

Environmental Product Declaration

In accordance with ISO 14025:2006 for

STAINLESS STEEL FLAT BAR

from

SeAH Changwon Integrated Special Steel

The logo for SeAH CSS, featuring the text "SeAH" in a bold, dark blue font with a red checkmark above the 'A', followed by "CSS" in a lighter blue font. The logo is enclosed in a black rectangular border.

Programme:

The International EPD® System, www.environdec.com

Programme operator:

EPD International AB

EPD registration number:

S-P-11135

Publication date:

2023-12-20

Valid until:

2028-12-20

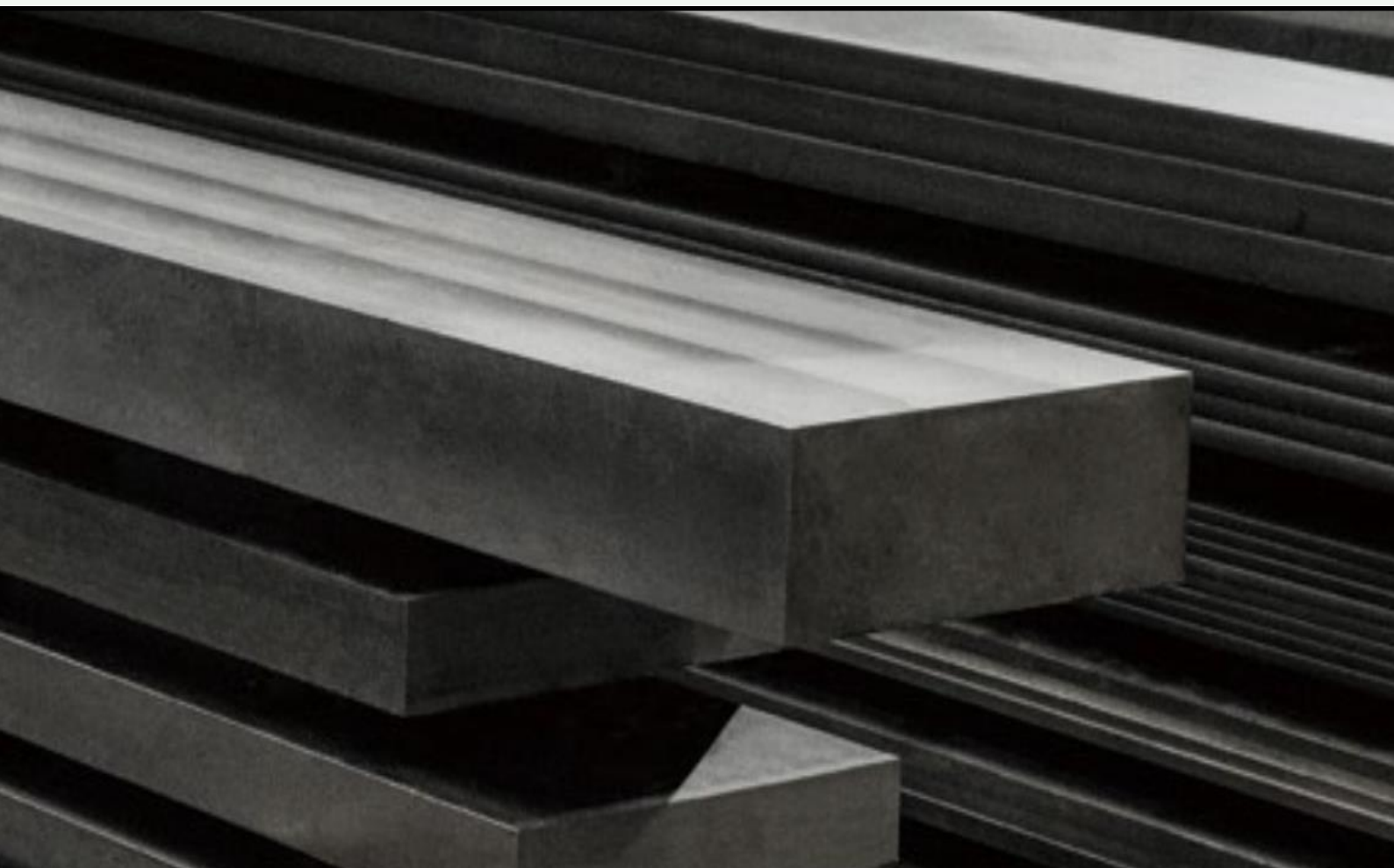
An EPD should provide current information and may be updated if conditions change. The stated validity is, therefore, subject to the continued registration and publication at www.environdec.com

The EPD logo, consisting of a horizontal bar with four segments in shades of green and black, followed by the text "EPD" in a bold, black font with a registered trademark symbol.

THE INTERNATIONAL EPD® SYSTEM

The EPD logo, consisting of a horizontal bar with four segments in shades of green and black, followed by the text "EPD" in a bold, black font with a registered trademark symbol.

THE INTERNATIONAL EPD SYSTEM



Programme information

Programme:	<p>The International EPD® System EPD International AB Box 210 60 SE-100 31 Stockholm Sweden</p> <p>www.environdec.com info@environdec.com</p>
-------------------	---

Accountabilities for PCR, LCA and independent, third-party verification
Product Category Rules (PCR)
PCR: <i>BASIC IRON OR STEEL PRODUCTS & SPECIAL STEELS, EXCEPT CONSTRUCTION STEEL PRODUCTS, PCR 2015:03, VERSION 2.1.0 and UN CPC 4112 AND 412</i>
PCR review was conducted by: <i>The Technical Committee of the International EPD® System. Chair: Massimo Marino Contact via info@environdec.com</i>
Life Cycle Assessment (LCA)
LCA accountability: Jihee Kim, SMaRTeco, e-mail: jihee@smart-eco.co.kr Jimin Lee, SMaRTeco, e-mail: jimin@smart-eco.co.kr
Third-party verification
Independent third-party verification of the declaration and data, according to ISO 14025:2006, via:
<input checked="" type="checkbox"/> EPD verification by individual verifier
Third-party verifier: <i>Vijay Thakur, Intertek Assuris</i>
Approved by: The International EPD® System Technical Committee, supported by the Secretariat
Procedure for follow-up of data during EPD validity involves third-party verifier:
<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No

EPDs within the same product category but from different programmes may not be comparable.
 EPD owner has the sole ownership, liability, and responsibility for the EPD.

Company information

Owner of the EPD: SeAH Changwon Integrated Special Steel

Contact:

Phone: 82-55-269-6114

Address: 147 Jeokhyeon-Ro, Seongsan-Gu, Changwon, Gyeongsangnam-Do, Republic of Korea

Contact: Kwon YongDal, sachool@seah.co.kr

Description of the organisation

SeAH CSS has founded in 1966 in the city of Changwon, Gyeong-sang South Province of Korea. Since its birth, SeAH CSS has led the growth of the country's special steel sector by producing high-grade steel products and bringing the optimized steel production process to the next level. Our great product portfolio and sophisticated manufacturing techniques allow us to be responsive to rapidly changing market needs and emerging industry trends. We continue to develop innovative solutions of great customer value based on market demand and industry trend.

Stretching over an area of 670,000 square meters, the Changwon Plant produces 1.2 million tons of crude steel annually. The entire manufacturing process has an integrated system, which takes place at a single factory. Changwon Plant produces a wide variety of high- grade special steel of different applications and offers products and services that target specific customer needs with its customized post-treatment services, such as heat treatment and processing. SeAH CSS is the seamless stainless-steel pipes & tubes manufacturer in Korea that uses the integrated steel manufacturing system. The Changwon Plant produces seamless large diameter steel pipes, and this recent addition of the new plant to the company successfully brings the company a step closer to becoming a leading special steel maker in the world.

SeAH CSS is the company in Korea to produce stainless steel round bars and wire rods. With our integrated production system dedicated to high-grade specialty steel, we are able to maintain market-leading positions in multiple product categories in Korea; including stainless steel, tool steel and special alloy. Our goal is to optimize the products to fulfill customers' needs and ensure the stable availability of supply by using our innovative technology.

Our advanced technology and production are based on over 50 years of experience of innovating high-grade special steel products and developing new materials to ultimately promote customers' Value.

Product-related or management system-related certifications

ISO 9001, ISO 14001, KS Q 9100(AS 9100) certificates

Name and location of production site(s)

147 Jeokhyeon-Ro, Seongsan-Gu, Changwon, Gyeongsangnam-Do, Republic of Korea

Product information

Product name

STAINLESS STEEL FLAT BAR

Product identification

5604F, 5604J, A276, A276M, A276MOD, A479, A479MOD, A564, D3706, G4303, G4303MOD, MED023B, MKD004F, MKD005F, MKD006F, MTD014F etc.

Product description

Blooms and ingots from a 60-ton or 100-ton electric furnace can be fed directly into a rolling facility without an intermediate stage, which allows us to reduce cost and meet delivery schedule. Electro slag re-melting is applied to ensure the cleanness of steel ingots and close-packed texture in the finished goods. We use a comprehensive set of facilities intended for the production of stainless steel flat bar including an SBM producing flat steel, an HV mill capable of horizontal and vertical, continuous precise rolling, 2,200- and 9,000-ton free forging units to offer a full product portfolio of different sizes ranging from small to large.

Further information is available on <http://www.seahss.co.kr/eng/pr/brochure.jsp>

Application & Characteristic:

Press molds, Power turbine blade and components etc.

304

Commonly used austenitic stainless steel.
Mainly used as parts for machinery, vacuum gauge, and etc that require high corrosion resistance.

Mechanical Properties

Grade	Heat treatment (°C)	Strength(N/mm ²)		Elongation(%)	RA(%)	Hardness(HB)
		Tensile	Yield			
304	Solution (1,010-1,150°C)	520 ↑	205 ↑	40 ↑	60 ↑	187 ↓
304L	water cooling	480 ↑	175 ↑	40 ↑	60 ↑	187 ↓

Physical Properties

Grade	Density	Specific Heat(0-100°C)	CTE(20-100°C)	TC(100°C)	Machinability (relative to AISI312)
304	8.0 g/cm ³	502 J/Kg K	17.3 μm/m K	16.3 W/m K	60%

* CTE: Coefficient of Thermal Expansion / TC: Thermal Conductivity

Applications

Parts of industrial machinery: Shafts, etc
Vacuum parts: Flanges, etc
Pump parts: Valves, etc



Parts for vacuum Gauge and Semiconductors

Cold workability – mechanical properties

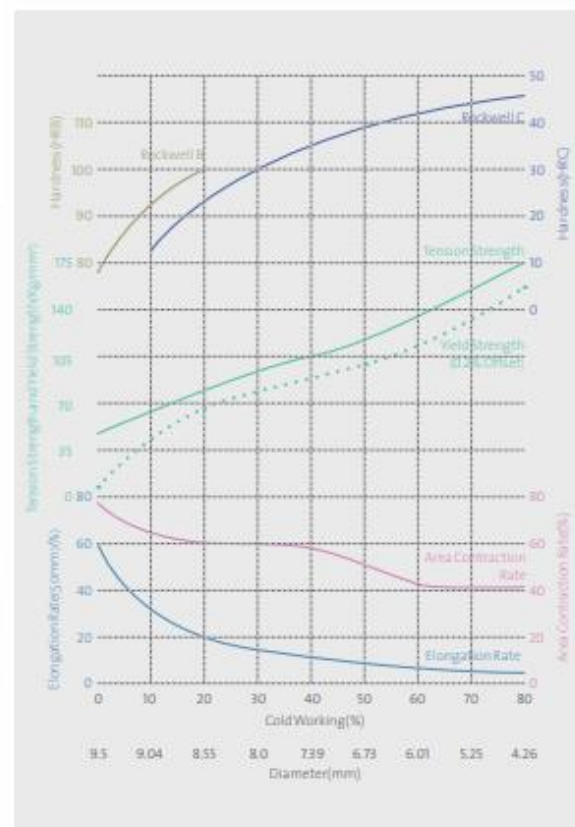


Figure 1 Characteristics and Applications of 304 series stainless steel Round Bar

316

Increased corrosion resistance and high temperature strength by adding Molybdenum to 304 grade. Mainly used as parts for seawater, petrochemical, and etc that require higher corrosion resistance.

Mechanical Properties

Grade	Heat treatment(°C)	Strength(N/mm ²)		Elongation(%)	RA(%)	Hardness(HB)
		Tensile	Yield			
316	Solution (1,010-1,150°C)	520 ↑	205 ↓	40 ↑	60 ↓	187 ↓
316L	water cooling	480 ↑	175 ↓	40 ↑	60 ↓	187 ↓

Physical Properties

Grade	Density	Specific Heat(0-100°C)	CTE(20-100°C)	TC(100°C)	Machinability (relative to AISI 1212)
316	8.0 g/cm ³	500 J/Kg K	15.9 μm/m K	16.3 W/m K	55%

* CTE: Coefficient of Thermal Expansion / TC: Thermal Conductivity

Applications

Seawater pump parts: Shafts and valves
Parts for chemical, oil refinery, and etc

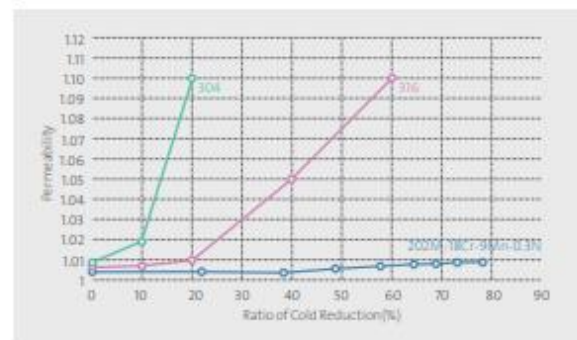


High corrosion resistant parts



Stainless valve

Cold Working – Investment Rate



Mechanical Properties

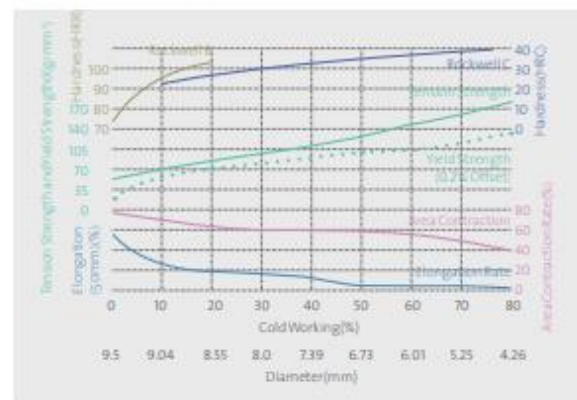


Figure 2. Characteristics and Applications of 316 series stainless steel Round Bar

410,403

410,403 are basic martensitic steels. They have a lack of corrosion resistance and magnetism when compared to 300s, however, their strength can be secured by having hardening heat treatment.

Mechanical Properties

ASTM A276	Heat treatment(°C)	Finish	Strength(N/mm ²)		Elongation(%)	RA(%)
			Tensile	Yield		
410,403	QT(Condition T)	Cold-finished	480 ↑	275 ↑	16 ↑	45 ↑
	Annealed	Hot-finished	480 ↑	275 ↑	20 ↑	45 ↑

Heat Treatment Method

Grade	Annealing	Quenching	Tempering
410,403	800-900°C, furnace cooling	850-1000°C, oil cooling	700-750°C, water cooling

* CTE: Coefficient of Thermal Expansion / TC: Thermal Conductivity

Physical Properties

Grade	Density	Specific heat(0-100°C)	CTE(20-100°C)	TC(100°C)	Machinability (relative to AISI312)
410,403	7.8 g/cm ³	460 J/Kg K	9.9 μm/m K	24.9 W/m K	55%

Applications

- High strength shafts
- Turbine parts for power generation: buckets and blades
- Pump parts: shafts and valves
- Parts for petrochemicals



Mechanical Properties

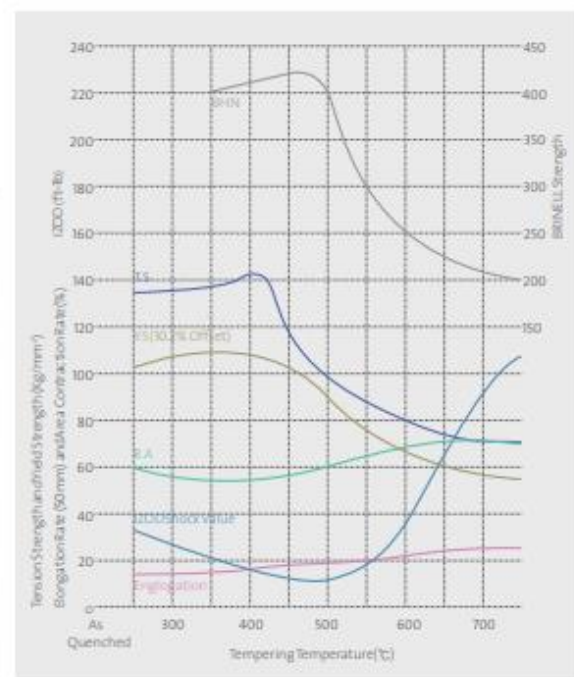


Figure 3. Characteristics and Applications of 410, 403 series stainless steel Round Bar

630,660

Boast high strength through precipitation hardening heat treatment.
Mainly used for parts with high temperatures and high strengths.

Mechanical Properties

Grade	Heat treatment/Cond.	Strength(N/mm ²)		Elongation (%)	RA(%)	Hardness (HRC)	
		Tensile	Yield				
630	Solution	-	-	-	-	38 ↓	
	Aging	H1025	1070 ↑	1000 ↑	12 ↑	45 ↑	35 ↑
		H1075	1000 ↑	860 ↑	13 ↑	45 ↑	32 ↑
		H1100	965 ↑	795 ↑	14 ↑	45 ↑	31 ↑
		H1150	930 ↑	725 ↑	16 ↑	50 ↑	28 ↑
660	Solution	-	-	-	-	-	
	Aging	A,B,C	585 ↑	895 ↑	15 ↑	18 ↑	24-37
		D	725 ↑	895 ↑	15 ↑	18 ↑	24-35

Physical Properties

Grade	Density	Specific heat (0-100 °C)	CTE (20-100 °C)	TC (100 °C)
630	7.81 g/cm ³	460 J/Kg K	10.4 μm/m K	17.8 W/m K
660	7.92 g/cm ³	460 J/Kg K	10.4 μm/m K	12.6 W/m K

* CTE: Coefficient of Thermal Expansion / TC: Thermal Conductivity

Applications



Mechanical Properties (630)

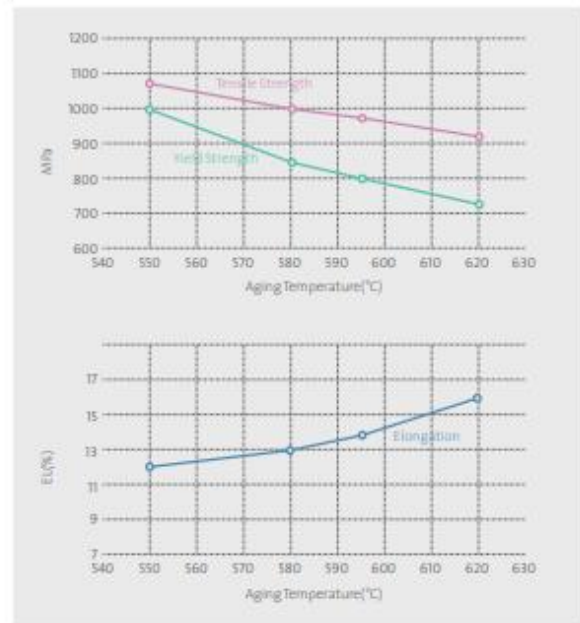


Figure 4. Characteristics and Applications of 630, 660 series stainless steel Round Bar

Turbine Blades (B50A365B, 10705BU, and etc.)

Produced with high strength, heat, and wear resistance.

Mainly used for turbine blades utilized in a field of thermal and nuclear power plant industry.

Chemical Composition

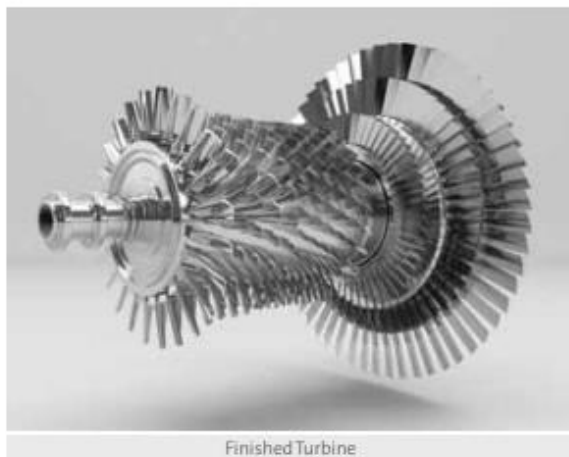
*GE: General Electronic, MHI: Mitsubishi Heavy Industries

Specification	Grade	Chemical composition (%)	
		Cr	Ni
GE	B50A365B	10.4	0.40
	B50A947A4	11.6	0.45
MHI	10705BU	11.7	0.70
	10705BA	11.8	0.45
SKODA-power	WNR1.4938MOD	11.2	2.20

Mechanical Properties

Grade	Heat treatment (°C)	Strength(N/mm ²)		EL(%)	RA(%)	Hardness(HB)
		Yield	Tensile			
B50A365B	QT	680 ↑	960 ↑	15 ↑	45 ↑	321 ↓
B50A947A4	QT	550 ↑	750 ↑	18 ↑	50 ↑	223-269
10705BU	QT	760 ↑	930 ↑	14 ↑	32 ↑	277-331
10705BA	QT	550 ↑	690 ↑	20 ↑	60 ↑	201-241
WNR1.4938MOD	QT	800 ↑	950 ↑	14 ↑	-	292-330

Applications



Finished Turbine



Turbine Blade

Figure 5. Characteristics and Applications of stainless steel(B50A365B etc.) Round Bar

Manufacturing Process

Stainless steel flat bars of widely different dimensions for a range of applications are available. Our highly flexible production facility can meet the needs of orders for multiple products in small lots and can fully incorporate new steel grades.

The steel-making process such as melting consistency, refining and casting critically determines the quality. The melting facility is capable of 60ton electric arc furnace for the highly clean quality steel production.

Refining can take place outside a furnace using LF, VD and VOD facilities, and Special ESR refining can be applied to highly functional materials. Casting consists of continuous casting and ingot casting. In the forging process, steel ingots produced in the steelmaking process are heated and then used in a press to create products of various shapes.

In rolling, large steel bars are produced with the latest SBM large-scale rolling mill, and the HV Mill performs horizontal and vertical continuous rolling to precisely control dimensions.

Our quality control scheme is fully compliant with major international standards, incorporating advanced inspection and testing practices including hot-rolled surface defect detection using eddy current testing (ECT), nondestructive testing (NDT) and ultrasonic testing (UT).

Finally, optimized packaging is applied to each stage of the process from handling through transport to delivery to ensure that flawless products reach our customers.

A detailed manufacturing process diagram is shown in Figure 6.

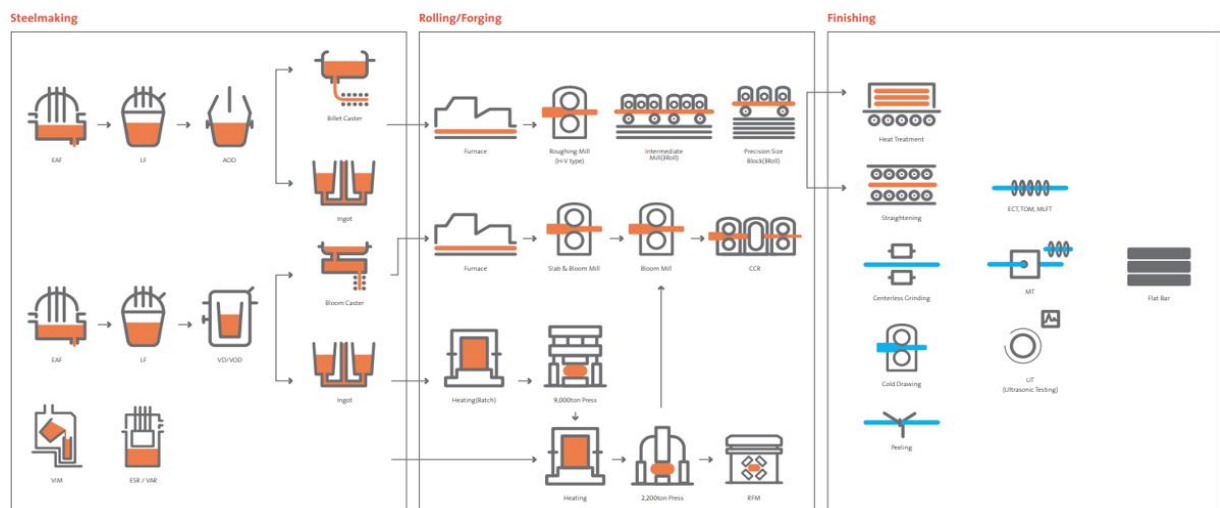


Figure 6 Manufacturing Process

UN CPC code
CPC412

Geographical scope
South Korea

LCA information

Declared unit

This study was used declared unit for 1 ton (1,000 kg) of stainless steel flat bar

Reference service life

Not applicable

Time representativeness

Primary on-site data were collected during fiscal year (FY) 2022.

Database(s) and LCA software used

Gabi LCA software (Version 10.6.1.35) was used to measure the lifecycle inventory profile and lifecycle impact results. All the background data relevant for modelling were taken from the Gabi professional database (version 2022) with DB extension by Sphera and Ecoinvent database (version 3.8)

Electricity Mix

The dataset for Korean national grid mix (reference year 2018) in this EPD study has climate change impact - total, 0.69kg CO₂/kWh.

Description of system boundaries:

The system boundary on the products adapted Cradle to Gate according to PCR section 4.2. The detailed information for manufacturing process from Module A3 is described in the product information above.

1. Upstream process

- a. Steel Scrap collection & processing
- b. Production of raw materials
- c. Transportation of raw/auxiliary materials from the supplier to manufacturing plant

2. Core process

- a. Production of auxiliary materials in the form of solid, liquid or gas (e.g., Argon, Nitrogen, Oxygen, LNG, etc.)
- b. Production of electricity from electricity mix in Korea from Ecoinvent Database
- c. Manufacturing of steel products and co-products
- d. Treatment of process wastes and emissions
- e. Direct emission to the environment

System diagram

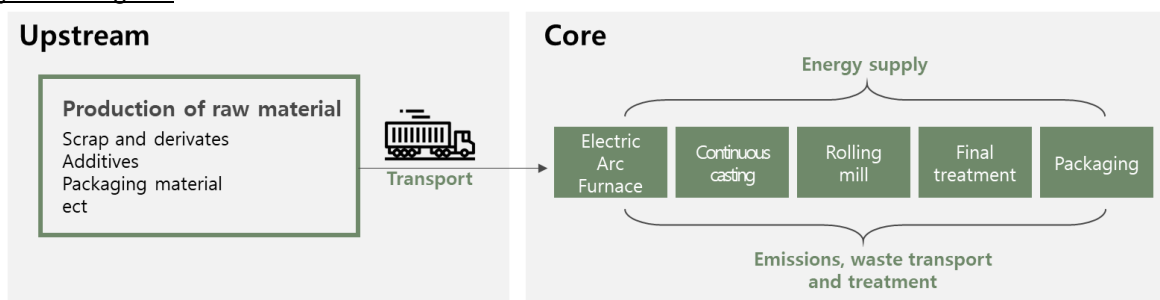


Figure 7 System boundary

Excluded life cycle stages

Use and End-of-life stages were not included, since they are out of the scope of the PCR.

Cut-Off Rule

In accordance with the PCR criteria, the gross weight/volume of all materials used in the manufacturing process has been included in the LCA, so that at least 99% of the weight of the product unit and environmental impacts is considered.

According to the cutoff rules, small amounts of metals (Co, Zr, etc.), diesel, and the like have been excluded.

Assumptions and Limitations

1) Upstream

a. Steels input

Steel scrap input is divided into purchased scrap and internally recycled scrap. The usage of each scrap is managed through the system at the plant, and the environmental impact of internally recycled scrap is not considered.

b. Transport

The transportation distance of domestic scrap was applied to the actual address of the scrap collecting company and the shortest distance to our plant site. The transportation distance of overseas scrap was applied as the shortest distance from the actual address of the scrap collection company to our factory site. For land transportation, the distance between the business site and the port was applied, and for sea transportation, the distance between the port of the country and Busan port was applied.

The transportation distance was calculated based on the addresses of the companies corresponding to each item. In cases where there are multiple suppliers for a single item, a weighted average was taken based on the amount of goods received to determine the distance. The transportation distance for each item was calculated by multiplying the corresponding distance by the inventory data value, and the sum of these values was indicated as the total in the inventory data.

2) Product stage (A3)

a. Waste

In module A3, the manufacturing phase, spills do not include wastes not directly related to production (e.g., packaging materials for raw materials, dust cloths for machine maintenance). The secondary database for waste treatment was classified into household waste and hazardous waste.

b. Waste Transportation

The distance from the manufacturing plant to the waste disposal site is set at 30 km taking site-specific data into account.

c. Wastewater

The plant operates an on-site wastewater treatment plant. A total of five wastewater treatment plants are in operation, and in this study, the data of one wastewater treatment plant was created by integrating the data.

Allocation Rules

In accordance with the PCR criteria, physical allocation has been applied.

At SeAH CSS, utilities, packaging, and waste data are managed for each unit process. Therefore, physical allocation coefficients were derived based on the total production quantity (mass) and the product production quantity (mass) for each unit process. The derived allocation coefficients were then

applied to the utilities, packaging, and waste for each unit process.

Content declaration

Product

Product components	Value[kg]	%	Environmental / hazardous properties
Steel	1.00E+03	100%	0
<i>Chemical Composition</i>			
Fe	805	80.5%	0
Ni	29	2.9%	0
Cr	141	14.1%	0
Si	10	1.0%	0
Others	14	1.4%	0
TOTAL	1,000		0

Packaging

Packaging is not relevant in case of semi-finished steel products manufacturing & delivery.

Recycled material

Recycled materials come from scrap and derivatives used in the manufacturing process, with a proportion of 66.2% post-consumer (External scrap).

Results of the environmental performance indicators

The estimated impact results are only relative statements, which do not indicate the endpoints of the impact categories, exceeding threshold values, safety margins and/or risks.

Impact category indicators

PARAMETER		UNIT	Upstream	Core	TOTAL
Global warming potential (GWP)	Fossil	kg CO ₂ eq.	3.19E+03	1.33E+03	4.52E+03
	Biogenic	kg CO ₂ eq.	1.84E+01	2.54E+00	2.09E+01
	Land use and land transformation	kg CO ₂ eq.	6.00E+00	5.14E-01	6.52E+00
	TOTAL	kg CO ₂ eq.	3.21E+03	1.34E+03	4.55E+03
Ozone layer depletion (ODP)		kg CFC 11 eq.	1.67E-04	6.72E-05	2.34E-04
Acidification potential (AP)		mol H ⁺ eq.	6.52E+01	8.87E+00	7.40E+01
Eutrophication potential (EP)	Aquatic freshwater	kg P eq.	1.37E+00	6.24E-01	1.99E+00
	Aquatic marine	kg N eq.	4.51E+00	1.94E+00	6.44E+00
	Aquatic terrestrial	mol N eq.	4.84E+01	2.00E+01	6.84E+01
Photochemical oxidant creation potential (POCP)		kg NMVOC eq.	1.56E+01	5.24E+00	2.09E+01
Abiotic depletion potential (ADP)	Metals and minerals	kg Sb eq.	3.53E-01	5.87E-04	3.54E-01
	Fossil resources	MJ, net calorific value	4.82E+04	2.56E+04	7.37E+04
Water deprivation potential (WDP)		m ³ world eq. deprived	2.64E+03	1.87E+02	2.83E+03

Resource use indicators

PARAMETER		UNIT	Upstream	Core	TOTAL
Primary energy resources – Renewable	Use as energy carrier	MJ, net calorific value	1.59E+04	3.62E+02	1.62E+04
	Used as raw materials	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00
	TOTAL	MJ, net calorific value	1.59E+04	3.62E+02	1.62E+04
Primary energy resources – Non-renewable	Use as energy carrier	MJ, net calorific value	4.90E+04	2.56E+04	7.46E+04
	Used as raw materials	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00
	TOTAL	MJ, net calorific value	4.90E+04	2.56E+04	7.46E+04
Secondary material (optional)		kg	9.18E+02	0.00E+00	9.18E+02
Renewable secondary fuels (optional)		MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00
Non-renewable secondary fuels (optional)		MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00
Net use of fresh water (optional)		m ³	6.15E+01	4.39E+00	6.59E+01

Waste indicators

PARAMETER	UNIT	Upstream	Core	TOTAL
Hazardous waste disposed	kg	4.29E-08	2.96E-09	4.59E-08
Non-hazardous waste disposed	kg	3.47E+00	3.95E-01	3.86E+00
Radioactive waste disposed	kg	6.00E-03	1.79E-02	2.39E-02

Output flow indicators

PARAMETER	UNIT	Upstream	Core	TOTAL
Components for reuse	kg	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ per energy carrier	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ per energy carrier	0.00E+00	0.00E+00	0.00E+00

References

The International EPD® System, The International EPD® System is a programme for type III environmental declarations, maintaining a system to verify and register EPD® s as well as keeping a library of EPD® s and PCRs in accordance with ISO 14025, www.environdec.com

Product Category Rules (PCR): Basic iron or steel products & special steels, except construction steel products 2015:3, version 2.1.0

General Programme Instructions of the International EPD® System. Version 3.01

ISO 14020:2000 Environmental labels and declarations - General principles

ISO 14025:2006 Environmental labels and declarations - Type III environmental declarations - Principles and procedures

ISO 14040:2006 Environmental management- Life cycle assessment - Principles and framework

ISO 14044:2006 Environmental management - Life cycle assessment - Requirements and guidelines

Impact assessment methods: Version 2.0 of the default list of indicators

: EN 15804. Version: August 2021.

