

When composites are used in contact with other materials (e.g. lining steel or concrete tanks), differences in the CTE of the materials must be considered. The CTE of composites is dependent on the type of reinforcement (e.g. glass, carbon, aramid), the form of reinforcement (e.g. mat, unidirectional roving, fabric etc.), the orientation of the reinforcement, and the quantity of reinforcement. While composites made from randomly distributed reinforcements (namely chopped fibres and chopped strand mat) have the same CTE in all directions, the CTE of anisotropic composites varies with direction. The CTE of composites decreases with increasing reinforcement content, particularly when carbon and aramid fibres are used due to their negative CTE.

**Table 7** Indicative thermal properties

Property	Polyester resin un-reinforced	Vinylester resin un-reinforced	Epoxy resin un-reinforced	E glass fibres	Aramid fibres	Carbon fibres
Heat distortion temperature (°C)	25–140	100–149	45–250	850	NA	NA
Thermal conductivity (K-Values: W/m°C)	0.17–0.21	0.18	0.21	1.04	4.11	-
Coefficient of linear thermal expansion (x 10 <sup>-6</sup> mm/mm/°C)	62–180	51–65	80–120	4.9–5	-2 to -6	-0.5 to -1.5
Specific heat (calorie/g/°C)	0.30	-	0.25	-	0.34	-

**Table 8** Effect of temperature on mechanical properties of resin with acknowledgement to Ashland, values taken from HETRON® and AROPOL™ Resin Selection Guide

Temperature (°C)	Property of un-reinforced resin (indicative only)			
	Tensile strength (MPa)	Tensile modulus (GPa)	Flexural strength (MPa)	Flexural modulus (GPa)
-43	117	9	160	7
25	109	10	154	6
65	147	9	163	6
95	147	8	150	6
120	121	6	82	4
150	74	5	23	0

## 5.8 Chemical properties

With the correct resin selection, laminate design and construction composites can withstand exposure to a wide range of acids, bases, chlorides, solvents, and oxidizers covering the pH scale from 0 to 14. In general, higher chemical concentrations and temperatures result in lower durability of composites. The resin plays the biggest role in resisting chemicals and the recommended resistance of each resin is given in chemical resistance guides of the suppliers found at the following URLs:

- [www.hetron.com](http://www.hetron.com)
- [www.derakane.com](http://www.derakane.com)
- [www.swancor.com](http://www.swancor.com)
- [www.cvk.co.kr](http://www.cvk.co.kr)
- [www.scottbader.com](http://www.scottbader.com)
- [www.reichhold.com](http://www.reichhold.com)



FRP filtration pressure cylinder for filtering a range of chemicals and water  
Image courtesy of A.C.Whalan Composites

The following table lists some of the chemicals in which composites have been successfully used. It is intended as a general guide and is in no way exhaustive. It does not imply suitability or approval for any given application. Furthermore, combinations of chemicals are often used in chemical or minerals processing plants and the performance of a resin in a combination of chemicals can be different from that of the two chemicals individually. Therefore, a material selection study should be completed and approval from the resin supplier obtained at the design stage.

**Table 9** List of chemicals in which composites have been used

Acetic acid	Carbon dioxide, aqueous
Adipic acid	Carbon tetrachloride
Alum (aluminium potassium sulphate)	Casein
Aluminium chloride, aqueous	Caustic potash (KOH)
Ammonia, aqueous	Chlorine, dry gas
Ammonium chloride, aqueous	Chlorine, water
Ammonium fluoride	Chlorine wet gas
Ammonium nitrate, aqueous	Chloroacetic acid
Ammonium phosphate monobasic, aqueous	Citric acid, aqueous
Ammonium sulphate, aqueous	Copper acetate, aqueous
Aniline hydrochloride	Copper chloride, aqueous
Antimony trichloride	Copper cyanide
Barium carbonate	Copper nitrate, aqueous
Barium chloride	Copper sulphate, aqueous
Barium sulphate	Crude oil (sour)
Beet sugar liquor	Crude oil (sweet)
Benzene sulfonic acid	Crude oil, salt water
Benzoic acid	Cyclohexane
Black liquor (paper)	Dibutyl sebacate
Bleach	Dibutylphthalate
Borax	Diesel fuel
Boric acid	Diocetyl phthalate
Bromine, aqueous	Ethylene glycol
Butyric acid	Ferric chloride, aqueous
Calcium bisulfide	Ferric nitrate, aqueous
Calcium carbonate	Ferric sulphate, aqueous
Calcium chloride	Ferrous sulphate, aqueous
Calcium hydroxide	Formaldehyde
Calcium hypochlorite	Fuel oil
Calcium nitrate	Gasoline, ethyl
Calcium sulphate NL AOC	Glycerine
Cane sugar liquors	Green liquor, aper



*Corrosion resistant fibre composite processing tanks for CAWSE Nickel Mine*

Image courtesy of Buchanan Advanced Composites



*'Webglas GC+' fibreglass roof sheeting and wall cladding installed at Xstrata Townsville Copper Refinery*

Image courtesy of Ampelite Australia Pty Ltd



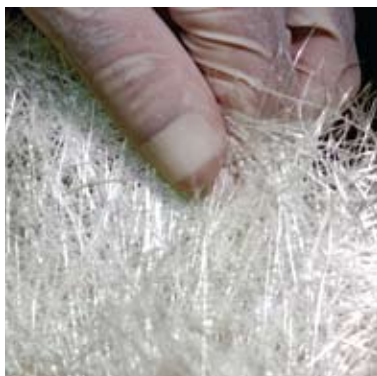
*L-R 4 x 2 GRP Electrostatic Mist Preceptors 6.5 m diameter x 18 m high, halide tower and gas cooling tower*

Image courtesy of Kalgoorlie Nickel Smelter

Hexane  
 Hydro bromic acid  
 Hydrochloric acid, up to 15%  
 Hydrofluoric acid  
 Hydrogen sulphide, dry  
 Kerosene  
 Lactic acid  
 Lactic acid  
 Lauric acid  
 Lauryl chloride  
 Lead acetate, aqueous  
 Lead acetate, aqueous  
 Lead nitrate  
 Lead sulphate  
 Linseed oil  
 Lithium bromide, aqueous  
 Lithium chloride, aqueous  
 Magnesium bicarbonate, aqueous  
 Magnesium carbonate  
 Magnesium nitrate, aqueous  
 Magnesium sulphate  
 Manganese chloride, aqueous  
 Manganese sulphate, aqueous  
 Mercuric chloride, aqueous  
 Mercurous chloride, aqueous  
 Mineral oils  
 n-Heptane  
 Naphthalene  
 Naphtha  
 Nickel chloride, aqueous

Nickel nitrate, aqueous  
 Nickel sulphate, aqueous  
 Nitric acid  
 Oleic acid  
 Oxalic acid, aqueous  
 Paraffin  
 Perchloric acid  
 Petroleum, refined and sour  
 Phosphoric acid  
 Phosphoric acid  
 Phthalic acid  
 Potassium permanganate  
 Potassium bicarbonate  
 Potassium bromide, aqueous  
 Potassium chloride, aqueous  
 Potassium dichromate, aqueous  
 Potassium ferrocyanide  
 Potassium ferrocyanide, aqueous  
 Potassium nitrate, aqueous  
 Potassium sulphate  
 Propylene glycol  
 Sea water  
 Sewage  
 Silicone oil  
 Silver nitrate, aqueous  
 Sodium bromide, aqueous  
 Sodium chloride, aqueous  
 Sodium dichromate  
 Sodium ferrocyanide  
 Sodium hydroxide

Sodium mono-phosphate  
 Sodium nitrate, aqueous  
 Sodium nitrite, aqueous  
 Sodium silicate  
 Sodium tetraborate  
 Stannic chloride, aqueous  
 Stannous chloride, aqueous  
 Stearic acid  
 Sulphur  
 Sulphuric acid  
 Tannic acid, aqueous  
 Tartaric acid  
 Toluene sulfonic acid  
 Tributyl phosphate  
 Triethanolamine  
 Triethylamine  
 Turpentine  
 Urea, (aqueous)  
 Vinegar  
 Water, distilled  
 Water, potable  
 Water, sea  
 Zinc chloride, aqueous  
 Zinc nitrate, aqueous.



*Chop strand fibreglass provides strength in all directions and good inter-laminar adhesion*

In addition to chemical exposure, many composite pipes and vessels have been tested and approved to AS 4020 for use with potable water. Suppliers of raw materials which are used in composites have also had certain products tested and approved to AS 4020.

In chemical environments outside the ability of composites, a thermoplastic liner can be installed. Such a system is sometimes referred to as a dual laminate. The liner may be made from a number of plastics including polyvinyl chloride (PVC), polypropylene or a fluorinated polymer such as polyvinylidene fluoride (PVDF) or polytetrafluoroethylene (PTFE or Teflon). It is a good idea to test the suitability of the liner, in terms of corrosion and erosion, in the operating fluid while the material is under a load. Many of the lining materials are supplied with a glass backing to allow for bonding to the composite surface.

## 5.9 Electrical properties

Composites are electrically insulating. They are therefore used in the electrical insulating of process equipments that have high electric currents or voltages (e.g. aluminium smelting, electrowinning). Cured resins have high permittivity and low dissipation factors. Non-conductive fillers can increase the arc resistance, and to some extent increase the dielectric constant of a composite.

*Table 10 Indicative electrical properties of composites*

Property	Indicative value for composite material
Dielectric strength (kV/25 mm)	225–350
Volume resistivity ( $\Omega$ /cm)	1012–1015 (PE)
Permittivity (Hz)	4.2–4.8 (PE 60Hz)
	4.1–4.5 (PE 1 kHz)
	4.0–5.2 (PE 1MHz)

In other applications, conductivity may be required. Static charge can build-up in stacks, tanks, pipes and ducts, so static dissipation and grounding of this equipment is critical. This is particularly applicable in solvent extraction, since the solvent used is non-conductive and a build-up of charge can initiate a fire. Electrostatic mist precipitators also require conductive laminates.

To make a conductive composite, carbon surfacing veil saturated with resin containing 5–15 wt per cent of carbon, graphite or metallic filler is used. The filler must be uniformly distributed in the resin with continuity across its joints as well as grounding through to the exterior of the equipment. Titanium or stainless steel bolts are inherently conductive, so can be used with conductive composite laminates. Where putties are used, putties can be made conductive by the incorporation of carbon/graphite filler into the putty. For some vessels, a vertical or horizontal strip of conductive material may be adequate to ensure conductivity. More information can be found in the static electricity code AS/NZS 1020 on the control of undesirable static electricity.

## 5.10 Performance of composites in fire

Since most resins used in composites are petroleum-based, composites can burn. To improve the performance of composites in a fire, fire-retardant resins are available including Hetron FR992, Hetron 197 or Derakane 510A and 510C. These are typically used for the internal layers of ducts for the transportation of flammable gases and for the external layer of some tanks.

Composites are generally poor thermal conductors, so the heat of a fire does not spread to the extent it does with metals. The lower mass of composite material required to provide the same strength of alternative materials can also mean a

*Fire retardant and/or low toxicity resins should be used where appropriate.*

reduced quantity of combustible material contributing to a fire. The smoke from a fire involving composites can be harmful, however, so fire retardant and/or low toxicity resins should be used where appropriate.

There are a number of tests to evaluate the performance of resins in fire. Cone calorimeter testing is becoming more widely used compared to the traditional Australian Standard AS1530 point 3, Test for Early Fire Hazard Properties of Materials. Results will vary from laminate to laminate depending on the glass content, glass placement and degree of cure. Properties which indicate the performance of composite in a fire are given in the table below.

Another test that relates to fire performance is ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials. This gives a value for flame spread categorised under three classes, with Class I being the best rating. Class I refers to 0 to 25 flame spread, Class II refers to above 25 to 75 flame spread, and Class III refers to a flame spread of over 75.

It must be noted modifications to improve the performance of resins in a fire can adversely affect other properties. For example, fire-retardant resins have lower resistance to weathering than standard resins, can have lower chemical resistance and are usually more costly. Fire-retardant composites are also usually opaque, limiting the ability to inspect composite equipment.

**Table 11** AS1530 Properties un-reinforced resins with acknowledgement to Nupol composites

Resin	Tendency to ignite	Heat developed	Flame spread	Smoke
Range (0 = best fire performance)	(0–20)	(0–10)	(0–10)	(0–10)
Polyester resin HETRON® 197	12	0	1	7
Polyester resin ESTAREZ® 244PA	14	0	2	5
Polyester resin ESTAREZ® 4065P	15	9	10	7
Polyester resin ESTAREZ® 6012P	0	0	0	7

**Table 12** Flame spread values of materials with acknowledgement to Ashland, with values taken from HETRON® and AROPOL™ Resin selection guide

Product	Flame Spread	Class
Asbestos/cement	0	I
Red oak lumber	100	III
Plywood	200	III
Halogenated vinyl ester (without antimony trioxide) † HETRON® FR998/35	<25	I
Halogenated vinyl ester (with 3% antimony trioxide) † HETRON® FR992	<25	I
Chlorendic polyester (without antimony trioxide) † HETRON® 92FR	<25	I
Chlorendic polyester (with 3–5% antimony trioxide) † HETRON® 197	30	II
Non-halogenated polyester and vinyl ester resins†	350–400	III

† 3 mm thick laminated composite with approximately 30 per cent chopped glass mat

## 5.11 UV resistance

Ultraviolet radiation from outdoor exposure can cause chalking of the outside layer of composites and degrade composites given sufficient time. While gel coats are used in the marine and automotive industries to protect composites, this expense is spared in industrial applications. In industrial applications pigment can be incorporated into the final layer of composites to prevent degradation. As the addition of pigment makes the outer layer opaque, it limits the ability to

visually inspect composites. Therefore, this layer should be applied after all quality assurance checks are complete. Alternatively, UV inhibitors or other additives can be incorporated into the resin of the outer layer to protect composites from UV degradation, while still allowing visual inspection for quality assurance and condition assessment.



*Capping boards for electro-winning cells installed at MICC Copper Refinery, Burma*

Image courtesy of Marky Industries Pty Ltd

### 5.12 Working with composites on site

Many tools can be used with composites, including drills, grinders and saws used for working with traditional materials on site. Traditional grinders and saws can be used to trim composites to size and drills can be used for bolt holes. Repair of composites is relatively straight forward using suitable resins and reinforcements (i.e. for patches). Composites cannot be welded by traditional methods, but can be bonded with adhesives. All cut edges should be sealed with resin to prevent fluids entering the laminate.

Research has been conducted into the health and safety aspects of working with, and in particular cutting, glass fibres. Fibres such as asbestos cause damage to the lungs, as they break down into particles small enough to enter the lungs. Glass fibres, on the other hand, do not break down into particles small enough to enter the lungs. Glass fibres are therefore classified as non-respirable and present little concern in terms of lung disease.

Composite materials, including the resins, are temperature-dependent and the temperature should be between 10 and 35°C in order to cure them properly. If work is required outside this temperature range, special care must be taken to achieve a satisfactory cure. On-site storage of composite raw materials requires careful consideration, as reinforcements must be dry and free from contamination and resins must be stored according to regulations.

### 5.13 Inspection and testing

As the composite material is made at the same time as the part, quality control throughout all stages, from design, manufacture, transport, installation and to after use, is particularly important. Manufacturers should have an inspection and test plan documenting quality control activities, controlling procedures, acceptance criteria, verifying documents and personnel involved. The principal stages of inspection, which may apply depending on the size and nature of the project, are:

1. Review of procedures, documentation and design, including design validation testing.
2. Inspection and testing during manufacture:
  - a. Identification of materials of construction and inspection of their storage conditions and the workshop conditions.
  - b. Inspection of work records relating to the control and issue of materials and the manufacturing process. This can include the records of resin type and quantity, glass type and quantity for each layer, personnel involved in the manufacture, curing system, resin gel time and cure time.
  - c. Approval of laminating procedures, tests for operators and the checking of validating documents.
  - d. Examination during manufacture for each manufacturing method and also for joints and fittings.
  - e. Inspection of any repairs.
3. Examination on completion of manufacture/factory acceptance tests.
4. Inspection upon receipt of goods.
5. Installation and commissioning inspection and tests—inspection of joints and fittings, hydrotesting, spark testing.
6. Condition assessment testing after time in operation.

Various tests are available for quality control during manufacture, and for condition assessment of composite equipment which have been in service for some time. AS/NZS 3572 Plastics—glass filament reinforced plastics (GRP)—Methods of Test is a useful standard for material qualification testing. This contains 24 different tests for composites, from tensile strength to chemical resistance.

Typical manufacture and factory acceptance tests include:

- visual examination to meet the relevant standard and specification. This can include visual examination of nozzle cut-outs. Permissible limits for laminate defects are given in BS7159 and ASTM2563
- verification of cure via Barcol hardness testing to AS/NZS 3572.22
- verification of cure via acetone testing
- verification of glass to resin ratio via loss on ignition testing (ash testing). This can be done on nozzle cut outs
- dimensional surveys and wall thickness determination. In particular, points of discontinuity (e.g. nozzles, fittings). should be measured
- mechanical tests that can include tensile strength, modulus, compressive strength and lap shear strength
- conductivity tests
- Differential Scanning Calorimeter (DSC) test of the resin
- static head test, hydrostatic testing test and vacuum test as required, using the methods given in the applicable standard.

There are also non-destructive test methods available to assess the condition of composites on site and/or which have been in service for some time. Commonly used techniques are:

- visual inspection
- “tap” testing
- barcol hardness testing
- ultrasonic testing
- acoustic emission testing.



*Pultruded fibreglass floor and wall grating and structural I-Beam*

Products installed at Incitec Pivot (Gibson Island) by Glass Reinforced Products Australia

## 6 Economic comparison

The cost of composites compared to other materials varies with the application. Often in corrosive environments, where the alternative materials are stainless steel or alloys, the capital cost of composites is lower. In other applications, composites may present a higher upfront cost but a lower lifetime cost. As the price of steel has increased in recent years, the balance has shifted somewhat in favour of composites. The following two examples are taken from cost comparisons performed for an Australian minerals processing company in 2007.

Costs were obtained for the manufacture, in a range of materials, of a quench tower pump tank using 70°C sulphuric acid. The 3 m diameter, 5 m high tank required a wall thickness of 6 mm for a steel tank, and 15 mm for a composite tank. Despite the thicker walls, the weight of the composite tank was approximately half that of the steel tank due to the specific gravity of composites and steel of 1.6 and 7.85 respectively. This data was used in obtaining the following cost estimates:

**Table 13** Cost comparison of materials for a tank

Tank material	Tank cost	Cost ratio
SAF2205 stainless steel	\$130,467	1.3
316 stainless steel	\$110,897	1.1
Mild steel	\$58,710	0.6
Composite	\$99,720	1.0

Since the process fluids contained chlorine and fluorine in addition to the acid, mild steel was not an option, which resulted in composites being the least expensive option. These figures were only based on fabrication costs. Further savings can be made when installation cost and lifetime cost are considered. The light weight of composites reduces installation costs, as it enables reduced transportation costs, the use of lighter cranes and easier installation in areas difficult to access. The proven corrosion resistance of composites tends to result in longer lifetimes in corrosive environments, which reduces maintenance costs.

The same company also made cost comparisons for a 150 mm diameter, schedule 10 (700 kPa) pipe, 12 m long, with one flange, one 90° elbow, two joints/welds and two mild steel supports to be used in the same chemical service. The table below shows the result of the cost calculations for various materials.

**Table 14** Cost comparison of materials for pipe

Tank material	Fabrication	Installation	Supply and installation
SAF2205 stainless steel	6.3	1.1	3.6
316 stainless steel	1.6	1.1	1.4
Composite	1.0	1.0	1.0

In this particular example, composites were lower in cost to fabricate and install than the alternative materials, 316 stainless steel and SAF2205 stainless steel.

## 7 Environmental comparison

A thorough comparison of the environmental costs of composites compared to alternative materials is beyond the scope of this document. However, the following points provide some guidance:

- using composites in place of materials such as steel and aluminium results in a significant reduction in environmental impact. While materials such as steel are produced using heat, composite parts are manufactured using a chemical curing process
- the manufacture of composite materials requires only a fraction of the oil used in the production of other resins. The manufacture of a high value construction product from this oil is considered a good use of resources
- the light weight of composites has a number of environmental advantages. For example, the use of composites in trucks and mobile plant equipments results in reduced fuel consumption. The need for supporting structures for composite materials is also relatively lower than for other materials
- the long lifetimes of corrosion-resistant composites reduces the need to replace equipment due to corrosion
- unlike thermoplastics or aluminium, composites cannot be easily recycled or broken down by biological means. Their durability, an advantage in some respects, is a disadvantage in terms of the ability to recycle the materials. Composites can be used as a fuel source at the end of life.



*'Wonderglas GC' clear fibreglass roof sheeting installed at the Toowoomba Sludge Drying Facility*

Image courtesy of Ampelite Australia Pty Ltd



*Maxiflow MV Vent Duct used in underground mining*

Image courtesy of A.C.Whalan Composites

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*Wagners Composite Fibre 100 x 100 mm pultruded sections*

Image courtesy of  
Wagners CFT Manufacturing Pty Ltd

## 9 Australian manufacturers of composite industrial products

Manufacturer	Products
<b>Queensland</b>	
<b>A.C. Whalan &amp; Co Pty Ltd</b> 28 Fursden St, Glenella Queensland 4740 Telephone +61 7 4942 5588 Facsimile +61 7 4942 5611 mackaysales@acwhalan.com.au www.acwhalan.com.au	<ul style="list-style-type: none"> <li>• bore hole casings</li> <li>• ducting (ventilation)</li> <li>• flues</li> <li>• panels</li> <li>• pipes</li> </ul>
<b>All Fibreglass Products Pty Ltd</b> 13 Strathvale Court, Caboolture Queensland 4510 Telephone +61 7 5495 7866 Facsimile +61 7 5495 2764 davidallfibre@ozemail.com.au www.allfibre.com.au	<ul style="list-style-type: none"> <li>• odour control units</li> <li>• scrubbers</li> <li>• tanks (water)</li> </ul>
<b>Amalgamated Plastic Engineering Pty Ltd</b> H2 Home and Centre, Vanity Street, Toowoomba Queensland 4350 Telephone +61 7 4633 1921 Facsimile +61 7 4633 1921 shane@apeplastics.com.au www.apeplastics.com.au	<ul style="list-style-type: none"> <li>• tanks (water, chemical and molasses)</li> </ul>
<b>Ampelite Fibreglass Pty Ltd</b> 43 Ellerslie Road, Meadowbrook Queensland 4131 Telephone +61 7 3808 6211 Facsimile +61 7 3808 4799 Unit 2, 29 Reward Court, Bohle, Townsville Queensland 4818 Telephone +61 7 4774 5007 Facsimile +61 7 4774 7898 sales@ampelite.com.au www.ampelite.com.au	<ul style="list-style-type: none"> <li>• sheeting (roof and wall)</li> </ul>
<b>APTEC Composites Pty Ltd</b> 17 Reynolds St, Mareeba Queensland 4881 Telephone +61 7 4092 4456 Facsimile +61 7 4092 4924 sales@apteccomposites.com www.apteccomposites.com	<ul style="list-style-type: none"> <li>• process vessels</li> <li>• scrubbers</li> <li>• tanks (chemical)</li> <li>• vent ducts</li> </ul>
<b>Austral-Powerflo Solutions Pty Ltd</b> 3/944 Nudgee Road, Banyo Queensland 4014 Telephone +61 7 3267 1328 Facsimile +61 7 3267 1340 aesqld@australeng.com.au www.australeng.com.au	<ul style="list-style-type: none"> <li>• valves (control and safety)</li> </ul>
<b>BAC Technologies Pty Ltd,</b> Trading as BAC Advanced Composites Technologies 9 Production Court, Toowoomba Queensland 4350 Telephone +61 7 4633 1856 Facsimile +61 7 4633 1115 bac@bac.net.au www.bac.net.au	<ul style="list-style-type: none"> <li>• cyclones</li> <li>• flooring</li> <li>• grates</li> <li>• ladders</li> <li>• panels</li> <li>• process vessels</li> <li>• rails</li> <li>• scrubbers</li> <li>• tanks (chemical)</li> <li>• truck bonnets</li> </ul>
<b>Composite and Plastic Solutions Pty Ltd</b> 3/780 Ingham Rd, Bohle, Townsville Queensland 4818 Telephone +61 7 4774 4815 Facsimile +61 7 4774 4816	<ul style="list-style-type: none"> <li>• coatings (bund and floor)</li> <li>• fittings</li> <li>• flanges</li> <li>• linings</li> <li>• tanks</li> </ul>

<p><b>Composite Solutions Pty Ltd</b>  13 Palings Court, Nerang Queensland 4211  Telephone +61 7 5502 0999  Facsimile +61 7 5502 0998  rob@composite solutions.com.au  www.compositesolutions.com.au</p>	<ul style="list-style-type: none"> <li>• industrial water management products (floodgates)</li> </ul>
<p><b>CQ Fibreglass Direct</b>  Shed 3, 41-45 Jabiru Drive, Yeppoon Queensland 4703  Telephone +61 7 4939 8444  Facsimile +61 7 4939 2544  cqfd@bigpond.com</p>	<ul style="list-style-type: none"> <li>• Vent ducts</li> </ul>
<p><b>Downer EDI Mining — Mineral Technologies Pty Ltd</b>  11 Elysium Road, Carrara Queensland 4211  Telephone +61 7 5569 1300  Facsimile +61 7 5525 3810  mineraltechnologies@downeredimining.com  www.mineraltechnologies.com.au</p>	<ul style="list-style-type: none"> <li>• MD Gravity separation equipment</li> <li>• Carrara Electrostatic separation equipment</li> <li>• Readings Magnetic separation equipment</li> <li>• Gemini Wet shaking tables</li> <li>• Contero ultra-fine grinding mill</li> <li>• Kelsey enhanced gravity jig</li> <li>• trommels</li> <li>• bucket elevators</li> <li>• conveyors</li> </ul>
<p><b>Exel Composites</b>  15 Ada Street, Coopers Plains Queensland 4107  Telephone +61 7 3274 1099  Facsimile +61 7 3274 2041  office.brisbane@exel.net  www.exelcomposites.net</p>	<ul style="list-style-type: none"> <li>• cable supports</li> <li>• covers</li> <li>• flooring</li> <li>• moulded gratings</li> <li>• handrails</li> <li>• ladders</li> <li>• reinforcing</li> <li>• rock bolts</li> <li>• stairs and stair treads</li> <li>• tool handles</li> </ul>
<p><b>Felco Manufacturing Pty Ltd</b>  32–34 Boothby St, Toowoomba Queensland 4350  Telephone +61 7 4630 2213  Facsimile +61 7 4630 2183  felco@bigpond.com  www.felco.net.au</p>	<ul style="list-style-type: none"> <li>• tankers</li> <li>• tanks (chemical, water and other)</li> </ul>
<p><b>Glass Reinforced Products Australia Pty Ltd</b>  Bay 10/25 Export St, Lytton Queensland 4178  Telephone +61 417 711 073  don@grpaustralia.com.au  www.grpaustralia.com.au</p>	<ul style="list-style-type: none"> <li>• moulded and pultruded gratings and profiles used as: <ul style="list-style-type: none"> <li>– anti-slip floors, stair treads, foot bridges</li> <li>– operation platforms, trench covers</li> <li>– off-shore oil rigs, shipyards, shipping decks, ceilings</li> <li>– security and safety fences, handrails</li> <li>– ramp ladders, scaffold, railway footpaths</li> <li>– decorative grids, fountains, pool grids</li> </ul> </li> </ul>
<p><b>Marky Industries Pty Ltd</b>  1 Magnesium Drive, Crestmead Queensland 4132  Telephone +61 7 3803 6244  Facsimile +61 7 3803 6360  martin@marky.com.au  www.marky.com.au</p>	<ul style="list-style-type: none"> <li>• baskets</li> <li>• booms</li> <li>• electrowinning cells</li> <li>• settlers</li> <li>• tanks (acid and chemical)</li> <li>• truck bonnets</li> </ul>
<p><b>Murraycraft Fibreglass</b>  1 Rockleigh Court, Glenella Queensland 4741  Telephone +61 7 4942 6400  Facsimile +61 7 4942 6350  murraycraft@optusnet.com.au</p>	<ul style="list-style-type: none"> <li>• ducting (air, coalmine, ventilation)</li> <li>• hoppers</li> <li>• pipes (sewerage and water)</li> <li>• tanks (chemical and water)</li> </ul>
<p><b>Pritchard Composites Pty Ltd</b>  37 Activity Street, Acacia Ridge Queensland 4110  Telephone +61 7 3219 8111  Facsimile +61 7 3219 8555  mail@pritchard.com.au</p>	<ul style="list-style-type: none"> <li>• cooling towers</li> <li>• tanks</li> </ul>
<p><b>Ron Gee Enterprises Pty Ltd</b>  461–465 Woolcock St, Garbutt Queensland 4814  Telephone +61 7 4775 5858  Facsimile +61 7 4775 5875  qld@rge.com.au  www.rge.com.au</p>	<ul style="list-style-type: none"> <li>• bore hole casings</li> <li>• bunds</li> <li>• channels</li> <li>• cyclones</li> <li>• drains</li> <li>• ducts</li> <li>• flooring</li> <li>• ladders</li> <li>• linings (pipe and tank)</li> <li>• panels</li> <li>• pipes</li> <li>• pits</li> <li>• process vessels</li> <li>• scrubbers</li> <li>• stacks</li> <li>• tanks</li> <li>• vents</li> </ul>

**Splash Plastic Fibreglass Products Pty Ltd**

Shed 1, 22 Musgrave Rd, Coopers Plains Queensland 4108  
 Telephone +61 411 354 180  
 splashplastics@bigpond.com.au

- coatings (floor and bund coatings)
- ducts
- linings
- pipes
- panels
- process vessels
- scrubbers
- stacks
- tanks
- truck bonnets

**Teakle Composites**

Level 2, Technology Transfer Building,  
 Queensland Centre for Advanced Technology,  
 1 Technology Court, Pullenvale Queensland 4069  
 Telephone +61 7 3378 4573  
 p.teakle@teaklecomposites.com.au  
 www.teaklecomposites.com.au

- bore hole liners
- drill rods
- pipes

**Wagners Composite Fibre Technologies**

PO Box 151, Drayton Queensland 4350  
 Telephone +61 7 4637 7777  
 Facsimile +61 7 4637 7778  
 www.wagner.com.au

- bridges (pedestrian and road)
- conveyors
- cross arms (power poles)
- flooring

**Windspeed Corporation**

PO Box 10, Beachmere Queensland 4510  
 Telephone +61 407 378 988  
 info@windspeed.com.au  
 www.windspeed.com.au

- panels

**New South Wales****A.C. Whalan & Co Pty Ltd**

1215 Castlereagh Highway,  
 Lidsdale New South Wales 2790  
 Telephone +61 2 6355 1001  
 Facsimile +61 2 6355 1010  
 sales@acwhalan.com.au  
 www.acwhalan.com.au

- bore hole casings
- ducting (ventilation)
- flues
- panels
- pipes

**Aco Polycrete Pty Ltd**

Telephone +61 1300 765 226  
 www.acoaus.com.au

- access covers
- bunds
- electrical cable jointing and drawing pits
- polymer concrete drains
- railway sleepers
- ramps
- trays

**Alminco Pty Ltd**

503–505 Princes Highway, Fairy Meadow New South Wales 2518  
 Telephone +61 2 4255 8600  
 Facsimile +61 2 4284 7783  
 michael.hart@alminco.com.au  
 www.alminco.com.au

- ducts
- pipes
- tanks

**Alsynite Roofing Products Pty Ltd**

PO Box 4754, North Rocks New South Wales 2151  
 Telephone +61 2 9890 9922  
 Facsimile +61 2 9683 5031  
 admin@alsynite.com  
 www.alsynite.com.au

- linings (pipe and tank)
- sheeting (roof and wall)

**Ampelite Australia Pty Ltd**

31 Sunblest Crescent, Mt Druitt New South Wales 2770  
 Telephone +61 2 9625 7200  
 Facsimile +61 2 9625 7211  
 sales@ampelite.com.au  
 www.ampelite.com.au

- sheeting (roof and wall)

**Armor Utility Structures Pty Ltd**

2/461 The Boulevard, Kirrawee New South Wales 2232  
 Telephone +61 2 9521 1901  
 Facsimile +61 2 9521 1941

- conveyor rollers
- power pole

**Baron Fibreglass**

2/64 Heather Street, Heatherbrae New South Wales 2324  
 Telephone +61 2 4987 1818  
 Facsimile +61 2 4987 2987  
 info@baronfibreglass.com.au  
 www.baronfibreglass.com.au

- corrosion resistant floor coatings
- fire retardant and anti-static GRP components suitable for underground mines
- tanks and vessels

**Craft Fibreglass Composites**

30–32 Fairfield St, Villawood New South Wales 2163  
 Telephone +61 2 9632 1100  
 Facsimile +61 2 9632 9955  
 info@craftfibreglass.com.au  
 www.craftfibreglass.com.au

- architectural mouldings
- building panels
- bunds
- channels
- covers
- drains
- ducts
- flooring
- grates
- linings (pipe and tank)
- pipes
- pits
- poles
- scrubbers
- tanks
- tubes
- vents

**EPTEC**

463–467 Harris St, Ultimo New South Wales 2007  
 Telephone +61 2 9034 6969  
 Facsimile +61 2 9034 6970  
 eptec@eptec.com.au  
 www.eptec.com.au

- pipe and ducting
- structural and corrosion resistant pipe and tunnel lining systems
- lightweight and corrosion resistant plant covers and walkways
- structural and geotechnical reinforcement
- ballistic protection
- underground fuel tank re-lining

**FCV Powerflow Pty Ltd**

Ermington, New South Wales  
 Telephone +61 2 9666 702X  
 Facsimile +61 2 9666 7011  
 www.nilcor.com/australia.html

- valves

**CST Composites**

PO Box 651, Caringbah New South Wales 1495  
 Telephone +61 2 9668 8488  
 Facsimile +61 2 9668 8499  
 www.compositespars.com

- rollers
- tubes

**Fiberglass (A/Asia)**

563 Willoughby Rd, Willoughby New South Wales 2068  
 Telephone +61 2 9958 5238  
 Facsimile +61 2 9958 0838

- bunds
- tanks

**Fibretank Systems Pty Ltd**

52 Parker Street, Carrington New South Wales 2294  
 Telephone +61 2 4961 2745  
 Facsimile +61 2 4962 2812  
 sales@ftstanks.com  
 www.ftstanks.com

- tanks

**Gebel Chemquip**

19–21 Clarke Street, Parkes New South Wales 2870  
 Telephone +61 2 6862 4866 Toll Free 1300 139 971  
 Facsimile +61 2 6863 5766  
 sales@gebelchemquip.com  
 www.gebelchemquip.com

- tanks (chemical)
- transport tanks
- process equipment
- HydroSave™ water retention systems
- stacks
- flanges
- launders
- ladders, walkways, platforms and handrails
- grating

**Pacific Resins**

3/7 Jannali Avenue, Jannali New South Wales 2226  
 Telephone +61 2 9528 6055  
 Facsimile +61 2 9528 0161  
 sales@pacificresins.com.au  
 www.pacificresins.com.au

- flooring

**RPC Technologies**

24 Powers Road, Seven Hills New South Wales 2147  
 Telephone +61 2 9624 9800  
 Facsimile +61 2 9624 2548  
 www.rpctechnologies.com

- bunds
- covers
- ducts
- flooring
- linings
- panels
- pile wraps
- pipes
- process vessels
- stacks
- scrubbers
- tanks
- vents

**South Australia****Ampelite Australia Pty Ltd**

3 E.W. Pitts Avenue, Cavan South Australia 5094  
 Telephone +61 8 8260 7391  
 Facsimile +61 8 8260 7397  
 sales@ampelite.com.au  
 www.ampeelite.com.au

- sheeting (roof and wall)

**Fibrelogic Pty Ltd**

11 Christie Rd, Lonsdale South Australia 5160  
 Telephone +61 8 8329 1111  
 Facsimile +61 8 8329 1122  
 www.fibreglogic.com

- Flowtite™ GRP Pipe
- Flowtite™ GRP Pipe Fittings
- Desalination / Industrial Pipe
- Jacking Pipe (Polymer Concrete)
- Composite Manholes

**Ron Gee Enterprises Pty Ltd**

PO Box 307, Roxby Downs South Australia 5725  
 Telephone +61 438 336 578  
 info@rge.com.au  
 www.rge.com.au

- bore hole casings
- bunds
- channels
- cyclones
- drains
- ducts
- flooring
- ladders
- linings (pipe and tank)
- panels
- pipes
- pits
- process vessels
- scrubbers
- stacks
- tanks
- vents

**The Newell Group**

191 Adelaide Road, Murray Bridge South Australia 5253  
 Telephone +61 8 8532 2455  
 Facsimile +61 8 8531 0157  
 enquiries@thenewellgroup.com.au  
 www.thenewellgroup.com.au

- coatings (bund and floor)
- ducts
- linings
- panels process vessels
- pipes
- scrubbers
- tanks
- stacks

**Tasmania****Corrosion Technology Australia Pty Ltd**

10 Stephen Street, East Devonport Tasmania 7310  
 Telephone +61 3 6427 0733,  
 Facsimile +61 3 6427 0751  
 tassales@ozemail.com.au  
 www.ctapl.com.au

- bore hole casings
- bunds
- channels
- cyclones
- drains
- ducts
- flooring
- grates
- ladders
- linings (pipe and tank)
- pipes and tubes
- pits
- process vessels
- rails
- scrubbers
- stacks
- tanks (chemical)
- vents

**Penguin Composites Pty Ltd**

808 South Road, Penguin Tasmania 7316  
 Telephone +61 3 6437 2791  
 Facsimile +61 3 6437 2792  
 sales@penguincomposites.com.au  
 www.penguincomposites.com.au

- bore hole casings
- bunds
- channels
- drains
- ducts
- linings (pipe and tank)
- pipes and tubes
- pits
- process vessels
- scrubbers
- tanks (chemical)
- vents

**Ron Gee Enterprises Pty Ltd**

44 Enterprise Avenue, Penguin Tasmania 7316  
 Telephone +61 3 6437 2288  
 Facsimile +61 3 6437 1381  
 13 Sunderland St, Moonah Tasmania 7009  
 Telephone +61 3 6273 9477  
 Facsimile +61 3 6272 7703  
 info@rge.com.au  
 www.rge.com.au

- tanks
- process vessels
- bore hole casings
- bunds
- channels
- cyclones
- drains
- ducts
- flooring
- linings (pipe and tank)
- panels
- pipes
- pits
- scrubbers
- stacks
- vents
- ladders

## Victoria

### Ampelite Fibreglass Pty Ltd

Cnr Kitchen and Zenith Roads, Dandenong Victoria 3175  
Telephone +61 3 9794 0977  
Facsimile +61 3 9794 0710  
sales@ampelite.com.au  
www.ampelite.com.au

- sheeting (roof and wall)

### Australian Fabricating Industries Pty Ltd

176 Grange Road, Fairfield Victoria 3078  
Telephone +61 3 9497 4949  
Facsimile +61 3 9497 4949

- linings (pipe and tank)
- pipes and tubes

### Corrosion Technology Australia Pty Ltd

18 Fowler Rd, Dandenong Victoria 3175  
Telephone +61 3 9706 0099  
Facsimile +61 3 9706 0111  
enquiries@ctapl.com.au  
www.ctapl.com.au

- bore hole casings
- bunds
- channels
- cyclones
- drains
- ducts
- flooring
- grates
- ladders
- linings (pipe and tank)
- pipes and tubes
- pits
- process vessels
- rails
- scrubbers
- stacks
- tanks
- vents

### Envirotank Pty Ltd

51-61 Maffra St, Coolaroo Victoria 3048  
Telephone +61 3 9302 1141  
Facsimile +61 3 93021272  
www.envirotank.com.au

- tanks (water and chemical)

### EPTEC

Ground Floor, Endeavour House  
Nelson Place, Williamstown, Victoria 3016  
Telephone +61 3 9397 3727  
Facsimile +61 3 9244 4044  
eptecvic@eptec.com.au  
www.eptec.com.au

- pipe and ducting
- structural and corrosion resistant pipe and tunnel lining systems
- lightweight and corrosion resistant plant covers and walkways
- structural and geotechnical reinforcement
- ballistic protection
- underground fuel tank re-lining

### Exel Composites (Australia) Pty Ltd

991 Mountain Highway, Boronia Victoria 3153  
Telephone +61 3 8727 9600  
Facsimile +61 3 8727 9688  
office.melbourne@exel.net  
www.exelcomposites.net

- cable supports
- covers
- flooring
- handrails
- ladders
- moulded gratings
- reinforcing
- rock bolts
- stairs and stair treads
- tool handles

### Optimised Composites Pty Ltd

Hanger 7, Wirraway Road, Essendon Airport Victoria 3041  
Telephone +61 3 9379 5706  
Facsimile +61 3 9379 1753

- bunds
- linings (pipe and tank)
- pipes and tubes
- tanks

## Western Australia

### Ampelite Australia Pty Ltd

91 Excellence Drive, Wangara Western Australia 6065  
Telephone +61 8 9302 6833  
Facsimile +61 8 9302 6855  
sales@ampelite.com.au  
www.ampeelite.com.au

- sheeting (roof and wall)

### Australian Fibreglass & Polyurethane Technologies

12 Dobra Road, Yangebup Western Australia 6164  
Telephone +61 8 9418 4288  
Facsimile +61 8 9418 1730

- tanks

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**Diverse Tank Engineering Pty Ltd**

27 Alacrity Place, Henderson Western Australia 6166  
Telephone +61 8 9410 8188  
Facsimile +61 8 9410 8187  
enquiries@dtgroup.com.au  
www.dtgroup.com.au

- tanks (steel tanks with composite outer jacket for storage of motor fuels, heating oil, ethanol, methanol, alcohol and alcohol blends)

**FRP Engineering**

2–28 Baile Road, Canningvale Western Australia 6155  
Telephone +61 8 9455 4343  
Facsimile +61 8 9455 4373

- bunds
- channels
- drains
- flooring
- grates
- ladders
- pits
- scrubbers

**G.K.S. Fiberglass Pty Ltd**

Enterprise Park, 17 Challenge Boulevard,  
Wangara Western Australia 6065  
Telephone +61 8 9302 1803  
Facsimile +61 8 9302 1804  
www.gksfibreglass.com.au

- industrial products

**GRP Technology Pty Ltd**

7 Kalmia Rd, Bibra Lake Western Australia 6163  
Telephone +61 8 9434 1707  
Facsimile +61 8 9434 2425  
grpotech@starwon.com.au  
www.grpotech.com.au

- covers
- ducts
- pipes
- scrubbers
- stacks

**Hawke Bros Pty Ltd**

21 Frobisher Street, Osborne Park Western Australia 6017  
Telephone +61 8 9242 2111  
Facsimile +61 8 9443 2448

- bores
- pipes
- tanks

**Industrial Catalyst Composites**

15 Pavers Circle, Malaga Western Australia 6090  
Telephone +61 8 9248 9901  
Facsimile +61 8 9248 9569  
strength@iceng.com.au  
www.iceng.com.au

- FRP based strengthening and repair technology

**Matrix Composites and Engineering Ltd**

42 Truganina Road, Malaga, Western Australia 6090  
Telephone +61 8 9249 3637  
Facsimile +61 8 9249 7815  
matrix@matrixap.com.au  
www.matrixap.com.au

- pipeline and riser clamping systems

**Mouldings Design**

3 Flindell St, O'Connor Western Australia 6163  
Telephone +61 8 9331 2811  
Facsimile +61 8 9314 1179

- industrial products

**Sealix Fibreglass**

4 Ilmenite Crescent, Capel Western Australia 6271  
Telephone +61 8 9727 2478  
Facsimile +61 8 9727 2956

- channels
- drains
- flooring
- linings (pipe and tank)
- pits
- tanks
- pipes and tubes

**Tanks West**

5–7 Uppsala Place, Canning Vale Western Australia 6155  
Telephone +61 8 9456 0677  
Facsimile +61 8 9456 0676  
Freecall 1800 812 677  
enquiries@tankswest.com.au  
www.tankswest.com.au

- tanks (cartage and storage)

**Vortex Pipes Limited**

2 Bell Street, Canning Vale Western Australia 6155  
Telephone +61 8 9456 1002  
Facsimile +61 8 9456 3091  
trevor.gosatti@vortexpipes.com  
www.vortexpipes.com

- fiberglass reinforced epoxy pipe products and fittings
-

## 10. Australian composites design and engineering service providers

Designers	Capabilities
<p><b>APTEC Composites Pty Ltd</b>            17 Reynolds St Mareeba Queensland 4880            Telephone +61 7 4092 4456            Facsimile +61 7 4092 4924            sales@apteccomposites.com            www.apteccomposites.com.au</p>	<ul style="list-style-type: none"> <li>• CAD design service.</li> <li>• Finite Element Analysis capabilities to optimise material selection and part design</li> </ul>
<p><b>CRC-ACS Ltd</b>            506 Lorimer St, Fishermans Bend Victoria 3207            Telephone +61 3 9676 4900            Facsimile +61 3 9676 4999            crc-acs@crc-acs.com.au            www.crc-acs.com.au</p>	<ul style="list-style-type: none"> <li>• Full design and analysis service for composite structures of any size and complexity</li> </ul>
<p><b>DIAB Australia Pty Ltd</b>            B1/183 Prospect Highway, Seven Hills New South Wales 2147            Telephone +61 2 9620 9999            Facsimile + 61 2 9620 9900            info@au.diabgroup.com            www.diabgroup.com</p>	<ul style="list-style-type: none"> <li>• DIAB Technologies provides a range of services that include auditing, laminate design, structural engineering, process optimization, training and testing.</li> <li>• Experience of both analytical and numerical (Finite Element Analysis) methods for composite structures.</li> <li>• Design decisions, calculations and material choices based on a fundamental understanding of how the component will be manufactured.</li> </ul>
<p><b>EMP Composites</b>            Unit 1, 92A Mona Vale Road, Warriewood New South Wales 2102            Telephone +61 2 9910 7300            Facsimile +61 2 9910 7301            info@empcomposites.com.au            www.empcomposites.com</p>	<ul style="list-style-type: none"> <li>• Structural engineering services that include finite element analysis, classic laminate theory and surface modelling.</li> <li>• Manufacturing and process technology know-how.</li> <li>• Mechanical testing of coupons and components.</li> </ul>
<p><b>Gurit (Australia) Pty Ltd</b>            U 1A/81 Bassett Street, Mona Vale New South Wales 2103            Telephone +61 2 9979 7248            www.gurit.com</p>	<ul style="list-style-type: none"> <li>• Conceptual design studies—rapid feedback on engineering methodology, construction procedures and cost estimates.</li> <li>• Laminate design, specification and analysis—prediction of the static and dynamic characteristics of a structure in advance of construction.</li> <li>• Finite element stress analysis—simple, cost effective solutions for components with complex geometry.</li> <li>• 2D draughting and 3D modelling, or just sketches—meeting the client’s design or fabrication needs.</li> <li>• Specification of manufacturing methodology—using our experience to provide a cost effective and high quality product.</li> <li>• Determination of production quality standards—tailored to suit the laminate specification, the manufacturing process and the performance criteria of the end product.</li> <li>• Through production support—providing validation of material properties in the production environment, and on-site advice.</li> <li>• Liaison with classification societies—guidance through the technical rules-book.</li> <li>• Specification of test programmes to demonstrate structural integrity—mechanical, analytical and environmental testing.</li> </ul>

**Lavender CE**

10/10 Miltiadis St, Acacia Ridge Queensland 4110  
Telephone +61 7 3255 6924  
Facsimile +61 7 3255 6923  
engineering@lavender-ce.com  
www.lavender-ce.com

- Structural design and feasibility studies
- Laminate design, specification, testing and in-service non-destructive testing
- Finite Element Analysis (simulation) of whole structures or individual components
- Full scale testing and support to qualify designs
- Manufacturing and quality assurance support
- Process design
- On-site assistance and diagnostic service

**Oceania Composites Engineering Pty Ltd**

PO Box 2150, Moorabbin Victoria 3189  
Telephone +61 3 5169 1554  
engineering@oceaniacomposites.com.au  
www.oceaniacomposites.com.au

- Design with composites and thermoplastics
- Manufacturing and process technology know-how.
- Engineering assistance for business decision making
- Assessment of existing assets.
- Rehabilitation of pipework and structures.

**Teakle Composites**

Level 2, Technology Transfer Building,  
Queensland Centre for Advanced Technology,  
1 Technology Court, Pullenvale Queensland 4069  
Telephone +61 7 3378 4573  
p.teakle@teaklecomposites.com.au  
www.teaklecomposites.com.au

- Mechanical and mechatronic design concept development
- 3D solid modelling and 2D engineering drawings
- Finite Element Analysis
- Filament winding
- Prototype construction



*Spent Electrolyte Tank installed at  
Cause Nickel, Kalgoorlie*

Image courtesy of Marky Industries Pty Ltd

## 11 Acknowledgements

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#### **Department of Employment, Economic Development and Innovation**

Jason Manttan Principal Project Officer

Thomas Wechselberger Project Manager



*Wagners Composite Fibre boardwalks  
installed on Magnetic Island,  
Queensland*

Image courtesy of  
Wagners CFT Manufacturing Pty Ltd

*Composites offer unique products in many of Queensland's most important industry sectors, including advanced manufacturing, aerospace, building and construction, defence, infrastructure, marine, mining and transport.*

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