.0688	2 21/32	67.4688	3 21/32	92.8688
11/32	8.7313	27/32	21.4313	1 11/16	42.8625	2 11/16	68.2625	3 11/16	93.6625
23/64	9.1281	55/64	21.8281	1 23/32	43.6563	2 23/32	69.0563	3 23/32	94.4563
3/8	9.5250	7/8	22.2250	1 3/4	44.4500	2 3/4	69.8500	3 3/4	95.2500
25/64	9.9219	57/64	22.6219	1 25/32	45.2438	2 25/32	70.6438	3 25/32	96.0438
13/32	10.3188	29/32	23.0188	1 13/16	46.0375	2 13/16	71.4375	3 13/16	96.8375
27/64	10.7156	59/64	23.4156	1 27/32	46.8313	2 27/32	72.2313	3 27/32	97.6313
7/16	11.1125	15/16	23.8125	1 7/8	47.6250	2 7/8	73.0250	3 7/8	98.4250
29/64	11.5094	61/64	24.2094	1 29/32	48.4188	2 29/32	73.8188	3 29/32	99.2188
15/32	11.9063	31/32	24.6063	1 15/16	49.2125	2 15/16	74.6125	3 15/16	100.0120
31/64	12.3031	63/64	25.0031	1 31/32	50.0063	2 31/32	75.4063	3 31/32	100.8060
1/2	12.7000	1 inch	25.4000	2 inches	50.8000	3 inches	76.2000	4 inches	101.6000

Linear conversion tables imperial - metric continued

Inches	mm
4 1/32	102.3940
4 1/16	103.1880
4 3/32	103.9810
4 1/8	104.7750
4 5/32	105.5690
4 3/16	106.3620
4 7/32	107.1560
4 1/4	107.9500
4 9/32	108.7440
4 5/16	109.5380
4 11/32	110.3310
4 3/8	111.1250
4 13/32	111.9190
4 7/16	112.7120
4 15/32	113.5060
4 1/2	114.3000
4 17/32	115.0940
4 9/16	115.8880
4 19/32	116.6810
4 5/8	117.4750
4 21/32	118.2690
4 11/16	119.0620
4 23/32	119.8560
4 3/4	120.6500
4 25/32	121.4440
4 13/16	122.2380
4 27/32	123.0310
4 7/8	123.8250
4 29/32	124.6190
4 15/16	125.4120
4 31/32	126.2060
5 inches	127.0000

Inches	mm
5 1/32	127.794
5 1/16	128.588
5 3/32	129.381
5 1/8	130.175
5 5/32	130.969
5 3/16	131.762
5 7/32	132.556
5 1/4	133.350
5 9/32	134.144
5 5/16	134.938
5 11/32	135.731
5 3/8	136.525
5 13/32	137.319
5 7/16	138.112
5 15/32	138.906
5 1/2	139.700
5 17/32	140.494
5 9/16	141.288
5 19/32	142.081
5 5/8	142.875
5 21/32	143.669
5 11/16	144.462
5 23/32	145.256
5 3/4	146.050
5 25/32	146.844
5 13/16	147.638
5 27/32	148.431
5 7/8	149.225
5 29/32	150.019
5 15/16	150.812
5 31/32	151.606
6 inches	152.400

Inches	mm
6 1/16	153.988
6 1/8	155.575
6 3/16	157.162
6 1/4	158.750
6 5/16	160.338
6 3/8	161.925
6 7/16	163.512
6 1/2	165.100
6 9/16	166.688
6 5/8	168.275
6 11/16	169.862
6 3/4	171.450
6 13/16	173.038
6 7/8	174.625
6 15/16	176.212
7 inches	177.800
7 1/16	179.388
7 1/8	180.975
7 3/16	182.562
7 1/4	184.150
7 5/16	185.738
7 3/8	187.325
7 7/16	188.912
7 1/2	190.500
7 9/16	192.088
7 5/8	193.675
7 11/16	195.262
7 3/4	196.850
7 13/16	198.438
7 7/8	200.025
7 15/16	201.612
8 inches	203.200

Inches	mm
8 1/16	204.788
8 1/8	206.375
8 3/16	207.962
8 1/4	209.550
8 5/16	211.138
8 3/8	212.725
8 7/16	214.312
8 1/2	215.900
8 9/16	217.488
8 5/8	219.075
8 11/16	220.662
8 3/4	222.250
8 13/16	223.838
8 7/8	225.425
8 15/16	227.012
9 inches	228.600
9 1/16	230.188
9 1/8	231.775
9 3/16	233.362
9 1/4	234.950
9 5/16	236.538
9 3/8	238.125
9 7/16	239.712
9 1/2	241.300
9 9/16	242.888
9 5/8	244.475
9 11/16	246.062
9 3/4	247.650
9 13/16	249.238
9 7/8	250.825
9 15/16	252.412
10 inches	254.000

Inches	mm
10 1/16	255.588
10 1/8	257.175
10 3/16	258.762
10 1/4	260.350
10 5/16	261.938
10 3/8	263.525
10 7/16	265.112
10 1/2	266.700
10 9/16	268.288
10 5/8	269.875
10 11/16	271.462
10 3/4	273.050
10 13/16	274.638
10 7/8	276.225
10 15/16	277.812
11 inches	279.400
11 1/16	280.988
11 1/8	282.575
11 3/16	284.162
11 1/4	285.750
11 5/16	287.338
11 3/8	288.925
11 7/16	290.512
11 1/2	292.100
11 9/16	293.688
11 5/8	295.275
11 11/16	296.862
11 3/4	298.450
11 13/16	300.038
11 7/8	301.625
11 15/16	303.212
12 inches	304.800

Linear conversion tables imperial - metric continued

ft/Inches		mm
1	1	330.200
1	2	355.600
1	3	381.000
1	4	406.400
1	5	431.800
1	6	457.200
1	7	482.600
1	8	508.000
1	9	533.400
1	10	558.800
1	11	584.200
2		609.600
2	1	635.000
2	2	660.400
2	3	685.800
2	4	711.200
2	5	736.600
2	6	762.000
2	7	787.400
2	8	812.800
2	9	838.200
2	10	863.600
2	11	889.000
3		914.400

ft/Inches		mm
3	1	939.800
3	2	965.200
3	3	990.600
3	4	1016.00
3	5	1041.40
3	6	1066.80
3	7	1092.20
3	8	1117.60
3	9	1143.00
3	10	1168.40
3	11	1193.80
4		1219.20
4	1	1244.60
4	2	1270.00
4	3	1295.40
4	4	1320.80
4	5	1346.20
4	6	1371.60
4	7	1397.00
4	8	1422.40
4	9	1447.80
4	10	1473.20
4	11	1498.60
5		1524.00

ft/Inches		mm
5	1	1549.40
5	2	1574.80
5	3	1600.20
5	4	1625.60
5	5	1651.00
5	6	1676.40
5	7	1701.80
5	8	1727.20
5	9	1752.60
5	10	1778.00
5	11	1803.40
6		1828.80
6	1	1854.20
6	2	1879.60
6	3	1905.00
6	4	1930.40
6	5	1955.80
6	6	1981.20
6	7	2006.60
6	8	2032.00
6	9	2057.40
6	10	2082.80
6	11	2108.20
7		2133.60

ft/Inches		mm
7	1	2159.00
7	2	2184.40
7	3	2209.80
7	4	2235.20
7	5	2260.60
7	6	2286.00
7	7	2311.40
7	8	2336.80
7	9	2362.20
7	10	2387.60
7	11	2413.00
8		2438.40
8	1	2463.80
8	2	2489.20
8	3	2514.60
8	4	2540.00
8	5	2565.40
8	6	2590.80
8	7	2616.20
8	8	2641.60
8	9	2667.00
8	10	2692.40
8	11	2717.80
9		2743.20

ft/Inches		mm
9	1	2768.60
9	2	2794.00
9	3	2819.40
9	4	2844.80
9	5	2870.20
9	6	2895.60
9	7	2921.00
9	8	2946.40
9	9	2971.80
9	10	2997.20
9	11	3022.60
10		3048.00

Linear conversion tables imperial - metric continued

Feet	mm
11	3352.80
12	3657.60
13	3962.40
14	4267.20
15	4572.00
16	4876.80
17	5181.60
18	5486.40
19	5791.20
20	6096.00

Feet	mm
21	6400.80
22	6705.60
23	7010.40
24	7315.20
25	7620.00
26	7924.80
27	8229.60
28	8534.40
29	8839.20
30	9144.00

Feet	mm
31	9448.80
32	9753.60
33	10,058.4
34	10,363.2
35	10,668.0
36	10,972.8
37	11,277.6
38	11,582.4
39	11,887.2
40	12,192.0

Feet	mm
41	12,496.8
42	12,801.6
43	13,106.4
44	13,411.2
45	13,716.0
46	14,020.8
47	14,325.6
48	14,630.4
49	14,935.2
50	15,420.0

Feet	mm
51	15,544.8
52	15,849.6
53	16,154.4
54	16,459.2
55	16,764.0
56	17,068.8
57	17,373.6
58	17,678.4
59	17,983.2
60	18,288.0

Feet	mm
61	18,592.8
62	18,897.6
63	19,202.4
64	19,507.2
65	19,812.0
66	20,116.8
67	20,421.6
68	20,726.4
69	21,031.2
70	21,336.0

Feet	mm
71	21,640.8
72	21,945.6
73	22,250.4
74	22,555.2
75	22,860.0
76	23,164.8
77	23,469.6
78	23,774.4
79	24,079.2
80	24,384.0

Feet	mm
81	24,688.8
82	24,993.6
83	25,298.4
84	25,603.2
85	25,908.0
86	26,212.8
87	26,517.6
88	26,822.4
89	27,127.2
90	27,432.0

Feet	mm
91	27,736.8
92	28,041.6
93	28,346.4
94	28,651.2
95	28,956.0
96	29,260.8
97	29,565.6
98	29,870.4
99	30,175.2
100	30,480.0

Extrusion terminology

Definitions

Standard Shape is an item that is available to all customers

Exclusive Shape is an item that is manufactured to the design of a client – it is not published and is retained for the client's exclusive use.

Standard is term applied to those alloys, tempers, dimensions and services which are always available and can be accepted for production without further reference.

Non-Standard is term applied to those alloys, tempers, dimensions and services which are outside normal availability and must always be the subject of special inquiry.

Section Drawings are prepared for every extruded shape that is manufactured by Altus.

Visible Face is the surface of the shape which is exposed to view and so nominated by the client.

Perimeter is the distance around the periphery of the extruded shapes (both internal and external surfaces).

External Perimeter is used in computing the price for surface finishes on hollow shapes in which the external perimeter only is measured, and the internal void excluded.

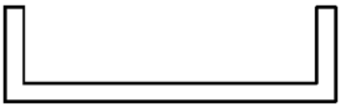
Factor is calculated by dividing the total perimeter (internal and external for hollow shapes) of the section in millimetres by the weight in kg/metre.

Circumscribing Circle is the minimum circle inside which the extruded shape will fit precisely.

Shape definitions

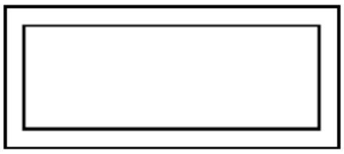
Solid shape

An extruded shape whose geometry does not form a void and which is long in relation



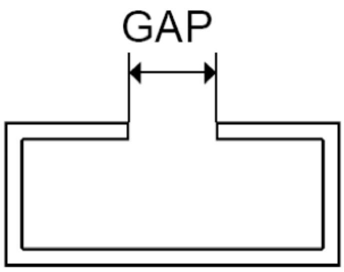
Hollow shape

A single void totally enclosed extruded shape with a width to depth ratio of not less than 5:1. Wall thickness should be uniform (except for radiused corners).

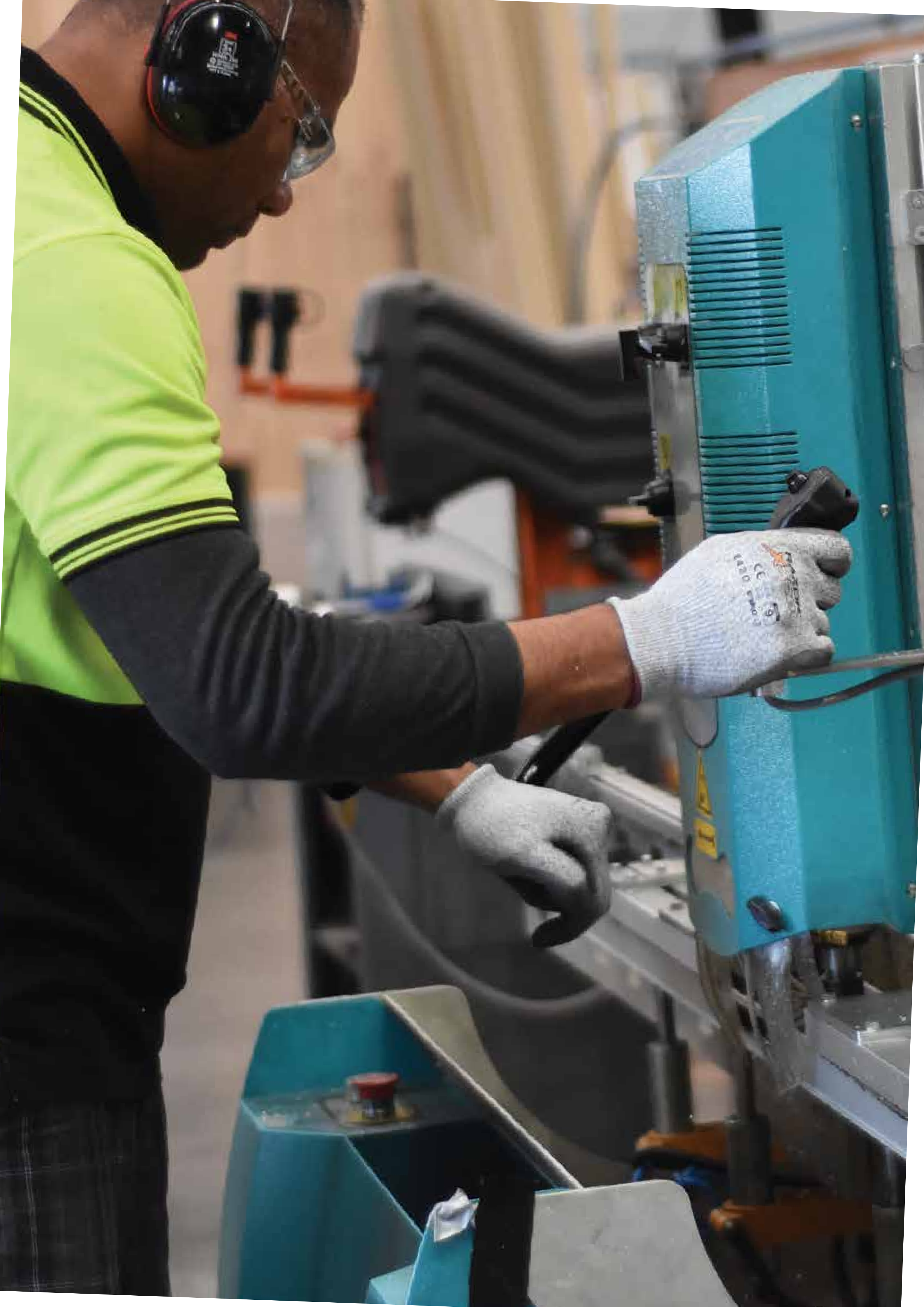


Semi-Hollow shapes

A solid shape with a cross-section that partially encloses a void and in which the area of the void is substantially greater than the square of the width of the gap, otherwise classified as a hollow.



Gap Dimensions (G) (mm)		Ratio Area/Gap squared over which a shape is classified as a Hollow
Over	Up to	
6		4
3	6	3
1.5	3	2.5
	1.5	2



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