FLOWGUARD GOLD®
PIPE & FITTINGS

Environmental Product Report

Cradle-to-grave

FlowGuard Gold® pipes and fittings for the USA market

SDR-11 1.25 inch

Lubrizol

The Lubrizol Corporation

January 2016

General Information

Manufacturer	The Lubrizol Corporation 29400 Lakeland Boulevard, Wickliffe, Ohio 44092, USA https://www.lubrizol.com/
Product:	FlowGuard Gold® SDR-11 1.25 inch for USA market
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Prepared by:	Environmental Resources Management Limited https://www.erm.com

LCA Study Information

This report has been generated from the externally peer reviewed cradle-to-grave life cycle assessment (LCA) of FlowGuard Gold® pipes and fittings, which was completed in October 2015 according to the requirements of ISO 14040/14044.

Product

FlowGuard Gold® pipes and fittings are constructed of specialized chlorinated polyvinylchloride (CPVC) and are designed specifically for hot and cold water distribution (HCWD) systems. The function of the product is the distribution of hot and cold water throughout a building. FlowGuard Gold® pipes and fittings have been installed in a wide array of constructions in both residential and commercial applications.

This environmental product report relates to FlowGuard Gold® pipes and fittings of wall thickness SDR-11 and diameter 1.25 inch, for the USA market. The product is referred to in this environmental product report as 'SDR-11 1.25 inch for the USA market'.

Functional unit

The environmental impacts are reported for the functional unit:

- 1000 feet (ft) of FlowGuard Gold® SDR-11 1.25 inch pipe and associated fittings for the USA market.

Reference service life

The reference service life of FlowGuard Gold® SDR-11 1.25 inch for the USA market is greater than 50 years.

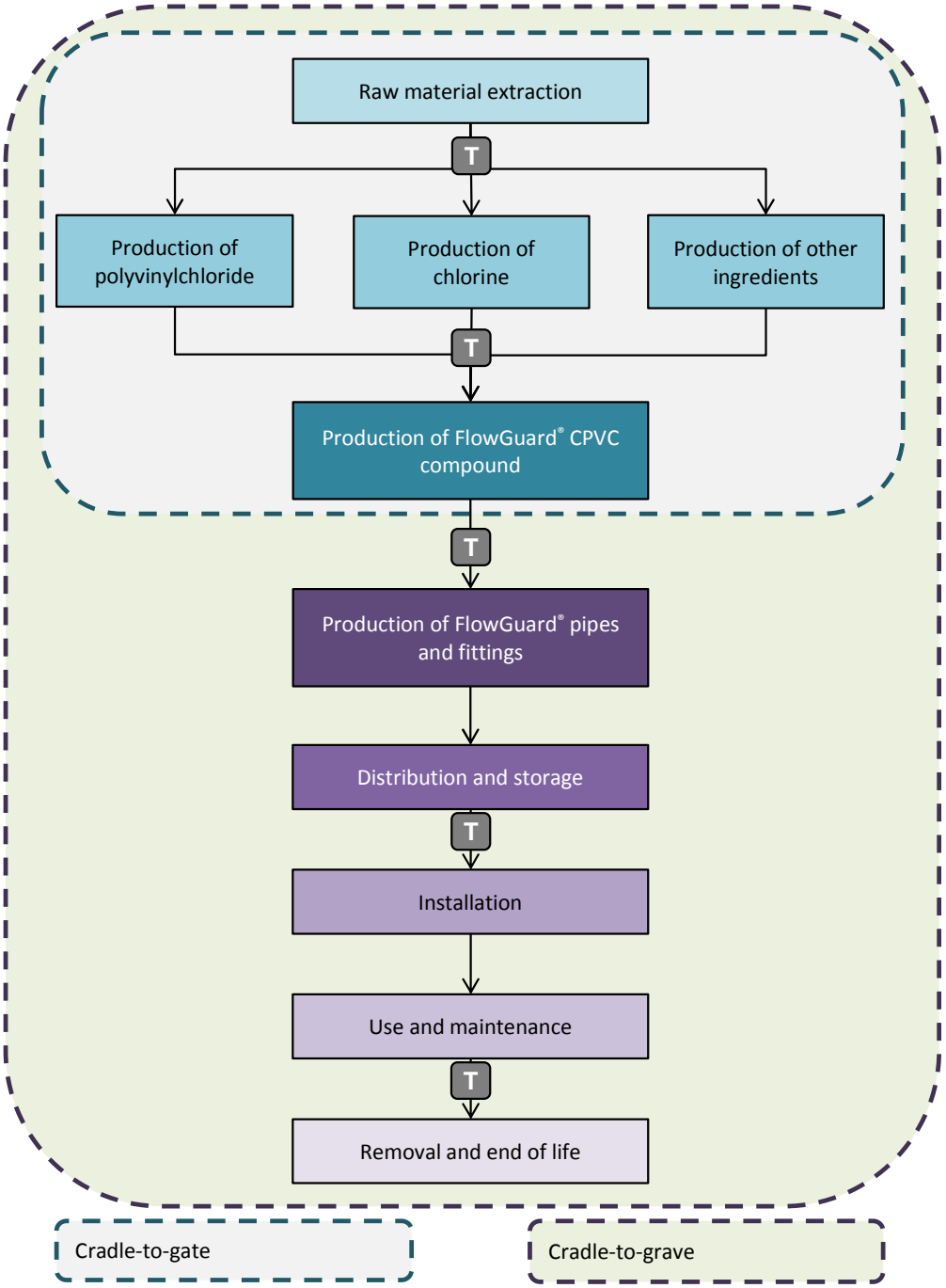
System boundary

The system boundary is the 'cradle-to-grave' life cycle of FlowGuard Gold® SDR-11 1.25 inch for the USA market. This report covers the following life cycle stages, as set out in *Figure 1*.

- extraction of raw materials;
- transportation of raw materials;

- conversion of raw materials to CPVC compound;
- transportation of CPVC compound to pipe and fittings manufacture;
- manufacture of FlowGuard Gold® pipes and fittings;
- distribution of FlowGuard Gold® pipes and fittings;
- installation, maintenance and use of FlowGuard Gold® pipes and fittings; and
- removal and end of life of FlowGuard Gold® pipes and fittings.

Figure 1: Life cycle of FlowGuard Gold® pipes and fittings



FlowGuard Gold® SDR-11 1.25 inch for the USA market is manufactured at piping and fittings fabrication facilities in the USA and Canada. The pipes are comprised of FlowGuard Gold® CPVC compound 3107 Tan 309 and the fittings are comprised of FlowGuard Gold® CPVC compound 3215 Tan 309, both manufactured at Lubrizol's facility in Louisville, Kentucky, USA. The CPVC compounds are transported to the pipes and fittings fabrication facilities, where they are manufactured into the FlowGuard Gold® SDR-11 1.25 inch piping system for the USA market.

Installation of FlowGuard Gold® SDR-11 1.25 inch for the USA market is undertaken using solvent cement. The pipes and fittings are cut to size using a mechanical saw and prepared for installation, ensuring surfaces are clean and dry. Solvent cement is applied with an applicator to the outside of the pipe end and to the fittings socket. The pipe is then immediately inserted into the fitting socket whilst rotating the pipe one-quarter turn. The pipes are left to set, the time required being a function of pipe size, temperature, relative humidity and tightness of fit.

Life cycle inventory data

The life cycle inventory (LCI) data for FlowGuard Gold® CPVC compounds 3107 Tan 309 and 3215 Tan 309 are available to our customers on request. These will facilitate the development of Type III Environmental Product Declarations (EPD) which can be used to achieve LEED Green Building points.

For more information, please visit www.flowguardlca.com. To reach a piping systems consultant, contact Lubrizol Advanced Materials at cpvc@lubrizol.com or (855) 735-1431.

Life Cycle Impact Assessment

The impact assessment method applied is the International Reference Life Cycle Data System (ILCD) impact assessment method [1] for global warming potential, ozone depletion, particulate matter, photochemical oxidant creation, acidification, eutrophication, water depletion. The ReCiPe impact assessment method was used to characterize the metal and fossil resource depletion impact category [2]. The environmental impact of FlowGuard Gold® SDR-11 1.25 inch for the USA market is provided in *Table 1* and the contribution from each life cycle stage is provided in *Table 2*. The environmental impacts were calculated as part of an externally peer reviewed cradle-to-grave life cycle assessment (LCA) of FlowGuard Gold® pipes and fittings, which was completed in October 2015 according to the requirements of ISO 14040/14044.

(1) http://lct.jrc.ec.europa.eu

(2) PRé Consultants, CML, University of Leiden, Netherlands, Radboud University Nijmegen Netherlands, RIVM Bilthoven, Netherlands (2013) ReCiPe 2008. A life cycle impact assessment method which comprises harmonised category indicators at the midpoint and the endpoint level. First edition (version 1.08

Table 1: Environmental impacts of FlowGuard Gold® SDR-11 1.25 inch for USA market per 1000 feet

Impact	Unit	Raw materials	Manufacture	Wholesale and distribution	Use	End of life	Total
Global warming potential	kg CO_2e	662	141	24.5	2.0E-02	0.957	828
Ozone depletion	kg CFC-11 eq	9.4E-05	1.0E-05	4.5E-06	3.6E-09	1.7E-07	1.1E-04
Particulate matter	kg PM2.5 eq	0.298	6.1E-02	1.4E-02	2.6E-05	7.8E-04	0.374
Photochemical oxidant creation	kg NMVOC eq	1.83	0.355	0.172	0.348	7.9E-03	2.71
Acidification	molc H+ eq	4.35	1.06	0.169	2.1E-04	6.7E-03	5.58
Eutrophication	kg P eq	0.128	5.4E-02	3.0E-04	6.7E-07	1.9E-05	0.183
Water depletion	m^3 water eq	1.61	8.6E-03	3.1E-03	2.4E-06	1.2E-04	1.62
Metal depletion	kg Fe eq	2074	1.29	4.3E-03	4.1E-06	1.7E-04	2076
Fossil depletion	kg oil eq	249	41.9	8.83	7.3E-03	0.343	300

Table 2: Environmental impacts of FlowGuard Gold® SDR-11 1.25 inch for USA market per 1000 feet: % contribution per life cycle stage

Impact	Unit	Raw materials	Manufacture	Wholesale and distribution	Use	End of life
Global warming potential	kg CO_2e	79.9%	17.0%	3.0%	<0.1%	0.1%
Ozone depletion	kg CFC-11 eq	86.3%	9.4%	4.1%	<0.1%	0.2%
Particulate matter	kg PM2.5 eq	79.9%	16.2%	3.7%	<0.1%	0.2%
Photochemical oxidant creation	kg NMVOC eq	67.4%	13.1%	6.3%	12.8%	0.3%
Acidification	molc H+ eq	77.9%	19.0%	3.0%	<0.1%	0.1%
Eutrophication	kg P eq	70.1%	29.7%	0.2%	<0.1%	<0.1%
Water depletion	m^3 water eq	99.3%	0.5%	0.2%	<0.1%	<0.1%
Metal depletion	kg Fe eq	99.9%	0.1%	<0.1%	<0.1%	<0.1%
Fossil depletion	kg oil eq	83.0%	14.0%	2.9%	<0.1%	0.1%

Specific conclusions related to the contribution of components and life cycle stages are noted below.

- Raw material production is the most significant contributor to all of the impact categories. The majority of the impact is from the production of CPVC compound for pipes and fittings, with PVC material input making the largest contribution.
- Manufacturing is the second most significant contributor. The impact relates predominantly to grid electricity consumption for the conversion of CPVC compound to pipes and fittings.
- Wholesale and distribution are relatively small impacts and relate to the impact from transportation and storage of the piping system prior to installation.
- Use does not contribute significantly to any of the environmental impacts assessed. VOC emissions from solvent cement use are shown to make a small contribution to the photochemical oxidant creation impact.
- End of life does not contribute significantly to any of the impacts.