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THE INTERNATIONAL EPD® SYSTEM

RIFENG PP-R PIPING SYSTEM

ENVIRONMENTAL PRODUCT DECLARATION

Rifeng PP-R Pipes

This EPD is representative of the weighted average PP-R pipe （single layer and double layer) production 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

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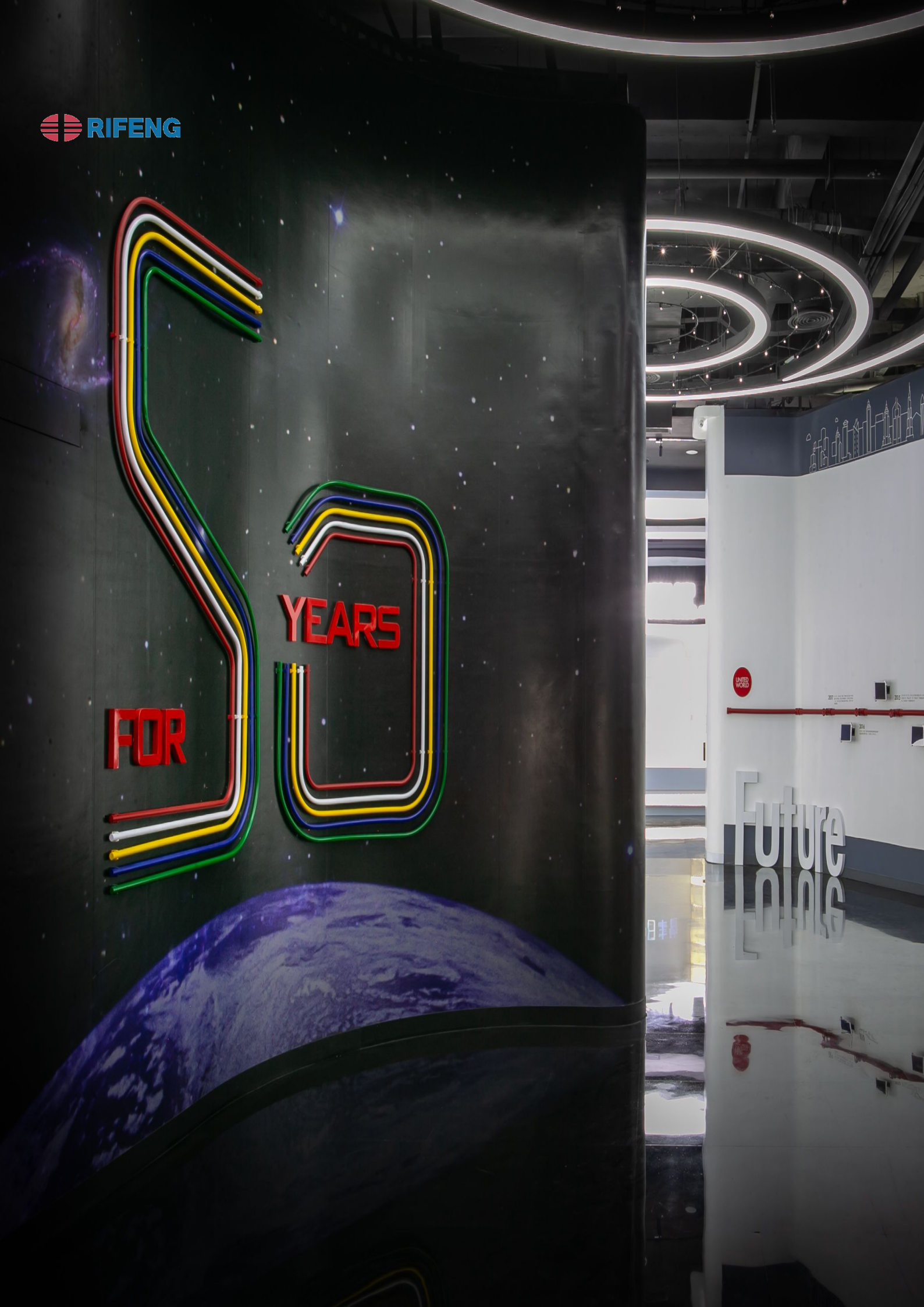
RIFENG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50
YEARS
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CONTENT

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 PP-R pipes EPD results can also be used to represent PP-R 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 PP-R Pipes

Rifeng PP-R pipes are produced from high-quality polypropylene materials and have been proved to comply with standard ISO 15874 :2013 and can withstand specified working conditions with 50 years. Trace back to 2008, Rifeng began to manufacture the unique and innovation PP-R piping system for plumbing application and gradually turns to be more professional in this field.

There are single-layer and double-layer for Rifeng PP-R pipes with 3 main colors including green, grey and white, other colors could be chosen by customers.The main difference between single and double layer pipe is the quantity of layers and the two layers of double-layer pipe are of different colour. See above second picture for double layer PPR pipe. PP-R pipes can be used together with relative various PP-R fittings types for installation by homogeneity melt. Complying with ISO 15874:2013, Rifeng PP-R pipes are under dimension class A with different pipe series including S5, S4, S3.2 and S2.5 with outer diameters ranging from DN 20mm to DN 160mm. Compared with metal pipes, Rifeng PP-R pipe is more convenient to install thanks to the advanced fusion technology and it is applied for potable water pipeline system with hygienic and non-toxic features.

Rifeng PP-R pipes are extensive used in a variety of applications including:

- Potable water, Hot &Cold water, Chemicals, Irrigation
- Residential Apartments, Condominiums, Public Housing
- Commercial shopping Centers, Official Building
- Industrial Plants dealing with Chemicals, Food Processing, Semi-Conductors
- Hospitals
- Schools, Laboratories and Chemical Sewerage
- Hotels and Resorts

Table 1 Product characteristics of Rifeng PP-R pipes

Product names	Rifeng PP-R pipes see table 9 for individual product codes
UN CPC Code	36320 - Tubes, pipes and hoses, and fittings therefore, of plastics
Melt flow rate 190/5	0.5g/10 dk (ASTM D 1238-13)
Tensile Stress at Yield	25 Mpa(ISO 527- 1: 2012)
Modulus of Elasticity	900N/mm^2 (ASTM E111-17)
Density	0.89~0.91 g/cm^3(ISO 1183-1:2019)
Coefficient of liner thermal expansion	1.5x10^{-4} K^{-1} (ASTM E831-19)
Thermal conductivity	0.24 W/mk(ASTM D5930-17)
Nominal diameter	20~160mm

Table 2 - Content Declaration

Material	Percentage Content	CAS No.
polypropylene resin	98%	9003-07-0
pigment	2%	Confidential (nothing hazardous)
Total	100%	

Rifeng PP-R 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 15804 2012+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 PPR assessment. The scope is “cradle to gate” as defined by EN 158042012+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 PP-R PIPES

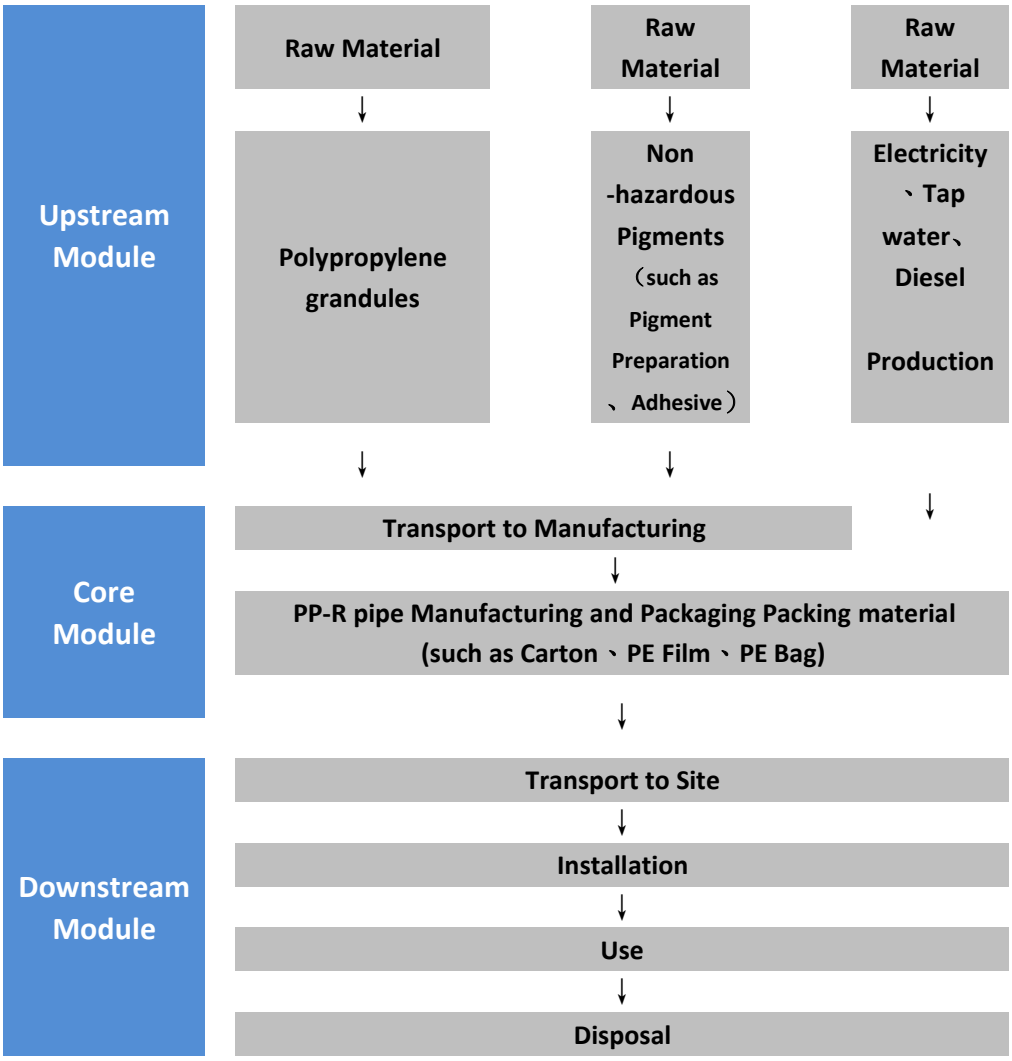

Figure 1 - life cycle diagram of PP-R pipe production

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 PP-R pipes are manufactured from polypropylene resin along with pigment using extrusion technology under technical control.

These materials are delivered to Rifeng Foshan base by truck and unloaded into warehouse by forklift after incoming inspection and confirm the quality of the material. It would be pre-heated and dried before blending in line. Extruder is the main production machine of Rifeng PP-R pipe. During manufacturing, the PP-R compound is mixed in the extruder barrel via computer control weighing system. The temperature is carefully controlled to ensure no thermal degradation during extrusion.

The PP-R pipe is necessary to cool 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.

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PP-R PIPE MANUFACTURE

Finished Rifeng PP-R 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 PP-R pipe production, incorporating PP-R pipes with single layer and double layer. 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 2.68E-01 km/per 1 kg of manufactured product.
- ✓ The packaging materials are transported as trucks with a total transport distance of 1.91E-03 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.

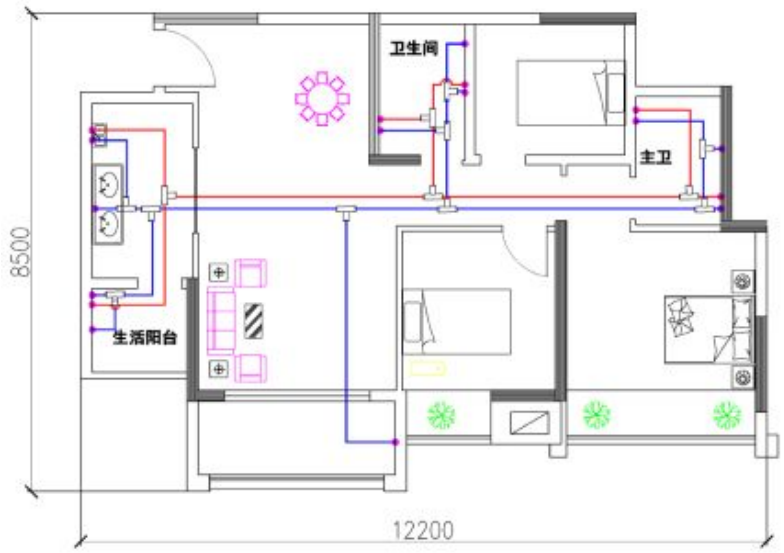
4.3 DISTRIBUTION STAGE

Rifeng has one PPR pipe, for export, manufacturing facility in China and the vast majority of pipes transportations are crossing a long way by ship to foreign region in Asia, America, Australia and Europe.

4.4 INSTALLATION STAGE

Rifeng PP-R pipes are normally applied for hot and cold water installation inside the building. They are typically installed in wall and floor before room decoration.
During the installation process, it would be systematically used with PP-R fittings by fusion. It is manual operation and the installation instruction refers to below steps. See figure 3 for reference. 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- piping diagram for PP-R system



1、Cut the pipe vertically with a pipe cutter and mark the fusing depth on the pipe

2、clean the pipe and fitting surface of fusion

3、Push the pipe and fitting simultaneously into the fusing adaptors for a proper time, while do not twist or turn the pipe and the fitting.

4、Put the pipe and fitting simultaneously when they are still hot. Insert rapidly without turning.

5、Fix linking for 5 seconds so as to cool them down.

6、Check the fusion whether right or not when it cool down.

Figure 3- installation drawing

4.5 USE STAGE

Maintenance of the piping systems is not required and not planned, because the PP-R pipes are designed to have a lifespan of 50 years,see below chart extracted from ISO15874:2013. The PP-R 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.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 discarding and landfilling.

Table 1 — Classification of service conditions

Application class	Design temperature, T_D °C	Time, t[a], at T_D years	T_{max} °C	Time, t, 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	2,5	70	2,5	100	100	Underfloor heating and low temperature radiators
	Followed by						
	40	20					
	Followed by						
	60	25					
	Followed by (see next column)		Followed by (see next column)				
5 [b]	20	14	90	1	100	100	High temperature radiators
	Followed by						
	60	25					
	Followed by						
	80	10					
	Followed by (see next column)		Followed by (see next column)				

[a] A country may select either class 1 or class 2 to conform to its national regulations.

[b] Where more than one design temperature appears for any class, the times should be aggregated (e.g. 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).

NOTE For values of T_D, T_{max} and T_{mal} in excess of those in this table, this International Standard does not apply.

4.6 END OF LIFE STAGE

The Rifeng PP-R pipes which are installed under floor and inside wall are assumed to remain underground at the end of life. The PP-R pipes are inert and there is no incentive to dig them up to send for waste treatment. Otherwise, PP-R 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 PP-R pipe product supplied to the market.

5.6 PP-R PIPES ENVIRONMENTAL PERFORMANCE

The potential environmental impacts used in this EPD are explained in Table 5 and the results for RIFENG PPR 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)	2.82E-07	4.29E-08	2.97E-07
ADPF (MJ)	7.05E+01	3.74E-01	4.33E+00
GWP (kgCO2 eq)	2.04E+00	2.18E-02	5.13E-01
ODP (kgCFC11 eq)	1.63E-08	4.31E-09	4.33E-09
POCP (kgC2H4 eq)	4.44E-04	3.69E-06	1.92E-04
AP (kgSO2 eq)	6.79E-03	6.55E-05	5.04E-03
EP (kgPO4 3- eq)	8.53E-04	1.48E-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)	3.28E-01	2.74E-03	3.66E-01
PERM (MJ)	0.00E+00	0.00E+00	0.00E+00
PERT (MJ)	3.28E-01	2.74E-03	3.66E-01
PENRE (MJ)	6.74E+01	3.62E-01	1.63E+00
PENRM (MJ)	0.00E+00	0.00E+00	0.00E+00
PENRT (MJ)	6.74E+01	3.62E-01	1.63E+00
SM (kg)	INA	INA	INA
RSF (MJ)	INA	INA	INA
NRSF (MJ)	INA	INA	INA
FW (m3)	2.03E-01	1.51E-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)	5.69E-04	6.33E-05	0.00E+00
NHWD (kg)	1.33E-03	1.48E-04	0.00E+00
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 PPR pipe manufacturing at RIFENG site.

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

- ✓ PP resin：
  - ✧ Approximately 96.48% of the environmental impact indicators of Abiotic depletion (fossil fuels).
  - ✧ Approximately 95.87% 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 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- The specification of Rifeng PP-R pipes.

Application	Product code	Nominal outside diameter dn	Mean Outside Diameter		PPR pipe series			
			dem,min	dem,max	S5	S4	S3.2	S2.5
					Thickness			
Hot and Cold water installation	PPR-DN 12	12	12.0	12.3	--	--	--	2.0
	PPR-DN 16	16	16.0	16.3	--	2.0	2.2	2.7
	PPR-DN 20	20	20.0	20.3	2.0	2.3	2.8	3.4
	PPR-DN 25	25	25.0	25.3	2.3	2.8	3.5	4.2
	PPR-DN 32	32	32.0	32.3	2.9	3.6	4.4	5.4
	PPR-DN 40	40	40.0	40.4	3.7	4.5	5.5	6.7
	PPR-DN 50	50	50.0	50.5	4.6	5.6	6.9	8.3
	PPR-DN 63	63	63.0	63.5	5.8	7.1	8.6	10.5
	PPR-DN 75	75	75.0	75.7	6.8	8.4	10.3	12.5
	PPR-DN 90	90	90.0	90.9	8.2	10.1	12.3	15.0
	PPR-DN 110	110	110.0	111.0	10.0	12.3	15.1	18.3
	PPR-DN 125	125	125.0	126.2	11.4	14.0	17.1	20.8
	PPR-DN 140	140	140.0	141.3	12.7	15.7	19.2	23.3
	PPR-DN 160	160	160.0	161.5	14.6	17.9	21.9	26.6

6.2 OTHER TECHNICAL INFORMATION

For the full overview of the environmental benefits and product features of Rifeng PP-R 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 15874-1:2013 Plastics piping systems for hot and cold water installations -- Polypropylene (PP) -- Part 1: General
9. ISO 15874-2:2013 Plastics piping systems for hot and cold water installations -- Polypropylene (PP) -- Part 2: pipes
10. ISO 15874-3:2013 Plastics piping systems for hot and cold water installations -- Polypropylene (PP) -- Part3: fittings
11. ISO 15874-5:2013 Plastics piping systems for hot and cold water installations -- Polypropylene (PP) -- Part 5:fitness for purpose of the system
12. DIN 8077:2008 Polypropylene (PP) pipes – PP-H, PP-B, PP-R, PP-RCT – Dimensions
13. DIN 8078:2007 Polypropylene(PP)pipes PP-H, PP-B, PP-R, PP-RCT- General quality requirements and testing
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
18. ISO 527-1:2012 Plastics - Determination of tensile properties -- Part 1: General
19. ASTM D1238-13 Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer

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