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Sulphur: GHS & MARPOL V Documentation

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Introduction

The determination as to whether bulk cargo for international marine transport is harmful to the marine environment must be made according to the seven criteria listed in Appendix I of MARPOL Annex V (Consolidated Edition 2022). These criteria are based on the UN Globally Harmonized System for Classification and Labelling of Chemicals (UN GHS), 9th revised edition (2021).

While recognizing that criterion 7 in Appendix I does not apply to bulk Sulphur product, this report aims to document the information used to support the classification of Sulphur (CASRN 7704-34-9) as not harmful to the marine environment, referenced by criteria 1 through 6, namely:

1. **Acute Aquatic Toxicity Category 1; and/or**
2. **Chronic Aquatic Toxicity Category 1 or 2; and/or**
3. **Carcinogenicity Category 1A or 1B combined with not being rapidly degradable and having high bioaccumulation; and/or**
4. **Mutagenicity Category 1A or 1B combined with not being rapidly degradable and having high bioaccumulation; and/or**
5. **Reproductive Toxicity Category 1A or 1B combined with not being rapidly degradable and having high bioaccumulation; and/or**
6. **Specific Target Organ Toxicity Repeated Exposure Category 1 combined with not being rapidly degradable and having high bioaccumulation;**

1. Acute Aquatic Toxicity Category 1; and/or

Criteria:

Category Acute 1:

96 hr LC_{50} (for fish)	≤ 1 mg/L and/or
48 hr EC_{50} (for crustacea)	≤ 1 mg/L and/or
72 or 96 hr ErC_{50} (for algae or other aquatic plants)	≤ 1 mg/L

Test Data:

	Lowest known value(s)
96 hr LC_{50} - Lepomis macrochirus (Bluegill)	> 180 mg/L
96 hr LC_{50} - Oncorhynchus mykiss (Rainbow Trout)	> 180 mg/L
48 hr EC_{50} - Daphnia magna (Water flea)	3850 mg/L

All known sources for acute aquatic toxicity are **well** above Category Acute 1 thresholds. See appendix B.

Governmental and Non-Government Sources:

#	Apendix A: Sources	Acute 1
3	Australia - Hazardous Chemical Information System - Safe Work Australia	Not classified as an environmental hazard.
6	CLP: Harmonised classification - Annex VI of Regulation (EC) No 1272/2008 (CLP Regulation)	Not classified as an environmental hazard.
7	CLP: Notified classification and labelling	Not classified as an environmental hazard.
9	ECHA - European Chemicals Agency	See Appendix B.
10	ECOTOX Database	See Appendix B.
11	Environment Canada CEPA, 1999: Schedule 1	Not CEPA Toxic.
12	Environment Canada: DSL Categorization	Does not Meet Environmental Criteria for Categorization.
14	German Federal Water Management Act (Wasserhaushaltsgesetz, WHG)	WGK nwg: Non-water polluting substance.
18	New Zealand: Hazardous Substances and New Organisms (HSNO) Chemical Classification and Information Database (CCID)	Not classified as an environmental hazard.
25	U.S. Environmental Protection Agency. May, 1991. Reregistration Eligibility Document (RED): Sulphur. US EPA, Office of Pesticide Programs, Washington, DC.	The studies available to EPA indicate that the element sulphur is of low toxicity, and its use as a pesticide poses very little known hazard to people and non-target species.
27	US EPA Toxics Release Inventory (TRI) List	Not listed for environmental hazards.
28	US Massachusetts Commonwealth's Right-to-Know Law (Appendix A to 105 Code of Massachusetts Regulations Section 670.000)	Not listed for environmental hazards.
29	US New Jersey Worker and Community Right-to-Know Act (New Jersey Statutes Annotated Section 34:5A-5)	Not listed for environmental hazards.
30	US Pennsylvania Worker and Community Right-to-Know Law (34 Pa. Code Chap. 301-323)	Not listed for environmental hazards.

Determination: Sulphur does not meet criteria for classification, and no available Government, NGO, or literature data source contradicts this determination.

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2. Chronic Aquatic Toxicity Category 1 or 2

Criteria:

Non-rapidly degradable substances for which there are adequate chronic toxicity data available

Category Chronic 1:

Chronic NOEC or EC_x (for fish)	≤ 0.1 mg/L and/or
Chronic NOEC or EC_x (for crustacea)	≤ 0.1 mg/L and/or
Chronic NOEC or EC_x (for algae or other aquatic plants)	≤ 0.1 mg/L

Category Chronic 2:

96 hr LC_{50} (for fish)	≤ 1 mg/L and/or
48 hr EC_{50} (for crustacea)	≤ 1 mg/L and/or
72 or 96 hr ErC_{50} (for algae or other aquatic plants)	≤ 1 mg/L

Test Data:

	Lowest known value(s)
Chronic NOEC - Oncorhynchus mykiss (Rainbow trout)	9.3 mg/L
Chronic NOEC - Gammarus fossarum (Scud, crustacea)	≥ 4.86 mg/L

Note: Only one chronic study was available with adequate chronic toxicity data for fish (a 28 day NOEC for rainbow trout at 9.3 mg/L), which was well above the Category Chronic 2 threshold. The other studies available on crustacea and algae were considered unreliable by ECHA. A more recent study from the US EPA ECOTOX database on the Crusteacean, Gammarus foassarum, (Scud) showed an NOEC of >= 4.86 mg/L, which is also well above the Category Chronic 2 threshold. See appendix B.

Governmental and Non-Government Sources:

#	**Apendix A: Sources**	**Chronic 1 & 2**
3	Australia - Annex VI of Regulation (EC) No 1272/2008 (CLP Regulation)	Not classified as an environmental hazard.
6	CLP: Harmonised classification - Annex VI of Regulation (EC) No 1272/2008 (CLP Regulation)	Not classified as an environmental hazard.
7	CLP: Notified classification and labelling	Not classified as an environmental hazard.
9	ECHA - European Chemicals Agency	See Appendix B.
10	ECOTOX Database	See Appendix B.
11	Environment Canada CEPA, 1999: Schedule 1	Not CEPA Toxic.
12	Environment Canada: DSL Categorization	Does not Meet Environmental Criteria for Categorization.
14	German Federal Water Management Act (Wasserhaushaltsgesetz, WHG)	WGK nwg: Non-water polluting substance.
18	New Zealand: Hazardous Substances and New Organisms (HSNO) Chemical Classification and Information Database (CCID)	Not classified as an environmental hazard.
25	U.S. Environmental Protection Agency. May, 1991. Reregistration Eligibility Document (RED): Sulphur. US EPA, Office of Pesticide Programs, Washington, DC.	The studies available to EPA indicate that the element sulphur is of low toxicity, and its use as a pesticide poses very little known hazard to people and non-target species.
27	US EPA Toxics Release Inventory (TRI) List	Not listed for environmental hazards.
28	US Massachusetts Commonwealth's Right-to-Know Law (Appendix A to 105 Code of Massachusetts Regulations Section 670.000)	Not listed for environmental hazards.
29	US New Jersey Worker and Community Right-to-Know Act (New Jersey Statutes Annotated Section 34:5A-5)	Not listed for environmental hazards.
30	US Pennsylvania Worker and Community Right-to-Know Law (34 Pa. Code Chap. 301-323)	Not listed for environmental hazards.

Determination: Sulphur does not meet criteria for classification, and no available Government, NGO, or literature data source contradicts this determination.

3. Carcinogenicity Category 1A or 1B combined with not being rapidly degradable and having high bioaccumulation

Criteria:

Carcinogens

Category 1A:	Known to have carcinogenic potential for humans; the placing of a substance is largely based on human evidence.
Category 1B:	Presumed to have carcinogenic potential for humans; the placing of a substance is largely based on animal evidence.

Test Data:
Not available.

Governmental and Non-Government Sources:

#	Apendix A: Sources	Carc 1A/1B
1	American Conference of Industrial Hygienists (ACGIH)	Not listed as a carcinogen.
2	ATSDR - Agency for Toxic Substances & Disease Registry (CDC) - Substance Priority List (SPL)	Does not represent significant potential threat to human health.
3	Australia - Hazardous Chemical Information System - Safe Work Australia	Not classified as a carcinogen.
4	California Proposition 65 (Prop 65)	Not listed as a carcinogen.
6	CLP: Harmonised classification - Annex VI of Regulation (EC) No 1272/2008 (CLP Regulation)	Not classified as a carcinogen.
7	CLP: Notified classification and labelling	Not classified as a carcinogen.
8	CSST (Commission de la santé et de la sécurité du travail)	Not classified as a carcinogen.
9	ECHA - European Chemicals Agency	"The Annex XIII criteria for the identification of persistent, bioaccumulative and toxic substances and very persistent and very bioaccumulative substances do not apply to inorganic substances such as sulphur"
11	Environment Canada CEPA, 1999: Schedule 1	Not CEPA Toxic.
12	Environment Canada: DSL Categorization	Does not meet the Human Health Categorization Criteria, and is not bioaccumulative.
16	National Toxicology Program (NTP) – Report on Carcinogens (Roc)	Not listed as a carcinogen.
18	New Zealand: Hazardous Substances and New Organisms (HSNO) Chemical Classification and Information Database (CCID)	Not classified as a carcinogen.
20	OSHA Carcinogens	Not listed as a carcinogen.
21	The International Agency for Research on Cancer (IARC)	Not listed as a carcinogen.
25	U.S. Environmental Protection Agency. May, 1991. Reregistration Eligibility Document (RED): Sulphur. US EPA, Office of Pesticide Programs, Washington, DC.	The studies available to EPA indicate that the element sulphur is of low toxicity, and its use as a pesticide poses very little known hazard to people and non-target species.
27	US EPA Toxics Release Inventory List (TRI)	Not listed as a carcinogen.
28	US Massachusetts Commonwealth's Right-to-Know Law (Appendix A to 105 Code of Massachusetts Regulations Section 670.000)	Not listed as a carcinogen.
29	US New Jersey Worker and Community Right-to-Know Act (New Jersey Statutes Annotated Section 34:5A-5)	Not listed as a carcinogen.
30	US Pennsylvania Worker and Community Right-to-Know Law (34 Pa. Code Chap. 301-323)	Not listed as a carcinogen.

Determination: Sulphur does not meet criteria for classification, and no available Government, NGO, or literature data source contradicts this determination. Further, while Sulphur is not expected to rapidly degrade, no information supports the ability of the substance to bioaccumulate.

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4. Mutagenicity Category 1A or 1B combined with not being rapidly degradable and having high bioaccumulation

Criteria:

Mutagens

Category 1A:	Substances known to induce heritable mutations in germ cells of humans.
Category 1B:	Substances which should be regarded as if they induce heritable mutations in the germ cells of humans.

Test Data:
Sulphur has tested negative in a Bacterial Reverse Mutation Assay (Ames test), [source: ECHA - European Chemicals Agency].

Governmental and Non-Government Sources:

#	Apendix A: Sources	Mut 1A/1B
2	ATSDR - Agency for Toxic Substances & Disease Registry (CDC) - Substance Priority List (SPL)	Does not represent significant potential threat to human health.
3	Australia - Hazardous Chemical Information System - Safe Work Australia	Not classified as a mutagen.
6	CLP: Harmonised classification - Annex VI of Regulation (EC) No 1272/2008 (CLP Regulation)	Not classified as a mutagen.
7	CLP: Notified classification and labelling	Not classified as a mutagen.
8	CSST (Commission de la santé et de la sécurité du travail)	Not classified as a mutagen.
9	ECHA - European Chemicals Agency	Negative Ames test (Bacterial Reverse Mutation Assay).
9	ECHA - European Chemicals Agency	“The Annex XIII criteria for the identification of persistent, bioaccumulative and toxic substances and very persistent and very bioaccumulative substances do not apply to inorganic substances such as sulphur”
11	Environment Canada CEPA, 1999: Schedule 1	Not CEPA Toxic.
12	Environment Canada: DSL Categorization	Does not meet the Human Health Categorization Criteria,and is not bioaccumulative..
13	European Food Safety Authority (EFSA) Scientific Report (2008)	"The weight of evidence indicates that sulphur is not a genotoxic agent."
18	New Zealand: Hazardous Substances and New Organisms (HSNO) Chemical Classification and Information Database (CCID)	Not classified as a mutagen.
25	U.S. Environmental Protection Agency. May, 1991. Reregistration Eligibility Document (RED): Sulphur. US EPA, Office of Pesticide Programs, Washington, DC.	The studies available to EPA indicate that the element sulphur is of low toxicity, and its use as a pesticide poses very little known hazard to people and non-target species.
27	US EPA Toxics Release Inventory List (TRI)	Not listed as a mutagen.
28	US Massachusetts Commonwealth's Right-to-Know Law (Appendix A to 105 Code of Massachusetts Regulations Section 670.000)	Not listed as a mutagen.
29	US New Jersey Worker and Community Right-to-Know Act (New Jersey Statutes Annotated Section 34:5A-5)	Not listed as a mutagen.
30	US Pennsylvania Worker and Community Right-to-Know Law (34 Pa. Code Chap. 301-323)	Not listed as a mutagen.

Determination: Sulphur does not meet criteria for classification, and no available Government, NGO, or literature data source contradicts this determination. Further, while Sulphur is not expected to rapidly degrade, no information supports the ability of the substance to bioaccumulate.

5. Reproductive Toxicity Category 1A or 1B combined with not being rapidly degradable and having high bioaccumulation

Criteria:

Reproductive Toxicants

Category 1A:	Known human reproductive toxicant.
Category 1B:	Presumed human reproductive toxicant.

Test Data:
Not available.

Governmental and Non-Government Sources:

#	Apendix A: Sources	Repro 1A/1B
2	ATSDR - Agency for Toxic Substances & Disease Registry (CDC) - Substance Priority List (SPL)	Does not represent significant potential threat to human health.
3	Australia - Hazardous Chemical Information System - Safe Work Australia	Not classified as a reproductive toxicant.
4	California Proposition 65 (Prop 65)	Not classified as a reproductive toxicant.
6	CLP: Harmonised classification - Annex VI of Regulation (EC) No 1272/2008 (CLP Regulation)	Not classified as a reproductive toxicant.
7	CLP: Notified classification and labelling	Not classified as a reproductive toxicant.
8	CSST (Commission de la santé et de la sécurité du travail)	Not classified as a reproductive toxicant.
9	ECHA - European Chemicals Agency	"The Annex XIII criteria for the identification of persistent, bioaccumulative and toxic substances and very persistent and very bioaccumulative substances do not apply to inorganic substances such as sulphur"
11	Environment Canada CEPA, 1999: Schedule 1	Not CEPA Toxic.
12	Environment Canada: DSL Categorization	Does not meet the Human Health Categorization Criteria, and is not bioaccumulative.
18	New Zealand: Hazardous Substances and New Organisms (HSNO) Chemical Classification and Information Database (CCID)	Not classified as a reproductive toxicant.
25	U.S. Environmental Protection Agency. May, 1991. Reregistration Eligibility Document (RED): Sulphur. US EPA, Office of Pesticide Programs, Washington, DC.	The studies available to EPA indicate that the element sulphur is of low toxicity, and its use as a pesticide poses very little known hazard to people and non-target species.
27	US EPA Toxics Release Inventory List (TRI)	Not listed as a reproductive toxicant.
28	US Massachusetts Commonwealth's Right-to-Know Law (Appendix A to 105 Code of Massachusetts Regulations Section 670.000)	Not listed as a reproductive toxicant.
29	US New Jersey Worker and Community Right-to-Know Act (New Jersey Statutes Annotated Section 34:5A-5)	Not listed as a reproductive toxicant.
30	US Pennsylvania Worker and Community Right-to-Know Law (34 Pa. Code Chap. 301-323)	Not listed as a reproductive toxicant.

Determination: Sulphur does not meet criteria for classification, and no available Government, NGO, or literature data source contradicts this determination. Further, while Sulphur is not expected to rapidly degrade, no information supports the ability of the substance to bioaccumulate.

6. Specific Target Organ Toxicity Repeated Exposure Category 1 combined with not being rapidly degradable and having high bioaccumulation;

Criteria:

STOT-RE (Specific Target Organ Toxicity following Repeated Exposure)

Category 1:	Substances that have produced significant toxicity in humans, or that, on the basis of evidence from studies in experimental animals can be presumed to have the potential to produced significant toxicity in humans following repeated exposure.
Category 2:	Substances that, on the basis of evidence from studies in experimental animals can be presumed to have the potential to be harmful to human health following repeated exposure.

Test Data:
Not available.

Governmental and Non-Government Sources:

#	Apendix A: Sources	STOT RE Cat 1
2	ATSDR - Agency for Toxic Substances & Disease Registry (CDC) - Substance Priority List (SPL)	Does not represent significant potential threat to human health.
3	Australia - Hazardous Chemical Information System - Safe Work Australia	Not classified for specific organ toxicity.
7	CLP: Notified classification and labelling	Not classified for specific organ toxicity.
8	CSST (Commission de la santé et de la sécurité du travail)	Not classified for specific organ toxicity.
11	Environment Canada CEPA, 1999: Schedule 1	Not CEPA Toxic.
12	Environment Canada: DSL Categorization	Does not meet the Human Health Categorization Criteria, and is not bioaccumulative.
18	New Zealand: Hazardous Substances and New Organisms (HSNO) Chemical Classification and Information Database (CCID)	Not classified for specific organ toxicity.
27	US EPA Toxics Release Inventory List (TRI)	Not listed for specific organ toxicity.
28	US Massachusetts Commonwealth's Right-to-Know Law (Appendix A to 105 Code of Massachusetts Regulations Section 670.000)	Not listed for specific organ toxicity.
29	US New Jersey Worker and Community Right-to-Know Act (New Jersey Statutes Annotated Section 34:5A-5)	Not listed for specific organ toxicity.
30	US Pennsylvania Worker and Community Right-to-Know Law (34 Pa. Code Chap. 301-323)	Not listed for specific organ toxicity.

Determination: Sulphur does not meet criteria for classification, and no available Government, NGO, or literature data source contradicts this determination. Further, while Sulphur is not expected to rapidly degrade, no information supports the ability of the substance to bioaccumulate.

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Conclusion

According to criteria 1 to 6 listed in Appendix I of MARPOL Annex V (Consolidated Edition 2022), it has been demonstrated that Sulphur (CASRN 7704-34-9) does not meet the classification criteria of any of the UN GHS hazard categories indicated, namely: Acute and Chronic Aquatic Toxicity, Carcinogenicity, Mutagenicity, Reproductive Toxicity, and Specific Target Organ Toxicity Repeated Exposure.

Therefore, for the purposes of classification under MARPOL Annex V, bulk Sulphur is not considered to be harmful to the marine environment.

Appendix A: Sources

1. **American Conference of Industrial Hygienists (ACGIH)**

2023 Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices

Threshold Limit Value – Time-Weighted Average (TLV-TWA): Not listed.

Threshold Limit Value – Short-Term Exsposure Limit (TLV-STEL): Not listed.

Threshold Limit Value – Ceiling (TLV-C): Not listed.

Carcinogenicity Categories A1 through A5: Not listed.

2. **ATSDR - Agency for Toxic Substances & Disease Registry (CDC) - Substance Priority List (SPL)**

Status: Not listed.

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) section 104 (i), as amended by the Superfund Amendments and Reauthorization Act (SARA), requires ATSDR and the EPA to prepare a list, in order of priority, of substances that are most commonly found at facilities on the National Priorities List (NPL) and which are determined to pose the most significant potential threat to human health due to their known or suspected toxicity and potential for human exposure at these NPL sites.

3. **Australia - Hazardous Chemical Information System - Safe Work Australia**

Harmonized Classification: Skin Irritant Category 2

4. **California Proposition 65 (Prop 65)**

Status: Not listed.

The Proposition was intended by its authors to protect California citizens and the State's drinking water sources from chemicals known to cause cancer, birth defects or other reproductive harm, and to inform citizens about exposures to such chemicals.

5. **ChemIDplus Lite**

National Library of Medecine - Chemical search engine.

6. **CLP: Harmonised classification - Annex VI of Regulation (EC) No 1272/2008 (CLP Regulation)**

Harmonized Classification: Skin Irritant Category 2

7. CLP: Notified classification and labelling

Approximately 99.7% of all notifiers classified Sulphur as Skin Irritant Cat. 2 under the CLP.

8. CSST (Commission de la santé et de la sécurité du travail)

WHMIS 2015 classification: Flammable solids - Category 2
Skin corrosion/irritation - Category 2

Transportation of Dangerous Goods: Class 4.1

9. ECHA - European Chemicals Agency

Sulphur tested negative in a Bacterial Reverse Mutation Assay (Ames test; OECD Guideline 471) performed with and without metabolic activation on TA98, TA100, TA1535 and TA1537 strains of Salmonella typhimurium and WP2uvrA (pKM 101) strain of Escherichia coli.

10. Ecotoxicity Values: US EPA - ECOTOX database

See Appendix B.

11. Environment Canada CEPA, 1999: Schedule 1

CEPA Schedule 1 ("List of Toxic Substances"): Not listed.

"A substance is toxic if it is entering or may enter the environment in a quantity or concentration or under conditions that:

1. have or may have an immediate or long-term harmful effect on the environment or its biological diversity;

2. constitute or may constitute a danger to the environment on which life depends; or

3. constitute or may constitute a danger in Canada to human life or health.

12. Environment Canada: DSL Categorization

Sorting of chemical substances on the Domestic Substances List - a list of substances used commercially in Canada between 1984 and 1986, before the original Canadian Environmental Protection Act was enacted. Most of these substances had not been examined by environmental and health scientists in government, and categorization was the first step to finding out which need further attention.

Substance Category: Inorganics

Meets CEPA Categorization Criteria: No

A substance meets the Government of Canada's criteria for categorization if it meets the human health criteria and/or the environmental criteria for categorization as defined in Section 73 of CEPA 1999.

Meets Human Health Categorization Criteria: No

A substance meets the human health categorization criteria as defined in Section 73 of CEPA 1999 if it has great potential for human exposure or if it is persistent and/or bioaccumulative and inherently toxic to humans.

Other Human Health Priorities: Low

Substances designated as "human health priorities"; are substances that did not necessarily meet the strict criteria of the categorization exercise, but do require further attention from a human health perspective because they have potential for human exposure and/or they are inherently toxic to humans.

Meets Environmental Criteria for Categorization: No

A substance meets the environmental criteria for categorization if it is Inherently Toxic to aquatic organisms, and it is Persistent and/or Bioaccumulative in the environment.

Persistant: Yes

Persistent chemical substances take a very long time to break down in the environment - sometimes many years. Because they last for so long, they can travel long distances and pollute a much wider area than those that break down quickly.

Bioaccumulative: No

Bioaccumulative chemical substances can be stored in the organs, fat cells or blood of living organisms. Concentrations can build up and reach very high levels, and can also be transferred up the food chain.

Inherently Toxic to Aquatic Organisms: No

Chemical substances that are known, through laboratory or other studies, or models to have a harmful effect on aquatic organisms, were considered, for the purpose of categorization, to represent substances that are inherently toxic to the environment.

13. European Food Safety Authority (EFSA) Scientific Report (2008)

Sulphur is generally regarded as safe for human exposure given the wide range of background exposure, since it is naturally present and abundant in food, where it can be found in the form of sulfate, free amino acids, proteins and vitamins, and it is an essential element needed at a high dose level. Toxicological studies showed that Sulphur has a low acute oral, dermal and inhalation toxicity. It is a skin irritant but not an eye irritant, nor a skin sensitizer.

The following classification was proposed: Xi, R38 “Irritating to the skin”. Sulphur has also a low short-term oral toxicity, since the NOAEL in a 28-day and 90-day rat study was the highest dose level tested (1000 mg/kg bw/day). The weight of evidence indicates that Sulphur is not a genotoxic agent. Thus, since Sulphur is an essential element, and considering its wide range of background exposure, its low acute and short-term toxicity and its lack of genotoxic potential, long-term toxicity-, carcinogenicity - and reproductive toxicity studies were not performed, nor they were required.

14. German Federal Water Management Act (Wasserhaushaltsgesetz, WHG)

Status: Non-water polluting substance.

The German Federal Water Management Act requires that substances be evaluated for negative influence on the physical, chemical or biological characteristics of water. These are classified into numeric water hazard classes.

WGK nwg: Non-water polluting substance
WGK 1: Slightly water polluting substance
WGK 2: Water polluting substance
WGK 3: Highly water polluting substance

15. HSDB (US National Library of Medicine)

See Appendix B.

16. National Toxicology Program (NTP) – Report on Carcinogens (Roc)

Status: Not listed.

The Report on Carcinogens (RoC) is a congressionally mandated, science-based, public health report that identifies agents, substances, mixtures, or exposures (collectively called "substances") in our environment that may potentially put people in the United States at increased risk for cancer.

17. New Jersey Hazardous Substance Fact Sheet

Background information.

18. New Zealand: Hazardous Substances and New Organisms (HSNO) Chemical Classification and Information Database (CCID)

Classification:

H228: Flammable solid.

H315: Causes skin irritation.

19. NIOSH - International Chemical Safety Cards

Background information.

20. OSHA Carcinogens

Status: Not listed.

Carcinogens are addressed in specific standards for general industry, shipyard employment, the construction industry, and the identification, classification, and regulation of carcinogens.

21. The International Agency for Research on Cancer (IARC)

Carcinogenicity (Group 1, Group 2A, Group 2B, Group 3, Group 4): Not listed.

22. The WHO Recommended Classification of Pesticides by Hazard (2019)

Status: Listed as Class III, Slightly hazardous technical grade active ingredient in pesticides. Skin and mucous membrane irritant.

23. Transport Canada: Transportation of Dangerous Goods Regulations

Schedule 1: UN1350, SULFUR, 4.1, PG III

24. U.S. Environmental Protection Agency. May, 1991. Reregistration Eligibility Document (RED): Sulphur. US EPA, Office of Pesticide Programs, Washington, DC.

Health Effects: Acute

Short-term studies show that sulphur is of very low acute oral toxicity and does not irritate the skin (it has been placed in Toxicity Category IV, the least toxic category, for these effects). Sulphur also is not a skin sensitizer. However, sulphur can cause some eye irritation, dermal toxicity and inhalation hazards (it has been placed Toxicity Category III for these effects).

Health Effects: Chronic

Chronic exposure to elemental sulphur at low levels is generally recognized as safe. Epidemiological studies show that mine workers exposed to sulphur dust and sulphur dioxide throughout their lives often had eye and respiratory disturbances, chronic bronchitis and chronic sinus effects. However, no known risks of oncogenic, teratogenic, or reproductive effects are associated with the use of sulphur. Also, sulphur has been shown to be non-mutagenic in microorganisms.

Environmental Hazards

All the environmental fate and ecological effects data requirements are satisfied for sulphur. This ubiquitous substance does not cause unreasonable adverse effects in the environment when used according to approved labeling, and poses little or no hazard to non-target organisms.

Environmental Fate

In the 1982 Registration Standard, all environmental fate data requirements were waived for sulphur based on the fact that it is a natural component of the environment. The use of elemental sulphur as a pesticide or a soil amendment is not an environmental concern because it becomes incorporated into the natural sulphur cycle.

Ecological Effects

In six studies on ecological effects (involving bobwhite quail, two fish species, daphnia, mysid shrimp and honey bees), sulphur has been shown to be practically non-toxic to the species tested. Thus, although there is potential for non-target organisms to be exposed to sulphur, little hazard to these species is expected to result.

Regulatory Conclusion

The studies available to EPA indicate that the element sulphur is of low toxicity, and its use as a pesticide poses very little known hazard to people and non-target species.

25. US DOT: Title 49 Transportation Part 172, Subpart B—Table of Hazardous Materials and Special Provisions

Classification: UN1350, SULFUR, 4.1, PG III

26. US EPA Toxics Release Inventory List (TRI)

Status: Not listed.

Toxicity categories evaluated for the TRI list of chemicals includes acute toxicity, carcinogenicity, reproductive and developmental toxicity, environmental toxicity and toxicity to organ systems including cardiovascular, liver, gastrointestinal, kidney, immune, hematological, and respiratory systems.

27. **US Massachusetts Commonwealth's Right-to-Know Law (Appendix A to 105 Code of Massachusetts Regulations Section 670.000)**

MA RTK Substance List: Listed.

Developed to protect the public health by providing and encouraging the greatest possible transmission of health and safety information concerning toxic and hazardous substances.

Rationale for listing: Source List 5; Substance listed by the National Fire Protection Association NFPA in "Hazardous Chemicals Data" (NFPA 49).

28. **US New Jersey Worker and Community Right-to-Know Act (New Jersey Statutes Annotated Section 34:5A-5)**

Right to Know Hazardous Substance List (RTKHSL): Listed.

Pursuant to the New Jersey Worker and Community RTK Act, the NJDOH is required to develop the Right to Know Hazardous Substance List (RTKHSL). The RTKHSL contains over 2,000 hazardous substances, including those on the Special Health Hazard Substance List (SHHSL).

Rationale for listing: Source List 3, 15, 17

3. Office of Hazardous Materials Safety, Research and Special Programs Administration, U.S. Department of Transportation, 49 CFR 172.101-Hazardous Materials Table, January 23, 2006.

15. "Fire Protection Guide to Hazardous Materials," NFPA 49 (Hazardous Chemicals Data), NFPA 325 (Guide to Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids), and NFPA 704 (Standard System for the Identification of the Hazards of Materials for Emergency Response), National Fire Protection Association (NFPA), 2001.

17. "2004 Emergency Response Guidebook," Research and Special Programs Administration, U.S. Department of Transportation, 2004.

Special Health Hazard Substance List (SHHSL): Not listed.

The SHHSL consists of over 1,000 hazardous substances that are defined as carcinogens, mutagens, teratogens, corrosive, flammables, and reactives.

29. US Pennsylvania Worker and Community Right-to-Know Law (34 Pa. Code Chap. 301-323)

Hazardous Substance List: Listed.

Special Hazardous Substance List: Not listed.

Hazardous substances which are considered special hazardous substances because their particular toxicity, tumorigenicity, mutagenicity, reproductive toxicity, flammability, explosivity, corrosivity or reactivity pose a special hazard to health and safety.

Environmental Hazard List: Not listed.

Hazardous substances which are considered environmental hazards because of their particular or extreme properties pose a danger if released into the environment are contained in an Environmental Hazard List.

30. IMSBC Code (International Maritime Solid Bulk Cargoes Code)

SULFUR (formed, solid): A co-product recovered from sour gas processing or oil refinery operations that has been subjected to a forming process that converts Sulphur from a molten state into specific solid shapes (e.g., prills, granules, pellets, pastilles or flakes); bright yellow in colour; odourless.

Hazard: Group C
1.7.14 Group C consists of cargoes which are neither liable to liquefy (Group A) nor to possess chemical hazards (Group B)

Appendix 1:
Hazard: This product is non-combustible or has a low-fire risk. If involved in a fire, cargo may generate harmful gases.

When handled and shipped in accordance with the provisions of the schedule, this cargo poses no corrosion or dust hazards for human tissue or vessel.

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Appendix B: Toxicity and Ecotoxicity

Ecotoxicity Values: US EPA - ECOTOX database

The ECOTOXicology database (ECOTOX) is a source for locating single chemical toxicity data for aquatic life, terrestrial plants and wildlife. ECOTOX was created and is maintained by the U.S.EPA, Office of Research and Development (ORD), and the National Health and Environmental Effects Research Laboratory's (NHEERL's) Mid-Continent Ecology Division (MED).

ECOTOX integrates three previously independent databases - AQUIRE, PHYTOTOX, and TERRETOX - into a unique system which includes toxicity data derived predominately from the peer-reviewed literature, for aquatic life, terrestrial plants, and terrestrial wildlife, respectively.

Species Name	Experiment Type	Media Type	Observed Duration (Days)	Endpoint	Concentration
Amphibians					
Rana limnocharis (Bog Frog)		Fresh water	2	LC50	F 2560000 ug/L
Crustaceans; Standard Test Species					
Daphnia magna (Water Flea)	Static	Fresh water	4	NOEL	F 2980000 ug/L
Daphnia magna (Water Flea)	Static	Fresh water	4	EC50	F 3850000 ug/L
Americamysis bahia (Opossum Shrimp)	Static	Salt water	4	LC50	F 736000 ug/L
Gammarus fossarum (Scud)	Static	Fresh water	6	NOEC	F ≥ 4.86 mg/L
Fish; Standard Test Species					
Lepomis macrochirus (Bluegill)	Static	Fresh water	4	LC50	F > 180000 ug/L
Lepomis macrochirus (Bluegill)	Static	Fresh water	4	NOEL	F 180000 ug/L
Fish; Standard Test Species; U.S. Threatened and Endangered Species					
Oncorhynchus mykiss (Rainbow Trout)	Static	Fresh water	4	LC50	F > 100000 ug/L
Oncorhynchus mykiss (Rainbow Trout)	Static	Fresh water	4	LC50	F > 180000 ug/L
Fish; U.S. Exotic/Nuisance Species					
Gambusia affinis (Western Mosquitofish)	Static	Fresh water	1	LC50/	F > 10000000 ug/L
Gambusia affinis (Western Mosquitofish)	Static	Fresh water	2	LC50/	F > 10000000 ug/L
Gambusia affinis (Western Mosquitofish)	Static	Fresh water	4	LC50/	F > 10000000 ug/L

Fungi Kingdom					
Fungi	Renewal	Fresh water	12	NOEC	F 3200 ug/L
Flowers, Trees, Shrubs, Ferns					
Phragmites sp. (Reed)	Renewal	Salt water	~ 292	NOEC	F 2396 lb/acre
Phragmites sp. (Reed)	Static	Salt water	14	NOEC	F 4792 lb/acre
Insects/Spiders					
Cloeon dipterum (Mayfly)		Fresh water	0.125	LD50	F > 40000 ug/L
Cloeon dipterum (Mayfly)		Fresh water	0.25	LD50	F > 40000 ug/L
Cloeon dipterum (Mayfly)		Fresh water	1	LD50	F > 40000 ug/L
Cloeon dipterum (Mayfly)		Fresh water	2	LD50	F > 40000 ug/L
Invertebrates					
Tetrahymena pyriformis (Ciliate)	Static	Fresh water	1	LC50	T 160 ug/L
Tetrahymena pyriformis (Ciliate)	Static	Fresh water	7	LC50	T 1540 ug/L
Molluscs					
Mytilus galloprovincialis (Mediterranean Mussel)		Salt water	4		T (5000-1000000) ug/L

Ecotoxicity Values: ECHA Database

Species Name	Experiment Type	Media Type	Observed Duration	Endpoint	Concentration
Fish					
Oncorhynchus mykiss (Rainbow trout)		Fresh water	96 hr	LC0; NOEC	> 5 ug/L *
Crustaceans; Standard Test Species					
Daphnia magna (Water Flea)		Fresh water	21 d	NOEC	> 2.5 µg/L *
Algae					
Desmodesmus subspicatus				NOEC EC10 EC50	> 5 ug/L *

Insects/Spiders				
Chironomus riparius (Harlequin fly)	soil	28 d	NOEC	608 mg/kg d.w.
Typhlodromus pyriwas (Mite)	soil	60 d	NOEC	1400 -1900 g/ha
Typhlodromus pyriis	soil	7 d	LR50	10000 g/ha
Aphidius rhopalosiphiis	soil	48 hr	LR50	24860
Aphidius rhopalosiphiis	soil	12 d	NOEC	25200 g/ha
Trichogramma cacoeciaeis	soil	7 d	ER50	197.57 g/ha
Soil Invertebrates				
Eisenia fetida (Red wiggler)	soil	14 d	NOEC	1000 mg sulfur/kg soil

* Sulphur water solubility: 5 ug/L. Concentrations in excess of the solubility limit have not been tested.

Non-Human Toxicity Values

HSDB (US National Library of Medicine)

Hazardous Substances Data Bank - Broad scope in human and animal toxicity, safety and handling, environmental fate, and more. Scientifically peer-reviewed.

LD50 Rabbit dermal >2000 mg/kg bw

LC50 Hamster inhalation >0.047 mg/L 4 hr

LC50 Mouse inhalation >0.047 mg/L 4 hr

LC50 Rat inhalation >0.047 mg/L 4 hr

LC50 Rat inhalation 0.067 mg/L 4 hr

LC50 Rat inhalation >9.23 mg/L 4 hr

LD50 Rat oral >5000 mg/kg bw

LDLo Dog intravenous 10 mg/kg

LDLo Guinea pig intraperitoneal 55 mg/kg

LC50 Mammal (species unspecified) inhalation 1660 mg/m3

LDLo Rabbit intravenous 5 mg/kg

LDLo Rabbit oral 175 mg/kg

LD Rat Oral > 8437 mg/kg

LDLo Rat intravenous 8 mg/kg

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Appendix C: References

#	Apendix A: Sources	Links
1	American Conference of Industrial Hygienists (ACGIH)	https://www.acgih.org/
2	ATSDR - Agency for Toxic Substances & Disease Registry (CDC) - Substance Priority List (SPL)	https://www.atsdr.cdc.gov/spl/index.html
3	Australia - Hazardous Chemical Information System - Safe Work Australia	https://hcis.safeworkaustralia.gov.au/chemical/?id=a50817d5-2296-f111-8075-00224896a864
4	California Proposition 65 (Prop 65)	https://oehha.ca.gov/proposition-65/proposition-65-list
5	ChemIDplus Lite	https://chem.nlm.nih.gov/chemidplus/chemidheavy.jsp
6	CLP: Harmonised classification - Annex VI of Regulation (EC) No 1272/2008 (CLP Regulation)	https://echa.europa.eu/information-on-chemicals/annex-vi-to-clp
7	CLP: Notified classification and labelling	https://echa.europa.eu/information-on-chemicals/cl-inventory-database
8	CNESST (Commission des normes, de l'équité, de la santé et de la sécurité du travail)	https://reptox.cnesst.gouv.qc.ca/en/Pages/information-sheet-whmis.aspx?langue=a&no_produit=8284
9	ECHA - European Chemicals Agency	https://chem.echa.europa.eu/100.028.839/overview?searchText=7704-34-9
10	Ecotoxicity Values: US EPA - ECOTOX database	https://cfpub.epa.gov/ecotox/search.cfm
11	Environment Canada CEPA, 1999: Schedule 1	https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/substances-list/toxic.html
12	Environment Canada: DSL Categorization	https://pollution-waste.canada.ca/substances-search/Substance/DisplaySubstanceDetails?Id=7704-34-9&SearchLang=en
13	European Food Safety Authority (EFSA) Scientific Report (2008)	https://efsa.onlinelibrary.wiley.com/doi/abs/10.2903/j.efsa.2009.221r
14	German Federal Water Management Act (Wasserhaushaltsgesetz, WHG)	https://www.bundesumweltministerium.de/en/topics/water-management/policy-goals-and-instruments/water-protection-policy-in-germany
15	HSDB (US National Library of Medicine)	https://pubchem.ncbi.nlm.nih.gov/compound/5362487

16	National Toxicology Program (NTP) – Report on Carcinogens (Roc)	https://ntp.niehs.nih.gov/whatwestudy/assessments/cancer/roc
17	New Jersey Hazardous Substance Fact Sheet	https://nj.gov/health/eoh/rtkweb/documents/fs/1757.pdf
18	New Zealand: Hazardous Substances and New Organisms (HSNO) Chemical Classification and Information Database (CCID)	https://www.epa.govt.nz/database-search/chemical-classification-and-information-database-ccid/
19	International Chemical Safety Cards	https://chemicalsafety.ilo.org/dyn/icsc/showcard.display?p_lang=en&p_card_id=1166&p_version=2
20	OSHA Carcinogens	https://www.osha.gov/carcinogens
21	The International Agency for Research on Cancer (IARC)	https://www.iarc.who.int/
22	The WHO Recommended Classification of Pesticides by Hazard (2019)	https://www.who.int/publications/i/item/9789240005662
23	Transport Canada: Transportation of Dangerous Goods Regulations	https://laws-lois.justice.gc.ca/eng/regulations/sor-2001-286/index.html
24	U.S. Environmental Protection Agency. May, 1991. Reregistration Eligibility Document (RED): Sulfur. US EPA, Office of Pesticide Programs, Washington, DC.	https://archive.epa.gov/pesticides/reregistration/web/pdf/0031fact.pdf
25	US DOT: Title 49 Transportation Part 172, Subpart B—Table of Hazardous Materials and Special Provisions	https://www.govinfo.gov/content/pkg/CFR-2017-title49-vol2/xml/CFR-2017-title49-vol2-part172.xml
26	US EPA Toxics Release Inventory List (TRI)	https://www.epa.gov/toxics-release-inventory-tri-program
27	US Massachusetts Commonwealth's Right-to-Know Law (Appendix A to 105 Code of Massachusetts Regulations Section 670.000)	https://www.mass.gov/files/documents/2017/09/11/105cmr670.pdf
28	US New Jersey Worker and Community Right-to-Know Act (New Jersey Statutes Annotated Section 34:5A-5)	https://web.doh.state.nj.us/rtkhsfs/rtkhsl.aspx

29	US Pennsylvania Worker and Community Right-to-Know Law (34 Pa. Code Chap. 301-323)	https://www.palegis.us/statutes/unconsolidated/law-information?sessYr=1984&sessInd=0&actNum=159
30	2022 IMSBC Code (International Maritime Solid Bulk Cargoes Code)	https://natcargo.org/train/2022-international-maritime-solid-bulk-cargoes-imsbc-code-online/