Quartz (CAS# 14808-60-7) GreenScreen® for Safer Chemicals (GreenScreen®) Assessment

Prepared for:

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Prepared by:

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TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

GreenScreen® Executive Summary for Quartz (CAS #14808-60-7)

Quartz is a chemical that has many uses, including use in glass manufacturing, ceramics, foundry, abrasives, hydraulic fracturing, furnaces, fillers, paints, and filtration.

Inhalation: Quartz was assigned a GreenScreen® Benchmark Score of 1 ("Avoid-Chemical of High Concern") as it has Very High persistence (P), High Group I Human Toxicity (carcinogenicity (C)), and High Group II* Human Toxicity (systemic toxicity-repeated dose (STr*)). This corresponds to GreenScreen® benchmark classifications 1c and 1e in CPA 2011. Data gaps (DG) exist for endocrine activity (E), acute toxicity (AT), neurotoxicity (single dose (Ns) and repeated dose(Nr*)), respiratory sensitization (SnR*), and chronic aquatic toxicity (CA). As outlined in CPA (2013) Section 12.2 (Step 8 – Conduct a Data Gap Analysis to assign a final Benchmark score), quartz meets requirements for a GreenScreen® Benchmark Score of 1 despite the hazard data gaps. In a worst-case scenario, if quartz were assigned a High or Very High score for any of the data gaps, it would still be categorized as a Benchmark 1 Chemical.

Oral: Quartz was assigned a GreenScreen® Benchmark Score of 2 ("Use but Search for Safer Substitutes") as it has Very High persistence (P) and Moderate Group I Human Toxicity (mutagenicity (M)). This corresponds to GreenScreen® benchmark classifications 2c and 2e in CPA 2011. Data gaps (DG) exist for endocrine activity (E), neurotoxicity (single dose (Ns) and repeated dose (Nr*)), respiratory sensitization (SnR*), and chronic aquatic toxicity (CA). As outlined in CPA (2013) Section 12.2 (Conduct a Data Gap Analysis to assign a final Benchmark score), quartz meets requirements for a GreenScreen® Benchmark Score of 2 despite the hazard data gaps. In a worst-case scenario, if quartz were assigned a High score for the data gaps endocrine activity (E), neurotoxicity (repeated dose (Nr*)), respiratory sensitization (SnR*), or chronic aquatic toxicity (CA), it would be categorized as a Benchmark 1 Chemical.

Dermal: Quartz was assigned a GreenScreen® Benchmark Score of U ("Unspecified Due to Data Gaps"). It has Very High persistence (P) and Moderate Group I Human Toxicity (mutagenicity (M)). This corresponds to GreenScreen® benchmark classifications 2c and 2e in CPA 2011. Data gaps (DG) exist for carcinogenicity (C), endocrine activity (E), systemic toxicity (repeated dose (STr*)), neurotoxicity (single dose (Ns) and repeated dose (Nr*)), respiratory sensitization (SnR*), and chronic aquatic toxicity (CA). As outlined in CPA (2013) Section 12.2 (Conduct a Data Gap Analysis to assign a final Benchmark score), quartz does not meet requirements for a GreenScreen® Benchmark Score of 2 due to the hazard data gaps. In a worst-case scenario, if quartz were assigned a High score for the data gaps carcinogenicity (C), endocrine activity (E), systemic toxicity (repeated dose (STr*)), neurotoxicity (repeated dose (Nr*)), respiratory sensitization (SnR*), or chronic aquatic toxicity (CA), it would be categorized as a Benchmark 1 Chemical.

GreenScreen® Benchmark Score for Relevant Route of Exposure:
In order to address route specific hazards, all exposure routes (oral, dermal, and inhalation) were evaluated separately and GreenScreen® Benchmark Scores were generated for each route of exposure.

GreenScreen® Hazard Ratings for Quartz

Route of Exposure	Group I Human					Group II and II* Human									Ecotox		Fate		Physical	
	C	M	R	D	E	AT	ST		N		SnS*	SnR*	IrS	IrE	AA	CA	P	B	Rx	F
							single	repeated*	single	repeated*										
Inhalation	**H**	**M**	*L*	*L*	DG	DG	*vH*	H	DG	DG	*L*	DG	*L*	*M*	*L*	DG	*vH*	*vL*	*L*	*L*
Oral	*L*					**M**	*L*	*L*												
Dermal	DG					*L*	*L*	**DG**												

Note: Hazard levels (Very High (vH), High (H), Moderate (M), Low (L), Very Low (vL)) in *italics* reflect estimated (modeled) values, authoritative B lists, screening lists, weak analogues, and lower confidence. Hazard levels in **BOLD** font are used with good quality data, authoritative A lists, or strong analogues. Group II Human Health endpoints differ from Group II* Human Health endpoints in that they have four hazard scores (i.e., vH, H, M, and L) instead of three (i.e., H, M, and L), and are based on single exposures instead of repeated exposures. Please see Appendix A for a glossary of hazard acronyms.
* Chemical is inorganic

GreenScreen® Assessment for Quartz (CAS #14808-60-7)

Method Version: GreenScreen® Version 1.2[1]
Assessment Type[2]: Certified

Chemical Name: Quartz

CAS Number: 14808-60-7

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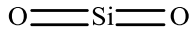
Date: April 24, 2014
Updated: October 13, 2014

Confirm application of the *de minimus* rule[3]: N/A

Chemical Structure(s):



Also called:
Agate, Amethyst, CCRIS 2475, Chalcedony, Cherts, Crystallized silicon dioxide, D & D, DQ12, EINECS 238-878-4, Flint, Flintshot, Gold bond R, Imsil, MIN-U-sil alpha quartz, Min-U-Sil, Novaculite, Onyx, Quartz, Quartz dust, Quartz silica, Quazo puro, Quazo puro [Italian], Rock crystal, Rose quartz, SF 35, Sand, Sicron F 300, Siderite (SiO2), Sikron F 100, Sil-Co-Sil, Silica dust, Silica flour (powdered crystalline silica, Silicon oxide, di- (sand), Silver bond B, Snowit, TGL 16319, Tiger-eye, W 12, W 12 (Filler), alpha-Quartz (ChemIDplus 2014)

Chemical Structure(s) of Chemical Surrogates Used in the GreenScreen®:
Data for crystalline silica, as well as amorphous silica (CAS# 7631-86-9), were considered to fill data gaps as this compound has an identical chemical structure to quartz. However, despite exploring this compounds as a surrogate, insufficient data were obtained for endocrine activity, neurotoxicity, respiratory sensitization, and chronic aquatic toxiticy. Scores based entirely on data for the surrogate

[1] Use GreenScreen® Assessment Procedure (Guidance) V1.2

[2] GreenScreen® reports are either "UNACCREDITED" (by unaccredited person), "AUTHORIZED" (by Authorized GreenScreen® Practitioner), "CERTIFIED" (by Licensed GreenScreen® Profiler or equivalent) or "CERTIFIED WITH VERIFICATION" (Certified or Authorized assessment that has passed GreenScreen® Verification Program)

[3] Every chemical in a material or formulation should be assessed if it is:
1. intentionally added and/or
2. present at greater than or equal to 100 ppm

amorphous silica are reported with reduced confidence, as the impact of physical structure (crystalline vs. amorphous) on oral and dermal toxicity are unclear.

Identify Applications/Functional Uses: (HSDB 2005)
1. Glass manufacturing
2. Ceramics
3. Foundry
4. Abrasives
5. Hydraulic fracturing (as a proppant)
6. Furnaces
7. Fillers
8. Paints
9. Filtration

GreenScreen® Summary Rating for Quartz[4]:

Inhalation: Quartz was assigned a GreenScreen® Benchmark Score of 1 ("Avoid-Chemical of High Concern") as it has Very High persistence (P), High Group I Human Toxicity (carcinogenicity (C)), and High Group II* Human Toxicity (systemic toxicity-repeated dose (STr*)). This corresponds to GreenScreen® benchmark classifications 1c and 1e in CPA 2011, 2012a. Data gaps (DG) exist for endocrine activity (E), acute toxicity (AT), neurotoxicity (single dose (Ns) and repeated dose (Nr*)), respiratory sensitization (SnR*), and chronic aquatic toxicity (CA). As outlined in CPA (2013) Section 12.2 (Step 8 – Conduct a Data Gap Analysis to assign a final Benchmark score), quartz meets requirements for a GreenScreen® Benchmark Score of 1 despite the hazard data gaps. In a worst-case scenario, if quartz were assigned a High or Very High score for any of the data gaps, it would still be categorized as a Benchmark 1 Chemical.

Oral: Quartz was assigned a GreenScreen® Benchmark Score of 2 ("Use but Search for Safer Substitutes") as it has Very High persistence (P) and Moderate Group I Human Toxicity (mutagenicity (M)). This corresponds to GreenScreen® benchmark classifications 2c and 2e in CPA 2011. Data gaps (DG) exist for endocrine activity (E), neurotoxicity (single dose (Ns) and repeated dose (Nr*)), respiratory sensitization (SnR*), and chronic aquatic toxicity (CA). As outlined in CPA (2013) Section 12.2 (Conduct a Data Gap Analysis to assign a final Benchmark score), quartz meets requirements for a GreenScreen® Benchmark Score of 2 despite the hazard data gaps. In a worst-case scenario, if quartz were assigned a High score for the data gaps endocrine activity (E), neurotoxicity (repeated dose (Nr*), respiratory sensitization (SnR*), or chronic aquatic toxicity (CA), it would be categorized as a Benchmark 1 Chemical.

Dermal: Quartz was assigned a GreenScreen® Benchmark Score of U ("Unspecified Due to Data Gaps"). It has Very High persistence (P) and Moderate Group I Human Toxicity (mutagenicity (M)). This corresponds to GreenScreen® benchmark classifications 2c and 2e in CPA 2011, 2012a. Data gaps (DG) exist for carcinogenicity (C), endocrine activity (E), systemic toxicity (repeated dose (Str*)), neurotoxicity (single dose (Ns) and repeated dose (Nr*)), respiratory sensitization (SnR*), and chronic aquatic toxicity (CA). As outlined in CPA (2013) Section 12.2 (Conduct a Data Gap Analysis to assign a final Benchmark score), quartz does not meet requirements for a GreenScreen® Benchmark Score of 2 due to the hazard data gaps. In a worst-case scenario, if quartz were assigned

[4] For inorganic chemicals with low human and ecotoxicity across all hazard endpoints and low bioaccumulation potential, persistence alone will not be deemed problematic. Inorganic chemicals that are only persistent will be evaluated under the criteria for Benchmark 4.

a High score for the data gaps carcinogenicity (C), endocrine activity (E), systemic toxicity (repeated dose (STr*)), neurotoxicity (repeated dose (Nr*)), respiratory sensitization (SnR*), or chronic aquatic toxicity (CA), it would be categorized as a Benchmark 1 Chemical.

Figure 1: GreenScreen® Hazard Ratings for Quartz

Route of Exposure	Group I Human					Group II and II* Human								Ecotox		Fate		Physical	
	C	M	R	D	E	AT	ST		N		SnS*	SnR*	IrS	IrE	AA	CA	P	B	Rx	F
							single	repeated*	single	repeated*										
Inhalation	H				DG	DG	*vH*	H												
Oral	*L*	**M**	*L*	*L*	DG	*M*	*L*	*L*	DG	DG	*L*	DG	*L*	*M*	*L*	DG	*vH*	*vL*	*L*	*L*
Dermal	DG					*L*	*L*	**DG**												

Note: Hazard levels (Very High (vH), High (H), Moderate (M), Low (L), Very Low (vL)) in *italics* reflect estimated (modeled) values, authoritative B lists, screening lists, weak analogues, and lower confidence. Hazard levels in **BOLD** font are used with good quality data, authoritative A lists, or strong analogues. Group II Human Health endpoints differ from Group II* Human Health endpoints in that they have four hazard scores (i.e., vH, H, M, and L) instead of three (i.e., H, M, and L), and are based on single exposures instead of repeated exposures. Please see Appendix A for a glossary of hazard acronyms.
* Chemical is inorganic

Transformation Products and Ratings:

Identify feasible and relevant fate and transformation products (i.e., dissociation products, transformation products, valence states) **and/or moieties of concern**[5]

No relevant transformation products were identified. Quartz is a stable crystalline solid that is naturally found in the environment and resistant to degradation. Upon contact with water, small amounts of silicon (as silicic acid) may be slowly released. Silicic acid was not evaluated as it is naturally occurring in the environment and dissolved silicon is essential to algae, plants, and animals (EC 2013).

Introduction

Quartz, also known as crystalline silica, is a form of silicon dioxide with building blocks arranged in a regular, repeating 3-dimensional pattern with long range order. Quartz is a component of sand and is naturally occurring in many rock formations and occurs in volcanic eruptions. It is isolated from ore through milling and grinding of the ore into particles that are then purified or used directly (EC 2013). Quartz has many uses, including use in glass manufacturing, ceramics, foundry, abrasives, hydraulic fracturing, furnaces, fillers, paints, and filtration (HSDB 2005).

ToxServices assessed quartz against GreenScreen® Version 1.2 (CPA 2013) following procedures outlined in ToxServices' SOP 1.37 (GreenScreen® Hazard Assessment) (ToxServices 2013).

GreenScreen® List Translator Screening Results

The GreenScreen® List Translator identifies specific authoritative or screening lists that should be searched to identify GreenScreen® benchmark 1 chemicals (CPA 2012b). Pharos (Pharos 2014) is an online list-searching tool that is used to screen chemicals against the List Translator electronically. The output indicates benchmark or possible benchmark scores for each human health and environmental endpoint. The output for quartz can be found in Appendix C, and classifications for

[5] A moiety is a discrete chemical entity that is a constituent part or component of a substance. A moiety of concern is often the parent substance itself for organic compounds. For inorganic compounds, the moiety of concern is typically a dissociated component of the substance or a transformation product.

specific endpoints can be found below and in the appropriate sections. When a classification from GHS New Zealand was available for any endpoint, it was converted to the harmonized GHS classifications using the "Correlation between GHS and New Zealand HSNO Hazard Classes and Categories" document from the New Zealand Environmental Protection Authority (N.Z. EPA 2009).

- Cancer
  - IARC Group I carcinogenic to humans
  - NIOSH-C: Occupational carcinogen
  - German MAK: Carcinogen Group I – Substances that cause cancer in man
  - GHS-New Zealand: 6.7A – Known or presumed human carcinogens
  - GHS-Japan: Carcinogenicity category 1A
  - EPA Action: Probable human carcinogen – TSCA criteria met

- Mammalian
  - GHS-Japan: Specific target organs repeated exposure – Category 1
  - GHS-Japan: Specific target organs single exposure – Category 1
  - WHMIS: Class D2A – Very toxic material causing other toxic effects

- Organ Toxicant
  - GHS-New Zealand: 6.9A (inhalation) – Toxic to human target organs or systems

- PBT
  - Environmental Canada: DSL substances that are persistent
  - EPA Action: High environmental persistence – TSCA criteria met
  - EPA Action: Low bioaccumulation potential – TSCA criteria met

Physicochemical Properties of Quartz

Quartz is a solid transparent crystal at room temperature. It is practically insoluble in water and therefore has very low bioavailability.

Table 1: Physical and Chemical Properties of Quartz(CAS #14808-60-7)

Property	Value	Reference
Molecular formula	SiO_2	HSDB 2005
SMILES Notation	[Si](=O)=O	ChemIDplus 2014
Molecular weight	60.09 g/mol	HSDB 2005
Physical state	Solid	HSDB 2005
Appearance	Transparent crystals	HSDB 2005
Melting point	1,710°C	HSDB 2005
Vapor pressure	N/A	HSDB 2005
Water solubility	Practically insoluble in water or acids; very slightly soluble in alkali	HSDB 2005
Dissociation constant	N/A	
Density/specific gravity	2.6	HSDB 2005
Partition coefficient	N/A	
Particle size	Not identified*	
Structure	Crystalline	EC 2013

Table 1: Physical and Chemical Properties of Quartz(CAS #14808-60-7)		
Property	**Value**	**Reference**
Bioavailability	Low	EC 2013

*As particle size was not specified, ToxServices considered data for all potential particle sizes in the assessment.

Hazard Classification Summary Section:

Group I Human Health Effects (Group I Human)

Carcinogenicity (C) Score (H, M, or L): H (inhalation), *L* (oral), DG (dermal)
Quartz was assigned a score of High for carcinogenicity via the inhalation route of exposure based on presence on authoritative lists. GreenScreen® criteria classify chemicals as a high hazard for carcinogenicity when the chemical is listed as IARC Group 1, NIOSH C-Occupational Cancer, MAL-Carcinogen Group 1, NTP-RoC –known to be a human carcinogen, or Prop 65 – Known to cause cancer (CPA 2012a).

- Authoritative and Screening Lists
    - *Authoritative:* International Agency for Research on Cancer - Cancer Monographs (IARC): Group 1: Agent is carcinogenic to humans (Direct Hazard Listing)
    - *Authoritative:* US CDC - Occupational Carcinogens (NIOSH-C): Occupational carcinogen (Direct Hazard Listing)
    - *Authoritative:* German MAK - List of Substances (MAK): Carcinogen Group 1 – Substances that cause cancer in man (Direct Hazard Listing)
    - *Authoritative:* International Agency for Research on Cancer – Cancer Monographs (IARC): Group 1: Agent is carcinogenic to humans – inhaled from occupational sources (Compound Group Hazard Listing)
    - *Authoritative:* German MAK - List of Substances (MAK); Carcinogen Group 1 – Substances that cause cancer in man (Compound Group Hazard Listing)
    - *Authoritative:* US NIH - Report on Carcinogens (NTP-RoC): Known to be Human Carcinogen (respirable size – occupational setting) (Compound Group Hazard Listing)
    - *Authoritative:* Cal/EPA - Chemicals Known to Cause Cancer & Reproductive Toxicity (Prop 65) (Compound Group Hazard Listing)
    - *Screening:* New Zealand HSNO/GHS (GHS-New Zealand): 6.7A – Known or presumed human carcinogens (Direct Hazard Listing) (Equivalent to GHS Category 1A)
    - *Screening:* Japan METI/MOE – GHS Classifications (GHS-Japan): Carcinogenicity – Category 1A (Direct Hazard Listing)

Quartz (CAS# 14808-60-7)

- IARC 1997
    - *Inhalation:* Fifty male and female Fischer 344 rats were exposed, in inhalation chambers, to 0.0 or 1.0 mg/m^3 silica for 6 hours a day, 5 days a week for 24 months. Animals that survived 24 months were maintained, without further exposure, for an additional 6 weeks. The incidences of primary lung tumors in exposed rats were 7/50 in males and 12/50 in females. Borderline adenomas were found in 13/100 exposed animals. No lung tumors were observed in controls. Lung tumors included adenoma, adenocarcinoma, benign cystic keratinizing squamous cell tumors, and adenosquamous carcinoma. Non-neoplastic changes reported in exposed animals included multifocal lipoproteinosis with adjacent fibrotic areas, fibrosis, and alveolar- and bronchiholar-type bronchoalveolar hyperplasia. The severity of these lesions was directly related to duration of exposure

(Muhle et al. 1989, 1991, 1995).

- *Inhalation:* Groups of female Wistar rats (total number of animals not provided) were exposed to 0.0, 6.1±0.36, or 30.6±1.59 mg/m^3 quartz for 6 hours a day, 5 days a week for 29 days (nose only exposure). Two to six animals per group were sacrificed at day 29 and at 6, 12, and 24 months. The study was terminated at 34 months, when the remaining animals were sacrificed. The overall incidence of lung tumors in the low- and high-dose groups after the 24 month sacrifice was 8/37 and 13/43, respectively. Total lung tumor incidences, at termination of the study, were 37/82 and 43/82 for the low- and high-dose groups, respectively. No lung tumors were observed in controls. Many animals exhibited lung tumor multiplicity, sometimes with the same tumor type, and sometimes with different tumor types. Tumor types included bronchiole-alveolar adenomas, bronchiole-alveolar carcinomas, squamous cell carcinomas, and anaplastic carcinomas. Metastases were observed in the tracheobronchial lymph nodes and, occasionally, in the kidneys and heart. Non-neoplastic pulmonary lesions included fibrosis and alveolar and bronchiolar epithelial proliferation (Spiethoff et al. 1992).
- *Inhalation:* BALB/cBYJ mice were exposed to respirable crystalline silica (greater than 96% quartz) for 8 hours a day, 5 days a week in inhalation chambers at concentrations for 150, 300, or 570 days. Average exposure concentrations were 1,475, 1,800, or 1,950 mg/m^3. Overall lung tumor incidences were 9/60 in exposed mice and 7/59 in controls (Wilson et al. 1986).
- *Unspecified:* Single 20 mg quartz injection administered to male and female rats increased the incidence of malignant lymphomas (Wagner 1976).

Amorphous silica (CAS# 7631-86-9)

- EC 2000
  - *Oral:* Male and female Fischer 344 rats were given 1.25, 2.5, or 5% fumed silica (equivalent to 143.46, 179.55, or 581.18 g for male rats and 107.25, 205.02, or 435.33 g for female rats, respectively) in their feed daily for 103 weeks. Tumor incidence in testes, mammary glands, prepuce and clitoris were higher in the controls than they were in the treated groups. Fumed silica was not carcinogenic under these test conditions.
  - *Oral:* Male and female B6C3F1 mice were given 1.25, 2.5, or 5% fumed silica (equivalent to 38.45, 79.78, or 160 g for male mice and 37.02, 72.46, or 157.59 g for female mice, respectively) in their feed daily for 93 weeks. While there were tumors found in the hematopoietic organs, the incidence of these lesions was not significant compared to control animals. While there were lung adenomas found, they were found to be neither sex- nor dose-related. Non-neoplastic lesions were seen in the subcutis, lungs, kidneys, and liver in the treated groups; however, these were found to be of no toxicological significance.

Mutagenicity/Genotoxicity (M) Score (H, M, or L): *M*

Quartz was assigned a score of Moderate for mutagenicity/genotoxicity based on positive genotoxicity tests in humans and mammalian cells. GreenScreen® criteria classify chemicals as a moderate hazard for mutagenicity/genotoxicity when available data support classification as GHS Category 2 for mutagenicity (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists

Quartz (CAS# 14808-60-7)

- ESIS 2000

  - *In vitro*: Quartz tested negative in a *Bacillus subtilis* recombination assay at concentrations of 0.005 to 0.5 M. No additional details were provided.
  - *In vitro*: Quartz tested negative in a *Salmonella typhimurium* reverse mutation assay at concentrations ranging from 0.3 to 10,000 µg/plate with and without metabolic activation. No additional details were provided.
  - *In vivo*: Quartz did not induce sister chromatid exchange in Chinese hamster cells at doses ranging from 1 to 15 µg or in Syrian hamster cells at doses ranging from 2 to 20 µg. No additional details were provided.
- IARC 1997
  - *In vitro*: Min-U-Sil quartz induced a significant increase in micronuclei in Syrian hamster embryo cells in one study (Hesterberg et al. 1986) but not in another (Oshimura et al. 1984).
  - Only one human study was available on subjects exposed to dust containing crystalline silica, with no indication of the level of exposure; it showed an increase in the levels of sister chromatid exchange and chromosomal aberrations in peripheral blood lymphocytes.
- NTP 1998
  - *In vitro*: Treatment with Min-U-Sil 5 and Min-U-Sil 10 in various concentrations (specific doses not reported) induced micronuclei in Chinese hamster lung fibroblasts (V79) or in human embryonic lung cells (Hel 299) (Nagalakshmi et al. 1995).
  - *In vitro*: V79 cells were treated with a crystalline and noncrystalline form of silica. Both forms, dispersed in media, induced micronuclei formation in a dose-dependent manner. The crystalline form of silica was more active than the noncrystalline silica on a mass basis. Treatment of cells with surfactant-coated silica was not significantly different from that of nontreated control cultures (Liu et al. 1996).
  - *In vitro*: Distinct alterations in the DNA spectra of fetal rat alveolar epithelial cells were observed following in vitro exposure to quartz. By means of electron microscopy and energy dispersive X-ray spectroscopy, they also demonstrated localization of quartz particles in the nuclei and mitotic spindles of the cells and related changes to the quartz spectra. The authors speculated that RCS particles in aqueous buffer produce oxygen radicals that can mediate DNA strand breakage. Estimating a hydroxyl radical reaction distance of 15 Angstoms, they described the likely hydrogen bonding between surface silanol groups of the quartz and the phosphate-sugar backbone of DNA. Finally, they discussed the means by which direct interaction of RCS with DNA may trigger carcinogenesis by interfering with DNA mitotic processes, replication, or repair (Daniel et al 1995).
  - *In vitro*: The single cell gel (SCG)/comet assay was used to compare DNA damage in cultured Chinese hamster lung fibroblasts (V79 cells) and human embryonic lung fibroblasts (Hel 299 cells) exposed to respirable crystalline silica (RCS), amorphous silica, and glass fibers. RCS and glass fibers caused a significant increase in DNA migration, measured as tail length in both cell lines, at almost all concentrations tested. The increase was much higher in the Chinese hamster lung fibroblasts than in human embryonic lung fibroblasts for RCS. These results indicate that silica and glass fibers induce DNA damage in mammalian cells. RCS was found to have a higher DNA-damaging activity than amorphous silica (Zhong et al. 1997).
  - *In vivo*: Treatment of rats with α-quartz could induce mutations in the hypoxanthine guanine phosphoribosyl transferase (hprt) gene of alveolar epithelial lung cells. Seven months after exposure to 100 mg/kg body weight of intratracheally instilled α-quartz, female F344 rats were sacrificed and alveolar type II cells harvested and cultured to

select for hprt mutants. Isolated cells showed a significant (greater than ten-fold) increase in hprt mutant frequency compared to cells isolated from saline instilled controls (Driscoll et al. 1995).

- Based on the weight of evidence, a score of Moderate was assigned. Quartz produced DNA damage in a comet assay and induced micronuclei in several *in vitro* assays, and one study in humans found an exposure related increase in sister chromatid exchanges and chromosomal aberrations. Evidence of somatic cell genotoxicity supports classification as GHS Category 2, which corresponds to a score of Moderate.

Reproductive Toxicity (R) Score (H, M, or L): *L*

Quartz was assigned a score of Low for reproductive toxicity based on negative results in an oral 1-generation reproductive toxicity of amorphous silica study in rats. GreenScreen® criteria classify chemicals as a Low hazard for reproductive toxicity when the adequate data are available and are negative for reproductive effects, and the chemical is not present on any authoritative or screening lists (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists

Quartz (CAS# 14808-60-7)

- No data were identified for this endpoint.

Amorphous silica (CAS# 7631-86-9)

- EC 2000
  - A 1-generation reproductive toxicity study was conducted using male and female Wistar rats. Males received 497 mg/kg and females received 509 mg/kg Aerosil (fumed silica) daily via their feed for 4.5 months prior to mating. There were no clinical symptoms, behavioral or developmental changes, or changes in any other examined parameters in pups. The NOAEL in both the F0 and F1 generations was at least 497 mg/kg/day.

Developmental Toxicity incl. Developmental Neurotoxicity (D) Score (H, M, or L): *L*

Quartz was assigned a score of Low for developmental toxicity based on negative results in several developmental toxicity studies in rats in rats, mice, rabbits, and hamsters. GreenScreen® criteria classify chemicals as a Low hazard for developmental toxicity when the adequate data are available and are negative for developmental effects, and the chemical is not present on any authoritative or screening lists (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists

Quartz (CAS# 14808-60-7)

- No data were identified for this endpoint.

Amorphous silica (CAS# 7631-86-9)

- EC 2000
  - A 1-generation reproductive toxicity study was conducted using male and female Wistar rats. Males received 497 mg/kg and females received 509 mg/kg Aerosil (fumed silica) daily via their feed for 4.5 months prior to mating. There were no clinical symptoms, behavioral or developmental changes, or changes in any other examined parameters in pups. The NOAEL in both the F0 and F1 generations was at least 497 mg/kg/day.

Endocrine Activity (E) Score (H, M, or L): DG

Quartz was assigned a score of data gap for endocrine disruption based on a lack of available data for this endpoint.

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists
- Not listed as a potential endocrine disruptor on the EU Priority List of Suspected Endocrine Disruptors.
- Not listed as a potential endocrine disruptor on the OSPAR List of Chemicals of Possible Concern.
- No data were identified for this endpoint.

Group II and II* Human Health Effects (Group II and II* Human)

Note: Group II and Group II* endpoints are distinguished in the v 1.2 Benchmark system. For Systemic Toxicity and Neurotoxicity, Group II and II* are considered sub-endpoints and test data for single or repeated exposures may be used. If data exist for single OR repeated exposures, then the endpoint is not considered a data gap. If data are available for both single and repeated exposures, then the more conservative value is used.

Acute Mammalian Toxicity (AT) Group II Score (vH, H, M, or L): DG (inhalation), **M** (oral), *L* (dermal)

Quartz was assigned a score of Data Gap for acute toxicity via the inhalation route of exposure based on a lack of adequate data for this endpoint. Quartz was assigned a score of Moderate for acute toxicity via the oral route of exposure based on its oral LD_{50} in rats. GreenScreen® criteria classify chemicals as a Moderate hazard for acute toxicity when oral LD_{50} values are 300 to 2,000 mg/kg. Quartz was assigned a score of Low for acute toxicity via the dermal route of exposure. GreenScreen® criteria classify chemicals as a Low hazard for acute toxicity when the dermal LD_{50} is greater than 2,000 mg/kg (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists

Quartz (CAS# 14808-60-7)

- ESIS 2000
  - *Oral*: LD_{50} (rat, sex and strain not specified) = 500 mg/kg (particle size 100-200 µm)

Amorphous silica (CAS# 7631-86-9)

- EC 2000
  - *Oral*: LD_{50} values in rats range from greater than 5,000 mg/kg to greater than 20,000 mg/kg (as chemically prepared silicon dioxide).
  - *Dermal*: LD_{50} values in rabbits range from greater than 2,000 mg/kg to greater than 5,000 mg/kg (as chemically prepared silicon dioxide).
  - *Inhalation*: A 1-hour LC_{50} value of greater than 2.2 mg/L was determined in the rat (as chemically prepared silicon dioxide).

Systemic Toxicity/Organ Effects incl. Immunotoxicity (ST)

***Group II Score (single dose)* (vH, H, M, or L):** *vH* (inhalation), *L* (oral), *L* (dermal)

Quartz was assigned a score of Very High for systemic toxicity (single dose) via the inhalation route of exposure based on it being listed on a screening list and experimental data in rats. GreenScreen® criteria classify chemicals as a very high hazard for systemic toxicity (single dose) when the chemical is classified as GHS Category 1 for STOT (single exposure) by GHS Japan and adverse

effects are seen at concentrations at most 1.0 mg/L in acute inhalation studies. Quartz was assigned a score of Low for systemic toxicity (single dose) via the oral route of exposure based on a lack of systemic toxicity observed in acute oral studies of amorphous silica that identified LD_{50} values of greater than 2,000 mg/kg. GreenScreen® criteria classify chemicals as a Low hazard for systemic toxicity (single dose) when no effects are seen below the guidance value of 2,000 mg/kg for an oral study. Quartz was assigned a score of Low for systemic toxicity (single dose) via the dermal route of exposure based on a lack of systemic toxicity observed in acute dermal studies of amorphous silica that identified LD_{50} values of greater than 2,000 mg/kg. GreenScreen® criteria classify chemicals as a Low hazard for systemic toxicity (single dose) when no effects are seen below the guidance value of 2,000 mg/kg for a dermal study (CPA 2012a).

- Authoritative and Screening Lists
    - *Authoritative:* Not present on any authoritative lists
    - *Screening:* Japan METI/MOE – GHS Classifications (GHS-Japan): Specific target organs/systemic toxicity following single exposure – Category 1 (Direct Hazard Listing)

Quartz (CAS# 14808-60-7)

- RTECS 2014
    - *Inhalation*: A TC_{Lo} of 248 mg/m^3/6h (0.248 mg/L[6]) was identified in rats based on changes in lung weight, metabolic changes, and increased cellular immune responses. No additional details were provided.
- Based on the weight of evidence, a score of High was assigned via the inhalation route of exposure due to classification as GHS Category 1 in Japan and an acute inhalation study in rats. Confidence in this score is reduced due to the use of a screening list and a poorly reported study.

Amorphous silica (CAS# 7631-86-9)

- EC 2000
    - *Oral*: In most oral toxicity tests no clinical signs of toxicity were observed. Occasional instances of gasping following gavage and colored stools, which was reversible during the observation period, were observed.
    - *Dermal:* Slight erythema and edema were observed following application of silica in acute toxicity studies.
    - *Inhalation:* No clinical signs of toxicity were observed in the acute inhalation studies.

Group II* Score (repeated dose) **(H, M, or L): H (**inhalation), *L* (oral), DG (dermal)
Quartz was assigned a score of High for systemic toxicity (repeated dose) via the inhalation route of exposure based on it being listed on a screening list and experimental data. GreenScreen® criteria classify chemicals as a high hazard for systemic toxicity (repeated dose) when the chemical is classified as GHS Category 1 for STOT (repeated exposure) by GHS Japan or New Zealand and adverse effects are observed at concentrations of less than 0.02 mg/L in inhalation studies (CPA 2012a). Quartz was assigned a score of Low for systemic toxicity (repeated dose) via the oral route of exposure based on NOAELs of 497 to at least 24,200 mg/kg for amorphous silica. GreenScreen® criteria classify chemicals as a Low hazard for systemic toxicity (repeated dose) when oral NOAELs/LOAELs are greater than 100 mg/kg. Quartz was assigned a score of Data Gap for systemic toxicity (repeated dose) via the dermal route of exposure based on the lack of data identified for this endpoint.

- Authoritative and Screening Lists
    - *Authoritative:* Not present on any authoritative lists
    - *Screening:* Japan METI/MOE - GHS Classifications (GHS-Japan): Specific target

[6] 248 mg/m^3 * 1L/1,000m^3 = 0.248 mg/L

organs/systemic toxicity following repeated exposure – Category 1 (Direct Hazard Listing)
    - *Screening:* New Zealand HSNO/GHS (GHS-New Zealand): 6.9A (inhalation) – Toxic to human target organs or systems (Direct Hazard Listing) (Equivalent to GHS Category 1)

Quartz (CAS# 14808-60-7)

- ESIS 2000
    - *Inhalation:* Rats (strain, sex, and number of animals not reported) were exposed to 30,000 particles/mL (40% less than 0.5 microns) for 18 hours a day, 5 days a week for up to 420 days. By day 220, animals exhibited silicotic nodules, showing only reticulin fibrosis. By 300 days, dense, rounded collagenous nodules were present. Similar findings were reported in guinea pigs, rabbits, and monkeys
- EC 2013
    - *Inhalation:* In a cohort study in male gold miners with an average of 9 years of underground exposure, cumulative exposure to quartz was predictive of silicosis. The rate of silicosis ranged from 1% with exposure to 0.05 mg/m^3 (equivalent to 0.00005 mg/L[7]) to 68-84% with exposure to 4 mg/m^3 (0.004 mg/L).
    - *Inhalation:* A LOAEC of 0.053 mg/m^3 (equivalent to 0.000053 mg/L) for silicosis was identified in a study of South African black gold miners. No additional details were provided.
    - *Inhalation:* A LOAEC of 0.064 mg/m^3 (equivalent to 0.000064 mg/L) for silicosis was identified in a study of a mining community in Colorado.
    - *Inhalation:* A LOAEC of 0.74 mg/m^3 (equivalent to 0.00074 mg/L) respirable quartz was identified based on lipoproteinosis, multifocal inflammatory cell infiltrate, and alveolar hyperplasia in rats exposed for 6 hours/day, 5 days/week for 24 months.
    - *Inhalation:* LOAEC values of 2 and 3 mg/m^3 (equivalent to 0.002 and 0.003 mg/L, respectively) based on inflammation and fibrosis of the lung were identified in rats and hamsters, respectively, following at least 6 months of exposure. No additional details were provided.
    - *Inhalation:* In a 28-day study in female rats exposed to 0, 0.1, 1, or 10 mg/m^3 (equivalent to 0, 0.0001, 0.001, or 0.01 mg/L, respectively) quartz for 6 hours/day, 5 days/week, elevated levels of granulocytes and markers of cytotoxicity were seen at concentrations of 1 mg/m^3 (0.001 mg/L) and higher. Authors identified a LOAEC of 0.001 mg/L.

Amorphous silica (CAS# 7631-86-9)

- EC 2000
    - *Oral:* Various strains of rats received fumed silica in their feed over periods of time ranging from two weeks to six months. There were no changes seen in any measured parameters. NOAEL values ranged from greater than 497 mg/kg to at least 24,200 mg/kg.
    - *Inhalation, dust*: Numerous studies have been conducted using rats, rabbits, guinea pigs, and monkeys. Studies ranged in length from 2 weeks to 1 year. In all cases, respiratory effects were seen at the lowest doses tested and no NOAECs could be established from these studies. LOAEC values for these studies would range from less than 0.001 mg/L to less than 0.10 mg/L.
    - *Inhalation, vapor:* Several studies have been conducted using rats, guinea pigs, and rabbits. Studies ranged in length from 12-27 months. In all cases, respiratory effects were seen at the lowest doses tested and no NOAECs could be established from these studies. It is believed that the NOAECs for repeated dose studies tested via the inhalation

[7] 0.05 mg/m^3 * 1L/1,000 m^3 = 0.00005 mg/L

route would be below the tested doses.

Neurotoxicity (N)
***Group II Score (single dose)* (vH, H, M, or L):** DG
Quartz was assigned a score of data gap for neurotoxicity (single dose) based on a lack of data for this endpoint.

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists
- Not classified as a developmental neurotoxicant (Grandjean and Landrigan 2006, 2014).
- No data were identified for this endpoint.

***Group II* Score (repeated dose)* (H, M, or L):** DG
Quartz was assigned a score of data gap for neurotoxicity (repeated dose) based on a lack of data for this endpoint.

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists
- Not classified as a developmental neurotoxicant (Grandjean and Landrigan 2006, 2014).
- No data were identified for this endpoint.

Skin Sensitization (SnS) Group II* Score (H, M, or L): *L*
Quartz was assigned a score of Low for skin sensitization based on a negative LLNA for silicon dioxide. GreenScreen® criteria classify chemicals as a low hazard for skin sensitization when adequate data are available and are negative for sensitization and the chemical is not present on authoritative or screening lists (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists
- Choi et al. 2011
  - Nano silicon dioxide (SiO_2) was negative in a LLNA according to OECD Guideline 442B in CBA/N mice. Authors did not specify whether the silicon dioxide was amorphous or crystalline.

<u>Amorphous silica (CAS# 7631-86-9)</u>

- EC 2000
  - In a guinea pig maximization test conducted according to Directive 84/449/EEC, B.6 "Acute toxicity (skin sensitization)," chemically prepared silica (CAS 7631-86-9) was found to be non-sensitizing (no further details available).
- Based on the weight of evidence, a score of low was assigned. Nano silicon dioxide, which is chemically identical to quartz, was negative in a mouse LLNA. Authors did not report whether the silicon dioxide was amorphous or crystalline. As sensitization is primarily due to chemical reaction with skin proteins, the physical structure is unlikely to impact sensitization potential. Therefore a score of low was assigned. In addition, a guinea pig maximization test for amorphous silica was negative. Confidence in this score is reduced as no data specifically for quartz (crystalline silica) were available.

Respiratory Sensitization (SnR) Group II* Score (H, M, or L): DG
Quartz was assigned a score of Data Gap for respiratory sensitization based on a lack of data for this endpoint.

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists
- No data were identified for this endpoint.

Skin Irritation/Corrosivity (IrS) Group II Score (vH, H, M, or L): *L*
Quartz was assigned a score of Low for skin irritation/corrosivity based on limited data and on its inert nature to the skin. Confidence level was reduced due to lack of study details. GreenScreen® criteria classify chemicals as a low hazard for skin irritation when adequate data are available and are negative for skin irritation and the chemical is not present on authoritative or screening lists (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists

Quartz (CAS# 14808-60-7)

- CCOHS 2013
  - Quartz is not irritating to skin.
- NIOSH 2010
  - Quartz may cause redness to skin, probably due to mechanical abrasions.

Amorphous silica (CAS# 7631-86-9)

- EC 2000
  - Silica was not irritating to the skin in a series of dermal irritation tests performed with rabbits. No additional details were provided.

Eye Irritation/Corrosivity (IrE) Group II Score (vH, H, M, or L): *M*
Quartz was assigned a score of Moderate for eye irritation/corrosivity based on the potential for mechanical irritation. GreenScreen® criteria classify chemicals as a moderate hazard for eye irritation/corrosivity when the chemical is mildly irritating (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists
- CCOHS 2013
  - Quartz may cause slight irritation (tearing, blinking, and mild temporary pain) as a "foreign object".
- NIOSH 2010
  - Quartz may cause redness and pain to eyes.

Amorphous silica (CAS# 7631-86-9)

- EC 2000
  - Silica was not irritating to the eyes in a series of ocular irritation tests performed with rabbits.
- Based on the weight of evidence, a score of Moderate was assigned using expert judgment. No ocular irritation studies were available for quartz, but as a non-soluble powder, quartz is likely to cause reversible mechanical eye irritation upon exposure to dust, and both NIOSH and CCOHS report that quartz may irritate eyes. Confidence in this score is reduced as no experimental data are available for this endpoint.

Ecotoxicity (Ecotox)

Acute Aquatic Toxicity (AA) Score (vH, H, M, or L): *L*

Quartz was assigned a score of Low for acute aquatic toxicity based on acute aquatic toxicity values for amorphous silica and its low solubility. GreenScreen® criteria classify chemicals as a low hazard for acute aquatic toxicity when acute aquatic toxicity values are greater than 100 mg/L (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists
- No acute aquatic toxicity data were identified for quartz.

Quartz (CAS# 14808-60-7)

- EC 2013
  - No aquatic toxicity data are available for quartz, but Environment Canada assessed data for amorphous silica (CAS# 7631-86-9) and soluble silicate salts to estimate the aquatic toxicity potential of quartz. Amorphous silica has an LL_0 of 10,000 mg/L in *Danio rerio* (96-hour) and LL_{50} greater than 10,000 mg/L in *Daphnia magna* (24-hour). The LC/EC_{50} values for various soluble silicate salts are 508-1,142 mg/L in fish, 33.5-730 mg/L in *Daphnia sp*., and 89 mg/L in algae. Environment Canada stated that as both quartz and amorphous silica have very low water solubility, amorphous silica is a closer analogue of quartz. Both quartz and amorphous silica are expected to undergo very slow dissolution thus limiting the release of SiO_2 ions into water. Therefore the lower aquatic toxicity values for amorphous silica compared to the salts are more representative of the aquatic toxicity potential of quartz. Environment Canada concluded that quartz is not highly hazardous to aquatic organisms.

Amorphous silica (CAS# 7631-86-9)

- EC 2000
  - 96-hour LC_{50} (*Brachydanio rerio*, zebrafish) = 5,000 mg/L (as chemically prepared silica (CAS #7631-86-9))
  - 48-hour EC_{50} (*Ceriodaphnia dubia*, water flea) = 7,600 mg/L (as chemically prepared silica (CAS #7631-86-9))
  - 72-hour EC_{50} (*Selenastrum capricornutum*) = 440 mg/L (as chemically prepared silica (CAS #7631-86-9); ISO 8691 "Water quality – fresh water algal growth inhibition test with *Scenedesmus subspicatus* and *Selenastrum capricornutum*")
- Based on the weight of evidence, a score of Low was assigned. Quartz is highly insoluble in water, and data for amorphous silica indicate very low toxicity to fish and invertebrates. Based on data for amorphous silica, Environment Canada determined that quartz is not highly toxic to aquatic organisms. Confidence in this score is reduced as no data were available for quartz.

Chronic Aquatic Toxicity (CA) Score (vH, H, M, or L): DG

Quartz was assigned a score of data gap for chronic aquatic toxicity based on a lack of data for this endpoint.

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists
- No data were identified for this endpoint.

Environmental Fate (Fate)

Persistence (P) Score (vH, H, M, L, or vL): *vH*

Quartz was assigned a score of Very High for persistence based on its presence on a screening list and estimated half lives in water, soil, and sediment. GreenScreen® criteria classify chemicals as a Very High hazard for persistence when the chemical is classified as persistent on Environment Canada's DSL and the chemical has a half-life of greater than 180 days in soil and sediment and greater than 60 days in water (CPA 2012a). Confidence level is reduced due to lack of experimental data.

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Environment Canada - Domestic Substances List (DSL): DSL substances that are Persistent

Quartz (CAS# 14808-60-7)

- UN 2013
  - The term degradation is defined as the decomposition of organic molecules to smaller molecules and eventually to carbon dioxide, water, and salts. For inorganic compounds, the concept of degradability as applied to organic compounds has limited or no meaning. Rather, the substance may be transformed by normal environmental processes to either increase or decrease the bioavailability of the toxic species. Quartz is not expected to transform in the environment as it is highly insoluble in water.
- EC 2013
  - Quartz has low susceptibility to chemical dissolution and physical alteration. When in contact with water, it releases small amounts of silicates that do not degrade. Empirical evidence suggests that quartz has long environmental persistence and meets persistence classification criteria. Quartz is expected to have half-lives of at least 2 days in air, at least 182 days in soil and water, and at least 365 days in sediment.

Bioaccumulation (B) Score (vH, H, M, L, or vL): *vL*

Quartz was assigned a score of Very Low for bioaccumulation based on expert judgment. GreenScreen® criteria classify chemicals as a Very Low hazard for bioaccumulation when the chemical is expected to have a BCF/BAF less than 100 (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists

Quartz (CAS# 14808-60-7)

- EC 2013
  - As a stable crystalline solid, quartz is expected to have very limited potential for uptake through the gill or gut of aquatic organisms. Although small amounts of silicon are released into solution when in contact with water, BCF and BAF ratios are inappropriate when applied to some elements as they may not accurately predict hazards. Silicon is a nutrient required by algae, plants, and animals. Environment Canada concluded that quartz is not bioaccumulative.
- Based on the weight of evidence, a score of Very Low was assigned. Quartz is highly insoluble in water and as a stable crystalline solid, uptake by aquatic organisms is unlikely. Confidence in this score is reduced as no experimental data are available for this endpoint.

Physical Hazards (Physical)

Reactivity (Rx) Score (vH, H, M, or L): *L*
Quartz was assigned a score of Low for reactivity based its HMIS rating for physical hazards. GreenScreen® criteria classify chemicals as a low hazard for reactivity when the chemical is not explosive, reactive with water, or self-reactive (CPA 2012a). Confidence level is reduced due to lack of experimental data.

- Authoritative and Screening Lists
    - *Authoritative:* Not present on any authoritative lists
    - *Screening:* Not present on any screening lists

Quartz (CAS# 14808-60-7)

- SCBT 2012
    - Quartz received an HMIS rating of 0 for physical hazards (Minimal Hazard: Materials that are normally stable, even under fire conditions, and will NOT react with water, polymerize, decompose, condense, or self-react. Non-Explosives. (Paint.org 2014))

Flammability (F) Score (vH, H, M, or L): *L*
Quartz was assigned a score of Low for flammability based on its HMIS rating for flammability. GreenScreen® criteria classify chemicals as a low hazard for flammability when the chemical is not flammable (CPA 2012a). Confidence level is reduced due to lack of experimental data.

- Authoritative and Screening Lists
    - *Authoritative:* Not present on any authoritative lists
    - *Screening:* Not present on any screening lists

Quartz (CAS# 14808-60-7)

- SCBT 2012
    - Quartz received an HMIS rating of 0 for flammability (Minimal Hazard: Materials that will not burn (Paint.org 2014)).

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APPENDIX A: Hazard Benchmark Acronyms
(in alphabetical order)

(AA) Acute Aquatic Toxicity

(AT) Acute Mammalian Toxicity

(B) Bioaccumulation

(C) Carcinogenicity

(CA) Chronic Aquatic Toxicity

(D) Developmental Toxicity

(E) Endocrine Activity

(F) Flammability

(IrE) Eye Irritation/Corrosivity

(IrS) Skin Irritation/Corrosivity

(M) Mutagenicity and Genotoxicity

(N) Neurotoxicity

(P) Persistence

(R) Reproductive Toxicity

(Rx) Reactivity

(SnS) Sensitization- Skin

(SnR) Sensitization- Respiratory

(ST) Systemic/Organ Toxicity

APPENDIX B: Results of Automated GreenScreen® Score Calculation for Quartz (CAS #14808-60-7)

TOXSERVICES
TOXICOLOGY RISK ASSESSMENT CONSULTING

GreenScreen® Score Inspector for Inhalation Exposure

Table 1: Hazard Table

			Group I Human					Group II and II* Human								Ecotox		Fate		Physical	
			Carcinogenicity	Mutagenicity/Genotoxicity	Reproductive Toxicity	Developmental Toxicity	Endocrine Activity	Acute Toxicity	Systemic Toxicity		Neurotoxicity		Skin Sensitization*	Respiratory Sensitization*	Skin Irritation	Eye Irritation	Acute Aquatic Toxicity	Chronic Aquatic Toxicity	Persistence	Bioaccumulation	Reactivity	Flammability
Table 2: Chemical Details									S	R *	S	R *	*	*								
Inorganic Chemical?	**Chemical Name**	**CAS#**	**C**	**M**	**R**	**D**	**E**	**AT**	**STs**	**STr**	**Ns**	**Nr**	**SNS***	**SNR***	**IrS**	**IrE**	**AA**	**CA**	**P**	**B**	**Rx**	**F**
Yes	Quartz	14808-60-7	H	M	*L*	*L*	DG	DG	*vH*	H	DG	DG	*L*	DG	*L*	*M*	*L*	DG	*vH*	*vL*	*L*	*L*

Table 3: Hazard Summary Table

Benchmark	a	b	c	d	e	f	g
1	No	No	Yes	No	Yes		
2	STOP						
3	STOP						
4	STOP						

Table 4

Chemical Name	Preliminary GreenScreen® Benchmark Score
Quartz	1

Note: Chemical has not undergone a data gap assessment. Not a Final GreenScreen™ Score

Table 6

Chemical Name	Final GreenScreen® Benchmark Score
Quartz	1

After Data gap Assessment
Note: No Data gap Assessment Done if Preliminary GS Benchmark Score is 1.

Table 5: Data Gap Assessment Table

Datagap Criteria	a	b	c	d	e	f	g	h	i	j	bm4	End Result
1												1
2												
3												
4												

TOXSERVICES
TOXICOLOGY RISK ASSESSMENT CONSULTING

GreenScreen® Score Inspector for Oral Exposure

Table 1: Hazard Table

			Group I Human					Group II and II* Human								Ecotox		Fate		Physical	
			Carcinogenicity	Mutagenicity/Genotoxicity	Reproductive Toxicity	Developmental Toxicity	Endocrine Activity	Acute Toxicity	Systemic Toxicity		Neurotoxicity		Skin Sensitization*	Respiratory Sensitization*	Skin Irritation	Eye Irritation	Acute Aquatic Toxicity	Chronic Aquatic Toxicity	Persistence	Bioaccumulation	Reactivity	Flammability
Table 2: Chemical Details									S	R *	S	R *	*	*								
Inorganic Chemical?	**Chemical Name**	**CAS#**	**C**	**M**	**R**	**D**	**E**	**AT**	**STs**	**STr**	**Ns**	**Nr**	**SNS***	**SNR***	**IrS**	**IrE**	**AA**	**CA**	**P**	**B**	**Rx**	**F**
Yes	Quartz	14808-60-7	*L*	M	*L*	*L*	DG	*M*	*L*	*L*	DG	DG	*L*	DG	*L*	*M*	*L*	DG	*vH*	*vL*	*L*	*L*

Table 3: Hazard Summary Table

Benchmark	a	b	c	d	e	f	g
1	No	No	No	No	No		
2	No	No	Yes	No	Yes	No	No
3	STOP						
4	STOP						

Table 4

Chemical Name	Preliminary GreenScreen® Benchmark Score
Quartz	2

Note: Chemical has not undergone a data gap assessment. Not a Final GreenScreen™ Score

Table 6

Chemical Name	Final GreenScreen® Benchmark Score
Quartz	2

After Data gap Assessment
Note: No Data gap Assessment Done if Preliminary GS Benchmark Score is 1.

Table 5: Data Gap Assessment Table

Datagap Criteria	a	b	c	d	e	f	g	h	i	j	bm4	End Result
1												
2	Yes	Yes	Yes	Yes	Yes							2
3												
4												

TOXSERVICES
TOXICOLOGY RISK ASSESSMENT CONSULTING

GREEN SCREEN FOR SAFER CHEMICALS

GreenScreen® Score Inspector for Dermal Exposure

Table 1: Hazard Table

			Group I Human					Group II and II* Human									Ecotox		Fate		Physical	
			Carcinogenicity	Mutagenicity/Genotoxicity	Reproductive Toxicity	Developmental Toxicity	Endocrine Activity	Acute Toxicity	Systemic Toxicity		Neurotoxicity		Skin Sensitization*	Respiratory Sensitization*	Skin Irritation	Eye Irritation	Acute Aquatic Toxicity	Chronic Aquatic Toxicity	Persistence	Bioaccumulation	Reactivity	Flammability
Table 2: Chemical Details									S	R *	S	R *	*	*								
Inorganic Chemical?	**Chemical Name**	**CAS#**	**C**	**M**	**R**	**D**	**E**	**AT**	**STs**	**STr**	**Ns**	**Nr**	**SNS***	**SNR***	**IrS**	**IrE**	**AA**	**CA**	**P**	**B**	**Rx**	**F**
Yes	**Quartz**	**14808-60-7**	DG	**M**	*L*	*L*	DG	*L*	*L*	DG	DG	DG	*L*	DG	*L*	*M*	**L**	DG	*vH*	vL	*L*	*L*

Table 3: Hazard Summary Table

Benchmark	a	b	c	d	e	f	g
1	No	No	No	No	No		
2	No	No	Yes	No	Yes	No	No
3	STOP						
4	STOP						

Table 4

Chemical Name	Preliminary GreenScreen® Benchmark Score
Quartz	2

Note: Chemical has not undergone a data gap assessment. Not a Final GreenScreen™ Score

Table 6

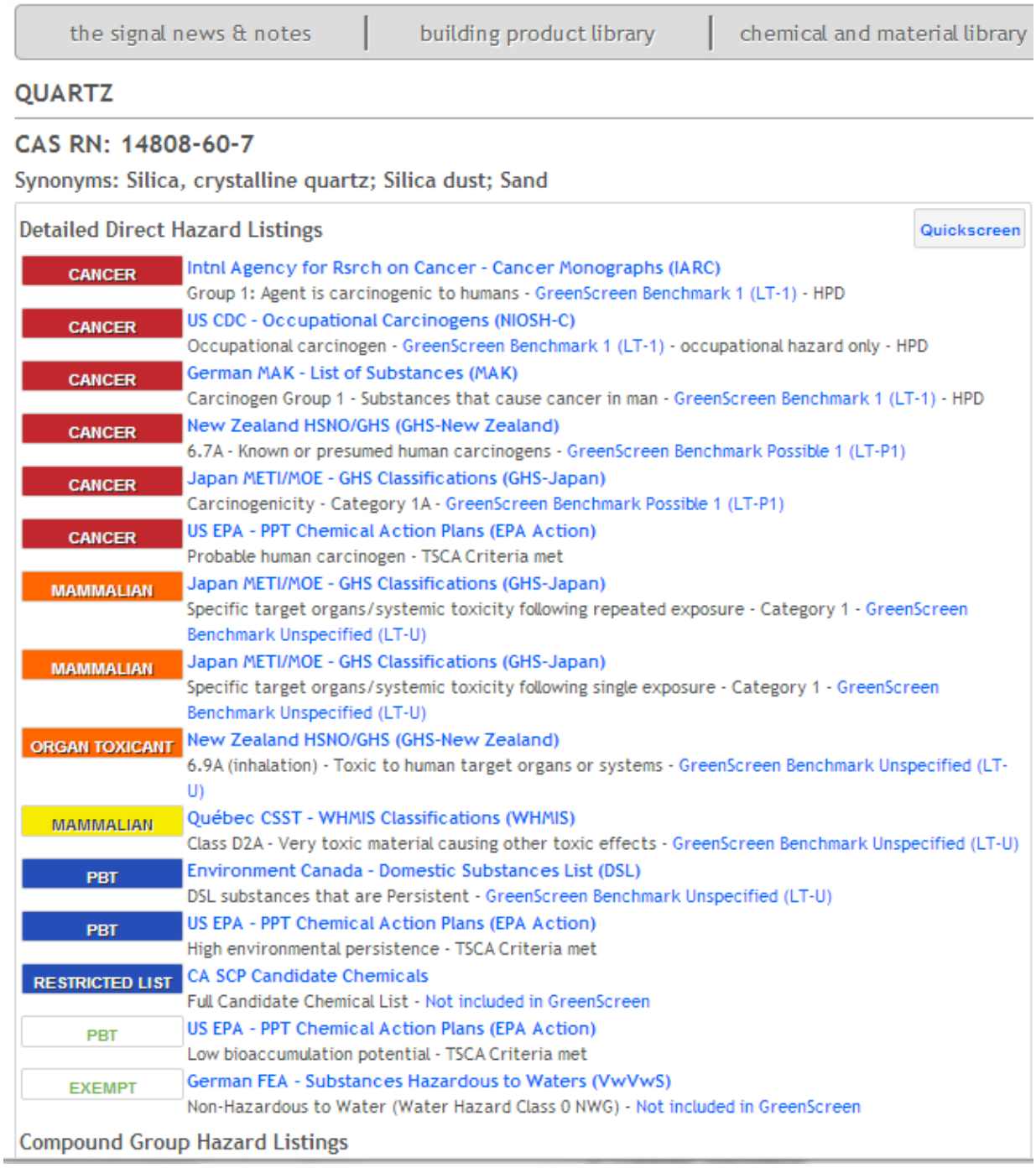
Chemical Name	Final GreenScreen® Benchmark Score
Quartz	U

After Data gap Assessment
Note: No Data gap Assessment Done if Preliminary GS Benchmark Score is 1.

Table 5: Data Gap Assessment Table

Datagap Criteria	a	b	c	d	e	f	g	h	i	j	bm4	End Result
1												
2	No	No	Yes	Yes	Yes							U
3												
4												

APPENDIX C: Pharos Output for Quartz (CAS #14808-60-7)



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QUARTZ

CAS RN: 14808-60-7

Synonyms: Silica, crystalline quartz; Silica dust; Sand

Detailed Direct Hazard Listings — Quickscreen

CANCER	Intnl Agency for Rsrch on Cancer - Cancer Monographs (IARC) Group 1: Agent is carcinogenic to humans - GreenScreen Benchmark 1 (LT-1) - HPD
CANCER	US CDC - Occupational Carcinogens (NIOSH-C) Occupational carcinogen - GreenScreen Benchmark 1 (LT-1) - occupational hazard only - HPD
CANCER	German MAK - List of Substances (MAK) Carcinogen Group 1 - Substances that cause cancer in man - GreenScreen Benchmark 1 (LT-1) - HPD
CANCER	New Zealand HSNO/GHS (GHS-New Zealand) 6.7A - Known or presumed human carcinogens - GreenScreen Benchmark Possible 1 (LT-P1)
CANCER	Japan METI/MOE - GHS Classifications (GHS-Japan) Carcinogenicity - Category 1A - GreenScreen Benchmark Possible 1 (LT-P1)
CANCER	US EPA - PPT Chemical Action Plans (EPA Action) Probable human carcinogen - TSCA Criteria met
MAMMALIAN	Japan METI/MOE - GHS Classifications (GHS-Japan) Specific target organs/systemic toxicity following repeated exposure - Category 1 - GreenScreen Benchmark Unspecified (LT-U)
MAMMALIAN	Japan METI/MOE - GHS Classifications (GHS-Japan) Specific target organs/systemic toxicity following single exposure - Category 1 - GreenScreen Benchmark Unspecified (LT-U)
ORGAN TOXICANT	New Zealand HSNO/GHS (GHS-New Zealand) 6.9A (inhalation) - Toxic to human target organs or systems - GreenScreen Benchmark Unspecified (LT-U)
MAMMALIAN	Québec CSST - WHMIS Classifications (WHMIS) Class D2A - Very toxic material causing other toxic effects - GreenScreen Benchmark Unspecified (LT-U)
PBT	Environment Canada - Domestic Substances List (DSL) DSL substances that are Persistent - GreenScreen Benchmark Unspecified (LT-U)
PBT	US EPA - PPT Chemical Action Plans (EPA Action) High environmental persistence - TSCA Criteria met
RESTRICTED LIST	CA SCP Candidate Chemicals Full Candidate Chemical List - Not included in GreenScreen
PBT	US EPA - PPT Chemical Action Plans (EPA Action) Low bioaccumulation potential - TSCA Criteria met
EXEMPT	German FEA - Substances Hazardous to Waters (VwVwS) Non-Hazardous to Water (Water Hazard Class 0 NWG) - Not included in GreenScreen

Compound Group Hazard Listings

Compound Group Hazard Listings

CANCER	Intnl Agency for Rsrch on Cancer - Cancer Monographs (IARC) Group 1: Agent is carcinogenic to humans - inhaled from occupational sources - GreenScreen Benchmark 1 (LT-1) - occupational hazard only - HPD
CANCER	German MAK - List of Substances (MAK) Carcinogen Group 1 - Substances that cause cancer in man - GreenScreen Benchmark 1 (LT-1) - HPD
CANCER	US NIH - Report on Carcinogens (NTP-RoC) Known to be Human Carcinogen (respirable size - occupational setting) - GreenScreen Benchmark 1 (LT-1) - occupational hazard only - HPD
CANCER	Cal/EPA - Chemicals Known to Cause Cancer & Reproductive Toxicity (Prop 65) Cancer (airborne particles of respirable size - occupational setting) - GreenScreen Benchmark 1 (LT-1) - occupational hazard only - HPD
MAMMALIAN	Québec CSST - WHMIS Classifications (WHMIS) Class D2A - Very toxic material causing other toxic effects - GreenScreen Benchmark Unspecified (LT-U)

Lifecycle Hazard Quickscreen

Full Lifecycle Map

Research Status: Preliminary literature review drafted
The Pharos team has undertaken a preliminary literature review of some of the processes involved in the manufacture of this substance and identified the following chemicals. This list of chemicals is not exhaustive of all chemicals that may be involved in the production or life cycle of this substance.

May contain residual manufacturing chemicals that have a hazard of...
Comes from additional manufacturing chemicals that have a hazard of...

PBT	SILICA, AMORPHOUS [7631-86-9] - Integral Feedstock
CANCER	SILICA, AMORPHOUS [7631-86-9] - Integral Feedstock

Description:

Crystallized silicon dioxide. Natural substance. Widely used in metal extraction, paints, polymers, cleaning agents, coloring agents, and fillers.

VOC designation: Non-volatile (Boiling point: 2230 degrees Celsius)

More Information: http://chem.sis.nlm.nih.gov/chemidplus/chemidlite.jsp

Find another material:

Sources to Check for GreenScreen® Hazard Assessment

Note: For a GreenScreen® Hazard Assessment, data queries should be initially limited to the following references. If data gaps exist after these references have been checked, additional references may be utilized.

U.S. EPA High Production Volume Information System (HPVIS):
http://www.epa.gov/hpvis/index.html

UNEP OECD Screening Information Datasets (SIDS):
http://www.chem.unep.ch/irptc/sids/OECDSIDS/sidspub.html

OECD Existing Chemicals Database: http://webnet.oecd.org/hpv/ui/SponsoredChemicals.aspx

European Chemical Substances Information System IUCLID Chemical Data Sheets:
http://esis.jrc.ec.europa.eu/index.php?PGM=dat

National Toxicology Program: http://ntp.niehs.nih.gov/

International Agency for the Research on Cancer:
http://monographs.iarc.fr/ENG/Classification/index.php

Human and Environmental Risk Assessment (HERA) on ingredients of household cleaning products:
http://www.heraproject.com/RiskAssessment.cfm

European Chemicals Agency (ECHA) REACH Dossiers: http://echa.europa.eu/

Licensed GreenScreen® Profilers

Quartz GreenScreen® Evaluation Prepared by:

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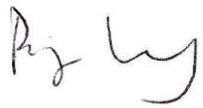
ToxServices LLC

Quartz GreenScreen® Evaluation QC'd by:



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