

Thallium oxide; CASRN 1314-32-5

Human health assessment information on a chemical substance is included in the IRIS database only after a comprehensive review of toxicity data, as outlined in the [IRIS assessment development process](#). Sections I (Health Hazard Assessments for Noncarcinogenic Effects) and II (Carcinogenicity Assessment for Lifetime Exposure) present the conclusions that were reached during the assessment development process. Supporting information and explanations of the methods used to derive the values given in IRIS are provided in the [guidance documents located on the IRIS website](#).

STATUS OF DATA FOR Thallium oxide

File First On-Line 01/31/1987

Category (section)	Assessment Available?	Last Revised
Oral RfD (I.A.)	qualitative discussion	09/30/2009
Inhalation RfC (I.B.)	qualitative discussion	09/30/2009
Carcinogenicity Assessment (II.)	yes	9/30/2009

I. HEALTH HAZARD ASSESSMENTS FOR NONCARCINOGENIC EFFECTS

I.A. REFERENCE DOSE (RfD) FOR CHRONIC ORAL EXPOSURE

Substance Name — Thallium oxide
CASRN — 1314-32-5
Section I.A. Last Revised — 09/30/2009

The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. The RfD is intended for use in risk assessments for health effects known or assumed to be produced through a nonlinear (presumed threshold) mode of action. It is expressed in units of mg/kg-day. Please refer to the guidance documents at <http://www.epa.gov/iris/backgrd.html> for an elaboration of these concepts. Because RfDs can be derived for the noncarcinogenic health effects of

substances that are also carcinogens, it is essential to refer to other sources of information concerning the carcinogenicity of this chemical substance. If the U.S. EPA has evaluated this substance for potential human carcinogenicity, a summary of that evaluation will be contained in Section II of this file.

The previous IRIS file for thallium (III) oxide (listed as thallic oxide) did not provide an oral RfD for this substance.

I.A.1. CHRONIC ORAL RfD SUMMARY

No oral studies of thallium oxide were found that are adequate to support derivation of an RfD. Only one repeat-dose study of thallium oxide (Downs et al., 1960) was identified. Downs et al. (1960) administered thallium oxide to Wistar-derived albino rats via the diet for 15 weeks at concentrations of 0, 20, 35, 50, 100, and 500 ppm. The study reported only body weights, mortality, kidney weights, and limited histopathology. Because all relevant endpoints were not evaluated, treatment group sizes were small (five per group per sex), and few animals survived to termination, this study could not be used to derive an RfD.

The toxicity literature for thallium compounds more generally cannot be used to inform the toxicity of thallium oxide. Accordingly, the available data do not support derivation of an RfD for thallium oxide.

I.A.2. PRINCIPAL AND SUPPORTING STUDIES

Not applicable.

I.A.3. UNCERTAINTY FACTORS

Not applicable.

I.A.4. ADDITIONAL STUDIES/COMMENTS

Information on the repeat-dose toxicity of thallium oxide is limited to Downs et al. (1960). Downs et al. (1960) examined the effects of thallium (III) oxide on weanling Wistar-derived albino rats (five rats/sex/treatment) at doses ranging from 20 to 500 ppm thallium (III) oxide in the diet for 15 weeks (equivalent to doses of 1.8 to 44.8 mg/kg Tl body weight-day, respectively). All rats (males and females) treated with ≥ 4.5 mg/kg-day Tl died before 8 weeks. In all thallium oxide-treated groups, investigators reported increased mortality, decreased body weight, and marked hair loss. Kidney weights were reduced in treated rats, although histopathologic examination did not reveal any alterations in the kidney related to

thallium treatment. Histopathologic evaluation of the skin revealed a decrease in the number of hair follicles and hair shafts, atrophy of the remaining follicles, decrease in the size of the sebaceous glands, and hyperkeratinized epidermis. The lowest level tested (1.8 mg/kg-day Tl) was considered a LOAEL; a NOAEL was not identified in this study.

The toxicology literature for thallium compounds more broadly demonstrates that symptoms of thallium toxicity are diverse in both humans and animals. The nervous system as a target organ of thallium is supported by observations from human case reports and animal studies. Relatively high doses of thallium caused neurological symptoms in humans (e.g., paresthesia of the hands and feet, weakness, tremors, coma, and convulsions). Some of these neurological symptoms (e.g., paresthesia and weakness) were reversible, although recovery was slow. Other effects, including mental and/or psychological problems, were more persistent. Neurological symptoms also were associated with chronic exposure to thallium in humans. These symptoms included sleep disorders, tiredness, weakness, nervousness, headache, other psychic alterations, and neurological and muscular problems. In experimental animal studies, thallium exposure was associated with biochemical changes, lipid peroxidation, histopathologic changes in the brain, and functional and histopathologic changes in peripheral nerves. The areas affected in the brain differed with the age of the treated animal; nevertheless, all measured endpoints (symptoms, biochemical measurements, and histopathology) indicated that high doses (close to lethal doses) of thallium induced significant degradation of the nervous system. Results from in vitro studies further confirmed these observations. See the *Toxicological Review of Thallium and Compounds* (U.S. EPA, 2009) for a more detailed summary and specific references.

In a 90-day gavage study (MRI, 1988), rats exposed to thallium sulfate showed consistently increased incidences of clinical observations related to the coat (rough coat, piloerection, shedding, and alopecia), eyes (lacrimation, exophthalmos, and miosis), and behavioral signs compared to untreated or vehicle controls. The underlying mode of action for these clinical observations is not known. Collectively, however, these observations suggest a treatment-related effect of thallium on the rats and possibly an indirect measure of stress or other effects on the nervous system. For example, it has been suggested that barbering (or overgrooming) in rodents may represent a stress-evoked behavioral response or other nervous system dysfunction (Welch et al., 2007; Kalueff et al., 2006; Kalueff and Tuohimaa, 2005; Greer and Capecchi, 2002).

Although paresthesia of the hands and feet is a trademark symptom of thallium toxicity, it is generally alopecia that leads to a diagnosis of thallium poisoning in humans. Alopecia occurs about 2 weeks after exposure and is reversible after exposure to thallium is discontinued. Alopecia has also been repeatedly observed in experimental animals exposed to thallium

compounds. See the *Toxicological Review of Thallium and Compounds* (U.S. EPA, 2009) for a more detailed summary and specific references.

Thallium exposure in humans has been associated with respiratory effects and gastrointestinal effects, including diarrhea and vomiting. Other toxic effects associated with oral thallium exposure in humans and animals are changes in blood pressure (high, low, and fluctuating values have all been noted) and liver and kidney damage (kidney damage is age dependent and occurs only in mature kidneys), all of which appear to be reversible with the removal of thallium exposure. Doses that do not affect survival have been shown to affect clinical chemistry parameters such as ALT, AST, BUN, blood glucose, and blood sodium levels, indicating liver and kidney damage with subchronic exposures (Leung and Ooi, 2000; Appenroth et al., 1996, 1995; Fleck and Appenroth, 1996; El-Garawany et al., 1990; Mourelle et al., 1988).

Thallium compounds have been shown to affect reproductive function. A dose as low as 0.7 mg/kg-day Tl (10 ppm of thallium (I) sulfate) resulted in testicular damage and reduced sperm motility in male Wistar rats within 60 days (Formigli et al., 1986). Wei (1987) reported that doses to male Kunming mice as low as 0.001 mg/L in the drinking water for 6 months reduced sperm motility (rapid speed only), and 0.01 mg/L reduced overall sperm motility and sperm counts and caused a reduction of live offspring. Confidence in this study, however, is low (see the *Toxicological Review of Thallium and Compounds* [U.S. EPA, 2009]) for a more detailed discussion of the limitations of this study).

Limited data in humans and experimental animals suggest that thallium may produce developmental toxicity. A review of case studies of women exposed orally to high levels (approximately 120 to 1,100 mg) of thallium during pregnancy suggested a trend toward premature and low-birth-weight infants, especially if exposure took place in the last trimester; no other developmental abnormalities were identified (Hoffman, 2000). Dolgner et al. (1983) examined birth defects in a German population living near a cement plant emitting thallium dusts during the mid-1970s and found a higher incidence of congenital malformations than the incidence documented in the government birth records from the area. The association between the number of birth defects and thallium exposure was weak, however, because two of the malformations were considered hereditary and the incidence of birth defects, although greater than that determined from civil records, was consistent with that reported in the literature. Confidence in this study was limited by lack of exposure data during pregnancy and possible underreporting in controls. In vivo data in rats support an association between intraperitoneal thallium exposure and low birth weight, although such an association has not been reported with orally administered thallium. In vitro data demonstrated an increase in bone malformations in both rat and chick embryos. See the *Toxicological Review of Thallium and Compounds* (U.S. EPA, 2009) for a more detailed summary and specific references.

For more detail on Susceptible Populations, exit to [the toxicological review, Section 4.8 \(PDF\)](#).

I.A.5. CONFIDENCE IN THE CHRONIC ORAL RfD

Not applicable.

For more detail on Characterization of Hazard and Dose Response, exit to [the toxicological review, Section 6 \(PDF\)](#).

I.A.6. EPA DOCUMENTATION AND REVIEW OF THE CHRONIC ORAL RfD

Source Document — U.S. EPA, 2009

This document has been reviewed by EPA scientists, interagency reviewers from other federal agencies and White House offices, and the public, and peer reviewed by independent scientists external to EPA. A summary and EPA's disposition of the comments received from the independent external peer reviewers and from the public is included in Appendix A of the *Toxicological Review of Thallium and Compounds* (U.S. EPA, 2009). [To review this appendix, exit to the toxicological review, Appendix A, Summary Of External Peer Review And Public Comments And Disposition \(PDF\)](#).

I.A.7. EPA CONTACTS

Please contact the IRIS Hotline for all questions concerning this assessment or IRIS, in general, at (202) 566-1676 (phone), (202) 566-1749 (fax), or hotline.iris@epa.gov (email address).

I.B. REFERENCE CONCENTRATION (RfC) FOR CHRONIC INHALATION EXPOSURE

Substance Name — Thallium oxide

CASRN — 1314-32-5

Section I.B. Last Revised — 09/30/2009

The RfC is an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. The RfC considers toxic effects for both the respiratory system (portal of entry) and for effects

peripheral to the respiratory system (extrarespiratory effects). The inhalation RfC (generally expressed in units of mg/m^3) is analogous to the oral RfD and is similarly intended for use in risk assessments for health effects known or assumed to be produced through a nonlinear (presumed threshold) mode of action.

Inhalation RfCs are derived according to *Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry* (U.S. EPA, 1994). Because RfCs can also be derived for the noncarcinogenic health effects of substances that are carcinogens, it is essential to refer to other sources of information concerning the carcinogenicity of this chemical substance. If the U.S. EPA has evaluated this substance for potential human carcinogenicity, a summary of that evaluation will be contained in Section II of this file.

An inhalation RfC for thallium oxide was not previously available on the IRIS database.

I.B.1. CHRONIC INHALATION RfC SUMMARY

An inhalation RfC for thallium oxide is not available at this time. There are no comprehensive inhalation toxicity studies involving exposure to any thallium compound.

I.B.2. PRINCIPAL AND SUPPORTING STUDIES

Not applicable.

I.B.3. UNCERTAINTY FACTORS

Not applicable.

I.B.4. ADDITIONAL STUDIES/COMMENTS

Not applicable.

For more detail on Susceptible Populations, exit to [the toxicological review, Section 4.8 \(PDF\)](#).

I.B.5. CONFIDENCE IN THE CHRONIC INHALATION RfC

Not applicable.

For more detail on Characterization of Hazard and Dose Response, exit to [the toxicological review, Section 6 \(PDF\)](#).

I.B.6. EPA DOCUMENTATION AND REVIEW OF THE CHRONIC INHALATION RfC

Source Document — U.S. EPA, 2009

This document has been reviewed by EPA scientists, interagency reviewers from other federal agencies and White House offices, and the public, and peer reviewed by independent scientists external to EPA. A summary and EPA's disposition of the comments received from the independent external peer reviewers and from the public is included in Appendix A of the *Toxicological Review of Thallium and Compounds* (U.S. EPA, 2009). [To review this appendix, exit to the toxicological review, Appendix A, Summary Of External Peer Review And Public Comments And Disposition \(PDF\).](#)

I.B.7. EPA CONTACTS

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II. Carcinogenicity Assessment for Lifetime Exposure

Substance Name — Thallium oxide
CASRN — 1314-32-5
Section II. Last Revised — 09/30/2009

This section provides information on three aspects of the carcinogenic assessment for the substance in question: the weight-of-evidence judgment of the likelihood that the substance is a human carcinogen, and quantitative estimates of risk from oral and inhalation exposure. Users are referred to Section I of this file for information on long-term toxic effects other than carcinogenicity.

The rationale and methods used to develop the carcinogenicity information in IRIS are described in the *Guidelines for Carcinogen Risk Assessment* (U.S. EPA, 2005a) and the *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* (U.S. EPA, 2005b). The quantitative risk estimates are derived from the application of a low-dose extrapolation procedure, and are presented in two ways to better facilitate their use. First, route-specific risk values are presented. The "oral slope factor" is a plausible upper bound on the estimate of risk per mg/kg-day of oral exposure. Similarly, a "unit risk" is a plausible upper bound on the estimate of risk per unit of concentration, either per µg/L drinking water

(see Section II.B.1.) or per $\mu\text{g}/\text{m}^3$ air breathed (see Section II.C.1.). Second, the estimated concentration of the chemical substance in drinking water or air when associated with cancer risks of 1 in 10,000, 1 in 100,000, or 1 in 1,000,000 is also provided.

The previous IRIS assessment for soluble thallium oxide (posted to the IRIS database in 1990) assigned this compound a weight-of-evidence classification of D, "not classifiable as to human carcinogenicity."

II.A. EVIDENCE FOR HUMAN CARCINOGENICITY

II.A.1. WEIGHT-OF-EVIDENCE CHARACTERIZATION

Under the *Guidelines for Carcinogen Risk Assessment* (U.S. EPA, 2005a), the database for thallium and compounds provides "inadequate information to assess carcinogenic potential." There are presently no studies that evaluate the carcinogenic potential of thallium in animals and no adequate studies of humans chronically exposed to thallium.

For more detail on Characterization of Hazard and Dose Response, exit to [the toxicological review, Section 6](#) (PDF).

For more detail on Susceptible Populations, exit to [the toxicological review, Section 4.8](#) (PDF).

II.A.2. HUMAN CARCINOGENICITY DATA

The data available for human carcinogenicity are inadequate. Medical records for 86 workers (sex and length of employment not reported) occupationally exposed to thallium at a magnesium seawater battery factory and 79 unexposed workers matched for age, length of employment, shift pattern, and type of work were examined (Marcus, 1985). No increase in incidence of benign neoplasms (site not specified) was observed. This study is limited by the examination of medical records only, lack of exposure quantitation, small cohort size, and unknown length of observation.

In another study, the health effects associated with exposure to thallium in 128 men (age 16-62 years) exposed for 1-42 years (average = 19.5 years) in three cement manufacturing plants were reported (Schaller et al., 1980). Analyses of roasted pyrites and electro-filter dust confirmed the presence of thallium in various production areas in the plant. Urinary thallium was elevated in the workers. The health evaluation, consisting of a medical history and a physical exam, did not show any indication of thallium poisoning. However, this health evaluation was not adequate to detect any oncogenic response.

II.A.3. ANIMAL CARCINOGENICITY DATA

There are no animal carcinogenicity studies of thallium. Several subchronic animal studies on thallium and compounds are available; however, they were not designed to examine carcinogenic endpoints.

II.A.4. SUPPORTING DATA FOR CARCINOGENICITY

Thallium (I) compounds were not mutagenic in reverse mutation assays using *Salmonella typhimurium* strains TA98, TA100, TA1535, and TA1538 and *Escherichia coli* strains B/r WP2 tr⁻ and WP2 her⁻ tr⁻; data were not available regarding the presence of metabolic activation (Kanematsu et al., 1980). Positive results were obtained in the Rec assay by using 0.001 M thallium nitrate with *Bacillus subtilis* strains H17 and M45; presence of metabolic activation was not reported (Kada et al., 1980; Kanematsu et al., 1980). Thallium nitrate was negative in a screening assay for mitotic gene conversion and reverse mutations in *Saccharomyces cerevisiae* (Singh, 1983). Thallium nitrate produced negative effects on cell division in *S. cerevisiae* and *E. coli* (Loveless et al., 1954). Cytotoxic levels (1,000 µg/mL) of thallium acetate depressed DNA synthesis in Chinese hamster ovary cells (Garrett and Lewtas, 1983). Single-strand DNA breaks occurred in mouse and rat embryo fibroblasts exposed to thallium carbonate at 10⁻⁶ to 10⁻⁴ M (Zasukhina et al., 1983). Thallium carbonate (0.005-0.5 µg/kg-day) was positive in a dominant lethal test in male white rats (Zasukhina et al., 1983); however, confidence in this study is low. No genotoxicity studies specifically of thallium oxide were identified.

II.B. QUANTITATIVE ESTIMATE OF CARCINOGENIC RISK FROM ORAL EXPOSURE

Not applicable.

II.C. QUANTITATIVE ESTIMATE OF CARCINOGENIC RISK FROM INHALATION EXPOSURE

Not applicable.

II.D. EPA DOCUMENTATION, REVIEW, AND CONTACTS (CARCINOGENICITY ASSESSMENT)

II.D.1. EPA DOCUMENTATION

Source Document — U.S. EPA, 2009

This document has been reviewed by EPA scientists, interagency reviewers from other federal agencies and White House offices, and the public, and peer reviewed by independent scientists external to EPA. A summary and EPA's disposition of the comments received from the independent external peer reviewers and from the public is included in Appendix A of the *Toxicological Review of Thallium and Compounds* (U.S. EPA, 2009). [To review this appendix, exit to the toxicological review, Appendix A, Summary Of External Peer Review And Public Comments And Disposition \(PDF\).](#)

II.D.2. EPA REVIEW

II.D.3. EPA CONTACTS

Please contact the IRIS Hotline for all questions concerning this assessment or IRIS, in general, at (202) 566-1676 (phone), (202) 566-1749 (fax), or hotline.iris@epa.gov (email address).

III. [reserved]

IV. [reserved]

V. [reserved]

VI. BIBLIOGRAPHY

Substance Name — Thallium oxide
CASRN — 1314-32-5

VI.A. ORAL RfD REFERENCES

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VI.B. INHALATION RfC REFERENCES

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VI.C. CARCINOGENICITY ASSESSMENT REFERENCES

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VII. Revision History

Substance Name — Thallium oxide

CASRN — 1314-32-5

File First On-Line — 01/31/1987

Date	Section	Description
06/30/1988	I.A.	RfD withdrawn
09/07/1988	I.A.	Revised oral RfD summary added
05/01/1989	I.A.	Oral RfD withdrawn pending further review
09/01/1990	II.	Carcinogen assessment on-line
12/03/2002	I.A., II.D.2.	Screening-Level Literature Review Findings message has been added.
09/30/2009	All	RfD, RfC, and cancer sections updated.

VIII. SYNONYMS

Thallium oxide

CASRN — 1314-32-5

Last Revised — 09/30/2009

- Dithallium trioxide
- Thallic oxide
- Thallium (3+) oxide
- Thallium (III) oxide
- Thallium oxide
- Thallium peroxide
- Thallium sesquioxide