Environmental Product Declaration for Galvanizers Association of Australia: Hot Dip Galvanizing in Australia

In accordance with EN 15804, ISO 14025 and *PCR 2011:16 V2.2*

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Contents

Front cover image: Austin Health Carpark, Victoria

Coverage of this EPD is limited to Australian GAA members. Member names are available here.

About the Galvanizers Association of Australia

Galvanizers Association of Australia (GAA) comprises the leading hot dip galvanizing companies throughout Australia and New Zealand. GAA is an industry Association established in 1963 to represent hot dip galvanizing companies and to provide technical consulting services on a not-for-profit basis.

The Association's objectives are to provide the highest standards in design and quality of hot dip galvanized products and to assist consumers achieve the economics and sustainability inherent in the correct design and application of hot dip galvanized products.

This is achieved by providing free technical publications and practical assistance on all aspects of design, application, process, sustainability, bolting, welding and painting of hot dip galvanized steel.

Map of GAA member hot dip galvanizing plants

Case studies

EXAMPLE 1

Noosa Junction Station (Qld)

Bark Design Architects, Guymer Bailey Landscape and SKM (2011).

Featuring hot dip galvanized steel, recycled timbers, significant shade plantings and even rainwater tanks for cleaning and flushing of toilets, Noosa Junction Station is an example of an integrated sustainable design solution.

The station features a series of public spaces and civic art installations that incorporate coastal architecture and natural landscape elements, including a pergola floating garden, a grove garden, a vertical garden and a melaleuca grove where travellers can sit and relax.

EXAMPLE 2

Federation Square (Vic)

Lab architecture studio in partnership with Bates Smart (2002).

Federation Square's distinctive façade uses three cladding materials: sandstone, zinc and glass within a triangular pinwheel grid. These are joined together to create a larger triangular 'mega panel', which is then mounted onto the structural hot dip galvanized steel frame to form the visible façade. The design uses Melbourne's unique climate to reduce artificial heating and cooling and the site is now carbon neutral.

In addition to the sustainable design, Fed Square now utilizes modern techniques for environmental sustainability and is aiming to become carbon negative.

EXAMPLE 3

Baldivis South Secondary School (WA)

Parry and Rosenthal Architects with BPA Engineering (2018).

To achieve economy, efficiency and sustainability the school buildings were designed as modular, rectilinear and oriented to maximise passive solar design and natural ventilation. Self-finished, robust and cost-efficient materials were selected and detailed to maximise the life of the buildings and minimise ongoing maintenance.

Materials were selected to be robust, cost effective, and to provide a consistent aesthetic. The new buildings comprise a mild steel structure with expressed architectural hot dip galvanized finish and supporting elements of steel reinforced concrete blockwork.

"All hot dip galvanized steel products are recyclable into equivalent or higher quality products"

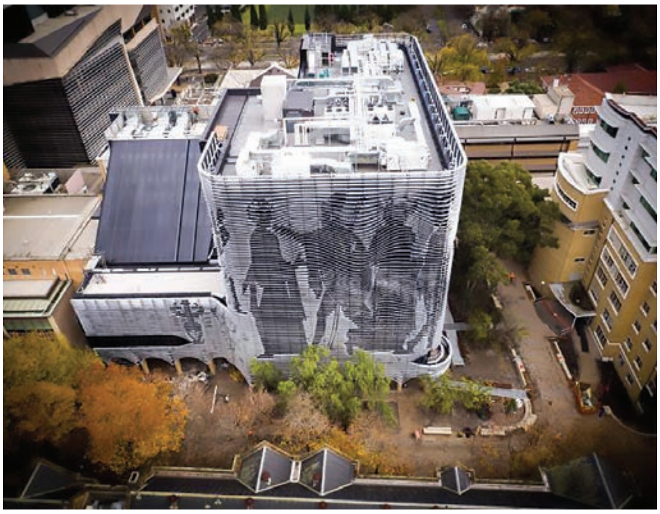
Hot Dip Galvanizing

The life of hot dip galvanized steel in the Australian environment is easily predicted using AS/NZS 2312.2. This Standard provides a range of durability for the coating depending on thickness and location; for an 85 µm thick coating, the durability extends to over 100 years in many capital cities to around 10 years immediately adjacent to surf beaches. Hot dip galvanized steel's excellent performance is due to its inherent corrosion resistance, high tolerance to mechanical damage and inertness to the high UV levels prevailing over all of Australia.

Hot dip galvanizing protects steel from corrosion by providing a thick, tough, metallurgically bonded zinc envelope completely covering the surface and stopping the steel from experiencing the corrosive action of its environment. It can be applied to an extensive selection of steel grades with a wide variety of shapes, sizes and functions; from single structural sections to large fabricated frames, from general road furniture to unique creative artworks.

Attention to the durability of steel structures and components has important environmental, economic and social consequences. By protecting steel from corrosion, hot dip galvanizing performs an invaluable service, including helping to preserve natural resources by significantly prolonging the life of steel and capital investments. At the end of life, the remnant primary components of a hot dip galvanized article, zinc and steel, are both recyclable into equivalent or higher quality products and this demonstrates hot dip galvanized steel's intrinsically sustainable nature.

"The life of hot dip galvanized steel in the Australian environment is easily predicted"



Melbourne University Arts West Redevelopment

Mars Stadium, Ballarat

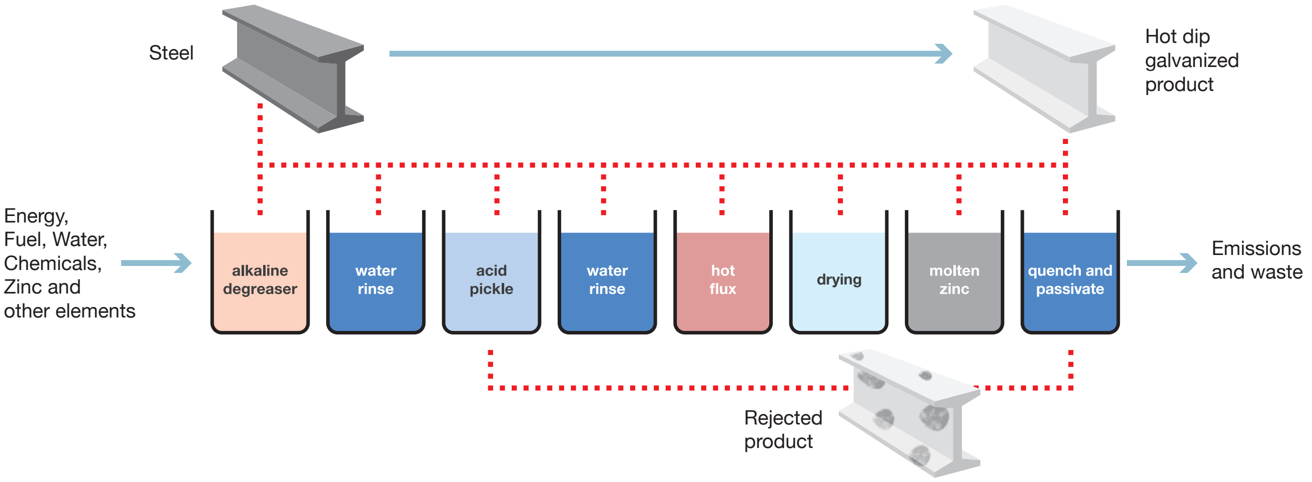
Coopers Brewery, SA

Black Rock Reclaimation Plant, Victoria

Hot Dip Galvanizing Process

The hot dip galvanizing service begins with the arrival of steel at the galvanizing plant. The typical processing of the steel consists of pre-treatment that chemically cleans the steel's surface, via caustic degreasing, acid pickling and fluxing, before the steel is immersed in a molten zinc bath where the hot dip galvanized coating is formed. The final stage of the process is generally quenching in a solution that promotes passivation of the zinc surface and then the hot dip galvanized steel product is transported back to the customer or direct to the end user.

The typical manufacturing process by GAA members



Hot Dip Galvanized Steel Products

This EPD covers steel products, such as hot-rolled structural steel sections, steel plate, and hollow structural steel sections, that are hot dip galvanized after fabrication by members of the Galvanizers Association of Australia (GAA). Data was collected from 23 member plants from all around Australia, which represents 72% of the total number of batch hot dip galvanizing plants in Australia and an estimated 70% of the steel tonnes galvanized. The remaining plants include some where data was not available and non-members of the GAA.

The hot dip galvanized coating is applied according to the requirements of AS/NZS 4680 or AS/NZS 1214.

Articles made from iron or steel products defined in Clause 4 of AS/NZS 2312.2 can be hot dip galvanized to AS/NZS 4680 or AS/NZS 1214.

The primary data was collected for the period 1 July 2016 to 30 June 2017 from all sites, and covers a range of heavy, medium and light products including the products coated via the centrifuging process available in 9 of the plants from which data was collected. Each member site was treated as an independent entity and the average life cycle inventory calculated as a product weighted average across each site.

Declared Unit

The declared unit for the EPD is 1 year of protection of a 1 m^2 coated 8 mm thick steel plate.

The area of application includes buildings and infrastructure, in a range of structural and non-structural components.

The EPD covers average values for the product category, hence, the declared unit is not available for purchase on the market. Details of average product is given in Table 1. See How to Use this EPD (page 13) to translate this declared unit into data for your practical application.

Table 1: Average Product Details

Substrate	Steel plate – 1 m x 1 m x 8 mm (weight 62.4 kg)
Hot dip galvanized coating thickness	85 µm (required minimum average coating thickness on each surface for steel >6mm, as per AS/NZS 4680)
Exposure environment	Category C3 (as defined in the PCR) with an average zinc corrosion rate of 1.4 µm/year
Predicted maintenance-free coating life	Minimum 61 years
Units (results)	Burdens per year of protection
UN CPC 88731	Metal treatment and coating services
ANZSIC 2293	Metal Coating and Finishing

The mass ratio of the steel and the zinc coating declared in the EPD are 98.1:1.9.

The coating primarily contains zinc along with very small amounts of other elements such as aluminium. Hot dip galvanized structural steel products do not require authorisation for any substances listed in the latest 'Candidate List of Substances of Very High Concern'.

System Boundaries

The scope of this EPD is ‘cradle-to-gate with options’. The ‘cradle-to-gate’ stages comprise Modules A1 to A3, and the options include Module A4 (transport to customer), Modules C2 to C4 (transport and end-of-life processing) and Module D (recycling potential).

Other life cycle stages (Modules A5, B1-B7 and C1) are dependent on particular scenarios and are best modelled at the building or structure level.

Modules included in the scope of the EPD

Product stage			Construction process stage		Use stage							End of life stage				Benefits and loads beyond the system boundary
Raw material supply	Transport of raw materials	Manufacturing	Transport to customer	Construction / Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction / demolition	Transport to waste processing	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	X	X	X	X

X = included in the EPD
MND = Module not declared (such a declaration shall not be regarded as an indicator result of zero)

Elizabeth and Munno Para stations, SA

Les Wilson Barramundi Discovery Centre, Karumba


A2 Transport of raw materials
Sea, road, rail
A3 Manufacturing
From pre-treatment to hot dip galvanizing
A1 Raw Materials
Steel, zinc & zinc alloys
Darwin
Townsville
Brisbane
Coffs Harbour
Perth
Newcastle
Sydney
Adelaide
Albury
Shepparton
Melbourne
Geelong
Launceston
D Recycling
A4 Transport of hot dip galvanized product by road
C3 Waste processing
"Use" phase of the product
Outside the scope of this EPD Includes Module A5 (construction), B1-7 (use) and C1 (deconstruction)
C2 Transport to waste processing
C4 Disposal

Production and Transport to Customer (Module A)

The production stage includes:

- Extraction and processing of raw materials (primarily the steel substrate and zinc) (A1)
- Transportation of material up to the factory gate and internal transport (A2)
- Pre-treatment and the hot dip galvanizing process (A3)
- Transport of product to the customer or end user (A4).

The choice of substrate has a dominant impact on the results of the EPD. This can include changing the thickness of the substrate and/or the type of substrate. See the section on How to Use this EPD (page 13) for more information.

End of Life (Module C)

When a structure reaches the end of its useful life, the majority of the steel (including hot dip galvanized products) is removed during demolition (Module C1) and transported to a recycling centre (Module C2). Module C1 (demolition) is not declared in this EPD as it should be modelled at the building or structure level, taking into account the various demolition practices.

This EPD declares Modules C2 (transport to waste processing) assuming the demolition waste is transported 100 km by truck for processing.

For waste processing (Module C3), a recycling rate of 89% based on Hyder Consulting (2012), has been applied. Module C3 also includes impact of shredding and baling of the product, ready to be shipped for recycling.

Additionally, the EPD includes waste disposal in landfill (Module C4) for the 11% of product not recycled under the recycling scenario.

Recovery and Recycling Potential (Module D)

Module D accounts for the potential benefits of post-consumer recycling.

As noted in the previous section, the EPD assumes a recycling rate of 89% for the galvanized product.

The amount of scrap input required for the production and galvanizing process (e.g. secondary steel inputs and secondary zinc inputs) is deducted from the total amount of recycled steel and zinc output. The net scrap (steel and zinc) is then given a credit in Module D.

Life cycle inventory (LCI) data and assumption

Primary data was used for all manufacturing operations gate-to-gate, covering all processes for hot dip galvanizing. The primary data are the transport mode and distance. Fuel use of transport processes is based on generic data.

All data in the background system was from the GaBi Life Cycle Inventory Database 2018 (thinkstep 2018). Most datasets have a reference year between 2014 and 2017 and all fall within the 10-year limit allowable for generic data under EN 15804.

Upstream data:

Data for steel input is taken from InfraBuild (OneSteel) hot rolled structural and rail products EPD (S-P-00854 Version 1, 2016). Data for steel used as process inputs (for tie wire and coil) was taken from InfraBuild (OneSteel) EPD for reinforcing rod, bar and wire (S-P-00855 Version 1, 2016).

As noted earlier, the choice of substrate has a dominant impact on the results of the EPD. This can include changing the thickness of the substrate and/or the type of substrate. For example, standard hot rolled angles vary in substrate thickness from 3 mm to 26 mm, while welded beams vary in substrate thickness from 10 mm to 40 mm. See the How to Use this EPD (page 13) for more information.

Electricity:

Electricity consumption was modelled using state specific electricity based on the percentage of galvanized products produced in each state. The state specific electricity data was based on background data from the GaBi Life Cycle Inventory Database 2018 (thinkstep 2018).

Recycling:

All steel products are recyclable at end of life. It is assumed that the majority of the galvanized steel is recovered during scrap processing (Module C3). A recycling rate of 89% has been applied for this EPD including the zinc coating. (Hyder Consulting 2012). The remaining 11% of coated steel is assumed to be landfilled (Module C4). This is considered to be a conservative estimate used in the absence of other verified recycling rates.

Of the 89% sent for recycling, the model assumes that all steel is recycled. Of the zinc coating, 75% is recycled, and 25% is assumed lost and sent to landfill. The non-metal proportion of coatings such as those in paints are assumed to be incinerated.

Transport:

Primary transport data was used for transport of production inputs (A2), waste from the hot dip galvanizing process (A3), and for transport of galvanized product to the customer (A4). Transport of galvanized product to the customer is calculated based on a mix of transport distance data provided by galvanizers and assumed distances of 100 km by articulated truck where distances were not available as per PCR 2011:16 Version 2.2 (2017-06-08).

Cut off criteria

The PCR 2011:16, v2.2 section 7.9 requires Life Cycle Inventory data for a minimum of 99% of total inflows to the core module. The system boundary for this EPD was defined based on relevance to the goal of the study. For the processes within the system boundary, all available energy and material flow data have been included.

Raw materials such as steel substrate and zinc do not contain significant quantities of packaging. As such, production of packaging for inbound raw materials is excluded. Packaging for process inputs (e.g. chemicals) are also considered to be insignificant and are excluded from the LCI.

Environmental impacts relating to personnel, infrastructure, and production equipment not directly consumed in the process are excluded from the system boundary as per PCR 2011:16, v2.2 section 7.3. All other reported data was incorporated and modelled using the best available life cycle inventory data.

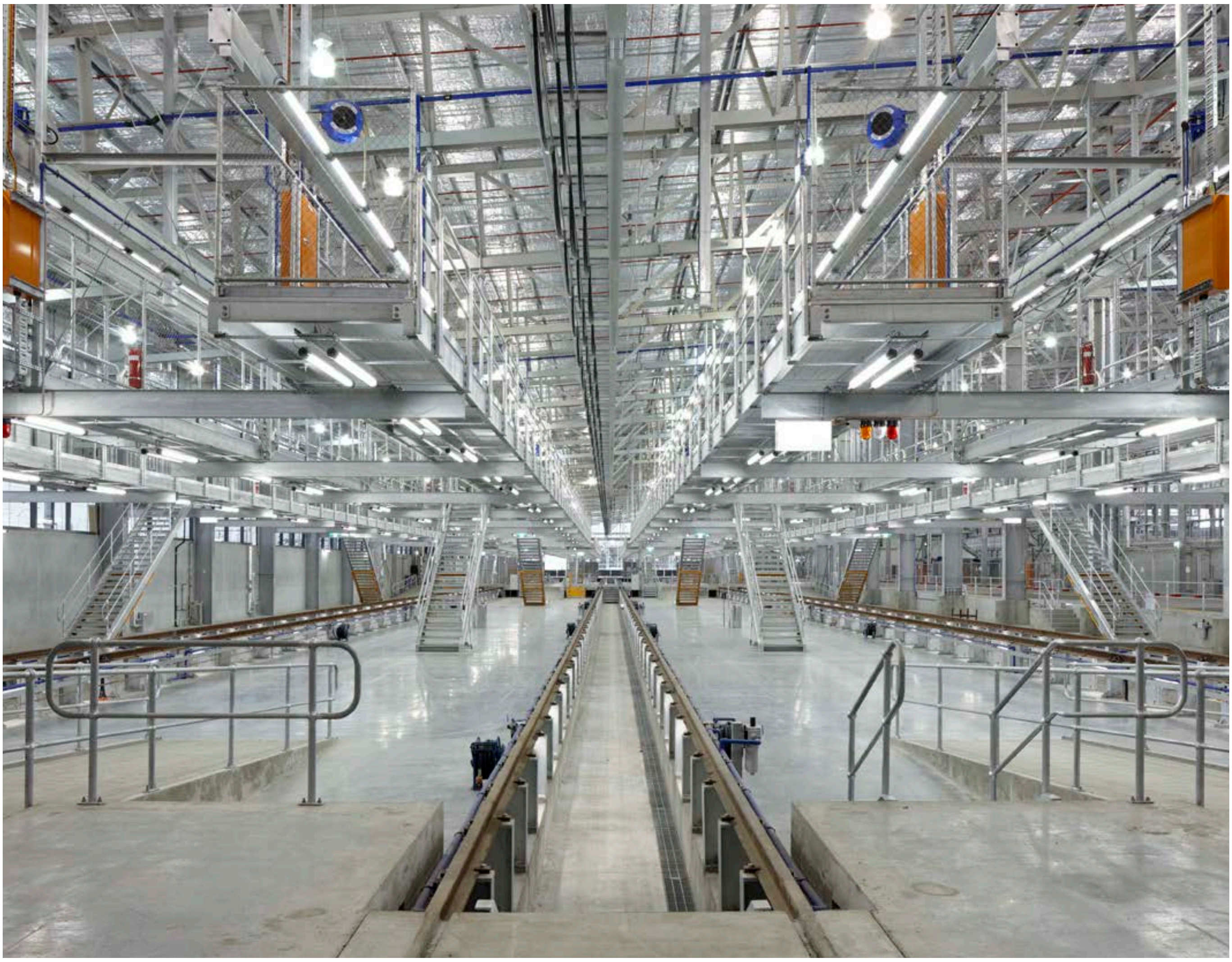
Allocation

Allocation rules for foreground processes as well as upstream data used within this project complies with the allocation principles outlined in the PCR 2011:16, v2.2 section 7.10. Allocation of co-products and waste from the galvanizing process is based on the mass of zinc in each co-product, as this is required by the PCR.

The PCR 2011:16 excludes the possibility of applying economic allocation criteria because of its sensitivity to market specific conditions. As such economic allocation is not applied for the EPD.

Allocation of recycling at end-of-life follows EN 15804 and the PCR.

Allocation rules for secondary data (upstream/downstream processes) are documented on the GaBi website (thinkstep 2018).



Craigieburn Train Maintenance Centre, Victoria

Noosa Junction Station, QLD

Results of Assessment

The declared unit for the EPD is 1 year of protection of a 1 m^2 zinc coated 8 mm thick steel plate which has a required minimum average coating thickness of 85 µm to conform to the requirements of AS/NZS 4680. The declared unit assumes exposure in a C3 corrosivity category as defined in ISO 9223 and AS/NZS 2312.2. This corresponds to an average of 61 years of service life. The EPD represents an average impact for 1 year out of 61 years. The product listed in the EPD presents an industry average for Australia and as such is not available for purchase on the market. Details of the average product is given earlier in Table 1 (page 4). See How to Use this EPD for more information.

Environmental impact indicators

The following indicators describe potential environmental impacts for each life cycle stage or module per declared unit.

The galvanizing contribution to the manufacturing phase (A1-A3) is reported in the last column, according to the same declared unit.

Table 2: EN15804 Environmental impact indicators

Indicator	Unit	Production A1 – A3	Transport A4	Transport to waste processing C2	Waste processing C3	Disposal C4	Recycling potential D	Galvanizing process only (A1-A3)
GWP	kg CO_2-eq.	3.37	0.00905	0.00846	0.0367	0.00547	-1.20	0.156
ODP	kg CFC11-eq.	2.19E-11	1.05E-17	9.85E-18	1.94E-16	1.45E-15	6.82E-09	5.76E-12
AP	kg SO_2-eq.	0.00775	1.74E-05	1.63E-05	1.57E-04	1.52E-05	-0.00132	0.000559
EP	kg PO_4^{3-}-eq.	0.00102	3.57E-06	3.33E-06	1.34E-05	1.91E-06	-7.19E-05	0.000095
POCP	kg C_2H_4-eq.	0.00205	-4.68E-06	-4.37E-06	8.33E-06	1.37E-06	-5.09E-04	4.04E-05
ADPE	kg Sb-eq.	1.49E-05	1.31E-10	1.22E-10	4.03E-09	5.92E-10	-8.90E-06	1.41E-05
ADPF	MJ	37.2	0.121	0.113	0.422	0.0793	-11.5	1.82

GWP = Global warming potential (total),
AP = Acidification potential of land and water;
POCP = Photochemical ozone creation potential;
ADPF = Abiotic depletion potential – fossil fuels
ODP = Depletion potential of the stratospheric ozone layer;
EP = Eutrophication potential;
ADPE = Abiotic depletion potential – elements;

Boral CBD Concrete Manufacturing Plant, Victoria

Galvanized Trees, Adelaide

Resource indicators

The following indicators describe the use of renewable and non-renewable material resources, renewable and non-renewable primary energy and water.

Table 3: EN15804 Resource use indicators

Indicator	Unit	Production A1 – A3	Transport A4	Transport to waste processing C2	Waste processing C3	Disposal C4	Recycling potential D	Galvanizing process only (A1-A3)
PERE	MJ	2.27	0.00619	0.00579	0.0613	0.00609	0.677	0.251
PERM	MJ	0	0	0	0	0	0	0.00
PERT	MJ	2.27	0.00619	0.00579	0.0613	0.00609	0.677	0.251
PENRE	MJ	37.5	0.121	0.113	0.422	0.0822	-11.1	1.96
PENRM	MJ	1.04E-04	0	0	0	0	0	1.04E-04
PENRT	MJ	37.5	0.121	0.113	0.422	0.0822	-11.1	1.96
SM	kg	0.442	0	0	0	0	0	0.149
RSF	MJ	5.68E-07	0	0	0	4.65E-25	1.17E-24	3.27E-08
NRSF	MJ	1.37E-04	0	0	0	5.46E-24	1.37E-23	1.32E-04
FW	m^3	0.180	1.29E-06	1.21E-06	2.26E-04	8.70E-06	-0.0998	0.168

PERE = Renewable primary energy as energy carrier;
PERT = Total use of renewable primary energy resources;
PENRM = Non-renewable primary energy as material utilization;
SM = Use of secondary material;
NRSF = Use of non-renewable secondary fuels;
PERM = Renewable primary energy resources as material utilization;
PENRE = Non-renewable primary energy as energy carrier;
PENRT = Total use of non-renewable primary energy resources;
RSF = Use of renewable secondary fuels;
FWT = Use of net fresh water

Wastes and other outputs

Table 4: EN15804 Waste categories and output flows

Indicator	Unit	Production A1 – A3	Transport A4	Transport to waste processing C2	Waste processing C3	Disposal C4	Recycling potential D	Galvanizing process only (A1-A3)
HWD	kg	5.74E-07	9.29E-12	8.68E-12	7.76E-11	4.40E-10	-8.86E-07	1.63E-07
NHWD	kg	0.669	8.63E-07	8.07E-07	1.20E-04	0.115	0.133	0.0145
RWD	kg	1.20E-04	7.04E-09	6.57E-09	7.15E-08	1.15E-06	-2.86E-05	5.53E-05
CRU	kg	0	0	0	0	0	0	0
MFR	kg	0.00417	0	0	0.778	0	0	0.00387
MER	kg	0	0	0	0	0	0	0
EEE	MJ	0	0	0	0	0	0	0
EET	MJ	0	0	0	0	0	0	0

HWD = Hazardous waste disposed;
RWD = Radioactive waste disposed;
MFR = Materials for recycling;
EEE = Exported electrical energy;
NHWD = Non-hazardous waste disposed;
CRU = Components for re-use;
MER = Materials for energy recovery;
EET = Exported thermal energy

Greenstar indicator results

Table 5: Greenstar indicator results for the galvanizing process

Indicator	Unit	A1-A3 (Galvanizing process only)
Human toxicity cancer effects	CTUh	9.91E-12
Human toxicity non-cancer effects	CTUh	3.39E-13
Land use	kg C deficit eq.	0.0579
Resource depletion – water*	m^3 eq.	0.0963
Ionising Radiation	kBq U235 eq.	6.36E-03
Particulate matter	kg PM2,5-Eq.	7.56E-05

*m^3 water consumption related to local scarcity of water.
The Australian national average is utilized for WSI in this EPD as GAA members are located throughout Australia.

Be Careful When Comparing EPD Data

Unless the EPDs comply with the comparability requirements in EN 15804, they should not be directly compared across product groups. For EPDs to be comparable, they must have been developed using equivalent methodology and assumptions (e.g. by using the same PCR).

Expert analysis is required in most cases, although if the product groups use the same PCR the comparison may be simpler, to conduct. An analysis should consider the whole life cycle of the building or structure to understand whether any differences in data are material to the overall project.

Variation of results

The data in this EPD is/are an average from multiple galvanizers. Although there is considerable variation in processes between galvanizers, mainly relating to energy inputs, the variance in the EPD results stays within ± 7% when the substrate is included. The substrate is integral to the galvanizing process and the EPD.

Galvanized Croc, Darwin

Potts Hill Pressure Tunnel Bridge, Sydney

How to use this EPD

To apply this EPD to a specific product, the average data provided in the EPD needs to be adjusted to align with the product specifications considering a) the substrate, b) substrate and coating thickness, and c) coating life. The choice of substrate is particularly important since it has a dominant impact on the results.

The industry average impacts given in this EPD should only be used directly if no further details/specification of the actual product are known.

Important factors for specific product

Substrate

This EPD uses upstream data for steel input from the InfraBuild (OneSteel) hot rolled structural and rail product EPD (S-p-00854 Version 1, 2016). It is possible to substitute this dataset with another dataset that conforms with EN 15804. For example: BlueScope Steel's Welded Beams and Columns, XLERPLATE®, or Hot Rolled Coil EPD's.

Substrate and coating thickness

The thickness of the substrate defines coating requirements such as the coating thickness. The EPD represents 8mm thick steel substrate requiring a minimum average coating thickness of 85 µm as specified in AS/NZS 4680 (the hot dip galvanizing standard). The minimum average coating thickness for different substrate thicknesses can be identified from the standard.

Coating life (Table 6)

Environmental exposure of a specific product may differ from the C3 exposure category applied for this EPD, depending on where the product is used (C1 to CX according to AS/NZS 2312.2). The average corrosion rate listed in ISO 9223 for the C3 corrosivity category is 1.4 µm/year. Based on this, the lifespan can be calculated as follows: 85 µm thick coating provides 85/1.4 = 61 years durability. A thinner coating in the same exposure has a shorter life span (e.g. 70/1.4 = 50 years) and vice versa. A more corrosive environment, such as C4, has a higher average corrosion rate of 3.15 µm/year, providing a reduced durability for the coating (e.g. 85/3.15 = 27 years). It is important to recognise that thicker coatings, usually for thick hot rolled sections, are available from hot dip galvanizers. This will increase the durability in any environment and therefore also impact the EPD results significantly.

Table 6: Substrate thickness, coating thickness and coating life

Steel Substrate Thickness (mm)	Minimum Average Coating Thickness (according to AS/NZS 4680) (µm)	Coating life compared to declared unit in a C2 exposure (years)	Coating life compared to declared unit in a C3 exposure (years)	Coating life compared to declared unit in a C4 exposure (years)
≥ 1.5 to ≤ 3	55	138	39	17
> 3 to ≤ 6	70	175	50	22
>6	85	213	61	27

Railway Station, Adelaide

Carousel Pavilion, Geelong

Hot dip galvanizing impact per 1 kg of zinc per year

Tables (7-10) show the HDG only impact divided by the mass of coating (1.2155 kg) per m² of the coated substrate in the EPD.

Table 7: EN15804 Environmental impact indicators for hot dip galvanizing only per 1 kg zinc coating

Indicator	Unit	Galvanizing process only (A1-A3)
GWP	kg CO_2-eq.	0.128
ODP	kg CFC11-eq.	4.74E-12
AP	kg SO_2-eq.	4.60E-04
EP	kg PO_4^{3-}-eq.	7.79E-05
POCP	kg C_2H_4-eq.	3.33E-05
ADPE	kg Sb-eq.	1.16E-05
ADPF	MJ	1.50

Table 8: EN15804 Resource use indicators for hot dip galvanizing only per 1 kg of zinc coating

Indicator	Unit	Galvanizing process only (A1-A3)
PERE	MJ	0.206
PERM	MJ	0
PERT	MJ	0.206
PENRE	MJ	1.61
PENRM	MJ	8.52E-05
PENRT	MJ	1.61
SM	kg	0.123
RSF	MJ	2.69E-08
NRSF	MJ	1.09E-04
FW	m3	0.138

Table 9 EN15804 Waste categories and output flows for hot dip galvanizing only per 1 kg of zinc coating

Indicator	Unit	Galvanizing process only (A1-A3)
HWD	kg	1.34E-07
NHWD	kg	0.0120
RWD	kg	4.55E-05
CRU	kg	0
MFR	kg	0.00318
MER	kg	0
EEE	MJ	0
EET	MJ	0

Table 10: Greenstar indicator results for hot dip galvanizing only per 1 kg of zinc coating

Indicator	Unit	Galvanizing process only (A1-A3)
Human Toxicity cancer effects	CTUh	8.16E-12
Human Toxicity non-cancer effects	CTUh	2.79E-13
Land use	kg C deficit eq.	0.0476
Resource depletion - water	m³ eq.	0.0792
Ionising Radiation	kBq U235 eq.	0.00524
Particulate Matter	kg PM2,5-Eq.	6.22E-05

A1-A3 Impact

For practical purposes, as per the examples shown in Table 12, the effect of the steel substrate and zinc coating will need to be adjusted based on the nominal mass of steel and zinc coating for specific product. If the nominal masses of steel and zinc coating for a specific product are known, A1-A3 impacts are calculated as shown in the worked example (Table 11).

Worked Example

To calculate the Global Warming Potential (GWP) impact for a Universal Beam (410UB53.7) for an actual coating thickness of 200 µm in a C3 corrosivity category and a design life of 100 years.

The design life is the controlling feature in this example as the design life of 100 years is less than the calculated coating life of 200 µm/1.4 µm per year = 144 years.

Table 11: Generic Steps and Worked Example

Generic Steps		Worked Example
1	**Calculate the impact of the steel substrate** Multiply the EPD results for the specific steel substrate by the nominal mass of the steel substrate (for 1 m²)	3.2 kg CO_2e (InfraBuild EPD) * 53.7 kg = 171.84 kg CO_2e or 1.72 kg CO_2e/y
2	**Calculate the impact of the coating** Multiply the A1-A3 hot dip galvanizing only impact per 1 kg of zinc coating (Table 7) by the nominal mass of zinc coating identified for the product	0.128 kg CO_2e/y * 0.898 kg = 0.11 kg CO_2e/y
3	**Calculate the impact for the design life (durability lifetime)** Adjust the results per year by taking into account the design life.	For a design life of 100 years Substrate (1.72) + Coating (0.11) = 1.83 kg CO_2e/y

If the nominal mass of steel and zinc coating for a specific hot dip galvanized product are unknown, these can be calculated as follows.

1. Obtain the mass (kg/m), thickness (mm) and coated area (m²/m) of the steel substrate by reference to the standard sections available in AS/NZS 3679.1, AS/NZS 3679.2, AS/NZS 3678 and AS/NZS 1163.
2. Using the thickness of the steel substrate as reference, identify the required minimum average coating thickness (µm) according to AS/NZS 4680, and calculate the coating mass (Coated area (m²/m) x Coating thickness (µm) x Density of coating (kg/m³)).
3. The steel and zinc coating mass for a range of standard steel sections are shown in the GAA's Advisory Note AN45, available for free download at gaa.com.au/technical-publications

Table 12: Examples of steel and zinc coating mass ratio calculations for standard steel sections

Material	Parameter	Unit	Section		
			Universal beam 410UB53.7	Welded beam 900WB257	Tubular section 100x100x5 SHS
Steel	Surface area of steel to be hot dip galvanized	m²/m	1.48	3.41	0.727
	Thickness of steel	mm	> 6	> 6	5
	Nominal mass of steel	kg/m	53.7	257	14.2
HDG (zinc) coating	Nominal HDG coating thickness to AS/NZS 4680	µm	85	85	70
	Density of coating	kg/m³	7140	7140	7140
	Nominal mass of coating	kg/m	0.898	2.07	0.363
Finished Product	Total article mass	kg/m	54.598	259.07	14.563

Notes:

1. It is not technically possible to hot dip galvanize only the external surface for tubular sections, so the surface area to be coated is the total of the external and internal surface areas.
2. For heavy sections such as a 900WB257 welded beam shown above, the practicalities of the hot dip galvanizing process are such that the actual coating thickness achieved is likely to be more than 125 µm and this will change the indicator data. If the actual thickness is important for durability or environmental impact data, please contact the GAA for further advice.

Benefits of using this EPD

This EPD provides an independently verified representation of the environmental impact of the hot dip galvanized product going into your project.

It enables you to calculate the impacts of hot dip galvanized steel used in your project from the independently verified representation of the environmental impacts of the hot dip galvanizing process.

See How to Use this EPD for more information.

Green Star® Points

This EPD complies with requirements under the Green Building Council of Australia's rating tool, Green Star – Design & As Built v1.3.

Green Star points for EPDs can be claimed under the Sustainable Products credit when the following criteria are met:

✓ EN 15804 and ISO 14025 compliant
✓ Verified by an independent third party
✓ Cradle-to-gate scope.

This EPD meets these requirements.

IS Tool®

This EPD complies with requirements under the Infrastructure Sustainability Council of Australia's IS® rating scheme.

Points can be claimed under the IS® rating scheme v1.2 Environmentally labelled products and supply chains credit (Mat-2) when the following criteria are met.

✓ Compliant with ISO 14025
✓ Compliant with EN15804
✓ Verified by a third party.

EPD results can also be included in the IS v2.0 Materials Calculator used in Material Life Cycle Impact Measurement and Reduction (Rso-6). This EPD meets these requirements.

The EPD also scores points under ISv2.0: Rso-7 Sustainability Labelled Products and Supply Chains.

Scenic World, Katoomba

General information

An Environmental Product Declaration, or EPD, is a standardised and verified way of quantifying the environmental impacts of a product based on a consistent set of rules known as a PCR (Product Category Rules).

Environmental product declarations within the same product category from different programmes may not be comparable. EPDs of construction products may not be comparable if they do not comply with EN 15804.

The Galvanizers Association of Australia, as the EPD owner, has the sole ownership, liability and responsibility for the EPD.

Declaration owner:

Galvanizers Association of Australia

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CEN standard EN 15804 served as the core PCR

PCR:	PCR 2011:16 Corrosion protection of fabricated steel products, Version 2.2, 2017-06-08 EN: 15804:2014
PCR review was conducted by:	The Technical Committee of the International EPD® System
Chair:	Massimo Marino Contact via info@environdec.com
Independent verification of the declaration and data, according to ISO 14025:	☐ EPD process certification (Internal) ☒ EPD verification (External)
Third party verifier:	Rob Rouwette, start2see Pty Ltd www.start2see.com.au Rob.Rouwette@start2see.com.au Approved by EPD Australasia Ltd

References

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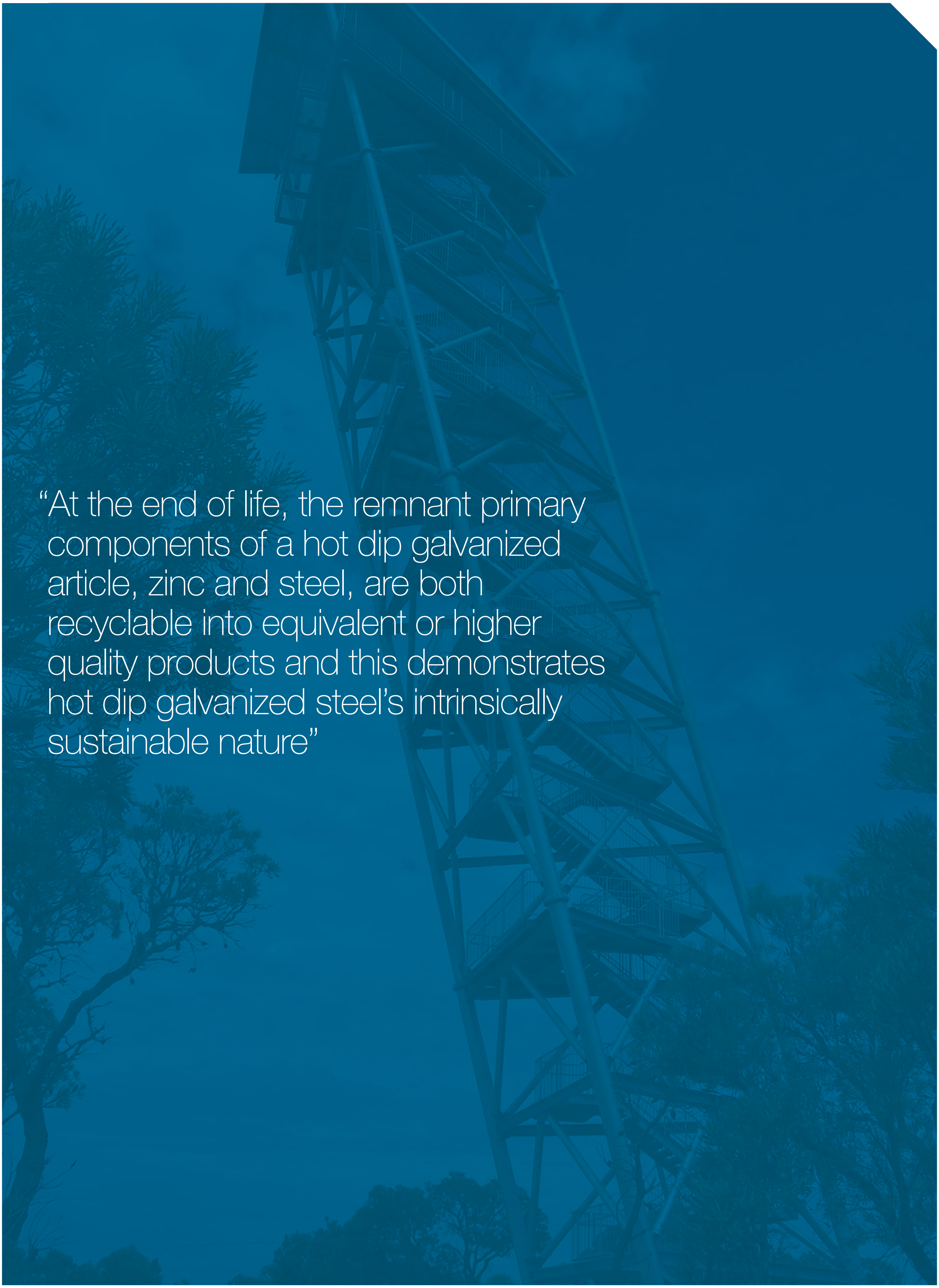
The Desiring Machine, Victoria



"At the end of life, the remnant primary components of a hot dip galvanized article, zinc and steel, are both recyclable into equivalent or higher quality products and this demonstrates hot dip galvanized steel's intrinsically sustainable nature"

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