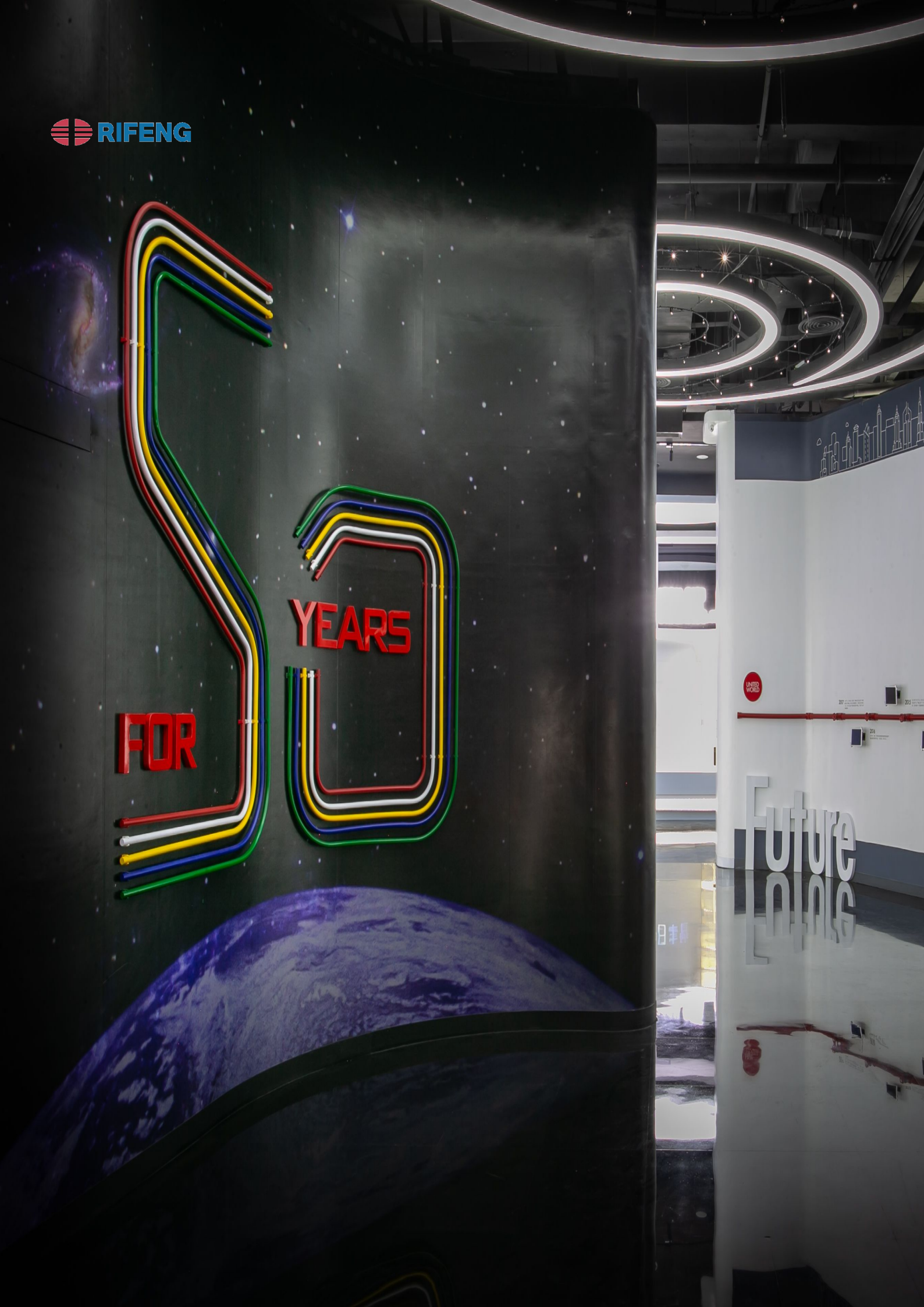
ENVIRONMENTAL PRODUCT DECLARATION

Rifeng PE-RT pipes

This EPD is representative of the weighted average PE-RT (barrier and non-barrier)pipe
Production and complied with ISO 14025:2006 and EN15804 2012+A1:2013
Geographical area of application of this EPD : China
Year taken as a reference for the data: 2017.7.1-2018.6.30
Registration number S-P-01645
Approval date 07/29/2019
Expiry date 07/29/2024

RIFENG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CONTENT

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. EPD of construction products may not be comparable if they do not comply with EN 15804 2012+A1:2013.

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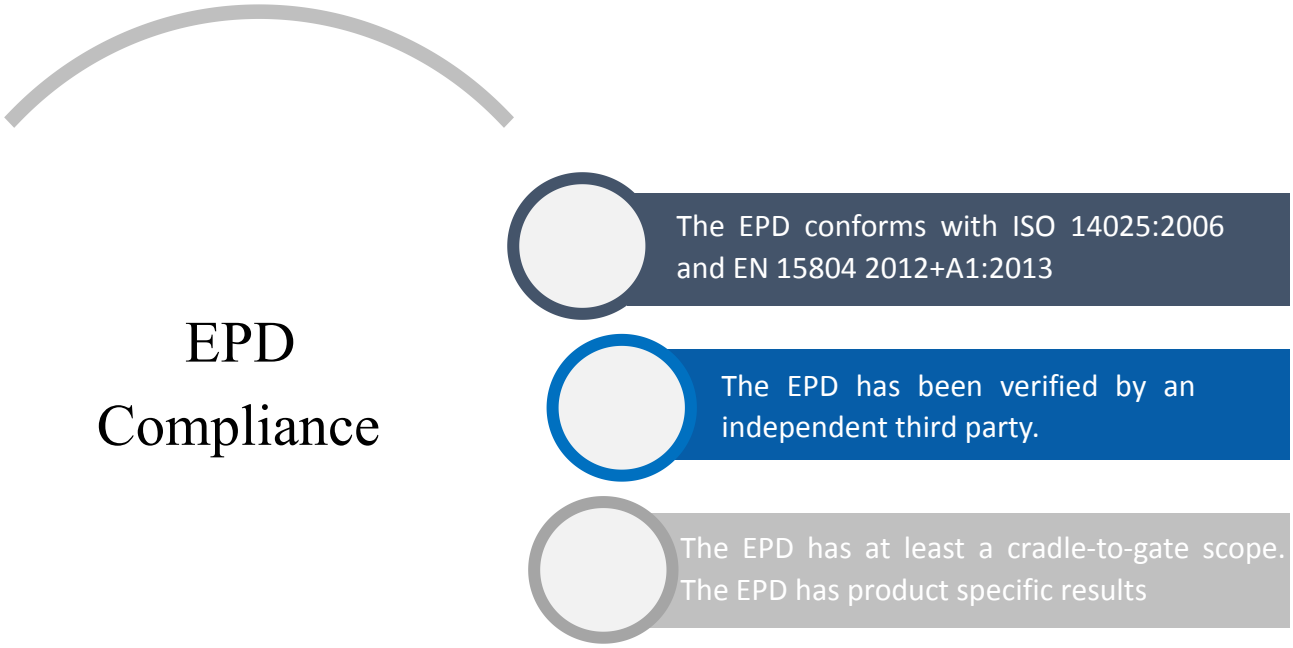
CEN STANDARD EN15804 2012+A1:2013 SERVED AS THE CORE PCR	
PCR	Construction Products and Construction Services, Version 2.3 (2018-11-15)
PCR prepared by	IVL Swedish Environmental Research Institute Moderator: Martin Erlandsson, martin.erlandsson@ivl.se
Accredited /approved by	EPD International AB
Independent external verification of the declaration and data, according to ISO 14025:2006	☐EPD process certification (Internal) ■EPD verification (External)

The Rifeng PE-RT pipes EPD results can also be used to represent PE-RT pipes products in Whole of Building Life Cycle Assessments.This EPD is complied with its requirement as below.



Rifeng Introduction

Rifeng Enterprise Group Co., Ltd., established in 1996, has been committed to developing high-quality and environmental - friendly piping products that cover the plumbing, indoor climate, drainage, electrical and gas fields with product systems ranging from multilayer pipes to PEX, PERT, PP-R, PVC, and brass hardware such as fittings, manifold and valves, under optional sizes from DN 09 to DN160 mm, to provide systematic solutions.

With over 5,000 employees and 6 manufacturing bases in China respectively located in Foshan, Shenyang, Tianjin, Shanxi, Hubei and Sichuan. It is only Foshan base has the business of export.Rifeng is increasingly taking an active role in the plastic piping markets and lays out a wide sales network over 67 countries.

Investments for international talents, accurate testing instruments and advanced hardware equipments are yearly increasing in R&D sector and it founded 2 research institutes, named National Technical Center and CNAS Certification Laboratory. With more technical improvement and product innovation, Rifeng is confident to provide customers with more hygienic and secure piping products all the time.

Rifeng piping system has more than 50 certificates, such as NSF, DVGW, AENOR, WRAS WaterMark, StandardsMark etc. These certificates worldwide underline our technical and quality know-how, and we can provide you with 25 years system warranty backed up by an international insurance company. Rifeng always implement the concept of customer value to satisfy different demands, and continuously provide customers with piping solutions and technical supports.

Rifeng PE-RT Pipes

PE-RT is a polyethylene resin, known as polyethylene of raised temperature resistance, in which the molecular structure has been designed to achieve the resistance of raised temperature. PE-RT pipes are available in non-barrier and barrier pipes. Barrier PE-RT pipe usually has three-layer or five-layer construction, which includes an EVOH layer, while non-barrier PE-RT is single layer. The EVOH barrier will keep the pipe from oxygen or other elements from infiltrating into the pipe.

Rifeng PE-RT pipes are designed and produced complied with American standard ASTM F2769-18 , ASTM F2623-14 or ISO 22391：2009. Rifeng PE-RT pipes could be supplied in the form of straight or coil pipe available in various colours like red, blue, white, green, purple, black and natural with dimension ranging from DN16 to DN 32 or 1/8 inch to 2 inch.

- Application

Rifeng PE-RT pipes shall be used with press or compression brass fittings, push fit fittings or manifolds to constitute the water or heating system which is extensively used in a variety of applications.

Radiate underfloor heating is one of the most common areas of application where PE-RT is used for its outstanding flexibility. Rifeng barrier PE-RT in conjunction with the fittings is used to distribute heat.

Table 1 Product characteristics of Rifeng PE-RT pipes

Product names	Rifeng PE-RT pipes see table 9 for individual product codes
UN CPC Code	36320 - Tubes, pipes and hoses, and fittings therefore, of plastics
Density	0.926 ~0.940g/cm^3 (ISO 1183-1:2019)
Normal working pressure (50 year @20℃)	10bar (ISO 22391：2009)
Yield strength	19 Mpa (ISO 527- 1: 2012)
Modulus of Elasticity	800Mpa (ASTM E111-17)
Thermal conductivity	0.40w/mK (ASTM D5930-17)
Coefficient of thermal expansion	0.20mm/mK (ASTM E831-19)
Nominal diameter	12~32mm or 3/8”~1”

Table 2 - Content Declaration

Material	Percentage Content	CAS No.
Non crosslinked PE resin	95%	9002-88-4
pigment	≤5%	Confidential (nothing hazardous)
Adhesive(If any)	＜1%	Confidential (nothing hazardous)
Total	100%	

Rifeng PE-RT piping system does not contain any substances as such or in concentration exceeding legal limits, which can adversely affect human health and the environment in any stages of its entire life cycle.

General

The life cycle of a building product is divided into three process modules according to EN 158042012+A1:2013 and ISO 14025:2006, the Product Category Rules for Type III environment product declaration of construction products of International EPD Program. Table 3 shows the scope and system boundary of Rifeng PE-RT assessment. The scope is "cradle to gate" as defined by EN 15804 2012+A1:2013.

This EPD intent is to cover all environmental impacts of significant concern over the product life cycle based on "cradle to gate" scope. Modules C1-C4 were deemed not relevant (of negligible impact) due to the fact that the pipes are left in the ground at end of life with negligible potential environmental impact. Other than module A1~A3, all other use stage modules were also deemed not relevant.

Table 3- System boundary and scope of assessment

Product stage			Construction stage		Use stage							End of life stage			
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
Raw material supply	Transport	Manufacturing	Transport	Installation	Material emissions	Maintenance	Repair	Replacement	Refurbishment	Operational energy	Operational water	Deconstruction/Demolition	Transport	Waste processing	Disposal
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

X = module include in EPD
MND= module not declared (does not indicate zero impact result)

4.1 LIFE CYCLE OF RIFENG PE-RT PIPES

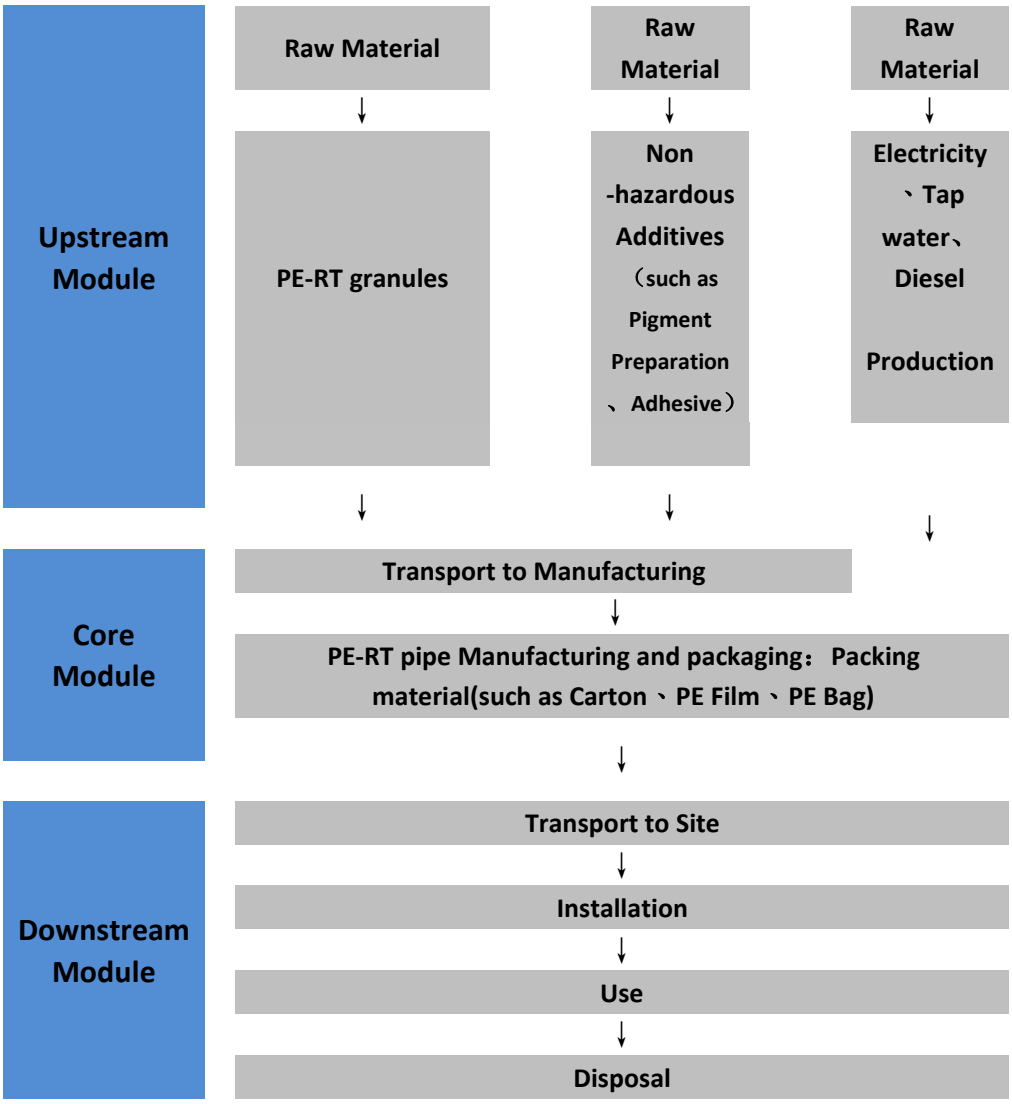


Figure 1 - life cycle diagram of PE-RT pipe production

System boundary in this EPD involves the upstream module and core module refering to A1~A3 stage in table 3. Downstream module (A4~A5,B1~B7,C1~C4) is out of the scope of study.

4.2 MANUFACTURE STAGE

RIFENG PE-RT PIPE MANUFACTURE

The screwed extruder as the main manufacture machine consists of extrusion, feeding, transmission, heating and cooling system as well as controlling system.

During manufacturing, the PE-RT compound is preheated to remove moisture and volatiles then mixed in the extruder barrel via computer control weighing system. The temperature is carefully controlled to ensure no thermal degradation during extrusion.

The PE-RT pipes are necessary to cooled down by cold water. The finished pipe is drying prepared to be printed with marking information, which is complied with requirements of standards and customers. Finished Rifeng PE-RT pipes will be inspected before package and shipment with plastic bags and cartons.
(Foshan base location of the map: F1-F14 No.1 Rifeng Road, Foshan, GuangDong, CHINA)

The results of this EPD are representative of the weighted average PE-RT pipe production, including barrier PE-RT and non barrier PE-RT pipes.It is based on 1kg product output to calculate the impact on environment in the phases of material supply, transport , manufacturing and packaging

In the A2 stage(Transport), the transport distances and means of transportation, as below.

- ✓ The raw material transportation is a truck, and the total transportation distance is 3.01E-01 km/per 1 kg of manufactured product.
- ✓ The packaging materials are transported as trucks with a total transport distance of 8.38E-04 km/per 1 kg of manufactured product.

In the manufacturing stage, there will be defective scrapping of the products, but these pipes can be recycled and reused through the crushing technology, and then can be put into remanufacturing.

4.3 DISTRIBUTION STAGE

Rifeng PE-RT pipes are manufactured in China and the vast majority of pipes transportations are crossing a long way by ship to foreign region mainly in Asia, America, Australia and Europe.

4.4 INSTALLATION STAGE

Rifeng PE-RT pipes are normally applied for floor heating installation, sometimes for water supply, inside the building. They are typically installed in wall and under floor before room decoration. During the installation process, it would be systematically used with brass fittings. It is manual operation and the installation instruction should be followed. Wastage of pipe is minimal as short lengths are often required elsewhere and easily reused on subsequent sites or within the same site.

Figure 2- PE-RT piping diagram for heating application

4.5 USE STAGE

Maintenance of the piping systems is not required and not planned, because the PE-RT pipes are designed to have a lifespan of 50 years,see below chart extracted from ISO2391：2009. The PE-RT pipes would be buried under the ground or inside the wall, exposure sometimes, in a finished building. The failure rate is also extremely low and is consider to be inconsequential (not relevant) in this EPD. Post installation problems, if any, tend to be linked to third party damage. In case of pipe repairing, you only need to cut out the damaged section and replaced by the new ones.The damage part would be directly discarding and landfilling.

Table 1 — Classification of service conditions

Application classes	Design temperature T_D °C	Time[a] at T_D years	T_{max} °C	Time at T_{max} years	T_{mal} °C	Time at T_{mal} h	Typical field of application
1[a]	60	49	80	1	95	100	Hot water supply (60 °C)
2[a]	70	49	80	1	95	100	Hot water supply (70 °C)
4[b]	20 Followed by: 40 Followed by: 60 Followed by: (see next column)	2,5 20 25 	70	2,5	100	100	Underfloor heating and low temperature radiators
5[b]	20 Followed by: 60 Followed by: 80 Followed by: (see next column)	14 25 10 	90 Followed by: (see next column)	1	100	100	High temperature radiators
ISO 22391 is not applicable to values of T_D, T_{max} and T_{mal} in excess of those given in this table.							

[a] A country may select either Class 1 or 2 in order to conform to its national guidelines.

[b] Where more than one design temperature appears for any class, the times should be aggregated. For example, the design temperature profile for 50 years for class 5 is 20 °C for 14 years, followed by 60 °C for 25 years, 80 °C for 10 years, 90 °C for 1 year and 100 °C for 100 h.

4.6 END OF LIFE STAGE

The Rifeng PE-RT pipes which are installed under floor and inside wall are assumed to remain underground at the end of life. The PE-RT pipes are inert and there is no incentive to dig them up to send for waste treatment. Otherwise, PE-RT pipes can be recycled to the initial material directly, the recycled material can be used in the production as standard required.

Based on the provisions of 「CONSTRUCTION PRODUCTS AND CONSTRUCTION SERVICES PRODUCT CATEGORY RULES Chapter 7 GENERAL SYSTEM BOUNDARIES Table 2」, this announcement is "cradle-to-gate EPD", so Product Stage(A1 Raw material supply、A2 Transport and A3 Manufacturing are Mandatory modules, but the remaining A4 ~ B7 are selective disclosure. Therefore, this EPD only discloses the necessary items for disclosure.

Chapter 4.3 to 4.6 are for reference only. They are not relevant in this EPD, so they are out of the study scope.

General

This section includes the main details of the LCA study as well as assumptions and methods of the assessment. A summary of the key life cycle assessment parameters is given in Table 4.

Table 4 - Details of LCA Study

Declared unit	1 kg of manufactured pipe
Geographical coverage	China
LCA scope	Cradle to gate

Life cycle thinking is a core concept in sustainable consumption and production for policy and business. Upstream and downstream consequences of decisions must be taken into account to help avoid the shifting of burdens from one type of environmental impact to another, from one political region to another, or from one stage to another in a product's life cycle from the cradle to the grave.

LCA is the compilation of the inputs, outputs and environmental impacts of a product system throughout its life cycle. It is a technique that enables industries to identify the resource flows and environmental impacts (such as greenhouse gas emissions, water and energy use) associated with the provision of products and services.

According to EN 15804 2012+A1:2013, EPDs of construction products may not be comparable if they do not comply with this standard, and EPDs might not be comparable, particularly if different functional units are used.

5.1 CORE DATA COLLECTION

Life cycle data has been sourced from material quantity data and production process data from:

- RIFENG reporting systems and staff
- RIFENG mix suppliers

Core manufacturing data was collected directly from RIFENG manufacturing sites.

- ✓ Electricity consumption was allocated to pipe via mass of pipe produced.
- ✓ Tap Water consumption was allocated to pipe via mass of pipe produced.
- ✓ Diesel consumption was allocated to pipe via mass of pipe produced.

5.2 BACKGROUND DATA

Generic background data was sourced for raw materials in the upstream module, and transport and manufacturing in the core module.

The LCA analysis method is adapted to Simapro 8.2.3 CML V3.02 (release by CML in April 2013 version 4.2) , and use the ecoinvent v3.0 database. For the EPD database, we used the 「Electricity, low voltage {CN}| market for | Alloc Def, S ;1.17 KgCO2e/kWh」.This general value means that when using 1 kWh electric power in China, there would be 1.17 Kg CO2e generating and we can see the different used energy sources as below:

Non-renewable energy	
Energy, gross calorific value, in biomass	0.83%
Energy, gross calorific value, in biomass, primary forest	0.00%
Oil, crude	1.47%
Gas, mine, off-gas, process, coal mining/m3	0.52%
Coal, brown	0.09%
Coal, hard	90.58%
Gas, natural/m3	1.12%
Renewable energy	
Energy, kinetic (in wind), converted	0.13%
Energy, solar, converted	0.00%
Energy, geothermal, converted	0.00%
Energy, potential (in hydropower reservoir), converted	5.27%

Emission factor for calculate carbon emissions from electricity use. Almost all background data used for calculation of results are not older than 10 years. Exceptions (reference year not older than 2000) have only a minor impact on the overall results and can be considered representative for the period under review.

5.3 CUT OFF CRITERIA

Environmental impacts relating to personnel, infrastructure, and production equipment not directly consumed in the process are excluded from the system boundary. All other reported data were incorporated and modelled using the best available life cycle inventory data.

5.4 ALLOCATION

Allocation was carried out in accordance with the PCR, section 7.7. No allocation between co-products in the core module as there were no coproducts created during manufacturing.

5.5 VARIATION

The project report does not have tested a variation between different manufacturing locations,because RIFENG just has one site to produce RIFENG PE-RT pipe product supplied to the market.

5.6 PE-RT PIPE ENVIRONMENTAL PERFORMANCE

The potential environmental impacts used in this EPD are explained in Table 5 and the results for RIFENG PE-RT pipe are shown in Table 6. The use of energy and fresh water resources is shown in Table 7. The use of secondary material and secondary material used as energy resources is listed as 'INA' (indicator not assessed). Table 8 shows the generation of waste throughout the product life cycle.

Table 5 - Environmental indicators used in the EPD

Environmental Indicator		Unit	Description
ADPE (kgSb eq)	Abiotic Depletion Potential – Elements / minerals	Kg antimony equivalents	The extraction of non-living and nonrenewable elements and minerals. These resources are essential in our everyday lives and many are currently being extracted at an unsustainable rate.
ADPF (MJ)	Abiotic Depletion Potential – Fossil Fuels	MJ net calorific value	The extraction of non-living and nonrenewable fossil fuels. These resources are essential in our everyday lives and many are currently being extracted at an unsustainable rate.
GWP (kgCO2 eq)	Global Warming Potential	kg carbon dioxide equivalents	Increase in the Earth's average temperature, mostly through the release of greenhouse gases. A common outcome of this is an increase in natural disasters and sea level rise.
ODP (kgCFC11 eq)	Ozone Depletion Potential	kg CFC-11 equivalents	The decline in ozone in the Earth's stratosphere. The depletion of the ozone layer increases the amount of UVB that reaches the Earth's surface. UVB is generally accepted to be a contributing factor to skin cancer, cataracts and decreased crop yields.
POCP (kgC2H4 eq)	Photochemical Ozone Creation Potential	kg ethylene equivalents	Ozone in the troposphere is a constituent of smog that is caused by a reaction between sunlight, nitrogen oxide and volatile organic compounds (VOCs). This is a known cause for respiratory health problems and damage to vegetation.
AP (kgSO2 eq)	Acidification Potential	kg sulphur dioxide equivalents	A process whereby pollutants are converted into acidic substances which degrade the natural environment. Common outcomes of this are acidified lakes and rivers, toxic metal leaching, forest damage and destruction of buildings.
EP (kgPO4 3- eq)	Eutrophication Potential	Kg phosphate equivalents	An increase in the levels of nutrients released to the environment. A common outcome of this is high biological productivity that can lead to oxygen depletion, as well as significant impacts on water quality, affecting all forms of aquatic and plant life.

Life cycle impact assessment methods used: Simapro 8.2.3 CML V3.02 (release by CML in April 2013 version 4.2)

Table 6 - Potential environmental impacts per 1 kg of manufactured pipe

	A1	A2	A3
ADPE (kgSb eq)	3.94E-07	4.80E-08	2.97E-07
ADPF (MJ)	7.55E+01	4.19E-01	4.33E+00
GWP (kgCO2 eq)	2.12E+00	2.44E-02	5.13E-01
ODP (kgCFC11 eq)	2.28E-08	4.83E-09	4.33E-09
POCP (kgC2H4 eq)	6.83E-04	4.13E-06	1.92E-04
AP (kgSO2 eq)	7.69E-03	7.33E-05	5.04E-03
EP (kgPO4 3- eq)	8.70E-04	1.66E-05	4.54E-04

ADPE = Abiotic Resource Depletion Potential – Elements,
ADPF = Abiotic Resource Depletion Potential – Fossil Fuel,
GWP = Global Warming Potential,
ODP = Ozone Depletion Potential,
POCP = Photochemical Oxidant Formation Potential,
AP = Acidification Potential,
EP = Eutrophication Potential

Table 7 - Use of resources per 1 kg of manufactured pipe

	A1	A2	A3
PERE (MJ)	6.47E-01	3.06E-03	3.66E-01
PERM (MJ)	0.00E+00	0.00E+00	0.00E+00
PERT (MJ)	6.47E-01	3.06E-03	3.66E-01
PENRE (MJ)	7.43E+01	4.05E-01	1.63E+00
PENRM (MJ)	0.00E+00	0.00E+00	0.00E+00
PENRT (MJ)	7.43E+01	4.05E-01	1.63E+00
SM (kg)	INA	INA	INA
RSF (MJ)	INA	INA	INA
NRSF (MJ)	INA	INA	INA
FW (m3)	3.35E-01	1.69E-02	1.60E-03

PERE = Use of renewable primary energy excluding raw materials,
PERM = Use of renewable primary energy resources used as raw materials,
PERT = Total use of renewable primary energy resources,
PENRE = Use of non-renewable primary energy excluding raw materials,
PENRM = Use of non-renewable primary energy resources used as raw materials,
PENRT = Total use of non-renewable primary energy resources,
SM = Use of secondary material,
RSF = Use of renewable secondary fuels,
NRSF = Use of non-renewable secondary fuels,
FW = Use of net fresh water,
INA = Indicator not accessed due to a limitation of the LCA tools and databases used to calculate the required resource flows. INA does not imply zero impact.

Table 8 - Generation of waste per 1 kg of manufactured pipe

	A1	A2	A3
HWD (kg)	1.74E-02	1.93E-03	0.00E+00
NHWD (kg)	4.05E-02	4.50E-03	2.77E-02
RWD (kg)	0.00E+00	0.00E+00	0.00E+00
HWD = Hazardous waste disposed, NHWD = Non-hazardous waste disposed, RWD = Radioactive waste disposed			

5.7 INTERPRETATION OF LCA RESULTS

The majority of environmental impact lies within the raw material supplied to RIFENG manufacturing site – comparatively little impact is caused by the PERT pipe manufacturing at RIFENG site.

From the input materials, PE resin is responsible for the majority of all environmental impacts and use of resources, although additives were still found to have a significant impact.

- ✓ PE resin：
  - ✧ Approximately 96.84% of the environmental impact indicators of Abiotic depletion (fossil fuels).
  - ✧ Approximately 95.17% of the environmental impact indicators of Global warming (GWP100a).

From the manufacturing stage, Electricity is responsible for the majority of all environmental impacts (more than 98%).

6.1 ADDITIONAL ENVIRONMENTAL INFORMATION

EMISSION TO INDOOR AIR, SOIL AND WATER DURIGN USE SATGE

When used for hot and cold water installation, it is an advantage for Rifeng PE-RT pipes to ensure potable water pipeline system with hygienic and non-toxic features under the strict requirement of relative standards. As it is installed under ground and inside wall, we can confirm that emissions to indoor air and soil are not relevant.

6.2 PRODUCT SPECIFICATION

The product model declared by this EPD includes a total of products. After LCIA analysis, the difference does not exceed ± 10% of the range(Because the functional units are set to be per kilogram of this type of product, so all of the following products are included in the inventory). Therefore, the LCA results announced by this EPD can be applied to the following products.

Table 9- PE-RT pipe specification

Standard	Product code	Nominal outside diameter dn	Mean Outside Diameter		PE-RT pipe series			
			dem,min	dem,max	S5	S4	S3.2	S2.5
					Thickness			
ISO 22391: 2009	PE-RT-DN 12	12	12	12.3	--	--	--	2
	PE-RT-DN 16	16	16	16.3	--	2	2.2	2.7
	PE-RT-DN 20	20	20	20.3	2	2.3	2.8	3.4
	PE-RT-DN 25	25	25	25.3	2.3	2.8	3.5	4.2
	PE-RT-DN 32	32	32	32.3	2.9	3.6	4.4	5.4

(Table 9 continue)

Standard	Nominal Tubing Size	Average Outside Diameter (inch)	Minimum Wall Thickness (inch)
ASTM F2769-18 & ASTM F2623-14	1/8	0.250	0.047
	1/4	0.375	0.062
	5/16	0.430	0.064
	3/8	0.500	0.070
	1/2	0.625	0.070
	5/8	0.750	0.083
	3/4	0.875	0.097
	1	1.125	0.125
	1 1/4	1.375	0.153
	1 1/2	1.625	0.181
	2	2.125	0.236

6.3 OTHER TECHNICAL INFORMATION

For the full overview of the environmental benefits and product features of Rifeng PE-RT piping systems please refer to Rifeng website: www.rifeng.com

1. Simapro 8.2.3 CML V3.02 (release by CML in April 2013 version 4.2)
2. PRODUCT CATEGORY RULES, Construction Products and Construction Services, Version 2.3,2018-11-15
3. EN 15804:2012+A1:2013 Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products
4. ISO 21930:2017 Environmental declaration of building products
5. ISO 14025:2006 Environmental labels and declarations -- Type III environmental declarations -- Principles and procedures
6. ISO 14040:2006 Environmental management -- Life cycle assessment -- Principles and framework
7. ISO 14044:2006 Environmental management -- Life cycle assessment -- Requirements and guidelines
8. ISO 22391:2009 Plastics piping systems for hot and cold water installations -Polypropylene of raised temperature resistance (PE-RT)-Part 1： General
9. ISO 22391:2009 Plastics piping systems for hot and cold water installations -Polypropylene of raised temperature resistance (PE-RT)-Part 2： Pipes
10. ISO 22391:2009 Plastics piping systems for hot and cold water installations Polypropylene of raised temperature resistance (PE-RT)-Part 5： Fitness for purpose of the system
11. ASTM F2769-18 Polyethylene of Raised Temperature (PE-RT) Plastic Hot and Cold-Water Tubing and Distribution Systems
12. ASTM F2623-14 Polyethylene of Raised Temperature (PE-RT) SDR 9 Tubing
13. ISO 527-1:2012 Plastics - Determination of tensile properties -- Part 1: General
14. ISO1183-1:2019 Plastics -methods for determining the density of non-cellular plastics
15. ASTM E111-17 Standard Test Method for Young's Modulus, Tangent Modulus, and Chord Modulus
16. ASTM D5930-17 Standard Test Method for Thermal Conductivity of Plastics by Means of a Transient Line-Source Technique
17. ASTM E831-19 Standard Test Method for Linear Thermal Expansion of Solid Materials by Thermomechanical Analysis

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