ENVIRONMENTAL PRODUCT DECLARATION

REBAR

(AVERAGE)

Rebar

A type of construction framework material used in reinforced concrete and prestressed reinforced concrete as a supporting structure.

WEI CHIH STEEL

Wei Chih Steel is actively engaging in international environmental advocacy efforts. As part of this commitment, we've launched the Environmental Product Declaration (EPD) project for all our products. By analyzing the entire product life cycle, we provide consumers with measurable and comparable environmental performance data, following ISO 14025 standards. Our goal is to enhance transparency by publicly sharing lifecycle assessments and environmental impact information. This empowers consumers to make informed choices about our products' environmental footprint. The data is independently verified. Purchasers can opt for our products based on the 'Type III Environmental Product Declaration,' which offers comprehensive environmental insights. This aligns with Sustainable Development Goals and promotes sustainable practices, corporate competitiveness, and the use of certified materials.

For more information visit:
http://www.weichih.com.tw/spic3.php?pid=7

or contact:
shj96012@weichih.com.tw

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ENVIRONMENTAL PRODUCT DECLARATION

WEI CHIH STEEL

BILLET
Product Category Rules (PCR) Guidance for Building-Related Products and Services - Part A: Life Cycle Assessment Calculation Rules and Report Requirements and Part B: Designated Steel Construction Product EPD Requirements

According to ISO 14025, EN 15804 and ISO 21930:2017

EPD PROGRAM AND PROGRAM OPERATOR NAME, ADDRESS, LOGO, AND WEBSITE	UL Solutions www.ul.com 333 Pfingsten Rd, Northbrook IL, 60062 www.spot.ul.com
GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER	Program Operator Rules v 2.7 2022
MANUFACTURER NAME AND ADDRESS	WEI CHIH STEEL INDUSTRIAL CO., Ltd./ KUANTIEN FACTORY NO.123, NanPu Village, KuanTien Distrect, Tainan City, Taiwan
DECLARATION NUMBER	4790852701.102.1
DECLARED PRODUCT & FUNCTIONAL UNIT OR DECLARED UNIT	product per metric ton
REFERENCE PCR AND VERSION NUMBER	Product Category Rule (PCR) Guidance for Building-Related Products and Services Part A: Life Cycle Assessment Calculation Rules and Report Requirements Part B: Designated Steel Construction Product EPD Requirements
DESCRIPTION OF PRODUCT APPLICATION/USE	Rebar is a type of steel rod that is primarily used in reinforced concrete structures as a building material. The surface is usually made with raised nodes or indented patterns to enhance the bond strength between the rebar and the concrete, allowing the two materials to exhibit higher combined strength when bonded together. The rebar products manufactured by our company are mainly used in construction and civil engineering projects such as buildings, tunnels, bridges, airport runways, factories, public works, and more.
PRODUCT RSL DESCRIPTION (IF APPL.)	40 years
MARKETS OF APPLICABILITY	Australia, Taiwan
DATE OF ISSUE	April 1, 2024
PERIOD OF VALIDITY	5 Years
EPD TYPE	Product specific
RANGE OF DATASET VARIABILITY	mean
EPD SCOPE	Cradle to gate with options (specify options)
YEAR(S) OF REPORTED PRIMARY DATA	2022
LCA SOFTWARE & VERSION NUMBER	SimaPro v9.4.0.2
LCI DATABASE(S) & VERSION NUMBER	SimaPro v9.4.0.2 Ecoinvent3.8, SimaPro v9.4.0.2 Industry data 2.0, SimaPro v9.4.0.2 USLCI, SimaPro v9.4.0.2 EU & DK Input Output Database, IPCC AR6 (2023): 7.SM Chapter 7: The Earth's energy budget, climate feedbacks, and climate sensitivity - Supplementary Material, Taiwan Ministry of Environment - GHG EF management table ver 6.0.4: Fugitive emission sources
LCIA METHODOLOGY & VERSION NUMBER	TRACI 2.1: US-Canadian 2008, CML-IA baseline: EU25+3, 2000, EF 3.0 Method (adapted): EF 3.0 normalization and weighting

The PCR review was conducted by:	UL Solutions PCR Review Panel epd@ul.com
This declaration was independently verified in accordance with ISO 14025: 2006. ☐ INTERNAL ☒ EXTERNAL	Cooper McCollum Cooper McCollum, UL Solutions
This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	WEI CHIH STEEL INDUSTRIAL CO., LTD.
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Sung Mo Yeon, H.I.P. Pathway

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LIMITATIONS

Exclusions: EPDs do not indicate that any environmental or social performance benchmarks are met, and there may be impacts that they do not encompass. LCAs do not typically address the site-specific environmental impacts of raw material extraction, nor are they meant to assess human health toxicity. EPDs can complement but cannot replace tools and certifications that are designed to address these impacts and/or set performance thresholds – e.g. Type 1 certifications, health assessments and declarations, environmental impact assessments, etc.

Accuracy of Results: EPDs regularly rely on estimations of impacts; the level of accuracy in estimation of effect differs for any particular product line and reported impact.

Comparability: EPDs from different programs may not be comparable. Full conformance with a PCR allows EPD comparability only when all stages of a life cycle have been considered. However, variations and deviations are possible". Example of variations: Different LCA software and background LCI datasets may lead to differences results for upstream or downstream of the life cycle stages declared.

1. Product Definition and Information

1.1. Description of Company/Organization

Wei Chih Steel, established in 1982, initially focused on processing black iron wire and trading in coil elements. In 1991, the company set up a large integrated smelting and rolling plant in Guantian, Tainan. By 1994 and 1996, we successfully completed the construction and testing of the rolling and smelting steel plants, marking a new era of production. In December 1996, Wei Chih Steel went public, and it currently occupies approximately 140,000 square meters of land with around 350 employees. Their primary product range includes high-quality steel such as billets, reinforcing bars, straight bars, coil elements, and special alloy steel. With rigorous production process control and robust micro-techniques, Wei Chih Steel has emerged as a leading player in the steel industry. It holds the distinction of being Taiwan's steel reinforcement manufacturer with the most national export certifications. Between 2007 and 2020, they obtained product certifications from countries including Hong Kong, South Korea, Singapore, the United States, Australia, New Zealand, the Philippines, and Malaysia. During this period, we produced over 150,000 tons of special steel coil elements and more than 430,000 tons of special straight bars, which are marketed both domestically and internationally. The precision and strength of Wei Chih Steel's MIT steel have become a hallmark of quality worldwide.

To gradually participate in international initiatives related to environmental climate, Wei Zhi Steel Industrial Co., Ltd. has promoted a project for all product Carbon Footprints (CFPs), including steel billets, rebar, round bar, and wire rod. Based on the characteristics of the product life cycle, we provide consumers with quantifiable and comparable environmental performance results in accordance with the ISO 14067 standard.

1.2. Product Description

Product Identification

The production of rebar products is carried out according to standard specifications, includling plain rebar and deformed rebar.

Product Specification

Table 1. Product spec. description

PRODUCT	SPEC DESCRIPTION	MECHANICAL PROPERTIES	STANDARD
Plain rebar: SR240 SR300	• D10, Nominal dia. 9.53mm, Unit weigh 0.560kg/m • D13, Nominal dia. 12.7mm, Unit weigh 0.994kg/m	• SR240: Yield strength >=240N/mm^2, Tensile strength >=380N/mm^2, elongation >=20% (No.2) and >=22% (No.14A) • SR300: Yield strength >=300N/mm^2, Tensile strength >=480N/mm^2, elongation >=18% (No.2) and >=19% (No.14A)	Taiwan CNS 560: 2018
Deformed rebar: SR280 SD280 SD280W SD420 SD420W SD490W SD550W SD690	• D16, Nominal dia. 15.9mm, Unit weigh 1.56kg/m • D19, Nominal dia. 19.1mm, Unit weigh 2.25kg/m • D22, Nominal dia. 22.2mm, Unit weigh 3.04kg/m • D25, Nominal dia. 25.4mm, Unit weigh 3.98kg/m • D29, Nominal dia. 28.7mm, Unit weigh 5.08kg/m • D32, Nominal dia. 32.2mm, Unit weigh 6.39kg/m • D36, Nominal dia. 35.8mm, Unit weigh 7.90kg/m • D39, Nominal dia. 39.4mm, Unit weigh 9.57kg/m	• SR280: Yield strength >=280N/mm^2, Tensile strength >=420N/mm^2, elongation >=18% (No.2) and >=19% (No.14A) • SR420: Yield strength >=420N/mm^2, Tensile strength >=620N/mm^2, elongation >=13% (No.2) and >=14% (No.14A) • SR280W[(a)]: Yield strength >=280~380N/mm^2, Tensile strength >=420N/mm^2, elongation >=18% (No.2) and >=19% (No.14A) • SR420W[(a)]: Yield strength >=420~540N/mm^2, Tensile strength >=550N/mm^2, elongation >=13% (No.2) and >=14% (No.14A) • SR490W[(a)]: Yield strength >=490~615N/mm^2, Tensile strength >=620N/mm^2, elongation >=13% (No.2) and >=14% (No.14A) • SR550W[(a)]: Yield strength >=550~675N/mm^2, Tensile strength >=690N/mm^2, elongation >=12% (No.2) and >=13% (No.14A) • SR690W[(b)]: Yield strength >=690~815N/mm^2, Tensile strength >=860N/mm^2, elongation >=10% (No.2) and >=10% (No.14A) (a) TS/YS>1.25, (b) TS/YS>1.15	Taiwan CNS 560: 2018

PRODUCT	SPEC DESCRIPTION	MECHANICAL PROPERTIES	STANDARD
Deformed rebar: 500N	10, Nominal dia. 10mm, Unit weigh 0.617kg/m 12, Nominal dia. 12mm, Unit weigh 0.888kg/m 16, Nominal dia. 16mm, Unit weigh 1.58kg/m 20, Nominal dia. 20mm, Unit weigh 2.47kg/m 24, Nominal dia. 24mm, Unit weigh 3.55kg/m 28, Nominal dia. 28mm, Unit weigh 4.83kg/m 32, Nominal dia. 32mm, Unit weigh 6.31kg/m 36, Nominal dia. 36mm, Unit weigh 7.99kg/m 40, Nominal dia. 40mm, Unit weigh 9.86kg/m	• 500N: Yield strength >=500~650N/mm^2, TS/YS>1.08, elongation Agt>=5%	Australia AS/NZS 4671: 2019
Plain rebar / deformed rebar: G40 G60 G80 G100	#3, Nominal dia. 9.5mm, Unit weigh 0.560kg/m #4, Nominal dia. 12.7mm, Unit weigh 0.994kg/m #5, Nominal dia. 15.9mm, Unit weigh 1.552kg/m #6, Nominal dia. 19.1mm, Unit weigh 2.235kg/m #7, Nominal dia. 22.2mm, Unit weigh 3.042kg/m #8, Nominal dia. 25.4mm, Unit weigh 3.973kg/m #9, Nominal dia. 28.7mm, Unit weigh 5.060kg/m #10, Nominal dia. 32.3mm, Unit weigh 6.404kg/m #11, Nominal dia. 35.8mm, Unit weigh 7.907kg/m	• G40 #3[(a)]: Yield strength >=280N/mm^2, Tensile strength >=420N/mm^2, elongation >=11% • G40 #4~#6[(a)]: Yield strength >=280N/mm^2, Tensile strength >=420N/mm^2, elongation >=12% • G60 #3~#6[(a)]: Yield strength >=420N/mm^2, Tensile strength >=550N/mm^2, elongation >=9% • G60 #7~#8[(a)]: Yield strength >=420N/mm^2, Tensile strength >=550N/mm^2, elongation >=8% • G60 #9~#11[(a)]: Yield strength >=420N/mm^2, Tensile strength >=550N/mm^2, elongation >=7% • G80 #3~#8[(a)]: Yield strength >=550N/mm^2, Tensile strength >=690N/mm^2, elongation >=7% • G80 #9~#11[(a)]: Yield strength >=550N/mm^2, Tensile strength >=690N/mm^2, elongation >=6% • G100 #3~#8[(a)]: Yield strength >=690N/mm^2, Tensile strength >=790N/mm^2, elongation >=7% • G100 #9~#11[(a)]: Yield strength >=690N/mm^2, Tensile strength >=790N/mm^2, elongation >=6% (a) TS/YS>1.1	US ASTM A615: 2020
Deformed rebar: G60 G80	#3, Nominal dia. 9.5mm, Unit weigh 0.560kg/m #4, Nominal dia. 12.7mm, Unit weigh 0.994kg/m #5, Nominal dia. 15.9mm, Unit weigh 1.552kg/m #6, Nominal dia. 19.1mm, Unit weigh 2.235kg/m #7, Nominal dia. 22.2mm, Unit weigh 3.042kg/m #8, Nominal dia. 25.4mm, Unit weigh 3.973kg/m #9, Nominal dia. 28.7mm, Unit weigh 5.060kg/m #10, Nominal dia. 32.3mm, Unit weigh 6.404kg/m #11, Nominal dia. 35.8mm, Unit weigh 7.907kg/m	• G60 #3~#6[(b)]: Yield strength >=420~540N/mm^2, Tensile strength >=550N/mm^2, elongation >=14% • G60 #7~#11[(b)]: Yield strength >=420~540N/mm^2, Tensile strength >=550N/mm^2, elongation >=12% • G80 #3~#11[(b)]: Yield strength >=550~675N/mm^2, Tensile strength >=690N/mm^2, elongation >=12% (b) TS/YS>1.25	US ASTM A615: 2016
Deformed rebar: 500B	10, Nominal dia. 10mm, Unit weigh 0.617kg/m 12, Nominal dia. 12mm, Unit weigh 0.888kg/m 16, Nominal dia. 16mm, Unit weigh 1.579kg/m 20, Nominal dia. 20mm, Unit weigh 2.466kg/m 25, Nominal dia. 25mm, Unit weigh 3.854kg/m 32, Nominal dia. 32mm, Unit weigh 6.313kg/m 40, Nominal dia. 40mm, Unit weigh 9.864kg/m 50, Nominal dia. 50mm, Unit weigh 15.413kg/m	• 500B: Yield strength >=500~650N/mm2, TS/YS>1.08, elongation Agt>=5%	Hong Kong CS2: 2012
Deformed rebar: SD400 SD500 SD600 SD400S SD500S SD600S	D10, Nominal dia. 9.53mm, Unit weigh 0.560kg/m D13, Nominal dia. 12.7mm, Unit weigh 0.995kg/m D16, Nominal dia. 15.9mm, Unit weigh 1.56kg/m D19, Nominal dia. 19.1mm, Unit weigh 2.25kg/m D22, Nominal dia. 22.2mm, Unit weigh 3.04kg/m D25, Nominal dia. 25.4mm, Unit weigh 3.98kg/m D29, Nominal dia. 28.6mm, Unit weigh 5.04kg/m D32, Nominal dia. 31.8mm, Unit weigh 6.23kg/m	• SD400[(a)]: Yield strength >=400~520N/mm^2, TS/YS>1.15, elongation >=16% (No.2) and >=18% (No.3) • SD500[(b)]: Yield strength >=500~650N/mm^2, TS/YS>1.08, elongation >=12% (No.2) and >=14% (No.3) • SD600[(b)]: Yield strength >=600~780N/mm^2, TS/YS>1.08, elongation >=10% (No.2 and No.3) • SD400S[(c)]: Yield strength >=400~520N/mm^2, TS/YS>1.25, elongation >=16% (No.2) and >=18% (No.3) • SD500[(c)]: Yield strength >=500~620N/mm^2, TS/YS>1.25, elongation >=12% (No.2) and >=14% (No.3) • SD600[(b)]: Yield strength >=600~720N/mm^2, TS/YS>1.25, elongation >=10% (No.2 and No.3)	Korea KS D 3504: 2021

PRODUCT	SPEC DESCRIPTION	MECHANICAL PROPERTIES	STANDARD
Deformed rebar: B500B	10, Nominal dia. 10mm, Unit weigh 0.617kg/m 12, Nominal dia. 12mm, Unit weigh 0.888kg/m 16, Nominal dia. 16mm, Unit weigh 1.58kg/m 20, Nominal dia. 20mm, Unit weigh 2.47kg/m 25, Nominal dia. 25mm, Unit weigh 3.854kg/m 32, Nominal dia. 32mm, Unit weigh 6.313kg/m 40, Nominal dia. 40mm, Unit weigh 9.864kg/m	B500B: Yield strength >=500~650N/mm2, TS/YS>1.08, elongation Agt>=5%	Malaysian MS 146: 2014

Flow Diagram

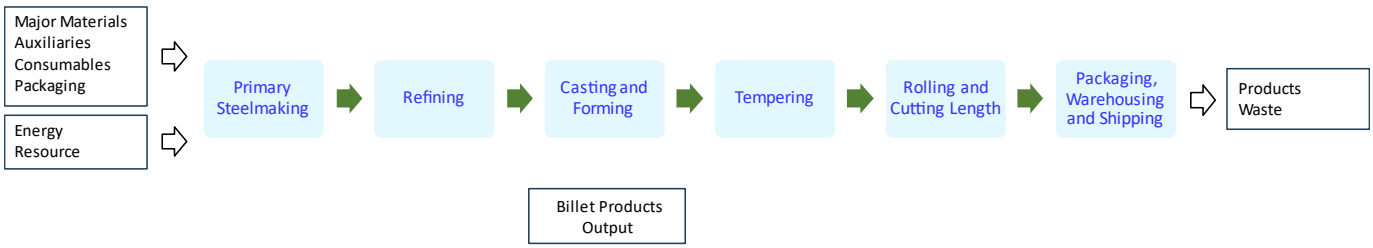

Figure 1. Production processes

Product Average

This EPD is a product-specific EPD. The declaration is for the rebar nominated as the product manufactured by Wei Chih Steel.

While allocating energy, resource, waste and material usage within the production site, allocation was carried out based on the average annual mass.

1.3. Application

Rebar is a type of steel rod that is primarily used in reinforced concrete structures as a building material. The surface is usually made with raised nodes or indented patterns to enhance the bond strength between the rebar and the concrete, allowing the two materials to exhibit higher combined strength when bonded together. The rebar products manufactured by our company are mainly used in construction and civil engineering projects such as buildings, tunnels, bridges, airport runways, factories, public works, and more.

Table 2. Range of application, product standard or accreditation

COUNTRY/ REGION	TYPE	STANDARD
Taiwan	Steel bar for concrete reinforcement	CNS 560
Korea	Steel bar for concrete reinforcement	KS D 3504
Australia	Steel bar for concrete reinforcement	AS/NZS 4671
Malaysia	Steel bar for concrete reinforcement	MS 146

1.4. Declaration of Methodological Framework

In this project, a full LCA approach was considered with some simplification on data modeling using generic data for most background systems. The EPD analysis uses a cradle-to-gate with options (specify options) system boundary.

Additional details on assumptions, cut-offs and allocation procedures can be found in section 2.3, 2.4, and 2.8, respectively.

1.5. Properties of Declared Product as Delivered

This product is primarily sold in Taiwan. Some products are exported by sea, with the main destinations being Australia. The total sales volume for the year 2022 was 463,936.70 metric ton.

1.6. Material Composition

1. Major materials: Scrap steel, Ferrosilicon, Ferromanganese-silicon, Ferromanganese, Ferromolybdenum, Ferrovanadium, Ferroniobium, Aluminum ingot.
2. Auxiliaries: Quicklime, CDQ, Anhydrous coke powder, Light calcined magnesia ball, Carburizing agent, Carbon wire, Aluminum wire, Calcium iron wire, Titanium wire, Artificial bauxite, Calcium aluminate, Boron wire, Carbonized rice husk, Calcium carbide, Argon, Nitrogen, Oxygen, EBT filling sand.
3. Consumables: Fluorite, Electrode bar, Tamping material, Magnesia carbon brick, Flexible freight bag, Magnesium oxide, Furnace material, Thermometer, Sampler, Refractory mortar, Roller, Cutting blade, Paint, T/D dry covering material, T/D tamping material, Tamping material (L/D), Acetylene.
4. Packaging: Package wire.

1.7. Manufacturing

To begin, scrap steel is sorted by grade after undergoing a radiation detection and weighing process. They are then melted in an electric arc furnace. The rapid melting process transforms the scrap steel into molten steel, which is then transferred to a refining furnace. In the refining furnace, the composition and casting temperature can be adjusted to improve the quality of the steel billet. Molten steel is cast into billets using a CONCAST five-way continuous casting machine and M-EMS electromagnetic stirring technology. The steel billet is heated or cold-fed to the BENDOTTI heating furnace. After being heated twice to 1200℃, it is processed by a rolling mill to create a product. The rolling mill has a capacity of up to 85 metric ton per hour and utilizes a POMINI straight-line design to ensure that the finished product is more compact and safer. We conduct rebar tensile tests to ensure that the mechanical properties meet the standards. Once the steel is shaped by the rolling mill, it is cut using a shearing machine and then automatically packaged by a packaging machine. After passing the quality inspection, the end face of the packaged product is spray-painted to ensure that each bundle of products has identification information.

1.8. Packaging

The products are using package wire in delivery.

1.9. Transportation

Only includes raw material transportation and final waste transportation.

1.10. Reference Service Life and Estimated Building Service Life

According to the “Product Category Rule (PCR) Guidance for Building-Related Products and Services - Part A: Life Cycle Assessment Calculation Rules and Report Requirements, Chapter 7.1.4”, the default values for Reference Service Life and Estimated Building Service Life are both 40 years.

1.11. Reuse, Recycling, and Energy Recovery

For the LCA study, the disposal of the used products adopted a country- and region-based weighted average disposal mode following literature review and Ecoinvent database. End of life disposal treatment process (C4) from Ecoinvent was used in this LCA study. According to public information, we distinguish the final disposal as recyclable and non-recyclable parts.

In the recyclable sector, the rates of collected and recycled scrap steel and packaged wire are sourced from CSC Company Sustainability, Statista Data Platform, and the Australian Steel Institute. The distance assumptions are based on data from the Statistics Department and Transport Department of Taiwan's MOTC, L.E.K. Consulting Australia Pty Ltd., as well as the Government of the Hong Kong Special Administrative Region.

The recycling information of product dis-assembly instructions is described by sorting from International Universal Recycling Codes and European EWC codes. See the following table.

Table 3. Recycling information

Type	Items	International Universal Recycling Codes		European EWC Codes	
		Code	Description	Code	Description
product	Billet	#40 FE	Steel	# 17 04 09*	Metal waste contaminated with hazardous substances
packaging	Package wire	#40 FE	Steel	# 17 04 09*	Metal waste contaminated with hazardous substances

1.12. Disposal

In non-recyclable part, the rate of sanitary landfill or incineration disposal we summarize recycling information and public data for statistics. See the following table.

Table 4. Recycling information

Module	Items	Treatment Assumptions		Distance Assumptions	
		Treatment	Ratio	Distance	Unit
Reuse, Recovery, Recycling Potential	Scrap steel in Taiwan	Recycling	94.10%	33.50	km
Waste processing, Disposal	Scrap steel in Taiwan	Disposal	5.90%	49.40	km
Reuse, Recovery, Recycling Potential	Scrap steel in Australia	Recycling	90.00%	170.00	km

Module	Items	Treatment Assumptions		Distance Assumptions	
		Treatment	Ratio	Distance	Unit
Waste processing, Disposal	Scrap steel in Australia	Disposal	10.00%	170.00	km
Reuse, Recovery, Recycling Potential	Package wire in Taiwan	Recycling	94.10%	33.50	km
Waste processing, Disposal	Package wire in Taiwan	Disposal	5.90%	49.40	km
Reuse, Recovery, Recycling Potential	Package wire in Australia	Recycling	90.00%	170.00	km
Waste processing, Disposal	Package wire in Australia	Disposal	10.00%	170.00	km

2. Life Cycle Assessment Background Information

2.1. Functional or Declared Unit

Functional and declared unit both are defined as one metric ton of rebar.

2.2. System Boundary

A full Life Cycle Assessment has been carried out according to ISO 14040 and ISO 14044. The following Life Cycle Stages are assessed:

- Product Stage(modules A1-A3)
- Construction Process Stage(modules A4-A5)
- Use Stage(modules B1-B7)
- End of life Stage(modules C1-C4)
- Benefits and Loads Beyond the System Boundary(module D)

The system boundaries of the LCA report, based on EPD-PCR rules, include the following study option: a) cradle to gate with modules C1–C4 and module D (modules A1–A3, + C + D).

1. Raw material supply and transport stages (modules A1-A2): including the relating information about energy use, transportation, waste disposal, etc., of the raw material acquisition process.
2. Manufacturing stage (module A3): including the relating information about energy use, transportation, waste disposal, etc., of the manufacturing process.
3. End of life stage, benefits and loads beyond the system boundary (modules C, D): to simulate local recycling and disposal information after the product discarded.

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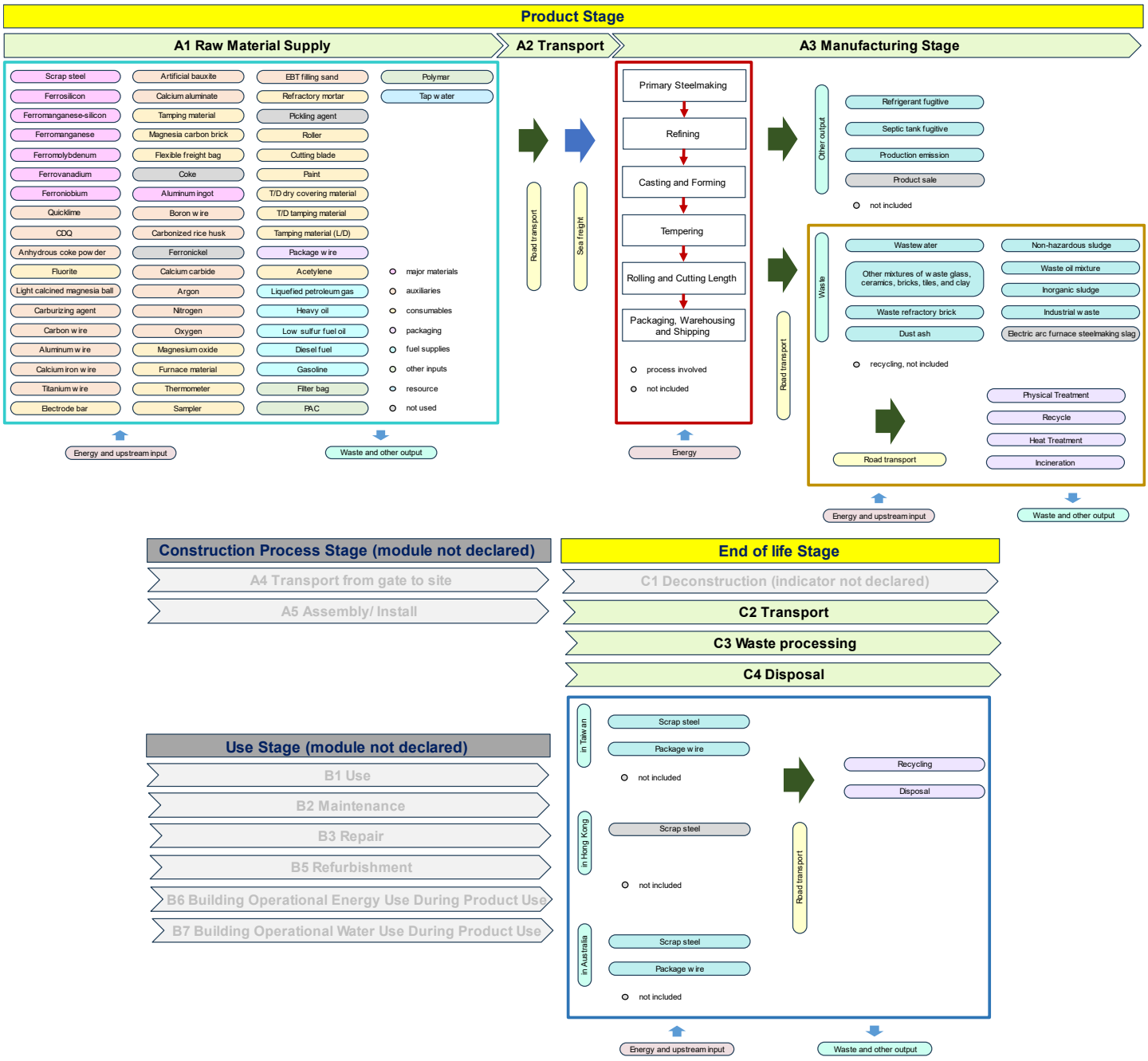

Figure 2. System boundary of EPD-PCR

2.3. Estimates and Assumptions

The assumptions and limitations of the study described as following:

1. During the inventory of this product, due to the lack of product carbon content testing data, and the additional emissions generated in the refining stage of the product characteristics assessment have limited changes, therefore, when calculating the overall process emissions of the final product, the carbon content of the steel billet is used as the basis.
2. For the requirements of EPD-PCR, the study covered life cycle stages for modules A1-A3, C, D of the targeted product from cradle to grave, and the environmental impact of end of life stage was assessed by the regional situational criteria of the EPD-PCR.
3. The weight of raw materials was collected by sampling, and the results would be different for the sampling.
4. As for the activity data, the refrigerant and septic tank items are calculated with the default value of IPCC fugitive source.
5. At end of life stage, the study estimated the distance by the public data of waste treatment location.
6. The deconstruction stage (module C1) is not accessible, and its expected impact on environmental categories is minimal, so the system boundaries indicator is not declared.
7. Because there is no specific data available for activities in waste processing and disposal stages (module C3 and C4), the study estimated the emissions from the final disposal of the product by the official announcement data of waste disposal where the first-tier distribution sites located. The coefficients in the database already account for C3 and C4 processes, so the environmental impact results can only be displayed when these stages are combined. However, this decision will lead to a decrease in accuracy.
8. The values in reuse, recovery, recycling potential stage (module D) include a recognition of the benefits or impacts related to steel recycling which occur at the end of the product's service life. The rate of steel recycling and related processes will evolve over time. The results included in reuse, recovery, recycling potential stage (module D) attempt to capture future benefits, or impacts, but are based on a methodology that uses current industry-average data reflecting current processes.

2.4. Cut-off Criteria

For any impact category, if the sum of the impact from a specific process/activity is less than 1% of the impact equivalent, such a process/activity may be neglected during the inventory analysis. Nonetheless, the accumulated impact of neglected process/activity may not exceed 5%. Components and materials omitted from the LCA shall be documented.

The neglected items of the LCA study include:

1. Refrigerant's Fugitive: Air conditioner in the information room office on 4F of the office building (the equipment data plate cannot be read)
2. Refrigerant's Fugitive: Refrigerator in the container of the raw materials section of steelmaking department (R600a of IPCC GWP undisclosed)
3. Self-disposal: Waste flexible freight bag (low frequency of activity data, unable to calculate)
4. Self-disposal: Waste paint bucket (low frequency of activity data, unable to calculate)
5. Refrigerant (Raw Material)-R22 (no environmental factors of raw material, unable to calculate)
6. Refrigerant (Raw Material)-R407C (no environmental factors of raw material, unable to calculate)

7. Refrigerant (Raw Material)-R410a (no environmental factors of raw material, unable to calculate)
8. Refrigerant (Raw Material)-R134a (being consistency, do not perform calculations)

For lacking of statistical data or relevant coefficient information (such as the limitations in the database and the absence of similar or closely related types for calculation) for the activities mentioned above in the investigation process, and reasonably estimated its contribution to the environmental impact categories are also very small, they have been excluded. No known flows are deliberately excluded from this report.

2.5. Data Sources

Most of the raw data collected by actual activities and purchase records of Wei Chih Steel and partially reasonable assumptions.See the following table.

Data	Time Related Coverage	Geographical Coverage	Technological Coverage	Data Source	Measured/ Estimated
Data Quality Assessment (A1, A2)					
Major Materials, Auxiliaries, Consumables, Packaging and Other Inputs Consumption	2022	Taiwan	Modern	Wei Chih	Measured
Distance of Materials Transportation to Production Line	2022	Taiwan	Modern	Digital Map	Measured
Fuel and Resources Consumption	2022	Taiwan	Modern	Wei Chih	Measured
Data Quality Assessment (A3)					
Electricity Use	2022	Taiwan	Modern	Wei Chih	Measured
Effusion Sources	2022	Taiwan	Modern	Wei Chih	Estimated
Waste and Wastewater Generation	2022	Taiwan	Modern	Wei Chih	Measured
Distance of Waste Transportation to Disposal Site	2022	Taiwan	Modern	Digital Map	Measured
Data Quality Assessment (C, D)					
Scrap Steel Generation	2014~2023	Australia, Taiwan	Unknown	Public Data	Estimated
Waste Paper Generation			Unknown	Public Data	Estimated
Waste Plastic Generation			Unknown	Public Data	Estimated
Distance of Waste Transportation to Disposal Site			Modern	Digital Map	Measured

2.6. Data Quality

Raw data of the report is based on 1 year averaged data (Year 2022). The date of the generic data used in the modelling typically covers information from the past ten years. For the requirement of boundaries regarding geographical coverage, waste generated by manufacturing process has to obey local regulation where the manufacturing processes located, to disclosure related information about recycling process of the product. Furthermore, for ease of comparison, no matter where the emissions are generated, the same environmental impact parameters should be used for life cycle impact assessment.

Data collection of the LCA study based on EPD-PCR rules, most of the data are actual measurement data in 2022 delivered by manufacturing plant, with regional and technical representation. The detailed data quality as shown in the table below.

2.7. Period under Review

1. The data inventory report is from 2022-01-01 to 2022-12-31.
2. LCA report review is from 2023-12-14 to 2024-03-12.

2.8. Allocation

Output

The allocation of outputs, such as refrigerant's fugitive, manufacturing waste and final waste derived from the system, would be based on actual production, IPCC emission factors, and data from local governmental investigation or public platform.

Input

The allocation of inputs, such as raw materials, energy and resources used in the production process, as well as upstream transportation, would be based on the actual production of the factory.

Therefore, all allocation factors are based on mass. The description of allocation rules in of this LCA report meets the requirements of the PCR. Detailed explanations can be found in the chapters below.

2.9. Comparability (Optional)

This report does not support to be used in comparative assertions intended to be disclosed to the public, and it is not applicable for measuring, comparing and analyzing the similar products.

3. Life Cycle Assessment Scenarios

Table 5. Reference Service Life

NAME	VALUE	UNIT
RSL	45	years
Declared product properties (at the gate) and finishes, etc.	1	metric ton

Table 6. End of life (C1-C4)

ITEMS	DESCRIPTION
Assumptions for scenario development (description of deconstruction, collection, recovery, disposal method and transportation)	The disposal information is from the product's sales data. It assumes the local waste disposal methods and transportation distances at the sales points based on publicly available information, and calculates the environmental impact assessment based on sales volume.

NAME		VALUE	UNIT
Collection process (specified by type)	Collected separately	1.00E+00	metric ton/per metric ton product
	Recycling	1.01E+00	metric ton/per metric ton product
	Mix of treatment (excluding recycling)	6.63E-02	metric ton/per metric ton product
Disposal (specified by type)	Product or material for final deposition	1.00E+00	metric ton/per metric ton product
Removals of biogenic carbon (excluding packaging)		2.98E-04	kg CO2 eq/per metric ton product

4. Life Cycle Assessment Results

Table 7. Description of the system boundary modules

	PRODUCT STAGE			CONSTRUCT-ION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
	Raw material supply	Transport	Manufacturing	Transport from gate to site	Assembly/Install	Use	Maintenance	Repair	Replacement	Refurbishment	Building Operational Energy Use During Product Use	Building Operational Water Use During Product Use	Deconstruction	Transport	Waste processing	Disposal	Reuse, Recovery, Recycling Potential
EPD Type	X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	IND	X	X	X	X

(X: included in LCA; MND: module not declared; IND: indicator not declared; MNR: module not relevant)

4.1. Life Cycle Impact Assessment Results

Table 8. North American Impact Assessment Results

TRACI v2.1	Unit	A1	A2	A3	A4-A5	B1-B7	C1	C2	C3-C4	Total	D
GWP	kg CO_2 eq	1.79E+02	5.54E+01	7.22E+02	MND	MND	IND	6.10E+00	5.51E-01	9.64E+02	-1.69E+03
ODP	kg CFC-11 eq	3.34E-05	1.19E-05	4.65E-05	MND	MND	IND	1.37E-06	1.92E-07	9.33E-05	-7.95E-05
AP	kg SO_2 eq	1.01E+00	1.25E+00	2.31E+00	MND	MND	IND	3.02E-02	4.09E-03	4.61E+00	-5.52E+00
EP	kg N eq	5.91E-01	7.79E-02	2.73E+00	MND	MND	IND	7.29E-03	8.89E-04	3.41E+00	-4.27E+00
SFP	kg O_3 eq	1.50E+01	2.36E+01	2.57E+01	MND	MND	IND	7.52E-01	1.02E-01	6.52E+01	-8.81E+01
ADPF	MJ surplus	3.05E+02	1.08E+02	7.37E+02	MND	MND	IND	1.30E+01	1.83E+00	1.16E+03	-5.90E+02

Table 9. EU Impact Assessment Results-CML

CML-IA	Unit	A1	A2	A3	A4-A5	B1-B7	C1	C2	C3-C4	Total	D
GWP	kg CO_2 eq	1.81E+02	5.54E+01	7.25E+02	MND	MND	IND	6.10E+00	5.52E-01	9.68E+02	-1.71E+03
ODP	kg CFC-11 eq	2.57E-05	8.90E-06	3.39E-05	MND	MND	IND	1.03E-06	1.44E-07	6.97E-05	-6.88E-05
AP	kg SO_2 eq	9.68E-01	1.18E+00	2.33E+00	MND	MND	IND	2.55E-02	3.46E-03	4.50E+00	-5.21E+00
EP	kg PO_4 eq	3.10E-01	1.38E-01	1.26E+00	MND	MND	IND	6.14E-03	7.90E-04	1.72E+00	-2.20E+00
POCP	kg C_2H_4 eq	6.11E-02	3.08E-02	9.35E-02	MND	MND	IND	8.94E-04	1.39E-04	1.86E-01	-9.05E-01
ADPE	kg Sb eq	1.06E-02	1.02E-04	3.43E-04	MND	MND	IND	2.09E-05	1.55E-06	1.11E-02	-1.72E-03
ADPF	MJ	3.01E+03	7.37E+02	7.39E+03	MND	MND	IND	9.12E+01	1.27E+01	1.12E+04	-1.43E-04

Table 10. EU Impact Assessment Results-EF

EF 3.0	Unit	A1	A2	A3	A4-A5	B1-B7	C1	C2	C3-C4	Total	D
GWP	kg CO_2 eq	1.87E+02	5.59E+01	7.35E+02	MND	MND	IND	6.19E+00	5.63E-01	9.85E+02	-1.79E+03
ODP	kg CFC-11 eq	3.08E-05	1.12E-05	4.26E-05	MND	MND	IND	1.30E-06	1.82E-07	8.61E-05	-6.52E-05
AP	mol H+ eq	1.19E+00	1.48E+00	2.75E+00	MND	MND	IND	3.39E-02	4.60E-03	5.46E+00	-6.48E+00
EP-freshwater	kg P eq	5.91E-01	7.79E-02	2.73E+00	MND	MND	IND	7.29E-03	8.89E-04	3.41E+00	-4.27E+00
EP-marine	kg N eq	2.48E-01	3.72E-01	4.81E-01	MND	MND	IND	1.21E-02	1.62E-03	1.11E+00	-1.52E+00
EP-terrestrial	mol N eq	2.69E+00	4.12E+00	4.50E+00	MND	MND	IND	1.30E-01	1.76E-02	1.15E+01	-1.61E+01
POCP	kg NMVOC eq	9.79E-01	1.08E+00	1.31E+00	MND	MND	IND	3.76E-02	5.10E-03	3.41E+00	-7.68E+00
ADPE	kg Sb eq	1.06E-02	1.02E-04	3.40E-04	MND	MND	IND	2.09E-05	1.55E-06	1.11E-02	-1.71E-03
ADPF	MJ	3.13E+03	7.40E+02	8.42E+03	MND	MND	IND	9.26E+01	1.28E+01	1.24E+04	-1.47E+04
WDP	m_3 depriv.	2.94E+02	1.69E+00	6.42E+01	MND	MND	IND	3.63E-01	4.45E-01	3.60E+02	-1.13E+02

4.2. Life Cycle Inventory Results

Table 11. Resource Use

Parameter	Unit	A1	A2	A3	A4-A5	B1-B7	C1	C2	C3-C4	Total	D
PERE	MJ	0.00E+00	6.95E+00	1.12E+02	MND	MND	IND	1.59E+00	1.49E-01	1.21E+02	-3.71E+02
PERM	MJ	2.17E+02	0.00E+00	0.00E+00	MND	MND	IND	0.00E+00	0.00E+00	2.17E+02	0.00E+00
PERT	MJ	2.17E+02	6.95E+00	1.12E+02	MND	MND	IND	1.59E+00	1.49E-01	3.37E+02	-3.71E+02
PENRE	MJ	0.00E+00	7.44E+02	8.42E+03	MND	MND	IND	9.28E+01	1.28E+01	9.27E+03	-1.47E+04
PENRM	MJ	3.10E+03	0.00E+00	0.00E+00	MND	MND	IND	0.00E+00	0.00E+00	3.10E+03	0.00E+00
PENRT	MJ	3.10E+03	7.44E+02	8.42E+03	MND	MND	IND	9.28E+01	1.28E+01	1.24E+04	-1.47E+04
SM	kg	0.00E+00	0.00E+00	0.00E+00	MND	MND	IND	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	MND	MND	IND	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	MND	MND	IND	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m_3 eq	2.93E+02	1.72E+00	6.49E+01	MND	MND	IND	3.64E-01	4.46E-01	3.61E+02	-1.11E+02

Table 12. Output Flows and Waste Categories

Parameter	Unit	A1	A2	A3	A4-A5	B1-B7	C1	C2	C3-C4	Total	D
HWD	kg	2.22E-03	1.00E-03	6.16E-03	MND	MND	IND	2.41E-04	2.29E-05	9.65E-03	-1.70E-01
NHWD	kg	6.47E+01	1.43E+01	2.75E+01	MND	MND	IND	6.42E+00	6.61E+01	1.79E+02	-3.35E+02
RWD	kg	1.41E-02	5.08E-03	3.30E-02	MND	MND	IND	6.10E-04	8.36E-05	5.29E-02	-3.99E-02
MFR	kg	0.00E+00	0.00E+00	2.18E-01	MND	MND	IND	0.00E+00	1.01E+00	1.23E+00	0.00E+00
MER	kg	0.00E+00	0.00E+00	3.62E-02	MND	MND	IND	0.00E+00	0.00E+00	3.62E-02	0.00E+00
CRU	kg	0.00E+00	0.00E+00	0.00E+00	MND	MND	IND	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	MJ	0.00E+00	0.00E+00	0.00E+00	MND	MND	IND	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EET	MJ	0.00E+00	0.00E+00	0.00E+00	MND	MND	IND	0.00E+00	0.00E+00	0.00E+00	0.00E+00

5. LCA Interpretation

The highest proportion of GWP of the product is module A3 manufacturing: 74.95% in TRACI method, 74.91% in CML-IA method, and 74.66% in EF method. The highest proportion of ODP of the product is module A3 manufacturing: 49.80% in TRACI method, 48.64% in CML-IA method, and 49.49% in EF method. The highest proportion of AP of the product is module A3 manufacturing: 50.18% in TRACI method, 51.64% in CML-IA method, and 50.42% in EF method. The highest proportion of EP of the product is module A3 manufacturing: 80.15% in TRACI method, and 73.53% in CML-IA method. The highest proportion of EP-freshwater of the product is module A3 manufacturing: 80.15% in EF method. The highest proportion of EP-marine of the product is module A1 raw material supply: 43.16% in EF method. The highest proportion of EP-terrestrial of the product is module A1 raw material supply: 39.26% in EF method. The highest proportion of POCP of the product is module A1 raw material supply: 50.14% in CML-IA method, and 38.51% in EF method. The highest proportion of SFP of the product is module A3 manufacturing: 39.52% in TRACI method. The highest proportion of ADPE of the product is module A1 raw material supply: 95.78% in CML-IA method, and 95.80% in EF method. The highest proportion of ADPF of the product is module A3 raw material supply: 63.26% in TRACI method, 65.74% in CML-IA method, and 67.94% in EF method. The highest proportion of WDP of the product is module A1 raw material supply: 81.49% in EF method.

The significant emission hotspots:

- GWP: Electricity, Dust ash, Low sulfur fuel oil (process), Quicklime, CDQ (process), Sea Freight (raw materials);
- ODP: Electricity, Dust ash, Low sulfur fuel oil, Sea Freight (raw materials), Low sulfur fuel oil (process), Scrap steel;
- AP: Electricity, Sea Freight (raw materials), Low sulfur fuel oil (process), Scrap steel;
- EP: Electricity;
- POCP: Electricity, Sea Freight (raw materials), Low sulfur fuel oil (process), CDQ, Scrap steel, Ferromanganese-silicon;
- SFP: Sea Freight (raw materials), Electricity, Scrap steel, Ferromanganese-silicon;
- ADPE: Ferromolybdenum (high-carbon), Scrap steel;
- ADPF: Electricity, Dust ash, Low sulfur fuel oil, Low sulfur fuel oil (process), Sea Freight (raw materials);
- WDP: Aluminum ingot, Electricity.

6. Additional Environmental Information

RoHS

As specified by client, with reference to RoHS 2011/65/EU Annex Ⅱ and amending Directive (EU)2015/863 to determine Cadmium, Lead, Mercury, Cr (VI), PBBs, PBDEs, DBP, BBP, DEHP, DIBP contents in the submitted sample(s).

Based on the performed tests on submitted sample(s), the test results of Cadmium, Lead, Mercury, Cr (VI), PBBs, PBDEs, DBP, BBP, DEHP, DIBP comply with the limits as set by RoHS Directive (EU)2015/863 amending Annex Ⅱ to Directive 2011/65/EU.

REACH

As specified by client, the sample(s) was/were tested with reference to Regulation (EC) No 1907/2006 concerning the REACH.

According to the ruling of the Court of Justice of the European Union on the definition of an article under REACH, and the specified scope as well as analytical technique, the test results of the selected component article are ≦0.1%(w/w) in the submitted sample(s).

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