GF Piping Systems

Environmental Product Declaration

Polybutene system

According to EN 15804+A1

Hot and cold water distribution on a cruise ship

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1. Declaration of general information

1.1 Introduction

GF Piping Systems is one of the three divisions within Georg Fischer Corporation and a leading provider of plastic and metal piping systems with global market presence. The product portfolio includes pipes, fittings, valves and the corresponding automation and jointing technology for industry, building technology as well as water and gas utilities. Georg Fischer Piping Systems proactively incorporates its environmental responsibility into its everyday business activities. Because we understand environmental awareness as one of the corporation´s core values, internal structures and processes are geared towards sustainability. In this context, life cycle assessments are the correct tool to gain insight in the different life cycle phases of our systems.

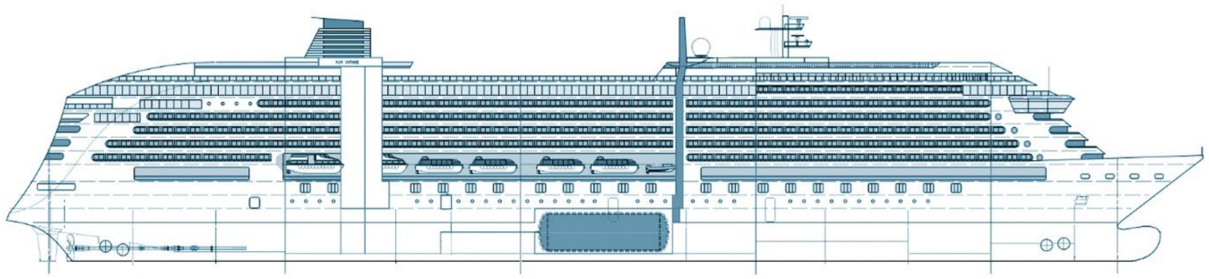
This EPD is based on a detailed background report written by the Flemish Institute for technological research (Vito). The report is in line with EN 15804+A1 "Sustainability of construction works – environmental product declarations – Core rules for the product category of construction products". The data of the study complies with the quality requirements set out in EN 15804+A1
(EN 15804 +A1:2013, Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products). Data regarding the production of the pipe system components is company specific and was provided by GF Piping Systems.

Declaration

Declaration owner & Program operator's name	Georg Fischer Piping Systems Ltd.
Validity	26.03.2020 – 25.03.2025
Declaration Number	GFPS-EPD_2005-2_5
EPD-Type	Cradle to grave
Data calculated by	Vito NV (Flemish Institute for technological research) www.vito.be
Life Cycle Inventory (LCI) source for generic background processes	Ecoinvent v 3.5 Industry data 2.0 database
Software	SimaPro 9.0.0

1.2 System

The analyzed case represents an exemplary system for the transport of fresh water to the cabins of a cruise ship. The installed piping system consists of the dimensions d110 (riser), d50 (decks) and d16 (cabins). The ship which has a length of 340 m comprises 18 decks with a length of 280 m and a total of 1 800 cabins. The system is installed in a dockyard in Turku (Finland). The used jointing technologies are socket welding and electrofusion.



Materials

The material of the main pipe system components (pipes and fittings) is PB. The whole system consists of the materials as listed below

Material		Weight (kg)
PB		10 777
Brass		6 397
Plastics (other than PB)		403
Rubber		40
Steel		25
Paper		18
Printed wiring board		7
Other metals		6
Wire		5
Pump	Iron	2 356
	Bronze	398
	Steel	217
	Other metals	33
	Rubber	8
	Neoprene	2
Motor	Steel	1 752
	Other metals	976
	Plastics	19
	Insulation material	18
	Chemicals organic, not specified	9
	Paint	7

Reference service life

20 years

Please refer to chapter 2.3 for further information on the reference service life of the system.

Functional unit (FU)

The transport of hot and cold water in a PB piping system on a cruise ship via a riser (d110) and the decks (d50) to the taps of the toilet, shower and sink in the cabins (d16) over the whole lifetime of the system.

Components of the system (number of pieces or meter)

The system mainly consists of Georg Fischer Piping Systems components. However, to complete the system also external components (Ext.) which are not produced by Georg Fischer Piping Systems are necessary. The calculation of the environmental impact of these products is based on publicly available data and assumptions.

	Product Code	Pieces or meter	Material
System Components			
Cabin			
INSTAFLEX pipe, d16	760856606	32 400 m	PB
INSTAFLEX socket, d20	761066661	3 600	PB
INSTAFLEX electrofusion reducer d20/d16	761069277	3 600	PB (body) and others
INSTAFLEX elbow 90°, d16	760854842	7 200	Brass
INSTAFLEX brass tee 90°, equal, d16	760853125	7 200	Brass
INSTAFLEX single pipe outlet with flange, d16	760853013	10 800	Brass
Deck			
INSTAFLEX Pipe PB, d50	760856611	10 080 m	PB
INSTAFLEX weld-in-saddle, d50-d20	761068003	3 600	PB
INSTAFLEX electrofusion coupler, d50	761069205	1 728	PB (body) and others
Ball valve type 546, d20	760000343	3 600	PP-H (body) and others
Riser			
INSTAFLEX pipe, d110	760856615	180 m	PB
INSTAFLEX tee 90° equal, d110	761066629	72	PB
INSTAFLEX reducing bush, d110/d63	761066747	72	PB
INSTAFLEX reducing bush, d63/d50	761066690	72	PB
Pump connection			
INSTAFLEX Pipe PB, d110	760856615	10 m	PB
INSTAFLEX electrofusion coupler, d110	761069267	8	PB (body) and others
INSTAFLEX electrofusion elbow 90°, d110	761069223	1	PB (body) and others
INSTAFLEX flange adapter, d110	761069315	4	PB
INSTAFLEX backing flanges PN 16, d110	761065278	4	Iron
Butterfly valve type 567, d110	167567005	2	PP-H (body) and others
Motor	Ext.	6	Various metals and others
Pump	Ext.	6	Various metals and others

1.3 Comparability

EPDs of construction products may not be comparable if they do not comply with the EN 15804+A1.

1.4 Demonstration of verification

CEN standard EN 15804 serves as the core PCR

Independent verification of the declaration and data, according to EN ISO 14025:2010

☐ internal ☒ external

Dr. Frank Werner

Company: Dr. Frank Werner Umwelt & Entwicklung, Zürich (Switzerland)

2. Declaration of environmental parameters derived from LCA

2.1 Flow diagram of the processes included in the LCA

Product stage
A1: Raw material supply
A2: Transport
A3: Manufacturing
Construction-installation process
A4: Transport to installation
A5: Installation

A

Use stage
B1: Use *
B2: Maintenance **
B3: Repair **
B4: Replacement **
B5: Refurbishment **
B6: Operational energy use
B7: Operational water use *

B

End of life stage
C1: De-construction/ Demolition **
C2: Transport
C3: Waste processing
C4: Disposal

C

* Stage not relevant, ** Environmental impact below cut-off criteria. Please refer to chapter 2.3 for details.

2.2 Parameters describing environmental impacts

	Impact category	Global warming	Ozone depletion	Acidification of soil and water	Eutro-phication	Photo-chemical ozone creation	Abiotic depletion - non fossil	Abiotic depletion - fossil
		kg CO_2 eq	kg CFC-11 eq	kg SO_2 eq	kg PO_4^{3-} eq	kg C_2H_4 eq	kg Sb eq	MJ
A1-3	Product stage	7.68E+04	3.43E-02	2.33E+03	6.41E+02	9.62E+01	2.47E+01	1.30E+06
A4	Transport to installation	4.91E+03	8.99E-04	2.05E+01	2.97E+00	9.38E-01	1.40E-02	7.39E+04
A5	Installation	2.85E+03	4.10E-04	9.01E+00	1.59E+00	2.39E+01	1.24E-02	3.66E+04
B1-5	Use, Maintenance, Repair, Replace-ment, Refurbish-ment	0	0	0	0	0	0	0
B6	Operational energy use	1.55E+05	2.15E-01	1.70E+03	1.58E+02	1.03E+02	6.07E-02	1.67E+07
B7	Operational water use	0	0	0	0	0	0	0
C1	De-construction/ Demolition	0	0	0	0	0	0	0
C2	Transport to end-of-life treatment	4.54E+03	7.91E-04	1.66E+01	2.84E+00	7.88E-01	2.50E-02	6.69E+04
C3	Waste processing	2.86E+04	2.36E-05	2.58E+00	6.59E-01	1.08E-01	3.13E-04	1.36E+03
C4	Disposal	0	0	0	0	0	0	0

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2.3 Scenarios and additional technical information

The analyzed case represents an exemplary system for the transport of fresh water to the cabins of a cruise ship.

Product stage	
A1	The production of the plastic raw material was modeled via generic European data (source: ecoinvent) and complemented by specific data from GF Piping Systems to consider the company specific formulation of the raw material.
A2	Wherever possible, the specific transport distances were taken into account. Data from ecoinvent with the respective parameters was used to model the transportation.
A3	The use of energy is the most important input for this process step. Pipes are extruded while fittings and valve parts are injection moulded. Each of GF Piping Systems' worldwide production sites is certified according to ISO 14001 (Environmental management systems) and to OHSAS 18001 (Occupational health and safety management systems) or is currently in the certification process. For the production of GF Piping Systems components, electricity mixes for the respective country/continent were used. The production of external products was modeled using generic ecoinvent data records for the process.

Construction process	
A4	The system is installed in a dockyard in Turku (Finland). Transportation modes and distances to the installation site are as listed below. The following ecoinvent datasets were used: "'Transport, freight, lorry 16-32 metric ton, EURO5 {RER}| transport, freight, lorry 16-32 metric ton, EURO5 | Cut-off, U'" (loading capacity 60%) and "Transport, freight, sea, transoceanic ship {GLO}| processing | Cut-off, U".

The following components are first transported to storage.

By truck	5 km	Flange adapters
	20 km	Sockets, electrofusion reducers, weld-in saddles, tees 90°, reducing bushes, electrofusion elbows 90°
	90 km	Pipes
	150 km	Valves
	459 km	Brass components (elbow 90°, tee 90°, single pipe outlet)
	808 km	Backing flanges
By ship	19 960 km	Backing flanges

Afterwards the components are transported to the installation site by truck (1 029 km) and ship (1 135 km).

Distances and transportation modes for components transported directly to the installation site are as following

By truck	1 300 km	Pumps
	1 097 km	Motors
By ship	1 135 km	Motors

A5	For the installation of the whole system 580 kWh welding energy (ecoinvent dataset: Electricity, low voltage {FI}| market for | Cut-off, U) is needed. Furthermore, specific cleaner (59 kg/FU) for the jointing is necessary. The cleaner is transported by truck and ship over a distance of 2 704 km. Outputs of the complete installation of the system are PB pipe cut-off (17 kg/FU) and packaging waste (7 086 kg/FU) whereof 78% is cardboard. Wood and cardboard is recycled. PB pipe cut-off and PE-film are incinerated. Transport distance to recycling is assumed to be 600 km, transport to incineration 150 km. Transport is carried out by truck.

Use stage	
B1	There are no further environmental impacts arising from the use of the system. This stage is considered as not relevant.
B2-B5	The system is designed to be operated without repair, maintenance, replacement or refurbishment during the reference service life. This is subject to the condition that the system is operated according to the specifications given by GF Piping Systems. The lifetime of a valve is mainly influenced by the actuation cycles. The number of actuation cycles the valves are tested for is not reached during the life time of the evaluated system. It is possible that in individual cases components of the valve (e.g. seals) must be replaced. In this case the environmental impact is negligible compared to the impact of the whole system and below the cut-off criteria defined in EN 15804+A1.
B6	The operational use of the system is an important stage because of the long reference service life of 20 years. 873 500 kWh of energy (ecoinvent dataset: Electricity, high voltage {Europe without Switzerland}| petroleum refinery operation | Cut-off, U) during the use stage is necessary per functional unit.
B7	No operational water use is necessary for the system. This stage is considered as not relevant.

End of life stage	
C1	De-construction of the system is mainly manual work. A small energy input is needed to cut the pipes. The environmental impact is negligible compared to the impact of the whole system and below the cut-off criteria defined in EN 15804+A1.
C2	Transportation to the end of life treatment facilities is carried out by truck. Distances are 600 km for recycling and 150 km for incineration.
C3	It is assumed that all metal parts are recycled and all other parts are incinerated with energy recovery. The exported energy is in the form of electricity and thermal energy. Approximately 11.5% of the net energy content of the incinerated waste is converted to electricity and 23.4% is converted to heat. Both are sold to external consumers. These values reflect the situation in Swiss municipal waste incinerators about 10 years ago, as reported in ecoinvent documentation.
C4	It is assumed that all metal parts are recycled and all other parts are incinerated with energy recovery. Therefore module C4 is not relevant.

Reference service life data

Parameter	Data
Reference service life	20 years

Declared product properties

System components are compliant with relevant international approvals and standards e.g.

- EN (European Standards)
- ISO (International Organization for Standardization)
- BS (British Standard)

Most relevant standards are:

ISO 15494	Plastics piping systems for industrial applications - Polybutene (PB), Polyethylene (PE) and Polypropylene (PP) - Specifications for components and the system
ISO 15876	Plastics piping systems for hot and cold water installations - Polybutene (PB)

Approvals for INSTAFLEX in Shipbuilding:

Country / Organization	Institute
Bureau Veritas	CCS
German Lloyds	GL
Italy	RINA
Lloyd's Register	LR
Norway	DNV
Russia	RMROS
USA	ABS

Design application parameters

PB characteristics	Value	Test standard
Operating temperature range	0 °C to + 95 °C	
Density	0.94 g/cm^3	EN ISO 1183
Melt flow index 190/2.16	0.4 g/10 min	EN ISO 1133
Yield stress at 23 °C	20 MPa	EN ISO 527-1
Elongation at break at 23°C	300%	EN ISO 527-1
Flexural modulus of elasticity at 23 °C	450 MPa	ISO 178
Notched impact test at 23 °C	37 kJ/m^2	EN ISO 179 – 1/1eA
Notched impact test at 0 °C	20 kJ/m^2	EN ISO 179 – 1/1eA
Ball indentation hardness (132 N)	43 MPa	EN ISO 2039 - 1
Coefficient of thermal expansion	0.13 mm/m K	ASTM D696
Thermal conductivity at 23 °C	0.19 W/m K	ASTM E1530
Moisture absorption at 23 °C	0.01-0.04%	EN ISO 62

For more information, please refer to the planning fundamentals which are available at: gfps.com › support & services › Planning Assistance › Planning Fundamentals › Building Technology

Assumed quality of work

- Constant water supply without interrupting operations
- Leakproof systems reduce water losses
- Flexibility of plastics pipes minimizes the risk of water hammer
- No corrosion and no incrustation reduces maintenance to a minimum
- Low thermal conductivity results in minimum heat loss
- Low noise transmission

Usage conditions

- SDR 11
- PN 16
- Flow rate 1.5 m/s (average), 5.5 m/s (maximum)

Maintenance

The system is designed to be operated without repair, maintenance, replacement or refurbishment. This is subject to the condition that the system is installed and operated according to the specifications given by GF Piping Systems. Please refer also to Chapter 2.3.

2.4 Parameters describing resource use

Parameters describing resource use, primary energy		Product stage	Construction process stage		Use stage			End of life			
		Total (of product stage)	Transport	Construction installation process	Use, Maintenance, Repair, Replacement, Refurbishment	Operational energy use	Operational water use	De-construction / Demolition	Transport	Waste processing	Disposal
		A1-3	A4	A5	B1-B5	B6	B7	C1	C2	C3	C4
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ, net calorific value	1.20E+05	8.23E+02	1.82E+03	0	4.93E+04	0	0	9.09E+02	6.91E+01	0
Use of renewable primary energy resources used as raw materials	MJ, net calorific value	1.68E+01	0	6.06E+00	0	0	0	0	0	0	0
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ, net calorific value	1.20E+05	8.23E+02	1.83E+03	0	4.93E+04	0	0	9.09E+02	6.91E+01	0
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	MJ, net calorific value	9.80E+05	7.55E+04	4.05E+04	0	1.69E+07	0	0	6.84E+04	1.49E+03	0
Use of non-renewable primary energy resources used as raw materials	MJ, net calorific value	4.74E+05	0	7.09E+02	0	0	0	0	0	0	0
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ, net calorific value	1.45E+06	7.55E+04	4.12E+04	0	1.69E+07	0	0	6.84E+04	1.49E+03	0

Parameters describing resource use, secondary materials and fuels, and use of water		Product stage	Construction process stage		Use stage			End of life			
		Total (of product stage)	Transport	Construction installation process	Use , Maintenance, Repair, Replacement, Refurbishment	Operational energy use	Operational water use	De-construction / Demolition	Transport	Waste processing	Disposal
		A1-3	A4	A5	B1 - B5	B6	B7	C1	C2	C3	C4
Use of secondary material*	kg	3.74E+03	0	0	0	0	0	0	0	0	0
Use of renewable secondary fuels*	MJ, net calorific value	0	0	0	0	0	0	0	0	0	0
Use of non-renewable secondary fuels*	MJ, net calorific value	0	0	0	0	0	0	0	0	0	0
Net use of fresh water	m^3	8.79E+02	1.20E+01	1.03E+01	0	1.78E+03	0	0	1.09E+01	5.75E+00	0

*Only for foreground process from which LCI data are made available by GF Piping Systems - the number does not include processes and materials modelled by means of background data, e.g. transportation, electricity, ancillary materials, etc.

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2.5 Environmental information describing output flows

Other environmental information describing output flows		Product stage	Construction process stage		Use stage			End of life			
		Total (of product stage)	Transport	Construction installation process	Use, Maintenance, Repair, Replacement, Refurbishment	Operational energy use	Operational water use	De-construction / Demolition	Transport	Waste processing	Disposal
		A1-3	A4	A5	B1-B5	B6	B7	C1	C2	C3	C4
Components for re-use*	kg	0	0	0	0	0	0	0	0	0	0
Materials for recycling*	kg	9.07E+01	0	6.96E+03	0	0	0	0	0	1.22E+04	0
Materials for energy recovery*	kg	0	0	0	0	0	0	0	0	0	0
Exported energy - electricity*	MJ per energy carrier	7.07E+01	0	7.32E+02	0	0	0	0	0	1.58E+05	0
Exported energy - thermal energy*	MJ per energy carrier	1.50E+02	0	1.47E+03	0	0	0	0	0	3.16E+05	0

*Only for foreground process from which LCI data are made available by GF Piping Systems - the number does not include processes and materials modelled by means of background data, e.g. transportation, electricity, ancillary materials, etc.

Other environmental information describing waste categories		Product stage	Construction process stage		Use stage			End of life			
		Total (of product stage)	Transport	Construction installation process	Use , Maintenance, Repair, Replacement, Refurbishment	Operational energy use	Operational water use	De-construction / Demolition	Transport	Waste processing	Disposal
		A1-3	A4	A5	B1-B5	B6	B7	C1	C2	C3	C4
Hazardous waste disposed	kg	7.71E+00	4.73E-02	3.35E-02	0	4.63E+00	0	0	5.79E-02	8.87E-03	0
Non-hazardous waste disposed	kg	1.92E+04	3.37E+03	9.97E+02	0	3.99E+03	0	0	2.06E+03	3.27E+02	0
Radioactive waste disposed	kg	2.67E+00	5.08E-01	2.66E-01	0	1.21E+02	0	0	4.45E-01	4.78E-03	0

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