

The Referee

2 8 T H E D I T I O N

A HANDBOOK OF USEFUL INFORMATION

WITH COMPLIMENTS

Lysaght

BUILDING INDUSTRIES

The Referee

2 8 T H E D I T I O N

A HANDBOOK OF USEFUL INFORMATION

The Referee

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DECEMBER 1988

Produced by

Coated Products Division



BHP
Steel

Central Office

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GPO Box 196, Sydney, NSW 2001

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FOREWORD

The Referee has been in continuous publication since 1897 when a large part of the output of the English rolling mills of John Lysaght was destined for Australia.

BHP Steel's Coated Products Division is proud to continue publication of this book founded by the organisation responsible for the building materials used in much of both early and modern Australia. This organisation, now part of Australia's own steel manufacturing company, is also responsible for the production of the steel sheet used to make so many of the necessities and luxuries we enjoy today.

The strength of this publication has been its range of content. It has become a valuable source of much varied information for engineers, businessmen, farmers, handymen and the householder.

This handbook is supplied free of charge by the Company and it is hoped it will continue to be as useful as we know previous issues have been.

Some of the information in this edition has been provided by recognised authorities and while great care has been taken to ensure accuracy, no responsibility can be accepted for any errors which may have escaped the attention of the editors.

**COATED PRODUCTS DIVISION
BHP STEEL
55 SUSSEX STREET, SYDNEY**

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BUILDING AUSTRALIA AND THE WORLD

BHP Steel's Coated Product Division is recognised as a world leader in steel sheet production and technology. The story of the Division, originally operating as John Lysaght (Australia) Limited, started in England when that country, as the leader of the industrial revolution, was pioneering new ways of making and using iron and steel.

In 1857 a young Irishman, John Lysaght, acquired a small business at Bristol making galvanized buckets. He immediately turned his attention to galvanizing and corrugating of sheet iron and later, steel.

Later he began exporting galvanized iron and steel for the booming building and rural markets in Australia. It was on this trade the fledgling company grew and prospered.

The high strength to mass ratio of galvanized corrugated steel sheet, its ease of transport and the protection of the steel base provided by the zinc coating against the elements made the product ideal for building in Australia. By 1900 Australia used three-quarters of the total output of this English company's corrugated steel.

In 1921, manufacture began in Australia with rolling and galvanizing of steel sheet in Newcastle using sheet bar feed from the recently completed nearby BHP mills. This started a long and mutually supporting relationship between the two companies.

Since that time the steel sheet industry has undergone a steady process of expansion.

In the mid 1930's Lysaght started its second works at Port Kembla, NSW, utilising AIS (BHP) feed. Post-war demand for its products, however, soon indicated a need for a major improvement in output and technique.

With the installation of a four-stand cold reduction mill, later enlarged to five stands, capacity was lifted to one million tonnes of steel coil per annum by the early 1970's. In addition, three continuous galvanizing lines, commissioned in the 1960's made Port Kembla one of the largest galvanizing works in the world.

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The company acquired full ownership of the Commonwealth Rolling Mills in 1946 by purchasing Armco's 51 per cent interest. The CRM Works is still the location for producing electrical steel, some of the Division's COLORBOND prepainted steel sheet and other specialised product.

BHP became joint owners of John Lysaght (Australia) Limited in 1970 with Guest, Keen and Nettlefold's, the owners since 1920. BHP acquired GKN's share in 1979.

A continuing expansion of its market saw the opening in 1972/3 of a new cold strip plant at Western Port, Victoria. Manufacturing equipment, including a five-stand wide cold strip mill, 1500 mm galvanizing and strip painting lines provided increased capacity for present and future home and export markets.

In 1978, a five-stand hot strip mill commenced operations at Western Port. This mill attracted great overseas interest because of the incorporation of the world's first operational coil box which conserved heat in the transfer bar. The installation of the coil box has meant a much shorter mill than is the case with older style mills, two fewer finishing stands than would otherwise be needed and substantial economies in the use of power and cooling services.

In 1976 the company introduced a new product, ZINCALUME zinc/aluminium alloy-coated steel sheet, which was to have a dramatic effect on its traditional markets. The alloy imparts greater protection than the traditional zinc coating on galvanized steel.

Lysaght expanded further when, in 1984, Comsteel's Stainless Steel Flat Products at Unanderra near Port Kembla became a subsidiary. It now operates as Stainless Products.

After the BHP re-organisation in 1985, John Lysaght (Australia) Limited became the Coated Products Division of BHP Steel. This division incorporates all aspects of the old company with the sheet manufacturing business operating as Sheet & Coil Products.

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SHEET & COIL PRODUCTS

Sheet & Coil Products (S&CP), Australia's producer and supplier of flat steel sheet and coil, is the biggest of the business units in the Coated Products Division.

S&CP is a major link in a chain which begins at the company's mines and collieries and ends with the supply of high value steel products to Australian consumers.

S&CP is comprised of the sheet and coil manufacturing plants at Port Kembla, New South Wales, and Western Port, Victoria, an electrical steel lamination and pressing plant at Newcastle, New South Wales and a network of State Sales Offices and Service Centres in all state capital cities. Linked to the Works by a dedicated computer network, the service centres provide a service for slitting and shearing as well as maintaining steel stocks on behalf of customers and giving a fast delivery service on urgent items.

S&CP manufacture and market a wide range of sheet and strip materials covering hot and cold rolled uncoated (including electrical steels), hot-dipped zinc-coated, zinc/aluminium alloy-coated and terne-coated, electrolytic zinc-coated, prepainted and PVC laminated steel sheet and strip.

MANUFACTURING PLANTS

Port Kembla, New South Wales

Springhill Works

Springhill Road, Wollongong
PO Box 77, Port Kembla 2505

CRM Works

Port Kembla Road, Port Kembla
PO Box 77, Port Kembla 2505

Western Port, Victoria

Western Port Works

Bayview Road, Hastings
Private Bag 1, Hastings 3915

Newcastle, New South Wales

Sankey

Ingall Street, Mayfield
PO Box 589, Newcastle 2300

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STATE OFFICES AND SERVICE CENTRES

Sydney, New South Wales

Anzac Street, Chullora
PO Box 144, Greenacre 2190
Ph: (02) 708 8888

Melbourne, Victoria

492 St Kilda Road, Melbourne
PO Box 6302, St Kilda Road Central 3004
Ph: (03) 268 7777

Adelaide, South Australia

69 Wingfield Road, Wingfield
PO Box 59, Rosewater East 5013
Ph: (08) 243 7333

Brisbane, Queensland

Lysaght Street, Acacia Ridge
PO Box 7, Sunnybank 4109
Ph: (07) 345 0555

Perth, Western Australia

Cnr Norma Road & McCoy Street, Myaree
PO Box 46, Applecross 6153
Ph: (09) 330 0666

Hobart, Tasmania

97a Grove Road, Glenorchy
PO Box 164, Glenorchy 7010
Ph: (002) 72 6616

Darwin, Northern Territory

Cnr Coonawarra & Bombing Roads, Winnellie
PO Box 39466, Winnellie 0821
Ph (089) 84 3311

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STAINLESS

The production of stainless steel is a specialised task and is undertaken at the Unanderra Works of Stainless near Port Kembla.

Tubing is produced at another factory in the Sydney suburb of Revesby.

Stainless is Australia's only manufacturer of cold rolled stainless steel sheet, strip and plate and the leading manufacturer of welded and seamless stainless tube.

Stainless steel is produced in a wide range of standard grades, sizes and finishes to cover all normal requirements of the Australian market.

MANUFACTURING PLANTS

Port Kembla, New South Wales

Old Five Islands Road, Unanderra
PO Box 1739, Wollongong 2500

Sydney, New South Wales

31 Mavis Street, Revesby
PO Box 208, Revesby 2212
Ph: (02) 774 9699

LYSAGHT BUILDING INDUSTRIES

Lysaght Building Industries evolved from a merger, in 1971, of Lysaght and Brownbuilt, both manufacturers of cold roll-formed long length building products.

Lysaght Building Industries is Australia's biggest and most successful supplier of steel building and industrial products. At factories located in all capital cities and many major country centres, steel strip from S&CP is shaped by roll-forming machines into finished products used by the building and construction industry.

Lysaght Building Industries is the only unit of Coated Products Division to retain the original Lysaght name which is synonymous with high quality steel building products. These products are used in roof and wall cladding, structural decking, building frames, purlins and girts, rainwater goods, fencing – in fact, for anything from a single steel component to a complete building.

Also available are various meshes, gratings and grills for commercial and domestic use, from factory stair treads to an expanded metal security mesh for a screen door.

MANUFACTURING CENTRES

New South Wales

Sydney

6 Brunker Road, Chullora
PO Box 103, Greenacre 2190
Ph (02) 707 7000

Newcastle

Lot 206 Munibung Road, Cardiff 2285
Ph (049) 56 5044

Tamworth

6 Hargreave Street, Tamworth
PO W353 West Tamworth 2340
Ph (067) 65 4166

Dubbo

35 Cobbora Road, Dubbo 2830
Ph (068) 82 6922

Albury

533 Dallinger Road, Lavington
PO Box 42, Lavington 2641
Ph (060) 25 7377

Victoria

Melbourne

Norcal Road, Nunawading
PO Box 9, Nunawading 3131
Ph (03) 875 0444

Geelong

St George's Road, Norlane
PO Box 210, Corio 3214
Ph (052) 75 1269

Horsham

Hamilton Road, Horsham
PO Box 738, Horsham 3400
Ph (053) 82 5444

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Traralgon

Rocla Road, Traralgon
PO Box 533, Traralgon 3844
Ph (051) 74 3233

Bendigo

Howard Street, Epsom 3551
Ph (054) 48 4600

Portland

Darts Road, Portland
Box 779, Portland 3305
Ph (055) 23 4444

Queensland

Brisbane

Lysaght Street, Acacia Ridge
PO Box 7, Sunnybank 4109
Ph (07) 345 0444

Townsville

592 Ingham Road, Townsville
PO Box 185, Garbutt 4814
Ph (077) 74 5200

North Rockhampton

10 Duck Street, North Rockhampton
PO Box 6211, Rockhampton Mail Centre 4702
Ph (079) 27 1255

Cairns

310 Spence Street, Bungalow
PO Box 1745, Bungalow 4870
Ph (070) 51 6433

Mackay

Presto Avenue, Outer Harbour, Mackay
PO Box 173, North Mackay 4740
Ph (079) 55 3355

Toowoomba

196 Margaret Street, Toowoomba
PO Box 5565, Toowoomba 4350
Ph (076) 38 2455

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South Australia

Adelaide

Cnr Eastern Parade and Bedford Street, Gillman
PO Box 69, Rosewater East 5013
Ph (08) 47 9666

Western Australia

Perth

Cnr Norma Road and McCoy Street, Myaree
PO Box 46, Applecross 6153
Ph (09) 330 0666

Tasmania

Hobart

97a Grove Road, Glenorchy
PO Box 164, Glenorchy 7010
Ph (002) 72 6616

Devonport

Off Kelcey Tier Road, Spreyton
PO Box 593, Devonport 7310
Ph (004) 27 2231

Northern Territory

Darwin

Cnr Coonawarra and Bombing Roads, Winnellie
PO Box 39466, Winnellie 0821
Ph (089) 84 3311

Alice Springs

Cnr Power and Cameron Streets, Alice Springs
PO Box 2558, Alice Springs 0871
Ph (089) 52 4555

Australian Capital Territory

Canberra

88 Townsville Street, Fyshwick
PO Box 268, Fyshwick 2609
Ph (062) 80 6354

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INTERNATIONAL BUSINESS

Coated Products Division has a world wide reputation for the high quality of its products, and for its technology, administration and marketing expertise.

This reputation is enhanced by the overseas operations of International Business which controls a large network of factories manufacturing building products from Australian steel. These factories operate through subsidiaries or joint partnerships with local participants in eleven countries from South-East Asia and the Pacific Basin to the United States of America.

International Business is also responsible for Coated Product Division's worldwide intellectual property licencing activity through BIEC International Inc, based in the heartland of the US steel industry in Pennsylvania, and John Lysaght International Holdings SA.

The international marketing success of ZINCALUME steel was achieved by Australian-American teamwork and the process has been licenced to more than 21 major steel companies in 16 countries.

Reduced scale galvanizing lines are another Australian success story. These lines, a Coated Products Division invention, are revolutionising steel processing in new industrialised countries, where they are meeting an urgent need for low volume, low cost, high quality building materials.

INTERNATIONAL INVESTMENTS

Fiji

John Lysaght (South Pacific) Ltd
Lakemba Street, Samabula, Suva
Ph 38 2388

Hong Kong

John Lysaght International Holdings SA
John Lysaght Hong Kong Limited
16th Fl, Wang Kee Building, Connaught Road, Hong Kong Central
Ph 24 7131

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Indonesia

PT BRC-Lysaght Indonesia
Jalan Rawaterate I No 1,
Pulogadung Industrial Estate,
Jakarta Timur
Ph 48 90795

Malaysia

John Lysaght (Malaysia) Sdn Bhd
16/9 Jalan Gudang,
Shah Alam Industrial Estate,
Selangor
Ph 59 2000

John Lysaght (Sabah) Sdn Bhd
Km 9, Jalan Ruaran,
Likas Industrial Estate,
Kota Kinabalu, Sabah
Ph 31 2616

Lysaght Sarawak Sdn Bhd
Lot 610, Section 66, Pending Industrial Area,
Kuching, Sarawak
Ph 33 3621

New Caledonia/Vanuatu

Sicotec
Perimetre Ducos,
Baie De Numbo, Noumea
Ph 28 2944

Papua New Guinea

John Lysaght (Papua New Guinea) Pty Limited
Montora Street, Lae

John Lysaght (Rabaul) Pty Ltd
Malaguna Road, Road, Rabaul
Ph 92 1044

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RMI Holdings Pty Ltd
New Britain Quarries Pty Ltd
Rabaul Masonry Brick Pty Ltd
Ferrocement Pty Ltd
Lot 8, Section 128, Rabaul
Ph 92 1627

Philippines

Philippine Steel Coating Corporation
Ground Floor, New Solid Building,
357 Buendia Avenue Extension,
Makati, Metro Manila
Ph 89 8586

Singapore

John Lysaght (SEA) Pte Ltd
18 Benoi Sector, Surong, Singapore 2262
Ph 26 41577

John Lysaght Singapore Pte Ltd
9th Fl, The Arcade, 11 Colyer Quay,
Singapore 0104
Ph 22 04622

Lysams Pte Ltd
C/- CAH, 583 Orchard Road No 09-04
Forum Galleria, Singapore 0923
Ph 73 46191

Taiwan

Lysaght Taiwan Limited
Room 401, Lotus Building
136 Jen-Ai Road, Section 3, Taipei

Thailand

Lysaght (Thailand) Ltd
279/2 Soi Thongpoon-U-Tis, Paholyothin Road
Km 33, Patumtani, 12130
Ph 51 68402

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United States of America

ASC Pacific, Inc
2110 Enterprise Boulevard, West Sacramento
California CA 95691
Ph 37 26851

BIEC International, Inc
Park Plaza, 3400 Bath Pike, Bethlehem PA 18017
Ph 69 42432

EXPORT

Sheet & Coil Products has always been an exporter of some consequence but increased manufacturing capacity since the commissioning of Western Port Works has led to a capability to satisfy a significant export market.

The combined S&CP plants are geared to the production of quality products such as zinc-coated, ZINCALUME and COLORBOND steels to satisfy this highly esteemed and important export business. Much of the market is supplied through subsidiaries organised by International Business.

S&CP is also a significant exporter of technology, based on the considerable experience of personnel who are leaders in their field of many aspects of steel sheet and coil production.

Export of S&CP steels is organised by BHP Trading Services Division, Melbourne.

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TRADE MARKS

With its origin dating back well over a century it is understandable that the Coated Products Division has manufactured and marketed countless flat and formed sheet steel products. These products have been identified by various trade marks and devices (logos) familiar in many parts of the world.

Perhaps one of the best known trade marks would be the Orb series. A great deal of interest has been indicated by independent researchers tracing the early history of 'corrugated iron' in colonial and later days, and it is significant that trade marks, still identifiable on very old sheets, have been the means of determining where and when the sheet was made.

The following list is by no means complete but shows some of the trade marks familiar to steel users in Australia, and likely to be mentioned in The Referee. The formed product trade marks are mainly associated with Lysaght Building Industries.

FLAT PRODUCTS

ZINCALUME	ZINCSEAL	COLORBOND	AQUAPLATE
ZINC-HI-TEN	ZINCANNEAL	MARVIPLATE	ACOUSTEEL
ZINCFORM	LY-CORE	COOLCLAD	GALVASPAN
GALVABOND	SANKORE		

FORMED PRODUCTS

Cladding, Guttering and Fencing

CUSTOM ORB	V-CRIMP	KLIP-LOK HI-TEN
CUSTOM BLUE ORB	V-CRIMP HI-TEN	PANELRIB
ZINCALUME CUSTOM BLUE ORB	WALL-CLAD	STYLE-DEK
BROWNBUILT 305 & 406	MINI-ORB	TRIM-WALL
SHEERLINE	EASYCLAD	TRIMLINE
SPANDEK HI-TEN	TRIMDEK HI-TEN	NEETASCREEN
	STREAMLINE	

Structural and Industrial

BONDEK	INTERLOK	HOOK-LOK	REDI-ZED
TRI-LOK	LYTGAL	BIG ZED	SPANHEAD

Expanded Metals

ORNAMESH	METALATH
GRINDMESH	MULTIMESH

Other

CUSTOMTEX
EZYFRAME

Sheet & Coil Products



SHEET & COIL PRODUCTS PREFERRED STEEL SHEET DIMENSIONS PREFERRED THICKNESS – millimetres

AS 2338		Sheet & Coil Products
First Choice	Second Choice	Third Choice
0.25		
0.30	0.28	
	0.35	0.32
0.40		0.38
	0.45	0.42
0.50		0.48
0.60	0.55	
	0.70	0.65
0.80		0.75
	0.90	0.85
1.0		0.95
1.2	1.1	
	1.4	1.3
1.6		1.5
	1.8	1.7
2.0		1.9
2.5	2.2	
3.0	2.8	
		3.2

PREFERRED WIDTHS AND LENGTHS

First preference	Second preference
Increments of 100 mm	Increments of 5 mm

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Width and length increments less than 5 mm are subject to special negotiation.

Stock products are produced to selected first preference widths and lengths, second preferences being available to meet the needs of manufacturers.

COATINGS ON STEEL SHEET

Coatings have been successfully applied to steel sheet for well over a century, the main purpose being to protect the steel against its natural tendency to form oxides of iron. Sometimes the purpose is to provide decoration but frequently both protection and decoration are required.

Steel coating technology has progressed to keep pace with, or ahead of, changing atmospheric environments in cities, industrial areas, etc., particularly where claddings for buildings are concerned.

Selection of the appropriate coated steel to suit conditions is important. For example, coating needs for rural or non-aggressive inland locations differ from those required for marine and industrial environments. Some useful information is included under the heading Atmospheric Exposure Conditions.

In general terms the coated steels produced on continuous coil coating lines by Sheet & Coil Products (S&CP) are:

- Hot-dip zinc-coated and zinc/aluminium alloy-coated (AS 1397)
- Electrolytic zinc-coated (AS 2551)
- Hot-dip lead/tin-coated (AS 2552)
- Paint coated (AS 2728)
- Organic film laminated (AS 2728)

Hot-dip zinc-coated products include GALVABOND (ductile-coated products), ZINCFORM (structural) and ZINC-HI-TEN (high strength) steels in various coating classes and finishes. ZINCANNEAL steel, a ductile product, has a surface modified in production by a post galvanizing heat treatment.

Hot-dip zinc/aluminium alloy-coated sheet is ZINCALUME steel in structural and high strength grades in two coating classes.

Electrolytic zinc-coated sheet is ZINCSEAL steel in ductile grades.

Paint coated products are the many variations of COLORBOND steel. COLORBOND has a ZINCALUME steel base for exterior applications. For interior use the base may be GALVABOND, ZINCSEAL or uncoated cold rolled steel in ductile grades.

Organic film laminated quality MARVIPLATE steel. For exterior use organic films are laminated to galvanized steel. MARVIPLATE steel for interior use has an electro-galvanized steel base in ductile grades.

HOT-DIP ZINC-COATED AND ZINC/ALUMINIUM ALLOY-COATED STEEL SHEET: AS 1397

Hot-dipped zinc-coated and zinc/aluminium alloy-coated steels are manufactured to AS 1397. Where no appropriate Australian standard exists steel is produced in accordance with the principles embodied in the standards.

Designations (AS 1397)

In AS 1397, continuously galvanized steel and hot-dip zinc/aluminium coated steels are signified by the first character in the designation, G.

Formable products are identified by a second character (1,2 or 3) to indicate progressively better formability:

- 1 = Profiling
- 2 = Commercial forming
- 3 = Drawing

For **structural products** a three-digit number is used to represent the minimum yield strength in megapascals, viz 550, 500, 450, 350, 250.

Coating Classes (AS 1397)

AS 1397 coating classes are designated by the prefix letter Z, ZF or AZ, as appropriate, followed by a three-digit number representing the minimum coating mass as determined by the triple spot test defined in AS 1397. Coating classes listed are:

Zinc		Zinc/Iron Alloy	Aluminium/Zinc alloy
Z100	Z450	ZF100	AZ150
Z275	Z600		AZ200
Z350			

SHEET & COIL PRODUCTS (S&CP) DUCTILE STEEL GRADES

GALVABOND G2, G3 (AS 1397)

GALVABOND steel is a general purpose zinc-coated flat sheet and is the most widely used of zinc-coated products. It is suitable for a broad range of applications demanding a high standard of formability, coating adhesion and resistance to corrosion. Several optional coating classes

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and finishes, and two steel base grades are available to suit specific applications.

GALVABOND base grade G2 with regular coating class Z275 will permit severe forming (including lock-forming) and many drawing operations. For the more critical drawing or spinning operations base grade G3 with coating class Z200 (for internal applications) is manufactured.

Coatings heavier than coating class Z275, while giving excellent protection against corrosive conditions, are not guaranteed for close forming. In Z450 coating class, if resistance to fluting is of prime importance, GALVABOND G1 should be specified (not guaranteed for lock-forming).

The coating, with its characteristic spangled pattern, has excellent adherence and will permit a wide range of forming operations without peeling or flaking. Soldering and welding, if carried out according to recommended practices, present no difficulties.

To achieve satisfactory paint adhesion, pretreatment or priming is required. Recommendations are given under Painting (see index) and in the Technical Information booklet "Painting", available from any S&CP State Office. Where higher standards of paint finish are required, alternative products are available.

Typical Applications

GALVABOND steel is recommended for:

Meter boxes	Containers
Motor housings	Garage doors
Ducting	Garbage cans
Cable Trays	Poultry feeding equipment
Expanded metal	

ZINCANNEAL G2 (AS 1397)

Modification by a post galvanizing heat treatment, which converts the coating into a zinc/iron alloy, gives ZINCANNEAL steel its distinctive smooth grey surface with a complete absence of spangle appearance. The coating, which possesses good adherence to the steel base, provides a corrosion-resistant surface produced for painting directly with high quality finishes without any additional surface treatment such as priming, except for severe external conditions where etch priming is recommended for optimum performance. ZINCANNEAL steel must be painted for external applications.

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The mechanical properties of the base are such that ZINCANNEAL steel permits many bending and forming operations, but as the zinc/iron alloy coating has only limited ductility, powdering may occur if the deformation becomes excessive.

ZINCANNEAL steel presents no difficulties in welding. It can be readily soldered, but attention must be paid to the use of recommended fluxing techniques.

Typical Applications

ZINCANNEAL steel is recommended for:

Signs	Commercial refrigerators & freezers
Number plates	Van & bus doors
Door frames	Louvres

S&CP STRUCTURAL STEEL GRADES

ZINCFORM G250, G300 (AS 1397)

ZINCFORM steel is produced to meet the minimum strength requirements of AS 1397 base grades G250 and G300. It has been specially developed for structural applications, particularly roll-formed sections and is available in a variety of coating classes to suit particular end uses. ZINCFORM is not suitable for applications where fluting is critical (eg, Rima machines) or for severe drawing, pressing or lock-forming.

ZINCFORM steel has a bright, relatively smooth appearance with a full spangle surface pattern. It has very good corrosion resistance and may be readily soldered, welded or painted. Pretreatment or priming is necessary to promote paint adhesion.

Typical Applications

ZINCFORM steel is recommended for:

Z200	Building section – studs, plates, wall
(Internal applications only)	frames, purlins – Ceiling hangers – Fittings –
Z275	General roll-formed sections
Z450	General roll-forming – Purlins
Z600	Rain-water goods and accessories
	Corrugated tank walls – General items exposed to severe corrosion

ZINCALUME G300 (AS 1397)

ZINCALUME steel provides significantly improved corrosion resistance. It is produced to meet the minimum strength requirements of AS 1397 base grade G300 and is suitable for roll-forming and bending.

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All materials (except lead) that can be used in contact with traditional zinc-coated steel can be used in contact with ZINCALUME steel in the field. Economical joining and sealing systems using silicone rubber sealants are described under Sealants.

Typical Applications

ZINCALUME G300 is recommended for:

Coating Class

- | | |
|-------|---|
| AZ150 | General roll-forming – Roof decking – Gutters and down-pipes – Ridge capping and valleys – Rain-water goods and accessories – Vertical walling – Fencing systems – House frames – Refrigerator and stove rear panels – Air conditioning panels (NOT DUCTWORK) |
| AZ200 | Near marine and industrial conditions |

HIGH STRENGTH STEEL GRADES

ZINC-HI-TEN G450, G500, G550 (AS 1397)

ZINC-HI-TEN steel is a flat zinc-coated product produced to meet the minimum strength requirements of AS 1397 base grades G450, G500 and G550, and a specific market demand for high strength zinc-coated steel sheet with very good corrosion resistance. Careful design will often make it possible to achieve savings in costs by allowing the substitution of thinner ZINC-HI-TEN sheet for thicker sheet otherwise required in other qualities. In some cases modifications to the profile may be necessary to compensate for any loss of rigidity under load resulting from this reduction in sheet thickness.

Although not intended for the same wide range of applications as GALVABOND, ZINC-HI-TEN has been used successfully in many roll-forming and bending operations.

ZINC-HI-TEN steel is readily formable on a press brake or other equipment in common use for cold forming operations. Only slightly higher forming pressures are required to produce a permanent set since the lighter ZINC-HI-TEN is usually used without any loss of structural strength. The technique of forming ZINC-HI-TEN consists mainly in making provision for more liberal radii of bends, for slightly increased die clearances, and for more springback.

The Referee

ZINC-HI-TEN steel may be soldered, welded and painted provided recommended procedures are followed. In welding, allowances should be made for the loss of strength in the area of the weld where the mechanical properties will revert to those of ZINCFORM steel. Priming or pretreatment is necessary before painting to achieve satisfactory adhesion.

Typical Applications

ZINC-HI-TEN steel is recommended for:

Coating Class

Z200	Internal structural sections – Structural decking – Concrete formwork
Z275	Fence droppers – Purlins – Tubing
Z600	General Items exposed to severe corrosion conditions

ZINCALUME G550 (AS 1397)

ZINCALUME steel provides significantly improved corrosion resistance. It is produced to meet the minimum strength requirements of AS 1397 base grade G550.

The same general comments apply to ZINCALUME steels as for ZINC-HI-TEN equivalent products. Two notable differences are that (a) priming or pretreatment are usually not necessary before painting and (b) ZINCALUME steel Does not readily solder – use sealants instead.

All materials (except lead) that can be used in contact with traditional zinc-coated steel can be used in contact with ZINCALUME steel. Do not use lead.

Typical Applications

ZINCALUME steel is recommended for:

Coating Class

AZ150	Fence droppers – Vertical walling – Painted roof and wall cladding – Fencing systems – Roof and wall cladding – House lockers – Mufflers – Heat shields and reflectors – Toasters – Ovens – Meter boxes – Swimming pool components
AZ200	For severe corrosion conditions

The Referee

DIMENSIONS OF HOT-DIP ZINC-COATED AND ZINC/ALUMINIUM ALLOY-COATED FLAT STEEL SHEET – Typical only

Most products are available as both sheet and strip. Typical dimensions are shown for regularly produced product but other thickness/width/length combinations are available subject to enquiry.

Maximum sheet length 4880 m.

Grade	ZINC-COATED		ZINC/ALUMINIUM-COATED	
	Typical thickness, mm	Maximum width, mm	Typical thickness, mm	Maximum width, mm
Formable				
Commercial	0.25-3.2	1525	—	—
Deep drawing	0.40-3.2	1525	—	—
Structural				
G250	1.0 -3.2	1350	0.30-1.2	1245
G300	0.25-3.2	1525		
High strength				
G450	1.5 -3.2	1350	—	—
G500	1.1 -1.4	1350	—	—
G550	0.35-1.0	1300	0.30-0.80	1245

A GENERAL GUIDE TO COMPARATIVE FEATURES — AS 1397 HOT-DIP PROCESS STEEL SHEET QUALITIES

Coating classes in **bold type** are normally supplied, others are optional.

CHARACTERISTICS	DUCTILE GRADES			STRUCTURAL GRADES		HIGH STRENGTH GRADES	
	GALVABOND G2	GALVABOND G3	ZINCANNEAL G2	ZINCFORM G250, G300	ZINCALUME G300	ZINC-HI-TEN G450, G500, G550	ZINCALUME G550
Main feature	General purpose	General purpose drawing	Direct-on paintability	Guaranteed strength	Long life. Guaranteed strength	High strength	Long life. High strength
Coating type	Zinc	Zinc	Zinc/iron alloy	Zinc	Zinc/aluminium alloy	Zinc	Zinc/aluminium alloy
Coating class	Z275 Z200	Z275 Z100 Z200 Z350	ZF100	Z275 Z200 Z350 Z450 Z600	AZ150 AZ200	G450- Z275 Z100 Z200 Z350 G500- Z275 Z200 Z350 G550- Z450 Z200 Z275 Z350 Z600	AZ150 AZ200
Surface finish and options	Spangled Colorbond Marvplate	Spangled Colorbond Marvplate	Smooth matt	Spangled Colorbond Marvplate	Spangled Colorbond	Spangled Colorbond Marvplate	Spangled Colorbond

The Referee

Paintability	Pretreatment required	Pretreatment required	Direct-on	Pretreatment required	Direct-on for water-based 100% acrylic, pretreatment for other paints	Pretreatment required	Direct-on for water-based 100% acrylic, pretreatment for other paints
Roll-forming	Excellent	Excellent	Excellent	Excellent	Excellent	G450 — Very Good G500, G550 — Good	Restricted
Bending	Excellent	Excellent	Excellent	Excellent	Excellent	G450 — good G500 — Moderate G550 — Limited	Restricted
Pressing	Good	Very good	Good	Restricted	Limited	Not recommended	Not recommended
Drawing	Good	Good	Good	Good	Moderate	Not recommended	Not recommended
Lock-forming	Excellent	Excellent	Excellent	Not recommended	Not recommended	Not suitable	Not suitable
Soldering	Excellent	Excellent	Excellent	Excellent	Not suitable - use sealant	Excellent	Not suitable use sealant
Welding	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent

ZINC-COATED AND ALUMINIUM/ZINC-COATED STEEL FLAT QUALITIES — AS 1397

APPROXIMATE MASS PER SHEET IN KILOGRAMS, AND SHEET COUNT PER NOMINAL TONNE
For Zinc Coating Class Z275 and Aluminium/Zinc Coating Class AZ150

Preferred thickness, mm	Preferred length, mm	Zinc Coating Class Z275						Aluminium/Zinc Coating Class AZ150			
		Preferred width, mm									
		900		1200		1500		900		1200	
		Sheet mass	Sheet count	Sheet mass	Sheet count	Sheet mass	Sheet count	Sheet mass	Sheet count	Sheet mass	Sheet count
0.30	1800	4.285	233								
0.40		5.557	180	7.409	135						
0.50		6.828	146	9.104	110						
0.60		8.100	123	10.800	93						
0.80		10.643	94	14.191	70						
1.0		13.187	76	17.582	57						
1.2		15.730	64	20.974	48						
1.6		20.817	48	27.756	36						
2.0		25.904	39	34.538	29						
2.5		32.262	31	43.016	23						
3.0		38.621	26	51.494	19						
0.30		5.713	175								
0.40		7.409	135	9.878	101			7.150	140	9.533	105
0.50		9.104	110	12.139	82			8.845	113	11.794	85
0.60		10.800	93	14.400	69			10.541	95	14.054	71

The Referee

0.80	2400	14.191	70	18.922	53			13.932	72	18.576	54
1.0		17.582	57	23.443	43			17.323	58	23.098	43
1.2		20.974	48	27.965	36			20.714	48	27.619	36
1.6		27.756	36	37.008	27			27.497	36	36.662	27
2.0		34.538	29	46.051	22						
2.5		43.016	23	57.355	17						
3.0		51.494	19	68.659	15						
0.30	3000	7.142	140								
0.40		9.261	108	12.348	81			8.937	112	11.916	84
0.50		11.381	88	15.174	66			11.056	90	14.742	68
0.60		13.500	74	18.000	56	22.500	44	13.176	76	17.568	57
0.80		17.739	56	23.652	42	29.565	34	17.415	57	23.220	43
1.0		21.978	46	29.304	34	36.630	27	21.654	46	28.872	35
1.2		26.217	38	34.956	29	43.695	23	25.893	39	34.524	29
1.6		34.695	29	46.260	22	57.825	17	34.371	29	45.828	22
2.0		43.173	23	57.564	17						
2.5		53.771	19	71.694	14						
3.0		64.368	16	85.824	12						
0.30	3600	8.570	117								
0.40		11.113	90	14.818	67			10.724	93	14.299	70
0.50		13.657	73	18.209	55			13.268	75	17.690	57
0.60		16.200	62	21.600	46	27.000	37	15.811	63	21.082	47
0.80		21.287	47	28.382	35	35.478	28	20.898	48	27.864	36
1.0		26.374	38	35.165	28	43.956	23	25.985	38	34.646	29
1.2		31.460	32	41.947	24	52.434	19	31.072	32	41.429	24
1.6		41.634	24	55.512	18	69.390	14	41.245	24	54.994	18
2.0		51.808	19	69.077	14						
2.5		64.525	15	86.033	12						
3.0		77.242	13	102.989	10						

The Referee

ELECTROLYTIC ZINC-COATED QUALITY STEEL SHEET: AS 2551

ZINCSEAL STEEL

ZINCSEAL steel is an electro-galvanized flat formable steel sheet quality conforming to AS 2551. It has a light zinc coating which provides resistance to corrosion during storage and fabricating operations without oiling. Characteristics of appropriate cold rolled steel bases are retained with added coating advantages of improved paintability, and the ability to form and draw to the limits of the steel base without loss of coating adhesion.

ZINCSEAL electrolytic galvanized steel is not a substitute for hot dipped zinc-coated steel in corrosive environments or external use.

A phosphate coating applied to ZINCSEAL steel during processing permits direct-on application of high gloss paint finishes without priming. For exterior applications a corrosion-inhibitive primer (etch primer) must be used to upgrade the paint system as the thin zinc coating does not offer any significant degree of protection in corrosive environments.

ZINCSEAL formable steels cover the range of forming and drawing operations, from moderate deformation to those of the most demanding nature involving a considerable degree of stretch forming. Some operations such as drawing are facilitated because the zinc coating acts as a lubricant.

ZINCSEAL steel is readily welded and soldered but in these operations care must be taken to avoid damage to the zinc coating.

Recommended uses for ZINCSEAL steel include:

Fluorescent lights	Office furniture
Internal acoustic ceiling tiles	Partitioning
Switchgear cabinets	Lift doors and panels
	Flexible tubing

HOT-DIP LEAD/TIN-COATED STEEL SHEET: AS 2552

TERNE SHEET

S&CP Terne sheets, produced to AS 2552, are supplied as appropriate cold rolled formable grades of steel sheet with a protective coating of terne metal, an alloy of lead and tin.

The Referee

Characteristics of cold rolled steel base products are retained, with the added coating characteristics of:

- improved paintability;
- excellent solderability;
- surface passive to petrol;
- forming and drawing to limits of steel base without loss of coating adhesion; spark dampening;
- lubricous coating (reducing friction and die wear during severe drawing operations).

The constituent coating metals, lead and tin, are both highly resistant to corrosion and, in conditions where zinc coating would form oxides and carbonates,terne metal remains virtually clean and free of corrosion products. This property is significant where corrosion product might otherwise detach from fuel tank metal surfaces and clog filters and fuel lines.

Coating class is PS100, typical uses being:

Fuel Tanks

Gaskets & washers

Auto radiator parts

Radio & TV chassis

COLORBOND PREPAINTED STEEL

COLORBOND high quality prepainted steel can be fabricated into an end product without further treatment. Produced on modern high speed continuous strip coating lines, COLORBOND steel is available with a base of cold rolled uncoated, zinc-coated or ZINCALUME steel.

COLORBOND prepainted steel for interior/exterior building applications conforms to the requirements of AS 2728.

A range of colours, coating types and gloss levels has been developed for a wide variety of applications, both exterior and interior. These products are available either single sided or double sided, in the same or different colours.

By selecting the correct COLORBOND steel product, standard fabrication techniques such as deep drawing, foll-forming, lock-seaming, stamping, spinning and press-brake forming are possible without damage or deterioration to the coating. In some fabrication techniques the paint coating acts as a lubricant and can measurably increase tool life.

The Referee

COLORBOND steel is available in widths from 25 mm to 1575 mm and in preferred thicknesses from 0.30 mm to 1.6 mm depending on steel substrate. Other thicknesses may be available on application.

The paint finish coating on COLORBOND steel for both interior and exterior use is applied over a corrosion-inhibitive primer, unless otherwise specified.

If it is intended to use COLORBOND in exterior applications within 1 km of a salt marine location or in severe industrial or unusually corrosive environments, please contact the nearest S&CP State Office for specialized advice.

Working with COLORBOND Prepainted Steel

Manufacturers planning to use COLORBOND prepainted steel are advised to contact S&CP State Offices for specialized advice. Benefits can accrue when new or modified production lines are planned to fully exploit the advantages of using COLORBOND prepainted steel. For example, it may simplify operations if the prime surface faces downwards, or if a bending operation is performed in an unconventional manner. In-line integral fastening or adhesives may reduce the quantity of mechanical fasteners otherwise required.

S&CP specialists have a lot of local and overseas experience in production innovation and welcome any opportunity to assist in early design stages. A fully equipped Product Application and Development (PAD) centre is located at the Research and Technology Laboratories, Port Kembla. Prototypes of customers' new applications can be developed to demonstrate the most cost effective material and manufacturing technique.

Typical Applications

COLORBOND product is manufactured to suit a range of end uses from severe exterior applications to interior fittings and fixtures. The following briefly outlines the COLORBOND steel types available and their applications:

Colorbond XRW – Exterior Roofing and Walling – designed for a range of roofing and walling applications, rainwater goods, garage doors and accessories.

Colorbond XPD – Exterior Premium Durability – for roofing, walling and architectural panel applications requiring the ultimate in long term colour and gloss durability.

The Referee

Colorbond XSE – Exterior Severe Environments – combines the long term durability of COLORBOND XPD with exceptional corrosion resistance near marine and industrial environments.

Colorbond XFP – Exterior Fencing Panels – designed to provide a high level of durability in fencing applications.

Colorbond XCR – Exterior Coolrooms – a product designed for the manufacture of sandwich panels for the coolroom industry.

Colorbond XMA – Exterior Manufactured Articles – designed for use in hot water service jackets, air conditioner cabinets, garden sheds and other applications requiring good exterior performance.

Colorbond HGA – High Gloss Appliance – a durable and mar resistant product for the manufacture of appliances.

Colorbond SWP – Sign Writing Panels – a product specifically developed for overpainting by the sign writing industry.

Colorbond IMA – Interior Manufactured Articles – a range of products individually formulated to meet the requirements of a range of manufactured articles for interior use. Please consult your S&CP Sales Office for specialised advice.

COLORBOND STEEL SPECIALTY COATINGS

COLORBOND steel specialty coatings offer new dimensions to the scope of prepainted steel.

Patterned COLORBOND Several types of patterned COLORBOND steel are available, with reproduction patterns ranging from fine wood-grain to coarse woodgrain or bold designs. Differing production processes for each system determine whether orders can be produced on a standard or special basis but all orders are subject to negotiation. All systems are suitable for interior

use, some for exterior applications.

Typical and recommended applications vary according to the particular system employed, and may include curtain rods and tracks, appliance wraps, shelving, office furniture, doors and door frames.

Ready-Prime Ready-Prime has been developed as a prime-coated sheet steel with a specially prepared surface which will accept normally available water-based or solvent-based decorative household exterior paints, after forming into such products as gutters or downpipes, and after installation.

The Referee

Ready-Prime coating contains pigments for inbuilt corrosion resistance and is a grey colour to emphasise that the surface should be finish painted.

Finish painting should be carried out as soon as possible after installation, at least within six months, otherwise finish painting problems could arise.

Ready-Prime is suitable for such items as formed gutters, downpipes and fascias where it is desired to finish paint with a colour to match or contrast with other painted areas of a building.

ORGANIC FILM LAMINATED STEEL SHEET

MARVIPLATE STEEL

MARVIPLATE steel is a laminate of polyvinyl chloride (PVC) film bonded to cold rolled metallic coated steel, which can be fabricated into an end product without further finishing treatment. It is available in either sheet or strip form.

By selecting the correct combination of steel substrate and MARVIPLATE PVC film, standard fabrication techniques such as deep drawing, roll-forming, lock-seaming, stamping, spinning and press-brake forming are possible without damage to the coating of MARVIPLATE steel. In some fabricating techniques the PVC film acts as a lubricant and can measurably increase tool life.

The chemical stability of the PVC film enables MARVIPLATE steel to withstand corrosive atmospheres and accidental contact with mineral acids, alkalis, alcohols and detergents.

A range of stylings and finishes has been developed for both interior and exterior applications, giving attractive surfaces which are colour fast and virtually maintenance free. These vinyls can be applied to either one or both sides of the sheet in the same or different finishes.

Exterior MARVIPLATE steel S&CP zinc-coated steel is the substrate for Exterior MARVIPLATE steel. Single-sided product has exterior grade PVC film bonded to the top side and an oven-baked interior paint backing coating on the reverse side.

Double sided product has exterior PVC film on one side and either an interior or exterior film on the other side, depending on requirement. All edges of double sided Exterior MARVIPLATE steel must be sealed with Parabond PVC edge sealing solution for added protection.

The Referee

Exterior MARVIPLATE steel is used for roofing and walling, guttering and other rainwater goods and accessories where atmospheres are aggressive. Exterior MARVIPLATE steel conforms to the requirements of AS2728.

Interior MARVIPLATE MARVIPLATE steel for internal use is metallic-coated steel with interior grade PVC film laminated to one or both sides. An extensive range of film grades, patterns, styles and colours is available.

MARVIPLATE steel is typically used for office, hospital and household furniture and equipment, component parts for appliances such as air conditioners, freezers, television units and oil and electric heaters.

Architectural uses include partitioning, acoustic ceilings, undersill assemblies, skirtings and ducting.

MARVIPLATE steel provides protection in a number of "hard-wear areas" such as doors, supermarket shelving, corridors and high traffic situations.

COOLCLAD – COATED STEEL/ALUMINIUM FOIL LAMINATED SHEET

Building Sheet with Built-in Solar Heat Barrier Coolclad is exterior grade COLORBOND steel (ideally Off White) or plain ZINCALUME steel sheet with a bright, low emittance aluminium foil laminated to the reverse side. It combines the strength and corrosion resistance of ZINCALUME steel with long-term low heat emittance.

COOLCLAD steel is suitable for roll-forming and is used primarily for the production of insulated roofing and walling sheets. CUSTOM ORB corrugated steel and TRIMDEK HI-TEN are two roofing and walling sheets available roll-formed from COOLCLAD laminated steel.

COOLCLAD laminated steel improves thermal comfort, whether used with normal ceilings or with unlined ceilings in rural, industrial and domestic buildings. Comprehensive literature is available from S&CP State Offices.

ACOUSTEEL SOUND DEADENED STEEL

S&CP ACOUSTEEL is a sound-deadened steel sheet, manufactured by laminating a thin viscoelastic layer between two metal sheets. This **metal/viscoelastic/metal** laminate has a high vibrational damping capacity and is designed for use where there is a need to reduce noise radiating from vibrating surfaces or equipment.

The Referee

Typical uses include:

Waste bins	Automotive panels
Chutes	Engine components
Hoppers	Machine enclosures
Ducting	

Standard Range: Sheets only, 1200 x 2400 mm

Metal laminates	Coating class	Steel base thickness, mm
ZINCSEAL CA2S-E	EZ10	0.50/0.50, 0.60/0.60, 1.0/1.0
GALVABOND G2	Z275	0.50/0.50, 0.60/0.60, 1.0/1.0

The steel sheets part of ACOUSTEEL laminate conforms to AS 2551 or AS 1397 depending on the sheet product used.

Laminates of dissimilar metals and sheet thicknesses are feasible. Information and literature are available from S&CP State Offices.

AQUAPLATE STEEL

AQUAPLATE is AS 1397 G300 Z275 galvanized steel sheet laminated with AS 2070 food grade polymer film. This steel/film laminate has been developed to make durable tanks for the storage of potable waters from rain, river, dam, spa or bore.

AQUAPLATE – W (film on one side) is for tank walls, and is available as flat strip or sheet, or as 8 or 10.5 x 76 mm corrugated sheet in custom cut lengths.

AQUAPLATE – B (film on two sides) is for tank bottoms, and is available 1200 mm wide as flat strip or sheet. The additional film surface is to protect the tank base from tank support materials.

Comprehensive literature and information is available from S&CP State Offices.

ATMOSPHERIC EXPOSURE CONDITIONS – STEEL CLADDING

CONTRIBUTING FACTORS

New technologies and innovation have resulted in many new or improved materials and products becoming available for building, construction, commercial, industrial, household and other uses. However, the products of today are exposed to much more severe conditions than were their counterparts of yesterday.

The Referee

Introduction of new industries, extensions of old ones on existing sites and decentralisation to rural and semi-rural areas, greater and continuing increases in the use of chemicals, pesticides, fungicides, fertilizers and even their method of application have all led to increasing degrees of air and water pollution.

People are generally prepared to accept the fact that they need to paint their house more often, and the family motor car needs to be washed each week. But rarely do houses or other buildings and items exposed to external atmospheres get washed other than by rain, and even rain only washes the areas it can reach.

PROTECTIVE AND/OR DECORATIVE COATINGS

Galvanized steel improvement over the years kept pace with the nation's increasing needs for corrosion resistant steel, and then in 1958 MAR-VIPLATE steel was introduced. This was coloured PVC film laminated to zinc-coated steel, a product which enabled steel roofing and walling to be used in severe marine and unusually corrosive atmospheres.

In 1966 COLORBOND steel was introduced and for exterior use was zinc-coated steel prepainted with an oven-baked silicone modified polyester paint system. This added a further colour dimension to steel. COLORBOND now has a ZINCALUME steel base.

1976 saw the introduction of ZINCALUME hot-dip zinc/aluminium alloy-coated steel for the building industry. ZINCALUME steel provides improved service life compared with traditional galvanized steel with a similar coating thickness under commonly encountered conditions.

Cost and service conditions are frequently the main factors determining the selection of steel cladding.

The Referee

SERVICE CONDITIONS AND SUITABLE PRODUCTS

(Information under this heading is derived in part from Appendix C to AS 2728. Acknowledgement and thanks to Standards Australia).

In the selection of an appropriate coated steel building product, it is important to assess the atmospheric conditions expected in the location of the intended building; this includes an assessment of both macro and micro environmental conditions.

On-site factors require additional consideration because a mildly corrosive atmosphere can be converted into an aggressive environment by rain, dew or humid conditions and can thus affect the choice of a particular category of prefinished metal product.

Typical on-site factors or types of microclimates which may cause a breakdown of protective coatings include:

- Concentrations of industry
- Contaminations from agricultural fertilizers or insecticides
- Damp locations not dried out by sunlight
- Exposure to sea breezes
- Alkaline or acidic fallout (eg fossil fuel combustion)
- Hot or cold surfaces
- Abrasion or impact
- Concentrations of organic matter (leaves etc)

Prevailing winds which can transport contamination from one location to another also require consideration.

High levels of ultra-violet light and humidity have adverse effects on the performance of organic coatings and thus reduce their durability. Because of the effects of high humidity, the designer of a building should take special care to ensure that the effects of condensation are minimized.

It should also be borne in mind that bending or roll-forming operations will cause stressing and may cause cracking of paint films. In moderate exposure conditions cracking does not adversely affect the expected life of a product. However, in severe environments products designed for such environments should be specified in order to ensure that the required service life is achieved.

The Referee

ATMOSPHERIC CLASSIFICATIONS

Microclimates can alter these classifications and should be taken into account.

Class	Condition	Typical locations
MILD Rural/arid	<ul style="list-style-type: none"> —Generally low rainfall. 200 mm/a or less. —Average humidity 25 per cent or less over majority of the year. —Sparsely settled, no industrial pollution and not within 50 km of the coastline 	Western and south-western Qld; western NSW; northern SA; southern NT; eastern WA.
MILD Rural/mild	<ul style="list-style-type: none"> —Rainfall up to 500 mm/a —Average humidity 25 to 55 per cent. —Rural local communities. 	Central southern Qld; western slopes and south-western NSW; north-western Vic; southern SA; western WA.

This environment covers areas away from the coast and remote from industrial or urban activity. Corrosive attack is governed mostly by humidity and rainfall; however, it is important to consider on-site conditions.

MODERATE Urban/light industrial	<ul style="list-style-type: none"> —Generally moderate rainfall 300 mm up to 1000 mm/a. —Average humidity 50 to 80 per cent. —Some industrial pollution; little or no marine influence. 	Urban and light industrial areas of major cities and towns; Appin and Lithgow, NSW; Toowoomba, Qld; Ballarat, Vic.
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This environment is encountered in locations away from heavy industrial activity where the significance of atmospheric pollution from attack by sulphur oxides or other fallout is diminished.

The effect of this type of environment on the integrity of coatings is not very great although grime deposited on the surface, and not removed, can affect the decorative appearance of coatings.

SEVERE INDUSTRIAL	<ul style="list-style-type: none"> —Generally high rainfall greater than 1000 mm/a. —Average humidity over 50 per cent with periods in excess of 80 per cent. —High level of industrial fallout and some marine influence. 	Industrial belts of Newcastle, Sydney and Wollongong; ports further than 500 m from the shoreline at Melbourne and Kwinana.
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This environment is encountered in locations where heavy industrial activity exists, eg, where atmospheric attack from sulphur oxides or other fallout is predominant. Conditions of high rainfall, humidity and specific chemical pollution can increase the corrosion rate drastically and additional protection is required.

The Referee

ATMOSPHERIC CLASSIFICATIONS (Cont)

Class	Condition	Typical locations
VERY SEVERE Coastal/marine	<ul style="list-style-type: none"> —Subject to 'marine' coastal fallout (salt deposition). —Humidity moderate (50 per cent) to severe (90 per cent). —Specific protection essential. 	<p>Near the coast or where chloride ions are present. The extent to which the conditions prevail inland is dependent upon geographical conditions and prevailing winds. Where on-shore wind predominates and the land rises steeply, contamination by airborne seawater and dried salt is usually restricted to a narrow belt of land which may extend for no more than 500 m from the shoreline. The incidence of heavy rainfall may somewhat reduce the aggressive nature of the environment by washing contamination from exposed surfaces.</p>
VERY SEVERE Tropical	<ul style="list-style-type: none"> —Subject to high rainfall, greater than 1200 mm/a. —Average humidity high all year round, typically above 65 per cent up to 100 per cent. —No industrial fallout. 	<p>Coastal areas of northern Qld and NT constitute the only Australian hot wet climatic region.</p>

Varying degrees of severity and micro-environments exist within each classification and some can be combined (industrial/marine). It is therefore difficult to reduce a complex situation to simple terms by providing a blanket recommendation as to which type of coated steel should be used in each location.

If it is intended to use S&CP coated steel within 1 km of salt marine locations, or in severe industrial or unusually corrosive atmospheric environments it is preferable that specialised advice be sought from a S&CP State Office. However, as a general rule S&CP recommendations are:

The Referee

ROOFING AND WALLING MATERIALS SELECTION GUIDE

ATMOSPHERIC EXPOSURE CONDITIONS	RECOMMENDATION
Immediate vicinity or rough, breaking surf eg, within approximately 100 metres; very close proximity to sources of industrial pollution, fallout, high levels of fossil fuel combination.	Consult Sheet and Coil Products State Office; consult supplier.
Reasonably close (about 100 to 500 metres) to either rough, breaking surf or sources of industrial pollution, fall-out or high levels of products of fossil fuel combustion.	COLORBOND XSE, consultation with Sheet and Coil Products State Office or supplier advisable.
Some distance from rough, breaking surf (about 500 to 1000 metres); immediate vicinity of calm flat marine, some distance from sources of industrial pollution and fallout; moderate levels of products of fossil fuel combustion.	COLORBOND XSE, COLORBOND XPD, COLORBOND XRW or ZINCALUME steel depending on individual requirements. (XSE longest service life, XRW and ZINCALUME would be satisfactory.)
Greater than 1 km from surf shoreline; some distance from calm, flat marine; remote from sources of industrial pollution and fallout; low levels of products of fossil fuel combustion, outer urban and rural areas.	COLORBOND XRW, ZINCALUME steel depending on individual requirements.

It should be remembered that adverse conditions can be generated within the whole or part of a building (chemical fume, etc) even though the building may be located in a bland rural atmosphere. Choice of building materials should be made accordingly.

Area Unwashed by Rain Particles of dust, salt and other grime settle on building cladding but are usually washed away by rain. However, some areas such as upper wall or upper garage door regions, under eaves, soffits, exterior ceilings etc remain unwashed because they are protected by overhangs (eaves, lintels). Galvanized, ZINCALUME and COLORBOND steel in such areas should be regularly maintained by washing with a fresh water and mild detergent solution to remove grime which could otherwise generate early corrosion. In hard-to-reach areas a hosing would suffice.

HOT ROLLED AND COLD ROLLED STEEL SHEET AND STRIP: AS 1594 AND AS 1595

Australian Standards 1594 and 1595 cover respectively hot rolled and cold rolled low carbon steel plate, sheet and strip. Products are aligned with international standards practice, modified to meet Australian conditions. A system of symbols identifies qualities and their properties.

HOT ROLLED STEEL SHEET PRODUCTS

S&CP hot rolled steel sheet is produced from selected steel slab by the continuous rolling process and supplied in accordance with AS 1594. Where no appropriate Australian Standard exists steel is produced in accordance with the principles embodied in the standards.

Because of the oxidation which occurs at hot rolling temperatures these products, unless pickled, characteristically carry surface scale. Hot rolled products are not used where high quality surface finish, as produced on cold rolled products, is a prime requirement.

Hot rolled sheet and strip are supplied in the as-rolled condition or, depending on the quality and customer specified requirements, may be pickled and oiled and/or skin-passed or supplied to special dimensional and flatness tolerances. Dimensional tolerances are in accordance with AS 1365.

Designations

In AS 1594, hot rolled steel is signified by the first character in the designation, H. The second character (A, K or U) indicates the steel type used in the product.

- A = Aluminium killed
- K = Silicon/Aluminium killed
- U = Unspecified steel type

Three basic categories or grades of steel may be specified:

- Formable (ductile) grades
- Structural grades
- Composition grades

Formable grades are identified by the third character (1,2 or 3) to indicate progressively better formability:

- 1 = Commercial forming
- 2 = Commercial drawing
- 3 = Deep drawing

For **structural products** a three-digit number is used to represent the minimum yield strength in megapascals.

The Referee

Other characters are added to the designation if required, for example:

S = Skin-passed P = Pickled

For **composition grades** a four-digit number indicates the chemical composition specification, as designated in AS 1594.

TYPICAL HOT ROLLED STEEL PRODUCTS

Details of the full range of hot rolled steel products are obtainable from S&CP State Offices. Assistance with the selection and specification of steels is also freely available.

Formable (Ductile) Grades

HU1S – a hot rolled non-drawing commercial forming grade, skin-passed to ensure good shape and freedom from coil break. Formability is sufficient for simple bending operations.

In standard thicknesses and sizes, HU1S is normally traded as merchant stock for applications requiring a flat sheet capable of bending and welding but not requiring the high surface finish of a cold rolled product. Typical examples:

General fabrication

Structural members

Shelving

Tanks

HA3-P – a hot rolled pickled and oiled deep drawing grade suitable for pressings of moderate severity where surface finish is not of prime importance. HA3-P is recommended and typically used for:

Sealed unit housings

Hydraulic jacks

Auto brake components

Clutch parts

Compressors

Structural Grades

These are steels supplied for applications where minimum design strengths are required but where surface standard is not of prime importance. Minimum yield strengths in the range 240 to 340 MPa are available, all with excellent weldability. HA340 is a typical example.

HA340 – a hot rolled structural grade, with a guaranteed yield strength of 340 MPa, used where surface is not of prime importance.

HA340 – is normally used for structural sections.

The Referee

Composition Grades

A range of steels supplied to guaranteed chemical compositions indicated by the 4 numerals, part of the designation system of AS 1594.

HK1073 – a fully hardenable carbon steel intended for applications requiring a good cutting edge or resistance to abrasion. Typical examples are shovels, cane knives and plough discs.

GENERAL GUIDE TO COMPARATIVE FEATURES – HOT ROLLED STEEL

Product	HU1S	HA3-P	HA340	HK1073
Form	strip	strip, sheet	strip, sheet	strip, sheet
Finish	skin-passed, not oiled	pickled, oiled	as rolled	as rolled
Bending	very good	excellent	good	limited*
Roll-forming	very good	excellent	good	—
Pressing	—	very good	moderate	—
Drawing	—	very good	moderate	—
Welding	excellent	excellent	excellent	limited

*HK1073 is normally hot worked

DIMENSIONS OF HOT ROLLED FLAT STEEL PRODUCTS

There is a wide range of thickness/width combinations available in all hot rolled strip and sheet. Details are available from S&CP State Offices. As a guide, the following table indicates normal thicknesses of some products.

Product	Thickness range, mm
Formable HU1S HA3-P	1.6-4.8 1.6-6.0
Structural HA340	1.6-8.0
Composition HK1073	2.5-6.0

COLD ROLLED STEEL PRODUCTS

S&CP produces a variety of cold rolled steel sheet and strip to AS 1595 specification. These steels are available in strip or sheet form in a range of surface finishes and surface qualities with formability and/or hardness requirements for most end applications.

Dimensional tolerances are in accordance with AS 1365.

Designations

In AS 1595 **cold rolled** steel is signified by the first character in the designation, **C**.

Basic types of cold rolled steel are:

- Formable (ductile)
- Hardness
- Strength (strength)
- Composition

In addition, the quality designation indicates:

- Surface finish, and
- Surface quality

Formable (Ductile) Grades The second character (**A, U, V, K, M** or **W**) indicates steel type:

- | | |
|--------------------------------------|--|
| A = Aluminium killed | K = Silicon/aluminium killed |
| U = Unspecified steel type | M = Modified with micro-alloy additions |
| V = Vitreous enamelling steel | W = Weathering steel |

The third character (**1, 2, 3** or **4**) indicates degree of formability:

- | | |
|-------------------------------|-------------------------------|
| 1 = Commercial forming | 3 = Deep drawing |
| 2 = Commercial drawing | 4 = Extra deep drawing |

A fourth character (**S** or **A**) is added to designate performance characteristics, and a fifth character (**N**) if non-ageing grade steel is necessary.

- S** = Skin-passed
- A** = Annealed last
- N** = Non-ageing (stabilized)

Hardness Grades The second and third characters are a two-digit number representing the minimum Rockwell hardness (scale B).

The fourth character is the letter **T** to indicate that the hardness has been achieved by temper rolling.

The Referee

Surface Quality Designated by a letter (**G**, **E**, **F**) joined to the quality designation by a dash.

G = General purpose

E = Exposed

F = Fully inspected

Surface Finish Indicated by a letter, joined to the quality designation by a dash, to signify a Lustre or Matt finish.

S&CP TYPICAL COLD ROLLED STEEL QUALITIES

Formable (Ductile) grades

For applications requiring formability, a range of steels is available with ductilities varying from commercial forming through to extra deep drawing. Non-ageing steel types are also available.

Details of the full range of S&CP cold rolled steel qualities can be obtained from S&CP State Offices. Assistance with the selection and specification of steels is also freely available.

Typical S&CP products include:

CA2S-E – a skin-passed commercial drawing steel capable of moderate forming and pressing and with a surface suitable for exposed panels. This is a very versatile product.

CA3SN-E – a skin-passed deep drawing steel guaranteed non-ageing and free from stretcher strain with a surface suitable for exposed components.

CA5SN-E – a skin-passed critical drawing steel suitable for severely drawn components in exposed applications with a minimum of rework. This product is guaranteed free of ageing and stretcher straining.

Hardness grades

These are produced for applications where minimum hardness is required and where ductility and surface finish are not of prime importance.

Strength grades

A range of strength grade steels is produced mainly for applications where design requirements specify minimum strength. Steels are available with minimum yield strengths varying from 350 to 600 MPa. These steels are outside the scope of AS 1595 but designation and supply follow the principles embodied in Australian standards.

The Referee

Composition grades

These are plain carbon steels often used in applications where heat treatment is a necessary part of the manufacturing process. The chemical composition is guaranteed and indicated by a four digit number. The first two for the steel type and the latter two to the nominal carbon content. The first two numbers in S&CP composition grades are "10" for plain, unalloyed, carbon steels.

GENERAL GUIDE TO COMPARATIVE FEATURES – COLD ROLLED STEEL

Quality	CA2S-E	CA3SN-E	CA5SN-E
Form	strip, sheet	strip, sheet	strip, sheet
Surface quality	oiled	exposed panel, oiled	exposed panel, oiled
Bending	excellent	excellent	excellent
Roll-forming	excellent	excellent	excellent
Pressing	good	excellent	excellent
Drawing	good	very good	excellent
Welding	excellent	excellent	excellent

DIMENSIONS OF COLD ROLLED FLAT STEEL PRODUCTS

Details of the wide range of thickness/width/length combinations possible are available from S&CP State Offices. The following table gives the normal thickness ranges of the formable products listed.

Product	Thickness range, mm
CA2S-E	0.40-4.0
CA3SN-E	0.60-3.2
CA5SN-E	0.60-3.2

The Referee

LY-CORE ELECTRICAL STEEL QUALITIES

S&CP produces a range of fully processed non-oriented electrical steels with magnetic properties covering the requirements of the electrical manufacturing industry.

These products are identified by the name LY-CORE followed by a number which is 100 times the guaranteed maximum core loss in watts per kilogram for 0.50 millimetre thick sheet at an induction of 1.0 tesla and a frequency of 50 hertz.

The following Table is a general guide to selection of the appropriate quality for a given end use.

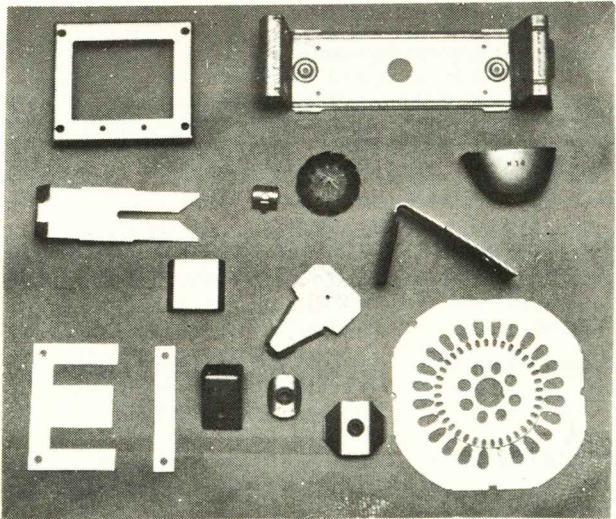
End Use	Ly-Core Grade				
	140	150	230	350	700
Large rotating machines		•			
DC motors			•		
AC motors					
Hermetically sealed			•	•	
General purpose			•	•	
Small and intermittent duty				•	•
Alternators				•	•
Current and power transformers	•	•			
Fluorescent lighting ballasts	•	•	•	•	
Welding transformers				•	

All qualities are available as wide or slit strip or as cut lengths, and with a choice of insulating coating. Further details are given in S&CP Electrical Steel literature available from S&CP State Offices.

Laminations

Sankey Division provides a range of standard and custom laminations for motors and transformers. Laminations are supplied either as stamped by core grades, or post annealed Sankore grades. Sankey also supplies grain oriented and nickel iron laminations, strip wound cores and slit strip. Details are available from Sankey at Sydney (02) 708 8811 or Newcastle (049) 67 1766.

Sankey is also one of the largest suppliers of metal stampings for building, automotive, electrical and general manufacturers.



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ZINCALUME AND COLORBOND STEEL ROOF AND WALL CLADDINGS

ZINCALUME zinc/aluminium alloy-coated steel roof and wall cladding, either with its now familiar silvery-matt finish or as prepainted COLORBOND steel, has largely replaced galvanized steel in the Australian building industry. The familiarity of steel roofing should not, however, be allowed to obscure even greater advantages derived from recent technical developments.

New Profiles Many modern profiles have been added to the range. Even the traditional corrugated sheet has been modernised. Wider, long-length sheets make a significant contribution to cost savings by reducing installation time. Some large building projects may need a cladding sheet specially designed to meet specific structural or other requirements. Given sufficient volume, sheets can be developed and produced by Lysaght.

Long Lengths Lysaght roofing and walling profiles are manufactured in long lengths so that one sheet will cover from ridge to gutter. The advantages of these long length sheets include neater appearance, reduced handling and installation costs, wider spacing for supports and the elimination of end laps and their attendant corrosion problems.

Improved Weather and Corrosion Resistance Lysaght roofing and walling produced from ZINCALUME steel gives improved corrosion resistance compared with traditional galvanized steel of similar coating thickness in similar environments. Anti-capillary side laps and new fastenings have been designed to ensure weather-tightness. In some profiles, fastenings are attached below or behind the cladding, avoiding the need for piercing.

Colour COLORBOND sheets feature colourful organic coatings applied under controlled factory conditions. Colour matched accessories and fastenings are available.

Strength Of the many roofing and walling materials now available, high tensile sheet steel remains the strongest.

The Referee

Thermal Insulation

Lined dwellings The Commonwealth Experimental Building Station has carried out very extensive studies of the thermal behaviour of buildings, and it has found that the major factor controlling internal room temperatures is the heat capacity or mass of the building. The material used for roof sheathing has little or no effect on room temperature or personal comfort in a lined building. The full findings are published in CEBS Technical Study No 34 "The Thermal Behaviour of Dwellings", from which the following passage is quoted: 'It was popularly believed that a galvanized iron roof caused a house to be hotter than it would be if sheeted with asbestos or roofed with clay tiles. This view is not supported by the results obtained.'

Unlined single membrane buildings A bright polished metal surface possesses relatively low thermal emissivity which reduces radiation intensity to a low value. At the same time the improved light reflectivity and distribution is a considerable advantage with a single membrane roof without ceiling.

COOLCLAD sheet is plain ZINCALUME or Off White COLORBOND steel cladding with bright aluminium foil bonded to the underside.

Where COOLCLAD roofing and/or walling is used on unlined buildings, particularly in high temperature regions, discomfort to the occupants – human or livestock – is reduced because the direct radiation from sunlit surfaces is less. COOLCLAD performance is improved if Off White COLORBOND steel is used.

Roofing Performance (Standards) Lysaght roofing and installation procedures comply with the requirements of AS 1562, 'Design and Installation of Metal Roofing'. The requirements of this standard include stringent proof tests to measure the ability of the roofing medium to withstand simulated wind uplift loads and superimposed concentrated loads.

Fastening should always be in accordance with the manufacturer's published recommendations.

Service Lysaght building profiles are now manufactured in every Australian capital city and in numerous strategic regional centres. Products are available through Lysaght roof and wall cladding distributors, either in stock sizes or on prompt delivery, factory cut to a customer's own precise needs. A range of accessories and fasteners is also available.

Lysaght State Offices can supply detailed technical literature for specific products and expert technical advice regarding any particular problems which may occur.

ZINCALUME STEEL ROOFING AND WALLING SELECTION GUIDE

New Homes One of the most extensive home building innovations of recent years has been the increased use of very low-pitched or flat roofs. It is in this area of design that the greater flexibility of steel over other materials has proved a significant factor. This flexibility allows steel to be used successfully at lower pitches than most other roofing products. In designs where a nearly flat roof is required, KLIP-LOK HI-TEN or BROWNBUILT Decking is the obvious choice since they allow pitches as low as 1°. Where the pitch is still low, but not as critical, other Lysaght profiles, such as CUSTOM ORB, TRIMDEK HI-TEN or SPANDEK HI-TEN may be used. In home construction, the use of low-pitched roofing gives the dual advantage of design freedom with cost saving in structural framing.

Home Extensions With steel sheet roofing it is usually possible to add extensions beneath the existing roof eaves and yet still maintain sufficient ceiling height to meet building regulations. By avoiding the necessity to interfere with the existing roof structure and drainage, major cost savings are possible. Where the roof slope must be kept to a minimum, KLIP-LOK, HI-TEN or BROWNBUILT decking are the most suitable profiles. Where there is sufficient height to permit a slightly steeper roof fall, CUSTOM ORB, SPANDEK HI-TEN and TRIMDEK HI-TEN make excellent choices.

Carports, Garages, Roofed Outdoor Areas Where a flat roof is desired, use KLIP-LOK HI-TEN or BROWNBUILT decking if long spans are necessary. Use CUSTOM ORB, SPANDEK HI-TEN or TRIMDEK HI-TEN where slightly more roof fall is possible. It should be noted that all these products have an underside which may be left exposed if desired, thus avoiding unnecessary additional cost where a ceiling is not required.

Fences, Privacy Screens NEETASCREEN is a complete coloured steel fencing system comprising COLORBOND infill panels with matching or contrasting COLORBOND posts and rails. The fence looks the same from both sides. Matching gates are optional. NEETASCREEN fences can be do-it-yourself or contract installed.

The Referee

Colour Regular finish for all Lysaght roofing and walling profiles is hot dipped ZINCALUME steel. But with colour such an important consideration in so many applications, most Lysaght roofing and walling profiles are also available as COLORBOND steel with a factory applied paint finish.

The paint system used for COLORBOND steel in exterior applications is specially formulated to resist outdoor exposure. The choice of profiles in this material is matched by an attractive range of colours. In addition, a range of colour and material matching accessories is available. Since colour and, often, a number of colours used in the same building or location is being increasingly used in modern design schemes, the wide range and variety offered by Lysaght prepainted profiles and accessories is often a significant factor in the choice of building materials.

Farm Buildings Lysaght CUSTOM ORB, TRIMDEK HI-TEN and SPANDEK HI-TEN are recommended materials for the roofing and walling of sheds, barns and other farm buildings. Complete EZYFRAME steel kit buildings for these applications are available from Lysaght Ezyframe Buildings, either do-it-yourself or erector installed.

Shop Roofs All Lysaght decking profiles are suitable for the roofing of shopping blocks. The final choice of profile will be influenced largely by the particular design. Generally, KLIP-LOK, HI-TEN or BROWNBUILT decking is used for modern low-pitched construction, while SPANDEK HI-TEN, TRIMDEK HI-TEN or CUSTOM ORB is recommended for roofs of steeper pitch.

Shop Facades There are a number of Lysaght building shapes which can be used to achieve a pleasing variety of design in shop facades. EASYCLAD cladding systems can be used for a clean, sheet appearance. Alternatively, V-CRIMP, V-CRIMP HI-TEN, PANELRIB and TRIMDEK HI-TEN or SPANDEK HI-TEN provide an attractive ribbed appearance. BROWNBUILT decking may also be used, erected with either the face or the reverse side exposed, with adequate weather protection, each side presenting a contrasting appearance.

Shop Awning Soffits Lysaght V-CRIMP, V-CRIMP HI-TEN, PANELRIB or any of the roof deckings may be used for awning soffits. Available as ZINCALUME steel or prefinished in COLORBOND, long length sheets virtually end the necessity for end lapping. The various types of cladding include the EASYCLAD cladding systems. The range takes in panels in differing tray modules, available as suitable ZINCALUME steel for on-site painting or as COLORBOND steel.

The Referee

Factories, Warehouses Strength and economy make TRIMDEK HI-TEN and SPANDEK HI-TEN steel the most commonly used materials for the roofing and walling of factories and similar buildings. Long lengths enable cladding to be carried out in a single run without end laps. This result is a saving in cladding time and a more pleasing finish. V-CRIMP and V-CRIMP HI-TEN walling sheets are suitable for factory cladding and have a distinctive shallow ribbed appearance.

For prestige building, or for feature areas, use KLIP-LOK or BROWN-BUILT decking, the fastening clips for which are hidden from view. Where appearance is a factor to be considered, Lysaght prepainted profiles are an excellent choice. The range of colours is wide enough and distinctive enough to ensure that no part of a factory area need look dreary merely because it is functional.

Buildings such as schools, hospitals, sporting centres, clubs and churches are usually architect-designed and the correct choice of roofing will usually be made from the individual design considerations.

Bull-nosing and Curving Many modern buildings feature bull-nosed or concave curved corrugated ZINCALUME CUSTOM BLUE ORB, usually, as colourful COLORBOND prepainted steel.

APPLICATION OF LYSAGHT CLADDING PROFILES

Profile	Roofing	Walling	Fencing and Privacy Screens	Fascias Soffits Awnings
CUSTOM ORB	•	•	•	•
TRIMDEK HI-TEN	•	•	•	•
SPANDEK HI-TEN	•	•	•	•
KLIP-LOK HI-TEN	•	•	•	•
BROWNBUILT 305 and 406 decking	•	•	•	•
V-CRIMP	—	•	•	•
V-CRIMP HI-TEN	—	•	•	•
PANELRIB	—	•	•	•
WALL-CLAD	—	•	•	•
TRIM-WALL	—	•	•	•
EASYCLAD panels	—	•	•	•
TRI-LOK	—	•	•	•

• = Suitable for indicated applications

LYSAGHT ROOF AND WALL SHEETING OPTIONAL FINISHES

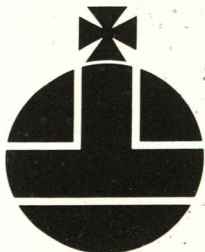
Lysaght Building Industries roofing and walling sheets are roll-formed from either plain or organic prefinished ZINCALUME zinc/aluminium alloy-coated steel manufactured to AS 1397 specification. Plain ZINCALUME steel has a characteristic silver grey spangle finish.

All the profiles are available as COLORBOND prepainted steel in a range of colours. Some selected profiles are also available formed as COOLCLAD steel, which is a laminate of ZINCALUME or COLORBOND steel and aluminium foil, for use as a solar energy barrier building sheet.

For a more detailed description of these steels, refer to the index under the appropriate product name.

In the following pages briefly describing each of the Lysaght roofing and walling profiles, the steel used is expressed by Australian Standard number, steel base minimum yield stress in megapascals, followed by the metallic coating class. Thus AS 1397 G550 AZ150 means steel conforming to Australian Standard 1397, with steel base minimum yield stress 550 MPa, zinc/aluminium alloy coating 150 g/m² minimum coating mass determined by a prescribed triple spot test.

The coating classes nominated relate to both ZINCALUME steel and the ZINCALUME base of COLORBOND steel.



THE ORB: SYMBOL OF QUALITY

Every sheet of Lysaght roof and wall cladding profiles is branded on the edge with the ORB symbol together with other facts like the base thickness of ZINCALUME or COLORBOND, the yield stress, the applicable Australian standard and the amount of protective coating per square metre.

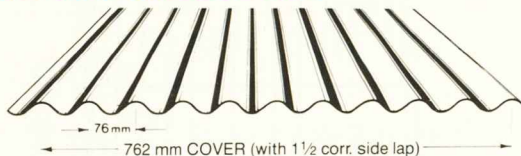
ROOFING AND WALLING SELECTION TABLES

Roofing and Walling Profiles	Total coated thickness, mm	Width of coverage, mm	Depth of rib, mm	Minimum recommended roof pitch, mm	Max recommended spacing of supports for normal conditions		
					ROOFS		WALLS
					Internal spans, mm	End spans, mm	Internal spans, mm
CUSTOM ORB	0.47 0.53	762 762	16	5° (1 in 12)	1200 1600	900 1200	1800 2400
CUSTOM BLUE ORB	0.66 0.86	762 762	17	5° (1 in 12)	1200 2400	900 1800	1800 2800
TRIMDEK HI-TEN	0.47 0.53	762 762	29	2° (1 in 30)	1700 2300	1000 1700	2200 2800
SPANDEK HI-TEN	0.47 0.53	700 700	24	3° (1 in 20)	2100 2800	1500 1950	2900 3100
KLIP-LOK HI-TEN*	0.47 0.53 0.65	406 406 406	41 41 41	2° (1 in 30) 1° (1 in 50) 1° (1 in 50)	1300 2100 2700	1200 1800 2300	2400 2900 3000
BROWNBUILT 305* (NSW, VIC, SA only)	0.60 0.75	305 305	48	1° (1 in 50)	1500 2500	1300 2000	1650 2900
BROWNBUILT 406* (Not NSW or QLD)	0.60 0.75	406 406	48	1° (1 in 50)	1500 2400	1300 2000	2450 2750

*Use caution when fixing down to 1° pitch. Refer to individual Lysaght technical literature for complete specification and details.

Walling only Profiles	Total coated thickness, mm	Width of coverage, mm	Depth of rib, mm	Max recommended spacing of wall supports for normal conditions Internal spans, mm
WALL-CLAD	0.40	762	16	1600
TRIM-WALL	0.40	762	29	1800
V-CRIMP (WA only)	0.53	610	16	1200
V-CRIMP HI-TEN (All states except WA)	0.40 0.47	800 800	13 13	1500 1700
EASYCLAD HI-TEN 4P 300	0.40	300	12	1200
EASYCLAD HI-TEN 2P 300	0.53	300	19	1500
PANELRIB	0.47	900	4	600
MINI-ORB	0.60	1055	6	1200

LYSAGHT CUSTOM ORB LYSAGHT ZINCALUME CUSTOM BLUE ORB LYSAGHT WALL-CLAD LYSAGHT CUSTOM BLUE ORB



Lysaght CUSTOM ORB, ZINCALUME CUSTOM BLUE ORB and WALL-CLAD sheets are ZINCALUME zinc/aluminium alloy-coated steel roll-formed to the familiar conventional 76 mm pitch corrugated profile. CUSTOM BLUE ORB has the same corrugated profile but with a zinc coating.

Each of these building products is produced according to its steel base/coating combination to suit particular requirements.

CUSTOM ORB steel Roofing and walling.

ZINCALUME CUSTOM BLUE ORB steel Curving quality roofing and walling sheet for bull-nosing.

WALL-CLAD steel walling only.

These sheets have one edge specially contoured to break contact between the sheets in the lap to prevent the possibility of capillary action drawing moisture into the lap.

CUSTOM ORB

CUSTOM ORB building sheet is a corrugated ZINCALUME steel sheet combining high strength, lightness and zinc/aluminium coating for outdoor exposure and corrosion resistance. It is intended for roof and wall cladding requiring high resistance to deformation, and relatively wide spacing of support centres. CUSTOM ORB conforms to AS 1445 G550 AZ150: 10½ x 76 mm corrugations; 762 mm cover width with 1½ corrugations side lap; total coated thickness 0.47 mm, steel base thickness 0.42 mm.

CUSTOM ORB steel is not suitable for curving. ZINCALUME CUSTOM BLUE ORB steel is a companion sheet which may be used where curving and bull-nosing are required.

The Referee

It is available in stock lengths up to 9000 mm or factory cut to lengths in 10 mm increments. Longer lengths can be supplied provided transport and on-site handling can be arranged.

The profile design, width and long sheet length of CUSTOM ORB steel provide design and installation advantages including:

- Custom cut lengths to avoid waste.
- Wide support spacings – internal spans up to 1200 mm for roofing and up to 1800 mm for walling in normal weather conditions.
- One sheet from roof ridge to gutter – no end laps.
- Minimum roof slope of 5° (1 in 12) on roofs without end laps.
- Consecutive side lapping and laying without the need to turn over alternate sheets.
- Weather-resistant 1 1/2 corrugations side laps.
- Maximum eaves overhang of 200 mm unstiffened, or 300 mm when stiffened with a 50 x 1.6 mm angle or equivalent.

CUSTOM ORB sheets can also be supplied as a COLORBOND (pre-painted) or COOLCLAD (bright aluminium foil laminate) steel.

Installation Data

Location of crest or valley fastenings for intermediate and end fastening for normal weather conditions.

Side lapping:

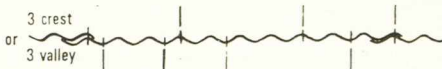
Right



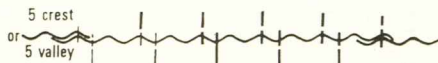
Wrong



Intermediate



End



ZINCALUME CUSTOM BLUE ORB

ZINCALUME CUSTOM BLUE ORB steel is essentially the same as CUSTOM ORB but being formed from a thicker ductile steel it is suitable for curving. It is used in roofing and walling applications where bull-nosing or concave curving is required, and for tank-making.

The Referee

ZINCALUME CUSTOM BLUE ORB conforms to specification AS 1445 G300 AZ150, 10½ x 76 mm corrugations; 762 mm cover width with 1½ corrugations side lap. Two thicknesses are available.

	Regular	Heavy
Total coated thickness	0.66 mm	0.86 mm
Steel base thickness	0.60 mm	0.80 mm

The long lengths available allow sheets to be curved into a full circle for tank-making, particularly where a curving machine with vertical rollers is used.

Lengths available and installation details are as for CUSTOM ORB, except that in addition, the 0.86 mm TCT sheet maximum support spacings in normal areas are 2400 mm for roof intermediate spans and 3000 mm for wall spans.

ZINCALUME CUSTOM BLUE ORB sheet can be supplied as ZINCALUME or COLORBOND prepainted steel.

WALL-CLAD

WALL-CLAD steel is an economy corrugated walling sheet produced from ZINCALUME steel with the same traditional profile as CUSTOM ORB. WALL-CLAD steel conforms to AS 1397 G550 AZ150; 10½ x 76 mm corrugations; 760 mm cover width with 1½ corrugations side lap; total coated thickness 0.40 mm; steel base 0.35 mm.

Lengths available and walling installation details are as for CUSTOM ORB except that maximum wall support spacing in normal areas for two or more spans is 1600 mm.

CUSTOM BLUE ORB

CUSTOM BLUE ORB sheet is a curving quality corrugated steel sheet produced with a heavy zinc coating to AS 1445-G300-Z600; total coated thickness 0.69 mm, steel base thickness 0.60 mm. Two widths are available:

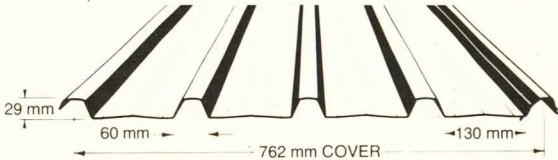
- 10½ x 76 mm corrugations
- 8 x 76 mm corrugations

Long lengths allow sheets to be curved into a full circle, particularly where a machine with vertical rollers is used.

CUSTOM BLUE ORB sheet is available in stock lengths up to 9000 mm or factory cut to lengths in 10 mm increments. Lengths over 9000 mm can be supplied provided transport and onsite handling can be arranged.

The Referee

TRIMDEK HI-TEN



TRIMDEK HI-TEN building sheet is ZINCALUME, high-tensile, light-weight sheet steel roofing and walling sheet roll-formed to a modern shape.

Material conforms to AS 1397 G550 AZ150; 762 mm cover width; total coated thickness 0.47 mm; steel base thickness 0.42 mm.

TRIMDEK HI-TEN steel is also available as a COLORBOND (pre-painted) steel.

Available in factory cut lengths up to 12 000 mm in 10 mm increments. Longer lengths available provided satisfactory transport and on-site handling can be arranged.

Features include:

- Custom cut lengths to avoid waste.
- One sheet from roof ridge to gutter – no end laps.
- Effective cover width of 762 mm.
- Minimum pitch of 2° (1 in 30) on roofs without end laps.

TRIM-WALL

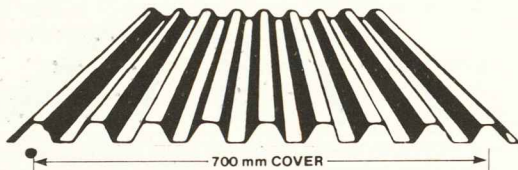
TRIM-WALL steel is an economy, steel walling sheet with a profile similar to TRIMDEK HI-TEN, produced from ZINCALUME or prepainted COLORBOND steel. TRIM-WALL conforms to AS 1397 G550 AZ150; total coated thickness 0.40 mm; steel base thickness 0.35 mm; sheet cover width 762 mm.

TRIM-WALL sheets are suitable for walling in non-critical rural applications; they are not suitable for roofing.

Available through Lysaght wall cladding distributors in stock lengths or custom cut to requirements.

The Referee

SPANDEK HI-TEN



SPANDEK HI-TEN steel is a ZINCALUME lightweight steel roofing and wall cladding sheet, roll-formed to a modern profile. SPANDEK HI-TEN steel is also available as a COLORBOND (prepainted) steel.

Material conforms to AS 1397 G550 AZ150; 700 mm cover width. Two thicknesses are supplied:

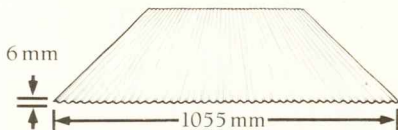
	Regular	Heavy
Total coated thickness	0.48 mm	0.53 mm
Steel base thickness	0.42 mm	0.47 mm

Available in factory-cut lengths up to 12 000 mm in 10 mm increments. Longer lengths available provided satisfactory transport and on-site handling can be arranged.

Features include:

- Custom cut lengths to avoid waste.
- Wide support spacings – regular product – internal spans up to 2100 mm for roofing and up to 3150 mm for walling for normal weather conditions.
- One sheet from roof ridge to gutter – no end laps.
- Effective cover width of 700 mm.
- Minimum pitch of 3° (1 in 20) on roofs without end laps.
- Patented fluted side lap for protection against moisture entry by capillary action.

MINI ORB



Lysaght MINI ORB is a sophisticated corrugated profile commonly known as Ripple Iron or 1" corrugated steel. It has the same shape as CUSTOM ORB but on a much reduced scale.

MINI ORB is suitable for use in exterior and interior applications on straight or curved surfaces.

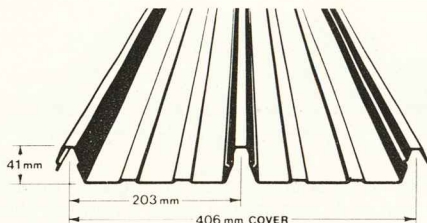
Material conforms to AS 1397 G300 A2150; 1055 cover width; total coated thickness 0.66 mm; steel base thickness 0.55 mm.

It is available in sheet lengths from 1500 mm to 3000 mm in increments of 300 mm.

MINI ORB is available in a range of attractive colours in COLORBOND prepainted steel and in ZINCALUME zinc/aluminium alloy coated steel. Other materials are available subject to enquiry.

The Referee

KLIP-LOK



KLIP-LOK building sheet is a lightweight, rigid roof decking or wall cladding roll-formed from ZINCALUME steel in a choice of three thicknesses.

Material specification is to AS 1397 G300 AZ150. The zinc/aluminium alloy coating provides outdoor exposure protection and long life. Effective cover width of KLIP-LOK decks is 406 mm.

Steel base thicknesses	0.42 mm	0.48 mm	0.60 mm
Total coated thicknesses	0.47 mm	0.53 mm	0.65 mm

Profile	TCT, mm	Width of coverage, mm	Depth of rib, mm	Minimum recommended roof pitch, mm	Max recommended spacing of supports for normal conditions		
					ROOFS		WALLS
					Internal spans, mm	End spans, mm	Internal spans, mm
KLIP-LOK HI-TEN	0.47	406	41	2° (1 in 30)	1300	1200	2400
	0.53	406	41	1° (1 in 50)	2100	1800	2900
	0.65	406	41	1° (1 in 50)	2700	2300	3000

KLIP-LOK decks are designed particularly for low pitch roof applications. The interlocking ribs, together with concealed fastening (no puncturing) ensure weather resistance on roof pitches as low as 1° (1 in 55) where no end laps are used. When used as a wall cladding, KLIP-LOK steel may be erected with either the face or reverse side exposed, with equal protection, each side presenting a contrasting appearance. Other design and installation features include:

- Custom cut lengths to avoid waste.
- Increased support spacing.
- Long deck lengths.

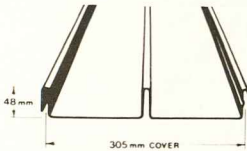
The Referee

- Special rib design which makes the deck a structural member in itself, thus permitting more economical use of framework.
- Positive side rib interlocking with concealed clips providing adequate fastening.
- Effective spreading of loads from one deck to adjacent decks.
- Modern architectural profile.

KLIP-LOK decks are also produced from COLORBOND prepainted steel. KLIP-LOK HI-TEN decks are available factory cut to lengths in 10 mm increments up to 15 000 mm. Longer lengths are available provided satisfactory transport and on-site handling can be arranged.

BROWNBUILT 305 and 406 DECKING

305 all States except Qld and WA



406 all States except Qld, NSW and WA



BROWNBUILT 305 and 406 deckings are self-supporting, ZINCALUME steel roof deckings and wall claddings featuring a narrow rib profile. The narrow rib allows positive button punching connection of decks. This technique is predictable in strength and contributes to both concentrated and live load supports.

Deckings are roll-formed from ZINCALUME steel conforming to specification AS 1397 G300 AZ150. Cover widths are 305 mm and 406 mm and rib height 48 mm. Available in lengths custom cut in 10 mm increments up to 15 000 mm. Longer lengths may be available provided satisfactory transport and on site handling can be arranged.

Deckings are also produced from COLORBOND prepainted steel.

The Referee

These decking systems provide a weather-resistant roof suitable for flat, low, gable or skillion application. The narrow rib enables clean under-soffit appearance for exposed eaves, carports and canopies. When used as a wall cladding, decks may be erected with either the face or reverse side exposed, with adequate weather protection, each side presenting a contrasting appearance.

Other design and installation features include:

- Custom cut lengths to avoid waste.
- Long deck lengths.
- Less structural formwork required.
- Increased support spacing.
- Positive and predictable button punch rib connection.
- Positive male rib concealed clip securement.
- Quick erection, saving time and cost.
- Aesthetically pleasing narrow rib.
- Effective spreading of loads from one deck to another.

The BROWNBUILT decking profile system embodies patented features which permit the fitting of insulating materials from the underside of the decking after completion of the roof.

Roofing and Walling Profiles	TCT, mm	Width of coverage, mm	Depth of rib, mm	Minimum recommended roof pitch, mm	Max recommended spacing of supports for normal conditions		
					ROOFS		WALLS
					Internal spans, mm	End spans, mm	Internal spans, mm
BROWNBUILT 305 (NSW, VIC, SA only)	0.60	305	48	1° (1 in 50)	1500	1300	1650
	0.75	305			2500	2000	2900
BROWNBUILT 406 (Not NSW or QLD)	0.60	406	48	1° (1 in 50)	1500	1300	2450
	0.75	406			2400	2000	2750

The Referee

V-CRIMP

(Not available Qld and NT)

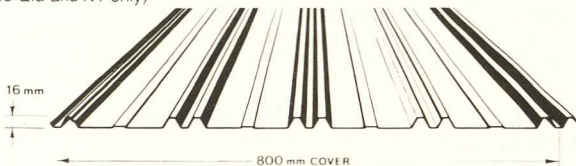


V-CRIMP is a coated steel sheet specifically designed for wall cladding and is therefore not suitable for roofing. It is roll-formed from ZINCALUME steel to AS 1397 G300 AZ150; total coated thickness 0.53 mm; steel base thickness 0.48 mm. COLORBOND (prepainted) steel is also used for V-CRIMP sheet.

V-CRIMP steel is available factory cut to lengths in 10 mm increments up to 7500 mm. Longer lengths may be supplied provided satisfactory transport and on-site handling can be arranged.

V-CRIMP HI-TEN

(Available Qld and NT only)



V-CRIMP HI-TEN wide-cover walling sheet is made from high strength ZINCALUME steel conforming to AS 1397 G550 AZ150; total coated thickness 0.47 mm; steel base thickness 0.42 mm.

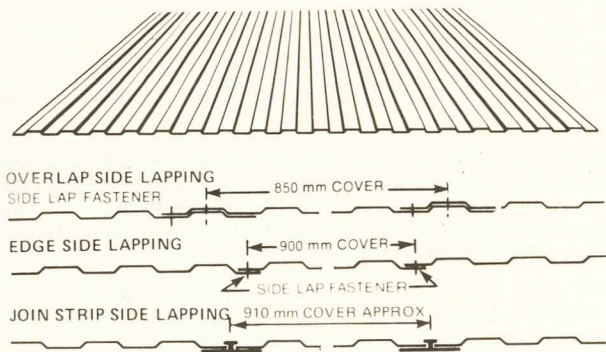
V-CRIMP HI-TEN ribs and flutes give rigidity and strength to the steel sheet and permit support spacings up to 1200 mm.

The shallow rib depths and sheet cover width of 800 mm make V-CRIMP HI-TEN steel suitable for a range of applications including walling, fascias, awnings, fences and garage doors.

V-CRIMP HI-TEN steel is also produced from COLORBOND prepainted steel.

Available factory cut to lengths in 10 mm increments up to 7500 mm. Longer lengths may be supplied provided satisfactory transport and on-site handling can be arranged.

PANELRIB



PANELRIB is a fluted steel cladding for exterior or interior straight or curved walls. It is roll-formed from ZINCALUME steel conforming to AS 1397 G550 AZ150 specification; total coated thickness 0.47 mm; steel base thickness 0.42 mm. PANELRIB steel is not suitable for roofing.

It is suitable for many applications where relatively flat sheet would not normally be considered, such as ceilings, partition facings, screens, garage doors, fascias and barge boards. Other uses include bus and truck body cladding and steel furniture.

The longitudinal flutes improve rigidity and strength along the sheet length, but flexibility across the width is maintained. The longitudinal stiffness of PANELRIB steel approximates that of a flat sheet six times as thick.

PANELRIB material options include COLORBOND prepainted steel.

PANELRIB steel is available in stock lengths from 1200 to 5000 mm or custom cut to lengths up to 6500 mm. Longer lengths are subject to enquiry.

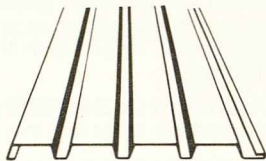
EASYCLAD HI-TEN CLADDING SYSTEM

EASYCLAD HI-TEN cladding system panels are used for sidings, feature panels, soffit linings, non-acoustic ceilings and in internal and external applications. It is also used for vertical or horizontal placement for walls and fascias. A range of accessories is available.

EASYCLAD panels are formed from ZINCALUME or COLORBOND steel conforming to AS 1397.

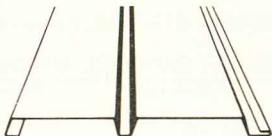
EASYCLAD 4P 300

Flat trays, 300mm sheet module, suits current architectural trends for raised board profile with sharp shadow line. Concealed fastening uses clip or direct fastening to supports up to 1500 mm.



EASYCLAD 2P 300

Flat trays, 300mm sheet module. The clean, flat pans suit current architectural demands with concealed fastening clips or direct fastening to supports up to 2400 mm centres.

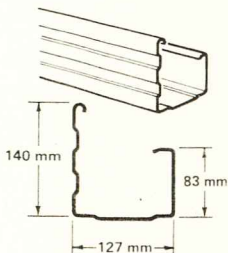


ROOFING ACCESSORIES

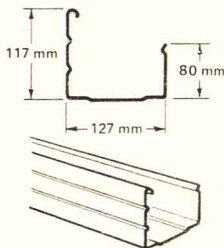
GUTTER SYSTEMS

Two Lysaght gutter profiles suitable for all types of roofs are SHEERLINE and TRIMLINE in plain ZINCALUME or COLORBOND ZINCALUME steel. Fastening clips to suit various requirements are available.

SHEERLINE



TRIMLINE



ROOF DRAINAGE

RAINWATER RUN-OFF

The drainage or run-off capacity of roof sheeting is a limitation on the total length of a sheet run that must be considered in roof design and construction.

As a guide, Table A gives examples of maximum length sheet runs for various Lysaght sheet profiles at the roof slopes and rainfall intensities shown. These examples are based on CSIRO report 02-2-32 'The Influence of Slope Upon the Discharge Capacity of Roof Drainage Channels'.

The sheet run is the total length of roof sheeting including any end laps or expansion joints that may be included in the roof.

The rainfall and run-off length can be proportioned linearly for a given roof slope and profile.

See Table B for rainfall intensities for selected localities.

Table A – RAINFALL: MAXIMUM ROOF RUN

LB1 deck type	Roof slope	Rainfall intensity, mm/hr	Max run-off length, m
CUSTOM ORB	10 (1 in 6)	200	25
CUSTOM ORB	5 (1 in 12)	200	20
SPANDEK HI-TEN 700	5 (1 in 12)	250	30
SPANDEK HI-TEN 700	3 (1 in 20)	250	25
TRIMDEK HI-TEN	2 (1 in 30)	300	30
KLIP-LOK	1 (1 in 55)	400	35
BROWNBUILT 406 and 305	1 (1 in 55)	400	40

The Referee

RAINFALL INTENSITIES

Table B – DESIGN RAINFALL INTENSITIES

Locality		For overflow of Eaves Gutters once in 20 years, mm/h	For overflow of Internal Box Gutters once in 100 years, mm/h
ACT	Canberra	125	174
NSW	Broken Hill	117	161
	Bathurst	121	154
	Sydney	212	277
	Newcastle	166	213
VIC	Mildura	103	141
	Melbourne	91	117
	Ballarat	96	125
QLD	Cloncurry	157	204
	Brisbane	239	312
	Rockhampton	217	267
	Cairns	318	427
SA	Mount Gambier	80	104
	Adelaide	85	111
WA	Geraldton	108	136
	Perth	111	144
TAS	Hobart	74	95
NT	Alice Springs	127	178
	Darwin	271	335

Values are for rainfall intensities of six minutes duration and were kindly provided by the Bureau of Meteorology.

GUTTER CAPACITY

The gutter cross-sectional areas given in Table C are provided for guidance only. Where more design detail is required, the aforementioned CSIRO Report 02.2.30 and The Institute of Engineers, Australia 'First Report of the Stormwater Standards Committee, Australian Rainfall and Run-Off' should be consulted.

Table C lists a selection of roof catchment areas that are drained by one downpipe and shows the cross-sectional area of gutter required for a range of rainfall intensities.

Australian Standard 2180 states that eaves gutters should have a fall towards the outlets of 1 in 500 and internal box gutters a fall of 1 in 200. If, for some design or other consideration, gutters are installed without fall, ponding will result. This could reduce the life of the gutter. In such situations the gutter should be cleaned out regularly.

The Referee

With high fronted eaves fascia-gutters, care should be taken, in the event of a blocked downpipe, to prevent overflow from the back of the gutter into the building. This can be done by providing drainage slots along the front of the gutter, at a lower level than the back of the gutter, or by providing extra downpipes.

Internal box gutters of more than 15 000 mm² cross-section, should be a minimum of 300 mm wide and fully supported to allow workmen to walk along the bottom of the gutter. Sheetting such as LBI SPANDEK HITTEN decking can be used under a wide box gutter to provide full support between the gutter hangers.

TABLE C – GUTTER SIZES FOR VARIOUS RAINFALL INTENSITIES AND ROOF CATCHMENT AREAS PER DOWNPIPE

Roof catchment area per downpipe ^a	10 m ²	20 m ²	50 m ²	100 m ²	200 m ²
Rainfall intensity ^b mm/hr	Cross-sectional area ^c of Gutter, mm ²				
100	1 480	2 570	5 360	9 320	16 230
120	1 680	2 930	6 100	10 620	18 490
130	1 790	3 120	6 500	11 310	19 690
140	1 900	3 310	6 890	12 000	20 890
150	2 020	3 510	7 310	12 730	22 170
170	2 230	3 880	8 080	14 070	24 490
180	2 350	4 090	8 500	14 810	25 770
190	2 460	4 290	8 920	15 540	27 050
200	2 560	4 450	9 270	16 140	28 100
250	3 060	5 320	11 080	19 290	33 590
275	3 310	5 760	12 000	20 890	36 360
375	4 240	7 390	15 370	26 770	46 590
400	4 430	7 700	16 040	27 930	48 620
500	5 190	9 030	18 790	32 720	56 960
525	5 380	9 360	19 480	33 930	59 060

^a The roof catchment area for each downpipe is the length of roof run (ridge to gutter) multiplied by the spacing between downpipes.

^b Rainfall intensities, related to a storm of 6 minutes duration and a return interval of once in 20 years and once in 100 years, are listed for major and other selected localities in Table B.

^c Eaves gutter sizes are based on rainfall intensities for an overflow of once in 20 years and internal box gutters for an overflow risk of once in 100 years.

A further margin of 25 mm freeboard, on the depth of internal box gutters, should be added to the cross-sectional areas given.

STEEL GUTTERS

Until recent years steel gutters have traditionally been galvanized. The adequate service provided by these gutters was largely due to the protective films developed on the zinc coating by reaction with beneficial compounds gathered from the roof by rain-water; these included zinc oxides and carbonates from the early oxidation of galvanized roofs and mainly calcium salts leached from asbestos cement or cement tile roofs.

Today, with the increased popularity of inert roofing materials such as COLORBOND steel, ZINCALUME steel and terracotta tiles, there is greater opportunity for the occurrence of shortened lives for galvanized gutters, especially in high rainfall areas near tropical coastlines, because of the high purity of the run-off water. The characteristics of the water running into gutters can be influenced by other factors such as atmospheric conditions, fallout, rainfall frequency and intensity.

It has now been established that long service can be assured from steel gutters used in combination with inert roofing materials and in all but the most severe environments if protected by the hot-dipped zinc/aluminium coating on to ZINCALUME steel.

The Lysaght recommendation for steel gutters is that ZINCALUME steel (either plain or as prepainted COLORBOND steel) specified in AS 2179 should be used in preference to galvanized steel.

DOWNPIPE CAPACITY

The cross-section of a downpipe from an eaves gutter should have 650 mm^2 for each of 10 m^2 of roof area draining into the downpipe.

The cross-section of a downpipe from an internal box gutter should have 650 mm^2 for each 7 m^2 of roof area draining into the downpipe.

However, the minimum cross-section of any downpipe should be at least half that of the gutter from which it drains.

It is good practice to provide drainage sumps at downpipe connections to gutters or at least funnels at the head of each downpipe, particularly for internal box gutters. Where possible downpipes should be spaced at no more than 18 m centres.

INSTALLATION AND SITE NOTES

INSTALLATION INSTRUCTIONS

Installation instructions for each Lysaght roofing and walling product are provided in individual product literature. A complete 'Steel Roofing and Walling Installation Manual' for all Lysaght claddings is available from Lysaght Offices or Distributors.

CARE AND STORAGE PRIOR TO INSTALLATION

Lysaght plain ZINCALUME, galvanized or organic coated steel roofing and walling products are normally delivered to the building site in strapped bundles.

If not required for immediate use, sheets or bundles should be neatly stacked clear of the ground and, if left in the open, should be protected from rain and moisture with tarpaulins or similar covers. On no account should sheeting in **any surface finish** be allowed to get wet while still bundled or nested in stacks. Rain or condensation is easily drawn between the surfaces of nested sheets by capillary action, or driven in by wind action, and as this trapped moisture cannot evaporate normally, it can cause deterioration of the coating which may lead to a reduced life expectancy or poor appearance.

If packs become wet the sheets should be separated without delay and the surface moisture removed with a clean cloth. The sheets should then be stacked so that air circulation completes the drying process.

Wet storage stain can occur from condensation alone – even in dry weather. **Keep the product dry.**

ATMOSPHERIC EXPOSURE CONDITIONS

If it is intended to use Lysaght steel products near salt marine locations, or in severe industrial or unusually corrosive atmospheric environments it is preferable that specialised advice be sought from a Lysaght Office. However, as a general guide Lysaght recommendations are provided in The Referee under the heading 'Atmospheric Exposure Conditions' (see index).

HANDLING ON SITE

On large building projects handling time can be reduced by lifting sheet bundles, by crane, direct from the delivery truck onto the roof frame. For long length sheets the use of a spreader bar and fabric slings is recommended for this operation. For small to medium size projects, without mechanical handling facilities, sheets can be unloaded by hand and passed up to the roof one at a time.

The Referee

To preserve the surface finish, and for personal safety, sheets should be handled wearing clean dry gloves. Do not slide sheets over rough surfaces or over each other and do not drag tools etc, over sheets.

CUTTING SHEETS ON SITE

If it is necessary to saw cut sheets on site, care should be taken to avoid cutting over other sheeting particularly when using power saws which project hot metal particles onto and, in the case of COLORBOND prefinished steels, possibly adhere to, the lower sheeting. Where cutting over other sheeting cannot be avoided, a protective covering should be placed over the lower sheets. When saw-cutting COLORBOND steel it is good practice to use padded supports and cut sheets with the face side downwards. Also, it is preferable to use metal cutting steel blades in power saws (minimum 4000 rpm) as they project fewer fine metal particles and leave less burred edge than carborundum discs.

PERFORMANCE

Lysaght roofing and walling will perform as specified if installed in accordance with the recommendations set out in individual product literature.

WALKING ON ROOF SHEETING

When walking along the length of roof sheeting walk in the trays of KLIP-LOK, BROWNBUILT and TRIMDEK HI-TEN steel and on at least two ribs or corrugations of SPANDEK HI-TEN and CUSTOM ORB steel. When walking across the length of roof sheeting walk over or close to the roofing supports. Generally, keep the load evenly distributed over the soles of both feet and try not to concentrate it on either heel or toe.

Always wear soft soled shoes, avoid the ribbed type that pick up and hold small stones etc.

Sheets taken freshly from packs may have an oily surface and care should be exercised when walking over them until the oil has had time to evaporate. This applies particularly to steeper pitched roofs.

The Referee

GALVANIC OR ELECTRO-CHEMICAL ACTION

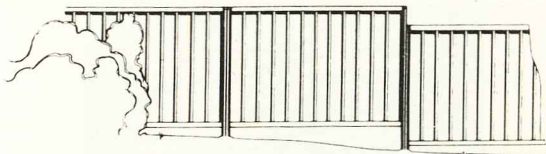
These terms refer to the corrosion set up when dissimilar metals are in contact with one another in the presence of moisture. In the case of zinc and steel, galvanic action leads to the protection of the steel by the sacrificial corrosion of the zinc. However, conditions can arise where zinc can be severely corroded by reason of its contact with dissimilar metals. In particular, contact with copper or brass, in the presence of moisture, will lead to the rapid removal of zinc from galvanized or ZINCALUME steel and likewise the corrosion of the underlying steel.

DO NOT use lead head nails or any lead as flashings, washers etc, in contact with ZINCALUME steel.

CLEANING UP

Normal installation procedures for roofing and flashing using self-drilling screws, drills, hack-saws, power saws or files will usually deposit metallic particles on or near the roof sheeting or roof area. These metallic particles and all other debris including blind rivet shanks, nails, screws, nuts, cuttings, swarf etc, should be swept from the roof sheeting, flashings and gutters as soon as possible; certainly at the end of each days' work and particularly on completion of the roof installation. Failure to take this precaution will result in unsightly staining of the surface as the metal particles oxidize during exposure. Corrosion and possible failure of the zinc/aluminium coating may take place when iron, lead or copper based materials are allowed to remain in contact with ZINCALUME steel surfaces subjected to moisture or condensation conditions.

LYSAGHT NEETASCREEN STEEL FENCING SYSTEM



NEETASCREEN fencing is a strong, impact resistant prepainted steel total fencing system for colourful dividing and wing fences, and for privacy around gardens and courtyards. The vertical-ribbed panels make the fence difficult for small children to climb.

The system utilises double-sided COLORBOND ZINCALUME profiled steel panel infills and specially designed COLORBOND steel posts and rails in matching or contrasting colours. The panels are colour finished on both surfaces, making the fence look the same from either side. Single or double matching gates are optional.

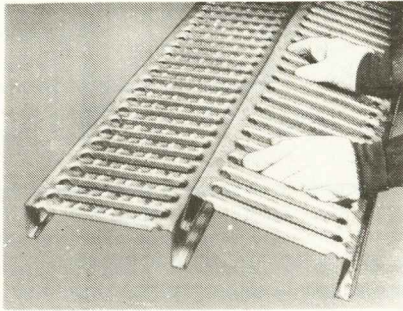
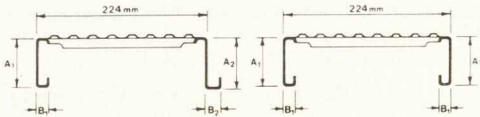
Fence heights are 1500mm and 1800mm. Assembled panel lengths approximate 2360mm and, if required, these panel lengths may be stepped to follow slopes of 1 in 8 with maximum steps of 300mm. Steeper slopes require shorter panel lengths.

If NEETASCREEN fencing is contemplated for use in cyclonic areas, specialized advice should be obtained from Lysaght Offices or product distributors.

Assembly and erection are simple and may be carried out by either the home handyman or a contractor.

Enquiries may be directed to Lysaght Offices or Lysaght fencing contractors.

LYSAGHT STEEL GRATING



Lysaght INTERLOK steel grating is a long-length roll-formed interlocking grating system suitable for numerous underfoot applications such as walkways, catwalks, platforms, ramps, decking, and for rack shelving.

A range of stair treads and accessories is also available.

Material: Zinc-coated steel to AS 1397 G300 Z275 in 1.2 and 2.9 mm thicknesses.

Stock lengths: 6000 mm, other lengths by arrangement.

Surface finishes: Regular or anti-skid.

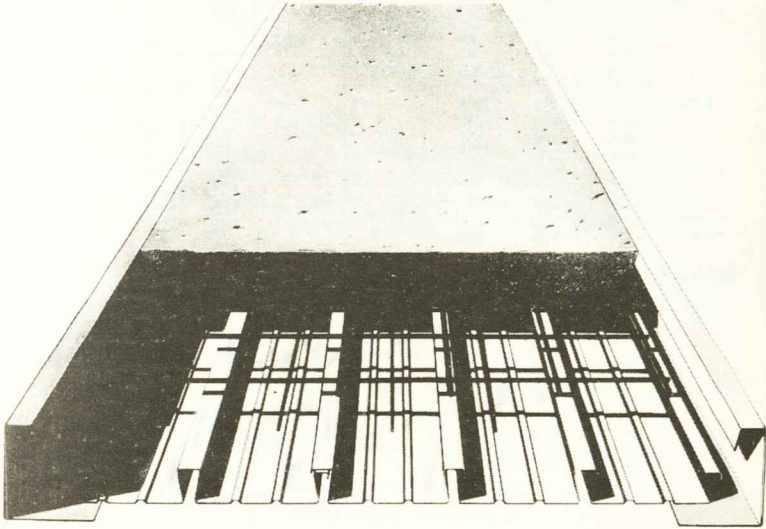
Leg shapes: Double male or male/female

Catalogue number	Thickness, mm	Dimension, mm				Mass per unit length, kg/m	Mass per unit area, kg/m ²
		A1	A2	B1	B2		
G06512	1.2	63	65	15	20	3.7	16.5
G06520	2.0	64	66	16	21	6.1	27.2

STRUCTURAL DECKING

BONDEK DECKING

Lysaght BONDEK is a high strength zinc-coated steel composite which acts as both permanent formwork and positive tensile reinforcement in one-way reinforced suspended concrete slab construction.



It is suited for most types of construction, high rise steel or concrete framed buildings, load-bearing brickwork as in home units, cottages, hospitals, motels and many other applications.

BONDEK composite slab construction conforms to SAA Concrete Structures Code AS 1480. Panels are roll-formed from zinc-coated steel in steel base thicknesses 0.75 and 1.0 mm to AS 1397 G550 Z200. BONDEK sheets provide an effective cover width of 600 mm with interlocking ribs at each edge for side lapping. Lengths are custom cut to project requirements, limited only by transportation and handling considerations in the factory and on site.

The Referee

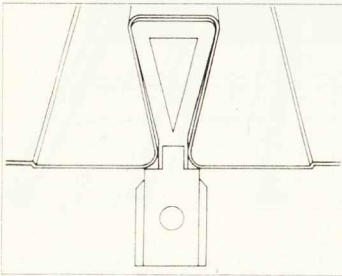
SLAB SELECTION — SIMPLE SPANS

Bondek steel thickness, mm	Span, mm	Minimum slab depth, mm, for superimposed load of		Proping
		2 kPa	4 kPa	
0.75	1500	90	90	No props required
	1800	90	90	
	2100	90	90	
	2400	90	90	
	2700	90	100	1 row props
	3000	100	110	
	3300	110	120	
	3600	120	130	
	3900	130	150	
	4200	140	170	2 rows props
1.0	4500	150	180	

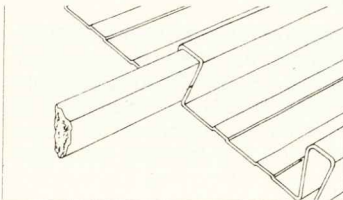
MINIMUM SECONDARY REINFORCEMENT TO AS 1480

Slab depth, mm	Conditions	
	Normal indoor	External and exposed
	Fabric number	
90	F42	F52
100	F52	F62
110	F52	F62
120	F52	F62
130	F62	F72
140	F62	F72
150	F62	F72
160	F62	F72
170	F72	F82
180	F72	F82

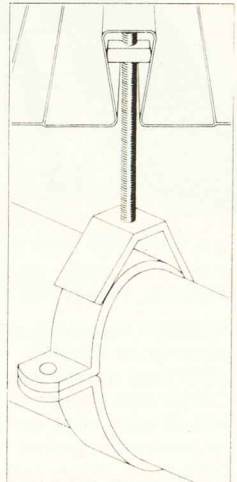
BONDEK ACCESSORIES



Bonwedge Suspension Bracket



Bonfill



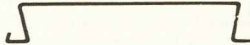
Pipe Suspension Using Bon-Nut

The Referee

TRI-LOK

Lysaght TRI-LOK decking is a strong, parallel interlocking steel structural system. Applications include wall and roof cladding, structural floors and roofs, ceilings, awnings, facades and other specialised architectural features.

The panels are formed from AS 1397 G250 Z275 zinc-coated steel in a range of sizes. Profile variations are to the web depths (50,75,100 mm) and flange widths (255,300 mm)

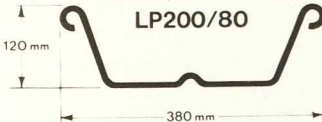
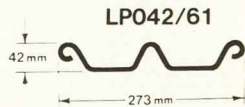


LYSAGHT SHEET PILING

Lysaght Sheet Piling are high strength structural steel panels cold roll-formed from AS 1594 Grade 280 hot rolled steel, 6mm and 4.8mm thick. They are designed for the efficient construction of virtually all earth and watertight permanent or temporary walls, either straight or contoured (free form).

Two profiles are manufactured: LP042/61 for where a lightweight section is adequate; LP200/80 for medium-duty applications outside the capacity of lightweight sections but below the point where the heavier BHP Steel hot rolled steel pilings become necessary.

Lysaght Sheet Piling is long lasting, extremely resistant to scouring forces, and extractable for re-use.



Cat No	SINGLE SECTION		INTERLOCKED WALL		Standard* lengths, m
	Steel thickness, mm	Mass per unit length, kg/m	Wall thickness, mm	Mass per unit area, kg/m ²	
LP200/80	6	27.9	200	79.8	5, 8, 12, 14
LP042/61	4.8	14.9	42	60.9	2.4, 3, 4.2, 4.8, 5.4, 10.8

* Custom cut lengths available subject to enquiry.

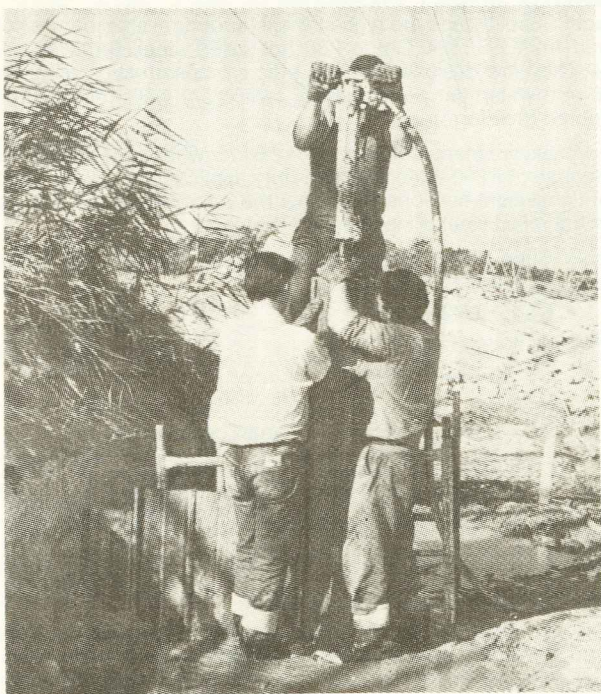
Handling, driving and extraction are assisted when proper practices and precautions are used. Holes for extraction can be provided near sheet ends, or special extracting machines with positive grip clamps may be used.

The Referee

Typical applications include:

- Trenching: pipe-laying and similar operations.
- Water conservation: dams, dam cores, well housings, coffer-dams.
- Waterways: canal walls, lakeside walls, dock walls, bulkheading, development of recreational areas.
- erosion control: check dams, beach groynes, cliff protection, dyke walls.
- Structural: excavation and retaining walls, under-pinning, formwork, machine-well linings, bridge decks and piers, footing, jetties, docks, causeways.

Full details are available from Lysaght Offices



EXPANDED METAL MESHES

Expanded metal meshes are used in almost every branch of engineering and building. They are made from sheet metal which, by slitting and expanding, without any waste of material, is converted into a network or diamond or other special shaped openings.

Unlike netting, expanded metal is not an interlacing of loose or separate pieces; the strands are all part of the parent metal, rigidly unified at their junctions.

Expanded metal meshes are produced in a variety of types and styles.

Lysaght METALATH – as a base for wet plaster work in the building trade.

Lysaght ORNAMEASH – for industrial, decorative and general use where a high degree of accuracy and finish is required.

Lysaght Restricted Vision (RV) Insect Screen Mesh – for use on security doors where both insect screening and restricted one-way vision is desirable.

Lysaght Balustrade Mesh – for balcony and stair railings, screen doors, room dividers and security partitions and doors.

Lysaght Louvre Mesh – for sun screens, wind breaks and privacy screens, infill panels, facades and soffits.

Lysaght MULTIMESH – for lightweight decorative and sun screens, infill panels, room dividers, baskets, grilles, etc.

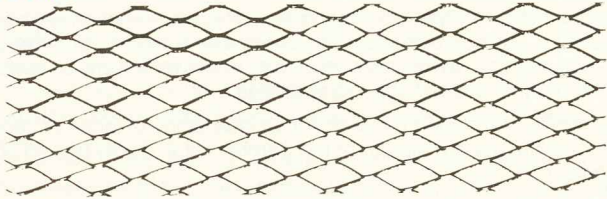
Lysaght GRIDMESH – produced from heavy steel plate for use on catwalks, work platforms, stair treads, livestock floors, etc.

Within the ORNAMEASH, Balustrade Mesh and GRIDMESH ranges are many types suitable for the screening of doors, windows and other points against illegal entry or damage.

Many ductile materials such as steel, aluminium, copper, brass and other alloys, can be expanded, but the chief material for expanded metal meshes is high-grade low carbon steel sheet. Many steel meshes are also available galvanized.

The Referee

METALATH



METALATH galvanized steel lathing mesh is used extensively in the building industry, particularly as a base for plaster ceilings, ceramic wall tiles on timber frames, soffits and other architectural effects. METALATH is widely used also to support fireproofing sprays on steel columns and beams in fire rated construction and for cement rendering.

METALATH is produced in two styles:

Catalogue number	Application
PL25, FL25	For general plastering and wall tiling
PL34, FL34	For lightweight fireproof construction

All available in sheets 685 mm wide x 2400 or 2700 mm long. PL25 is also produced in 60 metre coils; longer subject to enquiry.

Accessories A complete range of accessories for walls, ceilings and partitions is available for use with METALATH.

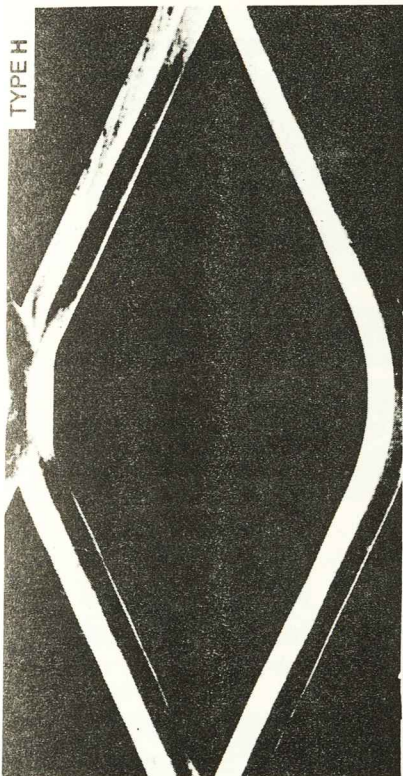
ORNAMESH

ORNAMESH is used extensively in industry for machinery guards, shelving pallets and racking; in manufactured products and equipment of all kinds; and in the building industry for concrete formwork, partitions, room dividers and similar applications.

It admits light and air and permits easy vision, yet it forms an effective barrier against entry, helps prevent accidents and has numerous other uses.

In some uses such as machinery guards, ironing boards, functional furniture and storage bins, a particularly smooth and flat surface is desirable. In these cases, Flattened Steel ORNAMESH is the best choice.

ORNAMESH is supplied in zinc-coated or uncoated steel, or in aluminium, depending on the mesh type required.



TYPE T



TYPE P



TYPE R



TYPE S



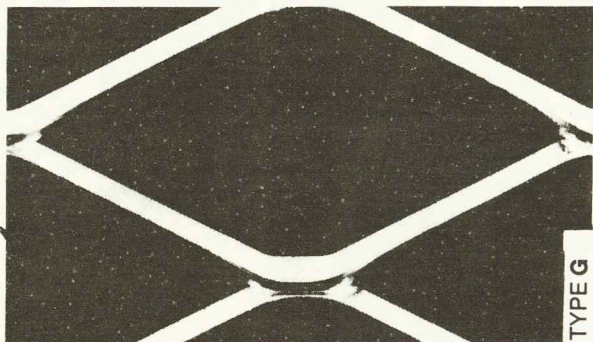
TYPE Q



TYPE A



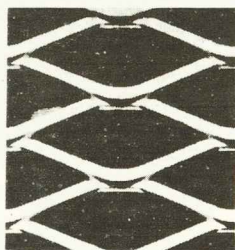
TYPE M



TYPE G

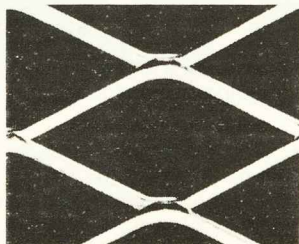


TYPE F



TYPE C

TYPE D



BALUSTRADE MESH

Balustrade Mesh is an ornamental expanded metal with a high percentage of open area giving the appearance of delicate wrought iron.

It is intended for internal and external balustrades, grills and dividers, window and door protectors, security partitions and stair railings. Four standard patterns are supplied in uncoated or zinc-coated steel or in aluminium in sizes to suit most domestic or architectural applications.



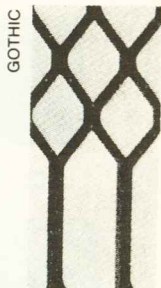
CAMELOT



PACIFIC



ARABESQUE



GOTHIC

LOUVRE MESH

Louvre Mesh is primarily a sun screen mesh. Because of the unique hooded mesh formation, which occupies only 20% of the total area, it forms an effective shield from the sun's rays, yet it permits free passage of air. Durability is assured by the use of galvanized steel.

In addition to being used for sun screens, Louvre Mesh is also suitable for infill panels, facades, and soffits. When Louvre Mesh is erected with the slit openings in a vertical position it can form a highly effective wind deflector for exposed balconies, patios, enclosed verandahs and outdoor living areas. Louvre Mesh can be left plain galvanized to blend with modern building styles or can be painted with readily available paints.



The Referee

MULTIMESH

The Lysaght MULTIMESH range of eight meshes meets the many needs of the hobbyist and home handyman. All sheets are 600 x 900 mm.

MULTIMESH is lightweight but strong and is easily worked. Its multitude of uses ranges from air vents and fire grilles to display stands and screen doors.



LACE (Q 0510-Steel)

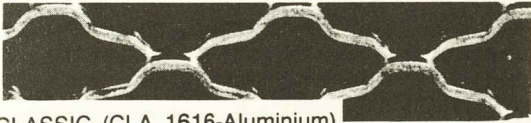


HONEYCOMB (R 0820-Steel)

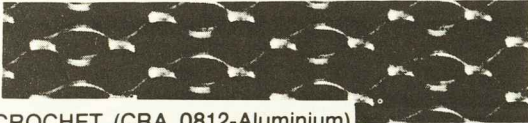


FRETWORK (C 1015/F-Steel)

The Referee



CLASSIC (CLA 1616-Aluminium)



CROCHET (CRA 0812-Aluminium)



FILIGREE (PA 0510-Aluminium)



LATTICE (DA 0820-Aluminium)



FINELINE (CA 0815-Aluminium)

The Referee

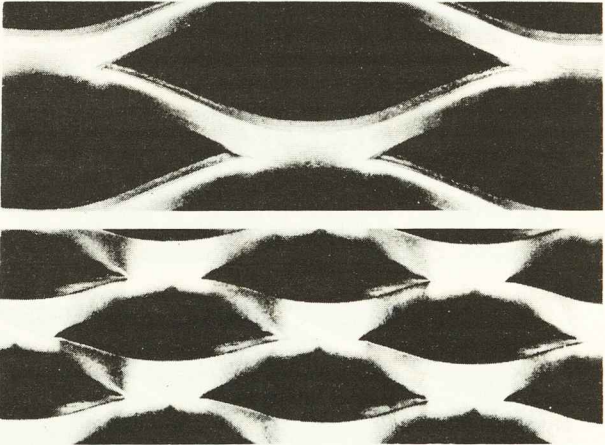
GRIDMESH

GRIDMESH is the heavy duty mesh in the Lysaght range. Its uses include heavy duty walkways and stair treads, gratings, ramps, flooring, work platforms, security screens, farrowing pens and abattoir floors.

The GR series is a comparatively open mesh for general use. GM series is for heavy duty use and where a smaller mesh opening is desirable.

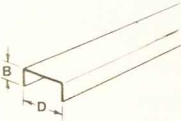
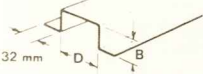
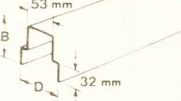
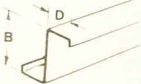
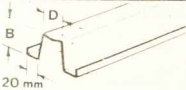
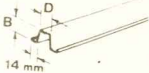
Meshes for farrowing (FM) and weaner (WM) floors are supplied in a flattened condition.

GRIDMESH is supplied in zinc-coated or uncoated steel or in aluminium.



LYSAGHT STEEL HOUSE FRAMING SYSTEMS FOR FLOORS, WALLS AND ROOFS

Lysaght supplies steel framing components for fabrication into wall, roof and floor frames in domestic cottage construction. The components are roll-formed from either zinc-coated or ZINCALUME zinc/aluminium alloy-coated steel.

Profile, mm	Section	Dimensions D x B, mm	Steel base thickness, mm
	Standard Plate Stud Nogging Light Duty Stud Hip Rafter (Nesting sections)	78 x 31 75 x 32 72 x 34 75 x 32 104 x 35	1.2 1.2 1.2 0.8 1.6
	Junction Stud	75 x 38	1.2
	Stiffened Plate	79 x 75	1.6
	Truss Chord	53 x 102	1.6
	Roof Batten	25 x 50	0.75
	Ceiling Batten	20 x 25	0.42

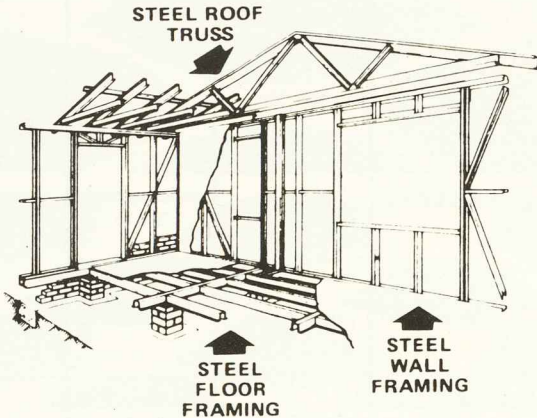
The Referee

Frame assembly is carried out by experienced fabricators to specifications accepted by local councils and lending authorities.

Steel frames will not warp, twist, shrink or deteriorate in normal use. Other features include:

- High strength with economy, long life and reliable performance.
- Rapid construction. Factory fabricated frames are delivered to the building site ready to erect.
- Straightness, rigidity and stability, eliminating wall cracking, fastener popping and door and window jamming.

The frames are compatible with all other materials currently used in home construction such as bricks, plasterboard, timber and flooring materials.



Comprehensive literature on steel framing and details of steel frame fabricators are available from Lysaght Offices.

PURLIN AND GIRT SYSTEMS

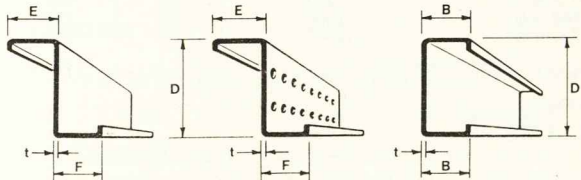
LYSAGHT ZED AND C SECTIONS

Lysaght Zed and C sections are lightweight structural members designed in accordance with the SAA Cold Formed Steel Structures Code, AS 1538. Cold roll-formed from high strength zinc-coated steel, they are specially designed for use as purlins and girts for the support of roofing and walling sheets.

The Zed profile has unequal flanges for lapping and additional strength. Downturn bottom lip is available on request.

Zed and C purlins and girts are supplied prepunched to suit most requirements. The range of accessories includes fascias, SPRING-LOK, bridging, bolts and nuts.

An additional Zed section, REDI-ZED, prepunched with 20mm round holes at 40 mm centres along its length, is available in the 150 and 200 series.



Cat No	* ZED SECTION				ZED or C SECTION	C SECTION			Cat No
	Dimension, mm				Mass per unit length, kg/m	Dimension, mm			
	D	E	F	t		D	B	t	
*Z10016	102	53	49	1.6	2.77	102	51	1.6	C10016
*Z10020	102	53	48	2.0	3.45	102	51	2.0	C10020
*Z15012	152	65	61	1.2	2.88	152	64	1.2	C15012
*Z15016	152	65	61	1.6	3.80	152	64	1.6	C15016
*Z15020	152	65	61	2.0	4.73	152	64	2.0	C15020
*Z15025	152	66	60	2.5	5.89	152	64	2.5	C15025
*Z20016	203	79	74	1.6	4.77	203	76	1.6	C20016
*Z20020	203	79	74	2.0	6.01	203	76	2.0	C20020
*Z20025	203	79	73	2.5	7.48	203	76	2.5	C20025
-	-	-	-	-	6.81	254	76	2.0	C25020
-	-	-	-	-	8.48	254	76	2.5	C25025
†Z30025	300	100	93	2.5	10.54	-	-	-	-
†Z30032	300	100	93	3.2	13.43	-	-	-	-
†Z35032	350	129	121	3.2	16.24	-	-	-	-

*Redi-Zed available in these sizes. Prefix letters are RZ.

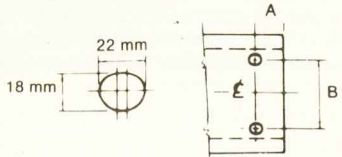
†Big Zed.

The Referee

A comprehensive technical purlin brochure, which includes load/span tables and section properties, is available from Lysaght Offices.

HOLE DETAILS AND GAUGE LINES FOR LYSAGHT ZED AND C SECTIONS

Lysaght standard elongated punched hole. Holes equally spaced above and below centre line.



Purlin or Girt		Dimension, mm	
Profile	Nominal web depth, mm	A	B
Zed & C	100	35	40
Zed & C	150	35	60 (70 Vic only)
Zed & C	200	35	110
C only	250	35	160
Zed only	300	35	210
Zed only	350	35	260

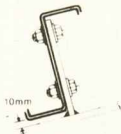
REDI-ZED has 20 mm round holes punched at 40 mm centres along its length.

CLEATS

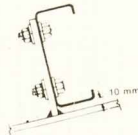
8 mm is the recommended steel thickness for cleats up to and including the 250 series. For the 300 and 350 series, cleats will be to consulting engineer standards.

Cleat dimensions and holing are detailed in the appropriate Lysaght brochures.

FASTENING TO CLEATS



Zed Purlins
lapped



C Purlins

The Referee

COLD FORMED STEEL CHANNELS, ANGLES AND CONVEYOR SECTIONS

Lysaght steel sections are roll-formed from zinc-coated or hot rolled steel strip as Angles, Plain Channels, Lipped Channels (ex stock) and Top Hot Channels and Conveyor Sections (by arrangement) in steel thicknesses 1.6 to 3.2 mm. Variations to standard dimensions may be produced by arrangement.

The strong lightweight sections in a range of sizes have many uses in the fields of construction and general fabrication. Sections are readily fastened by welding, mechanical fastening, adhesives or integral fastening methods. Some sections will nest into others.

LC05116 will nest into LC05725
LC05132 will nest into LC05725
LL05116 will nest into LC05725

LC05725 will nest into LC06425
LC09532 will nest into LC10332

PLAIN CHANNELS

Standard length 6000 mm

(n/a = not available)



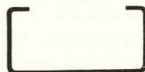
Cat No	Web, mm	Flange, mm	Base steel thick, mm
LC01916*	19	13	1.6
LC02516*	25	13	1.6
LC03816	38	17	1.6
LC05116*	51	15	1.6
LC05132	51	26	3.2
LC05725	57	27	2.5
LC06425	64	23	2.5
LC07632	76	38	3.2
LC08332*	83	36	3.2
LC08932	89	32	3.2
LC09532	95	37	3.2
LC10232	102	56	3.2
LC10332	103	34	3.2
LC12732*	127	50	3.2
LC15232	152	51	3.2

The Referee

LIPPED CHANNELS AND TOP HAT SECTIONS

Standard length 6000 mm

(n/a = not available)



Cat No	Web, mm	Flange, mm	Lip, mm	Base steel thick, mm
LL05116	51	35	10	1.6
LL06425	64	38	13	2.5
LL07625	76	44	14	2.5
LL10225	102	51	18	2.5
LL10232*	102	51	18	3.2
LL12725*	127	51	18	2.5
LL12732*	127	51	18	3.2
LL15232	152	64	18	3.2
LL20332*	203	76	21	3.2

ANGLES

Standard length 6000 mm



Cat No	Leg lengths, mm	Base steel thick, mm
LA2725	27 x 27	2.5
LA3225	32 x 23	2.5
LA4032°	40 x 40	3.2
LA4632	46 x 35	3.2
LA5132	51 x 30	3.2

Top hat sections are available subject to negotiation.

*Denotes hot rolled section produced only

° Denotes galvanized section produced only

CONVEYOR SECTIONS

Standard lengths 5990 mm to suit 6 m conveyor modules, other lengths may be available by arrangement. Punched to customer needs.



Designation	Web, mm	Plain flange, mm	Lipped flange, mm	Lip, mm	Steel thickness, mm
*CS10032	100	45	50	24	3.2
CS15032	150	55	75	24	3.2
CS20032	200	55	75	24	3.2
*CS25032	250	55	75	24	3.2
*CS30032	300	80	100	29	3.2

*Subject to quantity

CUSTOM COLD ROLL-FORMED SECTIONS

Custom Cold Roll-Forming is a service offered by Lysaght Building Industries to manufacturers and designers to meet their requirements when standard sections are unsuitable. A great variety of shapes and sizes can be produced with accuracy and consistency.

Roll-forming is a continuous process whereby coils of flat strip or other metals are progressively shaped into a simple or complex section by passing through a series of roller dies in tandem. This enables production of long lengths virtually limited only by ability to handle and transport.

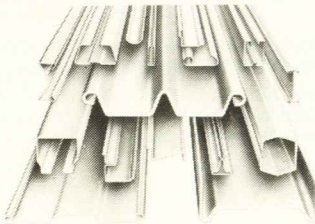
Other operations can be accomplished simultaneously during a mill run or after rolling. These include bending, punching, drilling, notching and welding. Such operations at this stage often obviate the necessity for extra work to be carried out by the client or another supplier.

The tooling design service team, available for consultation, can be used to assist in planning the most efficient section profile for specific needs.

Components can often be redesigned or the number reduced by the roll-forming specialist, giving a more economical and practical product design. In many instances needs can be met from the vast range of standard tooling, or a modification thereof, giving even greater economies.

All enquiries should be directed to Lysaght Offices.

Some typical examples of custom roll-formed profiles are shown.



LYSAGHT BUILDERS' STRAPPING



Lysaght Builders' Strapping is strong galvanized steel strapping available in three popular width/thickness combinations.

Material is zinc-coated steel conforming to AS 1397 G250 Z275 specification. Normal supply is 100 m coils but 50 m coils and other lengths, widths and thicknesses may be supplied subject to enquiry.

Builders' Strapping is typically used for:

- Fastening door and window frames to brickwork.
- Wall ties for brick veneer and full brick.
- Tying timber plates to brickwork.
- Diagonal wall bracing in timber construction.
- Ceiling hangers.
- Purlin ties.
- Wall straps for vent pipes and downpipes.
- Straps for fastening timber battens to concrete with power fasteners.
- Timber truss work.
- Straps and ties for concrete formwork.
- Tie rods for vent pipes.
- Ventilation cowl construction.
- Small brackets and angle pieces.

Approximate mass per 100 m coil:

25 x 1.2 mm	24 kg
32 x 1.2 mm	31 kg
25 x 1.0 mm	20 kg

Lysaght Builders' Strapping is obtainable from Lysaght distributors.



LYSAGHT EZYFRAME BUILDINGS

Lysaght Ezyframe Buildings is a division of Lysaght Building Industries.

Rural and many other industries require strong, functional buildings suitable for a multitude of uses including:

machinery sheds	workshops
storage sheds	hay sheds
aircraft hangars	industrial buildings
grain sheds	shearing sheds
poultry sheds	

Such requirements can be met by the use of EZYFRAME Buildings. These are modular prefabricated steel buildings, gable or skillion, available in a range of spans, heights and bay sizes. For adaptability to suit individual requirements, range of accessories such as sliding and roller doors, personnel access doors, windows and translucent skylights is provided. The buildings can be extended or re-located.

Structural frame members are galvanized steel, precut and prepunched to be readily bolted together, no on-site cutting or welding being required. Roof and wall cladding is Lysaght profiled ZINCALUME or COLORBOND Prepainted steel.

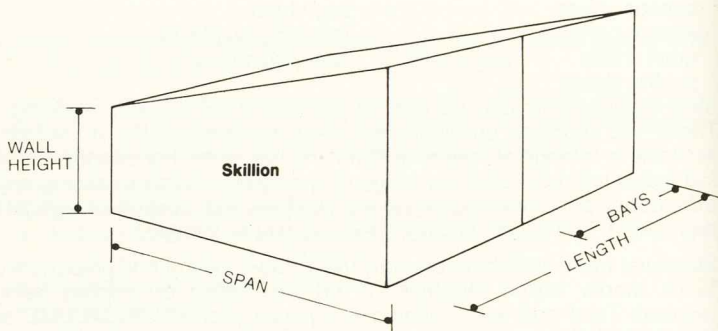
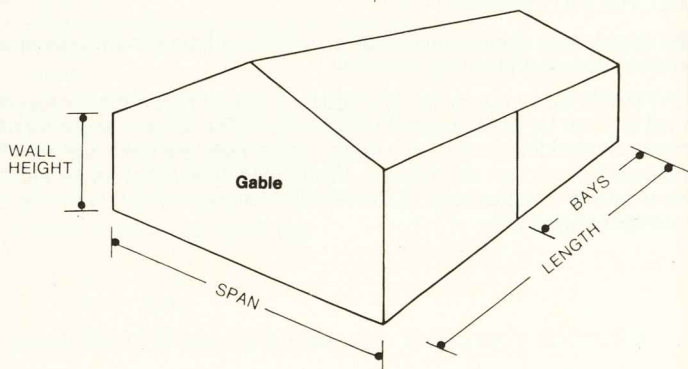
The steel frame, clear span design provides unobstructed interior space without internal supporting columns.

EZYFRAME buildings can be erected by a distributor/erector or supplied in full kit form for do-it-yourself construction. The kit contains structural members, cladding, foundation bolts, cleats, nuts and bolts, accessories and detailed erection instructions. When erected in accordance with the manufacturer's instructions, EZYFRAME buildings comply with relevant Australian Standards.

The Referee

BAY LENGTHS IN METRES

Span	Lowest wall height				
	3 m	3.6 m	4.2 m	4.8 m	5.5 m
Skillion Roof 6 m series	4.5 & 6	—	—	—	—
Gable Roof 6 m series	4.5	—	—	—	—
9 m series	6	6	6	6	—
12 m series	—	6	6	6	—
15 m series	—	—	6	6	—
18 m series	—	—	—	6	6

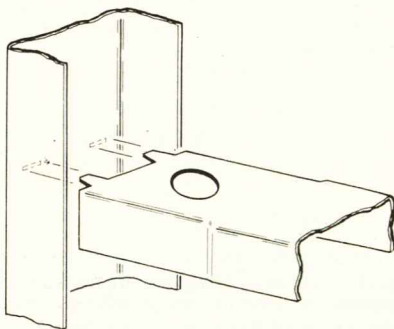


Arrow Framing Systems

Arrow Framing Systems is a business unit of Coated Products Division which manufactures and markets domestic steel framing. The framing is used for houses and a variety of other applications such as storage units, roof framing for flats and retirement villages. The product is the result of extensive research over approximately 5 years and was introduced to the Australian market in 1985.

The wall frames, roof trusses and floor framing are custom made to suit the requirements of architectural plans provided by the customer.

Arrow processes all Australian ZINCALUME steel into "C" shaped sections which are the components of the wall frames and roof trusses. The computerised production process punches the tabs and slots (for tab-into-slot assembly) as shown in the sketch below. Also provided are pre-punched in-line service holes for plumbing and electrical installation.

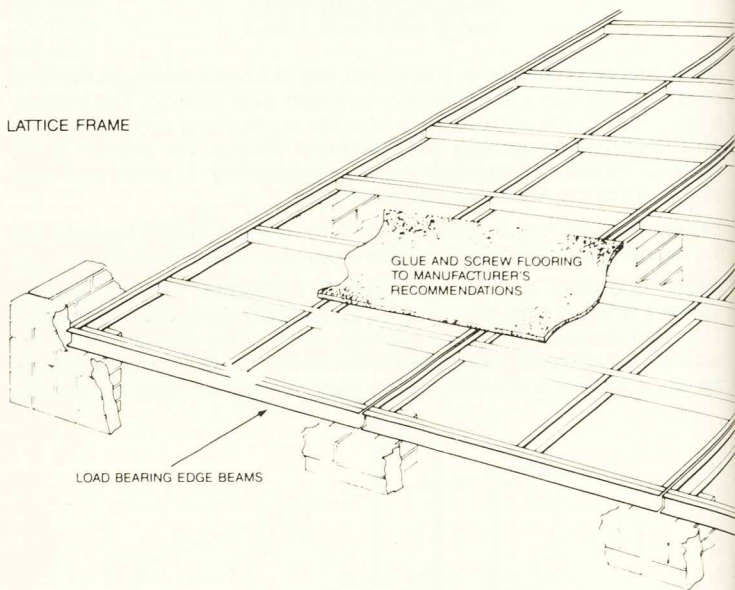


TAB INTO SLOT ASSEMBLY

Floor Framing

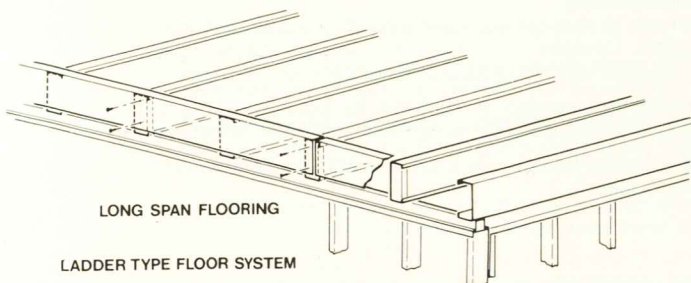
(a) For suspended floors on piers.

Floor framing on piers at 1800 mm centres consists of a pre-fabricated "ladder" type system which is placed over the piers. The pier layout is dependent on the design of the house and is determined by Arrow.



(b) For "long span" floors.

Long span or upper floors are constructed using Lysaght Building Industries "C" purlins as joists. The joists are spaced at 600 mm centres. "Bridging" members are used to prevent rolling of the joists. Stiffening members are also provided to prevent local crippling under load bearing jamb studs.

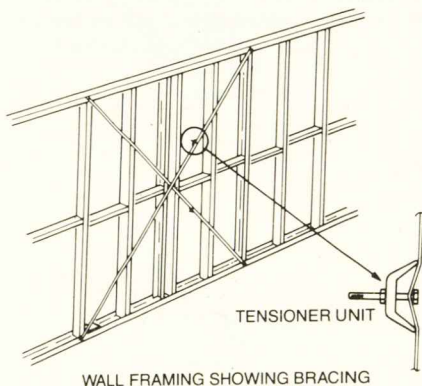


Wall Framing

Wall frames consist of pre-fabricated panels with studs at 600 mm centres. Openings are provided in the frame according to the window and door sizes shown on the window and door schedule provided by the customer.

A top plate stiffener allows roof trusses to be landed at any location along the top plate.

Bracing is by means of strapping tensioned with brackets and screwed to studs.

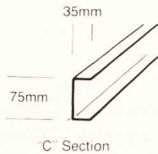
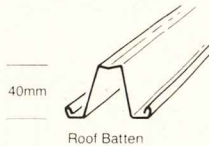
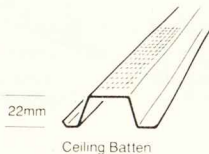


Roof Framing

Virtually all roof designs can be constructed using Arrow's patented roof system. Designs include hip and valley, straight gable, dutch gable, ranch style with verandahs or a combination of these.

Trusses are spaced at 1200mm for both tile and sheet roofs. Steel battens are supplied for fixing of roof cladding (sheet or tiles).

Steel ceiling battens are clipped at 600 mm centres to the underside of the trusses.



The Referee

Following Trades

Arrow caters for all the trades which follow the frame to the site.

Plumber – service holes are pre-punched in line and in every stud. Special plumbing grommets are supplied which snap into these holes.

Electrician – as for the plumber, electrical grommets snap into the service holes. Power point brackets are fixed to the studs using self-drilling screws.

Plasterboard fixer – self-drilling screws are used together with stud adhesive supplied by the board manufacturer. The screws are driven by a screw gun.

Internal carpenter – blocks are provided in jamb studs and for fixing the frame down through the bottom plate. Skirtings and jambs are fixed to these. Windows are nailed to the blocks.

Roof tiler – roof tiles are fixed to the battens using a wire clip supplied with the frame.

Bricklayer – wire type brick ties are supplied. These fix to the flange of the stud and the other end is embedded in the mortar.

Electrically safe

The Arrow steel framed house will conform to Australian Standards and will not be connected to the power supply unless it meets the local electricity authority's wiring regulations.

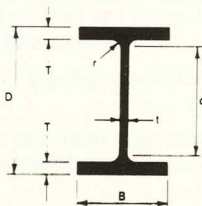
STRUCTURAL STEEL

Structural steels are covered by AS 1204, 'Structural Steels – Ordinary Weldable Grades'. The regular 'normal strength' steel that is widely available from distributors and stockists is Grade 250.

It is produced in a range of shapes and sections, including Universal Sections, Taper Flange Beams, Channels, Equal and Unequal Angles.

The entire range is detailed in AS 1131, 'Dimensions of Hot-Rolled Structural Steel Sections', and includes large and heavy members mostly used in fully-engineered structures. The tables here list the dimensions of some lighter sections.

UNIVERSAL SECTIONS

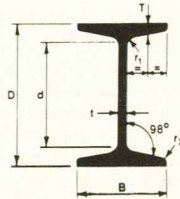


Dimensions

Designation	Mass per length, kg/m	Depth of section D, mm	Flange		Web thickness t, mm	Radius root r, mm	Depth between fillets d, mm	Area of section, mm ²
			Width B, mm	Thickness T, mm				
410 UB 54	53.7	403	178	10.9	7.6	10.2	361	6840
360 UB 45	44.7	352	171	9.7	6.9	10.2	312	5700
310 UB 40	40.4	304	165	10.2	6.1	8.9	266	5150
250 UB 31	31.4	252	146	8.6	6.1	7.6	219	4000
200 UB 25	25.4	203	133	7.8	5.8	7.6	172	3230
180 UB 18	18.1	175	90	8.0	5.0	9.0	141	2300
150 UB 14	14.0	150	75	7.0	5.0	8.0	120	1780
100 UC 15	14.8	97	99	7.0	5.0	10.0	63	1890

The Referee

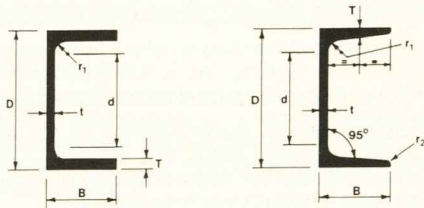
TAPER FLANGE BEAMS



Dimensions

Nominal size, mm	Mass per length, kg/m	Depth of section D, mm	Flange		Web thickness t, mm	Radii		Depth between fillets d, mm	Area of section, mm ²
			Width B, mm	Thickness T, mm		Root r ₁ , mm	Toe r ₂ , mm		
125 x 65	13.1	125	65	8.5	5.0	8.0	4.0	89.9	1670
102 x 45	7.2	100	45	6.0	4.0	7.0	3.0	72.9	917

CHANNELS



Dimensions

Nominal size D x B, mm	Mass per length, kg/m	Thickness		Area of section, mm ²	Radii		Depth between fillets d, mm
		Web t, mm	Flange T, mm		Root r ₁ , mm	Toe r ₂ , mm	
Parallel Flange							
200 x 75	23	6.0	12.0	2912	12	—	152
180 x 75	21	6.0	11.0	2660	12	—	134
150 x 75	18	6.0	9.5	2254	10	—	111
Taper Flange							
127 x 64	15	6.4	9.2	1900	11	2	84
102 x 51	10	6.1	7.6	1330	9	2	65
76 x 38	6.7	5.1	6.8	855	8	2	45

The Referee

Advice on the use of structural steel can be obtained from the Australian Institute of Steel Construction, PO Box 434, Milsons Point, NSW 2061. AISC also publishes a number of books on steel design, including a useful publication for home builders 'How to Use Steel in Homes'. This booklet gives advice in non-technical language on the selection of steel beams, columns, lintels, etc, in domestic construction. Information on steel beams commonly used in home building has been extracted from the booklet and appears in a condensed form in the next few pages.

Acknowledgement is made of the assistance given by the AISC in the preparation and updating of this section on structural steels.

SAFE LOAD TABLES

The Simplified Beam Load tables list the safe distributed load that can be carried by Universal Sections and Taper Flange Beams when used as simply supported beams over various spans. In using these tables the following points should be carefully noted.

- (i) the tables are for Grade 250 steel.
- (ii) loads are given as safe distributed loads, ie, spread evenly along the beam, and are expressed in kilonewtons. 1 kilogram imposes a load of 9.81 newtons; 1 tonne imposes a load of 9.81 kilonewtons.
- (iii) it is important that beams should be long enough to have adequate support or 'landing'. As a rule-of-thumb, the length of support at each end should be no less than the width of the flange, B.
- (iv) beams used as crane runways or for any hoisting purpose are subject to point loads and dynamic loading conditions. **These situations call for special design rules and the tables must NOT be used to select such members.**
- (v) the tables are intended to help in selecting beams to span openings in domestic and similar forms of construction where full engineering designs are not warranted. Where there are more complex conditions the services of a structural engineer should be sought.

SIMPLIFIED BEAM LOAD TABLES

(By Courtesy AISC)

Normal Strength Steel (Grade 250)

Designation	Mass per metre, kg/m	Safe distributed loads in kilonewtons, Spans in metres									Maximum centres of lateral* restraint, m
		2	2.5	3	3.5	4	5	6	7	8	
UNIVERSAL SECTIONS		SEE NOTE									
410 UB 54	53.7					315	251	209	158	120	2.42
360 UB 45	44.7				266	233	185	141	102	77	2.39
310 UB 40	40.4				219	191	143	98	71	53	2.36
250 UB 31	31.4		193	160	137	117	74	50	36	27	2.10
200 UB 25	25.4	158	126	105	81	62	39	26	19		1.97
180 UB 18		95	76	57	42	32	20	13			
150 UB 18		80	61	42	31	23	15				
100 UC 15	14.8	33	21	14	10	8					1.88
TAPER FLANGE BEAMS											
127 x 64 mm	13	48	30	21	15	11					1.07
102 x 45 mm	7	16	10	7							0.70

Note: For these short spans the load given to the right of the heavy line should not be exceeded without the advice of an Engineer.

*Lateral Restraint: Beams that directly support floor systems (concrete or timber) and are firmly connected to them can be regarded as being fully restrained. Other beams should have their top flanges restrained laterally at not more than the centres tabulated:

STEEL BEAMS IN HOME BUILDING

Steel beams are commonly used in home building to provide a safe and economic means of spanning wide openings. These condensed notes and tables have been extracted from 'How to Use Steel in Homes'. For proper use of this information, reference should be made to the supporting data published in the booklet.

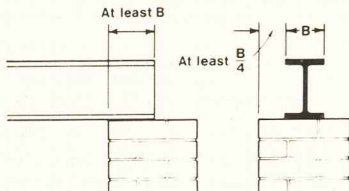
Design Loads

Loading due to wind is a complex matter which is beyond the scope of this publication, and whenever wind load (especially wind suction) is a consideration the advice of a structural engineer should be sought. Wind load is always an important consideration in roof structures, and may be a critical factor in light sheet roofs, especially those of low pitch. Wind load will not normally be a consideration for floor beams.

In some parts of Australia there may be a need to design for special loading circumstances such as those caused by cyclones, earthquake, mine subsidence, etc. All of these situations require the expertise of a structural engineer.

The Referee

WARNING – CRANE BEAMS used as crane runways, or for any hoisting purpose, are subject to point loads and dynamic loading conditions. These situations call for special design rules and for detailed analysis. Therefore this method must not be used to select such members.



A sufficient area of end support is necessary so that the bearing pressure on the supporting medium is kept within safe limits. As a general rule-of-thumb the support length at each end of the beam should be no less than the width B of the member.

In addition to providing adequate support length, brick piers should project on either side of the bottom flange of the steel beam by a distance at least equal to $B/4$.

The Referee

STEEL BEAM SELECTION TABLES

Table A – DIMENSIONS OF HOT-ROLLED SECTIONS

Code No	Designation	Mass per metre, kg/m	Depth D, mm	Flange		Web thickness, mm	Radii	
				Width B, mm	Thickness T, mm		r ₁ , mm	r ₂ , mm
UNIVERSAL SECTIONS								
①	310 UB 40	40.4	304	165	10	6	9	—
②	250 UB 31	31.4	252	146	9	6	8	—
③	200 UB 25	25.4	203	133	8	6	8	—
④	180 UB 18	18.1	175	90	8	5	9	—
⑤	150 UB 14	14.0	150	75	7	5	8	—
⑦	100 UC 15	14.8	97	99	7	5	10	—
TAPER FLANGE BEAMS								
⑥	125 x 65	13.1	125	65	9	5	8	4
⑧	100 x 45	7.2	100	45	6	4	7	3

RECTANGULAR HOLLOW SECTIONS			Mass per metre, kg/m	Outside corner radius, mm
Code No	Designation Size D x B, mm	Thickness t, mm		
③	203 x 152	6.3	32.9	12
④	203 x 102	4.9	22.0	10
⑤	152 x 102	4.9	18.1	10
⑥	127 x 76	6.3	17.8	12
⑦	127 x 76	4.9	14.2	10
⑧	102 x 51	4.0	8.6	8

The Referee

Table B – DIMENSIONS OF COLD-FORMED SECTIONS

Code No	Designation	Mass per m	Depth, D	Flange width			Thickness, t
				B or E	F	Lip, L	
		kg	mm	mm	mm	mm	mm
C-SECTIONS							
11	C 20016	4.75	203	76	—	16	1.6
	C 20015	4.37	200	76	—	17	1.5
12	C 15016	3.79	152	64	—	16	1.6
	C 15015	3.55	150	64	—	14	1.5
13	C 10016	2.76	102	51	—	14	1.6
	C 10015	2.62	100	50	—	13	1.5
Z-SECTIONS							
11	Z 20016	4.75	203	79	74	15	1.6
	Z 20015	4.37	200	80	74	15	1.5
12	Z 15016	3.79	152	65	61	17	1.6
	Z 15015	3.55	150	70	64	15	1.5
13	Z 10016	2.76	102	53	49	14	1.6
	Z 10015	2.54	100	53	49	13	1.5

Notes to Tables A & B:

1. The dimensions given are subject to the tolerances detailed in AS 1227 (I-sections), AS 1163 (hollow sections) and in manufacturers' literature (cold-formed sections).
2. The code numbers have no significance beyond this publication, and are not commercial identification symbols.

The Referee

ROOFS

Steel beam selection for total superimposed load of 1 kPa (typical of a domestic roof system of mass up to 50 kg per square metre, plus an allowance of 0.5 kPa for downward wind load and access load)

Spacing of beams (metres)	Span of beam (metres)						
	Up to 2	2.4	3	3.6	4	5	6

HOT-ROLLED SECTIONS

Up to 2					6		4
2.4			7				
3	8			6			
3.6							
4				5			3
5		7	6		4		2
6							

COLD-FORMED SECTIONS

0.9				12			
1.2	13						
2					11		
2.4							
3		12					
3.6							

Use hot-rolled sections or seek the services of a structural engineer

The Referee

TIMBER FLOORS

Steel beam selection for total superimposed load of 2 kPa (typical of a domestic timber framed floor carrying normal design load of 1.5 kPa)

Spacing of beams (metres)	Span of beam (metres)						
	Up to 2	2.4	3	3.6	4	5	6
HOT-ROLLED SECTIONS							
Up to 2						④	③
2.4	⑧			⑤			
3		⑦	⑥			③	②
3.6					④		
4			⑤				
5		⑥			③	②	①
6			④				

COLD-FORMED SECTIONS

0.45							
0.6				⑫			
0.9	⑬				⑪		
1.2							
1.8							
2.4			⑪				
3		⑫					
3.6							

Use hot-rolled sections or seek the services of a structural engineer

The Referee

CONCRETE FLOORS

Steel beam selection for total superimposed load of 5 kPa (typical of a domestic concrete floor up to 125 mm thick carrying normal design load of 1.5 kPa)

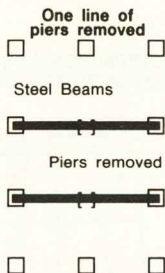
Spacing of beams (metres)	Span of beam (metres)						
	Up to 2	2.4	3	3.6	4	5	6
Up to 2	(7)	(6)	(5)	(4)		(2)	
2.4		(5)	(4)				
3					(3)		(1)
3.6	(6)						
4							
5	(5)	(4)	(3)		(2)		
6					(1)		

EXAMPLE OF BEAM SELECTION

It is planned to construct an extra room underneath an existing house by removing some of the brick piers supporting the main floor. These piers are positioned at 1.8m centres both ways, and the floor is of conventional timber construction. There are no load-bearing partitions on the floor above within the area concerned.

What size of steel beam is needed if (a) one line of piers is to be removed (b) two lines of piers are to be removed?

The Referee



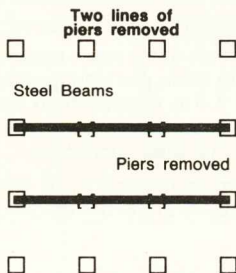
Span of beam = 2×1.8 = 3.6 m

Spacing of beams = spacing of piers = 1.8 m

Read off code number ⑤ under 3.6 m span and 2 m spacing –
Thus the required section is:

150 UB 14 (from Table A)

alternatively: 152 x 102 x 4.9 rectangular hollow section.



Span of beam = 3×1.8 = 5.4 m

Spacing of beams = spacing of piers = 1.8 m

Turn to Table D as before.

Read off code number ③ under 6 m span and 2 m spacing –

Thus the required section is:

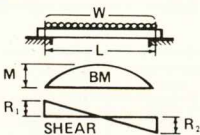
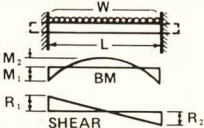
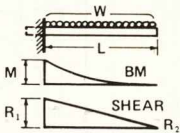
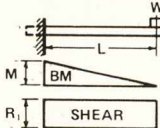
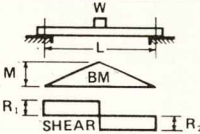
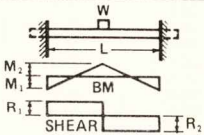
200 UB 25 universal beam (from Table A)

alternatively: 203 x 152 x 6.3 rectangular hollow section.

Note: Cold-formed sections do not suit either of these cases.

The Referee

BEAM LOADING

System of Loading	Max B M	Diagram	Shear Reactions	Max Deflection
Uniformly loaded. Ends supported.	$M = \frac{WL}{8}$		$R_1 = \frac{W}{2}$ $R_2 = \frac{W}{2}$	$\frac{WL^3}{76.8EI}$
Uniformly loaded. Ends fixed.	$M_1 = -\frac{WL}{12}$ $M_2 = \frac{WL}{24}$		$R_1 = \frac{W}{2}$ $R_2 = \frac{W}{2}$	$\frac{WL^3}{384EI}$
Uniformly loaded. One end fixed, other free.	$M = \frac{WL}{2}$		$R_1 = W$ $R_2 = 0$	$\frac{WL^3}{8EI}$
Load concentrated at free end. One end fixed, other free.	$M = WL$		$R_1 = W$	$\frac{WL^3}{3EI}$
Load concentrated at centre. Ends supported.	$M = \frac{WL}{4}$		$R_1 = \frac{W}{2}$ $R_2 = \frac{W}{2}$	$\frac{WL^3}{48EI}$
Load concentrated at centre. Ends fixed.	$M_1 = -\frac{WL}{8}$ $M_2 = \frac{WL}{8}$		$R_1 = \frac{W}{2}$ $R_2 = \frac{W}{2}$	$\frac{WL^3}{192EI}$

The Referee

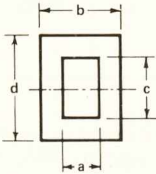
PROPERTIES OF SECTIONS

A = Area of Section

I = Second Moment of Area

r = Radius of Gyration = $\frac{1}{C}$

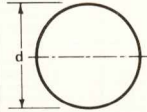
Z = Modulus of Section = $\sqrt{\frac{I}{A}}$



$$A = bd - ac$$

$$I = \frac{bd^3 - ac^3}{12}$$

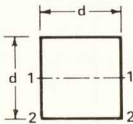
$$r = \sqrt{\frac{bd^3 - ac^3}{12(bd - ac)}}$$



$$A = \frac{\pi d^2}{4} = 0.7854d^2$$

$$I = \frac{\pi d^4}{64} = 0.0491d^4$$

$$r = \frac{d}{4}$$



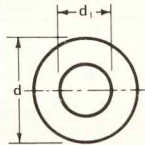
$$A = d^2$$

$$I_1 = \frac{d^4}{12}$$

$$I_2 = \frac{d^4}{3}$$

$$r_1 = 0.2887d$$

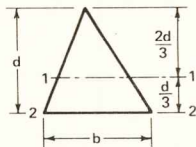
$$r_2 = 0.5774d$$



$$A = \frac{\pi(d^2 - d_1^2)}{4}$$

$$I = \frac{\pi(d^4 - d_1^4)}{64} = 0.0491(d^4 - d_1^4)$$

$$r = \frac{1}{4} \sqrt{d^2 + d_1^2}$$



$$A = \frac{bd}{2}$$

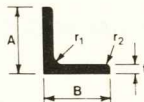
$$I_1 = \frac{bd^3}{36}$$

$$I_2 = \frac{bd^3}{12}$$

$$r_1 = 0.236d$$

$$r_2 = 0.408d$$

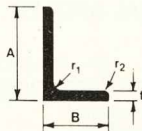
EQUAL ANGLES



Dimensions and properties of equal angles

Designation Nominal leg size A x B, mm mm	Nominal thickness, mm	Mass per metre, kg/m	Actual thickness t, mm	Radii	
				Root r ₁ , mm	Toe r ₂ , mm
200 x 200	26	76.8	26.0	18.0	5.00
	20	60.1	20.0	18.0	5.00
	18	54.4	18.0	18.0	5.00
	16	48.7	16.0	18.0	5.00
	13	40.0	13.0	18.0	5.00
150 x 150	19	42.1	19.0	13.00	5.00
	16	35.4	15.8	13.00	5.00
	12	27.3	12.0	13.00	5.00
	10	21.9	9.50	13.00	5.00
125 x 125	16	29.1	15.8	10.00	5.00
	12	22.5	12.0	10.00	5.00
	10	18.0	9.50	10.00	5.00
	8	14.9	7.80	10.00	5.00
100 x 100	12	17.7	12.0	8.00	5.00
	10	14.2	9.50	8.00	5.00
	8	11.8	7.80	8.00	5.00
	6	9.16	6.00	8.00	5.00
90 x 90	10	12.7	9.50	8.00	5.00
	8	10.6	7.80	8.00	5.00
	6	8.22	6.00	8.00	5.00
75 x 75	10	10.5	9.50	8.00	5.00
	8	8.73	7.80	8.00	5.00
	6	6.81	6.00	8.00	5.00
	5	5.27	4.60	8.00	5.00
65 x 65	10	9.02	9.50	6.00	3.00
	8	7.51	7.80	6.00	3.00
	6	5.87	6.00	6.00	3.00
	5	4.56	4.60	6.00	3.00
55 x 55	6	4.93	6.00	6.00	3.00
	5	3.84	4.60	6.00	3.00
50 x 50	8	5.68	7.80	6.00	3.00
	6	4.46	6.00	6.00	3.00
	5	3.48	4.60	6.00	3.00
45 x 45	3	2.31	3.00	6.00	3.00
	6	3.97	6.00	5.00	3.00
	5	3.10	4.60	5.00	3.00
	3	2.06	3.00	5.00	3.00
40 x 40	6	3.50	6.00	5.00	3.00
	5	2.73	4.60	5.00	3.00
	3	1.83	3.00	5.00	3.00
30 x 30	6	2.56	6.00	5.00	3.00
	5	2.01	4.60	5.00	3.00
	3	1.35	3.00	5.00	3.00
25 x 25	6	2.08	6.00	5.00	3.00
	5	1.65	4.60	5.00	3.00
	3	1.12	3.00	5.00	3.00

UNEQUAL ANGLES



Dimensions and properties of unequal angles

Designation Nominal leg size A x B, mm mm	Nominal thickness, mm	Mass per metre, kg/m	Actual thickness t, mm	Radii	
				Root r_1 , mm	Toe r_2 , mm
150 x 100	12	22.5	12.0	10.00	5.00
	10	18.0	9.50	10.00	5.00
150 x 90	16	27.9	15.8	10.00	5.00
	12	21.6	12.0	10.00	5.00
125 x 75	10	17.3	9.50	10.00	5.00
	8	14.3	7.80	10.00	5.00
	12	17.7	12.0	8.00	5.00
	10	14.2	9.50	8.00	5.00
100 x 75	8	11.8	7.80	8.00	5.00
	6	9.16	6.00	8.00	5.00
	10	12.4	9.50	8.00	5.00
	8	10.3	7.80	8.00	5.00
75 x 50	6	7.98	6.00	8.00	5.00
	8	7.19	7.80	5.00	5.00
	6	5.62	6.00	5.00	3.00
65 x 50	5	4.36	4.60	5.00	3.00
	8	6.59	7.80	6.00	3.00
	6	5.16	6.00	6.00	3.00
	5	4.02	4.00	6.00	3.00

The Referee

ROUND AND SQUARE STEEL BAR AND ROD

Mass per metre and length per tonne

Mass calculations are based on a density for steel of 7850 kg/m³

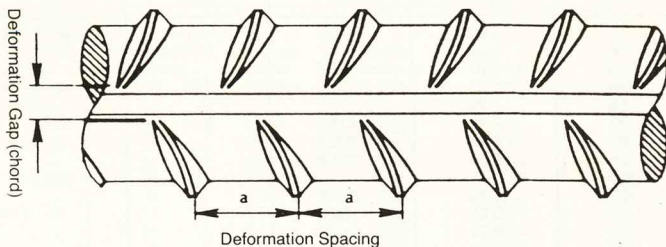
Thickness or dia, mm	Rounds		Squares	
	kg/m	m/t	kg/m	m/t
10	0.616	1622	0.785	1274
12	0.887	1126	1.13	884.6
14	1.21	827.5	-	-
16	1.58	633.6	2.01	497.6
18	1.99	500.6	-	-
20	2.46	405.5	3.14	318.5
22	2.98	335.1	-	-
24	3.55	281.6	-	-
25	-	-	4.91	203.8
27	4.49	222.5	-	-
30	5.55	180.2	-	-
33	6.71	148.9	-	-
36	7.99	125.2	-	-
39	9.38	106.6	-	-
40	-	-	12.6	79.6
42	10.9	91.9	-	-
45	12.5	80.1	-	-
48	14.2	70.4	-	-
50	15.4	64.9	-	-
56	19.3	51.7	-	-
60	22.2	45.1	-	-
65	26.0	38.4	-	-
70	30.2	33.1	-	-
75	34.7	28.8	-	-
80	39.5	25.3	-	-
90	49.9	20.0	-	-
100	61.7	16.2	-	-

REINFORCING BARS

BHP Steel currently produces two types of hot rolled reinforcing bars.

(1) TEMPCORE DEFORMED BAR

TEMPCORE bar pattern



A high strength reinforcing bar made by a mill heat treatment process to produce a combination of physical properties to suit the building and construction industry.

TEMPCORE bar complies with Australian Standard, Steel Reinforcing Bars for Concrete, AS 1302 grade 410Y in all respects including tensile properties, bending properties, chemical composition and deformation pattern.

TEMPCORE bar is fully weldable under the terms of Australian Standard, Structural Steel Welding Code, Welding of Reinforcing Steel, AS 1554 Part 3. It is more readily weldable than AS 1302 grades 230S and 410C.

DIMENSIONS AND MASS OF TEMPCORE BAR

Bar size mm	Calculated mass per metre kg/m	Calculated area mm ²	Nominal area mm ²	Deformation requirements		
				Maximum average spacing ^(a) mm	Minimum average height mm	Maximum gap mm
12	0.888	113.1	110	8.4	0.5	4.7
16	1.579	201.1	200	11.2	0.7	6.3
20	2.466	314.2	310	14.0	1.0	7.9
24	3.551	452.4	450	16.8	1.2	9.4
28	4.834	615.8	620	19.6	1.4	11.0
32	6.313	804.2	800	22.4	1.6	12.6
36	7.991	1017.9	1020	25.2	1.8	14.1

The Referee

TENSILE PROPERTIES

Specification	Yield strength MPa	Tensile strength/yield strength ratio	Total elongation ($5.65 \sqrt{S_0}$)%	Modulus of elasticity MPa
TEPCORE AS 1302:410Y	460 mean 410 min	1.21 mean 1.05 min	25 mean 12 min	200×10^3

DUCTILITY AND TOUGHNESS

Bending	180°	Minimum former dia 1-2d
Rebending (i) (ii)	Bend 90°, Rebend 20° Bend 90°, Rebend 90° (Restraighten)	2-4d 3-5d
Low Temperature Bending (i) Notch (ii) Arc Strike	180° @ - 50°C 180° @ - 50°C	3d 3d
Low Temperature Impact (Drop Weight Test) (i) Notch (ii) Arc Strike	@ - 50°C @ - 50°C	No Fracture No Fracture

TEPCORE bar exceeds the bending requirements of AS 1302 for all grades including the ductile lower strength grade 230S.

180° Bends	Minimum former diameter
TEPCORE	1d(12-28 mm) 2d(32 & 36 mm)
AS 1302:230S requirement	3d
AS 1302:410C requirement	4d
AS 1302:410Y requirement	4d

(2) PLAIN ROUND BARS

In structural grade AS 1302-230R. Available in 10, 12, 20, 24, 27, 33 and 36 mm diameters.

TOLERANCES OF HOT-ROLLED SECTIONS

UNIVERSAL SECTIONS

(Excluding Junior Universal Beams)

Length Tolerance

Length tolerance to AS 1227, except lengths 18.0 m and over, which are plus 150 mm minus nil. (Refer table Universal Sections and Structural Sections. This table also covers Junior Universal Beams.)

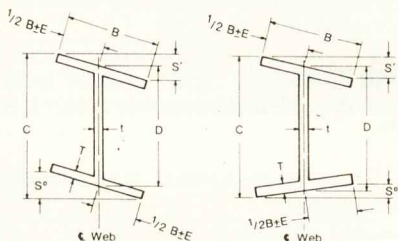
Straightness Tolerance (AS 1227)

millimetres

Nominal Size	Sweep	Camber
Sections with a flange width less than 150 mm	$\frac{\text{Length}}{500}$	$\frac{\text{Length}}{1000}$
Sections with a flange width approximately equal to the depth:		
Lengths of 14 m and under	$\frac{\text{Length}}{1000}$ but not more than 10 mm	
Length over 14 m	$10 \text{ mm} + \frac{\text{Length (mm)} - 14000}{1000}$	
All other sections	$\frac{\text{Length}}{1000}$	$\frac{\text{Length}}{1000}$

Note: Due to the extreme variations in the elastic flexibility of universal sections about the Y-Y axis, difficulty may be experienced in obtaining reproducible sweep measurements, and methods of measurement are therefore provided in AS 1227 Appendix C.

TOLERANCES ON CROSS-SECTIONAL DIMENSIONS (AS 1227)



Notes:

- 1 Dimensions C, D, S' and S° are measured parallel with the centreline of the web. Dimensions B and $\frac{1}{2}B \pm E$ are measured parallel with the plane of the flange.
- 2 Dimension D is measured at the centreline of the web.

UNIVERSAL SECTIONS

(Excluding Junior Universal Beams)

(A) Permissible Variations in Depth, Width, Out-of-square and Web-off-centre

Nominal depth of section	Permissible variation of depth D		Permissible variation of flange width B		Permissible out-of-square on each flange (S ¹ or S)	Permissible total out-of-square (S ¹ + S)	Permissible web-off-centre	Permissible overall depth over specified depth (C - D)
	Plus	Minus	Plus	Minus			E	
≤ 300	3	3	6	5	4	6	5	6
> 300	3	3	6	5	5	8	5	6

(B) Permissible Variations in Web and Flange Thickness

Nominal Thickness (t)	t web		T flange	
	Plus	Minus	Plus	Minus
≤ 15	0.7	0.7	1.0	1.0
> 15 ≤ 25	1.0	1.0	1.5	1.5
> 25 ≤ 40	1.5	1.5	2.0	2.0
> 40	2.0	2.0	2.5	2.5

(C) Maximum Difference in Thickness Over the Four Flanges

Nominal thickness (T)	Maximum difference
≤ 15	1.0
> 15 ≤ 25	1.5
> 25 ≤ 40	2.0
> 40	2.5

UNIVERSAL SECTIONS AND STRUCTURAL SECTIONS Length Tolerance (AS 1227)

Specified length, m		Permissible variation from specified length, mm	
Over	Up to and including	Plus	Minus
—	7	50	Nil
7	12	75	Nil
12	—	100	Nil

UNIVERSAL SECTIONS Junior Universal Beams

Permissible Variations in Depth, Width, Out-of-square and Web-off-centre millimetres

Nominal section	Permissible variation of depth D		Permissible variation of flange width B		Permissible out-of-square on each flange (S ¹ or S)	Permissible total out-of-square (S ¹ /S)	Permissible web-off-centre E	Permissible overall depth over specified depth (C - D)
	Plus	Minus	Plus	Minus				
150UB	2.5	1.5	3.0	3.0	1.5	2.5	2.5	4
180UB	2.5	1.5	3.0	3.0	2.0	2.5	2.5	4

Note:
Junior Universal Beams replaced 152 mm and 178 mm Taper Flange Beams mid '87. For normal dimensions refer to Hot Rolled Products brochure.

The Referee

MEASUREMENT OF CAMBER AND SWEEP IN UNIVERSAL SECTIONS (AS 1227)

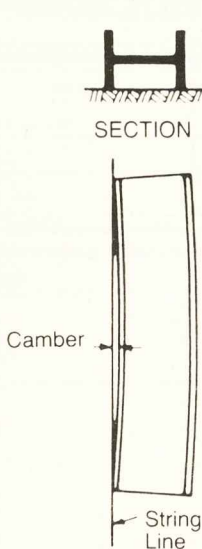
Camber The length of section to be tested shall be placed with its web horizontal on a test surface.

Camber is measured as illustrated in Fig. 1

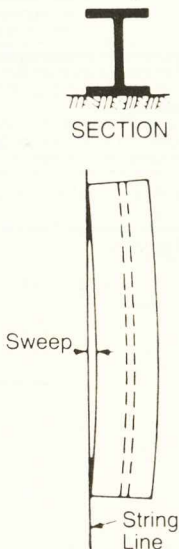
Sweep The length of section to be tested shall be placed with its web vertical on a test surface.

Sweep is measured as illustrated in Fig. 2.

Although this method works satisfactorily for the majority of members where sweep tends to be minimal, it may give unreliable answers on members with excessive sweep. Where a more accurate determination is needed, an alternative method of measuring sweep is contained in Report MRL S5/1 (BHP Melbourne Research Laboratories).



PLAN VIEW
Fig. 1. CAMBER



PLAN VIEW
Fig. 2. SWEEP

The Referee

STRUCTURAL SECTIONS ANGLES, CHANNELS, TAPER FLANGE BEAMS

Length Tolerance (AS 1227)

Specified length, m		Permissible variation from specified length, mm	
Over	Up to and including	Plus	Minus
—	7	50	Nil
7	12	75	Nil
12	—	100	Nil

Straightness Tolerance (AS 1227)

millimetres

Characteristic	Permissible variation
Camber +	$\frac{\text{Length}}{500}$
Sweep #	Owing to the extreme variations in flexibility of taper flange beams and channels about the Y-Y axis, straightness tolerances are subject to negotiation between the supplier and the purchaser for the individual sections involved.

+ For angles having a combined leg length greater than 153 mm, this is the straightness tolerance. For other angles see the next table.

Although not specified in AS 1227, sweep tolerance of $\frac{L}{500}$ is guaranteed for the following sections:

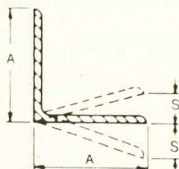
- Parallel Flange Channels 150 mm to 380 mm
- Equal Angles 125 x 125 mm and above
- Unequal Angles 150 x 90 mm and above

$$\text{Permissible variation in straightness}^* = \frac{\text{Length}}{250}$$

*This permissible variation does not apply if any heating operation has been performed subsequent to rolling.

The Referee

STRUCTURAL SECTIONS



Angles

Tolerance on Cross-sectional Dimensions (AS 1227)

Notes:

- 1 When measuring the out-of-square, the back of the square and the centreline of the reference leg must be parallel.
- 2 The nominal size is determined as follows:
For equal angles – the length of the leg, ie A.
For unequal angles – the length of the longer leg.

(A) Tolerances on Leg Length and Out-of-square

millimetres

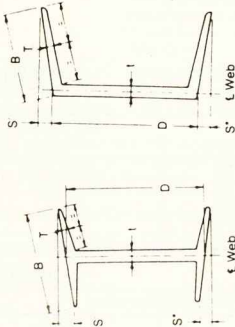
Nominal leg size	Permissible variation		Out-of-square S
	Leg Length Over	Leg Length Under	
≤ 40	2.5	1.5	1
> 40 ≤ 75	2.5	1.5	2
> 75 ≤ 125	3.0	3.0	3
> 125 ≤ 150	3.0	3.0	4
> 150	5.0	3.0	5

(B) Thickness Tolerance

millimetres

Thickness	Permissible variation	
	Plus	Minus
≤ 10	0.5	0.5
> 10 ≤ 15	0.7	0.7
> 15 ≤ 25	1.0	1.0
> 25	1.5	1.5

Taper Flange Beams, Taper Flange Channels and Parallel Flange Channels Tolerances on Cross-sectional Dimensions (AS 1227)



Notes:

- 1 Dimensions D, S and S' are measured parallel with the centreline of the web.
- 2 Dimension B is measured parallel with the plane of the flange.
- 3 Dimension D is measured at the centreline of the web for beams and at the back of the web for channels.
- 3 Out-of-square is given by S' or S whether the flanges are turned in the same or opposite directions.

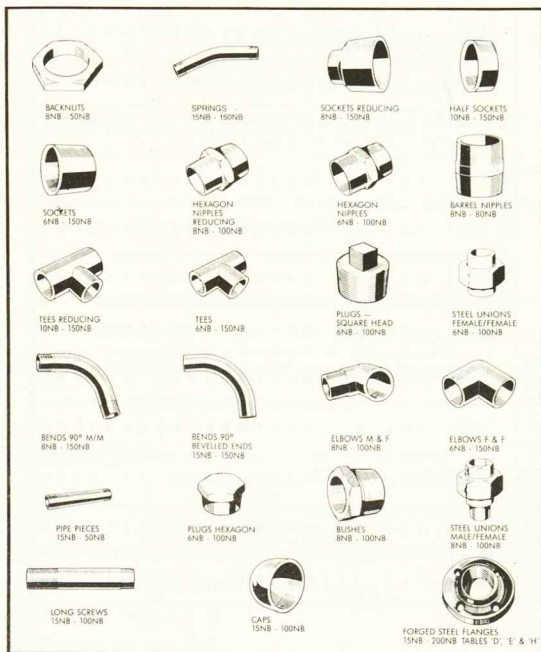
millimetres

Section	Nominal Depth D		Nominal Width B			
	Nominal dimension	Permissible variation		Permissible variation flange or web thickness (T or t)	Permissible out-of-square on each leg or flange (S' or S)	Permissible out-of-square per mm of nominal flange width B (S' + S)
		Plus	Minus			
Taper Flange Beams	75 180	2.5	1.5	Plus	0.7	0.030
				Minus	0.7	0.030
	75 180 180 350 350 380	3.0	1.5	Plus	1.0	0.030
				Minus	1.5	0.030
Channels	75 180 180 350 350 380	3.0	3.0	Plus	1.0	0.030
				Minus	2.0	0.030

TUBELINE

STEEL FITTINGS

AN OPERATING UNIT OF TUBEMAKERS OF AUSTRALIA LTD.



TUBELINE STEEL FITTINGS AND FLANGES

	Pipe size designation														
	6 NB	8 NB	10 NB	15 NB	20 NB	25 NB	32 NB	40 NB	50 NB	65 NB	80 NB	100 NB	125 NB	150 NB	200 NB
TUBULARS	—	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Bends (90°)	—	•	—	•	•	•	•	•	•	•	•	•	•	•	•
Longscrews	—	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Barrel Nipples	—	—	•	•	•	•	•	•	•	•	•	•	•	•	•
Pieces not socketed	—	—	—	•	•	•	•	•	•	•	•	•	•	•	•
(100 mm-600 mm)	—	—	—	—	—	•	•	•	•	•	•	•	•	•	•
Springs not socketed 45°	—	—	—	—	—	•	•	•	•	•	•	•	•	•	•
OTHER FITTINGS															
Elbows F & F	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Tees	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Tees, Reducing	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Sockets	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Sockets, Reducing	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Bushes	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Hexagon Nipples	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Hexagon Nipples, Reducing	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Backnuts	—	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Caps	—	—	—	•	•	•	•	•	•	•	•	•	•	•	•
Flanges, Table "D"	—	—	—	•	•	•	•	•	•	•	•	•	•	•	•
Flanges, Table "E"	—	—	—	•	•	•	•	•	•	•	•	•	•	•	•
Flanges, Table "H"	—	—	—	•	•	•	•	•	•	•	•	•	•	•	•
Elbows M & F	—	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Plugs	—	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Crosses	—	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Unions	—	•	•	•	•	•	•	•	•	•	•	•	•	•	•

• Indicates sizes available.

Finishes include plain end, bevelled and threaded, galvanised and ungalvanised.

The Referee

RECTANGULAR HOLLOW SECTIONS

Tubeline is the brand name of RHS made by Structural Products Tubemakers of Australia Limited. These sections are manufactured to either AS 1163 Grade C350 or Tubeline 350.

Guidance on the safe use of RHS may be found in AS 1250, AS 1511, AS 1554, AS 1170, AS 1538 and AS 1418.

Serial sizes, mm

Size Range:	Squares – 13 x 13 to 254 x 254 Rectangles – 38 x 19 to 254 x 152
Standard Lengths:	6.5 m – Up to and including 32 x 32 8.0 m – 38 x 19 to 254 x 152 10.0 m and 12.0 m – 102 x 102 to 254 x 254
Specials:	16.0 and 18.0 m – 152 x 152 to 254 x 254 available ex rollings.

Finish:

Black	– coated with a clear temporary rust preventative.
Painted	– coated with a blue alkyd based zinc chromate primer.
Galvanized	– coated internally and externally by hot-dip galvanizing.
N.O.P.	– not coated with oil or paint.

Mechanical Properties

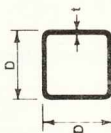
Grade designation	Minimum yield strength, MPa	Minimum tensile strength, MPa
C200, H200	200	320
C350	350	430

Corner Radii (t = section thickness)

Maximum outside radius – $3t$

Minimum inside radius – $0.8t$

TUBELINE RHS – SQUARES

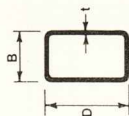


SERIAL SIZE DESIGNATION	WALL THICKNESS t, mm	MASS		SERIAL SIZE DESIGNATION	WALL THICKNESS t, mm	MASS	
		kg/m	m/t			kg/m	m/t
6.5 METRE LENGTHS				8 METRE LENGTHS (Cont.)			
13 x 13	1.8	0.551	1820	64 x 64 (Cont.)	4.0	7.04	142
16 x 16	1.8	0.731	1370		4.9	8.37	119
19 x 19	1.6	0.827	1210	76 x 76	6.3	10.2	97.6
	1.8	0.912	1100		2.0	4.58	218
	2.0	0.993	1010		2.3	5.23	191
25 x 25	2.0				2.6	5.87	170
	1.6	1.14	874		2.8	6.29	159
	2.0	1.39	720		3.2	7.06	142
	2.6	1.72	580		4.0	8.64	116
32 x 32	3.2	1.95	512		4.9	10.3	96.9
					6.3	12.8	78.4
	1.6	1.47	682	89 x 89	3.6	9.29	108
	2.0	1.79	558		4.9	12.3	81.5
	2.6	2.25	445				

The Referee

8 METRE LENGTHS				
38 x 38	1.6	1.78	102 x 102	6.3
	2.0	2.19		4.0
	2.3	2.48		4.9
	2.6	2.76		6.3
	2.8	2.95		8.0
51 x 51	3.2	3.23	127 x 127	9.5
	3.2	3.23		4.9
	3.2	3.23		6.3
	3.2	3.23		8.0
	3.2	3.23		9.5
64 x 64	4.0	5.45	152 x 152	4.9
	4.0	5.45		6.3
	4.0	5.45		8.0
	4.0	5.45		9.5
	4.0	5.45		9.5
64 x 64	4.9	6.42	203 x 203	6.3
	2.0	3.78		9.5
	2.3	4.31		6.3
	2.6	4.84		8.0
	2.8	5.18		9.5
64 x 64	3.2	5.78	254 x 254	6.3
	3.2	5.78		8.0
	3.2	5.78		9.5
	3.2	5.78		6.3
	3.2	5.78		8.0
38 x 38	1.6	1.78	102 x 102	6.3
	2.0	2.19		4.0
	2.3	2.48		4.9
	2.6	2.76		6.3
	2.8	2.95		8.0
51 x 51	3.2	3.23	127 x 127	9.5
	3.2	3.23		4.9
	3.2	3.23		6.3
	3.2	3.23		8.0
	3.2	3.23		9.5
64 x 64	4.0	5.45	152 x 152	4.9
	4.0	5.45		6.3
	4.0	5.45		8.0
	4.0	5.45		9.5
	4.0	5.45		9.5
64 x 64	4.9	6.42	203 x 203	6.3
	2.0	3.78		9.5
	2.3	4.31		6.3
	2.6	4.84		8.0
	2.8	5.18		9.5
64 x 64	3.2	5.78	254 x 254	6.3
	3.2	5.78		8.0
	3.2	5.78		9.5
	3.2	5.78		6.3
	3.2	5.78		8.0

TUBELINE RHS – RECTANGLES



SERIAL SIZE DESIGNATION	WALL THICKNESS t, mm	MASS		SERIAL SIZE DESIGNATION	WALL THICKNESS t, mm	MASS	
		kg/m	m/t			kg/m	m/t
6.5 METRE LENGTHS							
38 x 19	2.0	1.59	629	102 x 51 (Cont.)	4.0	8.64	116
38 x 25	2.0	1.79	559		4.9	10.3	96.9
	2.6	2.24	446		6.3	12.8	78.4
8 METRE LENGTHS							
51 x 25	1.6	1.78	561	102 x 76	3.6	9.29	108
	2.0	2.19	457		4.9	12.3	81.5
	2.3	2.48	403		6.3	15.3	65.5
	2.6	2.76	362	127 x 51	3.6	9.29	108
	2.8	2.95	340		4.9	12.3	81.5
	3.2	3.23	310		6.3	15.3	65.5

The Referee

64 x 38	2.0 2.3 2.6 2.8 3.2 4.0	2.98 3.40 3.80 4.06 4.51 5.45	335 294 263 246 222 184	127 x 64	4.0 4.9 6.3	11.0 13.3 16.5	90.7 75.4 60.5
76 x 38	2.0 2.6 3.2 4.0	3.38 4.32 5.14 6.24	296 232 194 160	127 x 76	4.9 6.3 8.0	14.2 17.8 21.8	70.3 56.2 45.9
76 x 51	2.0 2.3 2.6 2.8 3.2 4.0	3.78 4.31 4.84 5.18 5.78 7.04 8.37 10.2	264 232 207 193 173 142 119 97.6	152 x 76	4.9 6.3 8.0	16.2 20.3 25.0	61.8 49.3 40.0
76 x 51	2.0 2.3 2.6 2.8 3.2 4.0	3.78 4.31 4.84 5.18 5.78 7.04 8.37 10.2	264 232 207 193 173 142 119 97.6	152 x 102	4.9 6.3 8.0 9.5	18.1 22.8 28.2 32.6	55.1 43.8 35.5 30.7
102 x 51	2.0 2.3 2.6 2.8 3.2	4.58 5.23 5.87 6.29 7.06	218 191 170 159 142	203 x 102	4.9 6.3 8.0 9.5	22.0 27.8 34.5 40.2	45.4 35.9 28.9 24.9
102 x 51	2.0 2.3 2.6 2.8 3.2	4.58 5.23 5.87 6.29 7.06	218 191 170 159 142	203 x 152	6.3 9.5	32.9 47.8	30.4 20.9
102 x 51	2.0 2.3 2.6 2.8 3.2	4.58 5.23 5.87 6.29 7.06	218 191 170 159 142	254 x 152	6.3 8.0 9.5	37.9 47.3 55.3	26.4 21.1 18.1

The Referee

TUBEMAKERS STRUCTURAL

introduces

GALTUBE PLUS

Size	Section dimensions, mm	Wall thickness, mm	Mass, kg/m	Metres/tonne
RHS				
19 x 19	19.1 x 19.1	1.6	0.827	1210
25 x 25	25.4 x 25.4	1.6	1.14	874
32 x 32	31.8 x 31.8	1.6	1.47	682
38 x 38	38.1 x 38.1	1.6	1.78	561
38 x 38	38.1 x 38.1	2.0	2.19	457
51 x 25	50.8 x 25.4	1.6	1.78	561
51 x 25	50.8 x 25.4	2.0	2.19	457
50 x 50	50.0 x 50.0	1.6	2.38	420
50 x 50	50.0 x 50.0	2.0	2.93	341
64 x 64	63.5 x 63.5	1.6	3.06	327
64 x 64	63.5 x 63.5	2.6	4.84	207
76 x 38	76.2 x 38.1	2.0	3.38	296
76 x 38	76.2 x 38.1	2.6	4.32	232
PIPE NB				
	Outside diameter			
15	21.3	1.6	0.777	1290
15	21.3	2.0	0.952	1050
20	26.9	2.0	1.23	814
25	33.7	2.0	1.56	640
32	42.4	2.0	1.99	502
40	48.3	2.3	2.61	383
50	60.3	2.3	3.29	304
65	76.1	2.6	4.71	212

LENGTHS: Standard lengths 6.5 m
Cutting tolerance -0 to + 10 mm
Non-standard lengths from 1.0 to 8.0 m

SPECIFICATION: Dimensional tolerances generally in accordance with AS 1450

GRADE: RHS: Minimum yield strength - 350 MPa
PIPE: Minimum yield strength - 350 MPa

**TUBEMAKERS OF AUSTRALIA LIMITED,
STRUCTURAL PRODUCTS DIVISION
PLAIN END OR SCREWED STEEL PIPES**

Pipe size designation	OD, mm	Type	Wall thickness, mm	** Mass, kg/m	Pipe size designation	OD, mm	Type	Wall thickness, mm	** Mass, kg/m
8 NB	13.5	Medium	2.3	0.641	50 NB	60.3	Light*	2.9	4.11
		Heavy	2.9	0.765			Medium	3.6	5.03
10 NB	17.2	Medium	2.3	0.839			Heavy	4.5	6.19
		Heavy	2.9	1.02			Extra Heavy*	5.4	7.31
15 NB	21.3	Medium	2.6	1.21	65 NB	76.1	Light*	3.2	5.75
		Heavy	3.2	1.44			Medium	3.6	6.43
		Extra Heavy	3.6	1.57			Heavy	4.5	7.93
20 NB	26.9	Light*	2.3	1.40	80 NB	88.9	Extra Heavy*	5.9	10.2
		Medium	2.6	1.56			Light*	3.2	6.76
		Heavy	3.2	1.87			Medium	4.0	8.37
		Extra Heavy*	4.0	2.26			Heavy	4.9	10.3
25 NB	33.7	Light*	2.6	1.99	90 NB	101.6	Extra Heavy*	5.9	12.1
		Medium	3.2	2.41			Medium	4.0	9.63
		Heavy	4.0	2.94			Heavy	4.9	11.9
32 NB	42.4	Extra Heavy*	4.5	3.24	100 NB	114.3	Medium	4.5	12.2
		Light*	2.6	2.55			Heavy	5.4	14.5
		Medium	3.2	3.10	125 NB	139.7	Medium	4.9	16.6
		Heavy	4.0	3.80			Heavy	5.4	17.9
40 NB	48.3	Extra Heavy*	4.9	4.53	150 NB	165.1	Medium	4.9	19.7
		Light*	2.9	3.25			Medium	4.9	19.7
		Medium	3.2	3.57			Heavy	5.4	21.3
		Heavy	4.0	4.38			Medium	4.9	19.7
		Extra Heavy*	5.4	5.71			Heavy	5.4	21.3

Specification:
Light
AS 1450-H200

Extra Heavy
AS 1163-H200

Medium/Heavy
Plain ends: AS 1074, AS 1163
— H200, C200

Screwed: AS 1074

*Not available screwed.

**kg/m of screwed pipe is taken to be the same as plain end pipe.

The Referee

TUBEMAKERS OF AUSTRALIA LIMITED WATER, OIL AND GAS INDUSTRIES DIVISION OIL AND GAS PIPELINES

LARGE DIAMETER STEEL ERW PIPES

Produced to Standards: API 52, ASTM A53, AS 1163, AS 1836 and BS, ISO, DIN or JIS.

Lengths: Up to 18 m.

End finish: Normally supplied with ends bevelled for welding.

PLAIN END OR BEVEL END

OD, mm	Core wall thickness mm	Mass, kg/m	OD, mm	Core wall thickness, mm	Mass, kg/m
168.3	4.8	19.4	355.6	6.4	55.1
	6.4	25.6		7.9	67.7
	7.1	28.2		9.5	81.1
219.1			406.4	12.7	108
	4.8	25.4		6.4	63.1
	6.4	33.6		7.9	77.6
273.1	8.2	42.6		9.5	93.0
	4.8	31.8	457	12.7	123
	6.4	42.1		6.4	71.1
323.9	9.3	60.5		7.9	87.5
	4.8	37.8		9.5	105
	6.4	50.1		12.7	139
	9.5	73.7			

Above masses may differ slightly from American masses.
Please enquire for other thicknesses.

The Referee

TUBEMAKERS OF AUSTRALIA LIMITED MERCHANDISING DIVISION trading as METALCENTRES[®] MALLEABLE PIPE FITTINGS

Fitting	Pipe size designation														
	8	10	15	20	25	32	40	50	65	80	90	100	125	150	
	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	
Backnuts	X	X	X	X	X	X	X	X	X	X	—	X	—	—	
Bends, M & F	X	X	X	X	X	X	X	X	X	X	—	X	—	X	
Bends, F & F	—	—	X	X	X	X	X	X	X	X	—	—	—	—	
Bends, M & F 45°	—	—	X	X	X	X	X	X	—	—	—	—	—	—	
Bushes	X	X	X	X	X	X	X	X	X	X	X	X	—	X	
Caps	X	X	X	X	X	X	X	X	X	X	—	X	—	—	
Crosses	—	X	X	X	X	X	X	X	X	X	—	—	—	—	
Elbows, F & F	X	X	X	X	X	X	X	X	X	X	—	X	—	X	
Elbows, M & F	X	X	X	X	X	X	X	X	X	X	—	X	—	—	
Elbows, Three-way	—	—	X	X	X	X	—	—	—	—	—	—	—	—	
Elbows, 45°	—	—	—	—	X	—	X	—	—	—	—	—	—	—	
Elbows, Reducing	—	—	X	X	X	X	X	X	—	—	—	—	—	—	
Flanges	—	—	X	X	X	X	X	X	X	X	—	X	—	X	
Flanges, Oval	—	—	X	X	X	X	X	X	—	—	—	—	—	—	
Hexagon Nipples	X	X	X	X	X	X	X	X	X	X	—	X	—	X	
Hex Nipples, Reducing	X	X	X	X	X	X	X	X	X	X	—	X	—	—	
Plugs	X	X	X	X	X	X	X	X	X	X	—	X	—	—	
Sockets	—	—	X	X	X	X	X	X	X	X	—	X	—	—	
Sockets, Reducing	—	X	X	X	X	X	X	X	X	X	—	—	—	—	
Tees	X	X	X	X	X	X	X	X	X	X	—	X	—	X	
Tees, Reducing	—	X	X	X	X	X	X	X	X	X	—	X	—	—	
Tees, Four-way	—	—	X	X	X	—	—	—	—	—	—	—	—	—	
Unions, FS	X	X	X	X	X	X	X	X	X	X	—	X	—	—	
Unions, BS	X	X	X	X	X	X	X	X	X	X	—	—	—	—	



THE VICTAULIC® PIPING SYSTEM

- Dredging, fire protection, sewage disposal/treatment, water services, mining – compressed air lines, construction site services, plant processing, oil field and petroleum piping, shipbuilding.

The System

The Victaulic piping system consists of a self-sealing rubber ring embracing two pipe ends and a coupling which encloses the ring while engaging shoulders, or alternatively grooves, on the pipe ends.

The coupling centralises the self-sealing ring and keeps it firmly in position to prevent leaks and protect it from external damage. It engages the pipes positively and prevents separation; a small amount of end play is provided between the coupling and the pipe ends.

The Victaulic joint is leakproof under pressure or vacuum even when the pipeline is only partly full or under vibration.

The system provides for limited expansion and contraction and accommodates some longitudinal and angular movement.

For irrigation, dewatering of construction sites, and temporary installations, the Victaulic piping system in most instances does not require the design and supervision of a piping engineer or inspection by a statutory authority provided the working pressures shown on the couplings are not exceeded.

VICTAULIC® PIPE

Specification

Steel pipe for most pressure applications where the "Victaulic" system is employed will be manufactured to AS 1074. Other sizes may be ordered.

The Referee

Dimensions

Shouldered "Victaulic" pipe is normally supplied in 6.5m lengths. Longer lengths available to order.

Pipe dimensions, mm			Mass per unit length, kg/m	
Nominal size	OD	Wall thickness	Black	Galvanized
50	60.3	2.2	3.18	3.36
		2.3	3.32	3.50
		2.9	4.14	4.31
		3.6	5.06	5.22
80	88.9	2.2	4.75	5.03
		2.3	4.96	5.23
		3.2	6.81	7.06
		4.0	8.42	8.65
100	114.3	2.2	6.15	6.50
		2.6	7.23	7.57
		3.2	8.84	9.16
		4.5	12.26	12.54
		5.4	14.57	14.83
150	165.1	2.5	10.10	10.60
		2.6	10.53	11.02
		3.2	12.89	13.35
		4.9	19.47	19.86
		5.4	21.38	21.75
	168.3	4.8	19.45	19.86
		6.4	25.65	25.99
		7.1	28.32	28.63
200	219.1	4.8	25.58	26.11
		6.4	33.78	34.23
		8.2	42.86	43.21
250	273.1	4.8	32.02	32.69
		6.4	42.35	42.91
		9.3	60.76	61.13
300	323.9	6.4	50.41	51.08
		9.5	73.95	74.38
350	355.6	6.4	55.49	56.23
		9.5	81.46	81.92
400	406.4	6.4	63.56	64.40
		9.5	93.41	93.94
450	457.0	6.4	71.64	72.58
		9.5	105.36	105.95

The Referee

BUNDY TUBING COMPANY (AUSTRALIA) PTY LTD

BUNDYWELD TUBING

Copper brazed, double-walled steel tubing, in plain (coppered) finish, alternatively lead/tin alloy coated externally, to specification AS 1751.

Bundyweld tubing	Outside Diameter, mm	Wall thickness, mm
Standard sizes	4.75	0.51
	4.75, 6.35, 7.94, 9.53, 12.00	0.71
	9.53, 12.70	0.89
Immediate special sizes	3.18, 3.97, 4.50, 5.56, 7.14, 10.00, 11.11	Refer manufacturer

DC ELECTRICWELD TUBING

Single-wall steel tubing in bare metal finish, alternatively lead/tin alloy coated externally, to specification SAE J526.

Standard Range OD 4.75, 6.35 and 7.94 mm, all in 0.71 mm thickness.



VINIDEX TUBEMAKERS PTY LIMITED

PVC Pipes and Fittings

Further information and supplies from:

- Manufacturer and Vinidex Sales offices in each state.
- Major Building and Hardware Stores and Plumbing Supply Houses.

Pressure Pipes

Standard length – 6 m.

Solvent cement joint – nominal size 15 to 300 mm.

Polydex rubber ring joint – nominal size 50 to 375 mm.

Pipes and fittings manufactured to AS 1477.

Stormwater Drainage Pipes and Fittings

Sizes available – 90 to 315 mm.

Fittings available include Elbows, Tees, Reducers, Y Junctions and Downpipe Adaptors.

Manufactured to AS 1254.

Sewer Pipes and Fittings

Sizes available – 100 to 375 mm.

Pipe and Fittings Manufactured to AS 1260.

Soil, Waste and Vent Pipe and Fittings

Sizes available – 32 to 150 mm.

Full range of fittings.

Manufactured to AS 1415.

Electrical Conduits

LD and HD Conduits available. Sizes 16 to 150 mm.

Downpipe and Fittings

Size available – 100 x 50 mm rectangular.

The Referee

PVC PRESSURE PIPE

Sizes, Classes and Pressure Ratings at 20°C

Nominal size	Mean outside diameter, mm	CLASS 4.5			CLASS 6			CLASS 9		
		(0.45 MPa) 45 m Head			(0.60 MPa) 60 m Head			(0.90 MPa) 90 m Head		
		Mean bore, mm	Mean wall thickness, mm	Mass, kg/m	Mean bore, mm	Mean wall thickness, mm	Mass, kg/m	Mean bore, mm	Mean wall thickness, mm	Mass, kg/m
25	33.55							30.5	1.55	0.22
32	42.25							38.5	1.90	0.34
40	48.25				45.2	1.55	0.31	44.1	2.10	0.44
50	60.35				56.8	1.80	0.48	55.2	2.60	0.69
65	75.35	72.0	1.70	0.58	71.0	2.20	0.75	68.9	3.25	1.07
80	88.90	84.9	2.00	0.80	83.7	2.60	1.04	81.3	3.80	1.49
100	114.30	109.3	2.50	1.30	107.8	3.25	1.68	104.6	4.85	2.46
125	140.20	134.1	3.05	1.95	132.2	4.00	2.57	128.4	5.90	3.71
150	160.25	153.4	3.45	2.53	151.3	4.50	3.28	146.9	6.70	4.82
195	219.10	209.7	4.70	4.74	206.7	6.20	6.21	200.9	9.12	9.01
200	225.30	215.6	4.85	5.14	212.5	6.40	6.71	206.6	9.35	9.68
225	250.35	239.7	5.35	6.13	236.3	7.05	8.03	229.6	10.40	12.90
250	280.40	268.4	6.00	7.87	264.7	7.85	10.23	257.1	11.65	14.95
300	315.45	302.1	6.70	10.12	297.7	8.90	13.22	289.3	13.10	19.24

PVC PRESSURE PIPE

Sizes, Classes and Pressure Ratings at 20°C

Nominal size	Mean outside diameter, mm	CLASS 12			CLASS 15			CLASS 18		
		(1.20 MPa) 120 m head			(1.50 MPa) 150 m head			(1.80 MPa) 180 m head		
		Mean bore, mm	Mean wall thickness, mm	Mass, kg/m	Mean bore, mm	Mean wall thickness, mm	Mass, kg/m	Mean bore, mm	Mean wall thickness, mm	Mass, kg/m
15	21.35				18.3	1.55	0.14	17.8	1.55	0.16
20	26.75	23.7	1.55	0.18	23.0	1.90	0.22	22.4	2.20	0.25
25	33.55	29.8	1.90	0.28	29.0	2.30	0.33	28.1	2.75	0.39
32	42.25	37.5	2.40	0.44	36.4	2.95	0.53	35.4	3.45	0.62
40	48.25	42.8	2.75	0.57	41.6	3.35	0.69	40.5	3.90	0.80
50	60.35	53.7	3.35	0.89	52.2	4.10	1.07	50.5	4.95	1.26
65	75.35	67.0	4.20	1.38	65.1	5.15	1.68	63.2	6.10	1.95
80	88.90	79.0	4.95	1.92	76.7	6.10	2.33	74.6	7.15	2.71
100	114.30	101.7	6.30	3.17	98.8	7.75	3.85	96.0	9.15	4.49
125	140.20	124.9	7.65	4.77	121.3	9.45	5.81	117.7	11.25	6.79
150	160.25	142.7	8.80	6.24	138.7	10.80	7.56	134.7	12.80	8.75
195	219.10	195.3	11.90	11.36	189.6	14.77	14.12	184.2	17.46	16.44
200	225.30	200.7	12.30	12.60	194.9	15.20	15.23	189.4	17.95	17.72
225	250.35	223.1	13.65	15.27	216.6	16.90	18.70	210.5	19.95	21.72
250	280.40	249.7	15.35	19.41	242.6	18.90	23.70	235.7	22.35	27.56
300	315.45	281.1	17.20	24.54	273.1	21.20	29.90	265.3	25.10	34.87

STEEL RECTANGULAR SECTIONS

Mass per Unit Length (kg/m) of Flat-Rolled Carbon Steel Plate, Sheet, Coil and Bar

Mass per unit length table on the following two pages is theoretical only. Calculations are based on a mass for carbon steel of 7850 kg/m³ and are rounded off.

To obtain values for intermediate widths to 5 mm increments, select width combinations from the table to equal the width required and sum their respective mass values.

eg, to obtain the mass per linear metre fro a section 11 mm thick x 1275 mm wide

millimetres	kilograms per linear metre	
11 x 1000	weighs	86.4
11 x 200	weighs	17.3
11 x 75	weighs	6.48
<u>∴ 11 x 1275</u>	weighs	<u>110.18</u>

The value for any thickness or width may be obtained from the following formula:

Mass per linear metre (kg/m)

$$\text{kg/m} = \frac{t \times W \times 7850}{1\,000\,000}$$

where:

t = thickness (mm)

W = width (mm)

STEEL RECTANGULAR SECTIONS (cont...)

Mass Per Unit Length, kg/m

Width, mm	Thickness, mm													Width, mm
	1	2	3	4	5	6	7	8	9	10	11	12	13	
5	0.0393	0.0785	0.118	0.157	0.196	0.236	0.275	0.314	0.353	0.393	0.432	0.471	0.510	5
10	0.0785	0.157	0.236	0.314	0.392	0.471	0.550	0.628	0.707	0.785	0.864	0.942	1.02	10
15	0.118	0.236	0.353	0.471	0.589	0.707	0.824	0.942	1.06	1.18	1.30	1.41	1.53	15
20	0.157	0.314	0.471	0.628	0.785	0.942	1.10	1.26	1.41	1.57	1.73	1.88	2.04	20
25	0.196	0.393	0.589	0.785	0.981	1.18	1.37	1.57	1.77	1.96	2.16	2.36	2.55	25
30	0.236	0.471	0.707	0.942	1.18	1.41	1.65	1.88	2.12	2.36	2.59	2.83	3.06	30
35	0.275	0.550	0.824	1.10	1.37	1.65	1.92	2.20	2.47	2.75	3.02	3.30	3.57	35
40	0.314	0.628	0.942	1.26	1.57	1.88	2.20	2.51	2.83	3.14	3.45	3.77	4.08	40
45	0.353	0.707	1.06	1.41	1.77	2.12	2.47	2.83	3.18	3.53	3.89	4.24	4.59	45
50	0.393	0.785	1.18	1.57	1.96	2.36	2.75	3.14	3.53	3.93	4.32	4.71	5.10	50
55	0.432	0.864	1.30	1.73	2.16	2.59	3.02	3.45	3.89	4.32	4.75	5.18	5.61	55
60	0.471	0.942	1.41	1.88	2.36	2.83	3.30	3.77	4.24	4.71	5.18	5.65	6.12	60
65	0.510	1.02	1.53	2.04	2.55	3.06	3.57	4.08	4.59	5.10	5.61	6.12	6.63	65
70	0.550	1.10	1.65	2.20	2.75	3.30	3.85	4.40	4.95	5.50	6.04	6.59	7.14	70
75	0.589	1.18	1.77	2.36	2.94	3.53	4.12	4.71	5.30	5.89	6.48	7.07	7.65	75
80	0.628	1.26	1.88	2.51	3.14	3.77	4.40	5.02	5.65	6.28	6.91	7.54	8.16	80
85	0.667	1.33	2.00	2.67	3.34	4.00	4.67	5.34	6.01	6.67	7.34	8.01	8.67	85
90	0.707	1.41	2.12	2.83	3.53	4.24	4.95	5.65	6.36	7.07	7.77	8.48	9.18	90
95	0.746	1.49	2.24	2.98	3.73	4.47	5.22	5.97	6.71	7.46	8.20	8.95	9.69	95
100	0.785	1.57	2.36	3.14	3.93	4.71	5.50	6.28	7.07	7.85	8.64	9.42	10.2	100
200	1.57	3.14	4.71	6.28	7.85	9.42	11.0	12.6	14.1	15.7	17.3	18.8	20.4	200
300	2.36	4.71	7.07	9.42	11.8	14.1	16.5	18.8	21.2	23.6	25.9	28.3	30.6	300
400	3.14	6.28	9.42	12.6	15.7	18.8	22.0	25.1	28.3	31.4	34.5	37.7	40.8	400
500	3.93	7.85	11.8	15.7	19.6	23.6	27.5	31.4	35.3	39.3	43.2	47.1	51.0	500
600	4.71	9.42	14.1	18.8	23.6	28.3	33.0	37.7	42.4	47.1	51.8	56.5	61.2	600
700	5.50	11.0	16.5	22.0	27.5	33.0	38.5	44.0	49.5	55.0	60.4	65.9	71.4	700
800	6.28	12.6	18.8	25.1	31.4	37.7	44.0	50.2	56.5	62.8	69.1	75.4	81.6	800
900	7.07	14.1	21.2	28.3	35.3	42.4	49.5	56.5	63.6	70.7	77.7	84.8	91.8	900
1000	7.85	15.7	23.6	31.4	39.3	47.1	55.0	62.8	70.7	78.5	86.4	94.2	102	1000
2000	15.7	31.4	47.1	62.8	78.5	94.2	110	126	141	157	173	188	204	2000

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Width, mm	Thickness, mm											Width, mm		
	14	15	16	17	18	19	20	21	22	23	24		25	26
5	0.550	0.589	0.628	0.667	0.707	0.746	0.785	0.824	0.864	0.903	0.942	0.981	1.02	5
10	1.10	1.18	1.26	1.33	1.41	1.49	1.57	1.65	1.73	1.81	1.88	1.96	2.04	10
15	1.65	1.77	1.88	2.00	2.12	2.24	2.36	2.47	2.59	2.71	2.83	2.94	3.06	15
20	2.20	2.36	2.51	2.67	2.82	2.98	3.14	3.30	3.45	3.61	3.77	3.93	4.08	20
25	2.75	2.94	3.14	3.34	3.53	3.73	3.93	4.12	4.32	4.51	4.71	4.91	5.10	25
30	3.30	3.53	3.77	4.00	4.24	4.47	4.71	4.95	5.18	5.42	5.65	5.89	6.12	30
35	3.85	4.12	4.40	4.67	4.95	5.22	5.50	5.77	6.04	6.32	6.59	6.87	7.14	35
40	4.40	4.71	5.02	5.34	5.65	5.97	6.28	6.59	6.91	7.22	7.54	7.85	8.16	40
45	4.95	5.30	5.65	6.01	6.36	6.71	7.07	7.42	7.77	8.12	8.48	8.83	9.18	45
50	5.50	5.89	6.28	6.67	7.06	7.46	7.85	8.24	8.64	9.03	9.42	9.81	10.2	50
55	6.04	6.48	6.91	7.34	7.77	8.20	8.64	9.07	9.50	9.93	10.4	10.8	11.2	55
60	6.59	7.07	7.54	8.01	8.48	8.95	9.42	9.89	10.4	10.8	11.3	11.8	12.2	60
65	7.14	7.65	8.16	8.67	9.18	9.69	10.2	10.7	11.2	11.7	12.2	12.8	13.3	65
70	7.69	8.24	8.79	9.34	9.89	10.4	11.0	11.5	12.1	12.6	13.2	13.7	14.3	70
75	8.24	8.83	9.42	10.0	10.5	11.2	11.8	12.4	13.0	13.5	14.1	14.7	15.3	75
80	8.79	9.42	10.0	10.7	11.3	11.9	12.6	13.2	13.8	14.4	15.1	15.7	16.3	80
85	9.34	10.0	10.7	11.3	12.0	12.7	13.3	14.0	14.7	15.3	16.0	16.7	17.3	85
90	9.89	10.6	11.3	12.0	12.7	13.4	14.1	14.8	15.5	16.2	17.0	17.7	18.4	90
95	10.4	11.2	11.9	12.7	13.4	14.2	14.9	15.7	16.4	17.2	17.9	18.6	19.4	95
100	11.0	11.8	12.6	13.3	14.1	14.9	15.7	16.5	17.3	18.1	18.8	19.6	20.4	100
200	22.0	23.6	25.1	26.7	28.2	29.8	31.4	33.0	34.5	36.1	37.7	39.3	40.8	200
300	33.0	35.3	37.7	40.0	42.4	44.7	47.1	49.5	51.8	54.2	56.5	58.9	61.2	300
400	44.0	47.1	50.2	53.4	56.5	59.7	62.8	65.9	69.1	72.2	75.4	78.5	81.6	400
500	55.0	58.9	62.8	66.7	70.7	74.6	78.5	82.4	86.4	90.3	94.2	98.1	102	500
600	65.9	70.7	75.4	80.1	84.8	89.5	94.2	98.9	104	108	113	118	122	600
700	76.9	82.4	87.9	93.4	98.9	104	110	115	121	126	132	137	143	700
800	87.9	94.2	100	107	113	119	126	132	138	144	151	157	163	800
900	98.9	106	113	120	127	134	141	148	155	162	170	177	184	900
1000	110	118	126	133	141	149	157	165	173	181	188	196	204	1000
2000	220	236	251	267	283	298	314	330	345	361	377	393	408	2000

Where: t=thickness (mm)
W=width (mm)

$$\text{kg/m} = \frac{t \times W \times 7850}{1\,000\,000}$$

For any thickness or width:

STEEL CULVERT PIPE

Long length helical lock-seamed corrugated galvanized steel pipes, manufactured to AS 1761 specifications, are formed by a continuous lock-seam which runs helically around the periphery of the pipe.

AS 1761 requires that these helical pipes be formed from hot-dip continuous galvanized steel coil conforming to AS 1397 G250 Z600 specification. Sheet & Coil Products ZINCFORM steel conforms to this specification.

This continuous coil method of production has enabled manufacturers to significantly reduce manufacturing costs of full circle pipe (previously produced as modular riveted pipe). The result is a more cost-effective method to remove water run-off.

Long, custom made lengths up to 12 m, with diameters 300-3600 mm, are available for applications such as:

Road and rail culverts	Conveyor housings
Pedestrian underpasses	Pile shells
General drainage, agricultural and irrigation uses	Mine access and ventilation

Pregalvanized steel helical corrugated pipes can offer the following advantages over alternative pipe materials of heavier, shorter sections:

- Lower installed cost
- Shorter duration of disruptive traffic detours
- Less excavation
- No breakages
- Fewer weather hazards
- Custom made lengths
- Light and nestable, reducing freight costs

AS 1762 details the necessary requirements for culvert installation.

STEEL GUARDRAIL

Steel guardrail is made from strong, resilient steel, galvanized for corrosion protection. Beam and joint strength is adequate to redirect stray vehicles in a direction parallel to the traffic flow, under normal impact. If a guardrail has insufficient beam strength, 'pocketing' can result.

ROAD BRIDGE DECKING

The principal function of galvanized steel road bridge decking is to provide a serviceable material to substitute for timber decking on road bridges. AS 1397 G450 strength steel deck panels act as the main load-carrying element of the bridge deck. Lengths of 8, 10, 12 and 14 m are normally available; custom cut lengths by negotiation.

Bridge redecking can be speedily achieved, minimizing costs and keeping traffic disruption to a minimum. The decks can also be used for other applications such as railway platforms, loading docks etc.

Some helpful features include:

Minimal traffic disruption Half width of bridge can remain open to traffic while work in progress, when decks are laid longitudinally.

Directional placement Suitable for both longitudinal and transverse placement.

Easy handling Decks 5 or 6 metres can be handled by two men. Decks nest to reduce packaging size.

Bridge Widening Widening from one lane to two lanes can be achieved using cantilevered supports.

The infill materials used can vary from locally available earth to bitumen or structural grade concrete.

Road Bridge Decking Installation Manual and additional information available from Fletcher Manufacturing Pty Ltd (formerly Armco).

STEEL SHEET AND STRIP – CORRECT SELECTION FOR USE

Selection of the correct steel sheet type with the appropriate finish is the first and perhaps the most important step in producing a finished article.

Steel sheet is a generic term which covers a considerable array of metallurgical products presented as continuous strip in coil form or as sheets (cut lengths) or blanks.

The majority of steel sheet used in Australia is low carbon unalloyed steel, but even this type can be produced in differing ways to meet particular requirements of end users. Other types of steel include medium and high carbon, low-alloy high tensile, and a range of stainless steels.

The Referee outlines the steel sheet range regularly manufactured by Sheet & Coil Products but it is emphasised that special grades or varieties of regular products may be produced to satisfy specific customer needs.

TECHNICAL SERVICES

In each State capital and in some regional centres there is a S&CP Office with staff trained to assist customers in the selection of the most cost effective material for their requirements and in solving problems which may arise through the application of this material. Printed data and other information on steel sheet products are freely available in reply to approaches made by letter, telephone or in person.

A series of five Sheet Steel Fabrication Handbooks published to assist steel product designers, fabricators and other users, is available. These books cover the subjects described by their titles and, like The Referee, are provided as a service.

Vol 1 – Sheet Steel

Vol 2 – Design

Vol 3 – Pressing and Forming

Vol 4 – Fastening and Sealing

Vol 5 – Finishing and Corrosion Protection

Each steel product has its own characteristics and staff can not only indicate the product best suited for the particular application, but can, in many cases, show how savings can be made by making use of products which reduce or simplify the customer's processing operations.

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Included in the staff of each State Office are experienced and qualified technical representatives who can provide specialised services, often in customers' plants. They cover various aspects such as selection of steel sheet, processing in drawing, roll-forming or welding and finishing of components.

For more specialised advice or detailed problem investigation the local technical representative is able to draw upon the Division's extensive technical resources. Depending upon the problem, a detailed laboratory investigation may be arranged or a specialist may visit the customer for discussion, and in some cases an in-plant study, particularly if the problem is associated with a customer's manufacturing process.

The Division has modern, well equipped and staffed laboratories which are registered and approved by NATA (National Association of Testing Authorities) for chemical, mechanical and electrical steel testing.

Although primarily engaged in the development of new products, improvement of existing ones and optimisation of manufacturing processes, the major technical resources are also involved in quality control and have extensive experience of the type of problems which may arise in the use of the company's products.

In optimising complex operations like rolling, heat treatment, continuous galvanizing, coil painting, shearing and slitting as well as punching, press-brake forming and roll-forming involved in the manufacture of the product range, a knowledge of the fundamental principles involved has been gained, plus the expertise to apply these principles to actual manufacturing processes. This expertise and ability in process analysis and design is available to help customers with their particular problems.

A fully equipped Product Application and Development (PAD) centre is located at the Research and Technology laboratories at Port Kembla, NSW. Prototypes of customers' new applications can be developed to demonstrate the most cost effective material and manufacturing technique.

Technical services available for the benefit of customers may be obtained at all times. However the advice is particularly appropriate at times of product development or in the design stage or when extensions or changes to plant and equipment are being considered. By consultation prior to making decisions, economies in production and perhaps capital cost can often be achieved.

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AREA PER TONNE OF PRODUCT

Calculated area per tonne of product (square metres per tonne)
unpainted sheet and strip

Specified thickness of base steel, mm	Uncoated steel	Coating class							
		EZ10	Z100 ZF100 PS100	Z200	Z275	Z450	Z600	AZ50	AZ150
0.30	424.6	422.7	402.4	388.3	378.1	354.0	332.8	412.4	396.0
0.35	363.9	362.5	347.5	336.9	329.2	310.8	294.3	354.9	342.7
0.40	318.5	317.4	305.8	297.6	291.5	277.0	263.9	311.5	302.1
0.42	303.3	302.3	291.8	284.3	278.8	265.5	253.4	297.0	288.4
0.48	265.4	264.6	256.5	250.8	246.4	236.0	226.3	260.6	253.9
0.50	254.8	254.1	246.6	241.3	237.2	227.5	218.6	250.3	244.2
0.55	231.6	231.0	224.8	220.4	217.0	208.9	201.3	227.9	222.8
0.60	212.3	211.8	206.6	202.8	200.0	193.1	186.6	209.2	204.9
0.65	196.0	195.6	191.1	187.9	185.5	179.5	173.9	193.3	189.7
0.70	182.0	181.6	177.8	175.0	172.9	167.6	162.7	179.7	176.5
0.75	169.8	169.5	166.2	163.7	161.9	157.3	153.0	167.8	165.1
0.80	159.2	159.0	156.0	153.8	152.2	148.1	144.3	157.5	155.0
0.85	149.9	149.6	147.0	145.1	143.6	140.0	136.6	148.3	146.2
0.90	141.5	141.3	139.0	137.3	136.0	132.7	129.6	140.2	138.2
0.95	134.1	133.9	131.8	130.2	129.1	126.1	123.3	132.8	131.1
1.00	127.4	127.2	125.3	123.9	122.9	120.2	117.6	126.3	124.7
1.15	110.8	110.6	109.2	108.1	107.3	105.3	103.3	109.9	108.7
1.20	106.2	106.0	104.7	103.7	103.0	101.0	99.3	105.4	104.3
1.40	91.0	90.9	89.9	89.2	88.7	87.3	85.9	90.4	89.6
1.50	84.9	84.8	84.0	83.4	82.9	81.7	80.5	84.4	83.7
1.60	79.6	79.5	78.8	78.2	77.8	76.7	75.7	79.2	78.6
1.80	70.8	70.7	70.1	69.7	69.3	68.5	67.7	70.4	69.9
1.90	67.0	67.0	66.5	66.1	65.8	65.0	64.2	66.7	66.3
2.00	63.7	63.6	63.2	62.8	62.5	61.8	61.2	63.4	63.0
2.20	57.9	57.9	57.5	57.2	56.9	56.4	55.7	57.7	57.3
2.50	51.0	50.9	50.6	50.4	50.2	49.8	49.2	50.8	50.5
3.00	42.5	42.4	42.2	42.1	41.9	41.6	41.3	42.3	42.2
3.20	39.8	39.8	39.6	39.5	39.4	39.1	38.8	39.7	39.5

HANDLING AND STORAGE OF COATED STEEL SHEET PRODUCTS

Provided they are kept dry all Sheet & Coil Products steel products may be satisfactorily stored without deterioration in quality.

Both sheet and coils should be transported and stored so that water is unable to penetrate between adjacent sheet or wrap surfaces. Products must be kept dry in transit and stored in weatherproof buildings. Under conditions of high humidity, condensation must be prevented by adequate ventilation and air circulation.

If sheet storage racks are used, they should be constructed so that sheets are stored on edge, not flat. COLORBOND and MARVIPLATE steel sheets are best stored main surface to main surface. Access should be available at each end of racks so that sheets can be lifted, not dragged. Cleanliness is important in sheet storage; dirt fall-out, even inside buildings, promotes corrosion on unprotected steel.

Where practical, flat sheet products are best left in the protective pack until required for use. It is good practice to convey sheet packs to machinery for feeding direct from the pack.

KEEP THE PRODUCT DRY

It must be stressed that should water become trapped between adjacent surfaces on any sheet or coiled strip product the resulting corrosive reactions are far more aggressive than those encountered in normal service. In extreme cases and with COLORBOND steel or lighter coating class qualities such as ZINCSEAL and ZINCANNEAL steel, this may lead to early failure of the coating.

If, inadvertently, a stack or pack of any sheet product becomes wet, the suggested remedial action would depend greatly upon the nature of the product, its finish or coating, the length of time any water is present and the condition of the sheets on examination. In all cases excess water should be wiped off with a clean cloth without delay and the separated sheets stacked so that air circulation completes the drying process. In some cases it may be practical to immerse sheets in a tank containing a dewatering agent such as Castrol Electric Motor Solvent or WD40.

Obviously these procedures are not practical with coil, and technical advice should be sought without delay from the nearest Sheet & Coil Products State Office.

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FORMED CLADDING PROFILES

Plain ZINCALUME, galvanized or organic coated steel roofing and walling products are normally delivered to the building site in strapped bundles.

If not required for immediate use, sheets or bundles of formed building profiles should be neatly stacked clear of the ground and, if left in the open, should be protected by loose tarpaulins or similar covers allowing for adequate air circulation. On no account should packs be left exposed to the weather. Rain or condensation is easily drawn in between tightly nested sheets by capillary action. Because this moisture cannot then evaporate in the normal way it will cause unsightly stains which can detract seriously from the finished appearance of the installation. In the extreme a significant loss of coating can occur.

On large building projects handling time can be reduced by using a crane to lift bundles directly onto the roof. If required, Sheet & Coil Products and Lysaght Building Industries State Offices will give advice on lifting long-length bundles.

For small and medium jobs without mechanical handling facilities, sheets can easily be passed up one at a time by hand. Gloves should always be worn.

When handling COLORBOND, MARVIPLATE and COOLCLAD steel, do not drop sheets or drag one sheet over another. Always wear soft soled shoes and avoid the ribbed type that pick up and hold small stones, etc.

If a strippable film is present on any steel building product, it is essential that the film be stripped away as soon as possible after installation. Failure to do this can result in problems with stripping.

Do not drag tools and equipment over painted surfaces. Carefully sweep away any metal shavings caused by drilling or sawing. Touch-up paint supplied for the correction of minor erection damage should be used sparingly and only when absolutely necessary and in accordance with recommendations contained in specific literature available on request to Sheet & Coil Products or Lysaght Building Industries Offices. In other words use sensible care that befits a high-quality finish so that it may perform properly.

EXTERNAL FASTENERS FOR ZINCALUME PREPAINTED STEEL ROOFING AND WALLING PRODUCTS

Sheet & Coil Products manufactures a range of steel products specifically suitable for use in roofing and walling application in the building industry.

For best service the premium products are ZINCALUME hot dipped zinc/aluminium alloy, coated steel with thicker coating class designated AZ150 for long life and several COLORBOND prepainted finishes applied to ZINCALUME steel. The COLORBOND paint finishes not only add beauty to the product, but increase service life.

For the roofing and walling market the specific COLORBOND steels are COLORBOND XRW, COLORBOND XPD and COLORBOND XSE, each with their own characteristics and each tailored for use in specific environments (see section 2 for optimum choice).

In addition to the COLORBOND range S&CP markets Exterior MARVI-PLATE vinyl clad steel for severe exposure conditions.

Just as there is an optimum choice of sheeting material for any particular service environment, so too there is an optimum choice of external fasteners for pierce fixing of roofing and walling profiles.

Australian Standard AS 3566, "SCREWS – SELF-DRILLING FOR THE BUILDING AND CONSTRUCTION INDUSTRY", sets out the performance requirements for these fasteners in various environments, and Australian Manufacturers of fasteners market a range of fasteners which fulfil the requirements of the Standard. The correct choice of fastener is important. The more closely the service life of fasteners and sheeting are matched, the better. Premature failure of fasteners is clearly not desirable.

The table on the following page summarises S&CP recommended roofing and walling products for various degrees of severity of atmospheric exposure, together with the recommended fastener type for optimum service. These recommendations are in accordance with the requirements of AS 3566.

It should be noted that manufacturers of both roofing and walling profiles and fasteners are continually developing new products. They should be consulted before making final choice of either.

RECOMMENDED EXTERNAL FASTENER TYPES FOR EXTERNAL ROOFING AND WALLING PRODUCTS OF HOT DIPPED AND PREPAINTED STEEL

Sheet & Coil Products – Recommended Products					
Atmospheric Exposure	ZINCALUME Steel	COLORBOND XRW	COLORBOND XPD	COLORBOND XSE	MARVIPLATE Steel
Coastal – Severe	NR	NR	NR	NR	C,D,E
Coastal – Intermediate	NR	NR	NR	A,C	—
Coastal – Mild	A,B,C	A,B,C	A,B,C	A,B,C	—
Industrial – Severe	NR	NR	NR	A,B,C,D,E	C,D,E
Industrial – Moderate	A,B,C,D,E	A,B,C,D,E	A,B,C,D,E	A,B,C,D,E	—
Industrial – Light/Urban	A,B,C,D,E	A,B,C,D,E	A,B,C,D,E	A,B,C,D,E	—
Outer Urban/Rural	A,B,C,D,E	A,B,C,D,E	A,B,C,D,E	A,B,C,D,E	—

Key: A = Hot dipped galvanized 40µm min. coating thickness or equivalent

B = Fasteners conforming with AS3566 corrosion resistance Class 3

C = All-Plastic head

D = Stainless Steel capped

E = All Stainless Steel

NR = Not recommended for the atmospheric exposure conditions

— = Unlikely to be used.

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Note: These recommendations are consistent with the classes of exposure and test methods in Australian standard AS3566-1988, "Screws – Self-Drilling for the Building and Construction Industry". They take into account not only resistance to exposure conditions, but also compatibility of dissimilar metals.

In this regard it is important to point out that HOT DIPPED GALVANIZED 40 μm MINIMUM COATING THICKNESS FASTENERS ARE FULLY COMPATIBLE WITH ZINCALUME ZINC/ALUMINIUM COATED STEEL PRODUCTS.

Although highly corrosion resistant in their own right, compatibility considerations rule out the use of stainless steel and stainless steel capped fasteners for use with COLORBOND XRW, COLORBOND XPD and COLORBOND XSE in intermediate and mild coastal exposure.

For tropical exposure it is recommended that Hot Dipped Galvanized 40 μm minimum coating thickness be used.

ATMOSPHERIC EXPOSURE GUIDE

Because corrosion performance depends on so many variables it is not practical to completely cover all possibilities in a brief description. The following should be taken as a guide only, and for correct choice of fastener and roofing product we recommend consultation with either the fastener manufacturers, roofing product manufacturers, or Sheet & Coil Products State Offices.

Coastal – Severe: Immediate vicinity of surf coastline (say within 100 m).

Coastal – Intermediate: Reasonably close to surf coastline (say 100-500 m).

Coastal – Mild: Some distance from surf coastline (say 500-1000 m).

Industrial – Severe: Very close to sources of corrosive emissions, subject to heavy fallout, etc (say within 100 m).

Industrial – Moderate: Reasonably close to sources of corrosive emissions, subject to some fallout, etc (say 100-250 m).

Industrial – Light/Urban: Low levels of man-made corrosive influences (say 250-500 m).

Outer Urban/Rural: Corrosion and degradation of materials due principally to natural causes only (say greater than 1 km).

FASTENERS

All fasteners used for external steel roofing and walling applications should conform with the requirements of Australian Standard AS3566. "Screws – Self-Drilling for the Building and Construction Industries".

Fastener packages produced by leading Australian manufacturers are clearly labelled in accordance with AS3566 so that correct choice of fasteners can be made.

LBI SCREW FASTENERS CODE

Fasteners are a very important, integral component of the LBI roofing/walling systems. When fastened with the correct fasteners and installed in accordance with the appropriate LBI recommendations, the roofing/walling systems will perform as specified in product literature.

Fasteners used must be manufactured with protective coatings adequate for the product and service conditions.

Approved screw fasteners required for installation of LBI roofing/walling systems are obtainable from LBI roofing/walling distributors.

Fastener descriptions need to include the many features required. To avoid lengthy descriptions, a fastener code system is used by LBI; this comprises a set of three prefix letters followed by a set of four numbers:

First letter:	S = For fastening to STEEL supports T = For fastening to TIMBER supports
Second letter:	H = HEXAGON head screw S = SLOTTED pan head screw W = WAFER head screw
Third letter:	S = SELF-DRILLING screw P = PREDRILLED hole is required
First two numbers:	Screw major diameter, classified as a number – 08, 10, 12, 14
Second two numbers:	Screw length in mm

Thus, code number SHS 1235 nominates a fastener for fastening to a Steel support, Hex head, Self-drilling, No 12 diameter screw, 35 mm long.

In some cases a fourth letter may be added at the end of the code number. This would either be N (indicating a screw without EPDM seal) or P (indicating a prepainted head).

The Referee

FASTENERS – NON-CYCLONIC

Profile		Fixing to Steel		Fixing to Timber	
		1.0-2.5 mm thick	2.5-5.0 mm thick	Hardwood J1-J3	Softwood J4
CUSTOM ORB/ CUSTOM BLUE ORB	Crest Fixed	No. 14-10 x 42 mm Hex Head self drilling tapping screw (Lysaght No. SHS 1442)	No. 14-20 x 45 mm Hex Head self drilling tapping screw (Lysaght No. SHS 1445)	No. 14-10 x 50 mm Hex Head Type 17 self drilling screw (Lysaght No. THS 1450)	No. 14-10 x 65 mm Hex Head Type 17 self drilling screw (Lysaght No. THS 1465)
TRIMDEK HI-TEN SPANDEK HI-TEN		No. 14-10 x 50 mm Hex Head self drilling tapping screw (Lysaght No. SHS 1450C)	No. 14-20 x 50 mm Hex Head self drilling tapping screw (Lysaght No. SHS 1450)	No. 14-10 x 65 mm Hex Head Type 17 self drilling screw (Lysaght No. THS 1465)	No. 14-10 x 75 mm Hex Head Type 17 self drilling screw (Lysaght No. THS 1475)
KLIP-LOK HI-TEN	Clip Fixed	No. 10-16 x 16 mm Wafer Head self drilling tapping screw (Lysaght No. SWS 1016C)	No. 10-24 x 16 mm Wafer Head self drilling tapping screw (Lysaght No. SWS 1016)	No. 3.75 x 40 mm Nail* No. 10-12 x 25 mm Wafer Head Type 17 self drilling wood screw (Lysaght No. TWS 1025)	
EASYCLAD HI-TEN		No. 10-16 x 16 mm Wafer Head self drilling tapping screw (Lysaght No. SWS 1016C)	No. 10-24 x 16 mm Wafer Head self drilling tapping screw (Lysaght No. SWS 1016)	No. 10-12 x 25 mm Wafer Head Type 17 self drilling wood screw (Lysaght No. TWS 1025)	3.75 x 60 mm Nail*
PANELRIB	Valley Fixed on Wall	No. 10-16 x 16 mm Wafer Head self drilling tapping screw (Lysaght No. SWS 1016C)	No. 10-24 x 16 mm Wafer Head self drilling tapping screw (Lysaght No. SWS 1016)	3.75 x 40 mm Nail*	3.75 x 60 mm Nail*
CUSTOM ORB CUSTOM BLUE ORB TRIMDEK HI-TEN SPANDEK HI-TEN		No. 14-10 x 20 mm Hex Head self drilling tapping screw (Lysaght No. SHS 1420)	No. 14-20 x 22 mm Hex Head self drilling tapping screw (Lysaght No. SHS 1422)	No. 14-10 x 25 mm Hex Head Type 17 self drilling screw (Lysaght No. THS 1425)	No. 14-10 x 50 mm Hex Head Type 17 self drilling screw (Lysaght No. THS 1450)

Note: Fixing to supports thinner than 1.0 mm may be with the screws listed for 1.0-2.5 mm steel or with type 17 screws of the same size. All fasteners exposed directly to the weather should be fitted with sealing washers.

*Nails must be galvanised annular grooved or spiral threaded types. Nails must not be used to fix KLIP-LOK 0.65.

The Referee

FASTENERS – CYCLONIC

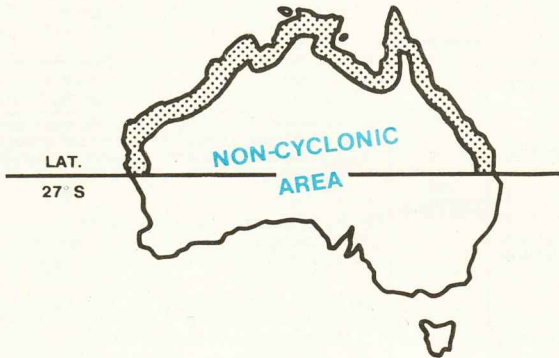
Profile	Fixing to Steel up to 5.0 mm thick		Fixing to Hardwood J1-J3
CUSTOM ORB CUSTOM BLUE ORB	Crest Fixed	No 12 x 35 mm Hex Head self-drilling tapping screw (Lysaght No SHS1235)	No 12 x 50 mm Hex Head Type 17 self-drilling screw (Lysaght No THS1250) 3.57 x 50 mm Nail*
TRIMDEK HI-TEN SPANDEK HI-TEN		No 12 x 45 mm Hex Head self-drilling tapping screw (Lysaght No SHS1245)	No 12 x 65 mm Hex Head Type 17 self-drilling screw (Lysaght No THS1265)
KLIP-LOK HI-TEN	Clip Fixed	No 10 x 16 mm Wafer Head self-drilling tapping screw (Lysaght No SWS1016 or SWS1016C)	No 10 x 25 mm Wafer Head Type 17 self-drilling wood screw (Lysaght No TWS1025) 3.75 x 40 mm Nail*
BROWNBUILT 305 BROWNBUILT 406		No 10 x 16 mm Wafer Head self-drilling tapping screw (Lysaght No SWS1016 or SWS1016C)	No 10 x 25 mm Wafer Head Type 17 self-drilling wood screw (Lysaght No TWS1025)
EASYCLAD HI-TEN		No 10-16 x 16 mm Wafer Head self-drilling tapping screw (Lysaght No SWS1016C)	No 10-12 x 25 mm Wafer Head Type 17 self-drilling wood screw (Lysaght No TWS1025) 3.75 x 40 mm Nail 3.75 x 60 mm Nail
CUSTOM ORB CUSTOM BLUE ORB TRIMDEK HI-TEN SPANDEK HI-TEN	Valley Fixed on walls	No 10 x 16 mm Hex Head self-drilling tapping screw (Lysaght No SHS1016)	No 12 x 25 mm Hex Head Type 17 self-drilling wood screw (Lysaght No THS1225)
PANELRIB		No 10-16 x 16 mm Wafer Head self-drilling tapping screw (Lysaght No SWS1016C)	No 10-12 x 25 mm Wafer Head Type 17 self-drilling wood screw (Lysaght No TWS1025) 3.75 x 40 mm Nail 3.75 x 60 mm Nail
Profile	Fixing to Steel up to 3.2 mm thick		Fixing to Timber
MINI-ORB	4.8 mm dia aluminium rivet No 8 x 12 Truss Head self-drilling tapping screw (Lysaght No STS0812)		No 8 x 25 Truss Head Type 17 self-drilling screw (Lysaght No TTS0825)

Notes:

1. Fixing to supports thinner than 1.0 mm may be with the screws listed for 1.0-5.9 mm steel, or with Type 17 screws of the same size.
2. All fasteners exposed directly to the weather should be fitted with sealing washers.
3. When fixing over insulation blanket, add minimum 10 mm to nominated fastener length except for the No 10 Wafer Head which should be replaced with one 22 mm long.
4. When fixing to softwood, add minimum 10 mm to nominated fastener length.
5. *Nail must be galvanized annular grooved or spiral threaded type.

The Referee

A non-cyclonic area is defined as one in which a tropical cyclone is unlikely to occur – ie, areas other than a 50 km coastal strip and offshore islands, north of latitude 27° south.



SOLDERING GALVANIZED STEEL SHEETS

All qualities of Sheet & Coil Products zinc-coated steel sheets may be soldered quickly and effectively if the simple procedures given below are followed.

COMMON SOLDERING PROBLEMS

The most common causes of problems in soldering are:

Refer to comments under

● Dirty soldering iron	Cleanliness
● Overheated soldering iron and abrasion	Applying the Solder
● Dirty and poor quality flux	Cleanliness; Fluxing
● Poor quality solder	Solder
● Use of percussion tools	Forming
● Resistance to wetting by flux	Fluxing
● Covering spangle cracks	Fluxing
● Soldering ZINCANNEAL steel	Fluxing

Storage of Sheets Sheets or products for soldering should be stored appropriately to avoid water damage or oxidation of the surface as it is necessary to remove any surface deposit with abrasive paper before soldering.

Forming The manner in which the material is formed before soldering has an important bearing on its soldering properties. It is important to ensure correct tailoring of seams and to avoid mechanical bruising in either:

- (a) **Hand Seaming.** Use a wooden dresser or mallet in preference to a steel hammer. A groover of the correct size should be used.
- (b) **Machine Seaming.** The size of the seam should be carefully tailored to suit the grooving machine. Care should be taken to ensure that machines are correctly set.

Cleanliness in Forming and Soldering Forming tools and working surfaces should be thoroughly clean, as grit ground into the surface during forming cannot be readily removed. Before seaming, sheets which are obviously dirty should be cleaned and, where applicable, surface deposits should be removed from the area to be soldered by the use of abrasive paper. Before fluxing, the job should be thoroughly cleaned to remove dirt, grease or oil picked up from the forming tools.

The Referee

Flux pots and flux brushes must be clean, and flux which has become contaminated through excessive use should be discarded. It is most important that the soldering iron be clean and well tinned and that the solder be free from contamination.

Keep the Zinc on the Sheet The technique of soldering – as described in both **Fluxing** and **Applying the Solder** – is built around the maxim “keep the zinc on the sheet”. This is particularly important with the thin coating of electro-galvanized sheet.

Fluxing Three types of flux are recommended: the conventional spirits flux and two proprietary fluxes, Kemtex Pinnacle Soldering Fluid and Baker's No 47 Soldering Fluid, with the latter two being preferred. A spirits flux is not recommended for ZINCANNEAL steel but this sheet may be readily soldered if Kemtex Pinnacle or Baker's No 47 Soldering Fluid is used.

- 1 Spirits Flux** A spirits flux is normally a mixture of killed spirits and raw spirits in equal proportions, but good results can be obtained with killed spirits alone or with raw spirits alone. Excessive use of raw spirits can effectively remove significant amounts of the zinc coating and this may lead to soldering problems or corrosion of adjacent areas.

Raw spirits, spirits of salts and muriatic acid are popular names for hydrochloric acid. Killed spirits (or zinc chloride) is hydrochloric acid to which zinc has been added until gas bubbles stop rising from the solution. These materials are normally obtainable from plumbing supply houses.

- 2 Proprietary Soldering Fluids** Kemtex Pinnacle and Baker's No 47 soldering fluids are the preferred choice for soldering and are highly recommended. Kemtex Pinnacle is manufactured by O T Lempriere and Co Ltd, and Baker's No 47 by Aston and Fendley Pty Ltd. Both products are available through normal supply sources in all capital cities as well as from many hardware and plumbing supply houses in both city and country areas. These fluxes instantly wet and superficially etch the zinc surface. They are easier to control than a spirits flux, fluxing time is reduced and, normally, greater speed and ease of soldering results in better joint penetration. The slightly higher cost tends to be offset by the smaller quantity required for effective fluxing. For best results the time between fluxing and soldering should be minimised by fluxing small areas.

The Referee

As a flux is corrosive, only the portions of the work to be covered with solder should be fluxed. This should be observed with particular care when using a high proportion of raw spirits, as it is very reactive with zinc.

The flux should be applied until it has uniformly covered the whole of the joint and has penetrated into the joint. With a spirits flux it is essential to ensure that the area to be soldered has been thoroughly wetted with flux; a second application may be necessary.

The wetting action and joint penetration of a spirits flux is improved by the use of a wetting agent in the proportion of one drop per cup of flux. This approach may be used with Pinnacle or Baker's flux for ensuring joint penetration, although usually penetration of both lapped and grooved seams is complete if sufficient flux is used.

The wetting agent may be an industrial surface active agent such as Nonidet 91/6, which is available from Shell Chemical (Australia) Pty Ltd. Alternatively, many of the readily available household detergents, preferably non-ionic, are satisfactory and a simple trial will establish suitability. Some cloudiness may occur following the addition of the detergent but this will not affect the fluxing operation.

When forming or seaming operations involve severe stretching of the coating relative to the base, minute surface fissures, or spangle cracks, may result. Spangle cracking does not normally interfere with the penetration of solder into a seam; but when appearance is important and smooth coverage of these areas is necessary, careful attention must be given to cleanliness and fluxing technique, and the speed of soldering must be reduced, particularly when a spirits flux is used. This problem can normally be overcome by the use of Pinnacle or Baker's flux.

At regular intervals the flux pot should be cleaned and filled with fresh flux. Constant use of the same flux, or adding to used flux, will result in contamination and ineffective fluxing action.

Solder A good quality 50-50 solder with a maximum antimony content of 0.5 per cent should be used. Australian Standard 1834 gives full details of a suitable composition. Solder sticks should be clean and the use of badly oxidized sticks should be avoided.

The Referee

Applying the Solder To obtain the best results the required heat should be applied in the shortest possible time at a minimum working temperature. Overheating may result in local buckling and it causes an excessive solution of the zinc coating, giving a rough sandy finish. The seam must, however, be adequately heated if good penetration is to be obtained. To achieve these objectives the following points should be observed:

- 1 Avoid heat conduction away from the joint. This will occur when the work is in contact with a heat conductor, such as a steel block, and inadequate heating may result.
- 2 Avoid soldering in draughty conditions. Inadequate heating may result.
- 3 Use a soldering iron with a high rate of heat transfer. It is desirable to dress the bit face to provide a large surface area in contact with the work.
- 4 The soldering iron should be clean and well tinned.
- 5 Do not overheat the soldering iron. An overheated iron, indicated by a pre-dominance of green colouration in the heating flame, will cause overheating of the work.
- 6 Avoid applying a direct flame to the work. Overheating may result.
- 7 Solder the joint in one run wherever possible. A second run serves little purpose if the first run has been properly applied.
- 8 Avoid undue abrasion of the zinc surface with the soldering iron.
- 9 The soldering iron should always be drawn along the seam towards the operator, because the iron preheats the seam, and should be drawn in a straight line with no movement from side to side.

After Soldering It is most important that the job be wiped with clean cloths dampened in clean water to remove excess flux and so prevent corrosion.

ADHESIVES FOR JOINING SHEET & COIL PRODUCTS STEEL SHEET

In the manufacture of products from steel sheet, adhesives are playing an increasingly important role as the benefits of adhesive joining become more widely known and accepted and as new adhesives are introduced. The progress from simple natural rubbers and adhesives and resins has enabled new dimensions in strength, flexibility and resistance to environmental conditions to be achieved. New formulations are being developed at an accelerating rate, increasing the number and variety of applications using Sheet & Coil Products steel sheet.

REASONS FOR USING ADHESIVES

Adhesive bonding is often a preferred method for joining and sealing steel sheet, with most benefits in the field of precoated sheet.

Subject to the provision of a uniform surface condition, the performance of modern adhesives is both reliable and predictable, and joints of moderate strength can be produced. As with any fastening method, limitations must be recognised along with advantages.

Advantages include:

- Uniform stress distribution
- Vibration dampening
- Seals as well as bonds
- Joins other materials to steel
- Joins thin steel sheets
- High joint security when combined with mechanical or integral fastening
- Smooth contoured outer surface
- Reduces corrosion caused by galvanic cells

Limitations include:

- Difficulty in the correct choice of adhesive from the large range available although this gives more flexibility of choice to suit specific requirements
- Need for careful surface preparation for some types
- Relatively long curing times for some adhesives
- Non-destructive inspection of joint is difficult
- Jigs and fixtures may be needed

JOINT DESIGN

To take full advantage of adhesives, joint design in steel sheet must be considered early in the development of the manufactured product. The two main aspects of study are **joint bonding** and **service environment**.

Joint loading must be known, including direction and type ie, whether the loading is in **compression, tension, shear** or whether a **cleavage** or **peel** loading predominates. In cleavage or peel loading, stress is concentrated at a fine line at the joint edge and unless the joint is wide or the stress small, failure will occur.

APPLICATION

Adhesives are used both for joining steel sheet surfaces together and for affixing attachments.

Service environment must be known and the appropriate adhesive chosen to withstand all temperature, moisture or corrosive conditions likely to be met. In many instances an adhesive can have the dual role of supporting the design load and acting as a sealant. In addition, depending on the final formulation, the adhesive can act as an insulator, conductor, gap filler, etc.

Adhesives may be combined with mechanical fastening or welding systems to give a highly desirable combination of strength combined with the advantage of load distribution over a wide area.

Common methods for applying adhesives include brush, spatula, roller, cartridge extrusion, pneumatic and electric hand guns and, for automated assembly lines, multi-nozzle applicators. Adhesives are often in tape form with some double sided tapes in varying thicknesses offering high strength under many service conditions.

The complexity of available variation possible with the use of adhesives makes it mandatory for **adhesive suppliers to be consulted in the design stage** of both the product to be made and the method of manufacture.

TYPES AND SELECTION

The variety of adhesives available to a manufacturer is rapidly increasing so it is important to understand the characteristics of adhesives. However, the properties of an adhesive can be altered by a change in formulation from a basic type to suit many different requirements and by mixing the basic types themselves to give a combination of desirable characteristics.

The Referee

The basic types of adhesives can be broadly categorised into three main groups: **thermoplastic, thermoset, elastomeric.**

Thermoplastic Adhesives

Thermoplastic adhesives soften when heated. The hot melt group needs heat for application whereas reactive acrylics, anaerobic and cyanoacrylates set at room temperature.

Hot melt adhesives soften in the general working range of 170-200°C. Available as tapes, films, powders, rods, pellets and blocks, they are applied by equipment such as hand-held or automated self-heating guns. At temperature, the adhesive flows onto the surfaces to be joined giving adhesion and strength as cooling and hardening occurs. No chemical change takes place as the adhesive sets and so it will soften again if reheated.

In general terms, hot melt adhesives are less expensive than other adhesive types and have:

- good flexibility
- high impact resistance
- tolerance to surface condition (less surface preparation)
- low creep strength

Differences in formulation permit a wide range of strength properties in hot melt adhesives.

Reactive acrylics are two-pack adhesives and have the advantage of a simple no-mix application with each part applied to one of the faces to be joined, a rapid bond at ambient temperature, good mechanical properties and a lesser need for surface preparation. The high solvent action of reactive acrylics is less affected by oil on steel surfaces than other adhesives. Nevertheless, properly prepared surfaces give a better joint strength and may be necessary for critical applications. Special activators have been developed to enable reactive acrylics to be used on zinc surfaces. Advice should be sought from adhesive suppliers to assist in selecting the best activator for a particular purpose.

Anaerobic adhesives set when starved of oxygen such as between closely matching metal surfaces. They are stored in low density polyethylene containers permeable to oxygen to prevent setting before use. Anaerobics are often used to secure tightly fitting joints such as threaded fasteners, gaskets, keyways and splines.

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Cyanoacrylates polymerise or harden at room temperature when pressed into a thin film between two tightly fitting surfaces. The hardening is initiated by the presence of a very thin film of moisture always present on surfaces at room temperature.

Both anaerobics and cyanoacrylates produce a high strength bond in tension or shear but are very low in cleavage or peel loadings. Resistance to impact loading is low.

Thermoset Adhesives

Thermoset adhesives, for example, the well known epoxy group, undergo chemical change during hardening at room temperature for the two-pack or elevated temperature for single-pack types. They will not soften when reheated. Characteristics are:

- high strength bonds (often called structural adhesives)
- high creep strength
- low impact resistance
- less flexible bond than thermoplastic bond

Elastomeric Adhesives

Elastomeric adhesives are the synthetic rubber-based group and usually set with the evaporation of a solvent. They can also be formulated as contact types which produce instant adhesion when adhesive coated surfaces are brought together.

SURFACE PREPARATION

The object of surface preparation is to remove a sufficient degree of contamination from a surface at a processing cost compatible with the bond strength required for most adhesives, not only for the initial bond strength but also for the durability of the bond when exposed to normal environmental conditions. Sheet & Coil Products organic finished steel sheets usually require only a solvent wipe. Uncoated and metal coated steels invariably require more cleaning to remove any oil and dirt contamination and oxide layers from the surface, the degree of removal depending on the adhesive to be used.

Mechanical cleaning, abrasive blasting and chemical etching can also be used for surface preparation of adhesive joints. Because of the many possible differences in both surfaces and adhesives, the adhesive manufacturers' directions should be followed explicitly.

Any calculations for bond areas needed to give the required joint strength must make allowances for variations in surface treatment likely to be encountered in normal production conditions.

SEALANTS FOR S&CP ZINCALUME, GALVANIZED, COLORBOND OR MARVIPLATE STEELS

Sealant is the descriptive word used, in this handbook, to mean polymeric sealants. Polymeric sealants are formulated to provide a continuous surface-polymer bonding layer to both opposing surfaces, to fill (seal) a gap and to set (cure) either by polymerization initiated by curing agents or by evaporation of constituent solvents, generally followed by polymerization of the resins. Polymerization is a process whereby small organic molecules chemically combine to form very large molecules. Polymeric sealants include natural rubber and synthetic elastomers of nitrile, Neoprene, silicone and butyl generic types.

Although, as part of their sealing function, sealants are designed to hold components together, for joining sheet steel they always require some form of supportive element such as a mechanical fastener (screw, rivet) or integral fastening (seam).

Sealants are not adhesives; their prime purpose is to exclude moisture.

EXTERIOR EXPOSURE APPLICATIONS

Joints for exterior applications such as steel roofs, walls, flashing and ducting constitute a special case due to the number of exposure environments and variables. The wide use of precoated steel for exterior use contributed to the development of sealants suitable for seams and joints.

Many steel roofing and walling shapes marketed under various respected brand names are formed from Sheet & Coil Products steel coated with the protective and/or decorative finishes applied to Exterior MARVIPLATE, COLORBOND, ZINCALUME and zinc-coated steels.

Recommended Sealants

Neutral curing silicone rubber sealants (**acetic acid-free** and **amine-free**) possess the most complete relevant list of properties required to service the total range of Sheet & Coil Products steel sheet exterior finishes, together with an adequate range of flashing materials.

Silicone rubber sealants containing either acetic acid or amines should not be used on zinc or zinc/aluminium finishes. This is due to the fact that wet conditions during early stages of sealant cure can promote a corrosive situation. It is not implied that other sealants may not be suitable. In fact, many others are satisfactory for some or all of the Sheet & Coil Products finishes, even though they may not provide all the optimum characteristics of those recommended.

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Other generic types such as butyl rubber and styrene butadiene rubber are quite acceptable in some cases where the optimum characteristics of the recommended sealants are not required.

Joint Design

Seams should always be mechanically fastened for strength, whether soldered or soft sealant sealed. Therefore the sealant does not require significant total adhesive strength, but it must bond positively to both opposing surfaces as a continuous layer. When sealing laps in roof sheeting, additional fasteners are not necessary where the join is held together by the roof fasteners.

Recommended sealants contain curing agents and do not rely on solvent evaporation for polymerization. To ensure complete sealant cure, the width of sealant in a lap should not exceed 25 mm when compressed.

Sheet thickness will determine distance between fasteners, but for roofing/walling applications generally, 45 to 50 mm should be considered the maximum. Fastener diameter size is dependent upon the sum of all material thicknesses joined. Where doubt exists it is better to select a thicker fastener as thin fasteners tend to work loose during thermal movement.

Spot Welded Joint If a sealed spot welded joint is required, and for aesthetic or practical reasons a sealing over technique is unacceptable, the sealant may be sandwiched between the workpieces and the joint spot welded as usual along the sealant-line. The spot welding operation must take place as soon as possible after sealant placement and before the sealant cures.

Normal welding pressures used for the particular substrates have been found to be sufficient for local displacement of sealant to occur and permit current flow. The recommended sealants do not emit volatile fumes.

Spot welding cannot be performed this way when the sealant has cured; the cured sealant layer acts as an insulator and impedes current flow.

Surface Preparation

For bonding, all workpiece surfaces must be clean and dry and free from contaminants such as old sealant or oil. An oil-free solvent such as toluol or xylol should be used to clean the surface, but this should be wiped off with a clean dry cloth before evaporation occurs. Mineral

The Referee

turpentine is a suitable and practical alternative, but being less volatile than toluol or xylol more wipe-off care may be necessary to ensure complete removal of residual solvent.

Sealant must be applied on the same day as the surface is prepared.

Lap Seam Fabrication

The preferred method for lap seam fabrication is:

- 1 Assemble and drill.
- 2 Separate components and remove drilling debris etc.
- 3 Clean joint surfaces.
- 4 Apply a 3mm sealant bead in a continuous line so that it envelops the fastener hole.
- 5 Relocate components and fasten as soon as practical after sealant placement.
- 6 Place some sealant over and around fasteners.

Fastening techniques are well established, but the need to seal over and around fasteners with a long lasting sealant is emphasised due to total exposure to sunlight in this situation.

For practical purposes it is sometimes necessary to place sealant prior to drilling.

Other Sealant Types

Apart from the cartridge-extrudable sealant types, a number of varieties are commercially available, all of which would probably perform predictably in given situations and with specific materials. It is not practicable for Sheet & Coil Products to extensively research and evaluate each and every one.

If a user is of the opinion that a particular sealing method may suit his purposes better than the method recommended, Sheet & Coil Products State Offices may be able to assist by suggesting a simple test, and/or to provide relevant additional information that could help.

Solid Sealants in Tape Form Solid sealants in tape form are generally semi-cured butyl rubber possessing positive initial adhesion to both opposing surfaces. As with the other sealants, the tapes are used in combination with mechanical fasteners.

For the tape to make positive contact with both surfaces and form a seal, it is important that the tape initial thickness is greater than the gap between the components of the finished joint.

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Used correctly under suitable conditions, these tapes would be satisfactory for use with Sheet & Coil Products exterior finishes. However, some types may be difficult to compress within a joint during cold weather, possibly resulting in a loose or leaking joint later.

Preformed Gaskets Gaskets preformed to some of the popular roofing profiles are generally made from cellular material, and intended for compression between such irregular surfaces as roofing sheets. By varying the compression they can perform different functions of sealing against water, dust, noise, draughts and snow.

The gaskets are non-adhesive and are often saturated with bitumen or acrylic resin. Fitted correctly they would be suitable for use with Sheet & Coil Products exterior finishes in situations where the installation of such bulky seals is indicated.

INTERIOR APPLICATIONS

Sealants for use on assemblies such as interior ducting or containers that will not be exposed to exterior environments, may not need to possess the same properties and characteristics required for exterior exposure.

Possible uses being so varied and complex it is always good practice, particularly for specialized applications, to consult the sealant manufacturer for expert advice. Sheet & Coil Products Offices may also be contacted for assistance in such matters. Exterior exposure application recommendations for joint design, surface preparation and other pertinent items also apply, as appropriate, for interior applications and should be followed.

AVOIDANCE OF CONTACT BETWEEN INCOMPATIBLE METALS – METAL ROOFING/ GUTTER SITUATIONS

These notes are not intended to cover all contingencies where metals incompatibility can cause problems. The subject matter is selective in that it relates to metal roofing/gutter situations, and as such it is also pertinent for steel rain-water tanks.

Data provided is based on a relatively small section of AS 2179 and AS 2180 published as one booklet by Standards Australia. These two standards combine 'Metal Rainwater Goods' together with 'Selection and Installation of Metal Rainwater Goods'. All trades and professions associated with this subject are urged to fully read and observe the practices and recommendations contained in this useful publication.

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Drainage systems should be so designed that direct contact between two or more incompatible metals or alloys does not occur. Drainage from copper or copper alloy roofs, pipes etc, must not be discharged onto or into aluminium alloy, zinc, zinc-coated or zinc/aluminium alloy-coated steel gutters, downpipes and the like.

Compatibility ratings shown indicate suitability in **industrial, coastal and rural atmospheres**. Where a rating would improve in a rural only atmosphere the improved rating appears in brackets, eg (●●●)

Rating: ●●● = **Acceptable**. Increase in the corrosion rate of the sheeting or contact material will be zero or slight.

●● = **Acceptable**, but increase in the corrosion rate of the sheeting or contact material can occur.

x = **Do not use**. Accelerated corrosion will occur, or the difference in the lives of the two materials is too great, or both.

Sheeting material	Contact Material					
	Aluminium and aluminium alloys	Copper and copper alloys	330 series stainless steels	Zinc-coated steel Zinc	Aluminium/zinc-coated steel	Lead
Aluminium and aluminium alloys	●●●	x	●●	●● (●●●)	●●●	x
Copper and copper alloys	x	●●●	●●	x	x	●●
300 series stainless steels	x (●●)	●●	●●●	x	x (●●)	●●
Zinc-coated steel Zinc	●●●	x	●●	●●●	●●●	●● (●●●)
Aluminium/zinc-coated steel	●●●	x	●●	●● (●●●)	●●●	x
Lead	x	●●●	●●●	●● (●●●)	x	●●●

NOTE: The avoidance of direct contact between incompatible metals, although minimizing electro-chemical corrosion, will not necessarily increase the resistance of the metals to general chemical attack in strong corrosive atmospheres. In such atmospheres, certain metals require the extra protection of a coating. Such extra protection should be applied to the sheet fastenings as well as to the sheeting and especially to those parts of the sheeting and/or fastenings in mutual contact. Lead must not be in contact with aluminium alloys or aluminium/zinc-coated steel.

PAINTING OF ZINC-COATED OR ZINCALUME STEEL SHEET

The painting of Sheet & Coil Products zinc-coated or ZINCALUME steel sheet for either decoration or added protection may be easily and effectively carried out, providing certain basic requirements are observed. Ordinary techniques combined with readily available appropriate paints should be used, but care must be taken in the choice of paint to ensure its suitability for application

in the field; (see Section 1)

or in the factory. (see Section 2)

Painting in the field requires **air drying** paints. Table 1 summarizes the general approach to the field painting of Sheet & Coil Products zinc-coated or ZINCALUME steel sheet.

Painting in the factory, normally on a line designed specifically for the purpose and using elaborate cleaning and pretreatment, usually requires **oven drying** paints.

Selection of paint for factory use is dictated by the final use and exposure conditions and should be chosen in consultation with a reputable paint manufacturer. Interior exposure tends to be less severe than exterior but many corrosive interior conditions are encountered eg, in washing machine cabinets.

Selection of paint for field use should take into account the severity of the environment in which the paint will be exposed eg, rural, coastal, industrial or other special conditions. Table 2 lists some proprietary paints which have been found suitable for use in a wide range of conditions. Omission of a system from this Table does not necessarily indicate unsuitability, but merely that circumstances have not permitted its evaluation by Sheet & Coil Products.

SECTION 1 – FIELD PAINTING

For satisfactory priming, the surface to be painted must be clean and dry. Dirt should be removed by washing with water, greasy deposits should be wiped with paint thinners and any loose corrosion product removed by wire brushing.

Weathering, formerly considered to improve long term paint adhesion, has since been found to give inconsistent results and is no longer recommended. One exception to this is for water-based acrylic-type paint where two weeks weathering makes painting easier by improving

the wettability of the surface. The choice of paint, as stated earlier, depends principally on the environmental conditions to be withstood – see Table 2.

Use of the recommended brands should produce a satisfactory result provided care is taken to follow the manufacturers' mixing and application instructions closely. The mixing of different brands of priming and finishing coats should be avoided. **DO NOT OVERPAINT WATER-BASED PAINTS WITH OIL OR ORGANIC SOLVENT TYPE PAINTS.**

A minimum of two finishing coats in addition to the priming coat is advised except for zinc-dust/zinc-oxide paints where a total of two is sufficient. Spray painting can be used to cover large areas at lower cost providing the paint is suitable for this method of application.

At all times it is important to avoid excessive paint build up as may occur in the valleys of formed roofing panels.

SECTION 2 – FACTORY PAINTING

Pretreatment of GALVABOND, ZINCFORM and ZINC-HI-TEN with a phosphate coating system is usually employed in factory applications prior to painting. Since ZINCALUME does not phosphate, the appropriate pretreatment is normally a chromate type.

Chromate coatings or two-pack etch primers may also be used. This confers a valuable combination of a high degree of adhesion and increased corrosion resistance under the types of paints, often stoving varieties, normally applied in factories. Pretreatment is particularly important if the products are to be used outdoors and for many interior applications where the product is exposed to humid conditions or the risk of mechanical damage.

Cleaning and appropriate pretreatment systems are available from companies dealing in metal pretreatment and known to the trade. Two suppliers whose systems have been found satisfactory are Oxy Metal Industries (Australia) Pty Limited and Dulux Australia Limited. Where pretreatment facilities are not available, two pack etch primers may be used.

The Referee

Material to be pretreated should be ordered unchromated and oiled. The light mineral oil used on unchromated strip for protection during transit does not provide the same resistance to corrosion as the chromate treatment. Particular care should be taken to keep packages dry prior to use. Water staining, usually a white corrosion product, should be removed by light abrasion before or during the normal cleaning before the phosphate process.

Usually, pretreatment is applied to the article after forming and immediately before painting, but the practice of prepainting before forming is increasing. This latter procedure requires special attention to the type and efficiency of the pretreatment system used and also to the selection of appropriate finish coats. Should forming occur after painting it is often more economical to use the works prepared prepainted sheet or strip such as COLORBOND steel.

A wide variety of basic paint types is available for factory finishing, but it is important that the most appropriate paint for the particular application is selected. Usually this involves consultation with a reputable supplier in the field and it is advisable that the supplier's recommendations and directions for the paint systems be incorporated into an integrated process and paint technique. As with 'field' painting, any doubts or queries should be referred to the supplier as quickly as possible.

Acrylics are very popular in the appliance and building industries because of their mar resistance and general resistance to the effect of heat and household chemicals.

The technique of post forming painted strip requires special, flexible paint systems and this technique should only be considered in close consultation with a paint manufacturer experienced in this particular field.

COLORBOND Steel In many instances, it is possible – and desirable – to avoid either field or factory painting. COLORBOND prepainted steel is available in a wide range of roofing and cladding profiles or as coil for fabrication.

The Referee

TABLE 1 – GENERAL APPROACH TO THE FIELD PAINTING OF ZINC-COATED OR ZINCALUME STEEL.

Cleaning

- 1 Remove dirt by washing with water.
- 2 Wipe off greasy deposits with paint thinners.
- 3 Remove any corrosion product by wire brushing, taking care not to unnecessarily remove any of the metal coating.

Priming and Finishing

- 1 Select paint system for Table 2 with due regard to environmental requirements.
- 2 Follow the paint manufacturer's instructions explicitly.
- 3 Do not mix different proprietary brands of primer and finisher.
- 4 Apply two finishing coats in addition to the primer. Principal exception is zinc-dust/zinc-oxide where two coats in total is usually sufficient.
- 5 Finishing coats may be applied directly to ZINCANNEAL steel without priming, but when a two pack type etch primer is used, the overall protection given by the paint system is very much improved.
- 6 Care should be taken to provide adequate ventilation as some volatile compounds may be toxic.
- 7 Where possible, contact with the skin should be avoided.

TABLE 2 – FIELD PAINTING OF ZINC-COATED OR ZINCALUME STEEL

(a) Recommendations for rural, urban and moderate industrial conditions

ZINCALUME steel may be painted quite successfully without etch priming but etch primers can improve corrosion resistance.

Primer type	Application	Brand Example	Finish type	Application	Brand Example
Low gloss water-borne acrylic	Brush	Taubmans Duraquaprime T7070 Berger Galvaprime Dulux Galvanized Iron Primer British Paints Galvanized Iron Primer VESSEY HYDROKOTE MIROSTONE 653 MIROCRYL UNIVERSAL PRIMER	Water-borne acrylic	Brush	Taubmans All Weather Gloss Dulux Weathershield Berger Bonanza British Paints Four Seasons MIROSTONE 651 MIROCRYL MIO

Water-borne acrylic	Brush	Dulux Weathershield	Water-borne acrylic	Brush	Dulux Weathershield
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Note: As some acrylic paints may contain chromium compounds, their use on water catchments is not advisable.

Note: For acrylics, overpainting with oil-based paints can reduce adhesion of total system; white is suitable for mild conditions only, colours contain anti-corrosive pigments.

(b) Recommendations for rural, urban, moderate industrial and moderate coastal conditions

approximately 800 metres and further from surf, depending on terrain and prevailing winds.

ZINCALUME steel may be painted quite successfully without etch priming but etch primers can improve corrosion resistance.

Primer type	Application	Brand example	Finish type	Application	Brand example
Two pack etch primer	Brush or spray - Spray preferred	Dulux Etch Primer Taubmans Met-L-Etch	Alkyd	Brush or spray	Dulux Hi-Gloss Taubmans Butex
			Oleoresinous/micaceous iron oxide	Brush or spray	Dulux Ferrodor Taubmans Mironite Roof and Metal

Zinc dust/zinc oxide	Brush or spray	Berger Galvanized Iron Primer Grey Taubmans Galva Kote	Zinc dust/zinc oxide	Brush or spray	Berger Galvanized Iron Primer Grey Taubmans Galva Kote
			Alkyd	Brush or spray	Berger Roofmaster Taubmans Butex
			Oleoresinous/micaceous iron oxide	Brush or spray	Berger Roofmaster MIO Taubmans Mironite Roof and Metal

Note: Before use, 3 kilograms of zinc dust must be added per 5 litres of zinc dust/zinc oxide paint.

(c) Recommendations for severe industrial and severe coastal conditions

within approximately 800 metres of surf, depending on terrain and prevailing winds. The paint types listed are the most appropriate for these severe conditions, and maintenance frequency will vary with the degree of severity. The alternative use of EXTERIOR MARVIPLE steel will generally solve such maintenance problems.

Primer type	Application	Brand example	Finish type	Application	Brand example
Two pack etch primer	Brush or spray. Spray preferred	Dulux Etch Primer Taubmans Met-L-Etch	High build vinyl	Spray preferred	Dulux VR3 Vinyl Taubmans Valchem Vinyl Enamel
Strontium chromate epoxy primer	Brush or spray	Taubmans T7050	Two pack polyurethane	Brush or spray	Dulux Durethane Taubmans Interthane
			Chlorinated rubber	Brush or spray	Dulux Thik-Clor Taubmans Valchem Chlorinated Rubber VESSEY ACIDOL
			Two pack coal tar epoxy	Brush or spray	Dulux Duretar Taubmans Bitoxy

Note: Suppliers' recommendations should be followed explicitly in regard to film builds and appropriate undercoats and primers.

(d) Recommendations for severe coastal and buried or immersion conditions, e.g., tanks storing ground waters.

Primer type	Application	Brand example	Finish type	Application	Brand example
Two pack etch primer	Brush or spray. Spray preferred	Dulux Etch Primer Taubmans Met-Etch	Two pack coal tar epoxy	Brush or spray	Dulux Duretar Taubmans Bitoxy

TABLE 3 – FACTORY PAINTING OF ZINC-COATED OR ZINCALUME STEEL

Brand name	Coating type		Cleaning	Pretreatment	Paint finish
GALVABOND ZINCFORM ZINC-HI-TEN ZINCMATTE	Zinc	For phosphating ensure that "unchromated and oiled" is specified on the order	Alkaline, usually part of pretreatment	Phosphates, chromates, or two pack etch primers	Stoving appliance or outdoor finishes (acrylics, alkyds, vinyls, epoxies)
ZINCSEAL	Zinc	Provided with sophisticated phosphate coating	Solvent wiping, 1,1,1-trichloroethane vapour degrease	None required. Two pack etch primers for damaged phosphate coating	Stoving appliance finishes (acrylics, alkyds)
ZINCANNEAL	Zinc/iron alloy	Provided with simple phosphate coating	Solvent wiping, 1,1,1-trichloroethane vapour degrease	None required. Performance can be upgraded by two pack etch priming	Stoving appliance or outdoor finishes (acrylics, alkyds, epoxies)
ZINCALUME	Zinc/aluminium alloy	Phosphating not applicable	Alkaline, usually part of pretreatment	Chromate or two pack etch primers	Stoving, outdoor finishes

MANUAL METAL ARC WELDING

Small portable electric arc welding machines are popular with the handyman, farmer, home tradesman and hobbyist but are somewhat limited in flexibility for larger jobs. General purpose welding of steel sheet is well within the capability of this type of equipment and many general purpose electrodes are quite suitable.

The table below gives electrode recommendations for the following steels:

- Hot rolled and cold rolled uncoated low carbon steel sheet.
- Hot dipped zinc-coated low carbon steel sheet.
- Aluminium/zinc alloy-coated low carbon steel sheet.
- Electro-galvanized low carbon steel sheet.

Sheet thickness, mm	AS 1552 electrode type	Electrode diameter, mm
1.6	E4112	1.75
2.5	E4112	2.5
3.0	E4112	2.5
4.0	E4112	3.25
5.0	E4112	3.25

Electrode type E4113 is a suitable alternative for most applications. Both types are available under various brand names.

If other electrode types are preferred for specific reasons, contact should be made with suppliers of welding consumables.

BUILDING A HOUSE WITH STEEL

Erecting Steel Frames

Construction of a house with a steel frame is not difficult. There are a number of different frame assembly methods and these may vary the installation procedure slightly, but overall, there are few differences between using steel and timber.

As a framing material, steel offers a number of benefits:

- High strength with light weight
- Straightness and dimensional accuracy
- Long life and fire resistance
- It does not shrink, warp or twist
- Borers and termites find it very hard to swallow.

High strength and light weight make frames easy to handle and install. Long life and fire resistance mean that a steel framed house will still be around in many years time and house insurance will be cheaper. As steel does not shrink, warp or twist, builders find that the frames remain straight after they are assembled. Time required to straighten walls prior to final finishing is eliminated as are popped nails, cracked plasterboard, jamming doors or windows and the resulting profit sapping maintenance callback visits.

However, when a steel frame is being erected on a suspended floor, rather than a concrete slab, it should be earthed with a conventional earthing rod. Once it is permanently fixed, the first section of framing should be connected to earth, thus providing electrical safety for subsequent work.

As a bonus, should any fault develop in the electrical wiring or in the unlikely event of current from a lightning strike reaching the frame, it is safely grounded immediately.

FLOOR CONSTRUCTION

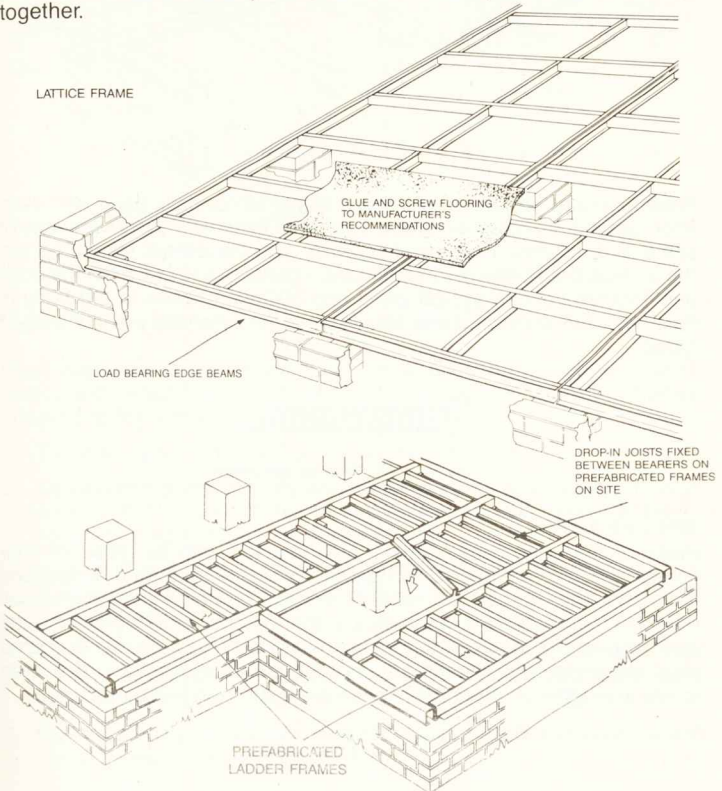
The floor for a steel framed house may be any of the conventional systems: concrete slab on ground, suspended concrete or suspended timber floors may be framed with light weight steel or the traditional timbers sitting on piers or stumps.

Lightweight steel can be partially factory pre-fabricated as ladder or lattice frames supported on conventional brick or concrete piers with ant caps. Ladder frames use top hat sections with short lengths of joist welded between them. They are laid, spaced apart so that rows of similar length joists can be used to join them on-site.

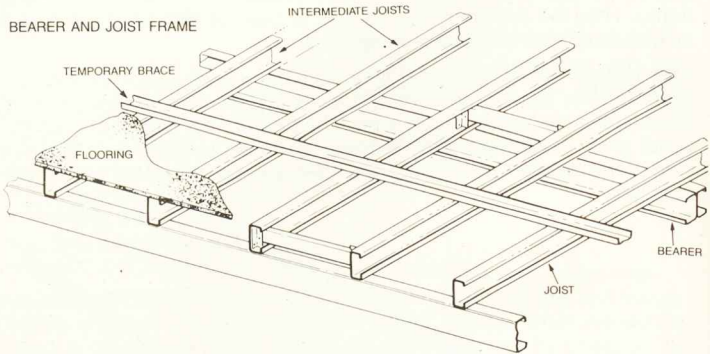
The Referee

Lattice frames are complete, factory prefabricated sections of floor frame. They too are placed on stumps or bearers with ant caps but are screwed together to produce a rigid floor grid.

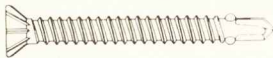
Alternatively, lightweight steel floor framing may be assembled on-site using top-hat section bearers and joists installed in the same way as traditional timber bearers and joists. The bearers are placed on conventional piers or stumps with ant caps and long length joists laid over them. The bearers and joists are then welded, screwed or rivetted together.



The Referee



Sheet flooring, either particle board or ply, is normally used with steel floor framing. It should be glued down and fixed with air driven nails or self-drilling screws. Fastener frequency and placement should be per the particle board makers instructions – generally 10 mm from the edge and 150 mm centres at butt joints and 300 mm centres in the body of the sheet. Self drilling screws should be of the extended point or winged types.

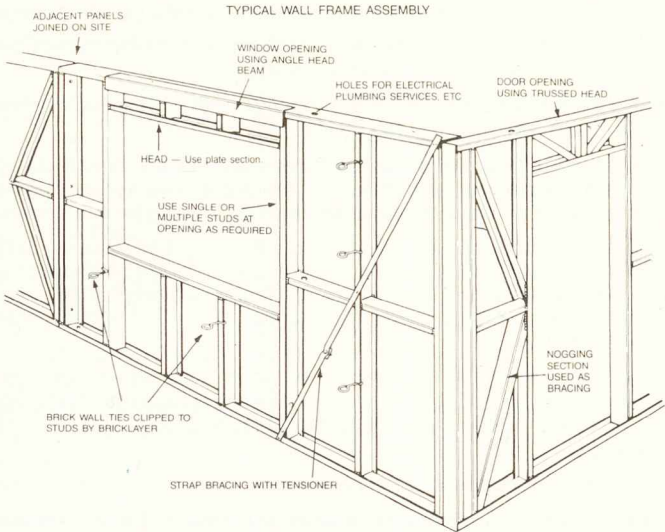


Countersunk Wing Tek self-drilling tapping screw.

WALL FRAMING

Prefabricated steel wall framing can be used with all types of floor construction, concrete slab (on ground or suspended) and suspended timber whether framed with steel or timber. The framing varies in detail between manufacturers but basically, the top and bottom plates, studs and noggings for load bearing and non-load bearing walls are all coated steel channels. Wall frames are normally pre-fabricated and delivered to site in lengths of about 6 m. These are easily handled by two men.

The Referee



Steel wall framing is erected in a similar sequence to pre-fabricated timber with squareness and vertical alignment of individual frames checked as for timber.

1. The wall layout is marked on the floor using string lines.
2. Squareness is checked by accurately measuring diagonals in large areas of the house first then individual rooms. The areas are square when the diagonals are the same length.
3. Internal wall frames are stacked inside the boundaries; external walls around the foundations. The first frames to be used must be at the top of any stack.
4. External frames are normally placed around the perimeter with their bottom plates adjacent to their final positions so that frames only need to be stood up square.
5. Starting at any convenient external corner, stand and brace a wall frame, plumb in its exact position.

The Referee

6. Stand and plumb the other frame to make a self supporting corner.
7. Clamp the frames together and check again that both frames are in their exact locations and standing vertical.
8. Connect the frames using the manufacturer's preferred method – welds, screws, rivets or tab connecting plates.
9. Proceed with the erection of frames around the house standing internal and external frames as they occur. This ensures that the frames remain square, plumb and provide bracing for one another.

Vertical alignment of the individual frames should be checked with a level and the line of top plates in a run of walling should be checked with a string line. Misalignment will indicate faulty slab level or floor frame construction, or poorly made wall frames, which will require careful realignment.

When wall framing is complete, it is worth considering the type of skirting to be used or, indeed, whether skirting is required. Traditionally, skirting boards were used to cover the gaps required to allow for timber shrinkage.

With steel frames, this is not necessary.

Some timber used for skirting boards is normally straight and easily fixed while others, despite being highly attractive, may be prone to warping. Fixing skirtings of the latter type will be greatly simplified by the provision of scrap timber nailing blocks placed between the studs. 70 x 45 mm pine building frame material is ideal; usually the length is 300 mm maximum.

Anchoring Wall Framing

Steel framing is fastened to the floor structure through the channel bottom plate after all panels have been correctly aligned and plumbed.

For concrete floor slabs, the frames should be bolted down using expanding shell masonry anchors or anchor bolts cast in the slab. Alternatively, in suburban, non-cyclonic areas, explosive driven fasteners, with 12 mm flat washers under their heads can be fired through the bottom plate into the concrete. Exact recommendations for the type and frequency of anchors should be available from local government authorities, the frame supplier or their engineer.

With steel floor framing, the bottom plate of the wall frames can be screwed to the joists with self drilling screws. If the wall frames are

The Referee

placed on top of, then fixed through the flooring, longer screws are required and bottom plates should be first drilled with a suitable clearance hole.

Wall frames are fixed to traditional timber floor framing at the ends of each frame and adjacent to the bracing with self drilling screws which can drill through the steel bottom plate. They are then fixed to all intermediate joists with galvanized flat head nails driven through holes punched in the bottom plates.

ROOF FRAMING

Most steel frame manufacturers are also able to supply prefabricated steel roof trusses to suit all types of roof designs – hip, gable, Dutch gable, steel sheet roof covering or tiles – and standard truss designs are available for spans up to 15 m. For long spans using raked ceilings, lightweight high tensile steel purlin sections may be used.

For example:

Depending upon location and site exposure and, therefore, total wind forces, C25025 sections simply supported and spaced at 1.2 m centres carrying sheet roofing can span up to about 6.3 m. Continuous over two spans, the same sections will span in excess of 7.5 m.

The exact designs of steel roof trusses are established in accordance with appropriate Australian Standards using tests, calculations or a combination of the two. The spacing of trusses varies depending on the truss design and the roofing material. It may be 600 mm, 900 mm or 1200 mm. Thanks to the strength of steel roof battens, 1200 mm truss spacings are quite acceptable even with tile roofs.

Fixing of trusses is, to some extent, dependent upon the precise design but the procedure is substantially the same, regardless of the truss material or style.

Roof Battens

Lightweight steel roof battens provide substantial benefit over their timber equivalents.

They are straight and remain so, long after they are installed. This is particularly important when some of the newer, almost flat, shingle type tiles are used as these tend to highlight any change in alignment.

Steel battens nest simplifying transport and storage. They are also easy to install and do not have to be butt joined at a rafter. When one batten

The Referee

ends, it is only necessary to lap the new length over it at a rafter and screw the two together.

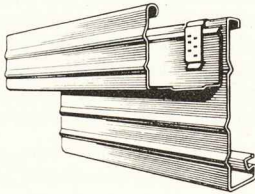
These battens are suitable for use with all types of roof-framing. They are fixed using self drilling screws to suit steel or timber as required.

Fascias

Steel roof trusses can be fabricated with brackets for attaching fascia boards, and trimmers for attaching the soffit lining.

Timber fascia boards are fastened from behind with conventional wood screws or self drilling screws. Fibre cement soffit linings can be fastened to the trimmers with self drilling, self-embedding screws with a filler applied over the heads before painting. For narrow eave overhangs, the soffit lining can be supported from the back of the fascia board and a steel trimmer angle or timber quad fixed along the top of the outside wall.

Prepainted steel fascia/gutter systems provide an attractive, quickly and easily installed alternative to timber. The fascia is simply clipped on to special brackets fixed to the rafter ends and matching gutter is mounted on clips fixed to the fascia. Steel fascias are designed to support the outer edge of the eave lining and they may be used with all types of roof framing.



STEEL FASCIA AND GUTTER SYSTEM

Tile Roofing

Steel tile battens are fixed to the trusses, usually over reflective foil laminate, with self drilling screws.

Roof tiles are secured to steel battens with ratchet type clips simply hooked on to the tile batten, or tiles with a fastening hole can be nailed with a special flat head annular threaded nail which is capable of piercing the top of the steel batten when driven with a hammer. These nails are fitted with a Neoprene washer to prevent tile breakage.

The Referee

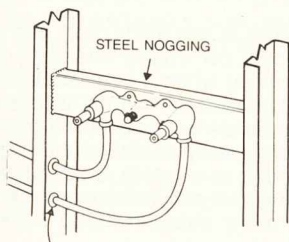
SERVICES IN A STEEL FRAMED HOUSE

Plumbing

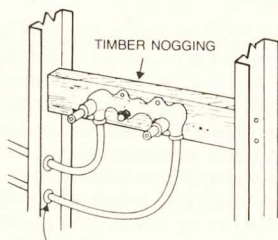
For quick and easy installation of plumbing and electrical services most steel frame manufacturers or fabricators provide holes punched in line through the webs of the studs.

In-wall piping is simply passed through the service holes to reach the required outlet locations. To avoid the possibility of corrosion by galvanic action, unlagged copper pipes must be separated from the framing. Plastic grommets are therefore snapped into the service holes before unlagged piping is installed. Grommets are not required to isolate lagged piping from the steel frame.

If extra service holes are required, they may be punched on site with a hand-operated punch or cut out with a hole saw in a slow speed electric drill. Service holes must always be located close to the centreline of each stud.



USE PRE-LAGGED PIPES OR
INSULATE PIPES FROM STUDS
WITH UNIVERSAL BUSHING



USE PRE-LAGGED PIPES OR
INSULATE FROM STUDS
WITH UNIVERSAL BUSHING

On brick veneer construction, piping may be run in the cavity and fixed to the studs with full saddles and self drilling screws. Unlagged copper piping should be isolated from the steel frame by fitting a short length of pipe lagging under each saddle.

In weatherboard or similar construction with external cladding attached directly to the steel studs, piping can of course be run over the ceiling or under the floor.

The Referee

Pipe sets for baths, basins and showers are supported in the normal way on timber or steel nogging. Neoprene sheeting should be inserted under each pipe set to isolate it from steel nogging.

Timber nogging should be cut to fit between the studs and fastened with galvanized nails driven through holes in the web of each stud into the ends of the nogging. Alternatively, Type 17 wood screws may be driven through the stud web into the ends of the nogging. Noggings are also fitted as required to support other plumbing fixtures such as cisterns, etc.

To provide support for the lip along the back of a bathtub, steel wall studs are notched, at the required height, and reinforced as shown. Most of this work can be done during fabrication of the wall frame.

Electrical Services

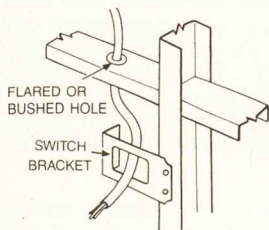
Steel house frames must be permanently earthed in accordance with the requirements of local electricity authorities. However, it is important that before any power tools are used on construction of a steel frame, a temporary earth must be established until the permanent earthing is installed.

Installation of wiring for electrical services is also made quick and easy by provision of pre-punched service holes, particularly where the holes are flared to prevent damage to the wiring when it is pulled through. Plain holes either pre-punched, hand punched or cut out with a hole saw, require a grommet or bush fitted before wiring is pulled through. Two piece threaded plastic bushes are readily available, the popular size being 25 mm dia. with a 20 mm dia. bore which is adequate for most electrical installations. Snap-in nylon grommets, which can be pushed in by hand, are available in many sizes, including the most common 25 mm and 28 mm dia.

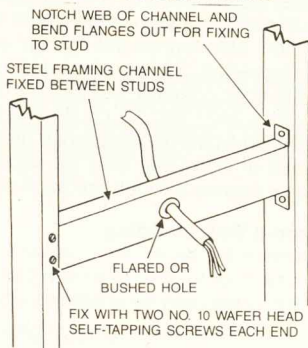
Wiring may be secured to steel framing with P clips, plastic ratchet straps or half saddles fastened with screws or blind rivets.

Backing plates for switches and power points are fixed to steel studs with wafer-head screws or blind rivets.

FIXING POWER POINT
AND SWITCH BRACKETS



FIXING ELECTRICAL FITTINGS



External Door and Window Frames

The same door and window frames as used in timber framed construction can also be used in steel framed construction. Again, screws are used instead of nails and the type will depend on the method of installation.

If aluminium window frames are fitted into timber surrounds, these surrounds and timber framed windows and doors can be fixed through the steel frame into the back of the timber surround after it has been located, aligned, plumbed and packed in position. Self drilling screws of a length appropriate for the total thickness of timber surround and packing should be used.

If it is not possible to secret fix the frame, as may be the case with a window or door head, No. 10 countersunk head self drilling screws of appropriate length can be driven through the frame and packing into the steel framing. In this case, a 5 mm dia. clearance hole should be first drilled through the timber frame and packing before inserting the self drilling screw. The screw is then free to drill and tap into the steel frame without binding in the timber. The same type of screws may also be used to fasten aluminium window frames direct to steel frame openings. Countersunk clearance holes would have to be pre-drilled in the aluminium frame.

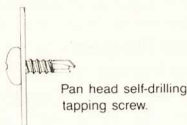
The Referee

Internal Door Frames

Timber door frames in internal walls can also be secret fixed through the back of adjacent studs with screws or nails, if the frames are installed before the wall lining, or if only one side of the lining is completed first. If it is preferred to fully line an internal wall before cutting out the door opening, the frame may be fastened through the jamb into the studs with No. 10 countersunk head self drilling screws, through pre-drilled 5 mm dia. clearance holes in the timber. Timber door frames in internal walls can also be secret fixed in the same way as timber window frames through the back of adjacent studs with screws or nails.

External Wall Cladding

Reflective foil laminated sarking if required in the external walls may be attached to the external flange of steel studs with self drilling No. 8 x 12 mm pan head screws fitted with 25 mm dia. flat fibre washers.



For brick veneer construction, these will provide sufficient resistance to wind forces during construction and will retain glass fibre insulation batts installed in the stud wall.

Wire brick ties which simply clip on to steel studs are available for brick veneer construction. Normal wall ties may also be used fixed to the studs with self drilling screws, blind rivets, or welding.

For single stud wall construction, fibre cement sheeting can be fixed to steel frames with self drilling, self-embedding head screws. With these, the depth control sleeve on the power screwdriver must be set so the head of the self-embedding screw finishes just below the surface. Filler can then be applied before painting.

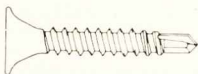
Timber weatherboards can be fastened to steel studs with extended point countersunk head, self drilling screws. Steel sheet cladding is also fixed with self drilling, tapping screws.

The Referee

Ceilings

When required, galvanized steel ceiling battens are fixed to the underside of the bottom cord of steel roof trusses or steel upper floor joists with self drilling screws or blind rivets through the flanges.

Plaster board ceiling lining is fixed to steel battens or furring channels with bugle head self drilling screws. The bugle head (Gypsum) screws recess themselves into the plasterboard without damaging the surface, especially if a correctly set depth control sleeve is used on the dry-wall screw gun.



Bugle head self-drilling tapping screw.

Internal Wall Lining

There is no change to the procedure for fixing plasterboard wall linings in a steel frame house, except that bugle head self drilling screws are used instead of clouts. The same adhesives are used on a steel frame. With a correctly set dry-wall screw gun, bugle head screws can be tightened to finish slightly below the surface of the plasterboard without damaging the paper facing. The screw heads are then cemented over with the same joining material used in any plasterboard construction.

In wet areas, water resistant lining board is fixed with self drilling, self-embedding head screws. Flashing and tiling are carried out in the usual way.

Pre-finished wall linings may be glued to steel studs with a wallboard adhesive and braced in place until bonded.

Skirtings

With a steel framed house, there is no shrinkage or movement in the frame so the need for skirtings may be seriously questioned. However, timber skirtings and any other mouldings which need to be fixed through the linings into a steel frame may be readily secured with countersunk head, extended point self drilling screws, 50 mm long for timber up to 23 mm thick and 65 mm long for timber 23 to 30 mm thick. With a correctly set power screwdriver, the small cross recessed heads of the screws are driven flush with the timber surface and are unobtrusive.

The Referee

Architraves are nailed to timber door jambs and window frames in the usual way.

Apart from the actual fabrication of a steel frame, the main difference between erection and fitting out of a steel framed house, compared with timber, is in fixing methods. The following discusses the differences, where they may occur and the tools and fasteners required. The use of these tools should be well within the capability of any competent building tradesman.

Welding

In steel frame fabrication, welding is commonly used to join frame components. It is usually carried out in a well-equipped, ventilated welding shop where frame panels are fabricated on adjustable jigs. A well-equipped contractor may also prefer to use welding on site to speed up the erection of the building frame. However, on-site welding is not necessary as other fastening methods are quite suitable.

Sealing

Soft soldering is still used as a method of sealing joints in zinc-coated steel sheet building components such as continuous ant-capping, etc. As it is not practical to solder ZINCALUME steel sheet in the field, neutral cure silicone sealants should be used. COLORBOND prepainted sheet and MARVIPLATE PVC laminated sheet should also be sealed with neutral cure silicone sealant.

The Referee

Adhesives Bonding

Adhesives have undergone significant development in recent years and provide a valuable means of permanently bonding building materials together.

The use of adhesives for securing wall and floor boards has been long accepted to minimise the use of fasteners and reduce movement. Adhesives may be readily used with steel framing for attaching many components to frames in addition to the established uses for wall linings and flooring.

Wall board adhesives from plasterboard manufacturers and general building adhesives from manufacturers like ICI, HB Fuller and Selleys are suitable for steel framed construction.

Self drilling, tapping screws

Self drilling, tapping screws are quick and simple to use for fastening steel building frame components. The most widely used brands are TEKS or DRILL-KWICK which have a drill point similar to a twist drill. These are used for fastening steel components from, say, 1 mm up to about 5 mm thick.

Another type of drill point used on small screws for fastening steel up to, say, 1 mm thick is the 'S' point or needle point. This is a fairly sharp point with a flat on one side. It partly extrudes the metal around the hole as it drills, thus increasing the thread engagement and grip of the screw.

The other self drilling screw used on steel building frame construction is the Type 17 which is basically a wood screw. The drill point could be described as a larger blunt 'S' point which can drill through steel up to about 1.2 mm thick. The Type 17 is usually used for fastening steel components to timber.

Blind rivets

Blind rivets are another simple and neat method for fastening steel building frame components on site. Not quite as quick as self drilling, tapping screws, they require that a hole first be drilled through the components. The rivet is inserted and set with a hand held riveting tool. Two types of hand operated riveting tools are available for use on site.

The Referee

Power driven nails

Nailing guns are usually pneumatic, so a source of compressed air is required.

The use of nails is not recommended for joining steel frame components but many jobs requiring timber, etc, to be attached to steel frames can be accommodated using this method.

TOOLS

To enable building trades to work on erecting and fitting out a steel framed building, the following tools would be required and may be extra to the normal kit used on timber frames. If mains power is not available on site a portable generating set would be required to operate the power tools.

All trades except plasterer

- Power drill
- Power screwdriver
- Riveting tool
- Hack saw
- Vice grips
- Small G clamp

Plasterer

- Power Drywall screwdriver

Carpenter

- Shear for cutting steel stud and nogging channel to length (optional)
- Alternative – Power saw fitted with metal cutting blade or disc
- Explosive nail gun – if fastening to concrete floor slab

Plumber and electrician

- Hole punch for service holes in steel studs or nogging
- Alternative – Slow speed heavy duty power drill with hole saw and arbor

ACCESSORY FITTINGS

Heyco universal bushes

These nylon bushes snap fit into the plain service holes in steel studs to support and isolate unlagged copper piping. Several sizes are available, 25 mm and 28 mm dia. the two most common size holes, which may be pre-punched, site punched or cut out with a hole cutter. Universal bushes have flexible shutters in the bore which adjust to accommodate a range of pipe sizes.

Heyco plain bushes

These nylon bushes snap fit into plain unflared service holes in steel studs to provide protection for the passage of electric wiring. They are available in several sizes including 25 mm and 28 mm dia.

Clipsal two piece threaded bushes

These threaded plastic bushes are assembled through plain unflared service holes in steel studs to provide protection for the passage of electric wiring. They are available in sizes to suit both 25 mm and 32 mm dia. holes.

WATER TANKS **AQUAPLATE POLYMER COATED STEEL**

Introduction

AQUAPLATE Polymer Coated steel fills the need for a reliable material suitable for producing tanks that can be used for storing the wide variety of potable waters available.

Film

Single Sided AQUAPLATE – W 200 μm thick polymer film as a single sided smooth laminate for tank walls.

Double Sided AQUAPLATE – B 200 μm thick polymer film for the interior lining of tank bottoms (0.60 x 1200 mm) with a reverse side polymer film to provide a protective barrier in contact with the tank support materials. The reverse side polymer film, not being exposed to the sunlight is also not UV resistant. Accordingly, it should only be used for this specific application and should not be used for other exposed tank applications.

To ensure that all materials and fittings used in the tank enjoy a similar service life, guidelines on materials and fabrication are set out below.

MATERIAL SELECTION

Walls AQUAPLATE – W (tank walls)

AQUAPLATE steel 0.60 mm ZINCFORM G300 Z275 supplied as both 8 and 10.5 x 76 mm pitch corrugated sheets in custom cut lengths.

Base AQUAPLATE – B (tank base)

AQUAPLATE steel 0.60 mm x 1200 mm ZINCFORM G300 Z275 flat sheet or coil.

Top

ZINCALUME AZ150 zinc/aluminium coated steel sheet.

Thickness to suit tank size.

AQUAPLATE steel tanks must be fitted with a lid to exclude sunlight which could degrade the film and also encourage the growth of algae within the tank.

FITTINGS

Inlet Filter

ZINCALUME steel with aluminium mesh or moulded polythene sieves such as a Capri garden sieve. Fibreglass may also be used.

The Referee

Filters should be positioned above the water level to avoid continuous immersion and also to discourage mosquito breeding. An opaque cover should be placed over the filter as a means of controlling algae and UV rays (sunlight) in the tank.

Overflows

PVC, polythene, ABS or polypropylene items affixed with corrosion resistant fasteners.

Gauze filters should be fitted to exclude mosquitoes.

Outlets

Polypropylene is recommended as the most universally acceptable material from a corrosion viewpoint.

Polythene ABS and PVC are also recommended. Metals such as zinc/aluminium alloys and aluminium are suitable under most conditions but it must be realised that ground water can range from benign to extremely corrosive. The composition of such waters can even change as the water table drops at times of drought.

Copper or its alloys, such as brass or bronze **must not** be used.

Fasteners

Stainless steel is recommended. However, it must be realised that the more corrosion resistant alloys cannot be produced in self drilling fasteners. It will be necessary to supplement the protection by coating the fastener, inside the tank, with neutral cure silicone rubber.

This is best achieved by placing the nozzle of the cartridge over the screw and extruding silicone down the shank onto the vinyl film to reseal the screw penetration area. Close inspection of the seal is necessary to ensure it completely covers the fastener.

Edge Sealing

Bare steel must not be exposed inside the tank. All internal cut edges must be completely sealed after fastening.

CLOSE INSPECTION IS IMPORTANT

Any cuts in the PVC film should be repaired with sealant. All rivet heads and screw heads exposed inside the tank should be coated with sealant.

AQUAPLATE steel provides the means to build a trouble free tank which will provide many years of service even in conditions not usually conducive to reliable metal tank life.

The Referee

The long life of the tanks is, however, conditional on the metal substrate and fastenings being completely sealed from the water. Perforation of the film is likely to lead to accelerated localised corrosion of the metal. The care taken by Sheet & Coil Products to avoid defects in the integrity of the polymer film during manufacture must be maintained at each step in the distribution chain including handling, sheeting and corrugation of the material.

The curving and subsequent fabrication involved in producing the tank is the responsibility of the tankmaker.

AQUAPLATE steel is a sophisticated material which requires additional care to protect the integrity of the film during tank fabrication. The fabrication methods employed **must avoid film damage**. Unrepaired damage will substantially reduce tank service life.

RECOMMENDED STEPS FOR FABRICATING AN AQUAPLATE TANK

Preparation

Prior to fabrication of any sort, a careful visual inspection of the laminated surface must be conducted to ensure that the film is completely free of abrasion damage.

Ensure that curving rolls are clean and free from foreign matter, particularly metallic particles, in order to prevent film damage.

Rippling of the steel surface can be caused if the pitch of the rolls does not match the pitch of the corrugations closely. If problems occur, discuss them with your supplier.

Curving

Curving of the walls involves normal practice such as feeding the sheets in squarely and forming the curve in relatively small increments. Sheet ends must meet and nest accurately.

Sealing

Lapping surfaces must be clean and dry. Methylated spirits used with clean cloths or tissue is recommended.

A heavy bead of neutral cure silicone rubber sealant is applied along the centre of the intended lap. This bead should be about the diameter of a thumb, for 100 mm lap.

The Referee

Fastening

A fastener at every valley on the inside lap and each crest on the outside lap will pull the joint tight. Those screws which would otherwise be positioned within the intended lapped girth joints should be left out for the time being.

Excess sealant on the outside is best removed at this stage using a spatula followed by a turps rag. An empty cartridge used in reverse is ideal for a spatula. More volatile solvents may be used but, for economy, safety and effect, turps works quite well.

Excess sealant on the inside lap edge can well serve to provide edge sealing. Additional silicone must be provided if necessary to ensure that all interior sheet edges are thoroughly sealed.

The girth joints require a bead about a small finger size with a little extra in the area where vertical seams meet horizontal seams because this is the area most prone to leaking.

Both slip and roping methods are applicable for joining rung to rung but emphasis is again placed on cleaning lap surfaces and preplacing sealant before lapping.

Girth Joint

Fastening of girth joints does not require closer spacings but tightness is important. For this reason roping is slightly favoured although slipping has proved successful.

When roping is the practice, fastening should begin on the opposite side to the vertical lap and proceed toward the vertical. This tends to pull the girth joint snug and tight.

Flanging

The flanging at the top and bottom can be achieved by rubber mallet and dolly but tools such as the Walker Edge Former do the job quickly, quietly, neatly and without abrasion to the film.

Tank Bottom

The base segments can be fastened through a sandwich of sealant but lockseaming is favoured.

Again ensuring a clean surface, a thin bead of sealant (about 2 to 3 mm diameter) is extruded into the recess of one edge prior to assembly and excess squeeze-out smoothed over with finger or removed with a solvent rag.

The Referee

The edge of the base can be flanged by hammering but a flanging attachment can be fitted to a lockseaming machine for this purpose. If it is necessary to walk on the sheets care must be taken to avoid damage to film.

Outlet Holes

Outlet holes can be cut with jewellers snips, but a punch or hole saw is quicker and neater. This should be done prior to fitting the bottom, in order to avoid swarf retention.

Outlet Fittings

If a polythene or polypropylene tank fitting is used it must be flame treated to promote adhesion. This involves a very short "lick" of flame to those surfaces of the fitting which require sealing.

If metal fittings are used, ensure that fittings are watertight but avoid over tightening.

A bead of silicone is extruded onto the cleaned surfaces each side of wall in the outlet hole region and the fitting inserted and tightened.

Wall to Base Joint

Extrude a 3 to 4 mm bead of silicone into the clean flanged turnup and lower the clean flanged wall into the base with as little side movement and adjustment as possible. The bottom is then single folded on as usual. The Walker Edge Crimper is a very suitable tool for this although a mallet and dolly is acceptable.

Inspection

All drillings, filings and other metal residues (swarf) must be removed.

Inspect the inner surface of tank to ensure thorough sealing of all edges, fasteners and damaged areas.

Overflows

Contoured PVC overflows are available from Fluid Industries, Maryborough, Queensland.

An alternative is to fit a 100 x 50 mm rectangular x 90 mm round PVC rainwater fitting. This can be attached by providing a flange at the lower edge of the cutout through which to attach the lower edge of the fitting.

The top side can be attached through the lid if the fitting is located flush with the rim. Post sealing is adequate.

A gauze filter should be fitted to exclude mosquitoes.

The Referee

Inlet Strainers

Although some areas currently demand bronze or copper gauze in the strainers for mosquito control, from a corrosion viewpoint, aluminium mesh should be used. However, most areas accept a far coarser filter and a Capri garden sieve makes a suitable alternative.

It is not practical to fabricate the strainer from AQUAPLATE steel as the laminate is single sided only and the unlined side could corrode.

ZINCALUME steel is suitable but must be continually immersed in ground water. Fit above water level.

Kerosene is not recommended as a measure for mosquito control.

Tank Top

Must be fitted.

Tank Stand

Must be flat and in the same plane.

SUMMARY

DO'S and DON'TS

DO store material under cover and sheltered from direct sunlight.

DO inspect material closely before fabrication.

DO have work area clean.

DO ensure clean, smooth, curving rolls.

DO ensure that all cut edges and fasteners are thoroughly sealed.

DO closely inspect finished tank for any damage.

DON'T wear footwear in tank that is liable to damage laminate.

DO'S and DON'TS of sealing

DO ensure clean surfaces.

DO sandwich seal within laps unless using a post sealing method.

Installation of AQUAPLATE water tanks

First fill: As with all water tanks it is essential that at least a portion of the first fill be drained from the tank. This is advisable for health reasons. The roof or gutter could have toxic matter on or in it. The tank itself could have residual contaminants within it as a result of its manufacture or transportation.

The Referee

If a roof is to be painted, always check the paint's suitability for collection of drinking water.

Do not collect drinking water from lead, copper or copper treated timber.

Location of Tank

Ideally, the tank should be installed in a shady location away from trees from which leaves and debris could clog the strainer or contaminate the water.

Tank Base

The AQUAPLATE tank must be installed on a firm, flat, stable platform the dimensions of which must be larger than the diameter of the tank.

As AQUAPLATE tanks are supplied with a protective membrane under the base, they may be placed directly onto a concrete pad.

Tank stands must be engineered to safely support the tank when full of water, bearing in mind that water has a mass of 1 kilogram per litre, or 10 pounds per gallon.

Copper pipes must not be connected to tanks. If copper outlet pipes are involved, there must be at least 2 metres of plastic pipe between the tank and the copper piping. Copper must not be used for recirculating water to an AQUAPLATE tank.

Do not store water in excess of 65°C.

Kerosene is often used to provide a film on the water surface as an anti-mosquito measure. This is not recommended for health reasons, besides the damage it may cause to the lining.

The Referee

DIMENSIONS OF WATER TANKS MADE FROM AQUAPLATE STEEL

Tank capacity in kilolitres	MEAN DIAMETER AND SHEET LENGTH REQUIRED TO CURVE RING FROM SINGLE SHEET ALLOWING FOR 100 mm END LAP, mm					
	Mean dia	Sheet length	Mean dia	Sheet length	Mean dia	Sheet length
Single sheet rings of 10½ x 76 mm corrugated sheet						
	1 ring, 810 mm high		2 rings, 1620 mm high		3 rings, 2380 mm high*	
0.5	885	2890				
1	1250	4040				
2	1775	5670	1255	4040		
3	2170	6920	1535	4930		
4	2505	7980	1775	5670		
5			1980	6330	1635	5240
6			2170	6920	1790	5730
7			2345	7470	1935	6180
10			2805	8910	2315	7370
14			3315	10520	2735	8700
16			3545	11240	2925	9290
20			3965	12560	3270	10380
Single sheet rings of 8 x 76 mm corrugated sheet						
	1 ring, 620 mm high		2 rings, 1230 mm high		3 rings, 1840 mm high	
0.5	1015	3290				
1	1435	4610	1015	3290		
2	2025	6470	1440	4630		
3	2480	7900	1765	5650		
4	2865	9100	2035	6500	1665	5330
5	3205	10170	2275	7250	1860	5950
6			2495	7940	2040	6510
7			2695	8570	2200	7020
10			3220	10220	2630	8370
14			3810	12070	3115	9890
16			4070	12890	3330	10560
20			4550	14400	3720	11790

*A half corrugation is trimmed off the top of the centre ring of 10½ corrugation three ring high tanks for slip joint assembly method.

STAINLESS STEEL

WHAT IS STAINLESS STEEL?

Stainless steels are alloys containing iron, relatively low carbon, a minimum 11% chromium and up to 30% nickel. For increased corrosion resistance or for manufacturing requirements in specific applications, chromium may be increased and other elements such as manganese, aluminium, titanium and/or molybdenum may be added as required.

Stainless steels are sometimes called corrosion-resisting steels since the term stainless may suggest non-staining. It does not mean non-staining in all environments, but less staining or more resistant to corrosive attack when compared with steels containing under about 11% chromium.

WHAT MAKES STAINLESS STEEL RESIST CORROSION?

Chromium (the key element in stainless steels) in excess of about 11% forms a tenacious, refractory oxide, protective film on any exposed layer, ie, a corrosion barrier. This relatively impervious film is considered to be self-healing or self-restoring. It will, if broken, repair itself spontaneously upon re-exposure to an oxidizing agent such as air or nitric acid.

Resistance to corrosive attack under specific conditions is enhanced by progressively increasing chromium over 11% and/or by the addition of other elements such as nickel, molybdenum and copper.

TYPES OF STAINLESS STEEL

Stainless steels are grouped according to the metallurgical structure which forms when they are cooled from high temperatures. Three basic types of stainless steel are recognised:

Austenitic

Martensitic

Ferritic

Austenitic Stainless Steel (301, 304, 304L, 316, 316L, 321, 310):

BHP's austenitic stainless steels are basically alloys of Iron, Chromium (17 to 25%), Nickel (7 to 20%).

The name comes from their stable metallurgical structure at room temperature, which is a single phase of austenite.

The Referee

Austenitic stainless steels have the following features:

- can be strengthened by cold working (up to 4 times)
- easily weldable
- high ductility
- good corrosion resistance
- suitable for high temperatures (eg, 310 up to 1100° C)
- suitable for low temperatures (including cryogenic applications)
- are non-magnetic

Ferritic Stainless Steel (409, 430, 3CR12)

BHP's ferritic stainless steels are basically alloys of iron and chromium (12 to 17%).

They derive their name from the ferritic metallurgical structure which is stable at room temperature.

When compared with austenitic stainless steels, ferritic stainless steels have the following features:

- less expensive
- lower corrosion resistance
- weldable (but require more care)
- easily formed (bent, cut, etc)
- moderate high temperature (up to 800°C for 430)
- slight increases in strength by cold working (up to 50%)
- superior resistance to stress corrosion cracking
- are magnetic

Martensitic Stainless Steel

These stainless steels are alloys of iron, chromium (12 to 18%) and carbon (up to 1%).

These steels can be hardened by heat treatment. This type of stainless steel is used where high mechanical strength combined with corrosion resistance is required (eg, knives).

The Referee

The BHP Stainless range of standard steel grades and finishes is structured to provide all normal requirements for the Australian market. These grades are manufactured to relevant Australian and international standards.

STANDARD PRODUCT RANGE

Classification	BHP Grade	Major Applications
Austenitic	310	Railcars, commercial fabricated items, sink drainers.
	304-304L	Sinks, tubs, architectural, chemical, food processing.
	310	L grade for heavier welded sections.
	316-316L	Furnace parts over 900°C. Severe industrial or marine, chemical food processing.
Ferritic	321	L grade for heavier welded sections. Heavy welded items and furnace parts.
	409	Auto exhausts.
	430	Architectural, auto trim.
	3CR12	Coal wagons, coal washery plants, sugar processing plants, sewage treatment plants.

Some other grades may be made available upon enquiry.

TYPICAL PHYSICAL PROPERTIES

BHP Stainless Grade	Modulus of Elasticity Annealed Conditions MPa	Density 0°C kg/m ³	Specific Heat 0°- 100° kJ/kg.K	Electrical Resistivity 20°C μΩm	Thermal Conductivity		Mean Co-efficient of Thermal Expansion per deg C	
					100°C W/m.K	500°C W/m.K	0-100°	0-650°
301	193 x 10 ³	80 x 10 ²	0.50	0.72	16.3	21.5	16.9 x 10 ⁻⁶	18.7 x 10 ⁻⁶
304	193 x 10 ³	80 x 10 ²	0.50	0.72	16.3	21.5	17.3 x 10 ⁻⁶	18.7 x 10 ⁻⁶
304L	193 x 10 ³	80 x 10 ²	0.50	0.72	16.3	21.5	17.3 x 10 ⁻⁶	18.7 x 10 ⁻⁶
310	193 x 10 ³	80 x 10 ²	0.50	0.78	13.0	17.3	14.4 x 10 ⁻⁶	17.4 x 10 ⁻⁶
316	193 x 10 ³	80 x 10 ²	0.50	0.74	15.6	21.0	16.0 x 10 ⁻⁶	18.5 x 10 ⁻⁶
316L	193 x 10 ³	80 x 10 ²	0.50	0.74	15.6	21.0	16.0 x 10 ⁻⁶	18.5 x 10 ⁻⁶
321	193 x 10 ³	80 x 10 ²	0.50	0.72	16.1	22.2	16.7 x 10 ⁻⁶	19.3 x 10 ⁻⁶
409	200 x 10 ³	77 x 10 ²	0.46	0.60	24.9	28.6	9.9 x 10 ⁻⁶	11.7 x 10 ⁻⁶
430	199 x 10 ³	77 x 10 ²	0.46	0.60	24.9	28.8	10.4 x 10 ⁻⁶	11.9 x 10 ⁻⁶

CHEMICAL COMPOSITION AND MECHANICAL PROPERTIES

Classification	Characteristics	BHP Stainless Grade	Typical Analysis					Typical Mechanical Properties			
			C	Ni	Cr	Mo	Ti	YP MPa	TS MPa	Elongation % on 50 mm	HV
Austenitic	Essentially non-magnetic in softened condition but show varying degrees of magnetism when cold worked Cannot be hardened by heat treatment	301	0.08	7.0	17.0	—	—	280 520 760 930	770 870 1040 1200	55 25 15 10	170 270 320 370
Ferritic	Magnetic Cannot be hardened by heat treatment	302	0.08	9.0	18.0	—	—	260	600	50	160
		304	0.06	9.0	18.5	—	—	260	600	50	160
		304L	0.03	10.0	18.5	—	—	220	560	50	145
		310	0.12	20.0	25.0	—	—	310	620	45	170
		316	0.06	12.0	17.0	2.2	—	260	600	50	155
		316L	0.03	12.0	17.0	2.2	—	230	560	50	145
		317	0.07	13.0	19.0	3.2	—	310	620	45	170
		321	0.06	10.0	18.0	—	0.5	250	580	45	160
		409	0.04	—	11.5	—	0.4	250	450	25	140
		430	0.08	—	17.0	—	—	310	540	30	170

Some other grades may be made available upon enquiry.

The Referee

SIZE RANGE: SHEET & COIL PRODUCTS

Finish	Thickness, mm	Width, mm	Length, mm
2B/2D			
Coil	0.30 to 0.40	13 to 750	— —
	0.45 to 0.60	13 to 1000	— —
	0.70 to 0.80	13 to 1200	— —
	0.90 to 1.60	20 to 1500	— —
	1.80 to 3.25	50 to 1500	— —
	3.50 to 5.00	150 to 1500	— —
Sheet	0.30 to 0.40	450 to 750	900 to 1800
	0.45 to 0.60	450 to 1000	900 to 3600
	0.70 to 0.80	450 to 1200	900 to 3600
	0.90 to 5.00	450 to 1500	900 to 3600
Bright Annealed			
Coil	0.30 to 0.40	13 to 750	— —
	0.45 to 0.60	13 to 900	— —
	0.70 to 0.80	13 to 1000	— —
	0.90 to 1.60	20 to 1200	— —
	1.80 to 2.00	50 to 1200	— —
Sheet	0.30 to 0.40	450 to 750	900 to 1800
	0.45 to 0.60	450 to 900	900 to 3600
	0.70 to 0.80	450 to 1000	900 to 3600
	0.90 to 2.00	450 to 1200	900 to 3600
No 4 Polish			
Coil	0.70 to 0.80	13 to 1200	— —
	0.90 to 1.60	20 to 1500	— —
	1.80 to 3.25	50 to 1500	— —
	3.50 to 5.00	150 to 1500	— —
Sheet	0.45 to 0.60	450 to 1000	900 to 2400
	0.70 to 1.00	450 to 1200	900 to 3600
	1.20 to 5.00	450 to 1500	900 to 3600

Sizes other than listed supplied by arrangement only.

Note: 1200 mm maximum width for BHP Stainless 400 series grades and BHP Stainless 310.

Coils: Inner diameter 508 mm.

The Referee

SIZE RANGE: PLATE

Thickness, mm	Width, mm	Length, mm
6.0	1500 2000	3000 6000
6.5	1500 2000	3000 6000
8.0	2000	6000
10.0	2000	6000
12.0	2000	6000
25.0	2000	6000

FINISH DESCRIPTION – SHEET & COIL

Symbol	Type of Finish	Features and Applications
2D	A dull silvery grey finish obtained by cold rolling to specified thickness, followed by softening and descaling.	The dull finish is favourable for the retention of lubricants in deep drawing operations.
2B	A silvery grey finish produced by cold rolling, softening and descaling and final light cold rolling on highly polished rolls (skin pass).	Brighter than 2D finish, this is the general purpose cold rolled finish. The surface is more readily polished than 2D.
N4 (No 4)	Uniformly polished with abrasive belt of approx 120 to 150 mesh.	Polished finish for general purpose. Widely used for decorative work, chemical, dairy, kitchen equipment.
BA (Bright Annealed)	Cold rolled, with final annealing in a controlled non-oxidising atmosphere, and subsequent light cold rolled pass (skin pass) for brightness.	A bright, highly reflective finish, used in decorative and other domestic articles, and commercial refrigeration.

FINISH DESCRIPTION – PLATE

S & D (Softened & Descaled)	A silvery grey matt finish.	Suitable for fabricating tanks, vats, heavy chemical and general industrial equipment.
Hot Rolled Annealed	A black undescalded finish.	Supplied on types 321 and 310 for heat resisting applications.
CI (Cold Improved)	A silvery grey smooth surface formed by cold rolling S & D coil plate.	Available on flat and coiled plate up to 6.35 mm thick and 1500 mm wide. Suitable for food and beverage equipment where a smooth surface is required.
XT	A superior cold improved finish.	Used where excellent slipability is required, eg coal or ore chutes, bin liners, etc.
Floor Plate	An embossed floor plate pattern with an S & D finish.	Used for walkways requiring an anti-slip surface.

The Referee

STAINLESS STEEL TUBE

BHP manufactures a range of tubular stainless steel products to many international standard specifications. Users of these stainless steel tubular products choose them for a variety of reasons including:

- decoration
- mechanical strengths
- product purity
- corrosion resistance
- heat transfer

Grades

BHP Stainless manufactures welded stainless tube in the following grades: 301, 304, 304L, 316, 316L, 321 and 409.

Other grades including titanium and high nickel alloys can be produced.

SECTION TUBE – TYPICAL SIZE RANGE – SQUARE SECTIONS

Nominal wall thickness, mm	0.9	1.2	1.6
Size			
12.7	x	x	
15.9	x	x	
19.1	x	x	
22.2	x	x	x
25.4	x	x	x
31.8		x	x
38.1		x	x
40.0		x	x
50.8		x	x

SECTION TUBE – TYPICAL SIZE RANGE – RECTANGULAR SECTIONS

Nominal wall thickness, mm	1.2	1.6	2.0
Size			
35 x 19	x	x	
38.1 x 25.4	x	x	
50.8 x 25.4	x	x	
50.8 x 38.1		x	x
84.1 x 38.1	x	x	

ROUND WELDED TUBE – TYPICAL SIZE RANGE

NOM WALL THICKNESS mm INS	0.5	0.6	0.7	0.9	1.2	1.6	2.0	2.6	3.2
	.020	.024	.028	.036	.048	.064	.080	.104	.128
SWG	25	23	22	20	18	16	14	12	10
NOM OUTSIDE DIA mm									
9.53									
12.70									
15.88									
19.05					x	x			
22.23					x	x			
25.40					x	x			
31.75					x	x			
34.93									
38.10					x	x			
41.28									
44.45									
47.63									
50.80					x	x			
63.50									
76.20									
88.90									
101.60									

x Preferred 304 and 316 grade sizes in regular PF

Standard production range

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TUBE CONDITIONS

AW (As Welded)	As welded tube receives no further treatment after forming and welding. It is used where limited manipulation is to be carried out. It has a smooth matt finish.
AWA (As Welded Annealed)	Bright annealing after welding increases corrosion resistance and softens the tube for severe manipulations such as bending, expanding and forming.
CW CWA (Cold Worked) & (Cold Worked Annealed)	For applications requiring a smooth internal surface, high corrosion resistance and compliance with specifications such as ASTM A249. Tube is available in cold worked annealed (CWA) condition. In both conditions the weld area is subject to a mechanical forging process for grain refinement. CWA tube is then bright annealed, an economical alternative to fully welded drawn tube.
WD WDA (Welded Drawn) & (Welded Drawn Annealed)	By cold drawing tube in AWA or CWA conditions, fine dimensional tolerances are achieved, having excellent uniformity of wall thickness and concentricity, uniform grain structure and hardness. For maximum corrosion resistance this tube is supplied in the annealed (WDA) condition.
S (Seamless)	Stocks of seamless hollows can be obtained for re-drawing as required.

SURFACE FINISHES

The natural metallic lustre of stainless steel, which remains during its extremely prolonged lifespan, can be further enhanced by polishing and buffing. This applies particularly in applications for decorative purposes. A number of polished finishes are available.

MF (Mill Finish)	An off-the-mill finish; roll forming marks are retained and an indication of the weld may be visible.
BP (Buff Polish)	A pleasing bright finish with medium lustre. Traces of external weldline and roll marks can be visible.
SL (Surfline Polish)	A bright and reflective finish, just short of a mirror polish, which may have traces of weldline markings.
GP (Grit Polish)	Produced by centreless belt polishing to the grit size specified by the customer, ie, 60, 120, 180, 240, 320, 400. There are no roll or weldline markings.
SP (Satin Polish)	Standard grit finish produced by polishing with 120-150 grit abrasive, and matches No 4 finish. On square or rectangular tube the polishing pattern runs longitudinally.
IP (Internal Polish)	Internally grit polished tube in lengths of up to 6 metres for diameters of 38.1 to 101.6 mm is available.
GENTUBE	Similar to surfline polish but confined mainly to small diameter light wall tube.

The Referee

STAINLESS STEEL SCHEDULE PIPE

BHP Stainless produces welded stainless steel schedule pipe. This pipe is manufactured in accordance with the American Specification ASTM A312.

Welded schedule pipe is used for conveying liquids and gases under pressure in chemical, process, petrochemical, oil and gas, metallurgical, food and beverage, and marine applications.

Grades available: 304 304L 316 316L

SIZE RANGE:

Schedule	Nominal Bore		Dimensions		Mass kg/m	Theoretical bursting pressure at ambient temp.	
	inch	mm	O.D.	WT.		MPa	psi
SCH10	1/2	15	21.34	2.11	1.00	102.2	14,825
	3/4	20	26.67	2.11	1.28	81.7	11,850
	1	25	33.40	2.77	2.09	85.8	12,450
	1 1/2	40	48.26	2.77	3.11	59.3	8,600
	2	50	60.33	2.77	3.93	47.4	6,875
	2 1/2	65	73.03	3.05	5.33	43.1	6,250
	3	80	88.90	3.05	6.45	35.5	5,150
	3 1/2	90	101.60	3.05	7.51	31.0	4,500
SCH 40	1/2	15	21.34	2.77	1.27	134.3	19,475
	3/4	20	26.67	2.87	1.68	111.4	16,150
	1	25	33.40	3.38	2.50	104.6	15,175
	1 1/2	40	48.26	3.68	4.05	78.9	11,450
	2	50	60.33	3.91	5.44	67.2	9,750

Finish: BHP Stainless schedule pipe has a smooth lustrous surface finish.

CHOOSING A SUITABLE GRADE OF STAINLESS STEEL

In choosing the most suitable stainless steel for a particular application, there are a number of important criteria which should be considered:

- **Corrosion**

What type of environment will the product be used in eg, exposed to the atmosphere, storing liquids, conveying corrosive gases.

- **Engineering Strength**

Some stainless steels have very high strengths.

- **Aesthetics**

What type of appearance is required; how often do you intend maintaining it.

- **Ease of Fabrication**

Can it be folded, cut, drilled, welded, etc, with the equipment available to you.

- **Temperature**

What temperature range will the product be used in.

- **Fatigue**

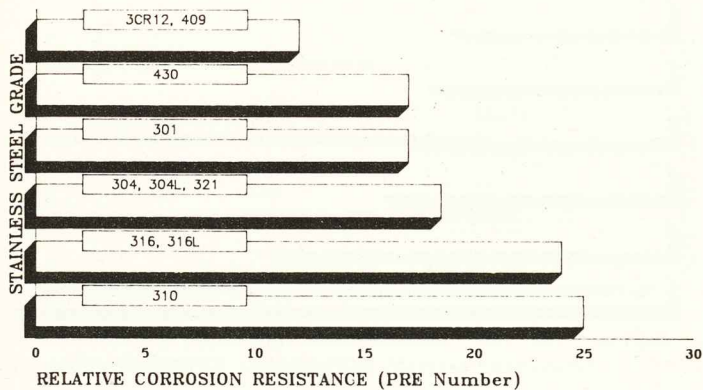
Is the product going to be subjected to a cyclic load.

As a quick guide to some of these aspects refer to the tables on features.

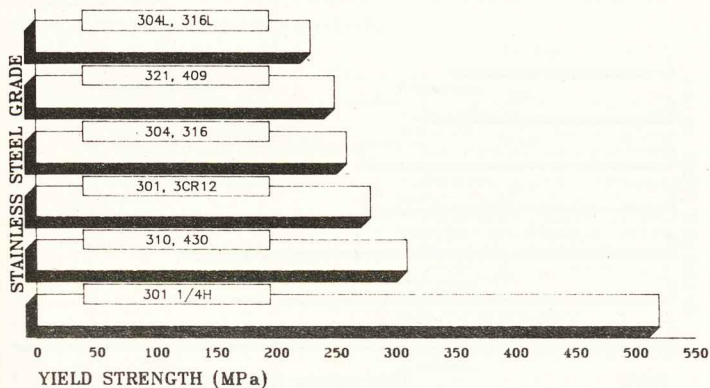
Feature	Application
Decorative & Mechanical Strength:	Space frames, sunshades, canopies, shop fittings, tubular furniture, hand rails, shower and towel rails, display stands, bus and train frames, boat fittings, commercial kitchens.
Product Purity:	Beer liners, food liners and equipment, dairy and milk equipment, fruit juice plants, hospital equipment, water pipes.
Corrosion Resistance:	Chemical and petrochemical plants, heat exchangers, pipelines, heaters, swimming pool equipment, marine rails and equipment, plating tanks and coils, exhaust pipes.
Heat Transfer:	'U' tube bundles, LP heaters in power stations, condensers, paper mills, juice heaters and extractors in sugar mills, cryogenic milk heaters and coolers, refrigeration.

The Referee

RELATIVE CORROSION RESISTANCE OF BHP STAINLESS STEEL GRADES

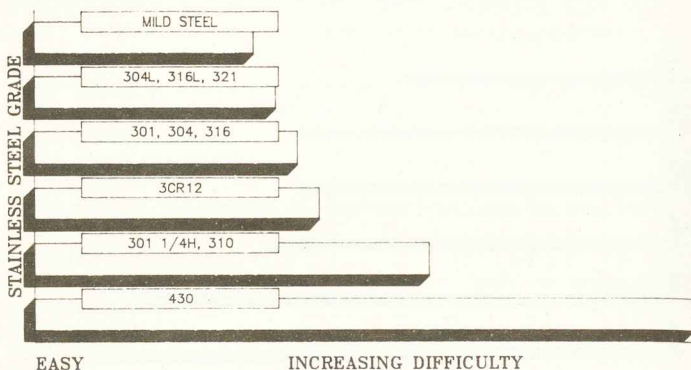


RELATIVE STRENGTH OF BHP STAINLESS STEEL GRADES

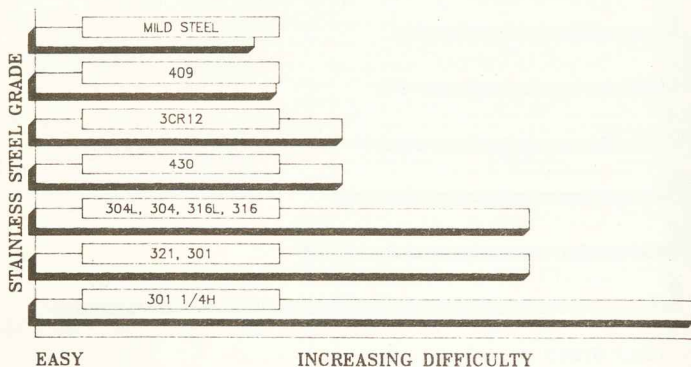


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WELDABILITY OF BHP STAINLESS STEEL

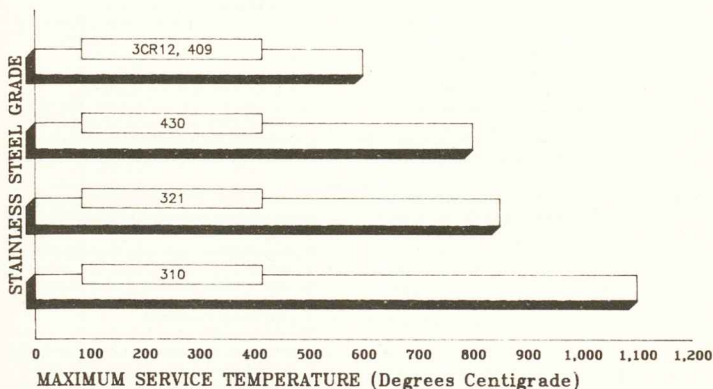


EASE OF FORMING, CUTTING, DRILLING BHP STAINLESS STEEL



The Referee

BHP STAINLESS STEEL GRADES SUITABLE FOR HIGH TEMPERATURE SERVICE



APPLICATIONS AND PROPERTIES

Austenitic

Grade	Applications	Properties
201	Railway carriages, buses; general roll formed sections; rainwater goods; fabricated sinks and drainers; commercial refrigeration cabinets; conveyor belts.	<p>A lower alloyed grade than either 302 or 304 which results in high strength with comparatively high ductility after cold working.</p> <p>Available in several cold rolled tempers (work hardened condition).</p> <p>Prolonged heating above 500°C reduces tensile strength and corrosion resistance.</p> <p>Welding is only advisable where subsequent use is in mildly corrosive environments.</p> <p>Spot or seam resistance welding is preferable to arc welding.</p> <p>Has a high work hardening rate and only suitable for moderate forming or drawing operations.</p>

The Referee

Austenitic

Grade	Applications	Properties
304	Architecture (exterior and interior); food processing, handling and serving equipment, saucepans; hospital equipment; rainwater goods; household appliances, domestic sinks and laundry troughs, general deep drawing applications; brewing and dairy equipment; evaporators; drums, barrels; heat exchangers and refrigerator parts.	A general purpose austenitic corrosion resistant steel. Excellent deep drawing and cold forming qualities in the annealed condition. Can be polished to a high finish. Readily weldable for use in moderate corrosion resistant applications. Using appropriate techniques, 304 can be welded in thickness up to 12 mm without subsequent heat treatment unless it is required for stress relieving purposes.
304L	Chemical plant; food processing equipment; and for use in coal and petroleum industry.	An extra low carbon austenitic stainless steel, with general corrosion resistance similar to 304, but with greater resistance to intergranular corrosion. Can be welded in greater thicknesses than 304, or heated for appreciable periods of time above 500°C without the need for subsequent solution heat treatment. Recommended when fabricating thicknesses in excess of 12 mm, or where high heat input methods are used and subsequent solution heat treatment cannot be performed.
310	Furnace parts and equipment, baffles, heat treatment boxes, retorts, furnace linings, heat exchangers.	Austenitic 25/20 chromium nickel steel offering excellent resistance to scaling at high temperatures. Mechanical properties in the higher temperature ranges are superior to other standard heat resisting steels. Can be employed for continuous service in the temperature range 900/950°C to 1100°C.
316	Exterior applications subject to severe industrial or marine atmospheres; chemical, textile, photographic and papermaking equipment; wine vats.	More resistant to certain corrosive conditions than the standard non-molybdenum bearing austenitic stainless steels. Suitable where protection is required from highly corrosive non-oxidising acids. Is used for plant and equipment in chemical manufacture. Has moderate deep drawing and cold forming properties. Weldable in thicknesses up to 12 mm without subsequent heat treatment for most applications.

The Referee

Austenitic

Grade	Applications	Properties
316L	Chemical plant and food processing equipment.	An extra low carbon modification for 316, with similar corrosion resistance. Intended for heavier sheet or plate fabrication where welding without subsequent heat treatment is required. Can be welded in heavy sections without the risk of inter-granular corrosion (weld decay) in the as-welded condition and also in the stress relieved condition under most circumstances. Suitable for polishing to a bright finish as required for pharmaceutical and food processing equipment.
321	Chemical and food processing equipment; furnace parts; general welding fabrication.	Titanium stabilised to overcome carbide precipitation in the range of 500°C-900°C. Excellent weldability and suitable as an alternative to 304L where full corrosion resistance of welded structure is required and where post-annealing is impractical. Excellent mechanical properties and good oxidation resistance suitable for oxidising atmospheres to 850°C. Recommended for applications where the combined effects of cold working and welding make stress relieving heat treatment necessary. Not suitable for bright polishing.

Ferritic

409	Automotive exhaust components.	Ferritic heat resistant chromium steel. Good workability, formability and moderate resistance to corrosion.
430	Interior architecture and automotive trim; domestic appliances; restaurant equipment; stove and heater components.	A 17% chromium stainless steel. Good resistance to normal atmospheric corrosive conditions. Can be used with various chemicals, such as nitric acid, caustic soda, ammonia, detergents and alkalis. Moderate ductility for forming and drawing operations. Not as suitable for welding as austenitic grades, as welds tend to be brittle. Satisfactory for resistance to scale and oxidation up to approximately 800°C, although its mechanical properties at elevated temperatures are inferior to the austenitic heat resisting steels such as 321.

PRECAUTIONS TO BE NOTED IN THE PROCESSING OF STAINLESS STEEL

(a) Handling of Material

Stainless steel should be handled with care. The surface is susceptible to scratching which needs to be avoided to minimise expensive finishing operations. In addition, scratches can be a source of foreign metal contamination which can initiate pitting corrosion. Protective plastic coating (PVC) can be applied at the mill.

(b) Storage

Store in a clean, dry, well ventilated area in the original package, preferably under cover. Avoid exposure of plastic coated material to direct sunlight. Test the adhesive power of the coating periodically and immediately remove the coating if any hardening is noted. Absorbent wrappings such as interleaving paper, cardboard, timber, etc, should be kept dry. All such wrapping must be removed, if wet, to prevent surface staining. (For removal see table below "Rust Stains from External Sources".)

(c) Deep Drawing

Stainless steels possess excellent deep drawability. For severe deep drawing use of PVC coating and lubricants having high film strength are required to reduce friction and to prevent seizing and galling. After forming, oil on the stainless steel surface should be removed completely.

(d) Bending

The austenitic stainless steels can be readily bent. For severe bending, particularly of the ferritic and temper rolled austenitic alloys, ragged edges should be ground to remove burr and any work hardened areas. Grinding marks should be along and not across the cut edge.

(e) Cutting

Due to the greater strength of stainless steel as compared with carbon steel, more force is needed for punch pressing or shearing. Clearance of dies and blades should be finer to ensure clean cutting without excess burr or work hardening. Cutting with gas or arc is not recommended but if used, the wide heat affected areas should be removed before fabrication.

Plasma or laser cutting is normally recommended. Arc-air gouging can be used for field work, but the heat affected zone should be removed by grinding.

(f) Installation

Where possible avoid the use of hydrochloric acid (muriatic acid) to clean brickwork, etc, in the vicinity of stainless steels during construction. If used, remove any residues which may arise with copious clean water washing. Such agents can cause rapid pitting and staining. Avoid contamination with iron base metals such as filings, nails, screws, etc, which cause unsightly rust stains and may initiate pitting. Remove splashes of wet solid matter before they dry and harden. Remove any protective coatings as soon as possible after construction is completed. Wipe off residual adhesive with an organic solvent. A complete cleaning immediately after the construction is completed is most important to ensure that the stainless steel is in a clean and passive condition at the commencement of its service life.

CARE AND CLEANING OF STAINLESS STEEL

Although stainless steel keeps its lustrous finish even under adverse conditions, it still needs regular cleaning. Soap and water is usually all you need.

The frequency of cleaning will vary according to the required appearance and environment. This is best determined by varying the cleaning cycle until a suitable programme is established. Patterned or textured finishes are useful for heavy traffic areas because they do not highlight finger marks, scratches, dents, etc.

In industrial applications, regular inspections should establish the material condition and ensure that deposit build-up, likely to cause crevices, is regularly removed. If rust staining is noted, or corrosion is suspected, closer inspection should be undertaken to determine the nature, cause and severity of the problem. If attack is detected, Coated Products Division – Stainless should be contacted to advise on corrective action. Normally cleaning and passivation can prevent further attack. Vessels not in use should be completely emptied, and if necessary residual pools of liquid sponged-up. This precaution prevents concentration of salts by evaporation of liquid. Failure to perform this task may lead to corrosive attack.

DO

- Wash regularly with soapy water or detergent using a clean cloth and, if necessary, a soft bristle brush.
- Remove non-washable deposits using an approved cleaner.
- Clean in one direction only, along the original polish lines.
- Rinse well with clean water and wipe dry.

The Referee

DON'T

- Use steel wool or metallic scrapers to remove non-washable deposits.
- Allow dirt to accumulate or to dry out and harden.
- Use cleaners containing harsh abrasives or high bleach contents.

RECOMMENDED CLEANING PROCEDURES

Condition	Cleaning Agents	Precautions
Readily removed stains. Construction dirt. Routine cleaning.	Soap Liquid detergents Powder detergents Hose pipe jet	Avoid scratching. Do not use cleaners containing bleaching agents. Rinse with clean water to remove residual cleaning compounds.
Non-washable deposits.	Domestic cleaning powders such as Bon Ami, Jiff, etc. Recommended stainless steel cleaners such as are supplied by some saucepan manufacturers.	Do not use steel wool. Stainless steel wool may be used. Rub in straight lines along the polish pattern. Avoid scratching.
Oil and greasy deposits.	(a) Organic solvents such as acetone, methylated spirits, Xylol, Benzene. (b) Caustic soda or tri sodium phosphate solutions (5 to 10%)	Final wash with detergent and clean water. Wipe dry. Care is required with flammable solvents.
Rust stains from external sources	(a) Oxalic acid, sulphamic acid (10%). (b) Abrasive cleaning paste. (c) Nitric acid (see passivation).	Avoid scratching. Rinse thoroughly with water and detergent. Wipe dry.
Finger prints	Dilute phosphoric acid with detergent.	Rinse thoroughly and wipe dry.
Requires maximum possible corrosion resistance. Free iron suspected. Passivation.	(a) 20 to 40% by volume nitric acid at 55° to 70° C for 30 to 60 minutes fully immersed. (b) A spreadable paste of the above made with an inert base such as diatomaceous earth or fullers earth may be applied for seven hours.	Will attack many other metals such as iron, copper, nickel. Protective clothing and care in handling and disposal required. Thoroughly rinse with clean warm water and wipe dry.
Welding scale. Heat tint.	(a) 10 to 15% by volume nitric acid with 1 to 2% by volume hydrofluoric acid up to 50°C for up to 15 minutes. (b) A spreadable paste of the above as for nitric acid.	As for nitric acid.
Water "scale" – calcium/magnesium salt deposits.	Citric acid solution. Tartaric acid solution. Up to 10% W/v hot versene may be added.	Wash with detergent and warm water. Wipe dry.

Proprietary brand cleaners formulated on these cleaning agents are often available from various suppliers. Care should be taken with all cleaning agents to avoid damage to any associated non-stainless steel components. Fire, safety and protective clothing regulations should be closely adhered to.

USEFUL INFORMATION

RURAL

DETERMINING THE QUANTITY OF HAY IN A STACK

Formulae for the exact calculation of the capacity of a haystack are rather complicated for general use. These formulae are used because of the fact that a haystack is irregular in shape and dimensions. However, since the volume of hay per tonne varies greatly with the age of the hay and its degree of settling, formulae which are not so accurate, but are sufficient for practical purposes, are given below. These will enable the farmer to obtain a reasonable estimate of the amount of fodder available in both rectangular and circular stacks.

Cubic Contents of a Rectangular Stack

To determine the volume of a rectangular stack:

- (a) Multiply length at base in metres by breadth at base in metres.
- (b) Multiply together length and breadth at eaves in metres.
- (c) Add length at base and length at eaves in metres together and multiply this figure by the sum of the breadth at the base and the breadth at the eaves in metres. Add (a), (b) and (c) together and multiply by the height in metres of the eaves above ground level. Divide this product by six, and the result is the volume of the body of the stack in cubic metres.

For the top portion:

- (d) Multiply together the length and breadth in metres at the eaves.
- (e) Multiply the breadth in metres at the eaves by the sum of the length at the eaves and length along the ridge in metres.

Add (d) and (e) together, multiply by the height of the ridge above the eaves in metres and divide by six. This gives the volume of the portion above the eaves which when added to the volume of the body gives the total volume of the stack.

Example Consider a rectangular stack the dimensions of which are: 12m by 6m at base; 15m by 7m at the eaves; 9m long at the ridge; eaves 3m above the ground; ridge 3m vertically above the eaves.

The Referee

CUBIC CONTENTS OF A RECTANGULAR STACK

Volume of base or body =

$$\begin{array}{lcl} \text{(a)} & 12 \times 6 & = 72 \\ \text{(b)} & 15 \times 7 & = 105 \\ \text{(c)} & (12 + 15) \times (6 + 7) & = 27 \times 13 = 351 \\ \text{(a)} + \text{(b)} + \text{(c)} & & = 528 \\ & \frac{528 \times 3}{6} & = 264 \text{ cubic metres} \end{array}$$

Volume of portion above eaves =

$$\begin{array}{lcl} \text{(d)} & 15 \times 7 & = 105 \\ \text{(e)} & 7 \times (15 + 9) & = 7 \times 24 = 168 \\ \text{(d)} + \text{(e)} & & = 273 \\ & \frac{273 \times 3}{6} & = 136.5 \text{ cubic metres} \end{array}$$

Total volume of stack = 400.5 cubic metres

Cubic Contents of a Circular Stack

To determine the volume of a circular stack:

- Measure the circumference at both the base and eaves in metres.
- Add these together and multiply this figure by itself (ie, square it).
- Multiply the circumference at the base by the circumference at the eaves and deduct this from the result of (b).
- Multiply the result of (c) by the height in metres of the eaves above the base and divide the result by thirty-eight. The figure obtained is the volume of the body of the stack in cubic metres.

For the top conical portion of the stack, square the circumference in metres at the eaves and multiply the height in metres of the top or peak above the eaves. Divide by thirty-eight and the result obtained is the volume in cubic metres of the top portion. By adding the volume of the base and top together, the total content of the stack is obtained.

Example Consider a circular stack with circumference at ground level 18 m, at the eaves 21 m and 3 m high at the eaves and 2 m at the top from the eaves. Applying the formula:

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CUBIC CONTENTS OF A CIRCULAR STACK

Volume of body of stack

$$= [(18 + 21) \times (18 + 21) - (18 \times 21)] \times \frac{3}{38}$$

$$= (1521 - 378) \times \frac{3}{38}$$

$$= 1143 \times \frac{3}{38}$$

$$= 90.2 \text{ cubic metres}$$

Volume of conical top

$$= \frac{21 \times 21 \times 2}{38}$$

$$= \frac{882}{38}$$

$$= 23 \text{ cubic metres}$$

Total volume of stack = 113.2 cubic metres

APPROXIMATE CONTENT OF HAYSTACK

After a paddock has been cut, the farmer will usually know, either from experience or from rough guides such as the amount of twine used, about how much hay is to be stacked.

The size of the haystack built should be in accordance with the expected yield. Stacks are usually about as high above the eaves as below when built in correct proportions, and the following table gives an idea of the content of various sized stacks.

MASS PER STACK OF HAY

Average width, metres	Average length, metres	Height to eaves, metres	Height of ridge, metres	Mass per stack, tonnes
3	6	2.5	1	1.5
3	6	3	1.5	2
4	8.5	3	3	4
5	9	3.5	3	6
6	15	4	3	15

APPROXIMATE NUMBER OF CUBIC METRES PER TONNE OF HAY

Period	Oats		Wheat		Lucerne, m ³
	Sheaf, m ³	Loose, m ³	Sheaf, m ³	Loose, m ³	
Freshly stacked.....	10	11	11	14	11-13
One month after stacking.....	8.5	10	10	11	10-11
One year after stacking.....	8.5	9	9	10	8.5-10

The Referee

STOCK BREEDING TABLE

Date of service	Expected date of parturition					
	Mares (340 days)*	Cows (283 days)*	Ewes (150 days)*	Does (147 days)*	Sows (116 days)*	Bitches (63 days)*
1 Jan	7 Dec	11 Oct	31 May	28 May	27 Apr	5 Mar
8 "	14 "	18 "	7 June	4 June	4 May	12 "
15 "	21 "	25 "	14 "	11 "	11 "	19 "
22 "	28 "	1 Nov	21 "	18 "	18 "	26 "
29 "	4 Jan	8 "	28 "	25 "	25 "	2 Apr
5 Feb	11 "	15 "	5 July	2 July	1 June	9 "
12 "	18 "	22 "	12 "	9 "	8 "	16 "
19 "	25 "	29 "	19 "	16 "	15 "	23 "
26 "	1 Feb	6 Dec	26 "	23 "	22 "	30 "
5 Mar	8 "	13 "	2 Aug	30 "	29 "	7 May
12 "	15 "	20 "	9 "	6 Aug	6 July	14 "
19 "	22 "	27 "	16 "	13 "	13 "	21 "
26 "	1 Mar	3 Jan	23 "	20 "	20 "	28 "
2 Apr	8 "	10 "	30 "	27 "	27 "	4 June
9 "	15 "	17 "	6 Sep	3 Sep	3 Aug	11 "
16 "	22 "	24 "	13 "	10 "	10 "	18 "
23 "	29 "	31 "	20 "	17 "	17 "	25 "
30 "	5 Apr	7 Feb	27 "	24 "	24 "	2 July
7 May	12 "	14 "	4 Oct	1 Oct	31 "	9 "
14 "	19 "	21 "	11 "	8 "	7 Sep	16 "
21 "	26 "	28 "	18 "	15 "	14 "	23 "
28 "	3 May	7 Mar	25 "	22 "	21 "	30 "
4 June	10 "	14 "	1 Nov	29 "	28 "	6 Aug
11 "	17 "	21 "	8 "	5 Nov	5 Oct	13 "
18 "	24 "	28 "	15 "	12 "	12 "	20 "
25 "	31 "	4 Apr	22 "	19 "	19 "	27 "
2 July	7 June	11 "	29 "	26 "	26 "	3 Sep
9 "	14 "	18 "	6 Dec	3 Dec	2 Nov	10 "
16 "	21 "	25 "	13 "	10 "	9 "	17 "
23 "	28 "	2 May	20 "	17 "	16 "	24 "
30 "	5 July	9 "	27 "	24 "	23 "	1 Oct
6 Aug	12 "	16 "	3 Jan	31 "	30 "	8 "
13 "	19 "	23 "	10 "	7 Jan	7 Dec	15 "
20 "	26 "	30 "	17 "	14 "	14 "	22 "
27 "	2 Aug	6 June	24 "	21 "	21 "	29 "
3 Sep	9 "	13 "	31 "	28 "	28 "	5 Nov
10 "	16 "	20 "	7 Feb	4 Feb	4 Jan	12 "
17 "	23 "	27 "	14 "	11 "	11 "	19 "
24 "	30 "	4 July	21 "	18 "	18 "	26 "
1 Oct	6 Sep	11 "	28 "	25 "	25 "	3 Dec
8 "	13 "	18 "	7 Mar	4 Mar	1 Feb	10 "
15 "	20 "	25 "	14 "	11 "	8 "	17 "
22 "	27 "	1 Aug	21 "	18 "	15 "	24 "
29 "	4 Oct	8 "	28 "	25 "	22 "	31 "
5 Nov	11 "	15 "	4 Apr	1 Apr	1 Mar	7 Jan
12 "	18 "	22 "	11 "	8 "	8 "	14 "
19 "	25 "	29 "	18 "	15 "	15 "	21 "
26 "	1 Nov	5 Sep	25 "	22 "	22 "	28 "
3 Dec	8 "	12 "	2 May	29 "	29 "	4 Feb
10 "	15 "	19 "	9 "	6 May	5 Apr	11 "
17 "	22 "	26 "	16 "	13 "	12 "	18 "
24 "	29 "	3 Oct	23 "	20 "	19 "	25 "
31 "	6 Dec	10 "	30 "	27 "	26 "	4 Mar

* Average length of gestation period; may be subject to slight variation in individual cases.

CAPACITY OF TANKS – CALCULATIONS

Square or Rectangular Section All dimensions in metres:

Length x breadth x depth = capacity in kilolitres.

Circular Capacity in kilolitres given by either of the following rules.

A Exact formula capacity = $\frac{\pi D^2 h}{4}$

B Approximate formula capacity = $\frac{8C^2 h}{100}$

C Approximate formula capacity = $\frac{4D^2 h}{5}$

Where capacity is in kilolitres and

C = circumference in metres

D = diameter in metres

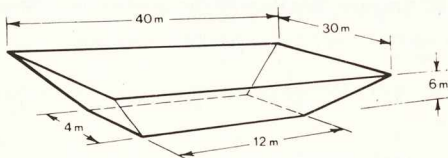
h = height in metres

Example:

Capacity of a tank with a diameter 2 metres and height 2 metres

$$\begin{aligned}\text{Approximate capacity} &= \frac{4D^2 h}{5} = \frac{4 \times 2^2 \times 2}{5} \\ &= 6.4 \text{ kilolitres}\end{aligned}$$

HOW TO MEASURE DAMS OR TANKS



In order to calculate the amount of excavation required or the capacity of a dam or tank, as illustrated, the following formula should be used.

- (a) Length at bottom multiplied by width at bottom $= 12 \times 4 = 48$
(b) Length at top multiplied by width at top $= 40 \times 30 = 1200$
(c) Sum of the lengths multiplied by sum of the widths $= 52 \times 34 = 1768$
(a) + (b) + (c) $= 3016$
(d) (a) + (b) + (c) multiplied by the depth and divided by six $= \frac{3016 \times 6}{6} = 3016 \text{ m}$

1 cubic metre is equal to 1 kilolitre.

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AVERAGE DISTRICT RAINFALL THROUGHOUT AUSTRALIA

	DISTRICT	Annual fall, mm	DISTRICT	Annual fall, mm
NSW	Western Far North West	229	Central Tablelands North	648
	Western Lower Darling	249	Central Tablelands South	904
	Western Upper Darling	349	Central Western Slopes North	630
	Western SW Plains	344	Central Western Slopes South	598
	Central Western Plains South	472	Metropolitan East	1142
	Central Western Plains North	474	Metropolitan West	814
	North-west Plains East	582	Illawarra	1101
	North-west Plains West	510	South Coast	938
	North-west Slopes North	675	Southern Tablelands, Goulburn, Monaro	670
	North-west Slopes South	658	Southern Tablelands, Snowy Mountains	879
	Northern Tablelands Western	810	South-west Slopes South	810
	Northern Tablelands Eastern	999	South-west Slopes North	604
	North Coast Upper	1445	Riverina East	471
	North Coast Lower	1489	Riverina West	362
	Manning	1342		
	Hunter	894		
VIC	Mallee North	307	East Gippsland	775
	Mallee South	351	West Gippsland	914
	North Wimmera	412	East Central	890
	South Wimmera	502	West Central	610
	Lower North	430	North Central	723
	Upper North	515	Western Plains	631
	Lower North-east	776	West Coast	775
	Upper North-east	1102		
TAS	Northern	993	Central Plateau	995
	East Coast	816	West Coast Mountain Region	2339
	Midlands	550	King Island	929
	South-east	760	Flinders Island	740
	Derwent Valley	689		
SA	North-West	191	Central West	424
	Far North	180	Central East	597
	Western Agricultural	340	Murray Valley	323
	Upper North	334	Murray Mallee	308
	North-east	211	Upper South-east	434
	Lower North	437	Lower South-east	657
WA	North Kimberley	1026	North Coast	395
	East Kimberley	540	Central Coast	850
	West Kimberley	550	South Coast	910
	De Grey	304	Central North	358
	Fortescue	277	Central South	433
	West Gascoyne	218	Eucla	238
	East Gascoyne	231	South-east	260
	Murchison	233	North-east	228

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AVERAGE DISTRICT RAINFALL THROUGHOUT AUSTRALIA

	DISTRICT	Annual fall, mm	DISTRICT	Annual fall, mm
NT	Darwin-Daly	1322	Victoria	605
	Arnhem	1211	Barkly	419
	Roper-McArthur	749	Alice Springs	253
QLD	Peninsula North	1451	Upper West	351
	Peninsula South	964	Lower West	245
	Carpentaria Lower	610	South Coast, Port Curtis	916
	Carpentaria Upper	629	South Coast, Moreton	1162
	North Coast, Barron	1604	Darling Downs East	701
	North Coast, Herbert	1954	Darling Downs West	562
	Central Coast East	976	Maranoa	550
	Central Coast West	610	Warrego	430
	Central Highlands	617	Far South West	294
	Central Lowlands	472		

Information courtesy Bureau of Meteorology.

AREA DISTRIBUTION OF MEDIAN ANNUAL RAINFALL: AUSTRALIA

(per cent)

Median annual rainfall	NSW(a)	VIC	QLD	SA	WA	TAS	NT	Aust
Under 200 mm	8.0	—	10.2	74.2	43.5	—	15.5	29.6
200 to 300 mm	20.3	6.3	13.0	13.5	29.6	—	35.6	22.9
300 to 400 mm	19.0	19.2	12.3	6.8	10.5	—	9.0	11.2
400 to 500 mm	12.4	11.8	13.5	3.2	4.3	—	6.6	7.6
500 to 600 mm	11.3	14.1	11.6	1.8	3.1	12.2	5.8	6.6
600 to 800 mm	15.1	24.5	20.5	0.5	4.6	18.2	11.6	10.7
800 to 1200 mm	11.3	17.7	12.6	—	3.7	25.0	9.6	7.7
Above 1200 mm	2.6	6.4	6.3	—	0.7	44.6	6.3	3.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

(a) Includes Australian Capital Territory.

Information courtesy Australian Bureau of Statistics.

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MAJOR DAMS AND RESERVOIRS IN AUSTRALIA

(H/E = hydro-electricity, FC = flood control and/or mitigation)

EXISTING

Name (Year of Completion)	Location	Gross capacity, gigalitres	Height of wall, metres	Purpose
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NEW SOUTH WALES

Eucumbene (1958)	Eucumbene River	4 807	116	Part of Snowy Mountains H/E Scheme
Hume (1936, 1961)	Murray River, near Albury	3 038	51	Irrigation, water supply, H/E
Warragamba (1960)	Warragamba River	2 057	137	Water supply for Sydney, H/E
Menindee Lakes (1960)	Darling River, near Menindee	1 794	18	Conservation storage for Murray River Agreement
Burrendong (1967)	Macquarie River, near Wellington	1 677	76	Conservation, FC, water supply
Blowering (1968)	Tumut River	1 628	112	H/E, irrigation
Copeton (1976)	Gwydir River	1 364	113	Irrigation
Wyangala (1936, 1971)	Lachlan River	1 220	85	Irrigation, stock, etc
Burrinjuck (1927, 1956)	Murrumbidgee River	1 026	79	Irrigation, H/E
Talbingo (1971)	Tumut River	921	162	H/E
Jindabyne (1967)	Snowy River	688	72	H/E
Lake Victoria (1928)	Murray River, near SA border	680	—	Conserves supplies for SA
Keepit (1960)	Namoi River, Gunnedah	423	55	Conservation, irrigation, H/E
Split Rock (1986)	Manilla River, Namoi Valley	370	64	Irrigation
Windamere (1984)	Cudgong River, near Mudgee	368	69	Irrigation
Glennies Creek (1983)	Hunter Valley, near Singleton	284	65	Irrigation, industrial, mining, water supply
Glenbawn (1958)	Hunter River, near Scone	360	78	Conservation, irrigation, FC, H/E
Tantangara (1960)	Murrumbidgee River	254	45	H/E
Avon (1927)	Avon River	214	72	Water supply for Sydney
Grahamstown (1969)	Grahamstown, near Newcastle	153	12	Industrial, mining, water supply
Lake Brewster (1952)	Lachlan River, near Hillston	150	—	Irrigation
Liddell (1968)	Gardiner Creek, near Muswellbrook	148	41	Cooling water for thermal electricity generation
Tallowa (1977)	Shoalhaven River, near Nowra	135	43	Water supply for Sydney
Googong (1978)	Queanbeyan River	125	59	Water supply for Canberra-Queanbeyan

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Name (Year of Completion)	Location	Gross capacity, gigalitres	Height of wall, metres	Purpose
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VICTORIA

Dartmouth (1979)	Mitta Mitta River	4 000	180	Irrigation, storage, H/E
Eildon (1927, 1955)	Upper Goulburn River	3 392	79	Irrigation, H/E
Thomson (1984)	Thomson River, near Moe	1 175	164	Irrigation, water supply
Waranga (1910)	Near Rushworth (Swamp)	411	12	Irrigation
Mokoan (1971)	Winton Swamp, near Benalla	365	10	Irrigation
Rocklands (1953)	Glenelg River	336	28	Domestic and stock water supply
Eppalock (1964)	Campaspe River	312	45	Irrigation, water supply
Cardinia (1973)	Cardinia Creek, near Emerald	287	79	Water supply for Melbourne
Upper Yarra (1957)	Yarra River	207	89	Water supply for Melbourne
Blue Rock (1984)	Tanjil River, near Moe	198	75	Industrial, mining, water supply
Glenmaggie (1927, 1958)	Macalister River	190	37	Irrigation
Cairn Curran (1958)	Loddon River, near Newstead	149	44	Irrigation
Yarrawonga (1939)	Murray River	117	22	Irrigation
Toolondo (1952, 1960)	Natural depression, near Horsham	107	—	Domestic and stock water supply
Winneke (1980)	Sugarloaf Creek, near Melbourne	100	89	Water supply

QUEENSLAND

Burdekin (1986)	Burdekin River, near Townsville	1 860	55	Irrigation, water supply
Fairbairn (1972)	Nogoa River, Central Qld	1 440	49	Irrigation, industrial
Wivenhoe (1985)	Brisbane River, near Ipswich	1 150	59	H/E, FC, water supply
Somerset (1959)	Stanley River	893	50	Water supply for Brisbane, H/E
Fred Haigh (1975)	Kolan River, near Gin Gin	586	52	Irrigation
Ross River (1974)	Near Townsville	417	35	FC, water supply
Tinaroo Falls (1958)	Barron River	407	47	Irrigation, H/E
Awoonga High Dam (1985)	Boyne River, near Gladstone	250	45	Industrial, mining, water supply
Glenlyon (1976)	Pike Creek, near Stanthorpe	261	62	Irrigation
Boondooma (1983)	Boyne River, near Proston	212	64	Industrial, mining, irrigation
North Pine (1975)	North Pine, near Brisbane	205	44	Water supply

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Name (Year of Completion)	Location	Gross capacity, gigalitres	Height of wall, metres	Purpose
Wuruma (1968)	Nogo River, near Eidsvold	194	46	Irrigation
Koombooloomba (1961)	Tully River	180	52	H/E, irrigation
Callide Dam (St II) (1986)	Callide Creek, near Biloela	127	35	Irrigation, water supply, industrial, mining
Julius (1977)	Leichhardt River, near Mt Isa	127	35	Water supply, mining
Leslie Dam (St II) (1985)	Sandy Creek, near Warwick	108	34	Water supply, irrigation
Lake Moondarra (1957)	Leichhardt River, near Mt Isa	107	27	Water supply, mining, industrial
Eungella (1969)	Broken River	131	46	Water supply, irrigation, industrial, mining
Beardmore (1972)	Balonne River	101	15	Water supply, irrigation

TASMANIA

Lakes Gordon and Pedder (1974)				
Gordon		11 728	140	
Scotts Peak	South West		43	H/E
Serpentine		2 963	38	
Degar			17	
Miena (1967)	Great Lake	2 390	18	Storage for H/E
Lake St Clair (1938)	Central Plateau	est 2 000	3	Natural storage for H/E
Mackintosh (1980)	Mackintosh River, near Queenstown		75	H/E
Tullibardine (1979)	Tullibardine River, near Queenstown	922	25	H/E
Lake Echo (1956)	Lake Echo	725	19	H/E
Lower Pieman	Pieman River, near Queenstown	641	122	H/E
Lake King William (Clark) (1949, 1966)	Derwent River	540	67	H/E
Arthur's Lake (1965)	Source of Lake River, near Great Lake	571	17	H/E
Devils Gate (1969)	Forth River, near Devonport	180	84	H/E
Rowallan (1967)	Mersey River	130	43	H/E
Bastyan	Pieman River, near Queenstown	124	75	H/E
Cethana (1971)	Forth River, near Devonport	108	110	

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Name (Year of Completion)	Location	Gross capacity, gigalitres	Height of wall, metres	Purpose
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NORTHERN TERRITORY

Darwin River (1972)	Darwin River	259	31	Water supply for Darwin
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WESTERN AUSTRALIA

Lake Argyle (Ord) (1971)	Ord River, near Kununurra	5 720	99	Irrigation, FC, H/E
South Dandalup (1973)	Near Dwellingup	208	41	Water supply for Perth
Wellington (1933, 1944, 1960)	Collie River	185	37	Water supply, irrigation
Serpentine (161)	Serpentine River	185	55	Water supply for Perth
Harding (1985)	Harding River, Pilbara	114	42	Water supply, industrial, mining

UNDER CONSTRUCTION OR PROJECTED

Crotty Dam	King River, near Queenstown, Tas	1 091	80	H/E
Proserpine Dam	Proserpine River, near Bowen, Qld	500	45	Water supply, irrigation
Bjelke Petersen	Barker Creek, near Murgon, Qld	125	33	Irrigation

Information courtesy Australian Bureau of Statistics.

AREA, COASTLINE, TROPICAL AND TEMPERATE ZONES

State or Territory	Estimated area		Length of coastline, km	Percentage of total area in	
	Total, km ²	Percentage of total area		Tropical zone	Temperate zone
New South Wales	801 600	10.43	1 900	-	100
Victoria	227 600	2.96	1 800	-	100
Queensland	1 727 200	22.48	7 400	54	46
South Australia	984 000	12.81	3 700	-	100
Western Australia	2 525 500	32.87	12 500	37	63
Tasmania	67 800	0.88	3 200	-	100
Northern Territory	1 346 200	17.52	6 200	81	19
Australian Capital Territory	2 400	0.03	35	-	100
Australia	7 682 300	100	36 735	39	61

AERIAL AGRICULTURE

Aircraft are widely used in Australia for top dressing and seeding, for spraying and dusting of crops and pastures, and for pest and vermin extermination. Landing areas for these aircraft are determined by the operator providing they meet the minimum requirements specified by the Civil Aviation Authority. However, if an Authorised Landing Area (ALA) is available, most operators prefer to use the ALA.

AUTHORISED LANDING AREA REQUIREMENTS

The development and maintenance of good airstrips on your own property can be highly advantageous to you in the following ways:

- 1 Greater safety for the pilot and aircraft while operating on your property.
- 2 Fast and efficient operation of aircraft.
- 3 Airstrip facilities add to the capital value of your property.
- 4 Good operating conditions mean fuller utilization of contractors' equipment, which affects the cost to you.

The minimum requirements for an airstrip are set out below but it is stressed that much depends upon particular aircraft that would be using the airstrip. A property owner contemplating construction of an airstrip on his property should consult the Visual Flight Guide, Section 81 and the aircraft's approved Flight Manual to ensure that the area complies with the approved standards.

Full details are, of course, available from the Civil Aviation Authority but below are the minimum authorized landing area specifications for day agricultural operations.

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General Conditions

Unless specifically approved by the Chief Executive Officer, Civil Aviation Authority, the area shall not be within a control zone nor within 10 nautical miles of an aerodrome for which an instrument approach procedure is prescribed, nor within 5 nautical miles of a licensed aerodrome, military aerodrome, or an aerodrome under the control and management of the Authority unless that aerodrome is unserviceable or is inaccessible by means of the surface transport normally used for travel to and from that aerodrome.

Additionally, it shall not be within any area, from time to time designated in the AIP (Aeronautical Information Publication) or by NOTAM (Notice to Airmen) wherein the density of aircraft movements makes it undesirable in the interests of safety to authorise the use of areas as landing or alighting areas.

The area shall be so situated that operations in the area shall not involve flights at a height of less than 1500 feet over any city, town or populous area.

The pilot in command shall not land or take off unless persons, animals, vessels and other objects are clear of the strip and clear of the aircraft on the ground when an engine is operating.

The pilot in command, before using a landing area, shall take all reasonable steps to ensure the physical dimensions and characteristics specified are met in full. In addition, he shall take all reasonable steps to ensure that the surface of the landing area is suitable prior to each landing or take-off, that a suitable means of determining the wind velocity is available at the landing area and that the aircraft can be safely manoeuvred in the circuit area clear of all obstructions.

Note – The fact that an area has been specifically authorised for use as an authorised landing area, or that it complies with the general specifications set out in this section, does not confer any right to land on or alight from that area against the wishes of the owner of the land. All relevant Commonwealth and State laws, including any regulations made by an authority controlling the use of a waterway, must be complied with by aircraft landing at or taking off from an authorised landing or alighting area. The pilot in command should therefore contact the owner, occupier

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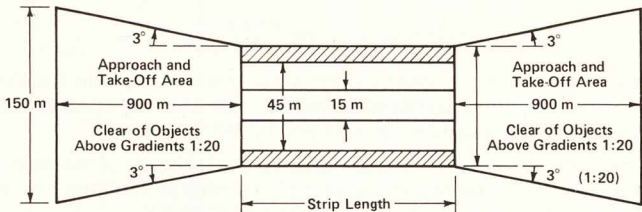
or controlling authority of an area which he wishes to use, prior to such use, in order to determine the conditions under which it may be used.

Authorised Landing Area Dimensions

Width and Approach Areas The strip width and the dimensions of the clearway and approach and take-off areas shall not be less, and the clearway and approach and take-off gradients shall not be steeper, than those shown in the diagram.

The term 'objects' used in the diagram includes any suspended object such as wires.

DIMENSIONS – DAY (GENERAL AIRCRAFT USE)



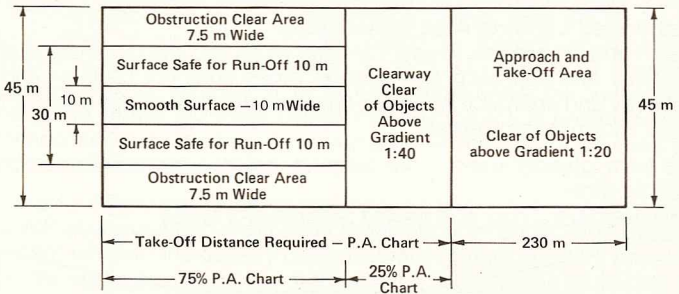
It is necessary to ensure that objects immediately beyond the approach and take-off area are not hazardous to the normal manoeuvring of an aircraft prior to landing or after taking-off.

Authorised Landing Areas – Agricultural Use Only

Length The effective length of strip available must not be less than that prescribed in the relevant Performance of Aircraft (PA) chart for the prevailing conditions. In determining the effective length it shall be acceptable for the final 25 per cent of the take-off distance required as prescribed in the relevant PA chart to be 'clearway'. Clearway is an area in which there are no obstructions above a plane of 1:40 measured from the end of the prepared surface over a width of 45 metres.

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DIMENSIONS – DAY (AGRICULTURAL AIRCRAFT ONLY)



Grades The maximum overall longitudinal gradient shall be 1:8. Where the overall longitudinal gradient exceeds 1:50, one way operations only are permitted (ie, down-hill take-off and up-hill landings).

The maximum transverse grade in the central 9 metres of the strip shall be 1:33; in the 10 metres either side of the central 9 metres it shall be 1:20 and over the remainder of the strip it shall be 1:8.

Surface The central 10 metres of the strip over its length shall be smooth, the 10 metres on each side of the central 10 metres shall be such that an aircraft running over it following a swing on take-off or landing would not suffer damage. There shall be no obstruction above the ground level over the whole area. Obstructions include suspended objects such as wires. A reasonable test for smoothness of the central section would be to drive a heavily sprung vehicle over the surface at 50 km/h without discomfort to the occupants.

General The strip surface should be well graded and then grassed so that it can stand up to maximum work and resist erosion. This will reduce maintenance costs to a minimum. When it becomes overgrown it should be mowed to the full length and the loose grass should be removed from the approach and take-off area, and all around the loading area. Long grass will retard aircraft acceleration and, if wet, can reduce brake control to a serious extent.

The reason for removing the cut grass as suggested is that it could otherwise be drawn into the intake of the aircraft with serious results, and there is always the possibility of dry loose grass being set alight by the aircraft exhaust.

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It is recommended that airstrip boundaries be indicated by frangible type markers.

AERIAL AGRICULTURE

Year ended 31 March	Area treated (^{'000} hectares)			Materials applied (^{'000} tonnes)		Productive hours flown (^{'000} hours)
	Top dressed and seeded	Sprayed	Total (a)	Super- phosphate	Seed	
1979	3,212	2,956	6,224	374.5	5.9	101.2
1980	4,416	2,412	6,907	514.2	6.4	127.3
1981	2,727	2,054	4,850	489.5	4.6	98.7
1982	2,461	2,760	5,395	276.7	2.9	86.3
1983	1,643	1,638	3,448	193.7	3.2	62.5
1984	1,999	3,613	5,710	196.6	5.7	82.0
1985	1,732	3,505	5,679	168.9	5.4	77.5

(a) Includes other types of treatment (rabbit baiting, etc).

ARTIFICIAL FERTILISERS: AREA AND USAGE

Year	Area fertilised	Super- phosphate used	Nitrogenous fertilisers used	Other fertilisers used
	^{'000} ha	^{'000} tonnes	^{'000} tonnes	^{'000} tonnes
1980-81	n.a.	2,947	392	609
1981-82	26,777	2,873	395	599
1982-83	n.a.	2,562	429	633
1983-84	n.a.	2,481	414	721
1984-85	26,407	2,374	421	885
1985-86	25,089	2,160	408	869

Information for both tables kindly supplied by Australian Bureau of Statistics.

PRODUCTION AND IMPORTS OF FERTILISERS

Item	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85p
PRODUCTION						
Superphosphate (a)						
Mixed chemical fertilisers (including complete manures)	'000 tonnes	4,202	3,464	2,877	2,668	n.a.
Leaf and foliage type fertilisers (including dry and liquid form)	'000 tonnes	1,050	1,092	967	990	n.a.
Manures (without added chemical fertilisers)	tonnes	3,758	7,765	6,846	n.p.	n.a.
(b)	tonnes	12,558	26,677	34,128	39,107	n.a.
IMPORTS						
Crude fertilisers (mainly natural phosphate)	'000 tonnes	2,181	2,772	2,148	1,689	1,772
	Value \$m	80.4	128.6	109.1	86.3	89.5
Manufactured, mineral or chemical fertilisers - Nitrogenous (c)	'000 tonnes	75	108	101	91	200
	Value \$m	9.4	16.2	15.6	14.8	41.8
Potassic (d)	'000 tonnes	215	255	203	228	234
	Value \$m	15.5	26.7	20.7	23.1	28.6
Other (e)	'000 tonnes	81	92	273	389	421
	Value \$m	7.2	14.8	53.1	87.8	110.4

(a) Includes double and triple superphosphate and ammonium phosphate in terms of single superphosphate. (b) Blood, bone and/or offal, and other material. (c) Mainly ammonium nitrate, ammonium sulphate, calcium ammonium nitrate, sodium nitrate and urea containing in the dry state more than 45 per cent by weight of nitrogen. (d) Mainly potassium chloride and potassium sulphate. (e) Includes phosphate fertilisers and compounds of the main elements nitrogen, phosphorus and potassium (N.K.P. complete fertilisers).

Note: Production data are derived from the Annual Manufacturing Census and the recorded monthly production. Kindly supplied by Australian Bureau of Statistics.

FARM FENCING CONSTRUCTION AND HANDLING OF FENCING MATERIALS

Few, if any, capital items on a farm or grazing block improve the general appearance and utilisation of the property more than sturdy, well constructed boundary and sub-divisional fences. The following notes are not designed to describe the exact method of erecting a farm fence, as this will vary from area to area and contractor to contractor, but rather to act as a guide when considering certain features of construction.

The class of fence to be erected depends mainly upon the site and material available, and whether the fence is to be rabbit- or dog-proof or merely stock-proof.

Fence Posts

Fence posts used in Australia are typically:

- Star steel posts
- Local timber (hardwood)
- Chemically impregnated pine
- Precast concrete
- Used materials, such as old railway line

If timber is available close to the fence line, it may be economical to use this, but the easy to handle and light Star steel post is usually used. The method of driving Star posts is by a manually operated tubular driver. There is no need to bore a hole in the ground prior to driving the post. Chemically treated posts are usually round, and about 75 to 100 mm in diameter. They are driven with a tubular driver into a pilot hole.

Other posts are set in the ground manually, with post hole digger, shovel and soil rammer.

On flat ground, posts would be spaced evenly apart (eg, each 5 m) but in undulating or hilly country, post spacings need not be regular. A nominal distance apart should be determined but this would be varied to allow for ground undulation. Whether posts are driven at right angles to the ground or perpendicular to the horizon will depend on the fencing conditions, but a perpendicular position is usually chosen because it is much easier to keep the line tidy in appearance.

Strainer Assemblies

The corner post is the anchor of the fence and, as such, should be immovable. Considerable loss of tension is experienced for a small amount of movement in a corner. There are two main designs for the construction of strainer assemblies used in Australia. They are a

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Horizontal stayed or a Box assembly and the Diagonal stayed assembly, both of which can be built using Waratah steel strainer assemblies. Waratah steel strainer assemblies were developed to provide an economical, quickly erected anchorage capable of withstanding strains up to 30 kN (700 lb).

Where the ground has poor holding properties, a double horizontal stayed assembly with three vertical and two horizontal posts can be used. Two diagonal braces are made of wire of the thickness being used in the fence, and are run around four times prior to straining up and tying off. Posts should not be bored as this allows moisture into the interior of the post and also where the wire passes through the post, it will corrode away more quickly. Boring of holes also increases the possibility of wooden posts burning.

Wire Components in Fencing

The choice of wire is influenced by the cost per kilometre, length of strain, type of stock run and so on. High tensile wires, such as Tyeasy, are cheaper per kilometre and are lighter to carry to the site. They can be strained over long distances without fear of losing the wire's elasticity. Their disadvantages include difficulty in handling and tying of knots and the need for more accurate straining.

Plain fencing wires are suitable for most conventional fencing applications. Being softer, knots can be tied relatively easily. Their disadvantages are the additional cost and weight per km, the need for closer post spacings and difficulty in maintaining tension due to their lower elastic rates of elongation.

This makes it necessary to have strainer posts closer together: 1 for every 1000 metres on flat country compared with every 1500 metres for high tensile wires. Soft wires are not suitable for use in a suspension fence.

The running-out procedure is the same for all types of wire. To run out a wire, it is suggested that certain procedures be observed in order to avoid tangles. A wire spinner makes the running-out of coil easy. The coil is placed on the spinner, with the top of the coil facing upwards. The four wire ties are then cut off and the starting end is pulled out in the same plane as the coil. A few metres are run slowly to avoid snags and then the coil is ready to run out by pulling on the free end.

The wire should be tied on the Star steel posts with preformed fence post clips or tie wire after the line has been run and strained.

Fabricated Fencing and its Erection

Fabricated fencing has the advantage of being the easiest fence to erect. Because fences should be erected from top to bottom, it is necessary to position posts and any wires run over the top of fabricated fencing first. Then one end of a roll is fixed to the end post and the balance of the roll is run out as near as possible to the line of fencing. It is then tied loosely in position prior to straining-up.

For many years, farmers have been straining fabricated fences by pulling it up with a tractor or four-wheel-drive vehicle. This is a quick method but it generally results in the material being over strained, unless a tension indicator is used.

The Waratah Field Fence Strainer comprises a clamp suitable for holding all sizes of field fence, a tension indicator and a hand tensioning mechanism. Components can be supplied individually if required.

It is only necessary to tie every second wire of fabricated fence to each fence post.

Horse Fences

Horses have difficulty seeing the wire component in fences. Waratah Horsesighter wire, coated with white PVC, can overcome the problem of horses colliding with fences.

Horsesighter wire has a finished diameter of 5.2 mm, a minimum breaking load of 6.1 kN and is packaged in 400 m coils weighing 43 kg.

A horse fence should consist of four or five lines of Horsesighter wire. If other stock are likely to be run in the same paddock, then only two of the top wires should be Horsesighter wire. Horsesighter wire should be strained to 2.0 kN and the strain should be greater than 100 m. Posts should be spaced at a maximum 5 m centres.

Wire Netting

Wire netting is erected in a similar manner to fabricated fencing except that the wire netting should not be tightly strained. Manual tightening is usually sufficient.

Netting should not be strained as tightly as other wires as it may distort under the strain. It is fastened to the fence by means of tie wire or ring fasteners. When the bottom edge is to be buried, the trench should be dug before the netting is run out. The soil is replaced after the fence is erected, and if properly done might help to tighten the netting.

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An alternative method of securing netting is to lay the bottom 180 mm flat on the ground and secure with rocks every 300 to 500 mm. Vegetation will soon grow through the netting and bind it to the ground. Rabbit netting should be placed in the ground at a depth of 180 mm, and this can most easily be accomplished by cutting a furrow with a small plough. Rabbit netting should be supported by three plain wires. A wire should run 60 mm above the ground to secure the netting, the portion below this being held by being buried in the ground. Another wire should be run along the top edge of the netting and, if using 1050 mm wide netting, the third should be 515 mm above the ground. Fasten the netting to the top wire with strong tie wire or ring fasteners at intervals of 1200 mm, but there should be a tie 300 mm on each side of every post. Also fasten the netting to the centre wire.

WARNING Attention is drawn to the absolute necessity of removing every trace of old netting and the earth in which it was buried when renewing rabbit netting. The trench should be thoroughly cleared out of all old soil, clean virgin soil being used to bury the new netting. It has been found that fragments of old wire or rust spots in the soil will rapidly destroy any new netting.

Barbed Wire

To position barbed wire, first fix one end to the corner post, then either run a bar through the reel and walk alongside it as it unwinds, or place it on a special spinner.

After straining, barbed wire is tied to fence posts, or in the barb slot of Star steel posts with either tie wires or preformed fence post clips. Strains not longer than 500 m are recommended, as longer strains become difficult to handle.

Electric Fencing

Electric fencing for cattle, sheep and control of feral animals such as kangaroos, dogs, may be either permanent or temporary, or combined with some conventional fencing. Waratah Permelec wire, used for permanent fencing, has high strength (minimum breaking load 4.8 kN) combined with good ductility. Tempelec wire is for temporary fencing.

Steel Fence Post Clips and Fastening Tools

The firm attachment of all fence wire (including plain fence wire) to the outside of the steel post rather than running the wire through the holes is faster and results in less damage to the zinc coating of galvanized wire.

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Fence post clips hold the wire firmly to the post after straining and fastening is performed by use of a small fastening tool.

Waratah clips hold the wire firmly to the post after straining and fastening is performed by use of a small fastening tool.

Waratah clips are available in packets of 300, including a fastening tool, or in pails of 1500 containing 5 plastic packs.

Strains for Fencing Products

The mass of a fence wire limits the practical length of strain. As a general rule, the maximum realistic strains are:

4.00, 3.55 & 3.15 mm Fencing Wire	– 1000 m
2.50 & 2.80 mm HT Wire	– 1500 m
Barbed Wire	– 500 m
Fabricated Fencing	– 400 m
Wire Netting	– 500 m

Tension in Wires

When overstrained, wire does not return to its original state but continues to stretch until it breaks. No wires should be strained to more than the following maximum loadings:

	(per wire)
4.00 mm Fencing Wire	– 1.8 kN
3.55 mm Fencing Wire	– 1.3 kN
3.15 mm Fencing Wire	– 1.2 kN
2.50 mm Flexabel	– 1.3 kN
2.50 mm Tyeasy	– 1.8 kN
2.80 mm HT Fencing Wire	– 2.0 kN
2.50 mm Iowa pattern and	
1.60 mm HT Barbed Wire	– 1.3 kN
Fabricated Fencing	– 1.0 kN
Wire Netting	Only until tight

A wire strainer should always incorporate a tension gauge. The jaws of the strainer must be smooth or the wire will be damaged, causing a weakness at that point.

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WARATAH HT FENCE DROPPERS

These fence droppers are made from high tensile galvanized steel so that they are fire- and rust-resistant. They are attached after the fence posts have been erected and line wires run and strained. They may be used on all fencing wire between 4.00 mm and 2.50 mm diameter, and barbed wire.

A suggested fence construction would be posts spaced at up to twenty metres apart with droppers clipped at intervals of two to four metres, depending on the number of line wires and site conditions.

Specification	Length, mm	Mass per bundle, kg	Fastening clips – included in bundles sufficient for fences of
HT galvanized steel	635	13	5 wires
fence droppers punched	815	17	6 wires
at 25 mm centres complete	940	19	7 wires
with fixing tool, instruction	1070	22	9 wires
sheet & clips	1170	24	9 wires

Packs measure approximately 40 x 150 mm x length of dropper. Packs of 250 clips have a mass of 0.5 kg.

ELECTRIC FENCING POWER POSTS AND DROPPERS

Sawn hardwood, creosote impregnated.

Sawn hardwood, creosote impregnated

Item	Length, mm	Section, mm	Quantity per	
			tonne	bundle
Power Post	1370	50 x 40	400	10
	1520	50 x 40	350	10
	1680	50 x 40	300	10
Power Dropper	940	40 x 25	1000	25
	1060	40 x 25	900	25
	1140	40 x 25	850	25
	1220	40 x 25	800	25

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WARATAH STEEL FENCE POSTS

Lengths, mm	Hole spacings (from top), mm
1350	25, 130, 100, 100, 100, 60, 120, 75, 75, 80, 75
1650	25, 130, 100, 100, 100, 60, 120, 75, 75, 80, 70, 75, 60, 95
1800	25, 130, 100, 100, 100, 60, 120, 75, 75, 80, 70, 75, 60, 95
2400	25, 275, 300, 300, 300, 300, 300

1 Post per 40 m = 25 per km	1 Post per 7 m = 143 per km
1 Post per 20 m = 50 per km	1 Post per 5 m = 200 per km
1 Post per 15 m = 67 per km	1 Post per 3 m = 333 per km
1 Post per 10 m = 100 per km	

STEEL STRAINER ASSEMBLIES

Description	Mass, kg
Strainer Assembly (single stay)	35
Corner Assembly (two stays)	52
Additional stay, base plate and bolts	17
Vertical Post only	19
Waratah Post Driver	28

WARATAH BARBED WIRE

Specification	Reel type	Wire per reel, m	Gross mass per reel, kg	Recom- mended tension, kN
2.50 mm Std galv Iowa Pattern	Wood	400	45	1.3
2.50 mm Hvy galv Iowa Pattern Red Reel	Wood	400	46	1.3
1.60 mm Hvy galv HT Red Reel	Wood	500	24	1.3
1.80 mm Hvy galv HT Red Reel	Wood	500	28	1.3

GALVANIZED FENCE WIRE

Diameter mm	Type	Length per coil, m	Recommended tension, kN
4.00	Standard galv	500	1.8
3.55	Standard galv	600	1.3
3.15	Standard galv	750	1.2
2.80	HT Heavy or std galv	1000	2.0
2.50	HT Std galv Flexabel	1500	1.3
2.50	HT Hvy or std galv Tyeasy	1500	1.8
2.50	HT Hvy galv Permelec	1000	1.5
1.60	Flexible Tempelec	500	NA

The above represents standard thicknesses regularly produced for fencing purposes.

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WIRE NETTING

The main sizes regularly produced are:

Size +	Suggested uses	Coil length, m	Approx mass per roll, kg
30 x 4 x 1.4	Reconditioning existing netting fences	100	27
90 x 4 x 1.4	Rabbit proof fencing, tree guards, bird cages	100	75
105 x 4 x 1.4	Rabbit proof fencing, tennis court fencing	100	87
90 x 3 x 0.9	Tree guards, bird cages	50	26
90 x 5 x 1.0	Trellising, animal enclosures	50	15
90 x 5 x 1.6	Flood gates, tree guards, farm fencing	50	37
180 x 5 x 1.6	Feral fencing, poultry and animal enclosures	50	68
180 x 5 x 1.0	Poultry enclosures, roof insulation support	50	29

+ Other sizes are available on request.

FENCE SPECIFICATIONS

1500 m length of fence	Number of strainer assemblies	Additional stay and base plates (if required)
100 m strain	16	14
200 m strain	9	7
400 m strain	5	3
800 m strain	3	1
1500 m strain	2	—

WARATAH HINGED JOINT FENCING

Type	Length per roll, m/roll	Mass per roll, kg/roll	Mass per kilometre, kg/km	Height of roll nominal, mm	Line-wire spacings from top nominal, mm	Picket spacing nominal, mm
5/67/30	200	64	320	670	200, 180, 150, 140	300
6/70/30	200	73	365	700	180, 150, 140, 130, 115	300
6/90/30	200	79	395	900	230, 200, 180, 150, 140	300
7/90/30	200	88	440	900	200, 180, 150, 140, 130, 115	300
8/80/15	100	63	630	800	150, 140, 130, 115, 100, 90, 75	150
8/90/30	200	97	485	900	180, 150, 140, 130, 115, 100, 90	300
8/115/30	200	104	520	1150	230, 200, 180, 150, 140, 130, 115	300

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ELECTRICITY

FUNDAMENTAL UNITS

Ampere is the unit in which electric current flow is measured.

Ohm is the unit in which resistance to the flow of an electric current is measured.

Volt is the unit of electric pressure. A pressure of 1 volt is required to force a current of 1 ampere through a resistance of 1 ohm.

Watt is the unit of power or rate of doing work.

watts = volts x amperes

Kilowatt hour For commercial purposes electrical energy is charged for in units of 1000 watt hours, and is called the kilowatt hour.

$$\text{kW.h} = \frac{\text{volts} \times \text{amperes} \times \text{hours}}{1000} \text{ or } \frac{\text{watts} \times \text{hours}}{1000}$$

Example: To find the cost of burning five 60-watt lamps for ten hours, assuming the cost per unit to be seven cents:

$$\text{Cost} = \frac{60 \times 5 \times 10 \times 7\text{c}}{1000} = \$0.21$$

The normal voltage for household appliances is 240; for 3-phases motors, etc., it is 415.

SAFETY PRECAUTIONS

One of the main advantages of electricity is that there is nothing complicated about its use. It is a good servant, but this does not mean that you can abuse it.

Fortunately fatal electrical accidents have been few compared with fatal accidents from other causes. But a few is still too many and these can be avoided by the observance of simple safety precautions.

FLEXIBLE CORD CORE COLOURS

In the past, the requirements concerning the identification of the conductors of flexible cords have provided that the colour green shall be used to identify the earthing conductor and that current-carrying conductors shall not be green. A new system of colour coding is now used in conformity with overseas practice and the earthing conductor is now coloured green/yellow.

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The colours of the cores of the old and new flexible cords are:

Old Cords	New Cords
Red	Brown
Black	Blue
Green or green/yellow	Green/yellow

In three-pin plugs and cord extension sockets, the green/yellow earthing core must be connected to the earth terminal (or the green core in old cords). This earth terminal is marked either E, EARTH or $\perp$. In modern plugs the earth terminal is also marked with the word GREEN and a green colour. No other conductor may be connected to this terminal.

THE ELECTRICAL INSTALLATION

It is illegal for any person other than a licensed electrical person or a person in the employment of and under the supervision of a licensed electrical person to carry out any electrical wiring work including the installation, repair or replacement of power points, dimmers, light fittings, etc.

DO NOT interfere with the fixed wiring in your home. If you do, you not only break the law, you run the risk of serious accident.

DO have your installation checked by a licensed electrical person if signs of wear and tear appear. Your local electricity supply authority also will inspect the installation if you suspect it is faulty.

DO inspect the main earth wire connection regularly. The earth wire should be connected to a rod driven directly into the ground and also to the water pipe system, except that in older installations it might be connected to the water pipe system only. Remember that an effective main earthing system is essential for personal safety.

DO arrange to have electrical repairs carried out by an electrical contractor as a matter of urgency if the main earth wire or its connection is found to be damaged or disconnected.

DO arrange for an electrical contractor to modify the main earthing system, if it is not connected to a driven rod, prior to any work being carried out on the water pipe system involving the use of non-metallic pipes or fittings.

FLEXIBLE CORDS

About one third of all electrical fatalities are associated with damaged,

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deteriorated, or incorrectly connected flexible cords. Two thirds of these are extension cords.

DO make sure that all flexible cords are correctly connected. If in even the slightest doubt, consult an electrician. Incorrect connection of the earthing core in flexible cords has accounted for almost half of the domestic fatalities associated with flexible cords.

DO treat extension cords with respect. As they are often subjected to rough treatment and are used in awkward work situations they should be inspected regularly.

Either buy ready-made extension cords or have them made up by an electrician. The do-it-yourself approach might have fatal consequences.

DO read and follow the instructions carefully when using a flexible cord wound on a reeling or coiling device. If used coiled up it may overheat and melt the insulation.

DO NOT dismantle, repair, or attempt to adjust contacts on cord fittings while the cord is switched on or plugged in. There is a golden rule which says *switch off the electricity then pull the plug out*. Every year someone makes the fatal mistake of disregarding this simple rule.

DO NOT join cords by twisting and taping. Makeshift joints are dangerous. If it is necessary to join two lengths of cord a correctly attached three-pin plug and cord extension socket should be used.

DO NOT use cords which are frayed, badly worn, or perished or which have chipped, cracked or broken fittings. Replace them now, later may be too late.

DO make sure that any cord you use is suitable in type and size for the job it has to do.

NEVER assemble extension cords from two-core cables. Even if intended for use with a double insulated appliance it is certain that the extension cord will be used inadvertently to supply single insulated equipment which must be earthed by a three-core cord for safety.

EQUIPMENT REQUIRED TO BE EARTHED

All equipment that is not double insulated is required to be earthed. All equipment that is double insulated is required to be marked with the symbol  or with the words DOUBLE INSULATED.

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DO make sure that all electrical appliances and other equipment that are not double insulated are fitted with a three-core supply flexible cord and three-pin plug.

OVERSEAS TYPE PLUGS

Two-pin parallel pin overseas type plugs are not suitable for connection to electricity supply in Australia, because they have a small distance between the pins and the edge of the plug body and are considered to be dangerous.

DO replace overseas type plugs with Australian approved plugs.

DO NOT bend or twist pins of two-point overseas type plugs to fit Australian power points.

PORTABLE APPLIANCES IN EARTHED SITUATIONS

Portable appliances commonly used in earthed situations include electric tools and welders, washing, polishing and ironing machines, mixers, blenders, kettles, toasters, irons, room heaters and any other appliances used in the kitchen, bathroom or laundry, or out-of-doors.

DO find out from a licensed electrician whether the power point to which you normally connect these appliances is effectively earthed.

DO make sure the flexible cord is properly connected.

DO NOT under any circumstances connect the appliance to a two-pin power point or a lampholder.

DO NOT use portable electric tools outdoors while barefooted. Bare feet, minimum clothing and wet skin lower body resistance, thus increasing the amount of shock current if an accident should occur.

The growing use of light metal ladders around the home gives cause for some further safety reminders. Remember when working from metal ladders that you are in metallic contact with the ground or wall (ie, earthed). Therefore even simple operations such as changing a lamp should be performed with care. Also keep well clear of overhead wires when moving metal ladders.

OUTSIDE THE HOME

DO take immediate action should you see overhead wires which have sagged or fallen. Keep well clear. Stand guard to warn others of the danger. Send somebody to inform the police or the electricity supply

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authority. Make sure somebody remains on guard until the supply authority's repair men arrive. In particular remember that both ends of a broken wire may be alive and need to be guarded.

DO take extreme care when climbing on a roof, ladder, tree, etc., near overhead electric wires. Touching these wires may mean death. Be careful when painting or carrying out repairs near electric wires.

DO take extreme care when operating mobile cranes, tip trucks or tall agricultural machinery, or when upending long pipes, boatmasts or erecting aerials or lengths of guttering in the vicinity of overhead power lines.

MAINTENANCE

DO NOT expect that electrical equipment you use every day will last forever.

DO arrange for your electrical equipment to be regularly checked by the manufacturer or a qualified electrical person.

DO NOT use any electrical equipment if there is any doubt about its safe condition.

DO NOT dismantle or attempt to repair or adjust internal parts of any electrical equipment or flexible cord while it is plugged into a power outlet. Each year someone makes the fatal mistake of disregarding this rule.

DO ensure that all repairs of electrical equipment are carried out by electrical persons.

DANGER SIGNALS

DO act immediately if the following danger signals appear. Call your electricity supply authority or a licensed electrical person without delay.

- An electric shock, however slight, is a warning that something is wrong with the installation or appliance. If you do not have it fixed the next shock may be fatal.
- When a fuse blows repeatedly there is a fault somewhere ... in the permanent wiring, an appliance, or the flexible cord.
- Sparking, spluttering or overheating at the fittings of a flexible cord or at the power point show that the cord connections or the power point are faulty. These symptoms are frequently accompanied by a crackling noise in the radio and interference lines on a TV screen.

CONCRETE

Concrete Information The Cement & Concrete Association of Australia is a national, non-profit organization sponsored by the Cement Industry. Publications on the making and uses of concrete are available from the Regional Office of the Association in each State.

SPECIFYING CONCRETE QUALITY

Concrete should be specified so that it will possess both adequate strength and durability (ie, resistance to environmental agents and wear). The quality of concrete is dependent upon the quality of materials used, the standard of workmanship in placing and upon the care with which the concrete is compacted, finished and cured.

Required quality (strength) is specified in AS 3600 'Concrete Structures'. This depends on exposure classification and for external members should be determined by a qualified specialist. Appropriate compressive strengths and curing periods, are shown on the following table for some common cases.

Member	Strength grade, MPa	Curing period, days	Cover, mm
Residential slab-on-ground floors, footings in non-aggressive soils, footpaths and driveways.	20	3	25
Industrial floors subject to light traffic only	25	3	25
subject to medium traffic	32	7	25
External members within 1 km of coast	40	7	45
1 to 50 km of coast	32	7	40
Elements in specific highly aggressive environments, eg marine conditions and chemical attack.	Obtain specialist advice.		

CONCRETE SUPPLY AND MANUFACTURE

Ready-Mixed Concrete

The easiest way of obtaining good quality concrete is to purchase it from a ready-mixed concrete supplier. Ready-mixed concrete is generally specified as normal-class. The purchaser has to nominate:

- the appropriate strength grade (one of N20, N25, N32, N40 and N50)
- appropriate slump (one of 40, 60, 80 or 100 mm) usually 80 mm
- appropriate maximum nominal size of aggregate (one of 10, 14 or 20 mm) usually 20 mm
- method of placement (eg, direct from truck, by pump)

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- whether project assessment is specified (not warranted for small projects).

If required the purchaser may also nominate:

- an early strength requirement and air-entrainment for freeze-thaw resistance. However, these would normally be specified where required by specialist consultants.

Site Mixed Concrete

Suggested mixes for some applications are shown in the following table.

Use	Nominal mix proportions by volume, cement: sand: coarse aggregate	Materials required for one cubic metre of concrete			Max added water per bag cement, litres
		Cement, bags	Sand, m ³	Coarse aggregate, m ³	
Mass footings, light duty drives and paths	2:5:8	8	0.5*	1	20
Fence posts, floors and wearing surfaces	2:3:6	10.5	0.5*	1	20

*When ordering sand allow 15-20% extra to the above figure for losses and bulking of sand.

MATERIALS

Cement Portland cement Type A (Normal) or blended cement Types FA and SA can be used. Other types are available but are used for special applications. Masonry cement should not be used to make concrete. Available in multi-layer paper bags:

1 bag = 40 kg
25 bags = 1 tonne

Sand Must be clean and free from clay, earth, humus, salt or other deleterious material. A coarse, well-graded (ie, from coarse to fine) sand is preferable.

Coarse aggregate May be river gravel or crushed stone. Material should be clean, hard, impervious and free from organic matter. For most work a well-graded material 10 to 20 mm is suitable.

Water Water should be clean and fresh. Generally mains water is satisfactory but bore water should be checked.

Storage of Materials

Cement must be kept dry. Stack off the ground and away from exterior walls. Cover so as to allow only limited air circulation but preventing condensation. Use on first in/first out basis.

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Aggregates should be stored on firm, hard surfaces and kept separate from each other.

Mixing

Concrete should be mixed in a hand or power-operated mixer. Mixers should not be overfilled and should revolve at speeds recommended by the maker. A minimum mixing time of two minutes after the addition of the last ingredients should be allowed.

Proportions must be controlled by mass or volume batching. When volume batching, proportions must be measured in boxes or buckets. Do not use shovelfuls as shovelfuls of cement, sand and coarse aggregate are not equal.

Ingredients should be added to the mixer in the following order:

- (a) half to two-thirds of the water,
- (b) coarse aggregate,
- (c) sand,
- (d) cement,
- (e) final water sparingly added until desired workability is reached.

Higher strengths and better durability are achieved by using as little water as possible.

CONCRETE CONSTRUCTION

Curing

The action of retaining water in the concrete so that it can react chemically with the cement to bond the aggregates together is known as curing. This process enables concrete to reach its design strength, ensures the surface is as hard as possible and minimises the tendency to surface cracking.

Curing is most simply done by covering or encasing the member immediately after finishing, with a plastic sheet secured to seal the surface from the atmosphere. This should be kept in place for three to seven days.

Alternatively, the surface of the concrete should be kept continuously wet for three to seven days.

Reinforcement

Concrete is strong in compression but needs the addition of steel reinforcing bars to carry the tensile forces resulting from the dead load of the member, the application of external loads or from the shrinkage of the concrete as it dries out.

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Determination of the amount and position of the reinforcement requires specialist knowledge. Once determined the steel must be accurately placed and firmly supported and tied to prevent displacement during the concreting operations. Tie wires used to bind the reinforcement in place should be trimmed off and bent back away from the concrete surface.

For slab-on-ground floors, driveways and paths the reinforcement is used to control the cracking of the concrete surface. It should be located in the top third of the slab but with appropriate cover to protect it against corrosion (see Table 1).

Formwork

The quality and rigidity of the formwork is reflected in the trueness of line and the surface finish exposed after the formwork is stripped. Some of the points to watch are:

- Formwork should be well braced, and rigid enough to remain true to line and level during the concreting operations.
- Joints between boards and at corners should be sealed to prevent loss of cement paste from the concrete, (causes honeycombing).
- Formwork should be treated with a form release agent to prevent concrete adhering to the form.
- Formwork should not be removed until the concrete has gained sufficient strength to carry the imposed loads. This will be longer in cold than in warm weather and will be affected by cement type.

Placing

The concrete should be placed as close as possible to its final location. Avoid flowing it along the forms as this can lead to segregation. The concrete should be spread by shovel and worked thoroughly into place, ramming with shovel or rod. Preferably concrete should be compacted by mechanical vibrators, using immersion vibrators for sections over 200 mm deep and beam/screed vibrators for slabs.

Concrete should be placed as soon as possible after arriving at the site.

Finishing Of Horizontal Surfaces

Many surface finishes and textures are possible. The type of surface finish should be chosen with regard to its use.

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Use	Concrete finish
Steep driveways, paving requiring high skid resistance.	Coarse brooming or grooving.
Surfaces to receive quarry or ceramic tiles.	Screeded.
Non-slip areas.	Light brooming.
Surfaces to be carpeted.	Wood float.
Smooth, clean areas. Surfaces to be covered with glued resilient coverings (eg vinyl sheet and tiles).	Mechanical trowel or hand steel trowel.

SLAB-ON-GROUND FLOORS

Site Considerations

Slab-on-ground floors are suitable for use on flat sites or, by using cut and fill techniques, on sites with moderate slopes (up to 1 in 5). For more steeply sloping sites, split level or suspended floors formed with Bondek structural decking should be considered.

Foundation material should be checked. Stable materials (eg, rock, sand, sandy clay) pose no constraints but expansive soils (eg, heavy plastic clays) and soils with low bearing capacity (eg, soft alluvial clays, peaty soils) may cause problems for all footing systems and should be investigated by a specialist consultant. Properly designed slabs are suited for use on expansive soils and those with low bearing capacity.

It is important to check the site drainage and the position of water courses during heavy rain. Low-lying sites should be avoided or built up to avoid flooding. Dish drains and sloped paving should be used to keep surface run-off away from a slab-on-ground floor.

Construction Considerations

The construction area should be cleared of all vegetable matter and the associated layer of topsoil.

In a cut-and-fill situation any fill should be well compacted in shallow layers using hand-operated vibrating rollers or mechanical tampers. To prevent water vapour rising through the slab a polyethylene sheet vapour barrier should be laid immediately under the slab and any beams or thickenings. The sheet should be purpose-made concrete underlay polyethylene of minimum thickness 0.2mm. Penetrations should be sealed with pressure sensitive tape. Joints should be lapped 200 mm.

Design of the slab and reinforcing details must conform to local building regulations and should follow AS 2870 'Residential Slabs and Footings'.

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Slab-on-ground construction should follow the preceding recommendations for concrete construction in general.

Landscaping

Large trees should not be planted close to any building. Where gardens are adjacent to the walls they should **not** be built up above the damp-proof course or the floor level. The ground in a one metre wide strip out from the walls should fall at least 25 mm away from the walls.

REINFORCING FABRIC FOR CONCRETE

Reinforcing fabric is manufactured in accordance with AS 1304 from hard-drawn steel wire conforming with AS 1303. Standard sheets are cut flush at the sides and have equal overhangs at the ends.

RECTANGULAR MESHES

Standard Sheets: 6 m x 2.4 m = 14.4 m²

Ref No	Standard unit	Longitudinal wires		Cross wires		Mass per sheet, kg
		Size, mm	Pitch, mm	Size, mm	Pitch, mm	
F1218	Sheet	12.5	@ 100	8	@ 200	173
F1118	Sheet	11.2	@ 100	8	@ 200	144
F1018	Sheet	10	@ 100	8	@ 200	121
F 918	Sheet	9	@ 100	8	@ 200	103
F 818	Sheet	8	@ 100	8	@ 200	88
F 718	Sheet	7.1	@ 100	8	@ 200	75
F 928	Sheet	9	@ 200	8	@ 250	62
F 828	Sheet	8	@ 200	8	@ 250	54

SQUARE MESHES

Standard Sheets: 6 m x 2.4 m = 14.4 m²

Standard Rolls: 60 m x 2.4 m = 144 m²

Ref No	Standard unit	Longitudinal wires		Cross wires		Mass per sheet or roll, kg
		Size, mm	Pitch, mm	Size, mm	Pitch, mm	
F 81	Sheet	8	@ 100	8	@ 100	116
F102	Sheet	10	@ 200	10	@ 200	92
F 92	Sheet	9	@ 200	9	@ 200	75
F 82	Sheet	8	@ 200	8	@ 200	59
F 72	Sheet	7.1	@ 200	7.1	@ 200	47
F 62	Sheet	6.3	@ 200	6.3	@ 200	37
F 52	Sheet	5	@ 200	5	@ 200	23
F 52	Roll	5	@ 200	5	@ 200	231
F 42	Sheet	4	@ 200	4	@ 200	15
F 42	Roll	4	@ 200	4	@ 200	148

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TRENCH MESH for slab-on-ground and strip footings

Standard lengths: 5.1 m in NSW, 6 m in all other States

Ref No	Std strip width, number of wires	Longitudinal wires		Cross wires		Mass per length, kg	
		Size, mm	Pitch, mm	Size, mm	Pitch, mm	5.1 m	6.0 m
F8TM	3	8 @	100	4 @	300	6	7
	4	8 @	100	4 @	300	8	10
	5	8 @	100	4 @	300	11	13

DEFORMED STEEL REINFORCING BARS FOR CONCRETE

All details for Steel Reinforcing Bars for Concrete are contained in AS 1302.

STANDARD REINFORCING BAR

Bar size, mm	Calculated mass per unit length, kg/m	Nominal area, mm ²	Calculated area, mm ²
10†	0.616	80	78.5
12	0.888	110	113.1
16	1.579	200	201.1
20	2.466	310	314.2
24	3.551	450	452.4
28	4.834	620	615.8
32	6.313	800	804.2
36	7.991	1020	1017.9
40*	9.864	1260	1256.6
50*	15.413	1960	1963.5

† Available as plain round

* Not normally available.

MASONRY – BRICKWORK AND BLOCKWORK

Masonry walls are commonly built using clay bricks, calcium silicate bricks or concrete bricks and blocks. In addition to the more routine uses, masonry walls offer properties such as high sound absorption coefficients, high sound transmission loss, and good thermal insulation and fire resistance.

Information is available from the Clay Brick and Paver Institute (most States) and the Concrete Masonry Association of Australia (most States).

DESIGN

The design of masonry structures is regulated by Australian Codes and Standards and Building Regulations of State Government. As with any other structure, design should be entrusted to a competent person experienced in such work and in the requirements of the applicable Codes, Standards and Regulations.

Points requiring special attention in design include the provision of control joints and other movement and crack control measures, the design of lintels over wall openings, and proper lateral support of loadbearing elements.

SPECIFICATION FOR BUILDING WALLS

Modular Planning To achieve economy in construction, walls should be dimensioned to suit brick or block sizes.

Dimensions Manufacturing dimensions of bricks and blocks are 10 mm less than nominal dimensions to allow for a standard 10 mm mortar joint.

Laying All manufacturers recommend that bricks and blocks should be laid as dry as possible. They should never be wetted to control suction prior to application of mortar. Keep units as dry as possible on the site. At the stoppage of work the tops of the walls should be covered to prevent moisture entering cores.

All joints are to be fully bedded except in the special situation where blockwork is face-shell bedded to prevent entry of water.

Support of Walls during Construction All walls must be braced during construction against lateral loads, especially wind loads, to ensure that adverse or unsafe conditions do not arise in the wall.

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The height of unbraced free-standing walls should be limited during construction to the heights specified in the appropriate State Building Regulations.

Damp-proof Courses Damp-proof courses should be provided in accordance with recognized practice.

External Finish If single-leaf clay or concrete block external walls are to be constructed they should be coated with an approved waterproofing film such as acrylic paint and protected by wide eaves overhangs.

MORTAR MIX

Mortar for brickwork and blockwork is made up from a mixture of cement, lime and sand, with sufficient water to provide a workable consistency. Material proportions are varied to suit the job, the most commonly used being:

1 cement : 1 lime : 6 sand

Where higher strength or impermeability is required, mortars richer in cement can be used. Lime-rich mortars should only be used where strength is not important.

If cement, other than portland cement, is used the mix proportions will need to be varied. For example, if a blended cement is used the common mix should be:

1 blended cement : 1 lime : 5 sand

For calcium silicate bricks and concrete masonry the manufacturers recommend the use of a particular mortar consisting of one part cement to five parts sand with the addition of Calsil Mortarbond to provide workability and water retention.

Quantities To lay 2000 standard size bricks uses approximately one cubic metre of mortar. To make up the quantity requires six bags cement, six bags lime and one cubic metre of sand for the 1 : 1 : 6 mix.

WALL TIES

Normal cavity walls are tied with wall ties spaced 600mm apart both vertically and horizontally. Some situations, however, do require special tying. For information refer to the appropriate SAA Code.

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BRICKWORK DIMENSIONS FOR MODULAR BRICKS

Modular brick dimensions are in even 100 mm increments, therefore all dimensions can be extrapolated from the following table:

Modular Brick

Size: 290 x 90 x 90 mm

No. of bricks per course	Wall length, mm	Opening size, mm	Height, mm
1	290	310	100
1 $\frac{1}{3}$	390	410	200
1 $\frac{2}{3}$	490	510	300
2	590	610	400
	etc	etc	etc

Note that wall panels are 10 mm shorter and openings 10 mm longer than figures below.

BLOCKWORK DIMENSIONS

Blocks, like modular bricks, are in dimensions which follow a simple arithmetic progression; therefore all dimensions required can be extrapolated from the following table:

No. of blocks	Length, mm (based on 400 mm long units)				Height, mm (based on 200 mm high units)	
	Full blocks	+ Fractional blocks			No. of courses	Height
		1/4	1/2	3/4		
1	400	500	600	700	1	200
2	800	900	1000	1100	2	400
3	1200	1300	1400	1500	3	600

BRICKWORK DIMENSIONS

METRIC STANDARD BRICK: 230 x 110 x 76 mm
JOINTS: 10 mm VERTICAL GAUGE: 7 courses = 600 mm

No. of Bricks	Length	Opening	Height	No. of Bricks	Length	Opening	Height
1	230	250	86	26	6230		2229
1½	350	370		26½	6350		
2	470	490	172	27	6470		2314
2½	590	610		27½	6590		
3	710	730	257	28	6710		2400
3½	830	850		28½	6830		
4	950	970	343	29	6950		2486
4½	1070	1090		29½	7070		
5	1190	1210	429	30	7190		2572
5½	1310	1330		30½	7310		
6	1430	1450	514	31	7430		2657
6½	1550	1570		31½	7550		
7	1670	1690	600	32	7670		2743
7½	1790	1810		32½	7790		
8	1910	1930	686	33	7910		2829
8½	2030	2050		33½	8030		
9	2150	2170	772	34	8150		2914
9½	2270	2290		34½	8270		
10	2390	2410	857	35	8390		3000
10½	2510	2530		35½	8510		
11	2630	2650	943	36	8630		3086
11½	2750	2770		36½	8750		
12	2870	2890	1029	37	8870		3172
12½	2990	3010		37½	8990		

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No. of Bricks	Length	Opening	Height	No. of Bricks	Length	Opening	Height
13	3110	3130	1114	38	9110		3257
13½	3230	3250		38½	9230		
14	3350	3370	1200	39	9350		3343
14½	3470	3490		39½	9470		
15	3590	3610	1286	40	9590		3429
15½	3710	3730		40½	9710		
16	3830	3850	1372	41	9830		3514
16½	3950	3970		41½	9950		
17	4070	4090	1457	42	10070		3600
17½	4190	4210		42½	10190		
18	4310	4330	1543	43	10310		3686
18½	4430	4450		43½	10430		
19	4550	4570	1629	44	10550		3772
19½	4670	4690		44½	10670		
20	4790	4810	1714	45	10790		3857
20½	4910	4930		45½	10910		
21	5030	5050	1800	46	11030		3943
21½	5150	5170		46½	11150		
22	5270	5290	1886	47	11270		4029
22½	5390	5410		47½	11390		
23	5510	5530	1972	48	11510		4114
23½	5630	5650		48½	11630		
24	5750	5770	2057	49	11750		4200
24½	5870	5890		49½	11870		
25	5990	6010	2143	50	11990		4286
25½	6110			100	23990		8572

LIQUEFIED PETROLEUM GAS (LPG)

When used properly and handled with appropriate care, LPG is a safe, clean efficient and convenient source of energy. It is used for domestic, leisure, commercial, industrial, and agricultural applications and as an automotive fuel.

Information about LPG and the appliances and equipment which use it is available from the Australian Liquefied Petroleum Gas Association, 275 Alfred Street North, North Sydney, NSW, 2060.

LPG is a generic term to describe a group of closely related hydrocarbon gases derived from oil and natural gas. When stored in a container under moderate pressure, or when refrigerated below its boiling point, it becomes a liquid. With the relief of pressure or an increase in temperature, it reverts to its gaseous form at an expansion ratio of 270:1. Thus it can be transported and stored as a liquid and burnt as a gas.

Cylinders and tanks are never filled to capacity; an ullage (vapour space) of about 20% of the container volume is necessary for the expansion of the liquid gas under possible temperature increases. The vapour pressure is dependent on the ambient temperature; for instance, commercial propane exerts a pressure at 15 degrees Celsius of approximately 760 kPa. As gas is drawn from a container during use the pressure in the vapour space is reduced and more gas boils off and will continue to do so until the cylinder is empty or the withdrawal is discontinued. This re-establishes an equilibrium condition with the LPG exerting a vapour pressure related to its temperature.

Tanks and cylinders are fitted with valves which incorporate a relief device. It is important that the containers always be stored or transported in a vertical position so that the relief valve connects to the gas, not to the liquid in the vessel.

Various standards and codes for the safe and efficient use of LPG are published by Standards Australia and the ALPGA. State governments also have regulations controlling LPG matters, either gazetting the codes of the SAA or ALPGA or including the requirements for these codes in their respective LPG regulations.

All LPG cylinders shall be stamped to indicate they have been checked at a test station. Reinspection and restamping at a test station shall be carried out every ten years. 3T88 stamped on a cylinder means it was tested March 1988 and by March 1998 it must be retested and re-

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stamped. It is illegal to fill a cylinder outside of the ten-year period since its last test.

Adequate ventilation with gas burning appliances is essential, particularly in caravans and marine craft where the free volume is limited.

All installation and repair work shall be carried out and checked by an authorised or licensed LPG installer.

Some additional safety hints:

- All appliances and equipment must be maintained in a serviceable condition and the overall installation must be checked regularly for leaks – with a detergent or soap solution, not with a naked flame.
- All appliances should meet LP Gas Industry approval requirements.
- The use of unflued water heaters or space heaters in caravans and marine craft is prohibited.
- Unless installations are fitted with automatic changeover regulators, all appliance doors should be closed during the exchange of cylinders.
- Cylinder valves shall be kept closed when the installation is not in use. This is of particular importance during the refuelling of caravans and marine craft. Never use any gas appliance including refrigerator in a moving vehicle.
- In the event of accidental gas leaks or fire, close cylinder valve(s) until hazard is removed.
- Close valve and fit gas tight sealing plug to all spare cylinders whether full or empty.
- Valves on caravan cylinders must be closed during transit.

GAS HAND CUTTING NOZZLES

STANDARD NOZZLE

Plate thickness, mm	Nozzle size	Pressure		Speed
		Oxygen, kPa	Acet & LPG, kPa	Acet & LPG, mm/min
6	8	200	100	450
12	12	200	100	380
20	12	250	100	340
25	15	220	100	320
40	15	350	100	270
50	15	400	100	240
75	15	450	100	180
100	20	400	100	150
125	20	450	100	150
150	20	520	100	130

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MASS DENSITIES OF MATERIALS

Mass densities shown in this selective list may vary, depending on material composition. Where calculations need to be precise, exact density factors should be obtained from manufacturers or other appropriate sources.

MATERIAL	kg/m ³	MATERIAL	kg/m ³
Aluminium, rolled	2710	Nails, wire, bags	1201
Bitumen, prepared	1362	Paper: printing, reels	897
Bolts and nuts, bags	1201	writing	961
Brass, cast	8330	Petrol	689-769
Bricks (common burnt clay):		Pine: Kauri, Qld	481
stacked	1602-1920	New Zealand	609
brickwork	1920	Oregon	529
Cement: bags	1281	Pipes: cast iron, stacked	961-1281
slurry	1442	earthenware, loose	320
Coal, loose lumps	897	wrought iron, 9.5 mm stacked	3204
slurry	993	Plywood	481-641
Coke	481-561	Pulp, wood: dry	561
Concrete, reinforced:		Rubber: processed sheet	1121
2 per cent steel	2420	sponge	48-160
Copper, drawn or sheet	8938	Sand: saturated	1922
Cyprus wood	593	undisturbed dry	1682
Douglas fir	529	Sawdust	208
Earth: dry, loose	1280	Screws, iron, packs	1602
moist, loose	1440-1600	Slag wool	224-288
Galvanized steel sheets, bundles	897	Snow: fresh	96
Glass, plate	2787	wet compact	320
Grain, wheat	770	Steel, low carbon	7850
barley	625	Straw, compressed bales	304
oats	416	Sulphate of ammonia, bags	641
rye	721	Tyres, rubber	176-256
Gypsum, plaster	737	Waste paper	352
Ice	913	Water: fresh	1001
Iron, cast	7208	salt	1009-1201
Lead, cast or rolled	11325	Wire: iron, coils	1185
Lime, hydrate, bags	513	rod, coils	801
Lime mortar: dry	1650	rope, coils	1442
wet	1748	Wool: compressed bales	769
Magnesite	3044	uncompressed	208
Maple: Canadian	737	Zinc: cast	6804
English	689	rolled	7192

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GAUGE NUMBERS AND EQUIVALENT THICKNESSES

Gauge Number	Birmingham Gauge, mm	US Manufacturers Gauge (Uncoated Sheet), inches	US Galvanized Sheet Gauge, inches
8	4.0	0.1644	0.1681
9	3.5	0.1495	0.1532
10	3.0	0.1345	0.1382
11	2.8	0.1196	0.1233
12	2.5	0.1046	0.1084
13	2.2	0.0897	0.0934
14	2.0	0.0747	0.0785
15	1.8	0.0673	0.0710
16	1.6	0.0598	0.0635
17	1.4	0.0538	0.0575
18	1.2	0.0478	0.0516
19	1.1	0.0418	0.0456
20	1.0	0.0359	0.0396
21	0.90	0.0329	0.0366
22	0.80	0.0299	0.0336
23	0.70	0.0269	0.0306
24	0.60	0.0239	0.0276
25	0.55	0.0209	0.0247
26	0.50	0.0179	0.0217
27	0.45	0.0164	0.0202
28	0.40	0.0149	0.0187
29	0.35	—	0.0172
30	0.30	—	0.0157
31	0.28	—	0.0142
32	0.25	—	0.0134

Note: The use of gauge numbers in the United States has been discontinued and is replaced by decimal thicknesses. Most ASTM standards for steel sheet products are issued as dual numbers, the metricated version having an "M" suffix.

TEMPERATURE CONVERSION TABLE

The numbers in **BOLD TYPE** refer to the temperature either in degrees Celsius or Fahrenheit which it is desired to convert into the other scale. If converting from Fahrenheit degrees to Celsius degrees the equivalent temperature will be found in the left column, while if converting from degrees Celsius to degrees Fahrenheit, the answer will be found in the column on the right.

°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	
-40	-40	90.6	195	383	640	1184	599	1110	2030	860	1580	2876
-37.2	-35	93.3	200	392	650	1202	604	1120	2048	866	1590	2894
-34.4	-30	96.1	205	401	660	1220	610	1130	2066	871	1600	2912
-31.7	-25	98.9	210	410	670	1238	616	1140	2084	877	1610	2930
-28.9	-20	100	212	413.6	680	1256	621	1150	2102	882	1620	2948
-26.1	-15	104	220	428	690	1274	627	1160	2120	888	1630	2966
-23.3	-10	110	230	446	700	1292	632	1170	2138	893	1640	2984
-20.6	-5	116	240	464	710	1310	638	1180	2156	899	1650	3002
-17.8	0	121	250	482	720	1328	643	1190	2174	904	1660	3020
-15.0	5	127	260	500	730	1346	649	1200	2192	910	1670	3038
-12.2	10	132	270	518	740	1364	654	1210	2210	916	1680	3056
-9.4	15	138	280	536	750	1382	660	1220	2228	921	1690	3074
-6.7	20	143	290	554	760	1400	666	1230	2246	927	1700	3092
-3.9	25	149	300	572	770	1418	671	1240	2264	932	1710	3110
-1.1	30	154	310	590	780	1436	677	1250	2282	938	1720	3128
1.7	35	160	320	608	790	1454	682	1260	2300	943	1730	3146
4.4	40	166	330	626	800	1472	688	1270	2318	949	1740	3164
7.2	45	171	340	644	810	1490	693	1280	2336	954	1750	3182
10.0	50	177	350	662	820	1508	699	1290	2354	960	1760	3200
12.8	55	182	360	680	830	1526	704	1300	2372	966	1770	3218
15.6	60	188	370	698	840	1544	710	1310	2390	971	1780	3236

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18.3	65	149	193	380	716	454	850	1562	716	1320	2408	977	1790	3254
21.1	70	158	199	390	734	460	860	1580	721	1330	2426	982	1800	3272
23.9	75	167	204	400	752	466	870	1598	727	1340	2444	988	1810	3290
26.7	80	176	210	410	770	471	880	1616	732	1350	2462	993	1820	3308
29.4	85	185	216	420	788	477	890	1634	738	1360	2480	999	1830	3326
32.2	90	194	221	430	806	482	900	1652	743	1370	2498	1004	1840	3344
35.0	95	203	227	440	824	488	910	1670	749	1380	2516	1010	1850	3362
37.8	100	212	232	450	842	493	920	1688	754	1390	2534	1016	1860	3380
40.6	105	221	238	460	860	499	930	1706	760	1400	2552	1021	1870	3398
43.3	110	230	243	470	878	504	940	1724	766	1410	2570	1027	1880	3416
46.1	115	239	249	480	896	510	950	1742	771	1420	2588	1032	1890	3434
48.9	120	248	254	490	914	516	960	1760	777	1430	2606	1038	1900	3452
51.7	125	257	260	500	932	521	970	1778	782	1440	2624	1043	1910	3470
54.4	130	266	266	510	950	527	980	1796	788	1450	2642	1049	1920	3488
57.2	135	275	271	520	968	532	990	1814	793	1460	2660	1054	1930	3506
60.0	140	284	277	530	986	538	1000	1832	799	1470	2678	1060	1940	3524
62.8	145	293	282	540	1004	543	1010	1850	804	1480	2696	1066	1950	3542
65.6	150	302	288	550	1022	549	1020	1868	810	1490	2714	1071	1960	3560
68.3	155	311	293	560	1040	554	1030	1886	816	1500	2732	1077	1970	3578
71.1	160	320	299	570	1058	560	1040	1904	821	1510	2750	1082	1980	3596
73.9	165	329	304	580	1076	566	1050	1922	827	1520	2768	1088	1990	3614
76.7	170	338	310	590	1094	571	1060	1940	832	1530	2786	1093	2000	3632
79.4	175	347	316	600	1112	577	1070	1958	838	1540	2804			
82.2	180	356	321	610	1130	582	1080	1976	843	1550	2822			
85.0	185	365	327	620	1148	588	1090	1994	849	1560	2840			
87.8	190	374	332	630	1166	593	1100	2012	854	1570	2858			

$$^{\circ}\text{F} = \frac{9}{5}^{\circ}\text{C} + 32$$

CONVERSION FORMULAE

$$^{\circ}\text{C} = \frac{5}{9}(^{\circ}\text{F} - 32)$$

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AREAS AND CIRCUMFERENCES OF CIRCLES

Diameter	Area	Circumference	Diameter	Area	Circumference
1	0.7854	3.1416	51	2042.8	160.22
2	3.1416	6.2832	52	2123.7	163.36
3	7.0686	9.4248	53	2206.2	166.50
4	12.566	12.566	54	2290.2	169.65
5	19.635	15.708	55	2375.8	172.79
6	28.274	18.850	56	2463.0	175.93
7	38.485	21.991	57	2551.8	179.07
8	50.266	25.133	58	2642.1	182.21
9	63.617	28.274	59	2734.0	185.35
10	78.540	31.416	60	2827.4	188.50
11	95.003	34.558	61	2922.5	191.64
12	113.10	37.699	62	3019.1	194.78
13	132.73	40.841	63	3117.3	197.92
14	153.94	43.982	64	3217.0	201.06
15	176.72	47.124	65	3318.3	204.20
16	201.06	50.266	66	3421.2	207.35
17	226.98	53.407	67	3525.7	210.49
18	254.47	56.549	68	3631.7	213.63
19	283.53	59.690	69	3739.3	216.77
20	314.16	62.832	70	3848.5	219.91
21	346.36	65.974	71	3959.2	223.05
22	380.13	69.115	72	4071.5	226.20
23	415.48	72.257	73	4185.4	229.34
24	452.39	75.398	74	4300.9	232.48
25	490.88	78.540	75	4417.9	235.62
26	530.93	81.682	76	4536.5	238.76
27	572.56	84.823	77	4656.6	241.90
28	615.75	87.965	78	4778.4	245.04
29	660.52	91.106	79	4901.7	248.19
30	706.86	94.248	80	5026.6	251.33
31	754.77	97.390	81	5153.0	254.47
32	804.25	100.53	82	5281.0	257.61
33	855.30	103.67	83	5410.6	260.75
34	907.92	106.81	84	5541.8	263.89
35	962.12	109.96	85	5674.5	267.04
36	1017.9	113.10	86	5808.8	270.18
37	1075.2	116.24	87	5944.7	273.32
38	1134.1	119.38	88	6082.1	276.46
39	1194.6	122.52	89	6221.2	279.60
40	1256.6	125.66	90	6361.7	282.74
41	1320.3	128.81	91	6503.9	285.89
42	1385.4	131.95	92	6647.6	289.03
43	1452.2	135.09	93	6792.9	292.17
44	1520.5	138.23	94	6939.8	295.31
45	1590.4	141.37	95	7088.2	298.45
46	1661.9	144.51	96	7238.2	301.59
47	1734.9	147.66	97	7389.8	304.74
48	1809.6	150.80	98	7543.0	307.88
49	1885.7	153.94	99	7697.7	311.02
50	1963.5	157.08	100	7854.0	314.16

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SQUARES, CUBES, SQUARE ROOTS AND CUBE ROOTS

n	n ²	n ³	√n	∛n	n	n ²	n ³	√n	∛n
1	1	1	1.000	1.000	50	2 500	125 000	7.071	3.684
2	4	8	1.414	1.260	51	2 601	132 651	7.141	3.708
3	9	27	1.732	1.442	52	2 704	140 608	7.211	3.733
4	16	64	2.000	1.587	53	2 809	148 877	7.280	3.756
5	25	125	2.236	1.710	54	2 916	157 464	7.348	3.780
6	36	216	2.449	1.817	55	3 025	166 375	7.416	3.803
7	49	343	2.646	1.913	56	3 136	175 616	7.483	3.826
8	64	512	2.828	2.000	57	3 249	185 193	7.550	3.849
9	81	729	3.000	2.080	58	3 364	195 112	7.616	3.871
10	100	1 000	3.162	2.154	59	3 481	205 379	7.681	3.893
11	121	1 331	3.317	2.224	60	3 600	216 000	7.746	3.915
12	144	1 728	3.464	2.289	61	3 721	226 981	7.810	3.936
13	169	2 197	3.606	2.351	62	3 844	238 328	7.874	3.958
14	196	2 744	3.742	2.410	63	3 969	250 047	7.937	3.979
15	225	3 375	3.873	2.466	64	4 096	262 144	8.000	4.000
16	256	4 096	4.000	2.520	65	4 225	274 625	8.062	4.021
17	289	4 913	4.123	2.571	66	4 356	287 496	8.124	4.041
18	324	5 832	4.243	2.621	67	4 489	300 763	8.185	4.062
19	361	6 859	4.359	2.668	68	4 624	314 432	8.246	4.082
20	400	8 000	4.472	2.714	69	4 761	328 509	8.307	4.102
21	441	9 261	4.583	2.759	70	4 900	343 000	8.367	4.121
22	484	10 648	4.690	2.802	71	5 041	357 911	8.426	4.141
23	529	12 167	4.796	2.844	72	5 184	373 248	8.485	4.160
24	576	13 824	4.899	2.884	73	5 329	389 017	8.544	4.179
25	625	15 625	5.000	2.924	74	5 476	405 224	8.602	4.198
26	676	17 576	5.099	2.962	75	5 625	421 875	8.660	4.217
27	729	19 683	5.196	3.000	76	5 776	438 976	8.718	4.236
28	784	21 952	5.292	3.037	77	5 929	456 533	8.775	4.254
29	841	24 389	5.385	3.072	78	6 084	474 552	8.832	4.273
30	900	27 000	5.477	3.107	79	6 241	493 039	8.888	4.291
31	961	29 791	5.568	3.141	80	6 400	512 000	8.944	4.309
32	1 024	32 768	5.657	3.175	81	6 561	531 441	9.000	4.327
33	1 089	35 937	5.745	3.208	82	6 724	551 368	9.055	4.344
34	1 156	39 304	5.831	3.240	83	6 889	571 787	9.110	4.362
35	1 225	42 875	5.916	3.271	84	7 056	592 704	9.165	4.380
36	1 296	46 656	6.000	3.302	85	7 225	614 125	9.220	4.397
37	1 369	50 653	6.083	3.332	86	7 396	636 056	9.274	4.414
38	1 444	54 872	6.164	3.362	87	7 569	658 503	9.327	4.431
39	1 521	59 319	6.245	3.391	88	7 744	681 472	9.381	4.448
40	1 600	64 000	6.325	3.420	89	7 921	704 969	9.434	4.465
41	1 681	68 921	6.403	3.448	90	8 100	729 000	9.487	4.481
42	1 764	74 088	6.481	3.476	91	8 281	753 571	9.539	4.498
43	1 849	79 507	6.557	3.503	92	8 464	778 688	9.592	4.514
44	1 936	85 184	6.633	3.530	93	8 649	804 357	9.644	4.531
45	2 025	91 125	6.708	3.557	94	8 836	830 584	9.695	4.547
46	2 116	97 336	6.782	3.583	95	9 025	857 375	9.747	4.563
47	2 209	103 823	6.856	3.609	96	9 216	884 736	9.798	4.579
48	2 304	110 592	6.928	3.634	97	9 409	912 673	9.849	4.595
49	2 401	117 649	7.000	3.659	98	9 604	941 192	9.899	4.610
					99	9 801	970 299	9.950	4.626
					100	10 000	1 000 000	10.00	4.642

TRIGONOMETRICAL RATIOS

Angle		Chord	Sine	Tangent	Co-tangent	Cosine		
Degrees	Radians							
0°	0	0	0	0	∞	1	1.414	1.5708
1	0.0175	0.017	0.0175	0.0175	57.2900	0.9998	1.402	1.5533
2	0.0349	0.035	0.0349	0.0349	28.6363	0.9994	1.389	1.5359
3	0.0524	0.052	0.0523	0.0524	19.0811	0.9986	1.377	1.5184
4	0.0698	0.070	0.0698	0.0699	14.3007	0.9976	1.364	1.5010
5	0.0873	0.087	0.0872	0.0875	11.4301	0.9962	1.351	1.4835
6	0.1047	0.105	0.1045	0.1051	9.5144	0.9945	1.338	1.4661
7	0.1222	0.122	0.1219	0.1228	8.1443	0.9925	1.325	1.4486
8	0.1396	0.140	0.1392	0.1405	7.1154	0.9903	1.312	1.4312
9	0.1571	0.157	0.1564	0.1584	6.3138	0.9877	1.299	1.4137
10	0.1745	0.174	0.1736	0.1763	5.6713	0.9848	1.286	1.3963
11	0.1920	0.192	0.1908	0.1944	5.1446	0.9816	1.272	1.3788
12	0.2094	0.209	0.2079	0.2126	4.7046	0.9781	1.259	1.3614
13	0.2269	0.226	0.2250	0.2309	4.3315	0.9744	1.245	1.3439
14	0.2443	0.244	0.2419	0.2493	4.0108	0.9703	1.231	1.3265
15	0.2618	0.261	0.2588	0.2679	3.7321	0.9659	1.218	1.3090
16	0.2793	0.278	0.2756	0.2867	3.4874	0.9613	1.204	1.2915
17	0.2967	0.296	0.2924	0.3057	3.2709	0.9563	1.190	1.2741
18	0.3142	0.313	0.3090	0.3249	3.0777	0.9511	1.176	1.2566
19	0.3316	0.330	0.3256	0.3443	2.9042	0.9455	1.161	1.2392
20	0.3491	0.347	0.3420	0.3640	2.7475	0.9397	1.147	1.2217
								70

The Referee

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The Referee

CONVERSION FACTORS

Factors listed are based on Australian Standard 1376 'Conversion Factors' and where not exact have been rounded to six significant figures. Exact values printed in bold type.

To convert from	to	multiply by
acre	hectare	0.404 686
acre foot	cubic metre	1 233.48
atmosphere	millibar	1 013.25
atmosphere	pascal	101 325
barrel	litre	159.113
barrel (US)	litre	158.987
barrel, dry (US)	cubic metre	0.115 627
British thermal unit	joule	1 055.06
British thermal unit	kilowatt. hour	0.000 293
British thermal unit	megajoule	0.001 055
Btu per cubic foot	kilojoule per cubic metre	37.258 9
Btu per gallon	kilojoule per litre	0.232 080
Btu per hour	watt	0.293 071
Btu per pound	kilojoule per kilogram	2.326
Btu per square foot hour °F	watt per square metre. kelvin	5.678 26
bushel	litre	36.368 7
bushel (US)	litre	35.239 1
cubic foot	cubic metre	0.028 317
cubic foot per second	cubic metre per second	0.028 317
cubic inch	cubic centimetre	16.387 064
cubic inch	cubic millimetre	16 387.1
cubic yard	cubic metre	0.764 555
fathom	metre	1.828 8
fluid ounce	millilitre	28.413 1
foot	metre	0.304 8
foot per minute	metre per minute	0.304 8
foot per minute	metre per second	0.005 08
foot per second	metre per second	0.304 8
foot pound force	joule	1.355 82
foot pound force per second	watt	1.355 82
furlong	metre	201.168
gallon	litre	4.546 09
gallon (US)	litre	3.785 41
gravity (standard)	metre per second per second	9.806 65
horse-power	kilowatt	0.745 700
hundredweight	kilogram	50.802 3
inch	metre	0.025 4
inch	micrometre	25 400.00
inch	millimetre	25.4
inch mercury	kilopascal	3.386 38
inch water gauge	kilopascal	0.248 642
kilowatt hour	megajoule	3.6
knot (international)	kilometre per hour	1.852

The Referee

CONVERSION FACTORS (Cont)

Factors listed are based on Australian Standard 1376 'Conversion Factors' and where not exact have been rounded to six significant figures. Exact values printed in bold type.

To convert from	to	multiply by
mile	kilometre	1.609 344
mile per gallon	litre per 100 kilometre	divide 282.481 by mile per gallon
mile per hour	kilometre per hour	1.609 344
millimetre mercury	kilopascal	0.133 322
millimetre water gauge	pascal	9.789 04
ounce	gram	28.349 5
ounce per square foot	gram per square metre	305.152
ounce per square yard	gram per square metre	33.905 7
pint	litre	0.568 261
pound	kilogram	0.453 592 37
pound force	newton	4.448 22
pound force foot	newton.metre	1.355 82
pound force inch	newton.metre	0.112 985
pound force per square inch	kilopascal	6.894 76
pound force per square inch	megapascal	0.006 895
pound per acre	pascal	6 894.76
pound per cubic foot	kilogram per hectare	1.120 85
pound per foot	kilogram per cubic metre	16.018 5
pound per gallon	kilogram per metre	1.488 16
pound per square foot	kilogram per litre	0.099 776
square foot	kilogram per square metre	4.882 43
square foot per gallon	square metre	0.092 903
square foot per ton	square metre per litre	0.020 436
square inch	square metre per tonne	0.091 436
square inch	square centimetre	6.451 6
square mile	square millimetre	645.16
square yard	square kilometre	2.589 99
superficial foot	square metre	0.836 127
ton	cubic metre	0.002 360
ton, freight (40 ft ³)	tonne	1.016 05
ton, register (100 ft ³)	cubic metre	1.132 67
ton force foot	cubic metre	2.831 68
ton force per square inch	kilonewton. metre	3.037 03
ton per cubic yard	megapascal	15.444 3
yard	tonne per cubic metre	1.328 94
	kilometre	0.000 914

DISTANCES BETWEEN AIRPORTS (nearest 5 kilometres)

Distances shown are those of the most probably selected direct or indirect commercial flights following the prescribed airline routes used by major and commuter airlines. Source: 'Great Circle Distances based on the International Reference Spheroid' as made available to the editor by Ansett Airlines of Australia.

PERTH

2120 ADELAIDE

2885 2610 DARWIN

3435 1315 1300 ALICE SPRINGS

2705 645 3255 1955 MELBOURNE

3175 1055 3665 2370 475 LAUNCESTON

3320 1260 3870 2570 615 145 HOBART

3090 970 3585 2285 470 945 1085 CANBERRA

3285 1165 3220 2020 705 1180 1320 235 SYDNEY

3600 1485 3540 2340 1025 1500 1640 555 320 TAMIWORTH

3725 1605 3660 2460 1145 1620 1765 675 440 185 COFFS HARBOUR

3595 1475 3530 2330 1015 1490 1630 545 310 625 750 DUBBO

3070 1005 3620 2320 365 840 980 160 365 685 805 675 WAGGA WAGGA

4030 1910 2850 2245 1375 1850 1990 980 745 510 320 765 1110 BRISBANE

4550 2430 3370 2335 1895 2370 2510 1500 1265 1025 840 1285 1630 520 ROCKHAMPTON

3960 1845 2940 2700 1330 1805 1945 915 680 600 415 860 1045 90 610 COOLANGATTA

4970 2850 2020 1450 2485 2960 3100 1920 1685 1620 1435 1880 2050 1110 600 1205 TOWNSVILLE

4825 2710 2350 1780 2170 2650 2790 1780 1545 1305 1120 1565 1910 800 280 890 320 MACKAY

5420 3300 1680 1455 2765 3240 3380 2370 2135 1900 1715 2155 2500 1390 880 1480 285 615 CAIRNS

PERTH 1310 1245 2885

PORT HEDLAND 195 1575

KARRATHA 1760

DARWIN

DISTANCES BY ROAD BETWEEN CITIES AND SELECTED TOWNS (nearest 5 kilometres)

Distances shown are by the shortest practical route between centres but do not necessarily represent distances by normally recommended roads. Main sealed roads formed the basis for most calculations.

PERTH	725	NORSEMAN	2395	3120	BROOME	410	685	2705	ALBANY	2765	2040	4353	2725	ADELAIDE	2445	1725	4035	2405	315	PORT AUGUSTA	4430	5150	2030	4835	3215	2900	DARWIN	3815	3095	2665	3775	1685	1370	1535	ALICE SPRINGS	3405	2685	4995	3470	745	960	3865	2330	MELBOURNE	3010	1285	4750	2970	395	565	3470	1935	555	MILDURA	3800	3075	5390	3760	1180	1355	4260	2725	650	785	CANBERRA	3975	3250	5560	3930	1400	1525	4435	2895	890	1025	300	SYDNEY	3395	2670	5255	3355	1050	950	3225	2320	1055	835	745	785	BOURKE	2855	2135	4445	2815	510	410	3310	1780	850	295	1090	1170	540	BROKEN HILL	3430	2170	5010	3390	815	985	3890	2355	305	420	335	585	750	835	ALBURY	4290	3570	4780	4250	2065	1845	3450	3055	1655	1585	1300	1000	1050	1545	1280	BRISBANE	4470	3750	4265	4430	2280	2050	2650	2935	2490	1995	1785	1960	1660	1570	2110	1605	660	ROCKHAMPTON	50095	4375	4850	5055	2580	2650	2520	2075	2515	2275	2735	2435	1580	2120	2225	1440	780	TOWNSVILLE	5270	4550	4200	5230	2830	2825	2870	2425	2865	2580	3090	2790	2020	2555	2580	1795	1130	355	CAIRNS	4970	4250	2960	4930	2625	2525	1630	1185	2765	2410	2335	2360	1575	2115	2460	1815	1305	885	1240	MT ISA
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The Referee

GEOMETRY AND MENSURATION

Circle Circumference = diameter $\times \frac{22}{7}$ (or 3.1416).

Area = diameter² $\times$ 0.7854.

Area of sector of circle = length of arc $\times$ half radius.

Area of segment of circle = area of sector, less area of triangle.

Side of square of area equal to circle = 0.8862 diameter of circle.

Diameter of circle equal in area to square = 1.1284 side of square.

Sphere Surface area = 3.1416 $\times$ diameter².

Volume = 0.5236 diameter³.

Areas generally.

Square, rectangle, rhombus or rhomboid = base $\times$ height.

Triangle = half base $\times$ perpendicular height.

Trapezoid = half sum of two parallel sides $\times$ height.

Area of any figure of four or more unequal sides is found by dividing it into triangles, finding areas of each, and adding together.

Regular polygon (inscribed circle) = half radius of circle $\times$ length of one side $\times$ number of sides.

Parabola = base $\times$ height $\times \frac{2}{3}$.

Ellipse = long axis $\times$ short axis $\times$ 0.7854.

Cubes a = length of one side, volume = a^3 , surface area = $6a^2$.

Rectangular Prism Volume = area of base $\times$ height = $\frac{bl \times h}{2}$ Total surface area = $2(bl + lh + bh)$.

Regular Prism Volume = $\frac{1}{2}n \times r \times a \times h$, where n = number of sides, r = radius of inscribed circle, a = length of side.

Cylinder (Right Circular) Volume = 0.7854 $\times$ diameter² $\times$ height.

Lateral surface area = 3.1416 $\times$ diameter $\times$ height. Total surface area = 3.1416 (diameter $\times$ height) + 1.5708 diameter².

Any Prism or Cylinder Volume = $h \times$ area of base. Lateral surface area = length of cylinder $\times$ perimeter of normal section.

Regular Pyramid or Cone Volume = $\frac{1}{3}$ (area of base $\times$ height). Lateral surface area of regular figure = $\frac{1}{2}$ (perimeter of base $\times$ slant height).

Any Pyramid or Cone Volume = $\frac{1}{3}$ (area of base $\times$ distance from vertex to plane of base).

Frustum of any Pyramid or Cone Volume = $\frac{h}{3} (A_1 + A_2 + \sqrt{A_1 A_2})$, where A_1 and A_2 are the areas of bases made by parallel planes.

The Referee

TABLES AND STATISTICS

OVERSEAS TRADE: AUSTRALIA, 1825-1835 TO 1986

Year	Exports \$m	Imports \$m	Excess of exports (+) or imports (-) \$m
1826-1835	0.8	1.6	-0.8
1836-1845	2.5	3.8	-1.3
1846-1855	13.7	13.0	+0.7
1856-1865	34.7	35.4	-0.7
1866-1875	43.7	37.0	+6.7
1876-1885	51.8	54.1	-2.3
1886-1895	60.3	56.4	+3.9
1896-1905	92.3	66.4	+25.9
1906-1915	143.8	113.6	+30.2
1916-1925	249.6	216.0	+33.6
1926-1935	252.3	193.1	+59.2
1936-1945	325.8	393.7	-67.9
1946-1955	1,246	1,104	+142
1956-1965	2,036	1,950	+86
1966-1975	4,742	4,304	+438
1976	9,640	8,241	+1,399
1977	11,489	10,330	+1,159
1978	12,050	11,082	+968
1979	14,071	13,651	+420
1980	18,606	16,045	+2,561
1981	18,949	18,790	+159
1982	19,294	22,767	-3,473
1983	21,454	21,216	+238
1984	24,013	23,540	+473
1985	29,708	29,049	+659
1986	32,818	34,691	-1,873
1987	35,725	37,092	-1,367

Information courtesy Australian Bureau of Statistics.

POPULATION, DENSITY, AND RATE OF INCREASE FOR THE WORLD AND CONTINENTS - SELECTED YEARS

(Source: United Nations Demographic Yearbook, 1986)

Macro regions and regions	Estimates of mid-year population, millions										Annual rate of increase, per cent	Density ¹
	1950	1960	1965	1970	1975	1980	1985	1986	1986	1986		
WORLD TOTAL	2516	3091	3335	3693	4076	4450	4837	4917		1.7		36
AFRICA	224	280	317	361	413	479	555	572		2.9		19
Western Africa	65	81	92	106	123	144	169	174		3.1		28
Eastern Africa	63	80	92	106	122	143	166	172		3.1		27
Northern Africa	52	65	73	83	94	108	123	126		2.6		15
Middle Africa	27	33	36	40	45	52	60	61		2.7		9
Southern Africa	17	21	23	26	29	33	37	38		2.5		14
AMERICA²	331	415	463	510	560	613	668	680		1.7		16
NORTH AMERICA	166	199	214	227	239	252	264	266		0.9		12
LATIN AMERICA	165	217	249	283	321	361	405	414		2.3		20
South America	111	147	168	190	214	240	268	274		2.2		15
Central America	37	50	58	68	80	92	105	108		2.7		44
Caribbean	17	20	23	25	28	30	32	32		1.5		136
ASIA	1376	1668	1861	2102	2354	2584	2818	2866		1.7		104
EAST ASIA	671	791	874	986	1096	1176	1250	1264		1.2		107
China	555	657	729	831	927	996	1060	1072		1.2		112
Japan	84	94	99	104	112	117	121	121		0.7		320
Other East Asia	33	40	46	51	57	63	69	71		1.9		40
SOUTH ASIA	704	877	988	1116	1258	1408	1568	1601		2.2		101
Southern Asia	480	595	669	754	849	949	1056	1078		2.1		159
South Eastern Asia	182	226	255	288	324	361	399	407		2.1		91
Eastern Asia	42	56	64	74	85	98	113	116		2.8		26

EUROPE^{3,4}	392	425	445	459	474	485	492	493	0.3	100
Western Europe	122	135	143	148	152	154	154	154	0.1	154
Southern Europe	109	118	123	128	134	140	143	143	0.4	109
Eastern Europe	89	97	100	103	106	109	112	113	0.5	114
Northern Europe	72	76	79	80	82	82	83	83	0.1	51
OCEANIA	12.6	15.8	17.5	19.3	21.1	22.9	24.6	25.0	1.5	3
Australia and New Zealand	10.1	12.7	14.0	15.4	16.7	17.9	19.0	19.2	1.3	2
Other Oceania	2.5	3.1	3.5	3.9	4.4	5.0	5.6	5.8	2.4	10
USSR	180	214	231	242	253	265	279	281	1.0	13

FOOTNOTES

1. Population per square kilometre of surface area. Figures are merely the quotients of population divided by surface area and are not to be considered as either reflecting density in the urban sense or as indicating the supporting power of a territory's land and resources.
2. Hawaii, a state of the United States of America, is included in Northern America rather than Oceania.
3. Excluding the USSR, shown separately.
4. European portion of Turkey is included with South Asia rather than Europe.

STANDARDS

AUSTRALIAN STANDARDS

With increased industrialisation and rapidly changing technology, standardisation now plays a bigger part in the life of the individual than ever before.

Everyone needs standards.

Apart from the essential part standards play in health and safety and their assistance to designers and specifiers, their appeal to the consumer is based mainly on guiding him or her towards getting value for money.

In Australia standards are prepared and published by Standards Australia.

Standards are in the form of specifications for materials and products, codes of sound or safe practice, methods of testing, nomenclature, etc. They are prepared by representative committees which coordinate manufacturing capacity and production efficiency with users' reasonable needs. Standards seek to achieve fitness for purpose by ensuring suitable quality and dimensions, economy through simplification of production and distribution, replacement interchangeability and adequate variety of choice without wasteful diversity.

Standards therefore lead to good, rational, economic design.

The presence of a Standards Australia mark or number is the consumer's guide to assured quality and acceptable value.

Standards result from full enquiry and are based on voluntary agreement with recognition of the interests of both producer and consumer.

Membership of Standards Australia is open to individuals, associations, industrial and commercial companies and public and local authorities.

It is to everyone's advantage to see that standards are promoted and adopted.

A list of most of the standards referred to in this publication follows.

The Referee

AUSTRALIAN STANDARDS RELEVANT TO ITEMS APPEARING IN THE REFEREE

(a) Dimensions and Tolerances

AS 2338 Preferred dimensions of wrought metal products.

AS 1365 Tolerances for flat-rolled steel products.

AS 1131 Dimensions of hot-rolled structural steel sections.

(b) Flat and Formed Products

AS 1594 Hot-rolled steel flat products.

AS 1595 Cold-rolled unalloyed low carbon steel sheet and strip.

AS 1397 Steel sheet and strip – Hot-dipped zinc-coated or aluminium/zinc coated.

AS 2551 Steel sheet and strip – Cold-rolled, electrolytic zinc-coated.

AS 2552 Steel sheet and strip – Terne (lead-tin Alloy) coated.

AS 1734 Aluminium and aluminium Alloys – Flat sheet, coiled sheet and plate.

AS 1445 Hot-dipped zinc-coated or aluminium/zinc-coated steel sheet – 76 mm pitch corrugated.

AS 2179 Metal rainwater goods – Specification.

AS 2728 Prepainted and organic film/metal laminate products – Performance requirements for interior/exterior applications in buildings.

AS 1227 General requirements for supply of Hot-rolled steel plates, sections, piling and bars for structural purposes.

AS 2935 Prepainted metal products for household appliances – Performance requirements.

(c) Building Codes

AS 1170 SAA Loading Code

Part 1 – Dead and live loads.

Part 2 – Wind forces.

AS 1562 Design and installation of metal roofing.

AS 1538 Cold Formed Steel Structures Code.

AS 2180 Metal rainwater goods – Selection and installation.

AS 1640 SAA Brickwork Code.

AS 1250 SAA Steel Structures Code.

AS 1480 SAA Concrete Structures Code.

(d) Structural Steels and Sections

AS 1204 Structural steels – Ordinary weldable grades.

AS 1205 Structural steels – Weather resistant weldable grades.

AS 1163 Structural steel hollow sections.

(e) Reinforcement

AS 1302 Steel reinforcing bars for concrete.

AS 1303 Hard-drawn steel reinforcing wire for concrete.

AS 1304 Welded wire reinforcing fabric for concrete.

(f) Pipes and Tubes

AS 1074 Steel tubes and tubulars threaded or suitable for threading with pipe threads of Whitworth form.

(g) Fasteners and Screw Threads

AS 1110 ISO metric hexagon precision bolts and screws.

AS 1111 ISO metric hexagon commercial bolts and screws.

AS 1112 ISO metric hexagon nuts including thin nuts, slotted nuts and castle nuts.

AS 1252 High strength steel bolts with associated nuts and washers for structural engineering.

AS 3566 Screws – Self-drilling for the building and construction industries.

AS 1390 Metric cup head bolts.

AS 1393 Coach screws – with ISO hexagon heads.

AS 1420 ISO metric hexagon socket head cap screws.

AS 1421 ISO metric hexagon socket set screws.

AS 1427 ISO metric machine screws.

AS 1474 Hexagon and square pressed nuts.

AS 1476 Metric wood screws.

AS 1275 Metric screw threads for fasteners.

(h) Bricks and Concrete.

AS 1225 Clay building bricks.

AS 1475 Concrete blockwork in buildings.

(i) Cement and Concrete

AS 1315 Portland cement.

AS 1316 Masonry cement.

AS 1317 Blended cement.

AS 1379 Ready-mixed concrete.

(j) Miscellaneous

AS 1834 Material for soldering

Part 1 – solder alloys.

Part 2 – flux cored solders.

AS 1553 Covered electrodes for welding

Part 1 – low carbon steel electrodes for manual metal-arc welding of carbon and carbon-manganese steels.

Part 2 – low and intermediate alloy steel electrodes for manual metal-arc welding of carbon steels and low and intermediate alloy steels.

AS 1650 Galvanized coatings.

AS 1376 Conversion factors.

AS 1377 Conversion tables – Parts 1 to 6.

AS 1449 Wrought alloy steels – Stainless and heat-resisting steel plate, sheet and strip.

AS 2070 Plastic materials for food contact use.

OVERSEAS STANDARDS

Australian users of steel sheet often find these materials specified using overseas standards. To assist in identifying the type of product involved, some of the main overseas standards have been listed according to product type. This will assist in converting to Sheet & Coil Products' steel manufactured to Australian standards.

HOT-ROLLED FORMING PRODUCTS

USA

ASTMA569 (A569M) Steel, Carbon (0.15 Maximum, per cent) Hot-Rolled Sheet and Strip Commercial Quality.

ASTMA621 (A621M) Steel, Sheet and Strip, Carbon, Hot-Rolled, Drawing Quality.

ASTMA622 (A622M) Steel, Sheet and Strip, Carbon, Drawing Quality, Special-Killed, Hot-Rolled.

Japan

JIS G 3131 Hot-Rolled Mild Steel Plates, Sheets and Strip.

West Germany

DIN 1614 Part 1 Hot-Rolled Strip and Sheet of Mild Unalloyed Steel.

Britain

BS 1449 Part 1 Carbon steel plate, sheet and strip.

HOT ROLLED STRUCTURAL PRODUCTS

USA

ASTMA570, A570M Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.

ASTMA607 Steel, Sheet and Strip, High Strength, Low-Alloy, Hot-Rolled, and Steel Sheet, Cold-Rolled, High-Strength, Low-Alloy, with Improved Formability.

Japan

JIS G 3101 Rolled Steel for General Structure

JIS G 3106 Rolled Steel for Welded Structure

JIS G 3113 Hot-rolled Steel Plates, Sheets and Strip for Automobile Structural Uses

JIS G 3132 Hot-rolled Carbon Steel Strip for Pipes and Tubes

West Germany

DIN 17 100 Steels for General Structural Purposes

COLD ROLLED PRODUCTS

USA

ASTMA109 Steel, Strip, Carbon, Cold-Rolled

ASTMA366, A366M Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality

ASTMA619, A619M Steel, Sheet, Carbon, Cold-Rolled, Drawing Quality

ASTMA620, A620M Steel, Sheet, Carbon, Drawing Quality, Special Killed, Cold-Rolled

Japan

JIS G 3141 Cold-Rolled Carbon Steel Sheets and Strip

West Germany

DIN 1623 Cold-Rolled Strip and Sheet of Mild Unalloyed Steels

DIN 1624 Cold Rolled Strip in Widths of up to 650 mm of Mild Unalloyed Steels

Britain

BS 1449: Part 1 Carbon Steel plate, sheet and strip

HOT-DIPPED ZINC-COATED PRODUCTS

USA

ASTMA526 Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality

ASTMA527 Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality

ASTMA361, A361M Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, for Roofing and Siding

ASTMA446, A446M Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality

ASTMA528, A528M Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Drawing Quality

ASTMA642, A642M Steel Sheet Zinc-Coated (Galvanized) by the Hot-Dip Process, Drawing Quality, Special Killed

Japan

JIS G 3302 Galvanized Sheets

West Germany

DIN 17 162 Part 1 Hot-Dip Zinc-Coated Strip and Sheet of Mild Unalloyed Steels

The Referee

DIN 17 162 Part 2 Hot-Dip Zinc-Coated Strip and Sheet Structural Steels for General Use

Britain

BS 2989 Hot-Dip Zinc-Coated Steel Sheet and Coil

New Zealand

NZS 3441 HOT-DIPPED ZINC-COATED STEEL COIL AND CUT LENGTHS

ELECTROLYTIC ZINC-COATED PRODUCTS

USA

ASTMA591 Steel Sheet, Cold-Rolled, Electrolytic Zinc-Coated

TERNE-COATED PRODUCTS

USA

ASTMA308 Steel Sheet, Cold-Rolled, Long Terne Coated

STAINLESS STEEL PRODUCTS

ASTMA269 Seamless and welded austenitic stainless steel tubing for general service

ASTMA268 Seamless and welded ferritic stainless steel tubing for general service

ASTMA554 Welded stainless steel mechanical tubing

ASTMA270 Seamless and welded austenitic stainless steel sanitary tubing

ASTMA249 Welded austenitic steel boiler, superheater, heat exchanger and condenser tubes

ASTMA688 Welded austenitic stainless steel feedwater heater tubes

ASTMA312 Seamless and welded austenitic stainless steel pipe

ASTMA789 Seamless and welded ferritic/austenitic stainless steel tubing for general service

ASTMA213 Seamless ferritic and austenitic alloy steel boiler, superheater and heat exchanger tube

ASTMB338 Seamless and welded titanium and titanium alloy tubes for condensers and heat exchangers

The Referee

ASTM and ASME tube users may find reference to some of the above specification numbers prefixed by an 'S' eg 'SA249'. The presence of the 'S' means that the specification is an ASME specification similar to (but not always the same as) the ASTM specification of the same number. ASTM – American Society for Testing & Materials; ASME – American Society of Mechanical Engineers.

Most United States ASTM standards are issued on a dual basis with metric versions containing the suffix "M" in the identification number.

GLOSSARY OF TERMS

METALLURGICAL TERMS

Ageing Changes in the properties of steel occurring with the passage of time affecting the mechanical properties of a metal or alloy. Usually accelerated by an increase in temperature and so, may be natural or artificial.

Annealing A process involving heating and cooling, applied usually to induce softening. The term annealing is also used to cover treatments:

- (a) to remove stresses,
- (b) to alter mechanical or physical properties,
- (c) to produce a definite microstructure, and
- (d) to remove dissolved gases.

Bend test A test of ductility, wherein a test piece must withstand, without fracture, bending through a specified angle around a specified radius at ordinary temperatures.

Brazing Joining metals by fusion of a non-ferrous filler metal with a melting point above approximately 450 degrees Celsius, but lower than those of the metals being joined. The filler metal flows by capillary action between the surfaces to be joined.

Bronze welding Similar to brazing but the joint is characterised by a substantial external fillet of filler metal.

Carbon steel A steel, free from intentionally added alloying elements, depending for its properties substantially upon its carbon content alone. Manganese up to 1% is not regarded as removing the steel from this designation.

Camber Camber is the greatest deviation of a side edge of a sheet from a straight line. The measurement of a camber must be taken on the concave side with a straight-edge which is in the same plane as the sheet.

Corrosion Destruction of a metal by electro-chemical reaction with its environment.

Cupping test A test of the ductility of metal sheet or strip obtained by measuring the depth of bulge which can be formed before fracture.

The Referee

Decarburization In steel, partial or complete loss of carbon by chemical reaction.

Deep drawing Forming cup-shaped articles, shells or deeply recessed parts by using a punch to force sheet metal into or through a die.

Ductility Relative ability of a metal to deform without fracture, that is, to work it into different or more complex shapes.

Elongation In tensile testing, the increase in the gauge length measured after fracture of the test specimen within the gauge length, usually expressed as a percentage of the original gauge length.

Fatigue A condition in metals resulting from fluctuating stresses, leading to failure at a stress substantially below the normal tensile strength of the material. Fatigue failures invariably manifest themselves in the progressive development of a crack, generally undetected until after complete failure has taken place, since they occur without prior visible strain. Fatigue cracks commonly originate at some point of local and predominantly tensile stress concentration either at the surface (sharp re-entrant corners, tool marks, scratches, etc) or in the interior (flakes, forging bursts, or inclusions) of the stressed component.

Where cracks develop under the combined effect of fluctuating stress and corrosive environment the subsequent failure is termed corrosion fatigue.

Finish Finish refers to the degree of smoothness or lustre of the sheet.

Flatness Flatness of sheet metal may be best defined as the absence of any waviness or buckles. The out-of-flatness of a sheet is the measured height of the buckles from a flat surface on which the sheet is lying.

Galvanizing The process of applying a coating of zinc to a surface of iron or steel to provide a corrosion resistant surface.

Zinc coating may be applied by hot-dipping or electroplating. Solid state diffusion (sherardizing) or spraying are not usually termed galvanizing.

From hot-dip galvanizing there developed a process for producing an zinc/aluminium alloy-coated steel. This process is used to produce S&CP ZINCALUME steel.

The Referee

Hardness The resistance offered by a metallic material to plastic deformation by indentation or penetration. The above defines hardness as it is commonly measured in metals. Quantitatively it has no absolute significance, but serves for purposes of comparison between materials of similar type (in particular, of similar elastic properties). It is more specifically referred to as indentation hardness or penetration hardness.

Heat treatment An operation or combination of operations involving the heating or cooling of a metal or alloy in the solid state for the purpose of obtaining certain desired conditions or properties.

Heating for the sole purpose of hot working is excluded from the meaning of this definition.

Hydrogen embrittlement Brittleness induced in steel due to absorption of hydrogen. This commonly occurs in pickling and electroplating operations. In the heat affected zones of welds, it can lead to cracking. Hydrogen embrittlement is particularly detrimental in steels of high hardness, and may be removed by annealing in the range 200 to 750 degrees Celsius.

Mechanical properties Properties relating to the behaviour of materials under load in conventional mechanical tests, such as elastic moduli, tensile strength, elongation, hardness.

Normalizing Heating steel to, and if necessary holding at, a suitable temperature above the transformation range, followed by cooling in a still atmosphere to ambient temperature, in order to produce a medium-to-fine pearlite microstructure.

The effect of normalizing is generally to refine the grain size, render the structure more uniform, and improve the mechanical properties.

Pickling Removal of oxide films from metal by immersion in an acid. The process is applied particularly to scale removal from metal prior to operations such as cold rolling, wire drawing and electroplating, and in general is carried out in dilute solutions of the mineral acids, often with additions of organic material (inhibitors) to restrain the rate of attack on the metal. Absorption of hydrogen may occur in pickling of steel causing embrittlement of hard steels, and necessitating low temperature annealing for its removal.

Resquared This term describes a sheet which has been sheared to accurate dimensional limits as a last operation in its production. The name is derived from early guillotining operations necessary to achieve the required tolerance.

The Referee

Skin-passing A light cold rolling operation (about 1-2 per cent of cold work) which removes the yield point in steel which otherwise causes coil break, fluting or stretcher strain in subsequent operations. It can also be used to:

- (a) modify surface, for example, by reducing surface roughness for bright (lustre) qualities or by specially controlled roughening for matt finish for drawing qualities, and
- (b) flatten strip being rolled.

Soldering Joining of metals by fusion with alloys that have relatively low melting points, most commonly lead and/or tin base alloys, which are known as soft solders.

Joining with higher melting point alloys, sometimes termed hard solders at temperatures over 450 degrees Celsius, is generally termed brazing.

Stress relieving Heating a metal to, and if necessary holding at some temperature generally below the recrystallization range, followed by uniform cooling, for the sole purpose of removing internal stresses.

Stretcher levelled Stretcher levelled, as applied to sheets, indicates a standard of flatness. The term originated from an early method of obtaining flatness. This was by gripping the ends of the sheet and stretching it to remove surface waves and buckles.

Stretcher strain markings Characteristic surface markings, usually of a parallel sided diagonal pattern, which appear during the early stages of the plastic deformation of mild steel and certain copper-base alloys. Their production is associated with sudden extension at the yield point. In steel, they are alternatively called Luders Lines.

Temper To modify hardness of metals.

- (a) Adjustment of hardness of heat treated articles by controlled heating after quenching.
- (b) Increase of hardness by cold rolling. The degree of cold rolling is variable depending on the required hardness and is more than that of skin-passing.

Tensile strength or Ultimate tensile strength If a prepared sample of steel is strained in a tensile testing machine until it breaks, then the ultimate tensile strength of the material is obtained by dividing the maximum observed load by the original cross-sectional area of the sample.

BUILDING AND ENGINEERING TERMS

Angle brace A brace that goes from corner to corner in framing. A tie to strengthen the angles of framing.

Apron flashing Sheet used to prevent water from percolating through where a vertical surface pierces a roof.

AS Australian Standard published by Standards Australia.

Astragal A small moulding with a semi-circular section projecting above the surface. Similar to a bead, but raised above the surface. A metal strap used to fasten downpipes to walls.

Backing The dihedral angle of a hip. Shaping the top of a hip to conform to the roof planes.

Balusters The vertical members supporting the handrail on a staircase.

Balustrade A series of balusters in the one flight or along a landing.

Barge board, verge or gable boards The inclined timbers on the gable ends which are fixed to the rafters and cover the ends of the roof timbers.

BT Boundary trap.

Battens Narrow pieces fixed to walls to receive sheeting or on roofs to receive tiles, slates, etc.

Bearers Members supporting the joists in timber framed or brick dwellings.

Bearing That part of the beam resting on the supports.

Bearing plate A stone or metal plate carrying the weight of a beam, etc.

Bell roof A roof shaped like a bell by fixing false feet to the foot of the rafters.

Box frame A window frame with enclosed boxes that contain the balancing weights.

Box gutter A gutter formed in the shape of a trough. It is formed between a roof surface and a parapet wall or between two roof surfaces.

Bracket The ornamental return piece fixed to the face of the string in a stair. A right angle support with angle brace, usually used to support a shelf, etc.

The Referee

Brick veneer A brick facing applied to the outside of a timber structure.

Building paper A waterproof paper used in construction work for insulation or as an undercover for roofs as a protection against weather.

Built-up Laminated work. Built up of several pieces to give the required thickness.

Built-up rib A rib or member that is built up of several thicknesses, usually in brick bond.

Bullnose The edge of a piece of timber, shaped to a quarter circle. A small metal plane with its cutter close to the fore end, used for cleaning up rebates .

Corrugated steel sheet curved on its outer end used as verandah roofing.

Bullnose step The lowest step in a flight of stairs that finishes to the newel in a quarter circle.

Camber To fix a horizontal structural member with a rise at its centre to counteract sagging.

Cant To incline on an angle other than a right angle.

Cantilever Beams that are supported at one end only as for a shop awning.

Cat ladder A ladder fixed vertically to a wall.

Ceiling joist Light member across a room to carry the ceiling sheeting.

Cellar An underground room in a basement used for storage.

Chalk line A long line or string used for setting out long straight lines. When coated with chalk, the ends are held taut, while the centre is lifted away from the surface and allowed to spring back, thus leaving a chalked line on the surface.

Chamfer A 45 degree bevel cut on the arris of timber, sometimes stopped before reaching the end of the timber. When the amount removed is unequal on each face it is called a splay or bevel.

Chord The horizontal member in a bowstring truss. A straight line drawn across a circle with each end touching the circumference.

Clear span The net distance between the walls of an arch or between the walls supporting beams or roof members.

The Referee

Composite Usually applied to roof trusses that are constructed of both timber and steel.

Condensation groove A groove formed for the purpose of collecting condensation on the inside of sashes to allow the moisture to escape to the outside, as in the bottom rail of a skylight.

Cornice The mould at the junction between the wall and the ceiling.

Cramping-up The act of tightening up the joints in framing by means of cramps.

DAR Dressed all round.

Dome A curved roof, semi-circular in elevation over a square, hexagonal, octagonal, or other shaped plan.

Dormer A window projecting from a roof surface.

Eaves The lower edge of a roof slope.

Elastic limit The stage at which a noticeable permanent set occurs when the material is loaded.

Elevation The part of a drawing which shows the front view, giving length and height.

Ellipse An oval. The figure produced by a cutting plane passing obliquely through a cylinder or a cone.

Factor of safety An arranged increase in size or strength of the member above that at which it is known to fail.

Fascia The upright board fixed to the feet of the rafters to carry the guttering. Any wide board fixed on edge.

Fibre cement A building board composed of cellulose fibres and cement.

Flashings Galvanized steel, lead, zinc sheet, etc. used to prevent water seeping through to an interior surface. Lead, however, should not be used with ZINCALUME sheet.

Footing The lowest part of a building, an enlargement at the base of a wall to distribute the load over a greater area.

Foundation The soil or strata which supports the lowest part of a building – ie. the footings.

The Referee

Gable The triangular end of a building above the plate line with the rafters meeting the apex at the ridge.

Gable roof A roof having two slopes only with a gable at each end.

Galvanizing The process in which steel is coated to prevent corrosion by (a) dipping it into a molten zinc bath or (b) electroplating with zinc.

GCI Galvanized corrugated iron, the old term for zinc-coated corrugated steel sheet and now usually but inaccurately used for corrugated ZINCALUME zinc/aluminium alloy-coated steel.

Girt Horizontal members in a wall used to support wall sheeting.

Gutter The spouting, or valley gutter, a channel formed to collect and carry away rain water off a roof.

Gypsum board A wallboard made from plaster of paris and covered with a stiff paper.

Hammer beam The lower cantilever member in the roof truss of the same name.

Hip The external angle formed on a roof where two inclined surfaces meet.

Hipped roof A roof with its ends inclined as well as its sides.

Hip rafter The inclined member at the intersection of two roof surfaces.

Jack rafter The rafters running from a wall plate to the end of a ridge (sometimes called crown end rafters).

Jambs The vertical sides of openings or the vertical timbers fixed to the jambs of the opening.

Joists Timbers of small section spanning a room, either to carry the floor or the ceiling.

King post The central vertical member of a roof truss, that from the centre of the tie beam to the apex of the roof.

Knee A curve in a handrail, convex on top and shaped in the form of a human knee.

Lean-to or Skillion A roof with only one slope, formerly when used against another building, but now applied to any roof with a single slope.

Lintel A horizontal member, steel or concrete, across an opening, usually to carry the wall above.

The Referee

Live load A moving or variable load on a floor or beam.

Mansard roof A form of roof having a break in the slope, the lower part being steeper than the upper.

Mullion The vertical dividing member in a window or door frame.

Nogging Horizontal pieces fixed between studs for bracing and to which plaster sheeting, skirting, etc. can be fixed.

Parapet gutter A gutter or water channel formed against a parapet wall at the bottom of a roof slope.

Party wall A wall between two adjoining properties, built half on one and half on the other; a wall separating one house from another.

Plaster board A wall board made of plaster and covered on both sides with heavy paper.

Plate A horizontal member in structural framework, a level piece that carries the vertical pieces.

Plumb To make perpendicular; in a perpendicular position.

Purlin The horizontal member supporting the common rafters in a roof which in turn is supported off the walls by struts or battens in industrial buildings supporting roof sheets.

Rafters The inclined members of a roof between the plate and the ridge which support the roof covering.

Roof truss A framed construction in a roof.

Sarking Boards nailed on as a roof covering before sheeting with other material such as lead, copper, zinc, etc.

Saw tooth roof A roof that in profile is the shape of the teeth of a saw. A trussed construction.

Scissors truss A roof truss so named because of its resemblance to a pair of scissors.

Skew At an angle or out of square.

Skew nailing Nails driven in at an angle to the surface to give greater holding power.

Skirting The moulded baseboard around a room.

The Referee

Span The horizontal distance between two supports as the springing points in an arch.

Spouting See Guttering.

Stanchion A steel or iron support for a beam.

Tilting batten A batten cut diagonally from a 75mm x 38mm timber and used at the eaves to tilt the bottom course of tiles so that the ones immediately above will have a firm seating.

Truss A triangulated frame for carrying a roof over a large span.

Trussed beam A beam formed of two timbers with triangulated strutting between, formed to distribute the load.

UB Universal beam.

UC Universal column

Valley The angle formed by two internal slopes of a roof.

Valley boards Boards nailed to the surface of the roof at the internal intersection of two roof surfaces.

Valley rafter The inclined member in a roof at the internal intersection of two roof surfaces.

Weep hole Joints in brickwork left free of mortar or a small hole bored through a trench in a window sill to allow the escape of water.

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