MATERIAL SAFETY DATA SHEET (MSDS)

SECTION 1. INTRODUCTION

This guideline summarizes pertinent information about titanium dioxide for workers and employers as well as for physicians, industrial hygienists, and other occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments; readers are therefore advised to regard these recommendations as general guidelines and to determine periodically whether new information is available.

Product class: Inorganic Oxides
Trade name of material: Titanium Dioxide

SECTION 2. SUBSTANCE IDENTIFICATION

* Formula: TiO_2
* Synonyms: Rutile, Anatase, Brookite, cosmetic white, Tipaque, Zopaque, titanic anhydride, titanium oxide.
* Appearance and odor: Titanium dioxide is a noncombustible, odorless white powder.
* Cas No.: 13463-67-7
* The product is not classified hazardous according to the Regulation (EC) No 1272/2008 and the Council Directives 67/548/eec AND 99/45/EEC.
* Usage: White pigment for cosmetics, food and pharmaceutical applications

SECTION 3. CHEMICAL AND PHYSICAL PROPERTIES

* Physical data
1. Molecular weight: 79.9.
2. Boiling point (760 torr): 2500 degrees to 3000 degrees C (4532 degrees to 5432 degrees F).
3. Specific gravity (water = 1): 3.9 at 20 degrees C (68 degrees F).
4. Vapor density: Not applicable.
5. Melting point: 1830 degrees to 1850 degrees C (3326 degrees to 3362 degrees F).
6. Vapor pressure: Not applicable.
7. Solubility: Insoluble in water.
8. Evaporation rate: Not applicable.
* Reactivity
1. Conditions contributing to instability: None reported.
2. Incompatibilities: Contact of titanium dioxide with lithium at 200 degrees C (392 degrees F) causes a violent reaction.
3. Hazardous decomposition products: None reported.
4. Special precautions: None.
* Flammability
There is no National Fire Protection Association fire hazard rating for titanium dioxide; this substance is not combustible.
1. Flash point: Not applicable.
2. Flammable limits in air: Not applicable.
3. Extinguishing: Use an extinguishing that is suitable for the materials involved in the surrounding fire. Firefighters should wear a full set of protective clothing, including a self-contained breathing apparatus, when fighting fires involving titanium dioxide.
* Warning properties: Titanium dioxide is odorless.
* Eye irritation properties: Titanium dioxide is not an eye irritant; however, as with all dusts, contact of titanium dioxide particles with the eye may cause physical irritation.

SECTION 4. EXPOSURE LIMITS

The current Occupational Safety and Health Administration (OSHA) permissible exposure limits (PELs) for titanium dioxide are 10 milligrams per cubic meter (mg/m^3) of air (total particulate) as an 8-hour time-weighted average (TWA) concentration and 5 mg/m^3 (respirable fraction) as an 8-hour TWA concentration.

SECTION 5. HEALTH HAZARD INFORMATION

* Routes of exposure: Exposure to titanium dioxide can occur via inhalation and eye or skin contact.

* Summary of toxicology:
1. Effects on Animals: When present in the lungs of experimental animals at high concentrations, titanium dioxide causes transient effects related to the accumulation of dust in the lungs [ACGIH 1986, p. 576]. Intratracheal administration of titanium dioxide (at a dose of 50 mg) in rats caused no nodule formation, although macrophage infiltration was seen in the alveoli of one animal and fibrosis developed in a second rat [ACGIH 1986, p. 576]. Rabbits injected intratracheally with titanium dioxide showed reduced pulmonary function 1 week after treatment; however, this effect had disappeared 3 months later [ACGIH 1986, p. 576]. Rats exposed to a heavy (not further specified) concentration of titanium dioxide dust for 13 months and observed for another 7 months showed dust accumulation in the lung but no lung lesions [Clayton and Clayton 1981-1982, p. 1974]. A 2-year carcinogenicity bioassay in mice and rats involving the administration of 2.5 or 5 percent titanium dioxide in the diet showed no evidence of carcinogenicity [HSDB 1992; Clayton and Clayton 1981-1982, p. 1975]. In another study, rats exposed to titanium dioxide by inhalation at 0, 10, 50, or 250 mg/m^3 for 2 years showed a statistically significant increase in the incidence of squamous cell carcinomas and bronchoalveolar adenomas. Nasal irritation and lung fibrosis were also noted at the two higher exposure levels. However, the tumors observed in this study have been ascribed to the pneumoconiosis-inducing properties of the hard mineral dusts believed to have contaminated the titanium dioxide rather than to the carcinogenic properties of titanium dioxide itself [HSDB 1992; Clayton and Clayton 1981-1982, p. 1979].

2. Effects on Humans: Titanium dioxide causes pulmonary irritation in chronically exposed workers [Hathaway, Proctor, Hughes, and Fischman 1991, p. 545]. Three workers from a group of 15 exposed to titanium dioxide dust at unspecified concentrations and for unknown durations showed radiographic evidence consistent with "slight" fibrosis, although these workers were asymptomatic [Hathaway, Proctor, Hughes, and Fischman 1991, p. 545]. In another study, three workers exposed to this substance during the manufacture of titanium dioxide pigments showed signs of fibrosis described as "slight" [Hathaway, Proctor, Hughes, and Fischman 1991, p. 545]. In intermittent contact with the skin for three days, titanium dioxide caused mild irritation [RTECS 1993].

* Signs and symptoms of exposure
1. Acute exposure: The signs and symptoms of acute exposure to titanium dioxide include physical irritation of the skin and eyes, with redness and swelling; cough; and sneezing.

2. Chronic exposure: The signs and symptoms of chronic exposure to titanium dioxide include X-ray evidence of mild fibrosis; dyspnea; cough; and declines in pulmonary function.

* Emergency procedures:
In the event of an emergency, the rescuer should don appropriate personal protective equipment, remove the victim from further exposure, send for medical assistance, and initiate the following emergency procedures:

1. Eye exposure: If titanium dioxide dust gets into the eyes, immediately flush the eyes with large amounts of water for a minimum of 15 minutes, lifting the lower and upper lids occasionally. If irritation develops, get medical attention as soon as possible.

2. Skin exposure: If titanium dioxide dust collects on the skin, the contaminated skin should be washed with soap and water.

3. Inhalation: If titanium dioxide dust is inhaled, move the victim at once to fresh air and get medical care as soon as possible. If the victim is not breathing, perform cardiopulmonary resuscitation; if breathing is difficult, give oxygen. Keep the victim warm and quiet until medical help arrives.

4. Rescue: Remove an incapacitated worker from further exposure and implement appropriate emergency procedures (e.g., those listed on the Material Safety Data Sheet required by OSHA's Hazard Communication Standard, 29 CFR 1910.1200). All workers should be familiar with emergency procedures, the location and proper use of emergency equipment, and methods of protecting themselves during rescue operations.

SECTION 6. EXPOSURE SOURCES AND CONTROL METHODS

The following operations may involve titanium dioxide and lead to worker exposures to this substance:

* Use as a pigment in paints, varnishes, enamels, and lacquers to impart whiteness, opacity, and brightness
* Use in paper coatings and fillers to improve opacity and brightness
* Use as a white pigment in ceramics, plastics, and in blow-molded plastic containers
* Use in ceramics and glass for capacitors, electromechanical transducers, and glass fibers
* Use in flexographic, gravure, and letterpress inks and in packaging, publication, offset, and screen-processing inks
* Use in coated fabrics and textiles on natural and artificial leather, oilcloth, upholstery materials, and wall coverings; as a delustrant for acrylic, nylon, and spandex fibers; and as a shoe whitener

* Use in such building materials as roofing granules, ceiling tiles, and cement-curing aids and in titanium carbide cutting tools
* Use as a welding rod coating and a sub-coating of confectionery panned goods
* Use in sunscreens, as a dusting powder, in ointments and lotions, and for radioactive decontamination of the skin
* Use as a clouding agent in dry beverage mixes, as a food additive, as a pigment in icings for baked goods, in tobacco wrappings and tobacco substitutes, in sugar syrup coatings for products sold in tablet form, and to whiten and age cheese
* Use as a chemical intermediate in the production of titanium compounds (barium titanate) and of titanium metal and alloys

Methods that are effective in controlling worker exposures to titanium dioxide, depending on the feasibility of implementation, are

* Process enclosure,
* Local exhaust ventilation,
* General dilution ventilation, and
* Personal protective equipment.

SECTION 7. MEDICAL MONITORING

Workers who may be exposed to chemical hazards should be monitored in a systematic program of medical surveillance that is intended to prevent occupational injury and disease. The program should include education of employers and workers about work-related hazards, early detection of adverse health effects, and referral of workers for diagnosis and treatment. The occurrence of disease or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical monitoring program is intended to supplement, not replace, such measures. To place workers effectively and to detect and control work-related health effects, medical evaluations should be performed (1) before job placement, (2) periodically during the period of employment, and (3) at the time of job transfer or termination.

* Preplacement medical evaluation

Before a worker is placed in a job with a potential for exposure to titanium dioxide, a licensed health care professional should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic and laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the respiratory system. Medical monitoring for respiratory disease should be conducted using the principles and methods recommended by NIOSH and the American Thoracic Society.

A preplacement medical evaluation is recommended to assess medical conditions that may be aggravated or may result in increased risk when a worker is exposed to titanium dioxide at or below the prescribed exposure limit. The health care professional should consider the probable frequency, intensity, and duration of exposure as well as the nature and degree of any applicable medical condition. Such conditions (which should not be regarded as absolute contraindications to job placement) include a history and other findings consistent with diseases of the respiratory system.

* Periodic medical examinations and biological monitoring

Occupational health interviews and physical examinations should be performed at regular intervals during the employment period, as mandated by any applicable Federal, State, or local standard. Where no standard exists and the hazard is minimal, evaluations should be conducted every 3 to 5 years or as frequently as recommended by an experienced occupational health physician. Additional examinations may be necessary if a worker develops symptoms attributable to titanium dioxide exposure. The interviews, examinations, and medical screening tests should focus on identifying the adverse effects of titanium dioxide on the respiratory system. Current health status should be compared with the baseline health status of the individual worker or with expected values for a suitable reference population.

Biological monitoring involves sampling and analyzing body tissues or fluids to provide an index of exposure to a toxic substance or metabolite. No biological monitoring test acceptable for routine use has yet been developed for titanium dioxide.

* Medical examinations recommended at the time of job transfer or termination

The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic or laboratory tests that were conducted at the time of placement should be repeated at the time of job transfer or termination to determine the worker's medical status at the end of his or her employment. Any changes in the worker's health status should be compared with those expected for a suitable reference population.

SECTION 8. WORKPLACE MONITORING AND MEASUREMENT PROCEDURES

Determination of a worker's exposure to airborne titanium dioxide is made using a tared low ash polyvinyl chloride (LAPVC) filter (5 microns) preceded by a 10-mm nylon cyclone. Samples are collected at a maximum flow rate of 2 liters per minute until a maximum air volume of 960 liters is collected. The sample is then analyzed gravimetrically. This method has a sampling and analytical error of 0.10 and is described in the Industrial Hygiene Technical Manual [OSHA 1985] and in the NIOSH Occupational Exposure Sampling Strategy Manual [NIOSH 1977].

SECTION 9. PERSONAL HYGIENE PROCEDURES

If titanium dioxide collects on the skin, workers should wash the affected areas with soap and water.
Clothing contaminated with titanium dioxide should be removed, and provisions should be made for the safe removal of the chemical from the clothing.
A worker who handles titanium dioxide should thoroughly wash hands, forearms, and face with soap and water before eating, using tobacco products, using toilet facilities, or applying cosmetics.
Workers should not eat, drink, use tobacco products, or apply cosmetics in areas where titanium dioxide is handled, processed, or stored.

SECTION 10. STORAGE

Titanium dioxide should be stored in a cool, dry, well-ventilated area in tightly sealed containers that are labeled in accordance with OSHA's Hazard Communication Standard. Containers of titanium dioxide should be protected from physical damage and should be stored separately from lithium. Because containers that formerly contained titanium dioxide may still hold product residues, they should be handled appropriately.

SECTION 11. SPILLS

In the event of a spill involving titanium dioxide, persons not wearing protective equipment and clothing should be restricted from contaminated areas until cleanup has been completed. The following steps should be undertaken following a spill:
1. Notify safety personnel.
2. Avoid creating airborne dust during cleanup to the extent feasible.
3. Place spilled material into a clean, dry container; cover and remove the container from the spill area.

SECTION 12. EMERGENCY PLANNING, COMMUNITY RIGHT-TO-KNOW, AND HAZARDOUS WASTE MANAGEMENT REQUIREMENTS

The Environmental Protection Agency's (EPA's) regulatory requirements for emergency planning, community right-to-know, and hazardous waste management may vary over time. Users are therefore advised to determine periodically whether new information is available.

* Emergency planning requirements
Titanium dioxide is not subject to EPA emergency planning requirements under the Superfund Amendments and Reauthorization Act (SARA) (Title III).

* Reportable quantity requirements (releases of hazardous substances)
Employers are not required by the emergency release notification provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to notify the National Response Center of an accidental release of titanium dioxide; there is no reportable quantity for this substance.

* Community right-to-know requirements
Employers are not required by Section 313 of the Superfund Amendments and Reauthorization Act (SARA) to submit a Toxic Chemical Release Inventory form (Form R) to EPA reporting the amount of titanium dioxide emitted or released from their facility annually.

* Hazardous waste management requirements
EPA considers a waste to be hazardous if it exhibits any of the following characteristics: ignitability, corrosively, reactivity, or toxicity, as defined in 40 CFR 261.21-261.24. Under the Resource Conservation and Recovery Act (RCRA), EPA has specifically listed many chemical wastes as hazardous. Although titanium dioxide is not specifically listed as a hazardous waste under RCRA, EPA requires employers to treat any waste as hazardous if it exhibits any of the characteristics discussed above.

Providing more information about the removal and disposal of specific chemicals is beyond the scope of this guideline. EPA, U.S. Department of Transportation, and State and local regulations should be followed to ensure that removal,

transport, and disposal of this substance are conducted in accordance with existing regulations. To be certain that chemical waste disposal meets EPA regulatory requirements, employers should address any questions to the RCRA hotline at (202) 382-3000 (in Washington, D.C.) or toll-free at (800) 424-9346 (outside Washington, D.C.). In addition, relevant State and local authorities should be contacted for information on any requirements they may have for the waste removal and disposal of this substance.

SECTION 13. RESPIRATORY PROTECTION

* Conditions for respirator use

Good industrial hygiene practice requires that engineering controls be used where feasible to reduce workplace concentrations of hazardous materials to the prescribed exposure limit. However, some situations may require the use of respirators to control exposure. Respirators must be worn if the ambient concentration of titanium dioxide exceeds prescribed exposure limits. Respirators may be used (1) before engineering controls have been installed, (2) during work operations such as maintenance or repair activities that involve unknown exposures, (3) during operations that require entry into tanks or closed vessels, and (4) during emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by NIOSH and the Mine Safety and Health Administration (MSHA).

* Respiratory protection program

Employers should institute a complete respiratory protection program that, at a minimum, complies with the requirements of OSHA's Respiratory Protection Standard. Such a program must include respirator selection (see Table 1), an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, periodic workplace monitoring, and regular respirator maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program (including selection of the correct respirator) requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly. For additional information on the selection and use of respirators and on the medical screening of respirator users, consult the NIOSH Respirator Decision Logic and the NIOSH Guide to Industrial Respiratory Protection.

Table 1 lists the respiratory protection that NIOSH recommends for workers exposed to titanium dioxide. The recommended protection may vary over time because of changes in the exposure limit for titanium dioxide or in respirator certification requirements. Users are therefore advised to determine periodically whether new information is available.

POTENTIAL HUMAN CARCINOGEN

Table 1.

NIOSH recommended respiratory protection for workers exposed to titanium dioxide*

Condition	Minimum respiratory protection**
Any detectable airborne concentration of titanium dioxide:	
	Any self-contained respirator equipped with a full facepiece and operated in a pressure-demand or other positive-pressure mode, or Any supplied-air respirator equipped with a full facepiece and operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode
Entry into unknown concentration(+)	Any self-contained respirator equipped with a full facepiece and operated in a pressure-demand or other positive-pressure mode, or Any supplied-air respirator equipped with a full facepiece and operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode
Firefighting	Any self-contained respirator equipped with a full facepiece and operated in a pressure-demand or other positive-pressure mode
Escape	Any air-purifying, full-facepiece respirator equipped with an organic vapor canister, or

	Any escape-type, self-contained breathing apparatus with a suitable service life (number of minutes required to escape the environment)

SECTION 14. TRANSPORT INFORMATION

Titanium Dioxide belongs to generic chemical, and doesn't belong to flammable explosive, corroding noxious radioactive, oxidizing substance. According to IMO IMDG CODE, Titanium Dioxide belong to safety commodity.

SECTION 15. PERSONAL PROTECTIVE EQUIPMENT

Protective clothing should be worn to prevent prolonged or repeated skin contact with titanium dioxide. Chemical protective clothing should be selected on the basis of available performance data, manufacturers' recommendations, and evaluation of the clothing under actual conditions of use. No reports have been published on the resistance of various protective clothing materials to titanium dioxide permeation. If permeability data are not readily available, protective clothing manufacturers should be requested to provide information on the best chemical protective clothing for workers to wear when they are exposed to titanium dioxide.

Safety glasses, goggles, or face shields should be worn during operations in which titanium dioxide might contact the eyes (e.g., through dust particles). Eyewash fountains and emergency showers should be available within the immediate work area whenever the potential exists for eye or skin contact with titanium dioxide. Contact lenses should not be worn if the potential exists for titanium dioxide exposure.