RESIDUES OF
FIRE ACCELERANT CHEMICALS

VOLUME I:
RISK ASSESSMENT

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Abstract

This report summarizes the results of quantitative human health and ecological risk assessments of chemical residues in the environment from the use of a variety of accelerants to ignite prescribed burns. On a per-unit basis for each ignition method, no risks were identified for human health, nor for general wildlife species. However, consideration should be given at the planning stage to protecting sensitive aquatic species in small watersheds that have limited potential for diluting residue chemicals that may run off or erode to surface water.

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RESIDUES OF FIRE ACCELERANT CHEMICALS

1.0 INTRODUCTION

The U.S. Forest Service and other natural resource agencies use a variety of chemical products to ignite prescribed burns in grass, shrub, and forest vegetation. The potential health and environmental impacts of these products has not been previously evaluated in a systematic manner, within the framework of their use as fire accelerants. This report presents an assessment of the potential impacts of these products.

This document is organized into nine major sections. Section 1.0 provides an introduction, background information, and an overview of the analysis approach. Sections 2.0 through 4.0 address the human health risks, including a hazard assessment (Section 2.0), exposure assessment (Section 3.0) and human health risk characterization (Section 4.0). Sections 5.0 through 7.0 present the ecological risk assessment, consisting of problem formulation (Section 5.0), analysis (Section 6.0) and ecological risk characterization (Section 7.0). Section 8.0 lists the references cited throughout this report.

1.1 BACKGROUND: FIRE ACCELERANTS

There are several types of equipment and associated chemical products that may be used to ignite prescribed burns, as summarized in this section.

Fusees (J. Schalau photo).

Fusees. Essentially the same as railroad flares, fusees can be attached together or put on a stick, are ignited, and then the employee will walk through the target area using it as a hand ignition device. A lit fusee may also be tossed to the target area. They contain strontium nitrate and potassium perchlorate.

Drip torch. A gasoline/diesel fuel mixture is dispensed by hand from a cylindrically shaped aluminum container with a handle. When inverted, fuel drips out of the container and a wick-like device on the top of the cylinder ignites the fuel. Authorized mixtures are one gallon of gasoline to three, four, or five gallons of diesel fuel.

Drip torch in use (BLM photo).

Use of gelled gasoline (Forest Service photo).

Helitorch/terra-torch or gelled gasoline in hand-thrown plastic bags. Gasoline can be mixed with a gelling agent, generally aluminum carboxylates (“alumagel”), which solidifies the gasoline into a jelly-like form, sold under the trade names FireGel®, Surefire®, and Petrol Gel®. The two substances are mixed in a mixing and storage tank, to which is attached a pump and firing wand. Gelled gasoline is sent through the pump and ignited by a propane lighter. The gelled fuel is projected from 20 to 150 feet, coating the vegetation. When this type of system is mounted on a helicopter, it is called a helitorch. When installed in a ground-based vehicle, it is a terra-torch. Gelled gasoline can also be hand-tossed to the target area in plastic bags with a section of igniter cord attached and lit.

Aerial ignition device system ("ping-pong balls"). Polystyrene spheres, about the size of ping-pong balls and containing potassium permanganate crystals, are dispensed from a machine mounted in a helicopter. Just prior to release, a small amount of ethylene glycol is automatically injected into each sphere by the dispensing machine. Within 20 to 30 seconds, the sphere ignites.

"Ping-pong ball" aerial ignition system (Forest Service Research photo).

Incendiary devices (flares) propelled by launcher pistols. A launcher pistol can be used to propel a flare-like device to the target area. A typical flare may contain aluminum, calcium sulfate, iron oxide, and other minor ingredients.

Launcher pistol firing flare (Quoin International, Inc.)

Propane dispensed from backpack tanks. A propane tank is carried on the back, supplying propane to a wand with an ignition device, which is used to directly apply flame to target fuels.

Propane-fueled wand (J. Wolf).

The chemicals that form the basis for the target fuel ignition process in each of these methods are collectively referred to as *accelerants*. When accelerants, or any other substances, are oxidized during the burning process, new chemicals may be formed. Many of these are gaseous or particulate chemicals that are quickly dispersed in the open air. However, it is possible that some solid or liquid residues may remain on the soil after these accelerants are used to start a prescribed burn. These accelerant residues are the focus of this risk assessment.

1.2 IDENTIFICATION OF ACCELERANT RESIDUES

The purpose of this assessment is to estimate the risks to human health and the environment from residues remaining after the use of fire accelerants. The chemicals addressed in this risk assessment were selected based on the residues identified in Table 1-1.

Based on the combustion products identified in Table 1-1 for each accelerant, the solid or liquid residues that may potentially be present are as follows:

- Aluminum
- Aluminum oxide

Table 1-1. Chemicals Evaluated in Risk Assessment

Accelerant	Components	Residues[1]
Fusee[2]	Strontium nitrate + Potassium perchlorate + Sulfur + Sawdust/oil binder	Strontium sulfate Strontium oxide Strontium sulfide *Nitrogen oxides* Potassium chloride Potassium hydroxide *Carbon dioxide* *Water vapor* *Sulfur dioxide*
Gasoline	Gasoline mixture + MTBE (additive)	Gasoline as a mixture MTBE
Diesel fuel	Diesel fuel mixture	Diesel fuel as a mixture
Firegel/Alumagel/Surefire/ Petrol Jel	Aluminum carboxylates	Aluminum oxide *Water vapor*
Ping-pong balls	Potassium permanganate + Ethylene glycol + Polystyrene ball	Manganese dioxide Potassium hydroxide *Carbon dioxide* *Water vapor* *Styrene* Uncombusted polystyrene
Flares propelled by launcher pistols	Aluminum + Calcium sulfate + Iron oxide + Copper oxide + Silicon + Potassium perchlorate + Lead oxide + Black powder: (Potassium nitrate + Sulfur + Charcoal)	Aluminum Aluminum oxide Calcium sulfate Iron oxide Copper oxide Silicon dioxide Potassium chloride *Carbon dioxide* *Water vapor* Lead Potassium hydroxide *Nitrogen oxides* *Sulfur dioxide*
Propane	Propane	*Carbon dioxide* *Water vapor*

[1] Gaseous compounds are presented in italics; they are not analyzed in this assessment.

[2] Fusees may not be completely used during fire ignition: an end piece remains that may contain some unburned fuel. This endpiece is generally tossed into the fire, where it would be consumed.

Sources: Etiumsoft 2002, Lewis 1994a, Lewis 1994b, Sumi and Tsuchiya 1971.

- Calcium sulfate
- Copper oxide
- Diesel fuel
- Gasoline
- Iron oxide

- Lead
- Manganese dioxide
- MTBE
- Polystyrene
- Potassium chloride
- Potassium hydroxide
- Silicon dioxide
- Strontium oxide
- Strontium sulfate
- Strontium sulfide

1.3 OVERVIEW OF THE HUMAN HEALTH RISK ASSESSMENT

To assess the risk of human health effects from residues of fire accelerant chemicals, it was necessary to estimate the human exposures that could occur as a result of their application and associated activities, and to estimate the probability and extent of adverse health effects that could occur as a result of those exposures. This risk assessment employs the three principal analytical elements that the National Research Council (1983) described and EPA (1989, 2000a) affirmed as necessary for characterizing the potential adverse health effects of human exposures to existing or introduced hazards in the environment: hazard assessment, exposure assessment, and risk characterization.

Hazard assessment requires gathering information to determine the toxic properties of each chemical and its dose-response relationship. Human hazard levels are derived primarily from the results of laboratory studies on animals. The goal of the hazard assessment is to identify acceptable doses for noncarcinogens, and identify the cancer potency of potential carcinogens.

Exposure assessment involves estimating doses to persons potentially exposed to the accelerant residues. In the exposure assessment, dose estimates were made for members of the public from exposure to water, fish, or soil containing accelerant residues.

Risk characterization requires comparing the hazard information with the dose estimates to predict the potential for health effects to individuals under the conditions of exposure. The risk characterization also identifies uncertainties (such as data gaps where scientific studies are unavailable) that may affect the magnitude of the estimated risks.

1.4 OVERVIEW OF THE ECOLOGICAL RISK ASSESSMENT

The ecological risk assessment follows the steps of problem formulation, analysis, and risk characterization, as described in the U.S. Environmental Protection Agency's *Guidelines for Ecological Risk Assessment* (EPA 1998). This risk assessment also identifies uncertainties that are associated with the conclusions of the risk characterization. The discussion that follows briefly describes these elements. A detailed description of ecological risk assessment methodology is contained in these guidelines (EPA 1998).

In *problem formulation,* the purpose of the assessment is provided, the problem is defined, and a plan for analyzing and characterizing risk is determined. The potential stressors (in this case, accelerant residues), the ecological effects expected or observed, the receptors, and ecosystem(s) potentially affected are identified and characterized. Using this information, the three products of problem formulation are developed: (1) assessment endpoints that adequately reflect management goals and the ecosystem they represent, (2) conceptual models that describe key relationships between a stressor and assessment endpoint, and (3) an analysis plan that includes the design of the assessment, data needs, measures that will be used to evaluate risk hypotheses, and methods for conducting the analysis phase of the assessment.

Analysis is a process that examines the two primary components of risk–exposure and effects–and the relationships between each other and ecosystem characteristics. The assessment endpoints and conceptual models developed during problem formulation provide the focus and structure for the analysis. Exposure characterization describes potential or actual contact or co-occurrence of stressors with receptors, to produce a summary exposure profile that identifies the receptor, describes the exposure pathway, and describes the intensity and extent of contact or co-occurrence. Ecological effects characterization consists of evaluating ecological effects (e.g., ecotoxicity) data on the stressor of interest, as related to the assessment endpoints and the conceptual models, and preparing a stressor-response profile.

Risk characterization uses the results of the analysis phase to develop an estimate of the risks to ecological entities, describes the significance and likelihood of any predicted adverse effects, and identifies uncertainties, assumptions, and qualifiers in the risk assessment.

2.0 HUMAN HEALTH HAZARD ASSESSMENT

This section presents the results of the hazard assessment—a review of available toxicological information on the potential human health hazards associated with the accelerant residues. Section 2.1 provides background information to familiarize the reader with the terminology and technical information in this hazard assessment. Section 2.2 describes the hazard assessment methodology. Section 2.3 summarizes the toxicity data and identifies the toxicity values used in this risk assessment. Section 2.4 lists hazard assessment data gaps that affect the ability to quantify risks from these chemicals.

2.1 Background Information

Because of the obvious limitations on testing in humans, information on effects in non-human test systems usually provides the basis for an informed judgment as to whether an adverse impact is correlated with a particular exposure. These animal toxicity test results may be supplemented by information on a chemical's effects on humans, such as the results of dermatologic or exposure testing in humans, and occasional studies of low-level dosing of human volunteers by oral or other routes.

Toxicity tests in laboratory animals are designed to identify specific toxic endpoints (effects of concern), such as lethality or cancer, and the doses associated with such effects. Studies vary according to the test species used, the endpoint, test duration, route of administration, and dose levels. The dosing schedule, number of test groups, and number of animals per group also vary from one test to another, but the tests are generally designed to demonstrate whether a causal relationship exists between administered doses and any observed effects.

2.1.1 Duration of Tests

The duration of toxicity tests ranges from single-dose (acute) or short-term (subacute) tests, through longer subchronic studies, to chronic studies that may last up to the lifetime of an animal. Acute toxicity studies involve administering a chemical to each member of a test group, either in a single dose or in a series of doses over a period less than 24 hours. Subacute, subchronic, and chronic studies are used to determine the effects of multiple doses. Subacute toxicity studies involve repeated exposure to a chemical for one month or less. Subchronic toxicity studies generally last from one to three months, and chronic studies last for more than three months.

Acute studies are used primarily to determine doses that are immediately lethal, which results in limited utility in an assessment of long-term or repeated low-level human exposures. Acute and subacute toxicity studies include dermal irritation tests, dermal sensitization tests, eye irritation tests, and inhalation exposure or daily oral dosing of laboratory animals for up to one month to further define effects from limited exposures.

Longer term studies are designed to characterize the dose-response relationship resulting from repeated exposure to a compound. All other things being equal, the greater the duration of the study, the more reliable will be the resulting value for estimating the effects of subchronic or chronic exposures in humans. Adverse effects in laboratory tests may include overt clinical signs of toxicity, reduced food consumption, abnormal body weight change, abnormal clinical hematology or chemistry, or visible or microscopic abnormalities in the tissue of the test organism. Chronic studies in rats or mice that continue for longer periods of time, usually about two years, may also be used to assess the carcinogenic potential of a chemical.

2.1.2 Routes of Exposure

For assessing hazards from the accelerant residues, the routes of administration in laboratory tests that reflect the likely types of exposures to humans are oral by dietary (in food or water) or gavage (forced into the stomach through tubing). Selection of the route of administration of a particular test material is based on the probable route of human exposure.

2.1.3 Units

A dose is expressed as milligrams of a chemical per kilogram of body weight of the test animal (mg/kg), in parts per million (ppm) in the animal's diet, or in milligrams per liter in the water that it drinks. In chronic studies, the test substance is generally administered in the diet at specified amounts in parts per million (mg of chemical per kg of food). The known weight of the animal over the test period and its food intake rate are used to convert parts per million in the diet to milligrams of a chemical per kilogram of body weight per day (mg/kg/day) for extrapolation to humans. In most chronic toxicity studies, at least two dosing levels are used, in addition to a zero-dose, or control group. In general, the control group receives only the vehicle (for example, water or saline) used in administering the test material. In a dietary study, the animal’s feed would serve as the vehicle.

2.1.4 Toxicity Endpoints

In acute toxicity studies, the endpoint of interest is often the median lethal dose (LD_{50}), which is the single dose that is calculated to be lethal to 50 percent of the test animals.

For examination of non-lethal, noncarcinogenic endpoints, toxicity testing can be used to estimate threshold exposure levels. The threshold level is the dose level at which a significant proportion of the test animals first exhibit the toxic effect. The threshold dose will vary among tested species and among individuals within species. Examples of toxic effects include pathologic injury to body tissue; a body dysfunction, such as respiratory failure; or another toxic endpoint, such as developmental defects in an embryo. It is not possible to determine threshold dose levels precisely; however, the no-observed-adverse-effect level (NOAEL) indicates the dose at which there is no statistically or biologically significant increase in the frequency or severity of an adverse effect in individuals in an exposed group, when compared with individuals in an appropriate control group. The next higher dose level in the study is the lowest-observed-adverse-effect level (LOAEL), at which adverse effects are observed. The true threshold dose level for the particular animal species in a study lies between the NOAEL and the LOAEL. If a chemical produces effects at the lowest dose tested in a study, the NOAEL must be at some lower dose. If the chemical produces no effects, even at the highest dose tested, the NOAEL is equal to or greater than the highest dose.

Carcinogenicity studies are used to determine the potential for a compound to cause malignant (cancerous) or benign (noncancerous) tumors when administered over an animal's lifetime. Several dose levels are used, with the highest set at the maximum tolerated dose, as established from preliminary studies. A control group is administered the vehicle (the liquid or food with which the test chemical is given) alone. Because tumors may arise in test animals for reasons unrelated to administration of the test compound, statistical analyses are applied to the tumor incidence results to determine the significance of observed results. Amdur et al. (1991) listed four types of responses that have generally been accepted as evidence of compound-induced tumors:

- The presence of types of tumors not seen in controls
- An increase in the incidence of the tumor types occurring in controls
- The development of tumors earlier than in controls
- An increased multiplicity of tumors

Some chemicals that elicit one or more of these responses may not be primary carcinogens (that is, tumor-inducers on their own), but may be enhancers or promoters. However, a carcinogenicity evaluation remains appropriate, because they may contribute to an increase in cancer incidence.

In a carcinogenicity assay, the dose-specific tumor incidence data are used to calculate a cancer slope factor, which represents the probability that a 1-mg/kg/day chronic dose of the agent will result in formation of a tumor, and is expressed as a probability, in units of "per mg/kg/day" or $(mg/kg/day)^{-1}$.

2.2 Hazard Assessment Methodology

The goal of the hazard analysis is to determine toxicity levels for quantification of risk. There are two types of toxicity endpoints: noncarcinogenic effects and carcinogenic effects.

For noncarcinogenic effects, it is generally assumed that there is a threshold level, and that doses lower than this threshold can be tolerated with little potential for adverse health effects. The U.S. EPA has determined threshold doses for many chemicals, and refers to these as reference doses (RfDs). The RfD is an estimate of the highest possible daily dose of a chemical that will pose no appreciable risk of deleterious effects to a human during his or her lifetime. The uncertainty of the estimate usually spans about one order of magnitude. The RfD is calculated using the lowest NOAEL from the species and study most relevant to humans, or the most sensitive species (the species that exhibited the lowest NOAEL overall). This NOAEL is divided by an uncertainty factor (usually 100) consisting of a factor of 10 to allow for the variation of response within the human population and a factor of 10 to allow for extrapolation to humans. Additional uncertainty factors may be applied to account for extrapolation from a shorter term study, overall inadequacy of data, or failure to determine a no-effect level. RfDs are expressed in units of mg/kg/day. EPA lists RfDs in its Integrated Risk Information System, a chemical risk database (EPA 2002a). RfDs can also be calculated using EPA's methodology. RfDs are analagous to the acceptable daily intake levels identified by groups such as the World Health Organization.

For compounds that are known, probable, or possible human carcinogens, cancer slope factors that have been calculated by EPA or other appropriate sources are identified for use in this risk assessment.

2.3 Toxicity Data

2.3.1 Aluminum and Aluminum Oxide

Free aluminum (Al) is reactive. Following combustion, aluminum oxide (Al_2O_3) will be the dominant form in the environment. ATSDR (1999a) estimated a minimal risk level of 2.0 mg Al /kg/day for intermediate (15 to 364 days) oral exposure, based on the most sensitive toxicity endpoint (neurotoxicity) identified in studies in laboratory animals. This minimal risk level is equivalent to 3.78 mg Al_2O_3/kg/day. Long-term feeding studies in mice and rats using aluminum potassium sulfate or aluminum phosphide led reviewers to conclude that aluminum has not demonstrated carcinogenicity in laboratory animals (ATSDR 1999a).

2.3.2 Calcium Sulfate

Calcium sulfate is widely present in the environment as gypsum; it is also known as plaster of Paris. The U.S. Food and Drug Administration stated that calcium sulfate is “generally recognized as safe”, or GRAS, when directly added to human food (21 CFR 184.1230). No specific acceptable ingestion intake level or limit was identified for calcium sulfate.

2.3.3 Copper Oxide

Copper oxide is a relatively insoluble form of the metal copper, which is found naturally in the environmental and is a necessary component of the human diet. Excessive intake of copper can cause dizziness, headaches, diarrhea, and liver and kidney damage (ATSDR 1999b). The mean dietary intake of copper in adults ranges from 0.9 to 2.2 mg (HSDB 2002). This corresponds to levels of 0.016 to 0.038 mg CuO/kg/day for an average-weight adult. EPA (40 CFR 141.51) has set a maximum contaminant level goal (MCLG) of 1.3 mg/L for copper in drinking water, which corresponds to 1.6 mg CuO/L. An oral RfD for CuO of 0.034 mg/kg/day was calculated, based on the MCLG.

No tumors were reported in rats injected with copper oxide; however, EPA has not classified copper as to its carcinogenic potential (EPA 1991a).

2.3.4 Diesel Fuel

Diesel fuel is a complex and variable mixture of petroleum hydrocarbons. It has an oral LD_{50} in rats of 7,400 mg/kg (API 1980a, as cited in CONCAWE 1996). No subchronic or chronic oral toxicity data are available. Therefore, an RfD was calculated based on a study by Layton et al. (1987) in which data for chemicals having known RfDs and LD_{50}s were compared. A conversion factor of 0.00005 was used to generate an RfD that corresponds to subchronic exposure. The conversion factor represents the median value of the reported ratios of reference doses to LD_{50} values. The estimated RfD is 0.37 mg/kg/day.

Although diesel fuel is not classifiable as to its carcinogenicity in humans according to IARC (1989), it contains many polycyclic aromatic hydrocarbons, some of which have been associated with cancer in laboratory animals (NPS 1997).

2.3.5 Gasoline

Like diesel fuel, gasoline is a petroleum hydrocarbon mixture. No NOAEL was identified for gasoline. The lowest LOAEL for toxicity endpoints relevant to human toxicity (body weight, gastrointestinal effects) was 2,000 mg/kg in a 28-day study in rats (ATSDR 1995). Based on this LOAEL, an RfD of 0.6 mg/kg/day was estimated, incorporating uncertainty factors of 0.1 to account for lack of a NOAEL, 0.3 for the absence of a longer-term study, and 0.01 for extrapolation from laboratory animals to humans and inter-individual variation among humans.

No studies were located regarding cancer in humans or animals after oral exposure to gasoline. However, gasoline is considered to be carcinogenic, since it contains benzene, a known human carcinogen (EPA 2000b). Two percent benzene content is representative of unleaded gasoline (Caprino and Togna 1998). Using the upper end of the oral cancer slope factor range for benzene of 0.015 to 0.055 per mg/kg/day, a cancer slope factor of 0.0011 was estimated for unleaded gasoline, based on its benzene content.

2.3.6 Iron Oxide

Iron oxide is the chemical name for the substance commonly observed as rust on items made of iron. It is regulated by the Food and Drug Administration for use as a food coloring and in food packaging, and is generally recognized as safe (21 CFR 186).

Iron is a required nutrient. The current recommended daily allowance (RDA) for iron varies by age, gender, and, for females, whether they are pregnant or breastfeeding. For children ages four to eight years old, the RDA is 10 mg/day. For adults, the RDA ranges up to 27 mg/day for pregnant women. Upper limits representing levels that are likely to pose no adverse effects are 40 mg/day for children through 13 years old, and 45 mg/day for adults (IOM 2002). These upper limits correspond to 1.8 mg/kg/day for a 6-year-old 22.6-kg child, and 0.63 mg/kg/day for an average 71.8-kg adult.

Severe toxicity may result in children following ingestion of more than 0.5 g of iron. In adults, chronic excessive ingestion may lead to toxicity, manifested by hemosiderosis, disturbances in liver function, diabetes mellitus, and possible endocrine disturbances and cardiovascular effects (Amdur et al. 1991). It is not classifiable as to its carcinogenicity in humans (IARC 1987).

EPA has established a secondary drinking water regulation of 0.3 mg/L for iron, based on aesthetic endpoints (EPA 1992).

2.3.7 Lead

EPA's reference dose workgroup concluded it was inappropriate to develop an RfD for lead because some of lead's adverse effects, particularly changes in the levels of certain blood enzymes and in aspects of children's neurobehavioral development, may occur at blood lead levels so low as to be essentially without a threshold (EPA 1993). Lead is a probable human carcinogen, but a quantitative estimate of risk is not appropriate given current data (EPA 1993).

EPA has recommended a screening level of 400 parts per million (ppm) lead in soil for residential land uses (the most restrictive category of exposure) (EPA 1994). This value was used in the risk assessment to assess soil exposures to residual lead. EPA’s maximum contaminant level for lead in drinking water is zero; if more than 10% of tap water samples exceed an action level of 0.015 mg/L, the water system must take additional steps, including corrosion control treatment, source water treatment, lead service line replacement, and public education (40 CFR 141.80). This level is used in this risk assessment to identify risks from drinking water.

2.3.8 Manganese Dioxide

The mean manganese intake in the U.S. from foodstuffs is estimated to be about 1.5 mg/child/day for a two-year-old child, and ranges from 2 to 9 mg/person/day for adults (HSDB 2002).

ATSDR (2000) adopted the National Research Council's upper range of the estimated safe and adequate daily dietary intake of 5 mg/day as a provisional guidance value for oral exposure to manganese; this is equivalent to 0.07 mg/kg/day. EPA (1996a) has set an oral reference dose of 0.14 mg/kg/day for manganese intake; this is equivalent to 0.22 mg manganese dioxide/kg/day. It is not classifiable as to its carcinogenicity in humans (EPA 1996a).

2.3.9 MTBE

ATSDR (1996) derived an intermediate-duration minimal risk level of 0.3 mg/kg/day, based on a 90-day study in rats in which decreased blood urea nitrogen levels were observed at the lowest dose tested of 100 mg/kg/day. This value is used as the RfD for MTBE in this risk assessment.

MTBE is considered a possible human carcinogen at high doses, with a cancer slope factor of 0.004 per mg/kg/day calculated for the oral route of exposure based on a study in rats, in which females exhibited a dose-related increase in lymphoma and leukemia, and male rats developed testicular tumors at the highest dose level (EPA 1997). However, EPA does not recommend calculating cancer risks for low doses to MTBE, due to uncertainties regarding this study’s dosing method, possible effects of the vehicle used, and lack of histopathological diagnoses and individual animal data.

2.3.10 Polystyrene

Polystyrene is formed by the polymerization of styrene to form a rigid, odorless, tasteless plastic. It is widely used in consumer products, including video and audio cassettes, cosmetic containers, toys, computer housings, and packaging and insulating materials for food, including the air-blown form of polystyrene known as Styrofoam® (EPA 1995).

Monte (1983) concluded that polystyrene was not absorbed when administered orally to laboratory rats. IARC (1979) reported that implantation of polystyrene materials under the skin in rats caused sarcomas. No quantitative toxicity data were available for the routes of exposure evaluated in this risk assessment; therefore, risk from polystyrene could not be quantified.

2.3.11 Potassium Chloride and Potassium Hydroxide

Potassium chloride is a commercial dietary salt substitute (HSDB 2002). The oral toxic dose ranges from 200 to 1,000 mg/kg, depending on kidney efficiency (HSDB 2002). Potassium chloride dissolves to potassium and chloride ions. Potassium compounds are ubiquitous in the earth’s crust, and the element is naturally found in the human bloodstream. Acute oral potassium poisoning is rare, since large doses usually induce vomiting (HSDB 2002). EPA has set a secondary (non-enforceable) drinking water standard for chloride of 250 mg/L.

Potassium hydroxide is one of the strongest alkalies—it is extremely corrosive. Swallowing caustic alkalies causes immediate burning pain in the mouth, throat, and stomach, and the lining membranes become swollen and detached. However, it is readily soluble in water, producing potassium and hydroxide ions. A significant amount of hydroxide ions in a water body *could* change the pH of the water, but that would not be the case from the amounts potentially present as a result of potassium hydroxide formation from use of a fire accelerant.

Since only very small amounts of the precursors to these chemicals would be present in fire accelerants that are widely dispersed over the terrain (fusees—6% potassium perchlorate; ping-pong balls—3 g potassium permanganate; and launcher pistol flares—0.1% potassium perchlorate), and the toxicity review does not associate health concerns with environmentally mediated contact with these residues and their dissolution products, these compounds are not further analyzed in the quantitative risk assessment.

2.3.12 Silicon Dioxide

Silicon dioxide occurs naturally as sand and quartz. It is chemically and biologically inert when ingested (HSDB 2002). No signs of toxicity or histologic changes were observed in dogs or rats that were fed 800 mg silicon/kg/day as the dioxide, equivalent to 1,700 mg silicon dioxide/kg/day (HSDB 2002). It is approved for use in food products at levels up to 2% when used for specific purposes (21 CFR 172.480). Crystalline silica is carcinogenic by the inhalation route of exposure (IARC 1997).

Since any silicon dioxide formed as a result of the combustion of the accelerants would be indistinguishable from sand in the soils on which it forms, it is not appropriate to analyze this compound further in this risk assessment.

2.3.13 Strontium Oxide, Strontium Sulfate, and Strontium Sulfide

The strontium ion has a low order of toxicity. It is chemically and biologically similar to calcium. The oxides are moderately caustic materials (Lewis 1994a). The human daily intake of strontium has been determined to be 2 mg (HSDB 2002). EPA (1996b) set an oral RfD of 0.6 mg/kg/day for strontium. There are no data on its potential for carcinogenicity.

3.0 HUMAN HEALTH EXPOSURE ASSESSMENT

3.1 Introduction

This section describes the pathways by which human populations could be potentially exposed to fire accelerant residues. The possible routes of exposure were identified as follows:

- drinking water
- ingestion of fish
- incidental soil ingestion

In this analysis, it was assumed that an adult weighs 71.8 kg (158 lb) and a six-year old child weighs 22.6 kg (49.8 lb) (EPA 1999a).

3.2 Exposure and Dose

Two primary conditions are necessary for a human to receive a chemical dose that may result in a toxic effect. First, the chemical must be present in the person's immediate environment—such as in food or water—so that it is available for intake. The amount of the chemical present in the person's immediate environment is the exposure level. Second, the chemical must enter the person's body by some route. Chemicals in food or water may be ingested. The amount of a chemical that moves into the body by an exposure route constitutes the dose. Exposure, then, is the amount of a chemical available for intake into the body; dose is the amount of the substance that actually enters the body.

3.3 Potential Exposures

This subsection describes the representative human health exposure scenarios analyzed in this risk assessment.

3.3.1 Ingestion of Surface Water

This scenario investigates the risk from drinking water contaminated by accelerant residues on soil that dissolve or are eroded in runoff to a stream or river. For this scenario, it was assumed that a 71.8-kg adult drinks 1.51 L (0.4 gal) of water per day, and a six-year-old 22.6-kg child drinks 0.74 L (0.2 gal) per day, based on statistics presented in EPA (1999a). The following equation was used to calculate the dose to adults and children:

$$DOSE = CONC \times AMT / BW$$

where:

DOSE = dose from drinking contaminated water (mg/kg)
CONC = concentration of chemical in water (mg/L)
AMT = water consumption amount (L)
BW = body weight (kg)

Since estimation of residue concentrations in groundwater would require knowledge of site specific soil, climate, and hydrology, this route of exposure was not analyzed quantitatively in this assessment. However, it is expected that the risks would be less than those estimated for drinking surface water from the small stream, given the simplified, conservative approach used in this scenario.

3.3.2 Ingestion of Fish

In this scenario, it was assumed that an adult or child ingests fish caught in a stream or river after it receives storm water containing runoff from an area where accelerant residues are present. It was assumed that 0.113 kg of fish per day is ingested by an adult and 0.072 kg/day by a six-year-old child (EPA 1999a). This dose was calculated using the following equation:

$$DOSE = CONC \times BCF \times AMT / BW$$

where:

DOSE = dose from ingesting fish (mg/kg)
CONC = concentration of chemical in river (mg/L)
BCF = bioconcentration factor (mg/kg per mg/L)
AMT = fish consumption amount (kg)
BW = body weight (kg)

3.3.3 Incidental Soil Ingestion

In this scenario, it was assumed that an adult or child ingests soil incidental to recreational or occupational activities undertaken on areas where accelerant residues may be present in soil. It was assumed that a child ingests 400 mg/day, the upper percentile recommended by EPA (1999a). It was assumed that an adult conducting outdoor work ingests 480 mg/day, as reported in EPA (1999a). Further, it was assumed that at most 1% of an individual’s daily soil contact is in the specific location where the accelerant residue remains. This dose was calculated using the following equation:

$$DOSE = RATE \times CONC \times FRAC \times CF / BW$$

where:

DOSE = dose from incidental soil ingestion (mg/kg)
RATE = soil ingestion rate (mg/day)
CONC = estimated concentration of chemical in soil (ppm, equal to mg/kg)
FRAC = fraction of soil exposure in area with accelerant residue (unitless)
CF = conversion factor (kg soil / 1×10^6 mg soil)
BW = body weight (kg)

3.3.4 Lifetime Doses

Lifetime doses were calculated for the potential carcinogens evaluated in this risk assessment: the benzene component of gasoline and the gasoline additive MTBE. The lifetime dose was estimated by assuming that an individual has exposure from three pathways (drinking water, consuming fish, incidental soil ingestion) for a one-week period. The estimated total dose from these exposures was averaged over a typical 75-year lifetime (EPA 1999a).

3.4 Estimated Environmental Concentrations

To estimate doses using the quantitative approaches listed in the previous section, it is necessary to predict the environmental concentrations of the accelerant residues. Since the amount per area (for example, gallons per acre or mg per square meter) of accelerant used to ignite a prescribed burn will vary based on the site-specific requirements, environmental concentrations were estimated based on a per-unit basis for the various accelerants. That is, concentrations of accelerant residues in two representative environments were estimated for the following amounts of accelerant:

- Fusee: one 0.52-lb fusee
- Drip torch: one gallon of 1:3 gasoline:diesel fuel mix
- Helitorch, terra-torch, or hand-thrown gelled gasoline: one gallon of gelled gasoline
- Ping-pong balls: one ball
- Flares from launcher pistol: one flare
- Propane-fueled wand: no residues (or associated risks) are expected

Environmental characteristics of ecosystems where prescribed burns may occur can vary widely. Some of the potential areas of variation, and the corresponding effect on potential exposures, are as follows:

- *Soil type*. Some soils, such as clays or soils high in organic matter, are less permeable to water drainage through the soil column or tend to bind dissolved chemicals to the soil particles. Other soils, such as those with a higher sand content or lower organic matter, could have the opposite tendency. In addition to these examples, many additional soil characteristics factor into runoff or leaching potential.

- *Slope.* On relatively flat terrain, precipitation has a longer time frame in which to pool and potentially permeate the soil and enter groundwater, whereas areas with increasing slopes will be associated with a greater potential for runoff to surface water.

- *Precipitation.* If rain or snow (and subsequent snowmelt) occurs, accelerant residues could be mobilized from their location on the soils where they were applied, leaching to groundwater or running off to surface water. If little or no precipitation is present, the chemicals may persist longer in the soil, subject to transformations by sunlight or microorganisms in the soil.

- *Revegetation.* Once an area where accelerants were applied is covered with new vegetation, the soil itself (and any remaining accelerant residues) will be more shielded from direct contact by humans using the area.

- *Surface water.* The type of surface water present in an area, if any, can vary greatly. Some streams and ponds may be present only at certain times of year or after significant rainfall events. Others may be continually present. Larger lakes and rivers can contain volumes of water that would so dilute any accelerant residues entering them as to make the water concentration non-detectable. Lakes that are slowly recharged or slow-flowing rivers and streams may allow chemical concentrations to persist locally within them for longer periods of time, whereas fast-flowing, turbulent rivers would more quickly mix and dilute any entering chemical.

- *Watershed.* The size of a watershed will be associated with the amount of noncontaminated runoff potentially entering a river or stream, to further dilute any accelerant residue in the runoff itself and in the stream. In addition, vegetated areas between the location of residues and surface water can act as buffers, slowing or stopping overland transport.

These characteristics provide just a few examples of the complexities in estimating exposures from runoff or leaching of a chemical when no specific location in which the exposure occurs has been identified. To offer a wide range of applicability for the results of this risk assessment, the following approach was taken to estimated the potential exposures:

- Two representative watersheds were assumed. One is a small, one-acre drainage area with a perennial stream that has an average flow rate of 12 cubic feet per second (cfs); and the other is a 100-acre basin with a river that flows at 350 cfs. Ingestion of fish and drinking surface water were evaluated for each chemical in both watersheds, assuming that the residue enters the water either dissolved in runoff or sorbed to eroded soil over a 15-minute period following a 0.5-inch rainfall event. For gasoline and diesel fuel, for which the primary chemical components contributing toxicity to the fuels are also significantly volatile and would largely evaporate during the burn, it was assumed that 1% of the applied volume remains as a residue.

- In the soil ingestion scenario, it is assumed that no precipitation or other weathering occurs, allowing all of the residue to remain in the top two cm of soil, the evaluation depth recommended by EPA (1996c). It was further assumed that physical disturbance and wind distributed the residue from a single fusee, flare, or ping-pong ball, or 0.1 gallon of liquid or gelled fuel, over a one-square-meter area.

Table 3-1 lists the estimated soil and water concentrations for the fire accelerants and their associated residues.

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4.0 HUMAN HEALTH RISK CHARACTERIZATION

4.1 Introduction

This section characterizes the estimated risks to human health that may result from accelerant residues. In the risk characterization, the human doses estimated in the exposure assessment (Section 3.0) are compared with the toxicity characteristics described in the hazard assessment (Section 2.0), to arrive at estimates of risk.

Section 4.2 describes the methods used to evaluate human health risks, including both noncarcinogenic and carcinogenic risks. Section 4.3 contains the results of the quantitative risk characterization for the accelerant residues. Section 4.4 discusses the uncertainties in this risk assessment.

4.2 Methodology for Assessing Risks

Several of the fire accelerants may leave residues that are mixtures of several chemicals. Risks from these mixtures were evaluated following the recommendations of EPA (2000c): *Supplementary Guidance for Conducting Health Risk Assessment of Chemical Mixtures*. Specifically, the following approaches were applied:

- EPA states that "whenever possible, the preferred approach to the health risk evaluation of chemical mixtures is to perform the assessment using health effects and exposure data on the whole mixture." In the case of gasoline and diesel fuel, this approach was taken, since toxicity data on the mixture were available.

- EPA also stated that "even if a risk assessment can be made using whole-mixture data, it may be desirable to also conduct a risk assessment based on toxicity data on the components in the mixture . . . When a mixture contains component chemicals whose critical effects are of major concern, e.g., cancer or developmental toxicity, an approach based on the mixture data alone may not be sufficiently protective in all cases." This analytical approach was applied for the multiple-chemical residues from flares, and from gasoline plus its additive MTBE.

The assessment of risks for the residues and residue mixtures was conducted following the standard risk assessment methodology described in NRC (1983) and EPA (1989), summarized in the following paragraphs.

4.2.1 Noncarcinogenic Risk Estimation

In this risk assessment, the potential risks were evaluated by comparing the representative doses (estimated in the exposure assessment) with the RfDs (identified in the hazard assessment). All the RfDs used in this risk analysis take into account the possibility of multiple exposures and represent acceptable dose levels. The comparison of dose to RfD consists of a simple ratio, called the Hazard Quotient:

$$Hazard\ Quotient = \frac{Estimated\ Dose\ (mg/kg/day)}{RfD\ (mg/kg/day)}$$

If the estimated dose does not exceed the RfD, the hazard quotient will be one or less, indicating a negligible risk of noncarcinogenic human health effects. It is important to note two characteristics of the hazard quotient: (1) the greater the value of the hazard above one, the greater the level of concern; but (2) the level of concern does not increase linearly as the hazard quotient increases, because RfDs do not have equal accuracy or precision and are not based on the same severity of toxic effects. Thus, the interpretation of the potential toxic response associated with a particular hazard quotient can range widely depending on the chemical (EPA 1989).

A dose estimate that exceeds the RfD, although not necessarily leading to the conclusion that there will be toxic effects, clearly indicates a potential risk for adverse health effects. Risk is presumed to exist if the hazard quotient is greater than one. However, comparing doses from short-term exposures (such as those from fire accelerant residues) to RfDs that are designed to represent long-term exposures with repeated daily doses tends to exaggerate the risk from those limited events.

Following the guidance presented in EPA (2000c), the additive approach was used to sum the hazard quotients when more than one residue chemical from a particular accelerant was quantified in the analysis. In these cases, a hazard index for the residue mixture, representing the sum of the hazard quotients, was calculated. The hazard index is interpreted in the same manner as the hazard quotient; that is, risk is presumed to exist if the accelerant hazard index exceeds one.

4.2.2 Cancer Risk Estimation

As a result of the review of cancer studies presented in the Human Health Hazard Assessment (Section 2.0), a risk analysis for cancer was two components of the gasoline mixture: benzene, and the additive MTBE. Although lead is a potential accelerant residue that is a probable carcinogen, no quantitative cancer slope factor is available on which to base a cancer risk estimate.

The mechanism for cancer dose-response can be complex, and EPA is currently developing updated guidance for deriving cancer slope factors that are applicable to human health risk assessment from the results of studies in laboratory animals. In laboratory studies, high doses are used to elicit an observable cancer incidence in a finite group of test animals. Historically, carcinogenic effects were assumed to have no threshold, requiring extrapolation to compare exposures from the much lower doses associated with environmental exposure to chemicals. EPA's current guidance in force, the 1986 *Guidelines for Carcinogen Risk Assessmen*t, provided a basic rationale for linear dose-response assumptions in cancer risk assessment (EPA 1986). However, new perspectives on methods to assess risks of cancer are gaining wider acceptance, such as consideration of mode of action, thresholds for carcinogenicity, and incorporating other types of biological data. In 1996, EPA proposed revised guidelines for carcinogen risk assessment which address these (and other) issues, but they have not yet been finalized.

Estimation of cancer slope factors using updated methods is occurring on a chemical-by-chemical basis, as new laboratory studies are completed and new risk assessments are conducted. For the chemicals identified as known or possible human carcinogens in this risk assessment, a linear (no-threshold) approach was used in calculating the cancer slope factors, in accordance with the guidance that has been in effect.

Cancer risk from a chemical is expressed as the probability that cancer will occur over the course of a person's lifetime, as a result of the stated exposure. This risk probability is calculated as follows:

$$RISK = DOSE \times CSF \times OCC / LIFE$$

where:

RISK	=	the lifetime probability of cancer as a result of the specified exposure
DOSE	=	estimated dose (mg/kg/day)
CSF	=	cancer slope factor (per mg/kg/day)
OCC	=	number of occurrences of the daily dose during an individual's lifetime
LIFE	=	the number of days in a 75-year lifetime (27,375 days)

The resulting cancer probability is compared to a benchmark value of $1x10^{-6}$ (or 1 in 1 million), a value commonly accepted in the scientific community as representing a cancer risk that would result in a negligible addition to the background cancer risk of approximately one in four in the United States. In some occupational health risk assessments, cancer risks as high as $1x10^{-4}$ (1 in 10,000) can be considered acceptable. However, the benchmark of 1 in 1 million is used in this risk assessment.

4.3 Estimated Risks from Accelerant Residues

Tables 4-1 and 4-2 present the residues' estimated human health risks to adults and children, respectively, from the residue of one "unit" of fire accelerant.

The risk tables in this section use scientific notation, since many of the values are very small. For example, the notation 3.63E-001 represents 3.63×10^{-1}, or 0.363. Similarly, 4.65E-009 represents 4.65×10^{-9}, or 0.00000000465.

All accelerant residues resulted in hazard quotients less than one and cancer risks less than 1 in 1 million, indicating negligible risk from each unit of accelerant used to ignite prescribed burns.

To develop this information into a form that will be useful for planners, decisionmakers, and those who may conduct site-specific environmental impact assessments, Table 4-3 displays the maximum number of units per watershed (small or large) that would be associated with a conclusion of "negligible risk," based on the methodology of this risk assessment.

Table 4-1. Unit Risks to Human Health from Accelerant Residues—Adults

		Incidental	Small Stream		River	
Accelerant	**Residue**	**Soil Ingestion**	**Drinking Water**	**Eating Fish**	**Drinking Water**	**Eating Fish**
		--Hazard Index--				
Fusee	Strontium compounds	2.24E-03	2.37E-03	1.88E-01	6.02E-05	4.78E-03
Gasoline	Gasoline	7.47E-05	2.37E-03	ND**	6.02E-05	ND**
	MTBE	2.64E-03	8.36E-02	1.07E-02	2.12E-03	2.72E-04
	Additive Hazard Quotient	*2.71E-03*	*8.59E-02*	*1.07E-02*	*2.18E-03*	*2.72E-04*
Diesel fuel	Diesel fuel	1.71E-04	5.42E-03	ND**	1.38E-04	ND**
Gasoline + diesel fuel (Driptorch 1:3 mix)	Gasoline, MTBE, diesel fuel	8.06E-04	2.56E-02	ND**	6.49E-04	ND**
Gelling agent	Aluminum oxide	1.79E-06	5.67E-05	1.45E-03	1.44E-06	3.69E-05
Gelled gasoline	Gasoline, MTBE, aluminum oxide	2.71E-03	8.60E-02	1.22E-02	2.19E-03	3.09E-04
Ping-pong balls	Manganese dioxide	1.39E-04	4.42E-04	1.89E-02	1.12E-05	4.79E-04
Launcher pistol flares	Aluminum oxide	3.95E-04	1.25E-03	3.21E-02	3.18E-05	8.15E-04
	Calcium sulfate	ND†	ND†	ND†	ND†	ND†
	Iron oxide	8.77E-05	2.78E-04	2.38E-05	7.07E-06	6.04E-07
	Copper oxide	2.32E-03	7.36E-03	6.29E-02	1.87E-04	1.60E-03
	Lead*	2.74E-03	7.37E-03	ND‡	1.87E-04	ND‡
	Additive Hazard Quotient	*5.55E-03*	*1.63E-02*	*9.50E-02*	*4.13E-04*	*2.41E-03*
Propane	-none-					
		--Cancer Risk--				
Gasoline	Gasoline	1.26E-11	4.00E-10	ND**	1.02E-11	ND**
	MTBE	8.09E-10	2.56E-08	3.29E-09	6.52E-10	8.35E-11
	Total Cancer Risk	*8.21E-10*	*2.60E-08*	*3.29E-09*	*6.62E-10*	*8.35E-11*

*Hazard Index calculated as soil or water concentration relative to criteria listed in Section 2.3.7.

**No BCF was available for these chemical mixtures.

†No reference dose was found for calcium sulfate. However, the substance is "generally regarded as safe" in small amounts in food.

‡No reference dose or medium-specific criterions was identified for lead in ingested fish.

Table 4-2. Unit Risks to Human Health from Accelerant Residues—Children

		Incidental Soil Ingestion	Small Stream		River	
Accelerant	**Residue**		**Drinking Water**	**Eating Fish**	**Drinking Water**	**Eating Fish**
			--Hazard Index--			
Fusee	Strontium compounds	5.93E-03	3.69E-03	3.34E-01	9.37E-05	8.48E-03
Gasoline	Gasoline	1.98E-04	3.69E-03	ND**	9.37E-05	ND**
	MTBE	6.98E-03	1.30E-01	1.90E-02	3.31E-03	4.83E-04
	Additive Hazard Quotient	*7.18E-03*	*1.34E-01*	*1.90E-02*	*3.40E-03*	*4.83E-04*
Diesel fuel	Diesel fuel	4.53E-04	8.44E-03	ND**	2.14E-04	ND**
Gasoline + diesel fuel (Driptorch 1:3 mix)	Gasoline, MTBE, diesel fuel	2.13E-03	3.98E-02	ND**	1.01E-03	ND**
Gelling agent	Aluminum oxide	4.74E-06	8.83E-05	2.58E-03	2.24E-06	6.55E-05
Gelled gasoline	Gasoline, MTBE, aluminum oxide	7.18E-03	1.34E-01	2.16E-02	3.40E-03	5.48E-04
Ping-pong balls	Manganese dioxide	3.69E-04	6.88E-04	3.35E-02	1.75E-05	8.50E-04
Launcher pistol flares	Aluminum oxide	1.04E-03	1.95E-03	5.69E-02	4.95E-05	1.45E-03
	Calcium sulfate	ND†	ND†	ND†	ND†	ND†
	Iron oxide	2.32E-04	4.33E-04	4.21E-05	1.10E-05	1.07E-06
	Copper oxide	6.15E-03	1.15E-02	1.12E-01	2.91E-04	2.83E-03
	Lead*	2.74E-03	7.37E-03	ND‡	1.87E-04	ND‡
	Additive Hazard Quotient	*1.02E-02*	*2.12E-02*	*1.68E-01*	*5.39E-04*	*4.28E-03*
Propane	-none-					
			--Cancer Risk--			
Gasoline	Gasoline	3.34E-11	6.22E-10	ND**	1.58E-11	ND**
	MTBE	2.14E-09	3.99E-08	5.83E-09	1.01E-09	1.48E-10
	Total Cancer Risk	*2.17E-09*	*4.06E-08*	*5.83E-09*	*1.03E-09*	*1.48E-10*

*Hazard Index calculated as soil or water concentration relative to criteria listed in Section 2.3.7.

**No BCF was available for these chemical mixtures.

†No reference dose was found for calcium sulfate. However, the substance is "generally regarded as safe" in small amounts in food.

‡No reference dose or medium-specific criterions was identified for lead in ingested fish.

4.4 Discussion and Uncertainties

On a per-unit basis in the representative small and large watersheds, and from incidental soil ingestion, no health risks were predicted from potential residues remaining after the use of accelerants to ignite a prescribed burn. Table 4-3 provides estimates of the maximum amount of each accelerant that could be used and still be associated with an expectation of no risks to the health of adults or children. It is important to note that if a prescribed burn was conducted in a dry section of a watershed, the drinking water and fish consumption pathways would not exist, resulting in hazard indices and cancer risks of zero from these exposure routes.

In a supplemental information report prepared by the Forest Service, ranges of estimates were included of the quantity used of several ignition sources for a proposed prescribed burn. These estimates are provided in Table 4-4, along with a comparison to the risk threshold values summarized in Table 4-3.

Risks from dermal exposure to the accelerant residuals was not quantified; however, based on the conclusions of the soil ingestion scenario, in which residues are transferred to the mouth via soil contamination of the hands, no risks would be expected from these levels of exposure. The skin is less permeable to chemical substances than are mucous membranes such as those lining the gastrointestinal system; therefore, dermal absorption would be expected to be minimal compared to the estimated oral doses.

Risks from inhalation exposures were outside the scope of this assessment, requiring a complex analysis of simultaneous exposure to the products of burning vegetation to accurately depict the overall risk from inhalation at a prescribed burn. The use of the accelerant chemicals outdoors would be expected to be associated with exposures of short duration, as any inhalable gases or particles would be quickly dispersed throughout the atmosphere.

It is important to note that several conservative assumptions were made in conducting this analysis, necessitated by the generic nature of this assessment; the primary source of likely overestimation of exposure is the assumption that all of the accelerant residue is mobilized into surface water. For inorganic chemicals, the nature of the soil, its pH, oxidation-reduction environment, temperature, and presence of other chemicals can all affect the mobility of the chemical (Maidment 1993). For the organic chemicals in this analysis, the presence of moisture, sunlight, and microorganisms can contribute to their degradation on the soil surface; some of the components of the gasoline and diesel fuel chemical mixtures are also likely to volatilize during or after their application, decreasing the toxicity of the mixture as a whole by their removal. However, complete mobility and no degradation were assumed, so that the analysis would provide an upper bound on the potential exposures from any accelerant residues, and so that it would be highly unlikely that any actual risks would exceed those presented in this report.

The risks summarized in this assessment are not probabilistic estimates of risk, but are conditional estimates. That is, these risks are likely only if all exposure scenario assumptions that were described are met. The primary areas of uncertainty in this analysis include the precise chemical composition of accelerant residues; their actual environmental concentrations in soil and water; the predicted RfDs and cancer slope factors, which are based on studies in laboratory

Table 4-3. Maximum Units Associated with Negligible Human Health Risk

Accelerant	Unit	Maximum Number of Units Associated with Negligible Risk	
		Small Watershed*	Large Watershed**
Fusee	One 0.53-lb fusee	3	118
Gasoline + diesel fuel (Driptorch 1:3 mix)	One gallon	25	989
Gelled gasoline	One gallon†	7	294
Ping-pong balls	One ball	30	1176
Launcher pistol flares	One flare	6	234
Propane	Tank	NR‡	NR‡

*One acre with 12-cfs stream.

**100 acres with 350-cfs river.

†Assumed mix rate of 4 lb gelling agent/55 gallons gasoline.

‡No residues expected.

Table 4-4. Comparison of Ignition Source Quantities Used to Estimated Risks

Ignition Source	Estimated Range of Quantity Used (per acre)*	Maximum Units Associated with No Risk		Comments
		Small Watershed	Large Watershed	
Drip torch	1 - 3 gal	25	989	No risk from estimated range.
Helitorch	1 -3 gal	7	294	No risk from estimated range.
Fusee	10 - 40	3	118	Small drainage areas should be evaluated for human water use patterns (particularly potential fish consumption)
Flare	10 - 50	6	234	Small drainage areas should be evaluated for human water use patterns (particularly potential fish consumption)
Plastic sphere	10	30	1,176	No risk from estimated range.

*Source: USDA undated.

animals using standard extrapolation methods; and the quantity of a chemical to which an individual may actually be exposed, compared to the standard exposure assumptions recommended by EPA.

These uncertainties could be addressed by conducting laboratory and field studies and monitoring sites where prescribed burns have occurred. However, the use history of these chemicals and the highly site-specific and variable nature of prescribed burn characteristics would require application of a large margin of error, limiting the utility of any studies in providing greater confidence in the risk conclusions.

5.0 ECOLOGICAL PROBLEM FORMULATION

This section presents the results of the ecological risk assessment problem formulation, in which the purpose of the ecological risk assessment is provided, the problem is defined, and a plan for analyzing and characterizing risk is determined. Section 5.1, integrating available information, identifies and characterizes the stressors, the ecological effects expected or observed, the receptors, and ecosystem potentially affected. Section 5.2 describes the assessment endpoints for the ecological risk assessment. Section 5.3 presents the conceptual model describing key relationships between the stressors and assessment endpoints. Section 5.4 summarizes the analysis plan that includes the design of the assessment, data needs, measures that will be used to evaluate risk hypotheses, and methods for conducting the analysis phase of the assessment.

5.1 Integration of Available Information

In this ecological risk assessment, the potential stressors are the accelerant residues on the site of a prescribed burn. The information presented in Sections 1.1 and 1.2 of this report provides detail on the types of fire accelerants that may be used to ignite a prescribed burn, their chemical nature, and the potential residues that may be left on the soil after the project. The amount and type of accelerant used in a particular prescribed burn will vary. Therefore, risks from all accelerant methods were evaluated, and the estimated environmental concentrations of the potential residues were associated with the accelerants on a per-unit basis (Section 3.4), to facilitate the utility of the conclusions of this risk assessment.

The ecological effects that may be associated with the accelerant residues are those associated with direct toxicity to wildlife species that encounter the chemicals. The impacts of the prescribed burn itself on wildlife are not within the scope of this analysis.

The receptors in this ecological risk assessment were selected to represent a range of wildlife species. These receptors include mammals, birds, reptiles, amphibians, fish, and aquatic invertebrates. In addition, exposures to these representative species were also compared to risk criteria relevant to endangered, threatened, and sensitive species that could occupy the same ecological “niche”.

There is wide variation in the type of habitat on which accelerants could be used to ignite a prescribed burn, including grass, shrubs, and forested areas.

5.2 Assessment Endpoints

Assessment endpoints are selected based on three criteria: ecological relevance, susceptibility to stressors, and relevance to management goals (EPA 1998). For species that are endangered, threatened, or sensitive, the assessment endpoint selected is individual survival, growth, and reproduction. For non-sensitive species, the assessment endpoint selected is the survival of populations.

Scenarios describing the potential impacts of accelerant residues on the assessment endpoints are developed in the conceptual model described in the next section.

5.3 Conceptual Model

A conceptual model consists of a risk hypothesis that describes relationships between the stressor, exposure, and assessment endpoint response; and a diagram illustrating these relationships. For the accelerant residues, the risk hypothesis is as follows.

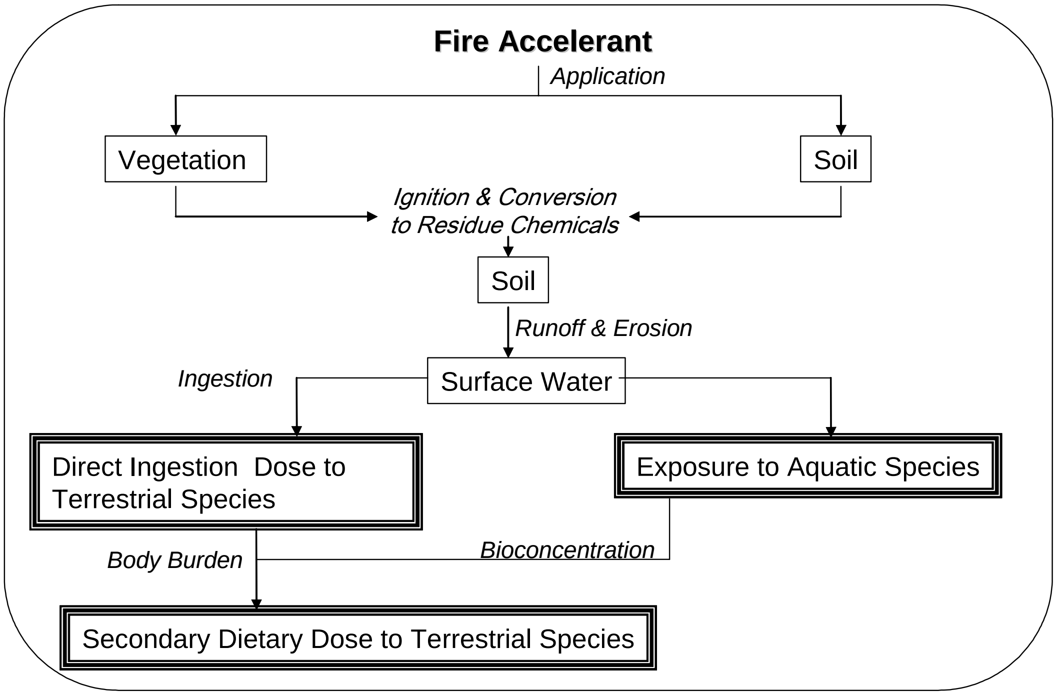
Risk Hypothesis
Residual chemicals from fire accelerants are toxic to wildlife species at various levels of exposure, based on laboratory and field tests that have characterized exposure-response relationships. The associated hypothesis is that use of accelerants to ignite prescribed burns will cause chemical toxicity from the accelerant residues, resulting in adverse effects to the individual's survival, growth, and reproduction for sensitive species, or to the survival of populations of non-sensitive species.

To test this hypothesis, a conceptual model was developed to illustrate the relationships between stressors, exposure routes, and receptors. The conceptual model is presented in Figure 5-1.

5.4 Analysis Plan

Based on the conceptual model, terrestrial and aquatic species exposure scenarios were selected to evaluate risks to ecological resources.

Figure 5-1. Conceptual Model



Representative terrestrial and aquatic species and their characteristics were identified, illustrating the various types of residue exposure for wildlife species. Using the results of the environmental fate assessment described in Section 3.4, environmental exposures were estimated, in terms of dose (mg/kg) for terrestrial species or concentration (mg/L) for aquatic species.

The toxic properties of each residual chemical to wildlife species were researched and summarized, using data available in scientific journals, reference books, and government sources. Endpoints were identified, consisting of median lethal doses (LD_{50}s) for terrestrial species and median lethal concentrations (LC_{50}s) for aquatic species.

The doses and concentrations identified in the exposure characterization were compared to the toxic properties identified in the effects characterization, using the guidelines specified by EPA for interpreting risk estimates to general wildlife and to endangered, threatened, or sensitive species.

6.0 ECOLOGICAL ANALYSIS

6.1 Data and Models for Analysis

A combination of laboratory study data, field study data, and modeling outputs were used in the ecological risk assessment.

A literature search was conducted to identify LD_{50}s (median lethal doses) and LC_{50}s (median lethal concentrations) for the accelerant residues. These values were used to represent the toxicity of the chemicals to the representative wildlife species.

The estimated environmental concentrations listed in Table 3-1 were used in the ecological risk assessment.

6.2 Characterization of Exposure

6.2.1 Terrestrial Species

The terrestrial species exposure scenario postulates that a variety of terrestrial wildlife species may be present at or near a site at which a prescribed burn has occurred. The scenario further postulates that these terrestrial species may be exposed to any accelerant residues through ingestion of surface water that has received runoff and, where appropriate, ingestion of terrestrial or aquatic species containing a body burden of accelerant residues.

The list of representative species is as follows:

Mammals
- Deer mouse (herbivore)
- Mink (carnivore/piscivore)

Birds
- Northern bobwhite (herbivore)
- Red-tailed hawk (raptor)
- Great blue heron (piscivore)

Reptiles/Amphibians
- Painted turtle (herbivore/piscivore)
- Racer (carnivore)

These particular wildlife species were selected because they represent a range of foraging habitat and diets relevant to the environmental fate of the residue chemicals, and for which parameters are generally available.

For each species, characteristics were identified that were used in estimating doses of the residue chemicals, including body weight, water intake, dietary intake, composition of diet, and home range/foraging area.

For terrestrial wildlife, exposures were assumed to occur through ingestion of food with body burden, and ingestion of water from small streams. Predators that feed on other animals were assumed to receive the total body burden that each of the prey species received. Wildlife that feed on aquatic species were assumed to receive residue levels based on the chemical concentrations in water and the associated bioconcentration factors. Chemical concentrations in drinking water sources for wildlife were assumed to be those predicted for a small stream in a one-acre watershed, as presented in Section 3.4.

To calculate doses for terrestrial wildlife, the doses from the exposure routes described in the preceding paragraph were summed, as follows:

$$DOSE = \left[\left(FRAC_t \times DIET_t \times BB\right) + FRAC_w \times CONC \times \left(DIET_w \times BCF + H2O\right)\right] \div BW$$

where:

DOSE = dose to wildlife species (mg/kg)
$FRAC_t$ = fraction of terrestrial diet assumed to be contaminated*
$DIET_t$ = daily dietary intake of other terrestrial animal species (kg)
BB = body burden of terrestrial prey items (mg/kg)
$FRAC_w$ = fraction of aquatic diet assumed to be contaminated**
CONC = concentration of chemical in small stream (mg/L)
$DIET_w$ = daily dietary intake of aquatic species (kg)
BCF = bioconcentration factor (mg/kg per mg/L)
H2O = daily water intake (L)
BW = body weight (kg)

*equivalent to 1 m^2, the soil area assumed to contain residues from one unit of accelerant, divided by the species' foraging area (m^2)
6 **assumed to be 1/3, since water flow will move stream concentration of chemical out of local area

6.2.2 Aquatic Species

The aquatic species exposure scenario postulates that fish, tadpoles, and aquatic invertebrates in streams or rivers may be exposed to accelerant residues as a result of chemicals in runoff coming from areas to which the accelerants were applied.

For each chemical, risks were estimated for general fish species, for the water flea (daphnid species) as a representative aquatic invertebrate, and for tadpoles, representing the aquatic stage of amphibians.

The concentrations of the accelerant residues were estimated using the approach described in Section 3.4 and listed in Table 3-1.

6.3 Characterization of Ecological Effects: Ecological Response Analysis and Stressor-Response Profiles

The most commonly used measurement of terrestrial species toxicity in ecological risk assessments is the acute toxicity test. Acute toxicity studies are used primarily to determine the toxicity reference level known as the median lethal dose (LD_{50}), which is the dose that kills 50 percent of the test animals within 14 days of administering a substance. The lower the LD_{50}, the greater the toxicity of the chemical. Toxic symptoms displayed by the animals are recorded throughout the study, and tissues and organs may be examined for abnormalities at the end of the test. In most cases, toxicity studies with laboratory animals such as rats and mice have been used because of the lack of specific wildlife studies. The results of laboratory animal studies are considered to be representative of the effects that would occur in similar species in the wild. Acute toxicity studies are also sometimes available for common avian species, such as bobwhite quail. The toxicity values identified in the following section include oral LD_{50}s for laboratory and field species, as available.

For aquatic species, the LC_{50} is the water concentration that is lethal to half the test population, and is presented in terms of milligrams per liter (mg/L).

The available ecotoxicity data for the accelerant residues are summarized in Tables 6-1 and 6-2 for terrestrial and aquatic species, respectively. If no data are displayed for a particular animal group (e.g., amphibians) for a chemical, it is because no studies were identified with that endpoint during the literature search.

Table 6-1. Ecotoxicity to Terrestrial Species

Accelerant Residue	Test Species	LD_{50} (mg/kg)	Reference
Aluminum oxide	Rat	162	ATSDR 1999a
	Mouse	164	ATSDR 1999a
	Northern bobwhite	>2,303	EPA 2002b
	Japanese quail	1,439	EPA 2002b
Calcium sulfate	No data		
Copper oxide	Rat	376 (lowest lethal dose)	ATSDR 1999b
	Domestic chicken	626	Eisler 1998
Diesel fuel	Rat	7,400	CONCAWE 1996
	Mallard	20	NPS 1997
Gasoline	Rat	14,063	ATSDR 1995
Iron oxide	Mice	5,400 (intraperitoneal)	DHHS 1987
Lead	Dog	1,307 (lowest lethal dose, estimated)	ATSDR 1999c
	Japanese quail	875	HSDB 2002
Manganese dioxide	Rat	17,803	ATSDR 2000
MTBE	Rat	2,962	HSDB 2002
Potassium chloride, potassium hydroxide	Not quantified for terrestrial species; see Section 2.3.10		
Silicon dioxide	Chemically unreactive in the environment, occurs naturally in various forms and is practically non-toxic to non-target organisms.	NA	EPA 1991b
Strontium compounds	Rat	1,139	Oxford 2002

Table 6-2. Ecotoxicity to Aquatic Species

Accelerant Residue	Test Species	LC_{50} (mg/kg)	Reference
Aluminum oxide	Rainbow trout	1.17	EPA 2002b
	Daphnia spp.	2.6	EPA 2002b
	Jefferson salamander	1.4	Pauli et al. 2000
Calcium sulfate	Bluegill sunfish	>2,980	EPA 2002b
	Daphnia magna	>1,970	EPA 2002b
Copper oxide	Rainbow trout	25.4	EPA 2002b
	Ceriodaphnia dubia	0.035	Eisler 1988
Diesel fuel	Rainbow trout	21	Chevron 2001a
	Daphnia magna	20	Chevron 2001a
	Wood frog	4.2	CONCAWE 1996
Gasoline	Rainbow trout	2.7	Chevron 2001b
	Daphnia magna	3.0	Chevron 2001b
Iron oxide	Iron oxide equivalent of iron ambient water quality criterion for protection of freshwater aquatic life	2.9	EPA 1999b
Lead	Rainbow trout	1.17	EPA 2002b
	Daphnia magna	4.4	EPA 2002b
	Northern leopard frog	105	Eisler 1988
Manganese dioxide	Rainbow trout	7.64	Reimer 1988
	Daphnia magna	7.4	Reimer 1988
MTBE	Rainbow trout	880	Johnson 1998
	Ceriodaphnia dubia	340	Johnson 1998
	European common frog	2,000*	Pauli et al. 2000
Potassium chloride, potassium hydroxide	Potassium chloride equivalent of chloride ambient water quality criterion for protection of freshwater aquatic life	230	EPA 1999b
Silicon dioxide	Chemical unreactive in the environment, occurs naturally in various forms and is practically non-toxic to non-target organisms.	NA	EPA 1991b
Strontium compounds	Rainbow trout	0.049**	EPA 2002b
	Eastern narrowmouth toad	0.16†	Pauli et al. 2000

*No lethality observed at this concentration, no LC_{50} available.
**LC_{10}, no LC_{50} available.
†Seven-day LC_{50}, not comparable to exposure durations in this risk assessment.

7.0 ECOLOGICAL RISK CHARACTERIZATION

Risk characterization is the last step in the ecological risk assessment process. The exposure profile is compared to the stressor-response profile, to estimate the likelihood of adverse effects.

7.1 Risk Estimation

By comparing the exposure profile data (estimated dose or water concentration) to the stressor-response profile data (LD_{50}s, LC_{50}s), an estimate of the possibility of adverse effects can be made. The levels of concern are determined following the quotient methodology used by EPA's Office of Pesticide Programs. The quotient is the ratio of the exposure level to the hazard level. For acute exposures, the levels of concern at which a quotient is concluded to reflect risk to non-target species are as follows:

- Terrestrial species (general): 0.5, where dose equals one-half the LD_{50}.
- Terrestrial species (endangered, threatened, sensitive): 0.1, where dose equals one-tenth the LD_{50}.
- Aquatic species (general): 0.5, where water concentration equals one-half the LC_{50}.
- Aquatic species (endangered, threatened, sensitive): 0.05, where water concentration equals one-twentieth the LC_{50}.

Tables 7-1 through 7-3 summarize the estimated risks to terrestrial species, and Table 7-4 summarizes the estimated risks to aquatic species. Ecological risks for each accelerant residue are presented on a per-unit basis, as previously described in the assessment of human health risks.

The risk tables in this section use scientific notation, since many of the values are very small. For example, the notation 3.63E-001 represents 3.63×10^{-1}, or 0.363. Similarly, 4.65E-009 represents 4.65×10^{-9}, or 0.00000000465.

7.2 Estimated Risks to Terrestrial Wildlife

Risks to General Species

On a per-unit basis, no risks from the fire accelerant residues are predicted for terrestrial wildlife species.

Although some terrestrial invertebrates in an area with accelerant residues in the soil may be exposed to accelerant residues and may constitute a portion of the dose to insectivorous wildlife species, populations of beneficial insects as a whole are not expected to suffer adverse impacts because the accelerant applications are quite dispersed over the landscape within a defined burn area.

Table 7-1. Unit Risks to Mammalian Wildlife

		Risk Quotient	
Accelerant	**Residue**	**Deer Mouse**	**Mink**
Fusee	Strontium compounds	1.13E-05	1.77E-03
Gasoline	Gasoline	9.13E-07	1.60E-07
	MTBE	7.65E-05	3.28E-05
	Additive Hazard Quotient	*7.74E-05*	*3.29E-05*
Diesel fuel	Diesel fuel	2.45E-06	4.30E-07
Gasoline + diesel fuel (Driptorch 1:3 mix)	Gasoline, MTBE, diesel fuel	2.12E-05	8.56E-06
Gelling agent	Aluminum oxide	1.18E-05	6.07E-04
Gelled gasoline	Gasoline, MTBE, aluminum oxide	8.92E-05	6.40E-04
Ping-pong balls	Manganese dioxide	4.93E-08	4.17E-06
Launcher pistol flares	Aluminum oxide	2.61E-04	1.34E-02
	Calcium sulfate	ND	ND
	Iron oxide	2.93E-07	1.01E-07
	Copper oxide	6.02E-06	1.03E-04
	Lead	1.61E-08	1.17E-07
	Additive Hazard Quotient	*2.67E-04*	*1.35E-02*
Propane	-none-		

Table 7-2. Unit Risks to Birds

		Risk Quotient		
Accelerant	**Residue**	**Northern Bobwhite**	**Great Blue Heron**	**Red-Tailed Hawk**
Fusee	Strontium compounds	2.27E-06	3.28E-03	5.00E-05
Gasoline	Gasoline	1.84E-07	7.21E-08	4.05E-06
	MTBE	1.54E-05	4.19E-05	1.92E-05
	Additive Hazard Quotient	*1.56E-05*	*4.20E-05*	*2.33E-05*
Diesel fuel	Diesel fuel	1.83E-04	7.15E-05	2.85E-03
Gasoline + diesel fuel (Driptorch 1:3 mix)	Gasoline, MTBE, diesel fuel	1.41E-04	6.41E-05	2.14E-03
Gelling agent	Aluminum oxide	1.70E-07	1.26E-04	3.96E-05
Gelled gasoline	Gasoline, MTBE, aluminum oxide	1.58E-05	1.68E-04	6.29E-05
Ping-pong balls	Manganese dioxide	9.95E-09	7.71E-06	3.20E-06
Launcher pistol flares	Aluminum oxide	3.74E-06	2.79E-03	3.96E-05
	Calcium sulfate	ND	ND	ND
	Iron oxide	5.92E-08	1.15E-07	1.06E-05
	Copper oxide	7.29E-07	1.13E-04	9.11E-05
	Lead	4.84E-09	3.17E-07	6.51E-05
	Additive Hazard Quotient	*4.54E-06*	*2.90E-03*	*2.06E-04*
Propane	-none-			

Table 7-3. Unit Risks to Reptiles and Amphibians

		Risk Quotient	
Accelerant	**Residue**	**Painted Turtle**	**Racer**
Fusee	Strontium compounds	2.06E-03	9.80E-12
Gasoline	Gasoline	3.20E-08	7.94E-13
	MTBE	2.53E-05	6.65E-11
	Additive Hazard Quotient	*2.53E-05*	*6.73E-11*
Diesel fuel	Diesel fuel	3.18E-05	7.88E-10
Gasoline + diesel fuel (Driptorch 1:3 mix)	Gasoline, MTBE, diesel fuel	3.02E-05	6.08E-10
Gelling agent	Aluminum oxide	7.07E-04	1.04E-11
Gelled gasoline	Gasoline, MTBE, aluminum oxide	7.32E-04	7.77E-11
Ping-pong balls	Manganese dioxide	4.86E-06	4.29E-14
Launcher pistol flares	Aluminum oxide	1.56E-02	2.29E-10
	Calcium sulfate	ND	ND
	Iron oxide	6.80E-08	2.55E-13
	Copper oxide	1.19E-04	5.23E-12
	Lead	1.99E-07	2.09E-14
	Additive Hazard Quotient	*1.57E-02*	*2.35E-10*
Propane	-none-		

Table 7-4. Unit Risks to Aquatic Species

		Hazard Quotient					
		Small Stream			Large River		
Accelerant	**Residue**	**Fish**	**Aquatic Invertebrate**	**Amphibian**	**Fish**	**Aquatic Invertebrate**	**Amphibian**
Fusee	Strontium compounds	ND	ND	ND	ND	ND	ND
	Potassium chloride	9.41E-05	9.41E-05	9.41E-05	2.39E-06	2.39E-06	2.39E-06
	Additive Hazard Quotient	*9.41E-05*	*9.41E-05*	*9.41E-05*	*2.39E-06*	*2.39E-06*	*2.39E-06*
Gasoline	Gasoline*	9.51E-03	8.56E-03	ND	2.42E-04	2.17E-04	ND
	MTBE	1.35E-03	3.51E-03	ND	3.44E-05	8.91E-05	ND
	Additive Hazard Quotient	*1.09E-02*	*1.21E-02*	*ND*	*2.76E-04*	*3.07E-04*	*ND*
Diesel fuel	Diesel fuel	8.22E-04	8.29E-04	2.27E-02	2.09E-05	2.11E-05	5.77E-04
Gasoline + diesel fuel (Driptorch 1:3 mix)	Gasoline, MTBE, diesel fuel	1.17E-02	1.29E-02	2.27E-02	2.97E-04	3.28E-04	5.77E-04
Gelling agent	Aluminum oxide	8.71E-03	3.92E-03	7.28E-03	2.21E-04	9.96E-05	1.85E-04
Gelled gasoline	Gasoline, MTBE, aluminum oxide	1.96E-02	1.60E-02	7.28E-03	4.97E-04	4.06E-04	1.85E-04
Ping-pong balls	Manganese dioxide	6.05E-04	6.24E-04	ND	1.54E-05	1.59E-05	ND
Launcher pistol flares	Aluminum oxide	1.92E-01	8.65E-02	1.61E-01	4.89E-03	2.20E-03	4.08E-03
	Calcium sulfate	1.60E-05	2.42E-05	ND	4.06E-07	6.14E-07	ND
	Iron oxide	2.87E-03	2.87E-03	2.87E-03	7.30E-05	7.30E-05	7.30E-05
	Copper oxide	4.69E-04	3.40E-01	ND	1.19E-05	8.64E-03	ND
	Potassium chloride	2.79E-07	2.79E-07	2.79E-07	7.08E-09	7.08E-09	7.08E-09
	Lead	9.45E-05	2.74E-07	1.05E-06	2.40E-06	6.95E-09	2.67E-08
	Additive Hazard Quotient	*1.96E-01*	*4.30E-01*	*1.64E-01*	*4.97E-03*	*1.09E-02*	*4.16E-03*
Propane	-none-						

*Concentration adjusted to reflect only benzene, toluene, ethylbenzene, and xylene (BTEX), to correspond to LC50 data.

No excess risks to terrestrial plants existing at the time of the burn from the accelerant residues are expected, since the prescribed burn's objective is to remove vegetation from the area. Some of the residues may have localized effects on regrowth vegetation, in the specific locations where any residues remain in the soil. Efroymson et al. (1997) evaluated the effects of soil concentrations of chemicals on plants. Adsorption of chemicals to soil can greatly decrease their availability for plant uptake. The organic carbon partition coefficient (K_{oc}) is a measure of soil adsorption. K_{oc}s for diesel fuel and gasoline, as mixtures, were identified in the literature search conducted to support this risk assessment. Diesel fuel is more strongly held to soil particles, while gasoline is more mobile. These mixtures are also subject to degradation by chemical and biological processes, which would steadily reduce any residue remaining in the soil during and after vegetative regrowth. Also, for metallic compounds, Efroymson and colleagues stated that, in addition to the metal species' characteristics, the potential for uptake is greatly determined by site-specific parameters: "Soil characteristics (e.g., pH, clay and organic matter content and type, and moisture content) also determine availability to plants by controlling speciation of the element, temporary immobilization by particle surfaces (adsorption-desorption processes), precipitation reactions, and availability in soil solution . . . Although particulate soil organic matter serves to immobilize metals, soluble organic matter may act to keep metals in solution in a form absorbed and translocated by plants." The authors established soil screening benchmarks for several chemicals in soil based on their effects on plants. The estimated localized concentrations of aluminum from a flare could exceed this level; however, the residue (and any effects on vegetation) would be so localized in the area of flare residues that no significant effect to vegetation or regrowth within a landscape would be expected.

Risks to Endangered, Threatened, and Sensitive Species

The hazard quotients estimated in Tables 7-1 through 7-3 were reviewed to determine if any exceeded the sensitive species threshold of 0.1. No quotients greater than 0.1 were identified. Therefore, on a per-unit basis, no risks to endangered, threatened, or sensitive terrestrial species are expected.

7.3 Estimated Risks to Aquatic Wildlife

Stream concentrations, summarized in Table 3-1, are compared to the LC_{50}s presented in Table 6-2, to calculate the risk quotients for aquatic species.

Risks to General Species

Per-unit hazard quotients for fish, aquatic invertebrates, or aquatic stages of amphibians are all less than the risk criterion of 0.5, indicating no risks to general aquatic species are expected.

Risks to Endangered, Threatened, and Sensitive Species

In the small representative watershed, the hazard quotients for fish and aquatic stages of amphibians from aluminum oxide residues from launcher pistol flares slightly exceeds the sensitive species risk criterion of 0.05. No risks were predicted for sensitive species in larger rivers.

7.4 Risk Discussion and Uncertainties

As in the human health risk assessment, the per-unit ecological risk conclusions were translated into the maximum number of units per watershed that would be associated with a conclusion of "negligible risk," based on the methodology of the ecological risk assessment. These results are presented in Table 7-5, and represent only the chemicals for which ecotoxicity data were available with which to quantify risks.

Table 7-5. Maximum Units Associated with Negligible Ecological Risk

		Maximum Number of Units Associated with Negligible Risk	
Accelerant	**Unit**	**Small Watershed***	**Large Watershed****
Fusee	One 0.53-lb fusee	153	209084
Gasoline + diesel fuel (Driptorch 1:3 mix)	One gallon	22	866
Gelled gasoline	One gallon†	26	1005
Ping-pong balls	One ball	801	31509
Launcher pistol flares	One flare	1	46
Propane	Tank	NR‡	NR‡

*One acre with 12-cfs stream; accounts for risks to terrestrial and aquatic species.

**100 acres with 350-cfs river; reflects only risks to aquatic species (all terrestrial species exposures assumed small stream).

†Assumed mix rate of 4 lb gelling agent/55 gallons gasoline.

‡No residues expected.

In a supplemental information report prepared by the Forest Service, ranges of estimates were included of the quantity used of several ignition sources for a proposed prescribed burn. These estimates are provided in Table 7-6, along with a comparison to the risk threshold values summarized in Table 7-5.

Widespread exposures to entire populations of wildlife species through environmental pathways are not expected, since the accelerants are used in small amounts in “scattered” patterns over defined areas.

No per-unit risks were predicted for general or sensitive terrestrial species, nor for general aquatic species. In the small representative watershed, the hazard quotients for fish and aquatic

Table 7-6. Comparison of Ignition Source Quantities Used to Estimated Risks

		Maximum Units Associated with No Risk		
Ignition Source	**Estimated Range of Quantity Used (per acre)[*]**	**Small Watershed**	**Large Watershed**	**Comments**
Drip torch	1 - 3 gal	22	866	No risk from estimated range.
Helitorch	1 -3 gal	26	1,005	No risk from estimated range.
Fusee	10 - 40	153	209,084	Small drainage areas should be evaluated for the presence of sensitive aquatic species
Flare	10 - 50	1	46	Areas to be burned should be evaluated for the presence of sensitive aquatic species
Plastic sphere	10	801	31,509	No risk from estimated range.

[*] Source: USDA undated.

stages of amphibians from aluminum oxide residues from launcher pistol flares slightly exceed the sensitive species risk criterion of 0.05. This screening-level conclusion indicates that impacts to small streams containing endangered, threatened, or sensitive aquatic species in the proximity of a proposed prescribed burn should be evaluated based on site-specific characteristics, to ensure that no toxicity from fire accelerant residues poses a risk of adverse effects to such species. This review should be conducted in concert with the pre-project evaluation of the potential effects of the prescribed burn itself on any adjacent aquatic habitat containing protected species. No risks were predicted for sensitive species in larger rivers, which offer greater dilution potential as a result of the river's water volume plus a greater amount of uncontaminated runoff from the larger drainage basin.

It is important to note that there are many conservative assumptions in this analysis that are prompted by the nature of the available information. In particular, a significant source of potential overestimation of risk to aquatic species is the use of 48- or 96-hour LC_{50}s, which are compared to stream and river concentrations at their initial peak loading value, prior to any longitudinal dispersion, hydrolysis, volatilization, degradation, or sorption to sediment, which would rapidly decrease chemical concentrations in the water column below the starting levels. That is, toxicity data from two- to four-day laboratory studies are being compared to stream concentrations that would be expected to be significantly reduced, likely to negligible levels, within 12 to 24 hours at the most. Also, the analytical approach did not reduce the initial residue levels on the soil to account for degradation, evaporation, binding, or other mechanisms that can reduce or remove a chemical from a given environmental transport and exposure route; and also assumed that all the mass of the identified residue chemicals remained as a solid or liquid on the soil, while a significant amount is actually likely to be dispersed in the air during the burning process. The environmental fate processes are dependent on site-specific parameters, including soil types; temperature; soil moisture; other chemicals present in the environment; pH, hardness, and turbulence of surface water; and many others. As a result of simplifying the environmental fate calculations to be independent of these site-specific variables, the results presented in this assessment provide a reasonable upper bound on the potential risks from accelerant residues.

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U.S. Environmental Protection Agency. 1996c. Soil screening guidance: User's guide. Publication 9355.4-23. Office of Solid Waste and Emergency Response. Washington, DC.

U.S. Environmental Protection Agency. 1997. Drinking water advisory: Consumer acceptability advice and health effects analysis on methyl tertiary-butyl ether (MtBE). EPA-822-F-97-009. Office of Water. Washington, DC.

U.S. Environmental Protection Agency. 1998. Guidelines for ecological risk assessment. EPA/630/R-95/002F. Risk Assessment Forum. Washington, DC.

U.S. Environmental Protection Agency. 1999a. Exposure factors handbook (EFH). EPA/600/C-99/001. Office of Research and Development. Washington, DC.

U.S. Environmental Protection Agency. 1999b. National recommended water quality criteria--Correction. EPA 822-A-99-01. Office of Water. Washington, DC.

U.S. Environmental Protection Agency. 2000a. Risk characterization handbook. EPA 100-B-00-002. Science Policy Council. Washington, DC.

U.S. Environmental Protection Agency. 2000b. Integrated risk information system—benzene. Office of Research and Development. Cincinnati, OH.

U.S. Environmental Protection Agency. 2000c. Supplementary guidance for conducting health risk assessment of chemical mixtures. EPA/630/R-00/002. Risk Assessment Forum Technical Panel. Washington, DC.

U.S. Environmental Protection Agency. 2002a. Integrated risk information system. Office of Research and Development. Cincinnati, OH.

U.S. Environmental Protection Agency. 2002b. Ecotox database. Mid-Continent Ecology Division, National Health and Environmental Effects Research Laboratory, Office of Research and Development. Duluth, MN.

U.S. National Park Service. 1997. Environmental contaminants encyclopedia: Diesel oil entry. Water Resources Division, Water Operations Branch. Fort Collins, CO.

ATTACHMENT 1:
SUMMARY OF LITERATURE SEARCH

Aluminum Oxide, CAS #1344-28-1 (Al_2O_3, aluminum trioxide, alumina)

Data Point	Data Summary	Reference
Water solubility	Practically insoluble 0.000098 g/100 cc = 0.0000098 mg/L	Budavari et al. 1989 ATSDR 1999
K_{oc}		
Soil half-life	No degradation.	ATSDR 1999
BCF	BCFs are less than 300 in fish, since aluminum is highly toxic to fish species.	ATSDR 1999
Ingestion toxicity	A minimal risk level of 2.0 mg/kg/day was estimated for intermediate (15 to 364 days) oral exposure, based on the most sensitive toxicity endpoint (neurotoxicity) identified in studies in laboratory animals.	ATSDR 1999
Carcinogenicity	Chronic ingestion studies in mice and rats using aluminum potassium sulfate or aluminum phosphide led reviewers to conclude that aluminum has not demonstrated carcinogenicity in laboratory animals.	ATSDR 1999
Mammalian tox	Oral LD_{50}s are 162 and 164 mg/kg in rat and mouse, respectively.	ATSDR 1999
Avian tox	14-day LD_{50} >8,000 mg/kg in northern bobwhite and 4,997 in Japanese quail for monoethyl ester phosphonic acid aluminum salt (CAS # 39148-24-8), equivalent to >2,303 and 1,439 mg Al_2O_3/kg, respectively.	EPA 2002
Fish toxicity	96-hour LC_{50} in rainbow trout = 0.310 mg Al/L, equal to 1.17 mg Al_2O_3/L	EPA 2002
Aq. invert. tox	24-hour LC_{50}s in water fleas (Daphnia spp.) were 2.6 and 3.5 mg/L	EPA 2002
Aq. amph. tox	96-hour LC_{50} for aluminum in Jefferson salamander embryos is approximately 0.38 mg/L, equivalent to 1.4 mg Al_2O_3/L LC_{10} (NOEC) was 0.3 mg/L, 24-hour LC_{50} was 0.5 mg/L, LC_{100} was 0.7 mg/L for aluminum in common toad embryos 7-day LC_{50} for aluminum in eastern narrowmouth toad embryo-larvae was 0.05 mg/L	Pauli et al. 2000

Agency for Toxic Substances and Disease Registry. 1999. Toxicological profile for aluminum. Atlanta, GA. http://www.atsdr.cdc.gov/toxprofiles/tp22.html

ATSDR. See Agency for Toxic Substances and Disease Registry.

Budavari, S., M.J. O'Neil, A. Smith, and P.E. Heckelman, eds. 1989. *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals.* Merck and Co., Inc. Rahway, NJ.

EPA. See U.S. Environmental Protection Agency.

Pauli, B.D., J.A. Perrault, and S.L. Money. 2000. RATL: A database of reptile and amphibian toxicology literature. Technical Report Series No. 357. Canadian Wildlife Service, Headquarters, Hull, Québec, Canada. http://www.cws-scf.ec.gc.ca/nwrc/ratl/about_e.htm

U.S. Environmental Protection Agency. 2002. Ecotox database: Aluminum. Mid-Continent Ecology Division, National Health and Environmental Effects Research Laboratory, Office of Research and Development. Duluth, MN. http://www.epa.gov/ecotox/

Relevant sections of ATSDR ToxFAQs document:

ToxFAQs^{TM} for Aluminum, CAS# 7429-90-5, June 1999

HIGHLIGHTS: Everyone is exposed to low levels of aluminum from food, air, and water. Exposure to high levels of aluminum may result in respiratory problems.

Aluminum occurs naturally and makes up about 8% of the surface of the earth. It is always found combined with other elements such as oxygen, silicon, and fluorine.

What happens to aluminum when it enters the environment? It binds to particles in the air. It can dissolve in lakes, streams, and rivers depending on the quality of the water. Acid rain may dissolve aluminum from soil and rocks. It can be taken up into some plants from soil. It is not known to bioconcentrate up the food chain.

How might I be exposed to aluminum? Eating small amounts of aluminum in food. Breathing higher levels of aluminum dust in workplace air. Drinking water with high levels of aluminum near waste sites, manufacturing plants, or areas naturally high in aluminum. Eating substances containing high levels of aluminum (such as antacids) especially when eating or drinking citrus products at the same time. Very little enters your body from aluminum cooking utensils.

How can aluminum affect my health? Low-level exposure to aluminum from food, air, water, or contact with skin is not thought to harm your health. Aluminum, however, is not a necessary substance for our bodies and too much may be harmful. People who are exposed to high levels of aluminum in air may have respiratory problems including coughing and asthma from breathing dust. Some studies show that people with Alzheimer’s disease have more aluminum than usual in their brains. We do not know whether aluminum causes the disease or whether the buildup of aluminum happens to people who already have the disease. Infants and adults who received large doses of aluminum as a treatment for another problem developed bone diseases, which suggests that aluminum may cause skeletal problems. Some sensitive people develop skin rashes from using aluminum chlorohydrate deodorants.

How likely is aluminum to cause cancer? The Department of Health and Human Services, the International Agency for Research on Cancer, and the EPA have not classified aluminum for carcinogenicity. Aluminum has not been shown to cause cancer in animals.

How does aluminum affect children? Children with kidney problems who were given aluminum in their medical treatments developed bone diseases. Other health effects of aluminum on children have not been studied. It is not known whether aluminum affects children differently than adults, or what the long-term effects might be in adults exposed as children. Large amounts of aluminum have been shown to be harmful to unborn and developing animals because it can cause delays in skeletal and neurological development. Aluminum has been shown to cause lower birthweights in some animals.

Calcium Sulfate, CAS #7778-18-9 ($CaSO_4$, plaster of Paris, gypsum)

Data Point	Data Summary	Reference
Water solubility	3,000 mg/L	HSDB 2002
K_{oc}	No data.	
Soil half-life	Stable. Naturally occurring compound as gypsum.	HSDB 2002
BCF	No data.	
Ingestion toxicity	Substance added directly to human food affirmed as generally recognized as safe (GRAS).	21 CFR 184.1230
Carcinogenicity	Inhalation of calcium sulfate fibers resulted in tumors in laboratory animals.	HSDB 2002
Fish toxicity	96-hour LC_{50} in bluegill sunfish >2,980 mg/L	EPA 2002
Aq. invert. tox	24-hour LC_{50} in water flea *Daphnia magna* >1,970 mg/L	EPA 2002
Aq. amph. tox	No data.	

21 CFR 184.1230. Direct food substances affirmed as Generally Recognized as Safe--Listing of Specific Substances Affirmed as GRAS. Calcium sulfate. U.S. Food and Drug Administration.

EPA. See U.S. Environmental Protection Agency.

Hazardous Substances Databank. 2002. On-line database. National Library of Medicine. Bethesda, MD. http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB

HSDB. See Hazardous Substances Databank.

U.S. Environmental Protection Agency. 2002. Ecotox database: Calcium sulfate. Mid-Continent Ecology Division, National Health and Environmental Effects Research Laboratory, Office of Research and Development. Duluth, MN. http://www.epa.gov/ecotox/

Relevant sections of HSDB file:

Human Toxicity Excerpts:

GYPSUM DUST HAS AN IRRITANT ACTION ON MUCOUS MEMBRANES OF THE RESPIRATORY TRACT & EYES, & THERE HAVE BEEN REPORTS OF CONJUNCTIVITIS, CHRONIC RHINITIS, LARYNGITIS, PHARYNGITIS, IMPAIRED SENSE OF SMELL & TASTE, BLEEDING FROM THE NOSE, & REACTIONS OF TRACHEAL & BRONCHIAL MEMBRANES IN EXPOSED WORKERS. /GYPSUM/
[International Labour Office. Encyclopedia of Occupational Health and Safety. Volumes I and II. New York: McGraw-Hill Book Co., 1971. 630]**PEER REVIEWED**

Because it hardens quickly after absorbing moisture, its ingestion may result in obstruction, particularly at the pylorus. ... To delay "setting," drink glycerin or gelatin solutions, or large volumes of water. Surgical relief may be necessary. /Plaster of Paris/
[Gosselin, R.E., R.P. Smith, H.C. Hodge. Clinical Toxicology of Commercial Products. 5th ed. Baltimore: Williams and Wilkins, 1984.,p. II-127]**PEER REVIEWED**

Copper Oxide, CAS #1317-38-0

Data Point	Data Summary	Reference
Water solubility	Practically insoluble. In its Cu(II) state, copper forms coordination compounds or complexes with both inorganic and organic ligands. At the pH values and carbonate concentrations characteristic of natural waters, most dissolved Cu(II) exists as carbonate complexes rather than as free (hydrated) cupric ions.	HSDB 2002 ATSDR 1990
K_{oc}	No data	
Soil half-life	Copper is a stable element. Copper oxide may form complexes with soil or dissolve in water, depending on the pH and organic carbon content of the specific soil.	
BCF	The bioconcentration factor (BCF) of copper in fish obtained in field studies is 10- 100, indicating a low potential for bioconcentration.	ATSDR 1990
Ingestion toxicity	The mean daily dietary intake of copper in adults ranges between 0.9 and 2.2 mg 300 mg Cu/kg/day was the LOAEL causing death in weanling rats when administered over a period of 2 to 15 weeks. Equivalent to 376 mg CuO/kg/day.	HSDB 2002
Carcinogenicity	Inadequate data to determine carcinogenicity.	EPA 1991
Avian toxicity	500 mg Cu/kg caused adverse effects in the domestic chicken, equivalent to 626 mg CuO/kg. No LD_{50} for avian species was identified.	Eisler 1998
Fish toxicity	The 96-hour LC_{50} for rainbow trout was 25.4 mg/L.	EPA 2002
Aq. invert. tox	The 48-hour EC_{50} for intoxication for the water flea *Daphnia magna* was 0.011 to 0.039 mg/L. The 48-hour EC_{50} for mortality in *Ceriodaphnia dubia* was 0.028 mg Cu/L = 0.035 mg CuO/L.	EPA 2002
Aq. amph. tox	No data.	

Agency for Toxic Substances and Disease Registry. 1990. Toxicological profile for copper. Atlanta, GA. http://www.atsdr.cdc.gov/toxprofiles/tp132.html

ATSDR. See Agency for Toxic Substances and Disease Registry.

Eisler, R. 1998. Copper hazards to fish, wildlife, and invertebrates: a synoptic review. Biological Science Report USGS/BRD/BSR--1998-0002. U.S. Geological Survey, Biological Resources Division. Laurel, MD. http://www.pwrc.usgs.gov/new/chrback.htm

EPA. See U.S. Environmental Protection Agency.

Hazardous Substances Databank. 2002. On-line database. National Library of Medicine. Bethesda, MD. http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB

HSDB. See Hazardous Substances Databank.

U.S. Environmental Protection Agency. 1991. Integrated risk information system. Office of Research and Development. Cincinnati, OH. http://www.epa.gov/iris/subst/0368.htm

U.S. Environmental Protection Agency. 2002. Ecotox database: Cupric oxide. Mid-Continent Ecology Division, National Health and Environmental Effects Research Laboratory, Office of Research and Development. Duluth, MN. http://www.epa.gov/ecotox/

Relevant sections of ATSDR ToxFAQs document:

> HIGHLIGHTS: Copper is an element that is found naturally in the environment. Small amounts of copper are necessary for good health; however, very large amounts can cause dizziness, headaches, diarrhea, and liver and kidney damage.
>
> What happens to copper when it enters the environment? Copper is emitted to the air through natural processes such as windblown dust and volcanic eruptions. Human activities such as copper smelting and ore processing also result in copper being released to the air. Copper may enter the air when it is applied as a fungicide to plants, wood, fabric, and leather. Copper is released to water as a result of natural weathering of soil. It may also be released to water from discharges from industries and sewage treatment plants. Copper may also be added to lakes and ponds to control algae.
>
> How can copper affect my health? Copper is necessary for good health. However, very large doses can be harmful. Long-term exposure to copper in the air can irritate your nose, mouth, and eyes, and cause dizziness, headaches, and diarrhea. Eating or drinking very high amounts of copper can cause liver and kidney damage and effects on the blood. Drinking water with higher than normal levels of copper can cause vomiting, diarrhea, stomach cramps, and nausea.
> Skin contact with copper can result in an allergic reaction in some people. This reaction is usually skin irritation or a skin rash. Animal studies have shown effects on the stomach and abnormalities in development when animals were fed a diet high in copper. Copper has not been shown to cause cancer in people or animals. The International Agency for Research on Cancer (IARC) has determined that copper is not classifiable as to human carcinogenicity.
>
> The EPA has set a treatment technique for copper in drinking water that includes an action level of 1.3 milligrams of copper per liter of water (1.3 mg/L). The EPA has also set a secondary maximum contaminant level (SMCL) of 1 mg/L of copper in drinking water. An SMCL is a nonenforceable drinking water standard based on taste, odor, or other aesthetic considerations.

Diesel Fuel, CAS #68334-30-5 (Diesel fuel no. 2)

Data Point	Data Summary	Reference
Water solubility	0.00076 mg/L.	TPHCWG 1997, 1998
K_{oc}	log K_{oc} is 6.7 (K_{oc} = 5,011,872)	TPHCWG 1997, 1998
Soil half-life	40% biodegradation in 28 days = $t_{1/2}$ of 21 days	Chevron 2001
BCF	Components of gas oil have measured or calculated log K_{ow} values in the range 3.9 to greater than 6, indicating a high potential to bioaccumulate. However there is little measured data on gas oils or their components and there are major technical difficulties in measuring bioconcentration (BCF) values with complex mixtures.	CONCAWE 1996
Ingestion toxicity	Oral LD_{50} in rats = 7,400 mg/kg Doses of 125+ mg/kg for five days increased the frequency of chromosomal aberrations in the bone marrow of Sprague-Dawley rats	API 1980a, as cited in CONCAWE 1996 WHO 1996
Carcinogenicity	Not classifiable as to carcinogenicity in humans	IARC 1989
Avian toxicity	Mallard LD_{50} = 20 mg/kg	NPS 1997
Fish toxicity	96-hour LC_{50} in rainbow trout is 21 to 210 mg/L 24-hour LC_{50}s were 1.40 to 1.97 for pink salmon, 26.7 to >55.6 for coho salmon, and >23.1 to 168.4 for rainbow trout.	Chevron 2001 WHO 1996
Aq. invert. tox	48-hour EC_{50} in *Daphnia magna* is 20 to 210 mg/L	Chevron 2001
Aq. amph. tox	96-hour LC_{50} for larvae of wood frog *Rana sylvatica* is 4.2 mg/L	Hedtke and Puglisi 1982, as cited in CONCAWE 1996

Chevron Products Co. 2001. Material safety data sheet 6894: Chevron LS diesel 2. San Ramon, CA.

CONCAWE. 1996. Gas oils (diesel fuels/heating oils). Product dossier no. 95/107. Brussels, Belgium.

IARC. See International Agency for Research on Cancer.

International Agency for Research on Cancer. 1989. Diesel fuels. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans 45:219. http://193.51.164.11/htdocs/monographs/vol45/45-05.htm

NPS. See U.S. National Park Service.

Total Petroleum Hydrocarbon Criteria Working Group. 1997. Volume III: Selection of representative TPH fractions based on fate and transport considerations Amherst Scientific Publishers. Amherst, MA. http://www.aehs.com/publications/catalog/contents/Volume3.pdf

Total Petroleum Hydrocarbon Criteria Working Group. 1998. Volume I: Analysis of petroleum hydrocarbons in environmental media. Amherst Scientific Publishers. Amherst, MA. http://www.aehs.com/publications/catalog/contents/Volume1.pdf

TPHCWG. See Total Petroleum Hydrocarbon Criteria Working Group.

U.S. National Park Service. 1997. Environmental contaminants encyclopedia: Diesel oil entry. Water Resources Division, Water Operations Branch. Fort Collins, CO. http://www1.nature.nps.gov/toxic/search/

WHO. See World Health Organization.

World Health Organization. 1996. Environmental health criteria 171: Diesel fuel and exhaust emissions. Geneva. http://www.inchem.org/documents/ehc/ehc/ehc171.htm

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Relevant sections of WHO Environmental Health Criteria document:

> The evaluation of diesel fuel opens with a discussion of the complexity of these mixtures and the many variables that affect their quality and composition. An evaluation of toxicity studies in laboratory animals and in vitro test systems concludes that diesel fuel has low acute toxicity when administered via oral, dermal, and inhalation routes. Findings on embryotoxicity, teratogenicity, mutagenicity, and genotoxicity were judged to be either negative or equivocal. In view of inadequacies in the few studies of carcinogenic risks, the report concludes that the main effect of exposure on human health is dermatitis following skin contact.
>
> The second and largest part evaluates diesel exhaust emissions. A review of the abundant data demonstrating adverse effects on the environment concludes that the major components of diesel exhaust contribute to acid deposition, tropospheric ozone formation, and global warming. The most extensive sections discuss the epidemiological studies in humans and studies in experimental animals considered useful for the assessment of risks to human health. Although a number of epidemiological studies have indicated an increased risk of lung cancer in bus and railroad workers, all studies suffered from weaknesses. The report concludes that diesel exhaust is probably carcinogenic to humans, and that inhalation of diesel exhaust contributes to both neoplastic and non-neoplastic diseases, including asthma. The report further concludes that the particulate phase has the greatest effect on human health.

Gasoline, CAS # 8006-61-9

Data Point	Data Summary	Reference
Water solubility	Insoluble	ATSDR 1995
K_{oc}	Log K_{oc} = 1.81 to 4.56 (K_{oc} = 65 to 36,300)	ATSDR 1995
Soil half-life	No data.	
BCF	No data.	
Ingestion toxicity	No NOAEL identified. Lowest LOAELs for endpoints relevant to human toxicity (body weight, gastrointestinal effects) were 2,000 mg/kg in 28-day studies in rats. The oral LD_{50} in rats was 14,063 mg/kg	ATSDR 1995
Carcinogenicity	No studies were located regarding cancer in humans or animals after oral exposure to gasoline. Gasoline is possibly carcinogenic to humans (Group 2B) by inhalation exposure.	ATSDR 1995 IARC 1989
Fish toxicity	96-hour LC_{50} in rainbow trout is 2.7 mg/l (based on values for BTEX).	Chevron 2001
Aq. invert. tox	48-hour LC_{50} in Daphnia magna is 3.0 mg/L (based on values for BTEX).	Chevron 2001
Aq. amph. tox	No data.	

Agency for Toxic Substances and Disease Registry. 1995. Toxicological profile for automotive gasoline. Atlanta, GA. http://www.atsdr.cdc.gov/toxprofiles/tp72.html

ATSDR. See Agency for Toxic Substances and Disease Registry.

Chevron Products Company. 2001. MSDS 2655: Regular unleaded gasoline. San Ramon, CA.

IARC. See International Agency for Research on Cancer.

International Agency for Research on Cancer. 1989. Gasoline. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans 45:159.
http://193.51.164.11/htdocs/monographs/vol45/45-03.htm

Relevant sections of ATSDR ToxFAQs document:

> ToxFAQs^{TM} for Automotive Gasoline, CAS# 8006-61-9, September 1996
>
> "SUMMARY: Exposure to automotive gasoline most likely occurs from breathing its vapor at a service station while filling a car's fuel tank. At high levels, automotive gasoline is irritating to the lungs when breathed in and irritating to the lining of the stomach when swallowed. Exposure to high levels may also cause harmful effects to the nervous system.
>
> Typically, gasoline contains more than 150 chemicals, including small amounts of benzene, toluene, xylene, and sometimes lead. How the gasoline is made determines which chemicals are present in the gasoline mixture and how much of each is present. The actual composition varies with the source of the crude petroleum, the manufacturer, and the time of year.
>
> What happens to automotive gasoline when it enters the environment? Small amounts of the chemicals present in gasoline evaporate into the air when you fill the gas tank in your car or when gasoline is accidentally spilled onto surfaces and soils or into surface waters. Other chemicals in

gasoline dissolve in water after spills to surface waters or underground storage tank leaks into the groundwater. In surface releases, most chemicals in gasoline will probably evaporate; others may dissolve and be carried away by water; a few will probably stick to soil. The chemicals that evaporate are broken down by sunlight and other chemicals in the air. The chemicals that dissolve in water also break down quickly by natural processes.

Many of the harmful effects seen after exposure to gasoline are due to the individual chemicals in the gasoline mixture, such as benzene and lead. Inhaling or swallowing large amounts of gasoline can cause death. Inhaling high concentrations of gasoline is irritating to the lungs when breathed in and irritating to the lining of the stomach when swallowed. Gasoline is also a skin irritant. Breathing in high levels of gasoline for short periods or swallowing large amounts of gasoline may also cause harmful effects on the nervous system. Serious nervous system effects include coma and the inability to breathe, while less serious effects include dizziness and headaches. There is not enough information available to determine if gasoline causes birth defects or affects reproduction. The Department of Health and Human Services (DHHS) and the International Agency for Research on Cancer (IARC) have not classified automotive gasoline for carcinogenicity. Automotive gasoline is currently undergoing review by the EPA for cancer classification. Some laboratory animals that breathed high concentrations of unleaded gasoline vapors continuously for 2 years developed liver and kidney tumors. However, there is no evidence that exposure to gasoline causes cancer in humans.

Iron Oxide, CAS # 1309-37-1

Data Point	Data Summary	Reference
Water solubility	Insoluble.	HSDB 2002
K_{oc}	No data.	
Soil half-life	Stable.	
BCF	No data.	
Ingestion toxicity	Iron oxide is regulated by the FDA for use as a food coloring and in food packaging; it is generally recognized as safe. Severe toxicity may result in children following ingestion of more than 0.5 g of iron. In adults, chronic excessive ingestion may lead to toxicity, manifested by hemosiderosis, disturbances in liver function, diabetes mellitus, and possible endocrine disturbances and cardiovascular effects. EPA has established a secondary drinking water regulation of 0.3 mg/L for iron, based on aesthetic endpoints. Intraperitoneal LD_{50} is 5,400 mg/kg in mice.	21 CFR 73.200, 186.1300, and 186.1374 (Amdur et al. 1991) EPA 1992 DHHS 1987
Carcinogenicity	Not classifiable as to its carcinogenicity in humans.	IARC 1987
Fish toxicity	EPA set an ambient water quality criteria level of 1 mg/L for protection of aquatic life from iron, equivalent to 2.9 mg Fe_2O_3/L.	EPA 1999
Aq. invert. tox		
Aq. amph. tox		

Amdur, M.O., J. Doull, and C.D. Klaassen (eds.). 1991 *Casarett and Doull=s Toxicology: The Basic Science of Poisons.* 4th edition. Pergamon Press, Inc. Elmsford, NY.

DHHS. See U.S. Department of Health and Human Services.

EPA. See U.S. Environmental Protection Agency.

Hazardous Substances Databank. 2002. On-line database. National Library of Medicine. Bethesda, MD. http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB

HSDB. See Hazardous Substances Databank.

IARC. See International Agency for Research on Cancer.

International Agency for Research on Cancer. 1987. Haematite and ferric oxide. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Supplement 7:216. http://193.51.164.11/htdocs/monographs/suppl7/haematite.html

U.S. Department of Health and Human Services (DHHS). 1987. Registry of Toxic Effects of Chemical Substances (RTECS). DHHS NIOSH Publication No. 87-114. U.S. Government Printing Office. Washington, DC.

U.S. Environmental Protection Agency. 1992. Secondary drinking water regulations: Guidance for nuisance chemicals. EPA 810/K-92-001. Office of Water. Washington, DC.

U.S. Environmental Protection Agency. 1999. National recommended water quality criteria--Correction. EPA 822-A-99-01. Office of Water. Washington, DC.

Summary from Amdur et al. 1991:

> Acute iron toxicity is nearly always due to accidental ingestion of iron-containing medicines, and most often occurs in children. ... Severe toxicity occurs after ingestion of more than 0.5 g of iron or 2.5 g of ferrous sulfate. ... Chronic toxicity or iron overload in adults is a more common problem. ... The pathologic consequences of iron overload are similar regardless of basic cause. The body iron content is increased to between 20 and 40 g. Most of the extra iron is hemosiderin. Greatest concentrations are in parenchymal cells of liver and pancreas, as well as endocrine organs and heart. ... Further clinical effects may include disturbances in liver function, diabetes mellitus, and even endocrine disturbances and cardiovascular effects.

Lead, CAS #7439-92-1

Data Point	Data Summary	Reference
Water solubility	Insoluble.	ATSDR 1999
K_{oc}	Most lead is retained strongly in soil, and very little is transported into surface water or groundwater. Lead is strongly sorbed to organic matter in soil, and although not subject to leaching, it may enter surface waters as a result of erosion of lead-containing soil particulates.	ATSDR 1999
Soil half-life	Stable.	
BCF	Median BCF = 42 in fish.	Eisler 1988
Ingestion toxicity	EPA's reference dose workgroup concluded it was inappropriate to develop a reference dose, or an acceptable daily intake, for lead because some of lead's adverse effects, particularly changes in the levels of certain blood enzymes and in aspects of children's neurobehavioral development, may occur at blood lead levels so low as to be essentially without a threshold. A lowest lethal dose of 1,400 mg/kg was estimated for lead oxide in dogs, equivalent to 1,307 mg/kg lead.	EPA 1993 ATSDR 1999
Carcinogenicity	Lead is a probable human carcinogen, but a quantitative estimate of risk is not appropriate given current data.	EPA 1993
Avian toxicity	5-day dietary LC_{50} in Japanese quail >5,000 ppm in food, equivalent to approximately 875 mg/kg.	HSDB 2002
Fish toxicity	96-hour LC_{50} in rainbow trout is 1.17 mg/L.	EPA 2002
Aq. invert. tox	48-hour LC_{50} in *Daphnia magna* is 4.4 mg/L.	EPA 2002
Aq. amph. tox	The 30-day LC_{50} value for *Rana pipiens* was 105 mg/L.	Eisler 1988

Agency for Toxic Substances and Disease Registry. 1999. Toxicological profile for lead Atlanta, GA. http://www.atsdr.cdc.gov/toxprofiles/tp13.html

ATSDR. See Agency for Toxic Substances and Disease Registry.

Eisler, R. 1988. Lead hazards to fish, wildlife and invertebrates: A synoptic review. Patuxent Wildlife Research Center, U.S. Fish and Wildlife Service. Laurel, MD. http://www.pwrc.usgs.gov/new/chrback.htm

EPA. See U.S. Environmental Protection Agency.

U.S. Environmental Protection Agency. 1993. Integrated risk information system. Office of Research and Development. Cincinnati, OH. http://www.epa.gov/iris/subst/0277.htm

U.S. Environmental Protection Agency. 2002. Ecotox database: Lead. Mid-Continent Ecology Division, National Health and Environmental Effects Research Laboratory, Office of Research and Development. Duluth, MN. http://www.epa.gov/ecotox/

Relevant sections of ATSDR ToxFAQs document:

> HIGHLIGHTS: Exposure to lead can happen from breathing workplace air or dust, eating contaminated foods, or drinking contaminated water. Children can be exposed from eating lead-

based paint chips or playing in contaminated soil. Lead can damage the nervous system, kidneys, and reproductive system.

What happens to lead when it enters the environment? Lead itself does not break down, but lead compounds are changed by sunlight, air, and water. When lead is released to the air, it may travel long distances before settling to the ground. Once lead falls onto soil, it usually sticks to soil particles. Movement of lead from soil into groundwater will depend on the type of lead compound and the characteristics of the soil. Much of the lead in inner-city soils comes from old houses painted with lead-based paint.

How can lead affect my health?
Lead can affect almost every organ and system in your body. The most sensitive is the central nervous system, particularly in children. Lead also damages kidneys and the reproductive system. The effects are the same whether it is breathed or swallowed. At high levels, lead may decrease reaction time, cause weakness in fingers, wrists, or ankles, and possibly affect the memory. Lead may cause anemia, a disorder of the blood. It can also damage the male reproductive system. The connection between these effects and exposure to low levels of lead is uncertain. The Department of Health and Human Services has determined that lead acetate and lead phosphate may reasonably be anticipated to be carcinogens based on studies in animals.
There is inadequate evidence to clearly determine lead’s carcinogenicity in people. Small children can be exposed by eating lead-based paint chips, chewing on objects painted with lead-based paint, or swallowing house dust or soil that contains lead. Children are more vulnerable to lead poisoning than adults. A child who swallows large amounts of lead may develop blood anemia, severe stomachache, muscle weakness, and brain damage. A large amount of lead might get into a child's body if the child ate small pieces of old paint that contained large amounts of lead. If a child swallows smaller amounts of lead, much less severe effects on blood and brain function may occur. Even at much lower levels of exposure, lead can affect a child's mental and physical growth. Exposure to lead is more dangerous for young and unborn children. Unborn children can be exposed to lead through their mothers. Harmful effects include premature births, smaller babies, decreased mental ability in the infant, learning difficulties, and reduced growth in young children. These effects are more common if the mother or baby was exposed to high levels of lead.

Manganese Dioxide, CAS #1313-13-9 (MnO_2)

Data Point	Data Summary	Reference
Water solubility	Insoluble.	ATSDR 2000
K_{oc}	Sorption of manganese is complicated by redox reactions that produce compounds of different oxidation states. Under aerobic conditions, insoluble manganese 3+ and 4+ compounds predominately form.	HSDB 2002
Soil half-life	Insoluble manganese 3+ and 4+ compounds in sediments may be reduced by manganese-reducing bacteria to soluble manganese 2+ compounds.	HSDB 2002
BCF	A BCF of 100 to 600 was estimated for fish.	ATSDR 2000
Ingestion toxicity	The mean manganese intake in the United States from foodstuffs for a 2-year-old child is estimated to be about 1.5 mg/child/day. The mean manganese intake in the United States from foodstuffs for 25- to 30-year-old man and woman are estimated to be about 2.1 and 2.7 mg/person/day, respectively. ATSDR adopted the National Research Council's upper range of the estimated safe and adequate daily dietary intake of 5 mg/day as a provisional guidance value for oral exposure to manganese; this is equivalent to 0.07 mg/kg/day. EPA has set an oral reference dose of 0.14 mg/kg/day for manganese intake. An oral LD_{50} of 11,250 mg/kg was identified for manganese in rats, equivalent to 17,803 mg MnO_2/kg.	HSDB 2002 ATSDR 2000 EPA 1996 ATSDR 2000
Carcinogenicity	Not classifiable as to carcinogenicity in humans.	EPA 1996
Fish toxicity	96-hour LC_{50} for manganese in rainbow trout was 4.83 mg/L, equivalent to 7.64 mg MnO_2/L.	Reimer 1988
Aq. invert. tox	48-hour LC_{50} for manganese in *Daphnia magna* was 4.7 to 56.1 mg/L, equivalent to 7.4 to 89 mg MnO_2/L.	Reimer 1988
Aq. amph. tox	No data.	

Agency for Toxic Substances and Disease Registry. 2000. Toxicological profile for manganese. Atlanta, GA. http://www.atsdr.cdc.gov/toxprofiles/tp151.html

ATSDR. See Agency for Toxic Substances and Disease Registry.

EPA. See U.S. Environmental Protection Agency.

Hazardous Substances Databank. 2002. On-line database. National Library of Medicine. Bethesda, MD. http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB

HSDB. See Hazardous Substances Databank.

Reimer, P. 1988. Environmental effects of manganese and proposed freshwater guidelines to protect aquatic life in British Columbia. Department of Chemical and Bio-Resource Engineering. University of British Columbia.

U.S. Environmental Protection Agency. 1996. Integrated risk information system. Office of Research and Development. Cincinnati, OH. http://www.epa.gov/iris/subst/0373.htm

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Relevant sections of ATSDR ToxFAQs document:

> Manganese is an essential trace element and is necessary for good health. Manganese can be found in several food items, including grains and cereals, and is found in high amounts in other foods, such as tea.
>
> What happens to manganese when it enters the environment? Manganese can enter the air from iron, steel, and power plants, coke ovens, and from dust from mining operations. It can enter the water and soil from natural deposits, disposal of wastes, or deposits from airborne sources. Manganese exists naturally in rivers, lakes, and underground water. Plants in the water can take up some of the manganese from water and concentrate it.
>
> How can manganese affect my health? Some individuals exposed to very high levels of manganese for long periods of time in their work developed mental and emotional disturbances and slow and clumsy body movements. This combination of symptoms is a disease called “manganism.” Workers usually do not develop symptoms of manganism unless they have been exposed to manganese for many months or years. Manganism occurs because too much manganese injures a part of the brain that helps control body movements. Exposure to high levels of airborne manganese, such as in a manganese foundry or battery plant, can affect motor skills such as holding one's hand steady, performing fast hand movements, and maintaining balance. Exposure to high levels of the metal may also cause respiratory problems and sexual dysfunction. There are no human cancer data available for manganese. Exposure to high levels of manganese in food resulted in a slightly increased incidence of pancreatic tumors in male rats and thyroid tumors in male and female mice. The EPA has determined that manganese is not classifiable as to human carcinogenicity.
>
> Daily intake of small amounts of manganese is needed for growth and good health in children. Manganese is constantly present in the mother and is available to the developing fetus during pregnancy. Manganese is also transferred from a nursing mother to her infant in breast milk at levels that are appropriate for proper development. Children, as well as adults, who lose the ability to remove excess manganese from their bodies develop nervous system problems. Because at certain ages children take in more than adults, there is concern that children may be more susceptible to the toxic effects of excess manganese. Animal studies indicate that exposure to high levels of manganese can cause birth defects in the unborn. There is no information on whether mothers exposed to excess levels of manganese can transfer the excess to their developing fetus during pregnancy or to their nursing infant in breast milk.
>
> The EPA has set a non-enforceable guideline for the level of manganese in drinking water at 0.05 milligrams per liter (0.05 mg/L). The National Research Council has recommended safe and adequate daily intake levels for manganese that range from 0.3 to 1 mg/day for children up to 1 year, 1 to 2 mg/day for children up to age 10, and 2 to 5 mg/day for children 10 and older.

MTBE, CAS #1634-04-4 (methyl *tert*-butyl ether)

Data Point	**Data Summary**	**Reference**
Water solubility	48,000 mg/L	ATSDR 1996
K_{oc}	Log K_{oc} estimated as 1.05 and calculated as 2.89 (K_{oc}s = 11.2 and 776, respectively) Log K_{oc}s reported as 1.091, 1.035, 1.049 (K_{oc}s = 12.3,10.8, and 11.2, respectively)	ATSDR 1996 Malcolm Pirnie 1999
Soil half-life	Rapid volatilization from surface soils, little degradation in subsurface.	ATSDR 1996
BCF	Insignificant (BCF = 1.5 to 3, with levels rapidly declining after exposure ends). Log BCF was 0.18 in Japanese carp (BCF = 1.5).	ATSDR 1996 EFDB 2002
Ingestion toxicity	ATSDR derived an intermediate-duration minimal risk level of 0.3 mg/kg/day. An oral rat LD_{50} of 4.0 mL/kg was identified; this is equal to 2,962 mg/kg.	ATSDR 1996 HSDB 2002
Carcinogenicity	Possible human carcinogen at high doses. Cancer slope factor = 0.004 per mg/kg/day.	EPA 1997
Fish toxicity	Rainbow trout LC_{50} is 880 to 1,240 mg/L	Johnson 1998
Aq. invert. tox	*Ceriodaphnia dubia* LC_{50} is 340 to 680 mg/L	Johnson 1998
Aq. amph. tox	100 mg/L led to increased weight, stimulated metamorphosis; <2,000 mg/L had no lethal effect on European common frog tadpoles	Pauli et al. 2000

Agency for Toxic Substances and Disease Registry. 1996. Toxicological profile for methyl *tert*-butyl ether. Atlanta, GA. http://www.atsdr.cdc.gov/toxprofiles/tp91.html

ATSDR. See Agency for Toxic Substances and Disease Registry.

EFDB. See Environmental Fate Database.

Environmental Fate Database. 2002. On-line database. Syracuse Research Corporation. http://esc.syrres.com/efdb.htm

EPA. See U.S. Environmental Protection Agency.

Hazardous Substances Databank. 2002. On-line database. National Library of Medicine. Bethesda, MD. http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB

HSDB. See Hazardous Substances Databank.

Johnson, M.L. 1998. Ecological risk of MTBE in surface waters. John Muir Institute of the Environment, University of California. Davis, CA.

Malcolm Pirnie, Inc. 1999. Technical memorandum: Evaluation of fate and transport of methyl tertiary butyl ether (MTBE) in gasoline following a small spill. Prepared for Oxygenated Fuels Association, Inc. Oakland, CA.

Pauli, B.D., J.A. Perrault, and S.L. Money. 2000. RATL: A database of reptile and amphibian toxicology literature. Technical Report Series No. 357. Canadian Wildlife Service, Headquarters, Hull, Québec, Canada. http://www.cws-scf.ec.gc.ca/nwrc/ratl/about_e.htm

U.S. Environmental Protection Agency. 1997. Drinking water advisory: Consumer acceptability advice and health effects analysis on methyl tertiary-butyl ether (MtBE). EPA-822-F-97-009. Office of Water. Washington, DC.

Relevant sections of ATSDR ToxFAQs document:

ToxFAQs™ for Methyl *tert*-Butyl Ether, CAS# 1634-04-4, September 1997

What happens to methyl tert-butyl ether (MTBE) when it enters the environment? MTBE quickly evaporates from open containers and surface water, so it is commonly found as a vapor in the air. Small amounts of MTBE may dissolve in water and get into underground water. It remains in underground water for a long time. MTBE may stick to particles in water, which will cause it to eventually settle to the bottom sediment. MTBE may be broken down quickly in the air by sunlight. MTBE does not build up significantly in plants and animals.

How can methyl tert-butyl ether (MTBE) affect my health? Breathing small amounts of MTBE for short periods may cause nose and throat irritation. Some people exposed to MTBE while pumping gasoline, driving their cars, or working in gas stations have reported having headaches, nausea, dizziness, and mental confusion. However, the actual levels of exposure in these cases are unknown. In addition, these symptoms may have been caused by exposure to other chemicals. There are no data on the effects in people of drinking MTBE. Studies with rats and mice suggest that drinking MTBE may cause gastrointestinal irritation, liver and kidney damage, and nervous system effects. There is no evidence that MTBE causes cancer in humans. One study with rats found that breathing high levels of MTBE for long periods may cause kidney cancer. Another study with mice found that breathing high levels of MTBE for long periods may cause liver cancer. The Department of Health and Human Services (DHHS), the International Agency for Research on Cancer (IARC), and the EPA have not classified MTBE as to its carcinogenicity.

Has the federal government made recommendations to protect human health? The EPA has issued guidelines recommending that, to protect children, drinking water levels of MTBE not exceed 4 milligrams per liter of water (4 mg/L) for an exposure of 1-10 days, and 3 mg/L for longer-term exposures. The American Conference of Governmental Industrial Hygienists (ACGIH) has recommended an exposure limit of 40 parts of MTBE per million parts of air (40 ppm) for an 8-hour workday, 40-hour workweek.

Polystyrene, CAS #9003-53-6

Data Point	Data Summary	Reference
Water solubility	ND	
K_{oc}	ND	
Soil half-life	ND	
BCF	ND	
Ingestion toxicity	Not absorbed when administered orally to laboratory rats.	Monte 1983
Carcinogenicity	Subcutaneous implantation of polystyrene discs, rods, spheres or powder in rats induced local sarcomas, the incidences of which varied with the size and form of the implant.	IARC 1979
Fish toxicity	ND	
Aq. invert. tox	ND	
Aq. amph. tox	ND	

International Agency for Research on Cancer. 1979. Styrene, polystyrene, and styrene-butadiene compounds. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Volume 19:231. http://193.51.164.11/htdocs/monographs/vol19/styrene%26polymers.html

Monte, W. 1983. Lack of gut absorption of solubilized polystyrene by the rat (abstract). Journal of Agricultural and Food Chemistry 31(1):174-175.

Summary of polystyrene uses and toxicity:

Polystyrene is formed by the polymerization of styrene to form a rigid, odorless, tasteless plastic. It is widely used in consumer products, including video and audio cassettes, cosmetic containers, toys, computer housings, and packaging and insulating materials for food, including the air-blown form of polystyrene known as Styrofoam® (EPA 1995)[1].

Monte (1983) concluded that polystyrene was not absorbed when administered orally to laboratory rats. IARC (1979) reported that implantation of polystyrene materials under the skin in rats caused sarcomas. No quantitative toxicity data were available for the routes of exposure evaluated in this risk assessment; therefore, risk from polystyrene could not be quantified.

[1] U.S. Environmental Protection Agency. 1995. AP-42: Compilation of air pollutant emission factors. 5th ed., volume 1. Office of Air Quality Planning and Standards. Research Triangle Park, NC.

Potassium Chloride, CAS # 7447-40-7 (KCl), and Potassium Hydroxide, CAS # 1310-58-3 (KOH)

Data Point	Data Summary	Reference
Water solubility	281,000 mg/L (KCl) and 970,000 mg/L (KOH)	HSDB 2002
K_{oc}	No data.	
Soil half-life	No data.	
BCF	No data.	
Ingestion toxicity	Maximal nontoxic oral dose of KCl in man varies from 200 to 1,000 mg/kg/day, depending on efficiency of individual renal excretory mechanism. KOH is one of the strongest alkalies--it is extremely corrosive. Swallowing caustic alkalies causes immediate burning pain in the mouth, throat, and stomach, and the lining membranes become swollen and detached.	HSDB 2002
Carcinogenicity	No data.	
Fish toxicity	EPA has set an ambient water quality criteria level of 230 mg/L for chloride for the protection of freshwater aquatic life.	EPA 1999
Aq. invert. tox		
Aq. amph. tox		

EPA. See U.S. Environmental Protection Agency.

Hazardous Substances Databank. 2002. On-line database. National Library of Medicine. Bethesda, MD. http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB

HSDB. See Hazardous Substances Databank.

U.S. Environmental Protection Agency. 1999. National recommended water quality criteria--Correction. EPA 822-A-99-01. Office of Water. Washington, DC.

Relevant sections of HSDB file:

HUMAN HEALTH EFFECTS:

HUMAN TOXICITY EXCERPTS:

LARGE DOSES BY MOUTH CAN CAUSE GI IRRITATION, PURGING, WEAKNESS AND CIRCULATORY DISTURBANCES. [The Merck Index. 9th ed. Rahway, New Jersey: Merck & Co., Inc., 1976. 990]**PEER REVIEWED**

NAUSEA, VOMITING, DIARRHEA, & ABDOMINAL DISCOMFORT COMMONLY OCCUR. OVERDOSES MAY CAUSE PARESTHESIAS, GENERALIZED WEAKNESS, FLACCID PARALYSIS, LISTLESSNESS, VERTIGO, MENTAL CONFUSION, HYPOTENSION, CARDIAC ARRHYTHMIAS, & HEART BLOCK. DEATH MAY ENSUE. [Osol, A. and J.E. Hoover, et al. (eds.). Remington's Pharmaceutical Sciences. 15th ed. Easton, Pennsylvania: Mack Publishing Co., 1975. 771]**PEER REVIEWED**

ACUTE POTASSIUM INTOXICATION BY MOUTH IS RARE BECAUSE LARGE SINGLE DOSES USUALLY INDUCE VOMITING AND BECAUSE IN THE ABSENCE OF PRE-EXISTING KIDNEY DAMAGE POTASSIUM IS RAPIDLY EXCRETED. /POTASSIUM SALTS/ [Gosselin, R.E., R.P. Smith, H.C. Hodge. Clinical Toxicology of Commercial Products. 5th ed. Baltimore: Williams and Wilkins, 1984.,p. II-124]**PEER REVIEWED**

Potassium chloride in a commercial dietary salt substitute ... has produced a near fatal poisoning in an 8 month old infant. [Gosselin, R.E., R.P. Smith, H.C. Hodge. Clinical Toxicology of Commercial Products. 5th ed. Baltimore: Williams and Wilkins, 1984.,p. II-124]**PEER REVIEWED**

MAXIMAL NONTOXIC ORAL DOSE OF KCL IN MAN VARIES FROM 0.2 TO 1.0 G K/KG/DAY, DEPENDING UPON EFFICIENCY OF INDIVIDUAL RENAL EXCRETORY MECHANISM; LOWER DOSES SOMETIMES CAUSE IMPAIRMENT OF RENAL FUNCTION AS SHOWN BY REDUCED INULIN & UREA CLEARANCE. ... SERUM K LEVEL OF 40 MG/100 ML IS FATAL IN MAN. [Venugopal, B. and T.D. Luckey. Metal Toxicity in Mammals, 2. New York: Plenum Press, 1978. 16]**PEER REVIEWED**

Silicon Dioxide, CAS #7631-86-9 (silica)

Data Point	Data Summary	Reference
Water solubility	Practically insoluble.	HSDB 2002
K_{oc}	Not applicable.	
Soil half-life	Stable (occurs as sand and quartz).	HSDB 2002
BCF	None.	
Ingestion toxicity	When male and female beagle dogs or CD rats were fed 800 mg silicon/kg/day as the dioxide for 1 month ... neither clinical signs of toxicity nor histologic changes were seen in these animals. It is chemically and biologically inert when ingested. It is approved for use in food products at levels up to 2%, and is Generally Recognized as Safe (GRAS).	HSDB 2002, EPA 2002
Carcinogenicity	Crystalline silica is carcinogenic.	HSDB 2002, EPA 1991
Fish toxicity	Chemically unreactive in the environment, occurs naturally in various forms and is practically non-toxic to non-target organisms.	EPA 1991
Aq. invert. tox		
Aq. amph. tox		

EPA. See U.S. Environmental Protection Agency.

Hazardous Substances Databank. 2002. On-line database. National Library of Medicine. Bethesda, MD. http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB

HSDB. See Hazardous Substances Databank.

U.S. Environmental Protection Agency. 1991. Reregistration eligibility document: Silicon dioxide and silica gel. Office of Pesticide Programs. Washington, DC. http://www.epa.gov/oppsrrd1/REDs/old_reds/4081red.pdf

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Relevant sections of HSDB file:

Human Toxicity Excerpts:

The details of toxicity associated with metallurgical silicon are unknown.
[Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. V20 851 (1982)]**PEER REVIEWED**

Nuisance particulate (accumulation in lungs).
[Cralley, L.J., L.V. Cralley (eds.). Patty's Industrial Hygiene and Toxicology. Volume III: Theory and Rationale of Industrial Hygiene Practice. 2nd ed., 3A:The Work Environment. New York, NY: John Wiley Sons, 1985. 181]**PEER REVIEWED**

... Increased renal silicon (200 ppm dry weight; normal = 14-23 ppm) /was found/in an adult male bricklayer who presented with proteinuria and hypertension, but who had a normal chest roentgenogram. Moderate thickening of the glomerular basement membrane was noted on transmission electron microscopy. [American Conference of Governmental Industrial Hygienists, Inc. Documentation of the Threshold Limit Values and Biological Exposure Indices. 6th ed. Volumes I,II, III. Cincinnati, OH: ACGIH, 1991. 1387]**PEER REVIEWED**

Unpleasant deposits /of silicon dust/ in eyes, ears & nasal passages & injury to the skin and mucous membranes may be caused by the dust itself or by cleansing procedures used for its removal. [Sittig, M. Handbook of Toxic and Hazardous Chemicals and Carcinogens, 1985. 2nd ed. Park Ridge, NJ: Noyes Data Corporation, 1985. 787]**PEER REVIEWED**

Silicon is not found free in nature, but occurs chiefly as the oxide, & as silicates. Sand, quartz, rock crystal, amethyst, agate, flint, jasper, & opal are some of the /oxide/ forms. Granite, hornblende, asbestos, feldspar, clay, mica ... are but a few of the numerous silicate minerals. [Lide, D.R. (ed.). CRC Handbook of Chemistry and Physics. 73rd ed. Boca Raton, FL: CRC Press Inc., 1992-1993.,p. 4-26]**PEER REVIEWED**

Strontium Oxides and Sulfate, CAS # 1314-11-0 (strontium oxide, SrO), 1314-18-7 (strontium peroxide, SrO_2), 7759-02-6 (strontium sulfate, $SrS0_4$)

Data Point	Data Summary	Reference
Water solubility	SrO forms the hydroxide with evolution of heat in presence of water. SrO_2 is almost insoluble in water, but is gradually decomposed by water with the evolution of oxygen. $SrSO_4$ is soluble in water at about 114 mg/L.	Budavari et al. 1989
K_{oc}	The distribution coefficient, K_d (amount of ion per kg of air dry soil/amount of ion per liter of soil solution), for strontium in a podsol forest soil was determined to be 140 L/kg in the top layer and 44 L/kg in the lower layer.	HSDB 2002
Soil half-life	No data.	
BCF	BCF of strontium was 576 to 1,286 in bluegill sunfish.	HSDB 2002
Ingestion toxicity	The strontium ion has a low order of toxicity. It is chemically and biologically similar to calcium. The oxides are moderately caustic materials. The human daily intake of strontium has been determined to be 2 mg. An oral reference dose of 0.6 mg/kg/day was estimated for stable strontium. An oral rat LD_{50} of 2,750 mg/kg was identified for strontium nitrate Sr(NO3)2. This is equivalent to an LD_{50} of 1,139 mg strontium/kg.	Lewis 1994 HSDB 2002 EPA 1996 Oxford 2002
Carcinogenicity	No data.	
Fish toxicity	A 96-hour LC_{10} of 0.049 mg/L was identified for Sr for newly hatched rainbow trout.	EPA 2002
Aq. invert. tox	No data.	
Aq. amph. tox	7-day LC_{50} for Sr in eastern narrowmouth toad embryo-larvae was 0.16 mg/L	Pauli et al. 2000

Budavari, S., M. O'Neil, A. Smith, and P. Heckelman, eds. 1989. *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals.* 11th ed. Merck & Co., Inc. Rahway, NJ.

EPA. See U.S. Environmental Protection Agency.

Hazardous Substances Databank. 2002. On-line database. National Library of Medicine. Bethesda, MD. http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB

HSDB. See Hazardous Substances Databank.

Lewis, R. 1994. *Sax's Dangerous Properties of Industrial Materials.* 8th ed. Van Nostrand Reinhold Company. New York.

Oxford University. 2002. Safety data for strontium nitrate. The Physical and Theoretical Chemistry Laboratory. http://physchem.ox.ac.uk/MSDS/ST/strontium_nitrate.html

Pauli, B.D., J.A. Perrault, and S.L. Money. 2000. RATL: A database of reptile and amphibian toxicology literature. Technical Report Series No. 357. Canadian Wildlife Service, Headquarters, Hull, Québec, Canada. http://www.cws-scf.ec.gc.ca/nwrc/ratl/about_e.htm

U.S. Environmental Protection Agency. 1996. Integrated risk information system. Office of Research and Development. Cincinnati, OH. http://www.epa.gov/iris/subst/0550.htm

U.S. Environmental Protection Agency. 2002. Ecotox database: Lead. Mid-Continent Ecology Division, National Health and Environmental Effects Research Laboratory, Office of Research and Development. Duluth, MN. http://www.epa.gov/ecotox/

Summary from Lewis 1994:

STRONTIUM COMPOUNDS
DPIM: SMH500 Hazard Rating: 1
SAFETY PROFILE:
The strontium ion has a low order of toxicity. It is chemically and biologically similar to calcium. Strontium salicylate is the most toxic compound. The oxides and hydroxides are moderately caustic materials. Symptoms of acute toxicity are excessive salivation, vomiting, colic, and diarrhea, and possibly respiratory failure. The gastrointestinal absorption of soluble strontium ranges from 5 to 25%. Workers in strontium salt plants have reduced activity of choline esterase and acetylcholine. Drinking water with 13 mg Sr/L caused impaired tooth development in 1-year-old children. As with other compounds, the toxicity of a given compound may be a function of the anion. Compounds are highly dangerous if they contain the radioactive isotope 90Sr.
Updated: 08/27/90

ATTACHMENT 2:
MATERIAL SAFETY DATA SHEETS

ORION SAFETY PRODUCTS

STANDARD FUSEE CORP. **NSN#: 1370-01-009-2593**

MATERIAL SAFETY DATA **EMERGENCY CONTACT:**

- RAILWAY & HIGHWAY FUSEES - CHIMFEX **CHEMTREC 1-800-424-9300**

- *ORION* MARINE SIGNAL PRODUCTS (FORMERLY OLIN SIGNAL PRODUCTS)

SECTION I - IDENTIFICATION

CHEMICAL NAMES & SYNONYMS: **FUSEE**

CHEMICAL FAMILY: PYROTECHNIC DEVICE	**FORMULA:** MIXTURE	**TRADE NAME:** ***FUSEE/FLARE***
DESCRIPTION: RED CARDBOARD TUBE CONTAINING YELLOWISH-TAN SOLID MIXTURE.		**CAS NO.:** NONE ASSIGNED/MIXTURE

SECTION II - HAZARDOUS INGREDIENTS

BASIC MATERIAL	OSHA P.E.L	LD 50	LC 50	SIGNIFICANT EFFECTS
STRONTIUM NITRATE C.A.S.# 10042769	NONE EST.	2750 mg/Kg (RAT)	NO DATA	IRRITANT TO SKIN, EYES AND MUCOUS MEMBRANES.
POTASSIUM PERCHLORATE C.A.S.# 7778747	NONE EST.	NO DATA	NO DATA	IRRITANT TO SKIN, EYES AND MUCOUS MEMBRANES.
SULFUR C.A.S.# 7704349	NONE EST.	NO DATA	NO DATA	MAY CAUSE EYE AND MUCOUS MEMBRANE IRRITATION.
SAWDUST/OIL BINDER C.A.S.# MIXTURE	NONE EST.	NO DATA	NO DATA	N/A

SECTION III - NORMAL HANDLING PROCEDURES

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE: **<u>KEEP ITEMS OUT OF THE REACH OF CHILDREN!!</u>**

CONTENTS MAY BE HARMFUL IF SWALLOWED. IF TUBE IS BROKEN, DO NOT GET CONTENTS IN EYES, ON SKIN OR ON CLOTHING. UPON CONTACT WITH SKIN OR EYES, WASH WITH WATER. AVOID BREATHING DUST. STORE IN A COOL, DRY, WELL-VENTILATED PLACE AWAY FROM ALL SOURCES OF IGNITION. EXERCISE CAUTION WHEN USING THIS PRODUCT SINCE MOLTEN FLECKS MAY BE EMITTED. DO NOT USE PRODUCT NEAR ANY FLAMMABLE OR COMBUSTIBLE MATERIALS. AVOID CONTACT WITH STRONG OXIDIZERS. AVOID OPEN FLAMES AND TEMPERATURES >167°F.

PROTECTIVE EQUIPMENT	VENTILATION REQUIREMENTS
FOLLOW DIRECTIONS ON PACKAGE. ALWAYS POINT FUSEE AWAY FROM FACE AND BODY WHILE IGNITING AND AFTERWARDS.	THIS PRODUCT SHOULD ONLY BE USED OUTDOORS. IF USED INDOORS, LOCAL MECHANICAL VENTILATION IS RECOMMENDED TO MINIMIZE EXPOSURE.

SECTION IV - FIRE AND EXPLOSION DATA

FLASH POINT/METHOD: N/A CONTENTS: >167°F (OVEN)	**OSHA CLASSIFICATION:** FLAMMABLE SOLID	**FLAMMABLE EXPLOSIVE LIMITS:** UPPER: NONE ESTAB. LOWER: NONE ESTAB.

EXTINGUISHING MEDIA: USE WATER DELUGE/FLOODING METHODS; **SUFFOCATION TECHNIQUES WILL NOT BE EFFECTIVE:** NO THREAT OF MASS EXPLOSION.

SPECIAL FIRE HAZARD & FIRE FIGHTING PROCEDURES: USE **NIOSH/MSHA** APPROVED POSITIVE PRESSURE SELF-CONTAINED BREATHING APPARATUS WHEN ANY MATERIAL IS INVOLVED IN FIRE.

SECTION V - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE: NONE ESTABLISHED FOR THE MIXTURE.

SYMPTOMS OF OVER EXPOSURE: TUBE CONTENTS ARE CORROSIVE TO THE EYES AND IRRITATING TO THE RESPIRATORY TRACT AND SKIN.

SKIN: IMMEDIATELY FLUSH WITH WATER FOR 15 MINUTES, CALL A PHYSICIAN IF IRRITATION OCCURS.

EYES: IMMEDIATELY FLUSH WITH WATER FOR 15 MINUTES, CALL A PHYSICIAN.

INGESTION: IF CONTENTS ARE INGESTED: IMMEDIATELY GIVE LARGE QUANTITIES OF WATER OR EPSOM SALT SOLUTION. INDUCE VOMITING AND CALL A PHYSICIAN.

INHALATION: IMMEDIATELY REMOVE VICTIM TO FRESH AIR. CALL A PHYSICIAN.

SECTION VI - TOXICOLOGY (PRODUCT)

ALL CHEMICAL IS CONTAINED IN CARDBOARD TUBE - NONE IS EXPOSED

ACUTE ORAL LD 50: APPROXIMATELY 3 GRAMS/kg (RAT)	CARCINOGENICITY: NOT KNOWN TO BE CARCINOGENIC MUTAGENICITY: NOT KNOWN TO BE MUTAGENIC
ACUTE DERMAL LD 50: APPROX. 2 GRAMS/kg (RABBIT)	EYE IRRITATION: CORROSIVE
ACUTE INHALATION LD 50: NOT ESTABLISHED	PRIMARY SKIN EFFECT: IRRITANT

PRINCIPLE ROUTES OF ABSORPTION: INHALATION; DERMAL CONTENT

EFFECTS OF ACUTE EXPOSURE: TUBE CONTENTS ARE CORROSIVE TO EYES AND IRRITATING TO RESPIRATORY TRACT AND SKIN. INHALATION OF COMBUSTION PRODUCTS WILL IRRITATE EYES, LUNGS, AND MUCOUS MEMBRANES.

EFFECTS OF CHRONIC EXPOSURE: NONE KNOWN OR REPORTED

SECTION VII - SPILL AND LEAKAGE PROCEDURES (CONTROL PROCEDURES)

ACTION FOR MATERIAL RELEASE OR SPILL: IN LARGE QUANTITY, REMOVE ALL SOURCES OF IGNITION. IF TUBE IS BROKEN, WEAR NIOSH/MSHA APPROVED DUST RESPIRATOR. FOLLOW O.S.H.A. REGULATIONS FOR RESPIRATOR USE, (SEE 29CFR 1910.134). WEAR GOGGLES, IMPERVIOUS COVERALLS, GLOVES AND BOOTS. CLEAN UP IN A MANNER TO MINIMIZE CONTAMINATION WITH ORGANIC MATERIAL. DO NOT RETURN MATERIAL TO ORIGINAL CONTAINER. PLACE IN A FRESH CONTAINER AND ISOLATE. DO NOT SEAL THE CONTAINER. IN THE EVENT OF A LARGE SPILL, CALL THE EMERGENCY TELEPHONE NUMBER.

TRANSPORTATION EMERGENCY, CONTACT CHEMTREC 800-424-9300

WASTE DISPOSAL METHOD: DISPOSE OF CONTAMINATED PRODUCT, EMPTY CONTAINER AND MATERIALS USED IN CLEANING UP SPILLS OR LEAKS IN A MANNER APPROVED FOR THIS MATERIAL. CONSULT APPROPRIATE FEDERAL, STATE AND LOCAL REGULATORY AGENCIES TO ASCERTAIN PROPER DISPOSAL PROCEDURES.
OPEN BURNING IS PREFERRED METHOD OF DISPOSAL FOR PYROTECHNICS, IN COMPLIANCE WITH STATE AND LOCAL REGULATIONS.

SECTION VIII - SHIPPING DATA

D.O.T. CLASS (DOMESTIC): FUSEE, 4.1, NA1325, PG II (GROUND ONLY) LABEL REQ: FLAMMABLE SOLID

INTERNATIONAL CLASS & DOMESTIC AIR: SIGNAL DEVICES, HAND, 1.4S, UN0373, PG II LABEL REQ: 1.4S

SECTION IX - REACTIVITY DATA

STABLE X UNSTABLE @______°C______°F	HAZARDOUS POLYMERIZATION	MAY OCCUR WILL NOT OCCUR X

CONDITIONS TO AVOID: HIGH HEAT, IGNITION SOURCES OF ANY KIND

INCOMPATIBILITY *(MATERIAL TO AVOID)*: STRONG OXIDIZERS; STRONG ACIDS; CHLORATE SALTS.

HAZARDOUS DECOMPOSITION PRODUCTS: SULFUR OXIDES, NITROGEN OXIDES, CARBON MONOXIDE.

SECTION X - PHYSICAL DATA

MELTING POINT: NO DATA	VAPOR PRESSURE: NO DATA	VOLATILES: NO DATA
BOILING POINT: NO DATA	SOLUBILITY IN WATER: >300 g/l pwdr	EVAPORATION RATE: NO DATA
SPECIFIC GRAVITY (H_2O = 1): NO DATA	pH NO DATA	VAPOR DENSITY (AIR = 1): NO DATA

INFORMATION FURNISHED BY: JEFFREY W. JOHNSON DATE: MARCH 1998

ORION SAFETY PRODUCTS/STANDARD FUSEE CORPORATION
P.O. BOX 1047 • EASTON, MD 21601 HIGHWAY and RAILWAY PRODUCTS 1-800-637-7807
***CHIMFEX and ORION** MARINE PRODUCTS: 1-800-851-5260*

MOBIL OIL CORP, AMERICAS MARKE -- MOBIL REGULAR UNLEADED GASOLINE

MSDS Safety Information

FSC: 9130
NIIN: 00-148-7103
MSDS Date: 05/17/2000
MSDS Num: CLDBG
Product ID: MOBIL REGULAR UNLEADED GASOLINE
MFN: 03
Responsible Party
Cage: 3U728
Name: MOBIL OIL CORP, AMERICAS MARKETING AND REFINING
Address: 3225 GALLOWS ROAD
City: FAIRFAX VA 22037
Info Phone Number: 800-662-4525/ 856-224-4644
Emergency Phone Number: 609-737-4411
Resp. Party Other MSDS No.: 33126-00
Chemtrec IND/Phone: (800)424-9300
Published: Y

Contractor Summary

Cage: 3U728
Name: MOBIL OIL CORP, NORTH AMERICAS MARKETING AND REFINING
Address: 3225 GALLOWS ROAD
City: FAIRFAX VA 22037
Phone: 800-662-4525/ 856-224-4644

Item Description Information

Item Name: GASOLINE,AUTOMOTIVE
Unit of Issue: GL
UI Container Qty: X

Ingredients

Cas: 8006-61-9
RTECS #: LX3300000
Name: GASOLINE (PRODUCT) (COMPONENTS FOLLOW BELOW)
Percent by Wt: 100.
OSHA PEL: 900 MG/KG;300 PPM
OSHA STEL: 1500 MG/KG;500 PPM
ACGIH TLV: 890 MG/M3;300 PPM
ACGIH STEL: 1480 MG/M3;500 PPM

Cas: 1634-04-4
RTECS #: KN5250000
Name: METHYL T- BUTYL ETHER
Percent by Wt: 15.
ACGIH TLV: 144 MG/M3;40 PPM
EPA Rpt Qty: 1 LB
DOT Rpt Qty: 1 LB

Cas: 64-17-5
RTECS #: KQ6300000
Name: ETHANOL
Percent by Wt: 11.
OSHA PEL: 1900 MG/M3;1000 PPM
ACGIH TLV: 1880 MG/M3;1000 PPM

Cas: 1330-20-7
RTECS #: ZE2100000

Name: XYLENE
Percent by Wt: 10.
OSHA PEL: 435 MG/M3; 100PPM
OSHA STEL: 655 MG/M3; 150 PPM
ACGIH TLV: 434 MG/M3;100 PPM
ACGIH STEL: 651 MG/M3;150 PPM
EPA Rpt Qty: 1000 LBS
DOT Rpt Qty: 1000 LBS

Cas: 78-78-4
RTECS #: EK4430000
Name: ISOPENTANE
Percent by Wt: 9.
ACGIH TLV: 1770 MG/M3; 600 PPM

Cas: 108-88-3
RTECS #: XS5250000
Name: TOLUENE
Percent by Wt: 5.
OSHA PEL: 375 MG/M3; 100 PPM
OSHA STEL: 560 MG/M3;150 PPM
ACGIH TLV: 188 MG/M3;50 PPM S
EPA Rpt Qty: 1000 LBS
DOT Rpt Qty: 1000 LBS

Cas: 95-63-6
RTECS #: DC3325000
Name: PSEUDOCUMENE
Percent by Wt: 5.
OSHA PEL: 125 MG/M3; 25 PPM
ACGIH TLV: 123 MG/M3; 25 PPM

Cas: 106-97-8
RTECS #: EJ4200000
Name: BUTANE
Percent by Wt: 4.
OSHA PEL: 1900 MG/M3; 800 PPM
ACGIH TLV: 1900 MG/M3;800 PPM

Cas: 107-83-5
RTECS #: SA2985000
Name: 2-METHYLPENTANE
Percent by Wt: 4.
ACGIH TLV: 1760 MG/M3;500 PPM
ACGIH STEL: 3500 MG/M3;1000 PPM

Cas: 109-66-0
RTECS #: RZ9450000
Name: PENTANE
Percent by Wt: 4.
OSHA PEL: 1800 MG/M3; 600 PPM
OSHA STEL: 2250 MG/M3; 750 PPM
ACGIH TLV: 1770 MG/M3;600 PPM

Cas: 25551-13-7
RTECS #: DC3220000
Name: TRIMETHYL BENZENE
Percent by Wt: 3.
OSHA PEL: 125 MG/M3; 25 PPM
ACGIH TLV: 123 MG/M3;25 PPM

Cas: 96-14-0
Name: 3-METHYLPENTANE

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Percent by Wt: 2.
ACGIH TLV: 1760 MG/M3; 500 PPM
ACGIH STEL: 3500 MG/M3;1000 PPM
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Cas: 71-43-2
RTECS #: CY1400000
Name: BENZENE
Percent by Wt: 2.
OSHA PEL: 1 PPM
OSHA STEL: 5 PPM
ACGIH TLV: 0.5 MG/M3;1.60 PPM
ACGIH STEL: 2.5 MG/M3; 8 PPM
EPA Rpt Qty: 10 LBS
DOT Rpt Qty: 10 LBS
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Cas: 79-29-8
RTECS #: EJ9350000
Name: 2,3-DIMETHYLBUTANE
Percent by Wt: 2.
ACGIH TLV: 1760 MG/M3;500 PPM
ACGIH STEL: 3500 MG/M3;1000 PPM
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Cas: 110-54-3
RTECS #: MN9275000
Name: N-HEXANE
Percent by Wt: 2.
OSHA PEL: 180 MG/M3; 50 PPM
ACGIH TLV: 176 MG/M3;50 PPM
EPA Rpt Qty: 1 LB
DOT Rpt Qty: 1 LB
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Cas: 100-41-4
RTECS #: DA0700000
Name: ETHYL BENZENE
Percent by Wt: 2.
OSHA PEL: 435 MG/M3;100 PPM
OSHA STEL: 545 MG/M3; 125 PPM
ACGIH TLV: 434 MG/M3;100 PPM
ACGIH STEL: 543 MG/M3;125 PPM
EPA Rpt Qty: 1000 LBS
DOT Rpt Qty: 1000 LBS
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Cas: 589-34-4
Name: 3-METHYLHEXANE
Percent by Wt: 2.
Other REC Limits: 1640 MG/M3; 400 PPM
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Cas: 591-76-4
Name: 2-METHYLHEXANE
Percent by Wt: 1.
Other REC Limits: 1640 MG/M3; 400 PPM
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Cas: 108-87-2
RTECS #: GV6125000
Name: METHYLCYCLOHEXANE
Percent by Wt: 1.
OSHA PEL: 1600 MG/M3;400 PPM
ACGIH TLV: 1610 MG/M3;400 PPM
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Health Hazards Data
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LD50 LC50 Mixture: ORAL, RATS, LD50:>2000 MG/KG.
Route Of Entry Inds - Inhalation: YES
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Skin: YES

Effects of Exposure: EYE IRRITATION, RESPIRATORY IRRITATION, DIZZINESS, NAUSEA, LOSS OF CONSCIOUSNESS. SKIN IRRITATION. STUDIES CONDUCTED EXAMINING CAUSES OF DEATH OF DISTRBUTION WORKERS WITH LONG-TERM EXPOSURE TO GASOLINE HAVE NOT FOUND ANY GASOLINE-RELATED HEALTH EFFECTS. REPORTS OF CHRONIC GASOLINE ABUSE (SUCH AS SNIFFING) AND CHRONIC MISUSE OF GASOLINE AS SOLVENT OR CLEANING AGENT HAVE REPORTED A RANGE OF NEUROLOGICAL EFFECTS (NERVOUS SYSTEM EFFECTS), SUDDEN DEATHS FROM CARDIAC ARREST, HEMATOLOGIC CHANGES (BLOOD EFFECTS) AND LEUKEMIA. THESE EFFECTS ARE NOT EXPECTED TO OCCUR AT EXPOSURE LEVELS ENCOUNTERED IN DISTRIBUTION AND USE AS A MOTOR FUEL.

Explanation Of Carcinogenicity: LONG-TERM EXPOSURE TO GASOLINE VAPOR HAS CAUSED KIDNEY AND LIVER CANCER IN LABORATORY ANIMALS.

Signs And Symptions Of Overexposure: EYES: IRRITATION. SKIN: IRRITATION. INHALATION: RESPIRATORY IRRITATION, DIZZINESS, NAUSEA, LOSS OF CONSCIOUSNESS. CHRONIC GASOLINE ABUSE (EFFECTS NOT EXPECTED TO OCCUR AT EXPOSURE LEVELS ENCOUNTERED IN THE DISTRIBUTATION AND USE OF GASOLINE AS A MOTOR FUEL.) : NERVOUS SYSTEM EFFECTS; SUDDEN DEATH FROM CARDIAC ARREST; HEMATOLOGIC CHANGES (BLOOD EFFECTS); LUKEMIA.

First Aid: EYE CONTACT: FLUSH THOROUGHLY WITH WATER. IF IRRITATION OCCURS, CALL A PHYSICIAN. SKIN CONTACT: WASH CONTACT AREAS WITH SOAP AND WATER. REMOVE CONTAIMINTED CLOTHING. LAUNDER CONTAMINATED CLOTHING BEFORE REUSE. INHALATION: MOVE TO FRESH AIR. IF RESPIRATORY IRRITATION, DIZZINESS, NAUSEA, OR UNCONSCIOUSNESS OCCCURS, SEEK MEDICAL ASSISTANCE. IF BREATHING STOPPED, ASSIST VENTILATION WITH BAG-VALVE-MASK DEVISE OR USE MOUTH-TO-MOUTH RESUSCITATION. INGESTION: SEEK IMMEDIATE MEDICAL ATTENTION. DO NOT INDUCE VOMITING.

Handling and Disposal

Spill Release Procedures: ELIMINATE IGNITION SOURCES. RUNOFF MAY CREATE FIRE OR EXPLOSION HAZARD IN SEWER SYSTEM. ABSORB ON FIRE RETARDANT TREATED SAWDUST, DIATOMACEOUS EARTH, ETC. SHOVEL UP AND DISPOSE. PREVENT SPILLS FROM ENTERING STORM SEWERS, DRAINS, SOIL. REPORT SPILLS AS REQUIRED TO AUTHORITIES. U.S. COAST GUARD REQUIRES IMMEDIATE REPORTING OF SPILLS THAT COULD REACH ANY WATERWAY INCLUDING INTERMITTENT (SEE BELOW).

Neutralizing Agent: (FROM ABOVE) DRY CREEKS. REPORT SPILL TO COAST GUARD TOLL FREE (800-424-8802); ROAD SPILLS NOTIFY CHEMTREC.

Waste Disposal Methods: PRODUCT IS SUITABLE FOR BURNING FOR FUEL VALUE IN COMPLIANCE WITH APPLICABLE LAWS AND REGULATIONS.DISPOSAL OF UNUSED PRODUCT MAY BE SUBJECT TO RCRA REGULATIONS (40 CFR 261) DUE TO BENZENE (2.32%, TCLP , FLASH<-40F). DISPOSAL OF USED PRODUCT MAY ALSO BE REGULATED DUE TO IGNITABILITY, CORROSIVITY, REACTIVITY, OR TOXICITY AS DETERMINED BY TCLP.

Handling And Storage Precautions: NEVER SIPHON GASOLINE BY MOUTH AND DO NOT USE AS A SOLVENT OR CLEANING AGENT. USE NON-SPARKING TOOLS AND EXPLOSION-PROOF EQUIPMENT. USE IN WELL VENTILATED AREAS AWAY FROM IGNITION SOURCES. PORTABLE CONTAINERS MUST BE PLACED ON GROUND AND NOZZLE KEPT IN CONTACT WHEN FILLING TO PREVENT STATIC SPARKS.

Other Precautions: DRUMS MUST BE GROUNDED AND BONDED AND EQUIPPED WITH SELF-CLOSING VALVES, PRESSURE VACUUM BUNGS, AND FLAME ARRESTERS. STORE AWAY FROM IGNITION SOURCES IN A COOL AREA EQUIPPED WITH AUTOMATIC SPRINKLING SYSTEM. OUTSIDE OR DETACHED STORAGE PREFERRED. STORAGE CONTAINERS SHOULD BE GROUNDED AND BONDED.

Fire and Explosion Hazard Information

Flash Point Method: TCC

Flash Point: <-40.C, -40.F

Lower Limits: 1.4

Upper Limits: 7.6

Extinguishing Media: CARBON DIOXIDE, FOAM, DRY CHEMICAL, WATER FOG. NFPA HAZARD ID: HEALTH: 1; FLAMMABILITY: 3; REACTIVITY: 0.

Fire Fighting Procedures: FOR FIRES IN ENCLOSED AREAS, FIRE FIGHTERS MUST USE SELF-CONTAINED BREATHING APPARATUS. FOR LARGE SPILLS, FOAM IS THE PREFERRED

AGENT; BLANKETING THE GASOLINE SURFACE. WATER SPRAY MAY BE USED TO FLUSH SPILL AWAY FROM EXPOSURE; PREVENT SPREADING GASOLINE INTO SEWERS, STREAMS, DRINKING WATER SUPPLIES.

Unusual Fire/Explosion Hazard: EXTREMELY FLAMMABLE. VAPOR ACCUMULATION COULD FLASH AND/OR EXPLODE IF IN CONTACT WITH OPEN FLAME. IF SPILL HAS NOT IGNITED, ADD FOAM BLANKET TO SUPPRESS RELEASE OF VAPORS. IF FOAM NOT AVAILABLE, A WATER SPRAY CURTAIN CAN BE USED TO DISPERSE VAPORS AND PROTECT PERSONNEL ATTEMPTING TO STOP THE LEAK.

Control Measures

Respiratory Protection: APPROVED RESPIRATORY EQUIPMENT MUST BE USED WHEN AIRBORNE CONCENTRATIONS ARE UNKNOWN OR EXCEED THE TLV.

Ventilation: USE IN WELL VENTILATED AREA WITH LOCAL EXHAUST VENTILATION. VENTILATION REQUIRED AND EQUIPMENT MUST BE EXPLOSION PROOF. USE AWAY FROM ALL IGNITION SOURCES.

Protective Gloves: IMPERVIOUS GLOVES SHOULD BE WORN.

Eye Protection: SAFETY GLASSES WITH SIDE SHIELDS OR CHEMICAL GOGGLES IF SPLASH IS POSSIBLE.

Work Hygienic Practices: GOOD PERSONAL HYGIENE PRACTICES SHOULD ALWAYS BE FOLLOWED.

Physical/Chemical Properties

HCC: F2
Boiling Point: >35.C, 95.F
Vapor Pres: >400.0 MMHG @20C
Vapor Density: 3.0
Spec Gravity: 0.79
Viscosity: <1.0 CST@ 40 C
Evaporation Rate & Reference: NOT ESTABLISHED
Solubility in Water: NEGLIGIBLE
Appearance and Odor: CLEAR LIQUID (MAY BE DYED), GASOLINE ODOR.

Reactivity Data

Stability Indicator: YES

Stability Condition To Avoid: HEAT, SPARKS, FLAME AND BUILD UP OF STATIC ELECTRICITY.

Materials To Avoid: HALOGENS, STRONG ACIDS, ALKALIES, AND OXIDIZERS.

Hazardous Decomposition Products: CARBON MONOXIDE.

Hazardous Polymerization Indicator: NO

Conditions To Avoid Polymerization: WILL NOT OCCUR.

Toxicological Information

Toxicological Information: ORAL, RATS, LD50: >2000 MG/KG; PRACTICALLY NON-TOXIC. DERMAL, RABBITS, LD50: > 2000 MG/KG, PRACTICALLY NON-TOXIC. INHALATION, RATS, LC50: > 5 MG/L, PRACTICALLY NON-TOXIC. EYE IRRITATION, RABBITS, DRAI ZE SCORE: >6 BUT 15 OR LESS, PRACTICALLY NON-IRRITATING. SKIN IRRITATION, RABBITS, PRIMARY IRRITATION INDEX: 3 OR > BUT < 5. IRRITANT. OTHER ACUTE TOXICITY DATA: INHALATION OF VAPORS/MISTS MAY CAUSE RESPIRATORY SYSTEM IRRITATION. EXPOSURE TO HIGH CONCENTRATIONS OF CARBON MONOXIDE CAN CAUSE LOSS OF CONSCIOUSNESS, HEART DAMAGE, BRAIN DAMAGE, DEATH. EXPOSURE TO HIGH CONCENTRATIONS OF CARBON DIOXIDE C AN CAUSE (CONTD. SEE "ECOLOGICAL")

Ecological Information

Ecological: ENVIRONMENTAL FATE AND EFFECTS: NOT ESTABLISHED. NOTE: MOBIL PRODUCTS ARE NOT FORMULATED TO CONTAIN PCBS. USE: UNLEADED MOTOR FUEL. (CONTD. FROM "TOXICOLOGICAL'') ASPHYXIATION. NEUROTOXICOLOGY: NO SIGNIFICIANT ADVERSE EFFECTS IN STUDY WITH RATS. REPRODUCTIVE TOXICOLOGY: ONE

GENERATION REPRODUCTION STUDIES, SHOWED NO ADVERSE EFFECTS IN RATS. A TWO GENERATION STUDY SHOWED NO REPRODUCTIVE OR DEVELOP MENTAL EFFECTS IN RATS. A TERATOLOGY INHALATION STUDY IN RABBITS SHOWED NO DEVELOPMENTAL EFFECTS. CHRONIC TOXICOLOGY: AN INCREASE INCIDENCE OF KIDNEY AND LIVER TUMORS (CONTD. SEE "FEDERAL")

MSDS Transport Information

Transport Information: USA DOT: PSN: GASOLINE; CLASS: 3; UN 1203; ERG NUMBER: 128; PG I I; LABEL: FLAMMABLE LIQUID; PLACARD: FLAMMABLE; RQ: N/A. RID/ ADR: CLASS: 3;SUB-CLASS: 3(B); LABEL: 3; DANGER NUMBER: 33; UN 1203; SHIP PING NAME: HYDROCARBONS, LIQUID HAVING A FLASH POINT BELOW 21C. IMO: CLASS: 3.1; UN 1203; PG I I; SHIPPING NAME: GASOLINE; LABEL: FLAMMABLE LIQUID. ICAO/ IATA: CLASS:3; UN 1203; PG I I; SHIPPING NAME : GASOLINE; LABEL: FLAMMABLE LIQUID.

Regulatory Information

Sara Title III Information: THIS PRODUCT CONTAINS N0 "EXTREMELY HAZARDOUS SUBSTANCES". SARA (311 / 312) REPORTABLE HAZARD CATEGORIES: FIRE, CHRONIC, ACUTE. THIS PRODUCT CONTAINS SARA (313) TOXIC RELEASE CHEMICALS: SEE MANUFACTUR ER'S MSDS FOR TOXIC RELEASE CHEMICALS AND THE LIST CITATIONS UNDER WHICH THE LISTED INGREDIENTS ARE CITED. PRECAUTIONARY LABEL TEXT: CONTAINS GASOLINE. DANGER! SEE MANUFACTURER'S MSDS FOR PRECAUTIONAR Y LABEL TEXT.

Federal Regulatory Information: ALL COMPONENTS COMPLY WITH TSCA, AND EINECS/ ELINCS. (CONTD. FROM "ECOLOGICAL") WAS OBSERVED IN LABORATORY ANIMALS. THESE EFFECTS ARE NOT CONSIDERED SIGNIFICANT TO HUMANS. SKIN SENSITIZATION: NEGATIVE GUINEA PIG TEST. GASOLINE AND REFINERY STREAMS: STUDIES CONDUCTED BY THE AMERICAN PETROLEUM INSTITUTE EXAMINED A REFERENCE UNLEADED GASOLINE FOR MUTAGENIC, TERATOGENIC, AND SENSITIZATION POTENTIAL; N O EVIDENCE OF THESE HAZARDS WAS FOUND. AS FAR AS SCIENTISTS KNOW, LOW LEVEL OR INFREQUENT EXPOSURES TO GASOLINE VAPORS ARE UNLIKELY TO BE ASSOCIATED WITH CANCER OR OTHER SERIOUS DISEASES IN HUMANS.

State Regulatory Information: THIS WARNING IS GIVEN TO COMPLY WITH CALIFORNIA HEALTH AND SAFETY CODE 25249.6 AND DOES NOT CONSTITUTE AN ADMISSION OR A WAIVER OF RIGHTS. THIS PRODUCT CONTAINS A CHEMICAL KNOWN TO STATE OF CALIFORNIA TO CAUSE CANCER, BIRTH DEFECTS, OR OTHER REPRODUCTIVE HARM. REFER TO PRODUCT MATERIAL SAFETY DATA BULLETIN FOR FURTHER SAFETY AND HEALTH INFORMATION.

Other Information

Other Information: EU LABELING: SYMBOL: F+ T EXTREMELY FLAMMABLE, TOXIC; RISK PHRASE: R 12-45-38-22; EXTREMELY FLAMMABLE. MAY CAUSE CANCER. IRRITATING TO SKIN. HARMFUL IF SWALLOWED. SAFETY PHASES: S53-45-2-23-24-29-43-6 2. AVOID EXPOSURE - OBTAIN INSTRUCTIONS BEFORE USE. IN CASE OF ACCIDENT OR IF YOU FEEL UNWELL, SEEK MEDICAL ADVICE (SHOW LABEL WHERE POSSIBLE). KEEP OUT OF REACH OF CHILDREN. DO NOT BREATHE VAPOR. AV OID CONTACT WITH SKIN. DO NOT EMPTY INTO DRAINS. IN CASE OF FIRE USE CARBON DIOXIDE, FOAM, DRY CHEMICAL, WATER FOG. IF SWALLOWED, DO NOT INDUCE VOMITING: SEEK MEDICAL ADVICE AND SHOW LABEL. CONTAINS : LOW BOILING POINT NAPHTHA.

Transportation Information

Responsible Party Cage: 3U728
Trans ID NO: 157074
Product ID: MOBIL REGULAR UNLEADED GASOLINE
MSDS Prepared Date: 05/17/2000
Review Date: 05/23/2001
MFN: 3
Net Unit Weight: BULK
Multiple KIT Number: 0
Unit Of Issue: GL

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Container QTY: X
Additional Data: TRANSPORTATION DATA PER MANUFACTURER'S MSDS.
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Detail DOT Information
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DOT PSN Code: GTN
DOT Proper Shipping Name: GASOLINE
Hazard Class: 3
UN ID Num: UN1203
DOT Packaging Group: II
Label: FLAMMABLE LIQUID
Special Provision: B33,B101,T8
Non Bulk Pack: 202
Bulk Pack: 242
Max Qty Pass: 5 L
Max Qty Cargo: 60 L
Vessel Stow Req: E
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Detail IMO Information
=======================================================
IMO PSN Code: HRV
IMO Proper Shipping Name: GASOLINE
IMDG Page Number: 3141
UN Number: 1203
UN Hazard Class: 3.1
IMO Packaging Group: II
Subsidiary Risk Label: -
EMS Number: 3-07
MED First Aid Guide NUM: 311
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Detail IATA Information
=======================================================
IATA PSN UC
IATA UN ID Num: 1203
IATA Proper Shipping Name: GASOLINE
IATA UN Class: 3
IATA Label: FLAMMABLE LIQUID
UN Packing Group: II
Packing Note Passenger: 305
Max Quant Pass: 5L
Max Quant Cargo: 60L
Packaging Note Cargo: 307
Exceptions: A100
=======================================================
Detail AFI Information
=======================================================
AFI PSN UC
AFI Proper Shipping Name: GASOLINE
AFI Hazard Class: 3
AFI UN ID NUM: UN1203
AFI Packing Group: II
Special Provisions: P5
Back Pack Reference: A7.3
=======================================================
HAZCOM Label
=======================================================
Product ID: MOBIL REGULAR UNLEADED GASOLINE
Cage: 3U728
Company Name: MOBIL OIL CORP, NORTH AMERICAS MARKETING AND REFINING
Street: 3225 GALLOWS ROAD
City: FAIRFAX VA
Zipcode: 22037
Health Emergency Phone: 609-737-4411
```

Label Required IND: Y
Date Of Label Review: 05/23/2001
Status Code: A
Label Date: 05/23/2001
Origination Code: F
Eye Protection IND: YES
Skin Protection IND: YES
Signal Word: DANGER
Respiratory Protection IND: YES
Health Hazard: Moderate
Contact Hazard: Moderate
Fire Hazard: Severe
Reactivity Hazard: None
Hazard And Precautions: DANGER ! CONTAINS GASOLINE. EXTREMELY FLAMMABLE LIQUID AND VAPOR. VAPOR MAY CAUSE FLASH FIRE. MAY CAUSE SKIN, NOSE, THROAT, LUNG IRRITATION, DIZZINESS, NAUSEA, AND LOSS OF CONSCIOUSNESS. IF SWALLOWED, MAY BE ASPIRATED AND CAN CAUSE SERIOUS LUNG DAMAGE.

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MSDS Safety Information

FSC: 9140
NIIN: 00-000-0184
MSDS Date: 01/10/1994
MSDS Num: BRTDK
Product ID: DIESEL FUEL NO. 2, LOW/HIGH SULFUR; 3502;3504;3510;4152.
MFN: 01
Responsible Party
Cage: 5R396
Name: CONOCO INC
Box: 2197
City: HOUSTON TX 77252
Info Phone Number: 713-293-5550
Emergency Phone Number: 800-441-3637/800-424-9300(CHEMTREC)
Preparer's Name: MSDS ADMINISTRATOR
Review Ind: Y
Published: Y

Preparer Co. when other than Responsible Party Co.

Cage: 5R396
Name: CONOCO INC
Address: 5 GREENWAY PLAZA E
Box: 2197
City: HOUSTON TX 77252

Contractor Summary

Cage: 5R396
Name: CONOCO INC
Address: 5 GREENWAY PLAZA E
Box: 2197
City: HOUSTON TX 77252
Phone: 713-293-5550PRODUCT/ 800-4413637MED

Item Description Information

Item Name: USED TO BE 26648
Specification Number: VV-F-800
Type/Grade/Class: DF2,LOW SULFUR
Unit of Issue: GL
UI Container Qty: X
Type of Container: UNKNOWN

Ingredients

Cas: 68476-34-6
Name: DIESEL FUEL, NO. 2 (PETROLEUM MID-DISTILLATE).
% Wt: 100
Other REC Limits: NONE RECOMMENDED
OSHA PEL: NOT ESTABLISHED
ACGIH TLV: NOT ESTABLISHED

Health Hazards Data

LD50 LC50 Mixture: LD50 ORAL RAT = 9ML/KG
Route Of Entry Inds - Inhalation: YES
Skin: YES
Ingestion: NO
Carcinogenicity Inds - NTP: NO

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IARC: NO
OSHA: NO
Effects of Exposure: MAY CAUSE IRRIT TO EYES/LUNGS/SKIN AFT PROLONG/REPEAT
  EXPOSURE. ASPIRATION INTO LUNGS MAY CAUSE LUNG DAMAGE & DEATH.
Explanation Of Carcinogenicity: THERE ARE NO INGREDIENTS ABOVE 0.1% WHICH ARE
  IDENTIFIED AS CARCINOGENS BY NTP,IARC OR OSHA.
Signs And Symptions Of Overexposure: OVEREXPOSURE MAY CAUSE WEAKNESS,HEADACHE,
  NAUSEA,CONFUSION,BLURRED VISION,DROWSINESS,UNSPECIFIED CNS EFFECTS.LARGE
  EXPOSURE MAY CAUSE DIZZINESS,SLURRED SPEECH,FLUSHED FACE,UNCONSCIOUSNESS,
  CONVULSIONS .STUDIES IN MICE/RATS W/CHRONIC EXPOUSRE HAVE SHOWN DIESEL
  EXHAUST MAY PRODUCE LUNG TUMORS AND LYMPHOMAS.
Medical Cond Aggravated By Exposure: NONE SPECIFIED BY MFG.
First Aid: INHAL:REMOVE TO FRESH AIR.GIVE OXYGEN IF BREATH DIFFI OR ARTI RESP
  IF NOT BRETH.CALL PHYSICIAN.SKIN:WASH W/SOAP & WATER.IF IRRIT
  DEVELOP/PERSIST,CALL PHYSICIAN.EYES:IMMED FLUSH W/PLENTY OF WATER FOR @
  15MINS.CALL PHYSICIAN.INGEST:DO NOT INDUCE VOMITING.IF CONSCIOUS GIVE 2
  GLASSES OF WATER.PHYSICIAN:GIVE 5ML/KG (OR 350ML) OF CHARCOAL SOLUTION (50GMS
  CHARCOAL IN 400ML WATER).
=======================================================
Handling and Disposal
=======================================================
Spill Release Procedures: REMOVE IGNITION SOURCES.USE EXPLOSION-PROOF EQPMT
  & APPROPRIATE PPE.DIKE & PREVENT FROM ENTERING SEWERS/WATERWAYS.SOAK
  UP W/ABSORBENT MATL.(SAWDUST,SAND,OIL DRY).IF SPILLED INTO NAVIGABLE WATERS
  REPOR T TO NAT RESP CNTR 800-424-8802.READ MSDS.
Neutralizing Agent: NONE
Waste Disposal Methods: TREATMENT/STORAGE/TRANSP/DISPOSAL MUST BE IAW
  APPLICABLE FED/STATE/PROVINCIAL/LOC REGS.DO NOT FLUSH TO SURFACE
  WATER/SANITARY SEWER SYS.BY ITSELF LIQ IS EXPECTED TO BE RCRA IGNITABLE HAZ
  WASTE.CONTAIN S PETRO HYDROCARBONS-RQ(FILM/SHEEN/DISCOLO WATER.
Handling And Storage Precautions: STORE IN WELL-VENTILATED AREA.KEEP CONTAINER
  TIGHTLY CLOSED.STORE IAW NAT FIRE PROTECTION ASSOC RECOMMENDATIONS.STORE AWAY
  FROM HEAT/SPARKS/FLAME/OXID
Other Precautions: DO NOT BREATH VAPORS/MISTS.GROUND CONTAINERS WHEN
  TRANSFERRING LIQUID (FLOWING FUEL GENERATES STATIC ELECTRICITY).
=======================================================
Fire and Explosion Hazard Information
=======================================================
Flash Point Method: TCC
Flash Point Text: 130F,54C
Lower Limits: 0.4
Upper Limits: 6
Extinguishing Media: WATER SPRAY, FOAM, DRY CHEMICAL, CARBON DIOXIDE. NFPA
  CLASSIFICATION:CLASS II COMBUSTIBLE LIQUID.
Fire Fighting Procedures: DON'T ENTER ENCLOSE/CONFINE SPACE W/O PROPER PROT
  EQPMT INCLUDING RESP PROT.W/WATER SPRAY COOL FIRE EXPOSED CNTNRS &
  DISPERSE/FLUSH VAP/PROTECT FROM SPILL/LEAK.
Unusual Fire/Explosion Hazard: PRODUCTS OF COMBUSTION MAY CONTAIN CARBON
  MONOXIDE, CARBON DIOXIDE & OTHER TOXIC MATERIALS.
=======================================================
Control Measures
=======================================================
Respiratory Protection: SELECT APPROPRIATE NIOSH-APPROVED RESP PROTECTION WHEN
  NEEDED TO AVOID INHAL OF MIST/VAPORS AND TO MAINTAIN EXPOSURES BELOW
  ACCEPTABLE LIMITS.
Ventilation: USE ONLY WITH ADEQUATE VENTILATION. MECHANICAL (GENERAL)
  VENTILATION TO MAINTAIN TLV/PEL.
Protective Gloves: NEOPRENE, NBR GLOVES.
Eye Protection: SAFETY GLASSES W/SIDE SHIELDS, CHEM GOGG
Other Protective Equipment: COVERALLS IF SPLASHING IS PROBABLE.
Work Hygienic Practices: WASH HANDS AFTER HANDLING. LAUNDER CONTAMIN CLOTHES
  PRIOR TO REUSE.
Supplemental Safety and Health: NOT SUBJECT TO CA PROP 65. CONTAINS DIESEL FUEL
```

OIL SUBJECT TO PEN WORKER/COMM RIGHT TO KNOW.

Physical/Chemical Properties

HCC: F4
B.P. Text: 350F,177C
Vapor Pres: 1MM@68F
Vapor Density: >1
Spec Gravity: 0.84-0.88 @60C
Viscosity: 1.9CAT@40C
Solubility in Water: INSOLUBLE
Appearance and Odor: AROMATIC ODOR;LIQUID;HIGH SULFUR-GREEN;LOW SULFUR-RED OR UNDYED(CLEAR OR STRAW)
Percent Volatiles by Volume: NIL

Reactivity Data

Stability Indicator: YES
Stability Condition To Avoid: AVOID HEAT, SPARKS, FLAME.
Materials To Avoid: INCMPATIBLE OR CAN REAC WTIH STRONG OXIDIZERS.
Hazardous Decomposition Products: CARBON MONOXIDE, CARBON DIOXIDE, AND OTHER TOXIC MATERIALS.
Hazardous Polymerization Indicator: NO
Conditions To Avoid Polymerization: NOT RELEVANT.

Toxicological Information

Ecological Information

MSDS Transport Information

Regulatory Information

Other Information

Transportation Information

Responsible Party Cage: 5R396
Trans ID NO: 43111
Product ID: DIESEL FUEL NO. 2, LOW/HIGH SULFUR; 3502;3504;3510;4152.
MSDS Prepared Date: 01/10/1994
Review Date: 09/02/1994
MFN: 1
Net Unit Weight: UNKNOWN
AF MMAC Code: NR
Multiple KIT Number: 0
Review IND: Y
Unit Of Issue: GL
Container QTY: X
Type Of Container: UNKNOWN
Additional Data: PER MSDS DOMESTIC PROPER SHIPPING NAME DIESEL FUEL, UN 1993, HAZ CLASS COMBUST LIQ. IF SHIPPED BY VE SSEL/AIR USE INTERNATIONAL DESCRIPTION WHICH IS GAS OIL, UN 1202, PACK GR III, FLAMM LIQ.

Detail DOT Information

DOT PSN Code: EXF
Symbols: D

```
DOT Proper Shipping Name: DIESEL FUEL
Hazard Class: 3
UN ID Num: NA1993
DOT Packaging Group: III
Label: NONE
Special Provision: B1
Non Bulk Pack: 203
Bulk Pack: 242
Max Qty Pass: 60 L
Max Qty Cargo: 220 L
Vessel Stow Req: A
=======================================================
Detail IMO Information
=======================================================
IMO PSN Code: HRR
IMO Proper Shipping Name: GAS OIL
IMDG Page Number: 3375
UN Number: 1202
UN Hazard Class: 3.3
IMO Packaging Group: III
Subsidiary Risk Label: -
EMS Number: 3-07
MED First Aid Guide NUM: 311
=======================================================
Detail IATA Information
=======================================================
IATA PSN TX
IATA UN ID Num: 1202
IATA Proper Shipping Name: GAS OIL
IATA UN Class: 3
IATA Label: FLAMMABLE LIQUID
UN Packing Group: III
Packing Note Passenger: 309
Max Quant Pass: 60L
Max Quant Cargo: 220L
Packaging Note Cargo: 310
Exceptions: A3
=======================================================
Detail AFI Information
=======================================================
AFI PSN Code: JEV
AFI Proper Shipping Name: DIESEL FUEL
AFI PSN Modifier: ,ALSO SEE GAS OIL
AFI Hazard Class: 3
AFI UN ID NUM: UN1202
AFI Packing Group: III
Special Provisions: P5
Back Pack Reference: A7.3
=======================================================
HAZCOM Label
=======================================================
Product ID: DIESEL FUEL NO. 2, LOW/HIGH SULFUR; 3502;3504;3510;4152.
Cage: 5R396
Company Name: CONOCO INC
Street: 5 GREENWAY PLAZA E
PO Box: 2197
City: HOUSTON TX
Zipcode: 77252
Health Emergency Phone: 800-441-3637/800-424-9300(CHEMTREC)
Label Required IND: Y
Date Of Label Review: 09/02/1994
Status Code: C
MFG Label NO: UNKNOWN
```

Label Date: 09/02/1994
Origination Code: F
Eye Protection IND: YES
Skin Protection IND: YES
Signal Word: WARNING
Respiratory Protection IND: YES
Health Hazard: Moderate
Contact Hazard: Moderate
Fire Hazard: Moderate
Reactivity Hazard: None
Hazard And Precautions: MAY CAUSE IRRIT TO EYES/LUNGS/SKIN AFT PROLONG/REPEAT EXPOSURE. ASPIRATION INTO LUNGS MAY CAUSE LUNG DAMAGE & DEATH. TARGET ORGANS:EYE/LUNGS/SKIN. FIRST AID: INHAL:REMOVE TO FRESH AIR.GIVE OXYGEN IF BREATH DIFFI OR ARTI RESP IF NOT BRETH.CALL PHYSICIAN.SKIN:WASH W/SOAP & WATER.IF IRRIT DEVELOP/PERSIST,CALL PHYSICIAN.EYES:IMMED FLUSH W/PLENTY OF WATER FOR @ 15MINS.CALL PHYSICIAN.INGEST:DO NOT INDUC E VOMITING.IF CONSCIOUS GIVE 2 GLASSES OF WATER.PHYSICIAN:GIVE 5ML/KG (OR 350ML) OF CHARCOAL SOLUTION (50GMS CHARCOAL IN 400ML WATER).

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FIRE-TROL HOLDINGS, L.L.C.
MATERIAL SAFETY DATA SHEET
FIRE-TROL® FIREGEL™

Fire-Trol Holdings, L.L.C.
2620 N. 37th Dr.
Phoenix, AZ 85009
(602) 262-5401
(530) 865-4932 (24 hr. number)

CAUTION

Avoid eye contact: may be irritating. Avoid unprotected exposure of the skin. Work in a ventilated area to avoid possible irritation of respiratory tract.

CLASSIFICATION: NON-HAZARDOUS

A. Product Identification. FIRE-TROL FIREGEL is an aluminum soap for use in thickening gasoline, kerosene or mineral spirits.

B. Occupational Control Procedures

1. Avoid eye contact. Wear goggles when handling.
2. Avoid skin contact. Use rubber or plastic gloves to avoid prolonged skin contact.
3. Avoid excessive inhalation of powder by wearing an OSHA approved dust mask.
4. Handle product in a well ventilated area. Permissible concentration in air of 10 mg/m3. (Nuisance dust.)
5. Avoid ingestion. (Estimated LD_{50}>50 mg/kg; oral, rat.)

C. Fire Protection Information

1. Extinguishing media for concentrate: Carbon dioxide, dry chemical, foam, or water spray. Class A, BC, or ABC fire extinguishers, sand/earth.
2. Special fire fighting procedures in enclosed areas: Fire fighters must be equipped to prevent breathing of vapors or products of combustion. Wear an approved self-contained breathing apparatus and protective clothing.
3. Unusual fire or explosion hazards: Hazardous only when present as a dust. Dust explosions can occur under conditions of high dust concentration in the presence of a spark or open flame.

D. Physical Data

1.	Color:	Greenish powder
2.	Odor:	Mild fatty
3.	Specific gravity:	1.01 to 1.03 (approximately), whereas water is 1.0
4.	Melting point:	Over 390°F
5.	pH:	5 to 6 in a 5% dispersion
6.	Percent volatile by weight:	1.5% (moisture)

E. Reactivity Data

1. Stability: Product has excellent long-term stability for an indefinite period.
2. Hazardous decomposition products: Carbon monoxide, carbon dioxide - these gases can be harmful in enclosed areas so fire fighters must wear an approved self-contained breathing apparatus and protective clothing.
3. Hazardous polymerization will not occur.
4. Incompatibility (keep away from): Flames and sparks under dusty conditions. Avoid strong acids and oxidizers.

F. Spill, Leak and Disposal Information. Sweep up and discard in closed containers. Dispose of in accordance with all applicable federal, state and local regulations.

G. Transportation Data

1. DOT: Not regulated
2. Reportable Quantity: Not applicable
3. Freight Classification: Metallic soaps of fatty acids
4. Non-hazardous, non-flammable, non-corrosive

H. Emergency & First Aid Procedures (for Concentrate)

1. Eye Contact. Flush eyes immediately with plenty of water for at least fifteen minutes and call a physician.
2. Skin Contact. Wash off with detergent and water.
3. Inhalation. Remove person to fresh air and provide oxygen if breathing is difficult. Get medical attention.
4. If swallowed, call a physician immediately.

NOTICE OF WARRANTY: Fire-Trol Holdings, L.L.C. warrants that FIRE-TROL products are reasonably fit for the purposes for which they were developed only when used in accordance with recommended use practices under normal conditions. In no case shall Fire-Trol Holdings, L.L.C. be liable for consequential, special, or indirect damages resulting from the use or handling of these products. ALL such risks shall be assumed by the buyer. FIRE-TROL HOLDINGS, L.L.C. MAKES NO WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE NOR ANY OTHER EXPRESSED OR IMPLIED WARRANTY EXCEPT AS STATED ABOVE.

Effective Date: January 4, 2000
Supersedes all previous dates for FIRE-TROL® FIREGEL™

MATERIAL SAFETY DATA SHEET

***** SECTION I *****

PRODUCT NAME: SUREFIRE SIZE:
CHEMICAL NAME:
FORMULA: ALUMINUM SOAPS AND OTHER COMPOUNDS
DISTRIBUTOR: SIMPLEX MANUFACTURING COMPANY
ADDRESS: 13340 NE WHITAKER WAY, PORTLAND, OR 97230 USA
FOR INFORMATION ON HEALTH HAZARDS CALL: (503) 257-3511
FOR OTHER INFORMATION CALL: AS ABOVE
INFORMATION EFFECTIVE AS OF:

SECTION II
***** HAZARDOUS INGREDIENTS OF MIXTURES *****

PRINCIPAL HAZARDOUS COMPONENTS (S)	%	TLV (Units)
NONE		

SECTION III
***** PHYSICAL DATA *****

BOILING POINT (°F.)	N.A.	SPECIFIC GRAVITY (H_2O=1)	1.01-1.03
VAPOR PRESSURE (mm Hg.)	N.A.	PERCENT VOLATILE BY VOLUME (%)	5
VAPOR DENSITY (AIR=1)	N.A.	EVAPORATION RATE (=1)	N.A.
SOLUBILITY IN WATER	INSOLUBLE		
APPEARANCE AND ODOR	TAN POWDER WITH CHARACTERISTIC ODOR		

SECTION IV
***** FIRE AND EXPLOSION HAZARD DATA *****

FLASH POINT (Method used)	FLAMMABLE LIMIT	Lel	Uel

EXTINGUISHING MEDIA: CO_2, H_2O

SPECIAL FIRE FIGHTING PROCEDURES
NONE

UNUSUAL FIRE & EXPLOSION HAZARDS
AVOID HIGH DUST CONCENTRATIONS

SECTION V
***** HEALTH HAZARD DATA *****

THRESHOLD LIMIT VALUE

NOT AVAILABLE

EFFECTS OF OVEREXPOSURE

NOT AVAILABLE; BUT TOXICITY WOULD PROBABLY BE VERY LOW

EMERGENCY AND FIRST AID PROCEDURES

EYE: AS FOR NUISANCE DUST.

SKIN CONTACT: WASH WITH SOAP AND WATER; (VERY LOW PROBABILITY OF DERMATITIS)

SECTION VI
***** REACTIVITY DATA *****

STABILITY	INSTABLE		CONDITIONS TO AVOID
	STABLE	X	
INCOMPATIBILITY (Materials to avoid)	STRONG ACIDS, OXIDIZERS		

HAZARDOUS DECOMPOSITION PRODUCTS

CO_x

HAZARDOUS POLYMERIZATION		CONDITIONS TO AVOID
May Occur	Will Not Occur X	

SECTION VII
***** SPILL OR LEAK PROCEDURES *****

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

SWEEP UP

WASTE DISPOSAL METHOD

LAND FILL (AS PER LOCAL REGULATIONS)

SECTION VIII
***** SPECIAL PROTECTION INFORMATION *****

RESPIRATORY PROTECTION (Specify type)	DUST MASK		
VENTILATION	LOCAL EXHAUST		SPECIAL NONE
	MECHANICAL (general) ACCEPTABLE		OTHER NONE
PROTECTIVE GLOVES	GLOVES	EYE PROTECTION	GOGGLES
OTHER PROTECTIVE **EQUIPMENT**	NONE		

SECTION IX
***** SPECIAL PRECAUTIONS *****

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

NO SPECIAL PRECAUTIONS

OTHER PRECAUTIONS

TAKE REASONABLE CAUTION, AND PRACTICE PERSONAL CLEANLINESS

I:\Optimum SUREFIRE Gels.doc

SIMPLEX

SIMPLEX MANUFACTURING CO.
13340 NE Whitaker Way
Portland, Oregon
97230

MATERIAL SAFETY DATA SHEET

SECTION I

HMIS

HEALTH:	2
FLAMMABILITY:	1
REACTIVITY:	1
PERSONAL PROT:	2

Emergency Telephone Number (503) 257 -3511

Chemical Name and Synonyms

Trade Name and Synonyms SURE-FIRE II

Chemical Family ALUMINUM CARBOXYLATES Formula

SECTION II — INGREDIENTS

MATERIAL	CAS NO.	%	TLV (UNITS)	MATERIAL	CAS NO.	%	TLV (UNITS)
Aluminum Soaps	NA	95	NA				
Others	NA	5	NA				

SECTION III — PHYSICAL DATA

Boiling Point (°F)	NA	Specific Gravity ($H_2O=1$)	>1.0
Vapor Pressure (mm Hg.)	NA	Percent Volatile by Volume (%)	1.0
Vapor Density (AIR=1)	NA	Evaporation Rate (Butyl Acetate=1)	<<<1.0
Solubility in Water	Negligible		

Appearance and Color
Off white powder

SECTION IV — FIRE AND EXPLOSION HAZARD DATA

Flash Point (Method Used) NA	Flammable Limits NA	Lel	Uel

Extinguishing Media
WATER, CO_2, FOG, DRY CHEMICAL

Special Fire Fighting Procedures
NA

Unusual Fire and Explosion Hazards
AS A FINE DUST IN AIR, IT MAY BE A HAZARD WITH AN IGNITION SOURCE.

SECTION V — HEALTH HAZARD DATA

PRIMARY ROUTE OF ENTRY: INHALATION

eshold Limit Value:
NOT LISTED BY ACGIH

ects of Overexposure:
MAY CAUSE EYE AND LUNG IRRITATION

ergency First Aid Procedures:
WASH WITH SOAP AND WATER. FLUSH EYES WITH WATER.

SECTION VI — REACTIVITY DATA

bility	Unstable	Conditions to Avoid:
	Stable XX	AVOID HIGH DUST CONCENTRATIONS

ompatibility (Materials to Avoid):
STRONG OXIDIZERS, STRONG ACIDS

zardous Decomposition Products:
CO_2, NORMAL COMBUSTION PRODUCTS OF ORGANIC MATERIAL

zardous Polymerization	May Occur	Conditions to Avoid:
	Will Not Occur XX	NONE

SECTION VII — SPILL OR LEAK PROCEDURE

ns to be Taken in Case Material is Released or Spilled:
REMOVE IGNITION SOURCES. SHOVEL INTO DRUMS.

ste Disposal Method:
DISPOSE OF CONSISTENT WITH LOCAL, STATE AND FEDERAL REGULATIONS.

SECTION VIII — SPECIAL PROTECTION INFORMATION

iratory Protection (Specify Type):
NIOSH APPROVED DUST MASK.

tilation	Local Exhaust SUFFICIENT TO CONTROL DUST.	Special
	Mechanical (General)	Other
ective Gloves: UBBER		Eye Protection: CHEMICAL GOGGLES

er Protective Equipment:
MPERVIOUS OUTERWEAR

SECTION IX — SPECIAL PRECAUTIONS

utions to be taken in Handling and Storing:
TORE IN COOL, DRY PLACE

er Precautions: DUST EXPLOSIONS CAN OCCUR UNDER CONDITIONS OF HIGH DUST ONCENTRATION IN PRESENCE OF AN IGNITION SOURCE.

OCTOBER 19, 1990

is information is furnished without warranty of any kind. Employers should use is information only as a supplement to other information gathered, and must make dependent determinations of suitability and completeness from all sources to sure use of these materials and the safety and health of employees.

✓

Potassium Permanganate ($KMnO_4$)

Material Safety Data Sheet

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration
Required under USDL Safety and Health Regulations for Ship Repairing, Shipbuilding, and Shipbreaking (29 CFR 1915, 1916, 1917)

Form Approved
OMB No. 44-R1387

Section I

MANUFACTURER'S NAME	CARUS CHEMICAL COMPANY			**EMERGENCY TELEPHONE NO.**	815/223-1500
ADDRESS	1500 Eighth Street – LaSalle, IL 61301				
CHEMICAL NAME AND SYNONYMS	Potassium Permanganate	CAS Registry No. 7722-64-7			
CHEMICAL FAMILY	Oxidizer	**TRADE NAME AND SYNONYMS**	CAIROX®	**FORMULA**	$KMnO_4$

Section II Hazardous Ingredients

	%	TLV (Units)
Section II is not applicable since product is a single compound – Potassium Permanganate.	98	by wt

Section III Physical Data

BOILING POINT (°F.)	302°F Decomposes with evolution of O_2	**SPECIFIC GRAVITY ($H_2O=1$)**	2.7
SOLUBILITY IN WATER	6.5 g/100mL water at 20°C (68°F)		

Section IV Fire and Explosion Hazard Data

FLASH POINT (Method used)	Not Flammable	**EXTINGUISHING MEDIA**	Water

SPECIAL FIRE FIGHTING PROCEDURES
Use plenty of water. Watch for rapid burning and be prepared to retreat to a safe distance. If yellow-brown fumes are present, wear a positive pressure, self-contained breathing apparatus.

UNUSUAL FIRE AND EXPLOSION HAZARDS:
May decompose spontaneously if exposed to intense heat, concentrated acids, hydrogen peroxide, reducing agents, or organic substances generally. In confined areas, this decomposition may become explosive.

Section V Health Hazard Data

THRESHOLD LIMIT VALUE
Manganese and its inorganic compounds as Mn C 5 mg/m3 (C=ceiling value).

EFFECTS OF OVEREXPOSURE
Prolonged inhalation of manganese in the form of its inorganic compounds may cause manganism.

EMERGENCY AND FIRST AID PROCEDURES

BODY: Wash contaminated areas with copious amounts of water.

EYES: Flood with water for 15 minutes, holding the eyelids open. Consult physician immediately. Do NOT attempt to neutralize chemically.

INTERNAL: Give lemon or orange juice to drink; in addition, a milk or sugar solution may be given. If none of these are available, give large quantities of water to drink. Consult physician.

(Continued on reverse side)

PG 1 OF 2

Section VI Reactivity Data

STABILITY Stable	**CONDITIONS TO AVOID** Exposure to incompatible materials or heat.
INCOMPATIBILITY (Materials to avoid) Including but not limited to alcohols, arsenites, iodides, acids, charcoal, organic substances generally, ferrous or mercurous salts, hypophosphites, hyposulfites, sulfites, peroxides, oxalates.	
HAZARDOUS DECOMPOSITION PRODUCTS With hydrochloric acid, chlorine is liberated.	**HAZARDOUS POLYMERIZATION** Will not occur

Section VII Spill or Leak Procedures

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Sweep up and remove as much as $KMnO_4$ as possible; do not return contaminated material to original drum; transfer to clean metal drum and dispose in hazardous landfill; flush floor with abundant quantities of water into sewer, if permitted by Federal, State and Local regulations; if not, treat chemically (see below).

WASTE DISPOSAL METHOD

Reduce $KMnO_4$ solution with sodium thiosulfate solution, mix the sludge with soda ash (Na_2CO_3) and deposit in an approved landfill. Where permitted, the sludge can be drained into a sewer with large quantities of water.

Section VIII Special Protection Information

RESPIRATORY PROTECTION (Specify type) Mechanical (General)	**VENTILATION** For dust, use a NIOSH approved dust mask.
PROTECTIVE GLOVES Rubber or Plastic Gloves	**EYE PROTECTION** Goggles/Face Shield

Section IX Special Precautions

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

Store in a cool, dry area in closed containers separate from organics, concentrated acids, peroxides, ammonium compounds, metallic powders, elemental sulfur, phosphorous, carbon, metal hydrides, hydrazine, hydroxylamines.

OTHER PRECAUTIONS

DOT class; oxidizer; reportable quantity – 100 lb;

RCRA; Oxidizers such as potassium permanganate meet the criteria of ignitable waste.

PG 2 OF 2

MSDS Number: **E5125** * * * * * *Effective Date:* ***11/02/01*** * * * * * *Supercedes:* ***02/25/99***

ETHYLENE GLYCOL

1. Product Identification

Synonyms: 1,2-Ethanediol; glycol; 1,2-Dihydroxyethane; Ethylene Alcohol; Ethulene Dihydrate
CAS No.: 107-21-1
Molecular Weight: 62.07
Chemical Formula: CH2OHCH2OH
Product Codes:
J.T. Baker: 5387, 5845, 9140, 9298, 9300, 9346, 9349, 9356, L715
Mallinckrodt: 5001, 5037

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Ethylene Glycol	107-21-1	99 - 100%	Yes

3. Hazards Identification

Emergency Overview

WARNING! HARMFUL OR FATAL IF SWALLOWED. HARMFUL IF INHALED OR ABSORBED THROUGH SKIN. MAY CAUSE ALLERGIC SKIN REACTION. MAY CAUSE IRRITATION TO SKIN, EYES, AND RESPIRATORY TRACT. AFFECTS CENTRAL NERVOUS SYSTEM.

J.T. Baker SAF-T-DATA$^{(tm)}$ Ratings (Provided here for your convenience)

Health Rating: 2 - Moderate

Flammability Rating: 1 - Slight
Reactivity Rating: 1 - Slight
Contact Rating: 2 - Moderate
Lab Protective Equip: GOGGLES; LAB COAT; VENT HOOD; PROPER GLOVES
Storage Color Code: Orange (General Storage)

Potential Health Effects

Inhalation:
Vapor inhalation is generally not a problem unless heated or misted. Exposure to vapors over an extended time period has caused throat irritation and headache. May cause nausea, vomiting, dizziness and drowsiness. Pulmonary edema and central nervous system depression may also develop. When heated or misted, has produced rapid, involuntary eye movement and coma.
Ingestion:
Initial symptoms in massive dosage parallel alcohol intoxication, progressing to CNS depression, vomiting, headache, rapid respiratory and heart rate, lowered blood pressure, stupor, collapse, and unconsciousness with convulsions. Death from respiratory arrest or cardiovascular collapse may follow. Lethal dose in humans: 100 ml (3-4 ounces).
Skin Contact:
Minor skin irritation and penetration may occur.
Eye Contact:
Splashes may cause irritation, pain, eye damage.
Chronic Exposure:
Repeated small exposures by any route can cause severe kidney problems. Brain damage may also occur. Skin allergy can develop. May damage the developing fetus.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders, eye problems, or impaired liver, kidney, or respiratory function may be more susceptible to the effects of this substance.

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4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.
Ingestion:
Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention.
Skin Contact:
Remove any contaminated clothing. Wash skin with soap and water for at least 15

minutes. Get medical attention if irritation develops or persists.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

Note to Physician:
Give sodium bicarbonate intravenously to treat acidosis. Urinalysis may show low specific gravity, proteinuria, pyuria, cylindruria, hematuria, calcium oxide, and hippuric acid crystals. Ethanol can be used in antidotal treatment but monitor blood glucose when administering ethanol because it can cause hypoglycemia. Consider infusion of a diuretic such as mannitol to help prevent or control brain edema and hemodialysis to remove ethylene glycol from circulation.

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5. Fire Fighting Measures

Fire:
Flash point: 111C (232F) CC
Autoignition temperature: 398C (748F)
Flammable limits in air % by volume:
lel: 3.2; uel: 15.3
Slight to moderate fire hazard when exposed to heat or flame.
Explosion:
Above flash point, vapor-air mixtures are explosive within flammable limits noted above. Containers may explode when involved in a fire.
Fire Extinguishing Media:
Dry chemical, foam or carbon dioxide. Water or foam may cause frothing. Water spray may be used to extinguish surrounding fire and cool exposed containers. Water spray will also reduce fume and irritant gases.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode. Toxic gases and vapors may be released if involved in a fire.

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6. Accidental Release Measures

Ventilate area of leak or spill. Remove all sources of ignition. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Use non-sparking tools and equipment. Collect liquid in an appropriate container or absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response

Center is (800) 424-8802.

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7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Separate from acids and oxidizing materials. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

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8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
-OSHA Permissible Exposure Limit (PEL):
50 ppm Ceiling

-ACGIH Threshold Limit Value (TLV):
50 ppm Ceiling (vapor)
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded, a half-face respirator with an organic vapor cartridge and particulate filter (NIOSH type P95 or R95 filter) may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. A full-face piece respirator with an organic vapor cartridge and particulate filter (NIOSH P100 or R100 filter) may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. Please note that N series filters are not recommended for this material. For emergencies or instances where the exposure levels are not known, use a full-face piece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.
Skin Protection:
Wear protective gloves and clean body-covering clothing.
Eye Protection:
Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

---

9. Physical and Chemical Properties

Appearance:
Clear oily liquid.
Odor:
Odorless.
Solubility:
Miscible in water.
Specific Gravity:
1.1 @20C/4C
pH:
No information found.
% Volatiles by volume @ 21C (70F):
100
Boiling Point:
197.6C (388F)
Melting Point:
-13C (9F)
Vapor Density (Air=1):
2.14
Vapor Pressure (mm Hg):
0.06 @ 20C (68F)
Evaporation Rate (BuAc=1):
No information found.

---

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
Carbon dioxide and carbon monoxide may form when heated to decomposition. May produce acrid smoke and irritating fumes when heated to decomposition.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Strong oxidizing agents. Reacts violently with chlorosulfonic acid, oleum, sulfuric acid, perchloric acid. Causes ignition at room temperature with chromium trioxide, potassium permanganate and sodium peroxide; causes ignition at 212F(100C) with ammonium dichromate, silver chlorate, sodium chloride and uranyl nitrate.
Conditions to Avoid:
Heat, flames, ignition sources, water (absorbs readily) and incompatibles.

---

11. Toxicological Information

Toxicological Data:
Oral rat LD50: 4700 mg/kg; skin rabbit LD50: 9530 mg/kg.
Irritation - skin rabbit: 555mg(open), mild; eye rabbit: 500mg/24H, mild.
Investigated as a tumorigen, mutagen, reproductive effector.
Reproductive Toxicity:
Has shown teratogenic effects in laboratory animals.

```
  --------\Cancer Lists\------------------------------------------------------
-
                                         ---NTP Carcinogen---
  Ingredient                             Known    Anticipated    IARC
Category
  ------------------------------------   -----    -----------    ------------
-
  Ethylene Glycol (107-21-1)              No           No            None
```

---

12. Ecological Information

Environmental Fate:
When released into the soil, this material is expected to readily biodegrade. When released into the soil, this material is expected to leach into groundwater. When released into the soil, this material is not expected to evaporate significantly. When released into water, this material is expected to readily biodegrade. When released into the water, this material is expected to have a half-life between 1 and 10 days. This material is not expected to significantly bioaccumulate. This material has a log octanol-water partition coefficient of less than 3.0. When released into water, this material is not expected to evaporate significantly. When released into the air, this material is expected to be readily degraded by reaction with photochemically produced hydroxyl radicals. When released into the air, this material is expected to have a half-life between 1 and 10 days.
Environmental Toxicity:
The LC50/96-hour values for fish are over 100 mg/l.

---

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

---

14. Transport Information

Not regulated.

15. Regulatory Information

```
  --------\Chemical Inventory Status - Part 1\-------------------------------
--
  Ingredient                                       TSCA  EC   Japan  
Australia
  -----------------------------------------------  ----  ---  -----  --------
-
  Ethylene Glycol (107-21-1)                        Yes  Yes   Yes      Yes

  --------\Chemical Inventory Status - Part 2\-------------------------------
--
                                                          --Canada--
  Ingredient                                       Korea  DSL   NDSL  Phil.
  -----------------------------------------------  -----  ---   ----  -----
  Ethylene Glycol (107-21-1)                        Yes   Yes   No     Yes

  --------\Federal, State & International Regulations - Part 1\--------------
--
                                             -SARA 302-    ------SARA 313----
--
  Ingredient                                 RQ    TPQ     List  Chemical  
Catg.
  -----------------------------------------  ---   -----   ----  ------------
--
  Ethylene Glycol (107-21-1)                 No    No      Yes        No

  --------\Federal, State & International Regulations - Part 2\--------------
--
                                                        -RCRA-    -TSCA-
  Ingredient                                 CERCLA     261.33     8(d)
  -----------------------------------------  ------     ------    ------
  Ethylene Glycol (107-21-1)                 5000       No         No


Chemical Weapons Convention:  No     TSCA 12(b):  No     CDTA:  No
SARA 311/312:  Acute: Yes      Chronic: Yes  Fire: No  Pressure: No
Reactivity: No          (Pure / Liquid)
```

Australian Hazchem Code: None allocated.
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

---

16. Other Information

NFPA Ratings: Health: **1** Flammability: **1** Reactivity: **0**

Label Hazard Warning:

WARNING! HARMFUL OR FATAL IF SWALLOWED. HARMFUL IF INHALED OR ABSORBED THROUGH SKIN. MAY CAUSE ALLERGIC SKIN REACTION. MAY CAUSE IRRITATION TO SKIN, EYES, AND RESPIRATORY TRACT. AFFECTS CENTRAL NERVOUS SYSTEM.

Label Precautions:

Do not breathe vapor or mist.
Use only with adequate ventilation.
Keep container closed.
Avoid contact with eyes, skin and clothing.
Wash thoroughly after handling.

Label First Aid:

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes. Call a physician if irritation develops or persists. If swallowed, give water or milk to drink and induce vomiting. Never give anything by mouth to an unconscious person. In all cases call a physician.

Product Use:

Laboratory Reagent.

Revision Information:

MSDS Section(s) changed since last revision of document include: 8.

Disclaimer:

Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

Quoin International

FIRE QUICK
WILDFIRE MANAGEMENT FLARE SYSTEMS

MATERIAL SAFETY DATA SHEET (MSDS)	HEALTH = 1 SLIGHT FLAMMABILITY = 3 SEVERE REACTIVITY = 0 NONE

SECTION I	CRITICAL NUMBERS
TRADE NAME **Fire Quick Flares Hot Shot", Sure Shot", Stubby , 2 ½-Inch"**	**EMERGENCY TELEPHONE** **(800) 535-5053**
Proper Shipping Name Flammable Solid, Inorganic, n.o.s (Aluminum Powder)	**<u>DOT Classification</u>** UN 3178, 4.1, Packaging Group III
Manufacture Name **Quoin International, Inc.**	**<u>MANUFACTURER PHONE</u>** (760) 446-4052
Address 1331 N. Inyo, Ridgecrest, CA 93555	

SECTION II HAZARDOUS INGREDIENTS		WEIGHT (grams per flare)
Aluminum	(CAS # 7429-90-5)	20 - 60
Calcium Sulfate (di-hydride)		10 - 70
Iron Oxide	(CAS # 1309-37-1)	4 - 10
Copper Oxide	(CAS # 1317-39-1)	1
Silicon		.1
Potassium Perchiorate	(CAS#07778-74-7)	.1
Lead Oxide		.1

SECTION III PHYSICAL DATA FOR MATERIAL			
Boiling Point	N/A	Specific Gravity	1.43
Vapor Pressure	N/A	Physical State	Solid
Solubility in Water	Insoluble	pH	Neutral
Color	Gray	Odor Threshold	N/A

SECTION IV FIRE AND EXPLOSION HAZARD DATA	
Flash Point Self Ignites at 800 °F	**UEL:** N/A **LEL:** N/A
MEANS OF EXTINCTION: FLOODING WITH WATER, DRY SAND, CARBON DIOXIDE. FLARES CAN IGNITE IF PACKAGING IS BURNING. LARGE AMOUNTS OF WATER PREVENT FLARE IGNITION IF PACKAGING IS BURNING.	
SPECIAL PROCEDURES: FIRE QUICK FLARES ARE PACKAGED IN BOXES OF 10 TO 50 EACH. FLARES ARE REACTIVE PRODUCING MOLTEN MATERIALS IN EXCESS OF 4000 °F AND LOCALIZED SMOKE. HEAT/FLAME IS THE ONLY KNOWN IGNITION SOURCE. FLOOD WITH WATER TO EXTINGUISH, DON'T <u>INHALE FUMES</u>	
EXPLOSIVE HAZARD: FIARES WILL NOT EXPLODE. DELAY FUSE IS PROTECTED BY SEAL, WHICH IS BROKEN BY THE OPERATOR BEFORE USE. FUSE LIGHTS FLARE RESULTING IN AGRESSIVE BURNING, MAY CAUSE FLARE MOTION.	**HAZARDOUS COMBUSTION PRODUCTS**: REACTION PRODUCES SUPERHEATED CALCIUM SULFIDE, WHICH REACTS WITH WATER TO PRODUCE HYDROGEN SULFIDE GAS. HUMAN EXPOSURE TO H_2S @ 800-1000 PPM FOR 30 MIN. MAY BE FATAL.

SECTION V REACTIVITY DATA

STABILITY: STABLE UNDER NORMAL CONDITIONS OF USE.

INCOMPATIBLE CONDITIONS: AVOID TEMPERATURE ABOVE 800 °F. STRONG ACIDS.

HAZARDOUS DECOMPOSITION PRODUCTS: CALCIUM SULFIDE

SECTION VI HEALTH DATA

ROUTE OF ENTRY:

INHALATION: YES, OF COMBUSTION PRODUCTS
INGESTION: N/A
EYE CONTACT: YES, OF COMBUSTION PRODUCTS
SKIN ABSORBTION: NO

SYMPTOM/EFFECT OF OVEREXPOSURE:

THE FLARE CAN BE HANDLED IN ITS PACKAGED STATE WITH NO RISK OF EXPOSURE. PRIMARY HAZARD IS EXPOSURE TO HOT COMBUSTION PRODUCTS CAUSING BURNS TO SKIN AND EYES. INHALATION OF COMBUSTION PRODUCTS IS PRIMARY ROUTE OF ENTRY TO HUMANS. THESE PRODUCTS CONTAIN CALCIUM OR HYDROGEN SULFIDE WHICH IS IRRATANT TO EYES AND MUCUS MEMBRANES.

CARCINOGENICITY: NONE KNOWN

MEDICAL CONDITIONS GENERALLY AGRAVATED BY EXPOSURE:

FLARE: NONE KNOWN

COMBUSTION REACTION: PROTECT EYES FROM "FLASH" DURING REACTION. SKIN BURNS CAN RESULT IF EXPOSED TO HOT COMBUSTION PRODUCTS.

INHALATION: PRE-EXISTING UPPER RESPRITORY AND LUNG DISEASES SUCH AS, BUT NOT LIMITED TO, BRONCHITIS, PHYSERA, AND ASTHMA.

SECTION VII PREVENTIVE MEASURES

GLOVES: SUITABLE FOR PROTECTION FROM POTENTIAL HIGH TEMPERATURE PRODUCTS.

EYEWARE: SAFETY GLASSES AND/OR GOGGLES SHOULD BE WORN TO PROTECT FROM COMBUSTION MATERIALS.

VENTILATION: FLARE IS TO BE USED IN OUTDOOR ENVIRONMENT ONLY. FLARE IGNITION NO CLOSER THAN 20 FEET TO HUMAN IS REQUIRED.

SPILLAGE: IF FLARES ARE CRUSHED DURING HANDLING, CAREFULLY PICK UP DAMAGED FIARE AND DISCARD IN APPROVED LANDFILL OR INCINERATE.

SECTION VIII SPECIAL PRECAUTIONS

STORE MATERIAL IN A COOL DRY AREA AND RESTRICT SMOKING AND OPEN FLAMES. DO NOT BREATHE SMOKE GENERATED DURING REACTION.

APPROVAL: CEO DATE: 8/12/1998

MATERIAL SAFETY DATA SHEET

EQUILON MSDS: 00436ET 01/04/99

TEXACO PROPANE

TELEPHONE NUMBER:

24 HOUR EMERGENCY ASSISTANCE	GENERAL MSDS ASSISTANCE
EQUIVA SERVICES: 877-276-7283	877-276-7285
CHEMTREC: 800-424-9300	

NAME AND ADDRESS:

EQUILON ENTERPRISES LLC
PRODUCT STEWARDSHIP
P.O. BOX 674414
HOUSTON, TX 77267-4414

LEGEND:

N.D. - NOT DETERMINED N.A. - NOT APPLICABLE N.T- NOT TESTED
< - LESS THAN > - GREATER THAN

1.NAME

MATERIAL IDENTITY

Product Code and Name:
00436 TEXACO PROPANE

Chemical Name and/or Family or Description:
Aliphatic Hydrocarbon

2. COMPOSITION/INFORMATION ON INGREDIENTS

THE CRITERIA FOR LISTING COMPONENTS IN THE COMPOSITION SECTION IS AS FOLLOWS: CARCINOGENS ARE LISTED WHEN PRESENT AT 0.1 % OR GREATER; COMPONENTS WHICH ARE OTHERWISE HAZARDOUS ACCORDING TO OSHA ARE LISTED WHEN PRESENT AT 1.0 % OR GREATER; NON-HAZARDOUS COMPONENTS ARE LISTED AT 3.0 % OR GREATER. THIS IS NOT INTENDED TO BE A COMPLETE COMPOSITIONAL DISCLOSURE. REFER TO SECTION 14 FOR APPLICABLE STATES' RIGHT TO KNOW AND OTHER REGULATORY INFORMATION.

Product and/or Component(s) Carcinogenic According to:

OSHA	IARC	NTP	OTHER	NONE
				X
_	_	_	_	_

Composition: (Sequence Number and Chemical Name)

This product may be odorized. The odorant content may vary from 0-50 ppm; common odorants include mercaptans and thiopane.

Seq.	Chemical Name	CAS Number	Range in %
01	* Propane	74-98-6	100.00

PRODUCT IS HAZARDOUS ACCORDING TO OSHA (1910.1200).

* COMPONENT IS HAZARDOUS ACCORDING TO OSHA.

Exposure Limits referenced by Sequence Number in the Composition Section

Seq.	Limit
01	1000 ppm TWA-OSHA
01	- - ASPHYXIANT (ACGIH)

3. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW

Appearance:
Gas

Odor:
If odorized will have rotten egg odor - otherwise, odorless

WARNING STATEMENT

DANGER ! FLAMMABLE GAS - MAY CAUSE FLASH FIRE
DELAYED EVAPORATION FROM CONTAMINATED CLOTHING MAY BE A FIRE HAZARD

LIQUID MAY CAUSE FROSTBITE
MAY CAUSE DIZZINESS AND DROWSINESS
GAS REDUCES OXYGEN AVAILABLE FOR BREATHING
GAS MAY ACCUMULATE IN CONFINED SPACES AND CAUSE SUFFOCATION

HMIS		NFPA	
Health: 1	Reactivity: 0	Health: 1	Reactivity: 0
Flammability: 4	Special : -	Flammability: 4	Special : -

POTENTIAL HEALTH EFFECTS

	EYE	SKIN	INHALATION	INGESTION
Primary Route of Exposure:	X	X	X	
	_	_	_	_

EFFECTS OF OVEREXPOSURE

Acute:

Eyes:

Eye contact with liquid product or gas under pressure can cause frostbite (cold burns).

Skin:

Brief contact is not irritating.

Product is a gas - not expected to be absorbed through the skin.

Skin contact with liquid product can cause frostbite (cold burns).

Inhalation:

Gas may be irritating and cause discomfort in nose and throat, nasal discharge, and coughing. Prolonged overexposure may cause difficulty breathing.

Inhalation may cause dizziness, drowsiness, euphoria, loss of coordination, disorientation, headache, nausea, and vomiting. In poorly ventilated areas or confined spaces, unconsciousness and asphyxiation may result.

Ingestion:

Product is a gas - not expected to cause toxic effects due to ingestion.

This material is a gas. Gas or liquid under pressure may cause frostbite (cold burns).

Sensitization Properties:

Unknown.

Chronic:

No adverse effects have been documented in humans as a result of chronic exposure. Section 11 may contain applicable animal data.

Medical Conditions Aggravated by Exposure:

There is no evidence that this product aggravates an existing medical condition.

Other Remarks:

If purchased for consumer use, contains or may release alkyl mercaptans (e.g., methyl mercaptan, ethyl mercaptan). Mercaptan concentrations above permissible concentrations can cause headache, dizziness, nausea, vomiting, and diarrhea. At concentrations above 400 ppm, respiratory paralysis, causing unconsciousness and death can occur.

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4. FIRST AID MEASURES

Eyes:

Flush eyes with plenty of water for several minutes. Get medical attention if eye irritation persists.

Skin:

Wash skin with plenty of soap and water for several minutes. Get medical attention if skin irritation develops or persists.

In case of cold burn, immediately place affected area in warm water (105 F) and keep at this temperature until circulation returns. Get medical attention.

If clothing becomes wetted, drench individual with water and remove contaminated clothing if possible. Slowly warm affected area of skin.

Ingestion:

No emergency care anticipated. This material is a gas at standard temperature and pressure.

Inhalation:

If inhaled, remove to fresh air. If not breathing, clear person's airway and give artificial respiration. If breathing is difficult, qualified medical personnel may administer oxygen. Get medical attention immediately.

Other Instructions:

Overexposure to this material may sensitize the heart to catecholamine-induced arrhythmias. Do not administer catecholamines to overexposed individuals. Contact a Poison Control Center for further treatment information.

This material is an asphyxiant which may have anesthetic properties at high concentrations. If present in sufficient concentrations to reduce the oxygen level below 18% in inhaled air, rapid respiration, mental dullness, incoordination, poor judgement, nausea, and unconsciousness may result. Oxygen deficiency may occur without warning in areas where this gas may displace air.

NOTE TO EMERGENCY RESPONDERS: The odor of mercaptans such as methyl mercaptan or ethyl mercaptan is offensive and similar to rotten eggs. The presence of odors is not a reliable warning signal. DO NOT use odor to estimate the amount of mercaptan vapors present.

5. FIRE-FIGHTING MEASURES

Ignition Temperature - AIT (degrees F):

Not determined.

Flash Point (degrees F):

-156

Flammable Limits (%):

Lower: 2.3

Upper: 9.5

Recommended Fire Extinguishing Agents And Special Procedures:

Fight fire from protected location or maximum possible distance. Stop flow of gas before attempting to extinguish flames. Use water spray to cool fire-exposed containers and to protect persons attempting to stop the flow of gas. Use flooding quantities of water as fog or spary. Use dry chemical or carbon dioxide to extinguish flames.

Unusual or Explosive Hazards:

Explosive air-vapor mixtures may form.

Danger! Readily forms explosive air-vapor mixtures; may release explosive vapors that travel, be ignited at remote locations, and flash back. Containers may explode in fire. Do not expose to heat, sparks, flame, static, or other sources of ignition. When handling, use non-sparking tool, ground and bond all containers.

Extinguishing Media Which Must Not Be Used:

Not determined.

Special Protective Equipment for Firefighters:

Wear full protective clothing and positive pressure breathing apparatus.

6. ACCIDENTAL RELEASE MEASURES (Transportation Spills: CHEMTREC (800)424-9300)

Procedures in Case of Accidental Release, Breakage or Leakage:

Eliminate all ignition sources including internal combustion engines and power tools. Ventilate area. Keep people away. Stay upwind and warn of possible downwind explosion hazard. Avoid breathing vapor. Avoid contact with eyes, skin, or clothing. Pressure demand air supplied respirators should always be worn when the airborne concentration of the contaminant or oxygen is unknown. Otherwise, wear respiratory protection and other personal protective equipment as appropriate for the potential exposure hazard.

If more than 2,000,000 pounds of product is spilled, then report spill according to SARA 304 and/or CERCLA 102(a) requirements, unless product qualifies for the petroleum exemption (CERCLA Section 101(14)).

7. HANDLING AND STORAGE

Precautions to be Taken in
Handling:
Use spark-proof tools. Material may be at elevated temperatures and/or pressures. Exercise care when opening bleeders and sampling ports.
Storage:
Ground and bond shipping container, transfer line, and receiving container. Keep away from heat, sparks, flame, and other sources of ignition.

---

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Protective Equipment (Type)
Eye/Face Protection:
Safety glasses, chemical type goggles, or face shield recommended to prevent eye contact.
Skin Protection:
Protective clothing such as coveralls or lab coats should be worn. Launder or dry-clean when soiled. Gloves and boots resistant to chemicals and petroleum distillates required. Insulated gloves also required if contact with liquid-cooled product or equipment is expected.
Respiratory Protection:
Airborne concentrations should be kept to lowest levels possible. If vapor, mist or dust is generated and the occupational exposure limit of the product, or any component of the product, is exceeded, use appropriate NIOSH or MSHA approved air purifying or air supplied respirator after determining the airborne concentration of the contaminant. Air supplied respirators should always be worn when airborne concentration of the contaminant or oxygen content is unknown.
Ventilation:
Use explosion-proof equipment to maintain adequate ventilation to meet occupational exposure limits, if applicable (see below), prevent accumulation of explosive air-gas mixtures, and avoid significant oxygen displacement. Oxygen levels should be at least 19.5% in confined spaces or other work areas (OSHA value).
Exposure Limit for Total Product:
Propane: OSHA PEL-TWA 1000 ppm.

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9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance:
Gas
Odor:
If odorized will have rotten egg odor - otherwise, odorless
Boiling Point (degrees F):
-40
Melting/Freezing point (degrees F):
Not applicable.
Specific Gravity (water=1):
.5077
pH of undiluted product:
Not applicable.
Vapor Pressure:
10 mmHg at 80.6
Viscosity:
Not applicable.
VOC Content:
Not determined.
Vapor Density (air=1):
1.5
Solubility in Water (%):
> 10
Other: None

---

10. STABILITY AND REACTIVITY

This Material Reacts Violently With:
(If Others is checked below, see comments for details)

Air	Water	Heat	Strong Oxidizers	Others	None of These
_	_	X _	X _	_	_

Comments:
None

Products Evolved When Subjected to Heat or Combustion:
Toxic levels of carbon monoxide, carbon dioxide, irritating aldehydes and ketones.

Hazardous Polymerizations: DO NOT OCCUR

11. TOXICOLOGICAL INFORMATION

TOXICOLOGICAL INFORMATION(ANIMAL TOXICITY DATA)
Median Lethal Dose
Oral:
Not applicable; material is a gas.
Inhalation:
Not determined.
Dermal:
Not applicable; material is a gas.
Irritation Index, Estimation of Irritation (Species)
Skin:
(Draize) Believed to be < .50 /8.0 (rabbit) no appreciable effect
Eyes:
(Draize) Believed to be < 15.00 /110 (rabbit) no appreciable effect
Sensitization:
Not determined.
Other:
None

12. DISPOSAL CONSIDERATIONS

Waste Disposal Methods
This product (as presently constituted) has the RCRA characteristics of ignitability, and, if discarded in its present form, would have the hazardous waste number of D001. Under RCRA, it is the responsibility of the user of the product to determine, at the time of disposal, whether the product meets RCRA criteria for hazardous waste. This is because product uses, transformations, mixtures, processes, etc. may change the classification to non-hazardous, or hazardous for reasons other than, or in addition to ignitability.

Remarks
This product is potentially biodegradable.

13. TRANSPORT INFORMATION

Transportation
DOT:
Proper Shipping Name:
Liquified Petroleum Gas
Hazard Class:
2.1
Identification Number: UN 1075
Packing Group:
Label Required:
Flammable gas
IMDG:
Proper Shipping Name:
Not evaluated
ICAO:

Proper Shipping Name:
Not evaluated
TDG:
Proper Shipping Name:
Not evaluated

14. REGULATORY INFORMATION

Federal Regulations:
SARA Title III:
Section 302/304 Extremely Hazardous Substances

Seq.	Chemical Name	CAS Number	Range in %
01	Methyl mercaptan (if odorized - 50 ppm max)	74-93-1	0.005

Section 302/304 Extremely Hazardous Substances (CONT)

Seq.	TPQ	RQ
01	500	100

Section 311 Hazardous Categorization:

Acute	Chronic	Fire	Pressure	Reactive	N/A
X		X			

Section 313 Toxic Chemical

Chemical Name	CAS Number	Concentration
None		

CERCLA 102(a)/DOT Hazardous Substances: (+ indicates DOT Hazardous Substance)

Seq.	Chemical Name	CAS Number	Range in %
01+	Methyl mercaptan (if odorized - 50 ppm max)	74-93-1	0.005

CERCLA/DOT Hazardous Substances (Sequence Numbers and RQ's):

Seq.	RQ
01+	100

TSCA Inventory Status:
This product, or its components, are listed on or are exempt from the Toxic Substance Control Act (TSCA) Chemical Substance Inventory.
Other:
None.
State Regulations:
California Proposition 65:
The following detectable components of this product are substances, or belong to classes of substances, known to the State of California to cause cancer and/or reproductive toxicity.

Chemical Name	CAS Number
None	

International Regulations:
Export Notification (TSCA-12b):
This product may be subject to export notification under TSCA section 12(b); contains:
Methyl mercaptan (if odorized - 50 ppm max)
WHMIS Classification:
Not determined
Canada Inventory Status:
This product, or its components, are listed on or are exempt from the Canadian Domestic Substance List (DSL).
EINECS Inventory Status:
This product, or its components, are listed on or are exempt from the European Inventory of Existing Chemical Substances (EINECS) or the European List of Notified Chemical Substances (ELINCS).
Australia Inventory Status:
Not determined.

Japan Inventory Status:
Not determined.

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15. ENVIRONMENTAL INFORMATION

Aquatic Toxicity:
Not determined.
Mobility:
Not determined.
Persistence and Biodegradability:
Not determined.
Potential to Bioaccumulate:
Not determined.
Remarks:
None

---

16. OTHER INFORMATION

This product is currently on the FDA's GRAS (generally regarded as safe) list.

NFPA NO. 58 REQUIRES ODORIZATION OF PROPANE SOLD FOR GENERAL CONSUMER USE. ODORIZATION PROVIDES A METHOD OF DETECTION IN THE EVENT OF A LEAK.

COMMON ODORANTS INCLUDE ETHYL MERCAPTAN AND THIOPANE.

A BRIEF SUMMARY OF THE SAFETY INFORMATION REGARDING THE ODORANT IS PROVIDED HERE. FOR MORE DETAILED INFORMATION, PLEASE REFER TO THE REFERENCE SECTION.

DO NOT RELY ON ODOR TO WARN OF PRESENCE OF GAS. IT IS IMPORTANT TO NOTE THAT NO ODORANT IS EFFECTIVE 100% OF THE TIME UNDER ALL CONDITIONS. THE EFFECTIVENESS OF THE ODORANT CAN BE REDUCED BY EXPOSURE TO SMALL AMOUNTS OF OXYGEN, MOISTURE, RUST OR SCALE. IN ADDITION, THE ODORANT MAY BE ABSORBED BY SOIL, NEW TANK SURFACES, NEW PIPING, OR CERTAIN BUILDING MATERIALS SUCH AS MASONRY. WHENEVER AN EMPTY TANK IS FILLED, IT MUST BE COMPLETELY PURGED IN ACCORDANCE WITH NPGA BULLETIN 133-89 TO REMOVE AIR AND WATER. THE INTEGRITY OF UNDERGROUND PIPES SHOULD BE CHECKED PERIODICALLY. IF PROPANE LEAKS FROM AN UNDERGROUND PIPE, THE SOIL MAY ABSORB THE ODORANT AS THE GAS MIGRATES TO THE SURFACE, WHICH COULD LEAVE THE GAS UNDETECTED BY SMELL. IF A PROPANE SYSTEM HAS NOT BEEN USED FOR AN EXTENDED PERIOD, IT SHOULD BE THOROUGHLY CHECKED BEFORE CONTINUING USE.

CERTAIN PHYSICAL CIRCUMSTANCES SUCH AS COLDS, ALLERGIES, SMOKING, ALCOHOL, AGE OR STRONG COMPETING ODORS MAY AFFECT A PERSON'S ABILITY TO SMELL ANY ODOR. IN ADDITION, AS WITH ANY ODOR, CONTINUED EXPOSURE TO PROPANE ODORANT CAN REDUCE A PERSON'S ABILITY TO DETECT THE ODORANT.

REFERENCES
NPGA BULLETIN NO. 133-80 "PURGING NEW CONTAINERS"
NFPA BULLETIN NO. 58, "STORAGE AND HANDLING OF LIQUIFIED PETROLEUM GAS"

Dispose of as a vapor, venting at a safe location, keeping gas below explosive limit (LEL).

The information below is given to call attention to the issue of "naturally occurring radioactive materials". Although radon-222 levels in this product do not present any direct radon exposure, customers should be aware of the potential of radon daughter product buildup within their processing streams whatever the source of their product streams. Radon-222 is a naturally occurring radioactive gas which can be a contaminant in natural gas. During subsequent processing, radon tends to be concentrated in the liquified petroleum gas stream and in product streams having a similar boiling point range. Industry experience has shown that this product may contain small amounts of radon-222 and its radioactive decay products, called radon "daughters". The actual concentration of Radon-222 and radioactive daughters in the process equipment (IE lines, filters, pumps and reactor units) may accumulate significant levels of radioactive daughters and show a gamma radiation reading during operation. A potential external radiation hazard exists at or near any pipe, valve or vessel containing a radon-enriched stream or containing internal deposits of radioactive material, due to the transmission of gamma radiation through

its wall.
Field studies in the literature and conducted by company personnel at selected sites, have not shown any conditions that subject workers to cumulative exposures in excess of general population limits. Equipment emitting gamma radiation should be presumed to be internally contaminated with alpha-emitting decay products which may be a hazard if inhaled or ingested. During maintenance operations that require the opening of contaminated process equipment, the flow of gas should be stopped and a four hour delay enforced to allow the gamma radiation to drop to background levels. Protective equipment E.G. coveralls, gloves and respirator (NIOSH/MSHA approved for high efficiency particulates and radionuclides, or supplied air) should be worn by personnel entering a vessel or working on contaminated process equipment to prevent skin contamination, ingestion or inhalation of any residue containing alpha radiation. Airborne contamination may be minimized by handling scale and/or contaminated materials in a wet state.

THE INFORMATION CONTAINED IN THIS DATA SHEET IS BASED ON THE DATA AVAILABLE TO US AT THIS TIME, AND IS BELIEVED TO BE ACCURATE BASED UPON THAT DATA. IT IS PROVIDED INDEPENDENTLY OF ANY SALE OF THE PRODUCT, FOR PURPOSE OF HAZARD COMMUNICATION. IT IS NOT INTENDED TO CONSTITUTE PRODUCT PERFORMANCE INFORMATION, AND NO EXPRESS OR IMPLIED WARRANTY OF ANY KIND IS MADE WITH RESPECT TO THE PRODUCT, UNDERLYING DATA OR THE INFORMATION CONTAINED HEREIN. YOU ARE URGED TO OBTAIN DATA SHEETS FOR ALL PRODUCTS YOU BUY, PROCESS USE OR DISTRIBUTE, AND ARE ENCOURAGED TO ADVISE THOSE WHO MAY COME IN CONTACT WITH SUCH PRODUCTS OF THE INFORMATION CONTAINED HEREIN.

TO DETERMINE THE APPLICABILITY OR EFFECT OF ANY LAW OR REGULATION WITH RESPECT TO THE PRODUCT, YOU SHOULD CONSULT WITH YOUR LEGAL ADVISOR OR THE APPROPRIATE GOVERNMENT AGENCY. WE WILL NOT PROVIDE ADVICE ON SUCH MATTERS, OR BE RESPONSIBLE FOR ANY INJURY FROM THE USE OF THE PRODUCT DESCRIBED HEREIN. THE UNDERLYING DATA, AND THE INFORMATION PROVIDED HEREIN AS A RESULT OF THAT DATA, IS THE PROPERTY OF EQUIVA SERVICES, LLC AND IS NOT TO BE THE SUBJECT OF SALE OR EXCHANGE WITHOUT THE EXPRESS WRITTEN CONSENT OF EQUIVA SERVICES, LLC.

Date: 1999-01-04 New X Revised, Supersedes: 1997-03-24

Inquiries regarding MSDS should be directed to:

Equiva Services LLC
Manager Product Stewardship
P.O. Box 674414
Houston, TX 77267-4414

17. PRODUCT LABEL Label Date: 1999-01-04

READ AND UNDERSTAND MATERIAL SAFETY DATA SHEET BEFORE HANDLING OR DISPOSING OF PRODUCT. THIS LABEL COMPLIES WITH THE REQUIREMENTS OF THE OSHA HAZARD COMMUNICATION STANDARD (29 CFR 1910.1200) FOR USE IN THE WORKPLACE. THIS LABEL IS NOT INTENDED TO BE USED WITH PACKAGING INTENDED FOR SALE TO CONSUMERS AND MAY NOT CONFORM WITH THE REQUIREMENTS OF THE CONSUMER PRODUCT SAFETY ACT OR OTHER RELATED REGULATORY REQUIREMENTS.

00436 TEXACO PROPANE

WARNING STATEMENT

DANGER ! FLAMMABLE GAS - MAY CAUSE FLASH FIRE
DELAYED EVAPORATION FROM CONTAMINATED CLOTHING MAY BE A FIRE HAZARD
LIQUID MAY CAUSE FROSTBITE
MAY CAUSE DIZZINESS AND DROWSINESS
GAS REDUCES OXYGEN AVAILABLE FOR BREATHING
GAS MAY ACCUMULATE IN CONFINED SPACES AND CAUSE SUFFOCATION

PRECAUTIONARY MEASURES

-Keep away from heat, sparks or flame.
-Use only with adequate ventilation.

- -This gas deadens sense of smell. Do not depend on odor to detect presence of gas.
- -Do not enter storage areas or confined spaces unless adequately ventilated.
- -Use supplied air respiratory protection for cleaning large spills or upon entry into tanks, vessels, or other confined spaces.
- -Avoid breathing vapor, mist, or gas.
- -Rescue procedures should be attempted ONLY after notifying others of emergency and ONLY if appropriate personal equipment is available.
- -Wear insulated gloves if contact with liquid cooled equipment is expected.
- -Keep container closed.
- -Workers should wash exposed skin several times daily with soap and water.

FIRST AID

Eye Contact:

Flush eyes with plenty of water for several minutes. Get medical attention if eye irritation persists.

Skin Contact:

Wash skin with plenty of soap and water for several minutes. Get medical attention if skin irritation develops or persists.

In case of cold burn, immediately place affected area in warm water (105 F) and keep at this temperature until circulation returns. Get medical attention.

If clothing becomes wetted, drench individual with water and remove contaminated clothing if possible. Slowly warm affected area of skin.

Ingestion:

No emergency care anticipated. This material is a gas at standard temperature and pressure.

Inhalation:

If inhaled, remove to fresh air. If not breathing, clear person's airway and give artificial respiration. If breathing is difficult, qualified medical personnel may administer oxygen. Get medical attention immediately.

Note to Physician:

Overexposure to this material may sensitize the heart to catecholamine-induced arrhythmias. Do not administer catecholamines to overexposed individuals. Contact a Poison Control Center for further treatment information.

This material is an asphyxiant which may have anesthetic properties at high concentrations. If present in sufficient concentrations to reduce the oxygen level below 18% in inhaled air, rapid respiration, mental dullness, incoordination, poor judgement, nausea, and unconsciousness may result. Oxygen deficiency may occur without warning in areas where this gas may displace air.

FIRE

In case of fire, use dry chemical or carbon dioxide to extinguish flames. Use water spray to keep containers cool and protect personnel attempting to stop the flow of gas.

If more than 2,000,000 pounds of product is spilled, then report spill according to SARA 304 and/or CERCLA 102(a) requirements, unless product qualifies for the petroleum exemption (CERCLA Section 101(14)).

Chemical Name	CAS Number	Range in %
This product may be odorized. The odorant content may vary from 0-50 ppm; common odorants include mercaptans and thiopane.		
* Propane	74-98-6	100.00

PRODUCT IS HAZARDOUS ACCORDING TO OSHA (1910.1200).

* COMPONENT IS HAZARDOUS ACCORDING TO OSHA.

Pennsylvania Special Hazardous Substance(s)	CAS Number	Range in %

None

HMIS

Health: 1
Reactivity: 0
Flammability: 4
Special : -

NFPA

Health: 1
Reactivity: 0
Flammability: 4
Special : -

Transportation

DOT:

Proper Shipping Name:
Liquified Petroleum Gas

Hazard Class:
2.1

Identification Number: UN 1075

Packing Group:

Label Required:
Flammable gas

CAUTION: Misuse of empty containers can be hazardous. Empty containers can be hazardous if used to store toxic, flammable, or reactive materials. Cutting or welding of empty containers might cause fire, explosion or toxic fumes from residues. Do not pressurize or expose to open flame or heat. Keep container closed and drum

MSDS Number: **A2844** * * * * * *Effective Date:* ***11/02/01*** * * * * * *Supercedes:* ***11/15/99***

ALUMINUM OXIDE

1. Product Identification

Synonyms: AluminAR® CC-10; Aluminum oxide; Alumina; activated Alumina; alpha-Alumina
CAS No.: 1344-28-1
Molecular Weight: 101.96
Chemical Formula: Al2O3 (contains about 11-12% bound water)
Product Codes:
J.T. Baker: 0536, 0537, 0538, 0539, 0540
Mallinckrodt: 0065

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Aluminum Oxide	1344-28-1	90 - 100%	Yes

3. Hazards Identification

Emergency Overview

CAUTION! MAY CAUSE IRRITATION TO SKIN, EYES, AND RESPIRATORY TRACT.

J.T. Baker SAF-T-DATA$^{(tm)}$ Ratings (Provided here for your convenience)

Health Rating: 1 - Slight
Flammability Rating: 0 - None
Reactivity Rating: 0 - None
Contact Rating: 1 - Slight
Lab Protective Equip: GOGGLES; LAB COAT
Storage Color Code: Orange (General Storage)

Potential Health Effects

Inhalation:
Hazard is principally that of a nuisance dust. Coughing or shortness of breath may occur in cases of excessive inhalation.
Ingestion:

No adverse effects expected.

Skin Contact:

May cause irritation with redness and pain.

Eye Contact:

No adverse effects expected but dust may cause mechanical irritation.

Chronic Exposure:

No adverse effects expected.

Aggravation of Pre-existing Conditions:

Not expected to be a health hazard.

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4. First Aid Measures

Inhalation:

Remove to fresh air. Get medical attention for any breathing difficulty.

Ingestion:

Give several glasses of water to drink to dilute. If large amounts were swallowed, get medical advice.

Skin Contact:

Immediately flush skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention if irritation develops.

Eye Contact:

Immediately flush eyes with plenty of water for at least 15 minutes, lifting upper and lower eyelids occasionally. Get medical attention if irritation persists.

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5. Fire Fighting Measures

Fire:

Not considered to be a fire hazard.

Explosion:

Not considered to be an explosion hazard.

Fire Extinguishing Media:

Use any means suitable for extinguishing surrounding fire.

Special Information:

Use protective clothing and breathing equipment appropriate for the surrounding fire and to protect against the aluminum oxide dust that may be dispersed in the air.

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6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Sweep up and containerize for reclamation or disposal. Vacuuming or wet sweeping may be used to avoid dust dispersal.

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7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

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8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
Alumina (Aluminum Oxide):
-OSHA Permissible Exposure Limit (PEL):
alpha alumina, 15 mg/m3 total dust, 5 mg/m3 respirable fraction
-ACGIH Threshold Limit Value (TLV):
aluminum oxide, 10 mg/m3 (TWA) inhalable (total) particulate matter containing no asbestos and < 1% crystalline silica, A4

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded and engineering controls are not feasible, a half facepiece particulate respirator (NIOSH type N95 or better filters) may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest.. A full-face piece particulate respirator (NIOSH type N100 filters) may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency, or respirator supplier, whichever is lowest. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:
Wear protective gloves and clean body-covering clothing.

Eye Protection:
Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

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9. Physical and Chemical Properties

Appearance:
White powder.
Odor:
Odorless.
Solubility:
Insoluble in water.
Density:
4.0 @ 20C/4C
pH:
No information found.
% Volatiles by volume @ 21C (70F):
0
Boiling Point:
2980C (5396F)
Melting Point:
ca. 2000C (ca. 3632F)
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
No information found.
Evaporation Rate (BuAc=1):
No information found.

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10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
No information found.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Chlorine trifluoride, Ethylene oxide.
Conditions to Avoid:
Incompatibles.

11. Toxicological Information

No LD50/LC50 information found relating to normal routes of occupational exposure.
Investigated as a tumorigen.

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  --------\Cancer Lists\------------------------------------------------------
-
                                           ---NTP Carcinogen---
  Ingredient                               Known    Anticipated    IARC
Category
  ------------------------------------   -----    -----------    ------------
-
  Aluminum Oxide (1344-28-1)                No          No              None
```

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

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  --------\Chemical Inventory Status - Part 1\---------------------------------
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Ingredient	TSCA	EC	Japan	Australia
Aluminum Oxide (1344-28-1)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\---------------------------------

		--Canada--		
Ingredient	Korea	DSL	NDSL	Phil.
Aluminum Oxide (1344-28-1)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\---------------

	-SARA 302-		------SARA 313------	
Ingredient	RQ	TPQ	List	Chemical Catg.
Aluminum Oxide (1344-28-1)	No	No	Yes	No

--------\Federal, State & International Regulations - Part 2\---------------

		-RCRA-	-TSCA-
Ingredient	CERCLA	261.33	8(d)
Aluminum Oxide (1344-28-1)	No	No	No

Chemical Weapons Convention: No   TSCA 12(b): No   CDTA: No
SARA 311/312: Acute: Yes   Chronic: No   Fire: No Pressure: No
Reactivity: No   (Pure / Solid)

Australian Hazchem Code: None allocated.
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: **1** Flammability: **0** Reactivity: **0**
Label Hazard Warning:
CAUTION! MAY CAUSE IRRITATION TO SKIN, EYES, AND RESPIRATORY TRACT.
Label Precautions:
Use with adequate ventilation.
Keep container closed.
Avoid breathing dust.
Wash thoroughly after handling.
Avoid contact with eyes, skin and clothing.
Label First Aid:
If inhaled, remove to fresh air. Get medical attention for any breathing difficulty. In case of

contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. Get medical attention if irritation develops or persists.

Product Use:

Laboratory Reagent.

Revision Information:

MSDS Section(s) changed since last revision of document include: 8.

Disclaimer:

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Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

MSDS Number: **C0497** * * * * * *Effective Date:* ***11/02/01*** * * * * * *Supercedes:* ***11/17/99***

CALCIUM SULFATE, ANHYDROUS, POWDER

1. Product Identification

Synonyms: Anhydrous Gypsum; Anhydrite; Anhydrous Calcium Sulfate
CAS No.: 7778-18-9
Molecular Weight: 136.14
Chemical Formula: CaSO4
Product Codes: 1458

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Calcium Sulfate (anhydrous)	7778-18-9	98 - 100%	Yes

3. Hazards Identification

Emergency Overview
\-------------------------
WARNING! CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. MAY BE HARMFUL IF SWALLOWED.

J.T. Baker SAF-T-DATA$^{(tm)}$ Ratings (Provided here for your convenience)
\---
Health Rating: 1 - Slight
Flammability Rating: 0 - None
Reactivity Rating: 0 - None
Contact Rating: 1 - Slight
Lab Protective Equip: GOGGLES; LAB COAT
Storage Color Code: Orange (General Storage)
\---

Potential Health Effects
\----------------------------------

Inhalation:
Causes irritation to the respiratory tract. Symptoms may include coughing, shortness of breath.
Ingestion:
May cause obstruction in stomach, as it hardens with moisture. Symptoms include stomach pain, distress.

Skin Contact:
Causes irritation, redness, pain.
Eye Contact:
Causes irritation, redness, and pain.
Chronic Exposure:
No information found.
Aggravation of Pre-existing Conditions:
No information found.

4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.
Ingestion:
Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention.
Skin Contact:
Immediately flush skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Get medical attention. Wash clothing before reuse. Thoroughly clean shoes before reuse.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

Note to Physician:
Drinking glycerin, gelatin solutions, or large volumes of water may delay the hardening of calcium sulfate in the stomach. Surgical relief of obstruction, particularly at the pylorus, may be necessary.

5. Fire Fighting Measures

Fire:
Not considered to be a fire hazard.
Explosion:
Not considered to be an explosion hazard.
Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Sweep up and containerize for reclamation or disposal. Vacuuming or wet sweeping may be used to avoid dust dispersal.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

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8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
-OSHA Permissible Exposure Limit (PEL):
15 mg/m3 total dust, 5 mg/m3 respirable fraction
-ACGIH Threshold Limit Value (TLV):
10 mg/m3 total dust containing no asbestos and < 1% crystalline silica

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded and engineering controls are not feasible, a half facepiece particulate respirator (NIOSH type N95 or better filters) may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest.. A full-face piece particulate respirator (NIOSH type N100 filters) may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency, or respirator supplier, whichever is lowest. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:
Wear protective gloves and clean body-covering clothing.

Eye Protection:
Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

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9. Physical and Chemical Properties

Appearance:
White granules or powder.
Odor:
Odorless.
Solubility:
Slight, 0.24g in 100g of water.
Specific Gravity:
2.96
pH:
No information found.
% Volatiles by volume @ 21C (70F):
0
Boiling Point:
1193C (2179F)
Melting Point:
1450C (2642F) Monoclinic
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):

No information found.
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Very hygroscopic. Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
Burning may produce sulfur oxides.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Diazomethane, aluminum, phosphorous.
Conditions to Avoid:
Air, moisture, and incompatibles.

11. Toxicological Information

No LD50/LC50 information found relating to normal routes of occupational exposure.

```
  --------\Cancer Lists\---------------------------------------------------
-
                                         ---NTP Carcinogen---
  Ingredient                             Known    Anticipated    IARC
Category
  ------------------------------------   -----    -----------    ------------
-
  Calcium Sulfate (anhydrous)             No          No            None
  (7778-18-9)
```

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

```
  --------\Chemical Inventory Status - Part 1\---------------------------------
--
  Ingredient                                       TSCA  EC   Japan
Australia
  -----------------------------------------------  ----  ---  -----  --------
-
  Calcium Sulfate (anhydrous) (7778-18-9)           Yes  Yes   Yes      Yes

  --------\Chemical Inventory Status - Part 2\---------------------------------
--
                                                          --Canada--
  Ingredient                                       Korea  DSL   NDSL  Phil.
  -----------------------------------------------  -----  ---   ----  -----
  Calcium Sulfate (anhydrous) (7778-18-9)           Yes   Yes   No     Yes

  --------\Federal, State & International Regulations - Part 1\---------------
--
                                             -SARA 302-    ------SARA 313----
--
  Ingredient                                 RQ    TPQ     List  Chemical
Catg.
  -----------------------------------------  ---   -----   ----  ------------
--
  Calcium Sulfate (anhydrous) (7778-18-9)    No    No      No         No

  --------\Federal, State & International Regulations - Part 2\---------------
--
                                                        -RCRA-    -TSCA-
  Ingredient                                 CERCLA     261.33     8(d)
  -----------------------------------------  ------     ------    ------
  Calcium Sulfate (anhydrous) (7778-18-9)    No         No         No


Chemical Weapons Convention:  No     TSCA 12(b):  No     CDTA:  No
SARA 311/312:  Acute: Yes      Chronic: No   Fire: No  Pressure: No
Reactivity: No          (Pure / Solid)
```

Australian Hazchem Code: None allocated.
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: **1** Flammability: **0** Reactivity: **0**
Label Hazard Warning:
WARNING! CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. MAY BE HARMFUL IF SWALLOWED.
Label Precautions:
Avoid breathing dust.
Keep container closed.

Use only with adequate ventilation.
Wash thoroughly after handling.
Avoid contact with eyes, skin and clothing.

Label First Aid:

If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse. In all cases, get medical attention.

Product Use:

Laboratory Reagent.

Revision Information:

MSDS Section(s) changed since last revision of document include: 8.

Disclaimer:

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Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

MSDS Number: **C5885** * * * * * *Effective Date:* ***01/31/00*** * * * * * *Supercedes:* ***12/08/96***

CUPRIC OXIDE

1. Product Identification

Synonyms: Black copper oxide; copper (II) oxide
CAS No.: 1317-38-0
Molecular Weight: 79.55
Chemical Formula: CuO
Product Codes:
J.T. Baker: 1814, 1820, 5255, 5256
Mallinckrodt: 3887, 4832

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Cupric Oxide	1317-38-0	100%	Yes

3. Hazards Identification

Emergency Overview

WARNING! HARMFUL IF SWALLOWED. AFFECTS THE LIVER AND KIDNEYS. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT.

J.T. Baker SAF-T-DATA$^{(tm)}$ Ratings (Provided here for your convenience)

Health Rating: 2 - Moderate
Flammability Rating: 1 - Slight
Reactivity Rating: 0 - None
Contact Rating: 1 - Slight
Lab Protective Equip: GOGGLES; LAB COAT
Storage Color Code: Orange (General Storage)

Potential Health Effects

Inhalation:
Causes irritation to respiratory tract, symptoms may include coughing, sore throat, and shortness of breath. May result in ulceration and perforation of respiratory tract. When heated, this

compound may give off copper fume, which can cause symptoms similar to the common cold, including chills and stuffiness of the head.

Ingestion:

Systemic copper poisoning may result from ingestion of this compound. Symptoms may include capillary damage, headache, cold sweat, weak pulse, kidney and liver damage, central nervous excitation followed by depression, jaundice, convulsions, blood effects, paralysis and coma. Death may occur from shock or renal failure.

Skin Contact:

Causes irritation, redness, pain.

Eye Contact:

Causes irritation with redness, pain. May cause eye damage.

Chronic Exposure:

Prolonged or repeated skin exposure may cause dermatitis. Prolonged or repeated exposure to dusts of copper salts may cause discoloration of the skin or hair, blood and liver damage, ulceration and perforation of the nasal septum, runny nose, metallic taste, and atrophic changes and irritation of the mucous membranes.

Aggravation of Pre-existing Conditions:

Persons with pre-existing skin disorders, impaired liver, kidney, or pulmonary function, glucose 6-phosphate-dehydrogenase deficiency, or pre-existing Wilson's disease may be more susceptible to the effects of this material.

---

4. First Aid Measures

Inhalation:

Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

Ingestion:

Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Call a physician immediately.

Skin Contact:

In case of contact, wipe off excess material from skin then immediately flush skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse. Call a physician.

Eye Contact:

Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

---

5. Fire Fighting Measures

Fire:

Not considered to be a fire hazard. Large masses exposed to moist air at over 100C can result in spontaneous combustion.

Explosion:

Not considered to be an explosion hazard. Reactions with incompatibles may pose an explosion hazard.

Fire Extinguishing Media:

Use any means suitable for extinguishing surrounding fire.

Special Information:

In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

---

6. Accidental Release Measures

Ventilate area of leak or spill. Keep unnecessary and unprotected people away from area of spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Pick up and place in a suitable container for reclamation or disposal, using a method that does not generate dust. US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

---

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Isolate from incompatible substances. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

---

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
-OSHA Permissible Exposure Limit (PEL):
1 mg/m3 (TWA) for copper dusts & mists as Cu
-ACGIH Threshold Limit Value (TLV):
1 mg/m3 (TWA) for copper dusts & mists as Cu

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded, a half-face dust/mist respirator may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. A full-face piece dust/mist respirator may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency, or respirator supplier, whichever is lowest. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:
Wear protective gloves and clean body-covering clothing.

Eye Protection:
Use chemical safety goggles and/or full face shield where dusting or splashing of solutions is possible. Maintain eye wash fountain and quick-drench facilities in work area.

---

9. Physical and Chemical Properties

Appearance:
Black to brownish-black powder, granules, or wire.

Odor:
Odorless.

Solubility:
Insoluble in water.

Density:
6.32 @ 14C/4C

pH:
No information found.
% Volatiles by volume @ 21C (70F):
0
Boiling Point:
Not applicable.
Melting Point:
1026C (1879F)
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
No information found.
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
Toxic metal fumes may form when heated to decomposition.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Aluminum, boron, cesium acetylene carbide, dirubidium acetylide, hydrazine, hydrogen, hydrogen sulfide, lead oxide, magnesium, metals, phospham, potassium, phthalic anhydride, rubidium acetylene carbide, sodium, titanium, and zirconium. Forms acetylides with acetylene, sodium hypobromite and nitromethane.
Conditions to Avoid:
Incompatibles.

11. Toxicological Information

No LD50/LC50 information found relating to normal routes of occupational exposure.

```
  --------\Cancer Lists\----------------------------------------------------
-
                                         ---NTP Carcinogen---
  Ingredient                             Known    Anticipated    IARC
Category
  ------------------------------------   -----    -----------    ------------
-
  Cupric Oxide (1317-38-0)                No          No             None
```

12. Ecological Information

Environmental Fate:
When released into the soil, this material is not expected to biodegrade. When released into water, this material is not expected to biodegrade. When released into water, this material is not expected to evaporate significantly.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

```
  --------\Chemical Inventory Status - Part 1\-------------------------------
--
  Ingredient                                       TSCA  EC   Japan
Australia
  -----------------------------------------------  ----  ---  -----  --------
-
  Cupric Oxide (1317-38-0)                          Yes  Yes   Yes      Yes

  --------\Chemical Inventory Status - Part 2\-------------------------------
--
                                                          --Canada--
  Ingredient                                       Korea  DSL   NDSL  Phil.
  -----------------------------------------------  -----  ---   ----  -----
  Cupric Oxide (1317-38-0)                          Yes   Yes   No     Yes

  --------\Federal, State & International Regulations - Part 1\--------------
--
                                             -SARA 302-    ------SARA 313----
--
  Ingredient                                 RQ    TPQ     List  Chemical
Catg.
  -----------------------------------------  ---   -----   ----  ------------
--
  Cupric Oxide (1317-38-0)                   No    No      No    Copper compo

  --------\Federal, State & International Regulations - Part 2\--------------
--
                                                        -RCRA-    -TSCA-
  Ingredient                                 CERCLA     261.33     8(d)
  -----------------------------------------  ------     ------    ------
  Cupric Oxide (1317-38-0)                   No         No         No


Chemical Weapons Convention:  No     TSCA 12(b):  No     CDTA:  No
SARA 311/312:  Acute: Yes      Chronic: Yes  Fire: No  Pressure: No
Reactivity: No          (Pure / Solid)
```

Australian Hazchem Code: None allocated.

Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

---

16. Other Information

NFPA Ratings: Health: **2** Flammability: **1** Reactivity: **0**
Label Hazard Warning:
WARNING! HARMFUL IF SWALLOWED. AFFECTS THE LIVER AND KIDNEYS. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT.
Label Precautions:
Avoid breathing dust.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.
Avoid contact with eyes, skin and clothing.
Label First Aid:
If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse. In all cases, get medical attention.
Product Use:
Laboratory Reagent.
Revision Information:
MSDS Section(s) changed since last revision of document include: 3, 9, 16.
Disclaimer:

Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

MSDS Number: **F1306** * * * * * Effective Date: **05/17/01** * * * * * Supercedes: **06/30/98**

Ferric Oxide

1. Product Identification

Synonyms: Iron (III) Oxide; Red Iron Oxide; C.I. 77491; Iron Sesquioxide
CAS No.: 1309-37-1
Molecular Weight: 159.69
Chemical Formula: Fe2O3
Product Codes: 2024

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Iron Oxide, Fe2O3	1309-37-1	98 - 100%	Yes

3. Hazards Identification

Emergency Overview

WARNING! HARMFUL IF INHALED. AFFECTS RESPIRATORY SYSTEM. MAY CAUSE IRRITATION TO EYES AND RESPIRATORY TRACT.

J.T. Baker SAF-T-DATA$^{(tm)}$ Ratings (Provided here for your convenience)

Health Rating: 1 - Slight
Flammability Rating: 0 - None
Reactivity Rating: 1 - Slight
Contact Rating: 1 - Slight
Lab Protective Equip: GOGGLES; LAB COAT
Storage Color Code: Orange (General Storage)

Potential Health Effects

Inhalation:
May cause irritation to the respiratory tract. Symptoms may include coughing and shortness of breath.
Ingestion:

Extremely large oral dosages may produce gastrointestinal disturbances.
Skin Contact:
No adverse effects expected.
Eye Contact:
May cause mechanical irritation.
Chronic Exposure:
Long-term inhalation exposure to iron has resulted in mottling of the lungs, a condition referred to as siderosis. This is considered a benign pneumoconiosis and does not ordinarily cause significant physiological impairment. Long term eye exposures may stain the eyes and leave a "rust ring".
Aggravation of Pre-existing Conditions:
Persons with impaired respiratory function may be more susceptible to the effects of the substance.

4. First Aid Measures

Inhalation:
Remove to fresh air. Get medical attention for any breathing difficulty.
Ingestion:
If large amounts were swallowed, give water to drink and get medical advice.
Skin Contact:
Wash exposed area with soap and water. Get medical advice if irritation develops.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting upper and lower eyelids occasionally. Get medical attention if irritation persists.

5. Fire Fighting Measures

Fire:
Not expected to be a fire hazard.
Explosion:
No information found.
Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Pick up and place in a suitable container for reclamation or disposal, using a method that does not generate dust.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
- OSHA Permissible Exposure Limit (PEL) -
Iron oxide fume: 10 mg/m3
- ACGIH Threshold Limit Value (TLV) -
Iron oxide dust and fume (Fe_2O_3) as Fe: 5 mg/m3 (TWA), inhalable particulate;
for particulate matter containing no asbestos and < 1% crystalline silica.
A4 - Not classifiable as a human carcinogen.

Ventilation System:

A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):

If the exposure limit is exceeded, a half-face dust/mist respirator may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. A full-face piece dust/mist respirator may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency, or respirator supplier, whichever is lowest. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:

Wear protective gloves and clean body-covering clothing.

Eye Protection:

Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

---

9. Physical and Chemical Properties

Appearance:
Reddish-brown powder.
Odor:
No information found.
Solubility:
Negligible (< 0.1%)
Specific Gravity:
5.24
pH:
No information found.
% Volatiles by volume @ 21C (70F):
0
Boiling Point:
No information found.
Melting Point:
1565C (2849F)
Vapor Density (Air=1):
Not applicable.
Vapor Pressure (mm Hg):
Not applicable.
Evaporation Rate (BuAc=1):
No information found.

---

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
No information found.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Carbon monoxide, hydrazine, calcium hypochloride, performic acid, bromine pentafluoride.
Conditions to Avoid:
Incompatibles.

11. Toxicological Information

No LD50/LC50 information found relating to normal routes of occupational exposure.
Investigated as a tumorigen.

```
  --------\Cancer Lists\------------------------------------------------------
-
                                         ---NTP Carcinogen---
  Ingredient                             Known    Anticipated    IARC
Category
  ------------------------------------   -----    -----------    ------------
-
  Iron Oxide, Fe2O3 (1309-37-1)           No           No               3
```

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

```
  --------\Chemical Inventory Status - Part 1\---------------------------------
--
  Ingredient                                       TSCA  EC   Japan
Australia
```

```
  ----------------------------------------------  ----  ---  -----  --------
-
  Iron Oxide, Fe2O3 (1309-37-1)                     Yes  Yes   Yes      Yes

  --------\Chemical Inventory Status - Part 2\---------------------------------
--
                                                          --Canada--
  Ingredient                                      Korea  DSL   NDSL  Phil.
  ----------------------------------------------  -----  ---   ----  -----
  Iron Oxide, Fe2O3 (1309-37-1)                     Yes   Yes   No     Yes

  --------\Federal, State & International Regulations - Part 1\--------------
--
                                            -SARA 302-    ------SARA 313----
--
  Ingredient                                RQ    TPQ     List  Chemical
Catg.
  ----------------------------------------  ---   -----   ----  ------------
--
  Iron Oxide, Fe2O3 (1309-37-1)             No    No      No         No

  --------\Federal, State & International Regulations - Part 2\--------------
--
                                                        -RCRA-    -TSCA-
  Ingredient                                CERCLA     261.33     8(d)
  ----------------------------------------  ------     ------    ------
  Iron Oxide, Fe2O3 (1309-37-1)             No         No         No


Chemical Weapons Convention:  No     TSCA 12(b):  No     CDTA:  No
SARA 311/312:  Acute: Yes      Chronic: Yes  Fire: No  Pressure: No
Reactivity: No          (Pure / Solid)
```

Australian Hazchem Code: None allocated.
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

---

16. Other Information

NFPA Ratings: Health: **1** Flammability: **0** Reactivity: **0**
Label Hazard Warning:
WARNING! HARMFUL IF INHALED. AFFECTS RESPIRATORY SYSTEM. MAY CAUSE IRRITATION TO EYES AND RESPIRATORY TRACT.
Label Precautions:
Avoid contact with eyes, skin and clothing.
Wash thoroughly after handling.
Avoid breathing dust.
Keep container closed.
Use only with adequate ventilation.
Label First Aid:
If inhaled, remove to fresh air. Get medical attention for any breathing difficulty. In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention

if irritation develops or persists.

Product Use:

Laboratory Reagent.

Revision Information:

No changes.

Disclaimer:

****
****

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****
****

Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

MSDS Number: **L2347** * * * * * *Effective Date:* ***11/02/01*** * * * * * *Supercedes:* ***11/17/99***

LEAD METAL

1. Product Identification

Synonyms: Granular lead, pigment metal; C.I. 77575
CAS No.: 7439-92-1
Molecular Weight: 207.19
Chemical Formula: Pb
Product Codes:
J.T. Baker: 2256, 2266
Mallinckrodt: 5668

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Lead	7439-92-1	95 - 100%	Yes

3. Hazards Identification

Emergency Overview

POISON! DANGER! MAY BE FATAL IF SWALLOWED OR INHALED. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. NEUROTOXIN. AFFECTS THE GUM TISSUE, CENTRAL NERVOUS SYSTEM, KIDNEYS, BLOOD AND REPRODUCTIVE SYSTEM. POSSIBLE CANCER HAZARD. MAY CAUSE CANCER BASED ON ANIMAL DATA. Risk of cancer depends on duration and level of exposure.

J.T. Baker SAF-T-DATA$^{(tm)}$ Ratings (Provided here for your convenience)

Health Rating: 3 - Severe (Life)
Flammability Rating: 0 - None
Reactivity Rating: 0 - None
Contact Rating: 1 - Slight
Lab Protective Equip: GOGGLES; LAB COAT; VENT HOOD; PROPER GLOVES
Storage Color Code: Blue (Health)

Potential Health Effects

Inhalation:

Lead can be absorbed through the respiratory system. Local irritation of bronchia and lungs can occur and, in cases of acute exposure, symptoms such as metallic taste, chest and abdominal pain, and increased lead blood levels may follow. See also Ingestion.

Ingestion:

POISON! The symptoms of lead poisoning include abdominal pain and spasms, nausea, vomiting, headache. Acute poisoning can lead to muscle weakness, "lead line" on the gums, metallic taste, definite loss of appetite, insomnia, dizziness, high lead levels in blood and urine with shock, coma and death in extreme cases.

Skin Contact:

Lead and lead compounds may be absorbed through the skin on prolonged exposure; the symptoms of lead poisoning described for ingestion exposure may occur. Contact over short periods may cause local irritation, redness and pain.

Eye Contact:

Absorption can occur through eye tissues but the more common hazards are local irritation or abrasion.

Chronic Exposure:

Lead is a cumulative poison and exposure even to small amounts can raise the body's content to toxic levels. The symptoms of chronic exposure are like those of ingestion poisoning; restlessness, irritability, visual disturbances, hypertension and gray facial color may also be noted.

Aggravation of Pre-existing Conditions:

Persons with pre-existing kidney, nerve or circulatory disorders or with skin or eye problems may be more susceptible to the effects of this substance.

4. First Aid Measures

Inhalation:

Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Ingestion:

Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention.

Skin Contact:

Immediately flush skin with plenty of soap and water for at least 15 minutes. Remove contaminated clothing and shoes. Get medical attention. Wash clothing before reuse. Thoroughly clean shoes before reuse.

Eye Contact:

Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:

Not considered to be a fire hazard. Powder/dust is flammable when heated or exposed to flame.

Explosion:

Not considered to be an explosion hazard.

Fire Extinguishing Media:

Use any means suitable for extinguishing surrounding fire. Do not allow water runoff to enter sewers or waterways.

Special Information:

In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode. Can produce toxic lead fumes at elevated temperatures and also react with oxidizing materials.

---

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Sweep up and containerize for reclamation or disposal. Vacuuming or wet sweeping may be used to avoid dust dispersal. US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

---

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Isolate from incompatible substances. Areas in which exposure to lead metal or lead compounds may occur should be identified by signs or appropriate means, and access to the area should be limited to authorized persons. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

---

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
For lead, metal and inorganic dusts and fumes, as Pb:
-OSHA Permissible Exposure Limit (PEL): 0.05 mg/m3 (TWA)
For lead, elemental and inorganic compounds, as Pb:
-ACGIH Threshold Limit Value (TLV): 0.05 mg/m3 (TWA), A3 animal carcinogen
ACGIH Biological Exposure Indices (BEI): 30 ug/100ml, notation B (see actual Indices for more information).
For lead, inorganic:
-NIOSH Recommended Exposure Limit (REL): 0.1 mg/m3 (TWA)

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded and engineering controls are not feasible, a half-face high efficiency particulate respirator (NIOSH type N100 filter) may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. A full-face piece high efficiency particulate respirator (NIOSH type N100 filter) may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.

Eye Protection:

Use chemical safety goggles and/or full face shield where dusting or splashing of solutions is possible. Maintain eye wash fountain and quick-drench facilities in work area.
Other Control Measures:
Eating, drinking, and smoking should not be permitted in areas where solids or liquids containing lead compounds are handled, processed, or stored. See OSHA substance-specific standard for more information on personal protective equipment, engineering and work practice controls, medical surveillance, record keeping, and reporting requirements. (29 CFR 1910.1025).

---

9. Physical and Chemical Properties

Appearance:
Small, white to blue-gray metallic shot or granules.
Odor:
Odorless.
Solubility:
Insoluble in water.
Density:
11.34
pH:
No information found.
% Volatiles by volume @ 21C (70F):
0
Boiling Point:
1740C (3164F)
Melting Point:
327.5C (622F)
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
1.77 @ 1000C (1832F)
Evaporation Rate (BuAc=1):
No information found.

---

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
Does not decompose but toxic lead or lead oxide fumes may form at elevated temperatures.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Ammonium nitrate, chlorine trifluoride, hydrogen peroxide, sodium azide, zirconium, disodium acetylide, sodium acetylide and oxidants.
Conditions to Avoid:
Heat, flames, ignition sources and incompatibles.

---

11. Toxicological Information

Toxicological Data:
Investigated as a tumorigen, mutagen, reproductive effector.
Reproductive Toxicity:
Lead and other smelter emissions are human reproductive hazards. (Chemical Council on Environmental Quality; Chemical Hazards to Human Reproduction, 1981).

Carcinogenicity:
EPA / IRIS classification: Group B2 - Probable human carcinogen, sufficient animal evidence.

```
  --------\Cancer Lists\-----------------------------------------------------
-
                                         ---NTP Carcinogen---
  Ingredient                             Known    Anticipated    IARC
Category
  ------------------------------------   -----    -----------    ------------
-
  Lead (7439-92-1)                        No          No             2B
```

12. Ecological Information

Environmental Fate:
When released into the soil, this material is not expected to leach into groundwater. This material may bioaccumulate to some extent.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste facility. Although not a listed RCRA hazardous waste, this material may exhibit one or more characteristics of a hazardous waste and require appropriate analysis to determine specific disposal requirements. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

```
  --------\Chemical Inventory Status - Part 1\-------------------------------
--
  Ingredient                                       TSCA  EC   Japan
Australia
  -----------------------------------------------  ----  ---  -----  --------
-
  Lead (7439-92-1)                                  Yes  Yes   Yes      Yes

  --------\Chemical Inventory Status - Part 2\-------------------------------
--
                                                          --Canada--
  Ingredient                                       Korea  DSL   NDSL  Phil.
  -----------------------------------------------  -----  ---   ----  -----
  Lead (7439-92-1)                                  Yes   Yes   No     Yes

  --------\Federal, State & International Regulations - Part 1\-------------
--
```

```
                                              -SARA 302-    ------SARA 313----
--
  Ingredient                                  RQ    TPQ     List  Chemical
Catg.
  -----------------------------------------   ---   -----   ----  ------------
--
  Lead (7439-92-1)                            No    No      Yes        No

  --------\Federal, State & International Regulations - Part 2\--------------
--
                                                           -RCRA-    -TSCA-
  Ingredient                                  CERCLA     261.33     8(d)
  -----------------------------------------   ------     ------    ------
  Lead (7439-92-1)                            10         No         No


Chemical Weapons Convention:  No     TSCA 12(b):  No     CDTA:  No
SARA 311/312:  Acute: Yes      Chronic: Yes  Fire: No  Pressure: No
Reactivity: No          (Pure / Solid)
```

WARNING:
THIS PRODUCT CONTAINS CHEMICALS KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER AND BIRTH DEFECTS OR OTHER REPRODUCTIVE HARM.

Australian Hazchem Code: None allocated.
Poison Schedule: S6
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

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16. Other Information

NFPA Ratings: Health: **3** Flammability: **1** Reactivity: **0**
Label Hazard Warning:
POISON! DANGER! MAY BE FATAL IF SWALLOWED OR INHALED. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. NEUROTOXIN. AFFECTS THE GUM TISSUE, CENTRAL NERVOUS SYSTEM, KIDNEYS, BLOOD AND REPRODUCTIVE SYSTEM. POSSIBLE CANCER HAZARD. MAY CAUSE CANCER BASED ON ANIMAL DATA. Risk of cancer depends on duration and level of exposure.
Label Precautions:
Do not get in eyes, on skin, or on clothing.
Do not breathe dust.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.
Label First Aid:
If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse. In all cases, get medical attention.
Product Use:
Laboratory Reagent.
Revision Information:
MSDS Section(s) changed since last revision of document include: 8.
Disclaimer:

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Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

MSDS Number: **M0716** * * * * * *Effective Date:* ***08/08/02*** * * * * * *Supercedes:* ***09/14/00***

MANGANESE DIOXIDE (TECHNICAL GRADE)

1. Product Identification

Synonyms: Pyrolusite; Manganese black; Manganese peroxide; Manganese (IV) oxide
CAS No.: 1313-13-9
Molecular Weight: 86.94
Chemical Formula: MnO2
Product Codes: 2526

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Manganese Dioxide	1313-13-9	72 - 80%	Yes
Quartz	14808-60-7	1 - 3%	Yes
Barium	7440-39-3	1 - 2%	Yes
Nonhazardous Ingredients (Nuisance Particulates)	N/A	15 - 25%	No
Lead	7439-92-1	0 - 0.2%	Yes

3. Hazards Identification

Emergency Overview

DANGER! OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE. HARMFUL IF SWALLOWED OR INHALED. AFFECTS LUNGS, CENTRAL NERVOUS SYSTEM, BLOOD AND KIDNEYS. MAY CAUSE IRRITATION TO EYES AND RESPIRATORY TRACT. MAY AFFECT THE GUM TISSUE AND REPRODUCTIVE SYSTEM. INHALATION CANCER HAZARD. CONTAINS QUARTZ WHICH CAN CAUSE CANCER. Risk of cancer depends upon duration and level of exposure.

SAF-T-DATA$^{(tm)}$ Ratings (Provided here for your convenience)

Health Rating: 3 - Severe (Cancer Causing)
Flammability Rating: 0 - None
Reactivity Rating: 3 - Severe (Oxidizer)

Contact Rating: 2 - Moderate
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: Yellow (Reactive)

Potential Health Effects

Inhalation:
Inhalation can cause a flu-like illness (metal fume fever). This 24- to 48-hour illness is characterized by chills, fever, aching muscles, dryness in the mouth and throat and headache. May irritate the respiratory tract. May increase the incidence of upper respiratory infections (pneumonia). Absorption of inorganic manganese salts through the lungs is poor but may occur in chronic poisoning. Lead can be absorbed through the respiratory system.
Ingestion:
May cause abdominal pain and nausea. Although they are poorly absorbed through the intestines, inorganic manganese salts may produce hypoglycemia and decreased calcium blood levels should absorption occur. The symptoms of lead poisoning include abdominal pain and spasms, nausea, vomiting, headache. Acute poisoning can lead to muscle weakness, "lead line" on the gums, metallic taste, definite loss of appetite, insomnia, dizziness, high lead levels in blood and urine with shock, coma and death in extreme cases.
Skin Contact:
No adverse effects expected.
Eye Contact:
May cause irritation, redness and pain.
Chronic Exposure:
Chronic manganese poisoning can result from excessive inhalation and ingestion exposure and involves impairment of the central nervous system. Early symptoms include sluggishness, sleepiness, and weakness in the legs. Advanced cases have shown fixed facial expression, emotional disturbances, spastic gait, and falling. Illness closely resembles Parkinson's Disease. Kidney effects, blood changes and manganese psychosis also may occur as a result of chronic exposure. Chronic inhalation exposure can cause lung damage.
Inhalation of quartz is classified as a human carcinogen. Chronic exposure can cause silicosis, a form of lung scarring that can cause shortness of breath, reduced lung function, and in severe cases, death.
Lead is a cumulative poison and exposure even to small amounts can raise the body's content to toxic levels. The symptoms of chronic exposure are like those of ingestion poisoning; restlessness, irritability, visual disturbances, hypertension and gray facial color may also be noted.
Aggravation of Pre-existing Conditions:
Persons with impaired respiratory function, psychiatric or neurological disturbances, and nutritional deficiencies may be more susceptible to the effect of this substance. Inhalation of quartz may increase the progression of tuberculosis; susceptibility is apparently not increased.

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4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.
Ingestion:
Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention.
Skin Contact:
Not expected to require first aid measures. Wash exposed area with soap and water. Get medical advice if irritation develops.

Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting upper and lower eyelids occasionally. Get medical attention if irritation persists.

5. Fire Fighting Measures

Fire:
Not combustible, but substance is a strong oxidizer and its heat of reaction with reducing agents or combustibles may cause ignition. Increases the flammability of any combustible material.
Explosion:
Contact with oxidizable substances may cause extremely violent combustion.
Fire Extinguishing Media:
Dry chemical, foam or carbon dioxide.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Ventilate area of leak or spill. Keep unnecessary and unprotected people away from area of spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Pick up and place in a suitable container for reclamation or disposal, using a method that does not generate dust. Keep combustibles (wood, paper, oil, etc.) away from spilled material. US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage and moisture. Isolate from any source of heat or ignition. Avoid storage on wood floors. Separate from incompatibles, combustibles, organic or other readily oxidizable materials. Wear special protective equipment (Sec. 8) for maintenance break-in or where exposures may exceed established exposure levels. Wash hands, face, forearms and neck when exiting restricted areas. Shower, dispose of outer clothing, change to clean garments at the end of the day. Avoid cross-contamination of street clothes. Wash hands before eating and do not eat, drink, or smoke in workplace. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
- OSHA Permissible Exposure Limit (PEL):
5 mg/m3 (Ceiling) for Manganese
30 mg/m3 (%SiO2+2) for Quartz, total dust
10 mg/m3 (%SiO2+2) for Quartz, respirable fraction
0.5 mg/m3 (TWA) for Barium
0.05 mg/m3 (TWA), 0.03 mg/m3 (Action Level) for Lead
- ACGIH Threshold Limit Value (TLV):
0.2 mg/m3 (TWA) for Manganese
0.05 mg/m3 (TWA), respirable fraction, A2 - Suspected Human Carcinogen.for Quartz

0.5 mg/m3 (TWA), A4 - not classifiable as a human carcinogen, for Barium
0.05 mg/m3 (TWA), A3 - animal carcinogen, for Lead

Ventilation System:

A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):

If the exposure limit is exceeded and engineering controls are not feasible, a half facepiece particulate respirator (NIOSH type N95 or better filters) may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest.. A full-face piece particulate respirator (NIOSH type N100 filters) may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency, or respirator supplier, whichever is lowest. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres. Where respirators are required, you must have a written program covering the basic requirements in the OSHA respirator standard. These include training, fit testing, medical approval, cleaning, maintenance, cartridge change schedules, etc. See 29CFR1910.134 for details.

Skin Protection:

Wear protective gloves and clean body-covering clothing.

Eye Protection:

Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

Other Control Measures:

Clothing contaminated with this material may be an increased fire hazard. Wash contaminated clothing as soon as possible.

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9. Physical and Chemical Properties

Appearance:

Gray lumps or fine, black to brownish-black powder.

Odor:

Odorless.

Solubility:

Insoluble in water.

Specific Gravity:

5.0

pH:

9 - 10 (10% aqueous slurry)

% Volatiles by volume @ 21C (70F):

0

Boiling Point:

Not applicable.

Melting Point:

> 1539C (> 2802F)

Vapor Density (Air=1):

No information found.

Vapor Pressure (mm Hg):

No information found.

Evaporation Rate (BuAc=1):

No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
Toxic metal fumes may form when heated to decomposition.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Easily oxidizable materials, sulfur, sulfides, phosphids, hypophosphites, chlorates, peroxides, aluminum powder, rubidium acetylide, potassium azide, chlorine trifluoride. Reacts with hydrochloric acid to form corrosive chlorine gas. Heating or rubbing this material with organic materials can cause a fire hazard.
Conditions to Avoid:
Heat, flames, ignition sources and incompatibles.

11. Toxicological Information

Toxicological Data:
Manganese Dioxide: LD50 oral rat > 3478 mg/kg. Investigated as a reproductive effector. Quartz: Investigated as a tumorigen and mutagen. Lead: Investigated as a tumorigen, mutagen, reproductive effector.
Reproductive Toxicity:
For manganese metal:
May damage the reproductive system. Has shown teratogenic effects in laboratory animals.
Lead and other smelter emissions are human reproductive hazards. (Chemical Council on Environmental Quality; Chemical Hazards to Human Reproduction, 1981).
Carcinogenicity:
Quartz: NIOSH considers this substance to be a potential occupational carcinogen.
For lead and inorganic lead compounds:
EPA / IRIS classification: Group B2 - Probable human carcinogen, sufficient animal evidence.

--------\Cancer Lists\---

	---NTP Carcinogen---		
Ingredient	Known	Anticipated	IARC Category
Manganese Dioxide (1313-13-9)	No	No	None
Quartz (14808-60-7)	Yes	No	1
Barium (7440-39-3)	No	No	None
Nonhazardous Ingredients (Nuisance Particulates)	No	No	None
Lead (7439-92-1)	No	No	2B

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste facility. Although not a listed RCRA hazardous waste, this material may exhibit one or more characteristics of a hazardous waste and require appropriate analysis to determine specific disposal requirements. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

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14. Transport Information

Not regulated.

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15. Regulatory Information

--------\Chemical Inventory Status - Part 1\---------------------------------

Ingredient	TSCA	EC	Japan	Australia
Manganese Dioxide (1313-13-9)	Yes	Yes	Yes	Yes
Quartz (14808-60-7)	Yes	Yes	Yes	Yes
Barium (7440-39-3)	Yes	Yes	No	Yes
Nonhazardous Ingredients (Nuisance Particulates)	Yes	Yes	Yes	Yes
Lead (7439-92-1)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\---------------------------------

		--Canada--		
Ingredient	Korea	DSL	NDSL	Phil.
Manganese Dioxide (1313-13-9)	Yes	Yes	No	Yes
Quartz (14808-60-7)	Yes	Yes	No	Yes
Barium (7440-39-3)	Yes	No	No	Yes
Nonhazardous Ingredients (Nuisance Particulates)	Yes	Yes	No	Yes
Lead (7439-92-1)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------------

	-SARA 302-		------SARA 313------	
Ingredient	RQ	TPQ	List	Chemical Catg.
Manganese Dioxide (1313-13-9)	No	No	No	Manganese co
Quartz (14808-60-7)	No	No	No	No
Barium (7440-39-3)	No	No	Yes	No
Nonhazardous Ingredients (Nuisance Particulates)	No	No	No	No
Lead (7439-92-1)	No	No	Yes	No

--------\Federal, State & International Regulations - Part 2\---------------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Manganese Dioxide (1313-13-9)	1	No	No
Quartz (14808-60-7)	No	No	No
Barium (7440-39-3)	No	No	No
Nonhazardous Ingredients (Nuisance Particulates)	No	No	No
Lead (7439-92-1)	10	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: Yes Fire: Yes Pressure: No
Reactivity: No (Mixture / Solid)

WARNING:
THIS PRODUCT CONTAINS CHEMICALS KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER AND BIRTH DEFECTS OR OTHER REPRODUCTIVE HARM.

Australian Hazchem Code: 1WE
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

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16. Other Information

NFPA Ratings: Health: **2** Flammability: **0** Reactivity: **1** Other: **Oxidizer**
Label Hazard Warning:
DANGER! OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE. HARMFUL IF SWALLOWED OR INHALED. AFFECTS LUNGS, CENTRAL NERVOUS SYSTEM, BLOOD AND KIDNEYS. MAY CAUSE IRRITATION TO EYES AND RESPIRATORY TRACT. MAY AFFECT THE GUM TISSUE AND REPRODUCTIVE SYSTEM. INHALATION CANCER HAZARD. CONTAINS QUARTZ WHICH CAN CAUSE CANCER. Risk of cancer depends upon duration and level of exposure.
Label Precautions:
Keep from contact with clothing and other combustible materials.
Store in a tightly closed container.
Remove and wash contaminated clothing promptly.
Do not get in eyes, on skin, or on clothing.
Wash thoroughly after handling.
Do not breathe dust.
Use only with adequate ventilation.
Label First Aid:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention. If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention. In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention if irritation develops or persists.
Product Use:
Laboratory Reagent.
Revision Information:
MSDS Section(s) changed since last revision of document include: 3, 14.
Disclaimer:

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Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

MSDS Number: **B7222** * * * * * *Effective Date:* ***03/15/02*** * * * * * *Supercedes:* ***09/14/00***

METHYL TERT-BUTYL ETHER

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1. Product Identification

Synonyms: 2-Methoxy-2-methylpropane; tert-Butyl methyl ether; Methyl 1,1-dimethyl ethyl ether; MTBE
CAS No.: 1634-04-4
Molecular Weight: 88.15
Chemical Formula: $C_5H_{12}O$
Product Codes:
J.T. Baker: 9034, 9042, 9043
Mallinckrodt: 5398

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2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Methyl tert-butyl Ether	1634-04-4	99 - 100%	Yes

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3. Hazards Identification

Emergency Overview

DANGER! EXTREMELY FLAMMABLE LIQUID AND VAPOR. VAPOR MAY CAUSE FLASH FIRE. HARMFUL IF SWALLOWED, INHALED OR ABSORBED THROUGH SKIN. MAY AFFECT CENTRAL NERVOUS SYSTEM, BLOOD, AND KIDNEYS. A CENTRAL NERVOUS SYSTEM DEPRESSANT. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT.

J.T. Baker SAF-T-DATA$^{(tm)}$ Ratings (Provided here for your convenience)

Health Rating: 2 - Moderate
Flammability Rating: 4 - Extreme (Flammable)
Reactivity Rating: 2 - Moderate
Contact Rating: 2 - Moderate
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES; CLASS B EXTINGUISHER
Storage Color Code: Red (Flammable)

Potential Health Effects

Inhalation:
Inhalation of vapor can irritate respiratory tract. Causes central nervous system effects. Breathing high concentrations in air can cause lightheadedness, dizziness, weakness, nausea, headache.
Ingestion:
May cause nausea, vomiting. Other symptoms similar to inhalation may occur. Laryngeal, ocular, and respiratory muscles are affected in severe poisoning.
Skin Contact:
A mild skin irritant which causes loss of natural oils. May be a route of absorption into the body.
Eye Contact:
Vapors can irritate eyes; splashes may cause damage to eye tissue.
Chronic Exposure:
Symptoms noted above may be produced by cumulative exposure.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or eye problems or impaired respiratory function may be more susceptible to the effects of the substance.

4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.
Ingestion:
Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention.
Skin Contact:
Remove any contaminated clothing. Wash skin with soap and water for at least 15 minutes. Get medical attention if irritation develops or persists.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:
Flash point: -27C (-17F)
Autoignition temperature: 435C (815F)
Flammable limits in air % by volume:
lel: 1.6; uel: 8.4
Extremely Flammable Liquid and Vapor! Vapor may cause flash fire.
Explosion:
Above the flash point, explosive vapor-air mixtures may be formed. Vapors can flow along surfaces to distant ignition source and flash back. Sealed containers may rupture when heated. Sensitive to static discharge.
Fire Extinguishing Media:
Water spray, dry chemical, alcohol foam, or carbon dioxide. Water spray may be used to keep fire exposed containers cool.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Ventilate area of leak or spill. Remove all sources of ignition. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Use non-sparking tools and equipment. Collect liquid in an appropriate container or absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! If a leak or spill has not ignited, use water spray to disperse the vapors, to protect personnel attempting to stop leak, and to flush spills away from exposures. US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker SOLUSORB® solvent adsorbent is recommended for spills of this product.

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7. Handling and Storage

Protect against physical damage. Store in a cool, dry well-ventilated location, away from any area where the fire hazard may be acute. Outside or detached storage is preferred. Separate from incompatibles. Containers should be bonded and grounded for transfers to avoid static sparks. Storage and use areas should be No Smoking areas. Use non-sparking type tools and equipment, including explosion proof ventilation. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

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8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
-ACGIH Threshold Limit Value (TLV): 50 ppm (TWA), A3 - Confirmed animal carcinogen with unknown relevance to humans
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details. Use explosion-proof equipment.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded and engineering controls are not feasible, a half-face organic vapor respirator may be worn for up to ten times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. A full-face piece organic vapor respirator may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. For emergencies or instances where the exposure levels are not known, use a full-face piece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres. Where respirators are required, you must have a written program covering the basic requirements in the OSHA respirator standard. These include training, fit testing, medical approval, cleaning, maintenance, cartridge change schedules, etc. See 29CFR1910.134 for details.
Skin Protection:
Wear protective gloves and clean body-covering clothing.
Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

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9. Physical and Chemical Properties

Appearance:
Clear, colorless liquid.
Odor:
Characteristic ethereal odor.
Solubility:
4.8 g/100g of water.
Specific Gravity:
0.74
pH:
No information found.
% Volatiles by volume @ 21C (70F):
100
Boiling Point:
55C (131F)
Melting Point:
-110C (-166F)
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
245 @ 25C (77F)
Evaporation Rate (BuAc=1):
No information found.

---

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Unstable in acid solutions.
Hazardous Decomposition Products:
Carbon dioxide and carbon monoxide may form when heated to decomposition.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Oxidizers, acids.
Conditions to Avoid:
Heat, flames, ignition sources and incompatibles.

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11. Toxicological Information

Methyl tert butyl ether: Oral rat LD50: 4 gm/kg; inhalation rat LC50: 23576 ppm/4H.

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  --------\Cancer Lists\------------------------------------------------------
-
                                         ---NTP Carcinogen---
  Ingredient                             Known    Anticipated    IARC
Category
  ------------------------------------   -----    -----------    ------------
-
  Methyl tert-butyl Ether (1634-04-4)     No          No              3
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12. Ecological Information

Environmental Fate:
When released into the soil, this material is not expected to biodegrade. When released into the air,

this material is expected to adversely affect the ozone layer. When released into the soil, this material is expected to quickly evaporate. When released to water, this material is expected to quickly evaporate. When released into the water, this material is expected to have a half-life between 1 and 10 days. This material has an estimated bioconcentration factor (BCF) of less than 100. This material is not expected to significantly bioaccumulate. When released into the air, this material is expected to be readily degraded by reaction with photochemically produced hydroxyl radicals. When released into the air, this material is not expected to be degraded by photolysis. When released into the air, this material is expected to have a half-life between 1 and 10 days.

Environmental Toxicity:
No information found.

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13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved incinerator or disposed in a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

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14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: METHYL TERT-BUTYL ETHER
Hazard Class: 3
UN/NA: UN2398
Packing Group: II
Information reported for product/size: 335LB

International (Water, I.M.O.)

Proper Shipping Name: METHYL TERT-BUTYL ETHER
Hazard Class: 3
UN/NA: UN2398
Packing Group: II
Information reported for product/size: 335LB

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15. Regulatory Information

```
  --------\Chemical Inventory Status - Part 1\-----------------------------
--
  Ingredient                                       TSCA   EC   Japan
Australia
  -----------------------------------------------  ----  ---  -----  --------
-
  Methyl tert-butyl Ether (1634-04-4)               Yes  Yes   Yes      Yes

  --------\Chemical Inventory Status - Part 2\-----------------------------
--
                                                          --Canada--
  Ingredient                                       Korea  DSL   NDSL  Phil.
  -----------------------------------------------  -----  ---   ----  -----
  Methyl tert-butyl Ether (1634-04-4)               Yes   Yes   No     Yes
```

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  --------\Federal, State & International Regulations - Part 1\--------------
--
                                             -SARA 302-    ------SARA 313----
--
  Ingredient                                 RQ    TPQ     List  Chemical
Catg.
  -----------------------------------------  ---   -----   ----  ------------
--
  Methyl tert-butyl Ether (1634-04-4)        No    No      Yes        No

  --------\Federal, State & International Regulations - Part 2\--------------
--
                                                        -RCRA-    -TSCA-
  Ingredient                                 CERCLA     261.33     8(d)
  -----------------------------------------  ------     ------    ------
  Methyl tert-butyl Ether (1634-04-4)        1000       No         No


Chemical Weapons Convention:  No     TSCA 12(b):  Yes    CDTA:  No
SARA 311/312:  Acute: Yes      Chronic: Yes  Fire: Yes Pressure: No
Reactivity: No          (Pure / Liquid)
```

Australian Hazchem Code: 3[Y]E
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

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16. Other Information

NFPA Ratings: Health: **2** Flammability: **4** Reactivity: **0**
Label Hazard Warning:
DANGER! EXTREMELY FLAMMABLE LIQUID AND VAPOR. VAPOR MAY CAUSE FLASH FIRE. HARMFUL IF SWALLOWED, INHALED OR ABSORBED THROUGH SKIN. MAY AFFECT CENTRAL NERVOUS SYSTEM, BLOOD, AND KIDNEYS. A CENTRAL NERVOUS SYSTEM DEPRESSANT. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT.
Label Precautions:
Keep away from heat, sparks and flame.
Avoid contact with eyes, skin and clothing.
Avoid breathing vapor.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.
Label First Aid:
If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse. In all cases call a physician.
Product Use:
Laboratory Reagent.
Revision Information:

MSDS Section(s) changed since last revision of document include: 8.
Disclaimer:
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Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

```
BANGS LABORATORIES, INC        -- POLYSTYRENE OR POLYSTYRENE SURFACTANT FREE
=======================================================
MSDS Safety Information
=======================================================
FSC: 6850
MSDS Date: 05/28/1997
MSDS Num: CJQVN
LIIN: 00N092276
Product ID: POLYSTYRENE OR POLYSTYRENE SURFACTANT FREE
MFN: 01
Responsible Party
Cage: TO292
Name: BANGS LABORATORIES, INC
Address: 9025 TECHNOLOGY DRIVE
City: FISHERS IN 46038
Info Phone Number: 317-570-7020
Emergency Phone Number: 317-570-7020
Review Ind: Y
Published: Y
=======================================================
Contractor Summary
=======================================================
Cage: TO292
Name: BANGS LABORATORIES, INC
Address: 9025 TECHNOLOGY DRIVE
City: FISHERS IN 46038
Phone: 317-570-7020
=======================================================
Item Description Information
=======================================================
=======================================================
Ingredients
=======================================================
Cas: 9003-53-6
RTECS #: WL6475000
Name: POLYSTYRENE (PLAIN POLYSTYRENE SUSPENDED IN WATER)
------------------------------
Cas: 7732-18-5
RTECS #: ZC0110000
Name: WATER
=======================================================
Health Hazards Data
=======================================================
Route Of Entry Inds - Inhalation: YES
Skin: YES
Ingestion: YES
Carcinogenicity Inds - NTP: NO
IARC: NO
OSHA: NO
Effects of Exposure: EYES: MILD IRRITATION. SKIN CONTACT: CONTACT MAY CAUSE
  SLIGHT IRRITATION. SHORT EXPOSURE: NO IRRITATION. REPEATED PROLONGED
  EXPOSURE, ESPECIALY IF CONFINED; MILD IRRITATION, POSSIBLY A MILD
SUPERFICIA
  L BURN. SKIN ABSORPTION: NOT LIKELY TO BE ABSORBED IN TOXIC AMOUNTS.
POSSIBLY
  WEAK SENSITIZER. INGESTION: LOW SINGLE DOSE TOXICITY. INHALATION: NO GUIDE
  ESTABLISHED. CONSIDERED TO BE LOW IN HAZARD FRO M INHALATION. SYSTEMIC AND
```

```
  OTHER EFFECTS: NONE KNOWN. HUMAN EFFECTS NOT ESTABLISHED.
Signs And Symptions Of Overexposure: SEE HEALTH HAZARDS.
First Aid: EYES: FLUSH IMMEDIATELY WITH WATER FOR AT LEAST 15 MINUTES IS GOOD
  SAFETY PRACTICE. MD SHOULD STAIN FOR EVIDENCE OF CORNEAL INJURY. SKIN: WASH
  OFF IN FLOWING WATER OR SHOWER. WASH CLOTHING BEFORE REUS E. TREAT AS ANY
  CONTACT DERMATITIS. IF BURN IS PRESENT, TREAT AS ANY THERMAL BURN.
INGESTION:
  INDUCE VOMITING IF LARGE AMOUNTS ARE INGESTED. INHALATION: REMOVE TO FRESH
  AIR IF EFFECTS OCCUR. CONSULT M EDICAL PERSONNEL. SYSTEMIC: NO SPECIFIC
  ANTIDOTE. TREATMENT BASED ON SOUND JUDGEMENT OF MD & INDIVIDUAL REACTIONS
  OF PATIENT.
=======================================================
Handling and Disposal
=======================================================
Spill Release Procedures: FLUSH AREA WITH WATER IMMEDIATELY. AVOID
UNNECESSARY
  EXPOSURE AND CONTACT.
Waste Disposal Methods: DISPOSAL MUST BE I/A/W FEDERAL, STATE & LOCAL
  REGULATIONS (FP N). MAY PLUG UP SANITARY SEWERS. DIVERT TO POND OR BURN
SOLID
  WASTE IN AN ADEQUATE INCINERATOR. FLUSH SEWERS WITH LARGE AMOUNTS OF WATER.
Handling And Storage Precautions: STORE AT ROOM TEMPERATURES BETWEEN 4C AND
5C.
  MATERIAL MAY DEVELOP BACTERIA ODOR ON LONG TERM STORAGE. NO SAFETY PROBLEMS
  KNOWN.
=======================================================
Fire and Explosion Hazard Information
=======================================================
Extinguishing Media: WATER FOG - DRIED RESIN ONLY.
Fire Fighting Procedures: USE NIOSH APPROVED SCBA AND FULL PROTECTIVE
EQUIPMENT
  (FP N).
Unusual Fire/Explosion Hazard: THE DRIED RESIN IS FLAMMABLE SIMILAR TO WOOD.
  BURNING DRY RESIN EMITS DENSE, BLACK SMOKE. SUSPENDED MATERIAL IS NOT
  FLAMMABLE.
=======================================================
Control Measures
=======================================================
Respiratory Protection: NONE NORMALLY NEEDED. IN CASES WHERE THERE IS A
  LIKELIHOOD OF INHALATION EXPOSURE TO DRIED PARTICLES, WEAR A NIOSH APPROVED
  DUST RESPIRATOR.
Ventilation: GOOD ROOM VENTILATION USUALLY ADEQUATE FOR MOST OPERATIONS.
Protective Gloves: IMPERVIOUS GLOVES (FP N).
Eye Protection: ANSI APPROVED CHEMICAL WORKERS GOGGLES (FP N).
Other Protective Equipment: ANSI APPROVED EYE WASH & DELUGE SHOWER (FP N).
=======================================================
Physical/Chemical Properties
=======================================================
Boiling Point: =100.C, 212.F
Spec Gravity: 0.95-1.05 G/CC
Solubility in Water: EMULSION
Appearance and Odor: MILKY WHITE LIQUID EMULSION.
=======================================================
Reactivity Data
=======================================================
Stability Indicator: YES
```

Stability Condition To Avoid: MAY COAGULATE IF FROZEN AT 0C/32F. DRIED RESIN IS COMBUSTIBLE. ADDITION OF CHEMICALS MAY CAUSE COAGULATION.
Hazardous Decomposition Products: IF BURNED, PRODUCES A DENSE BLACK SMOKE AND NOXIOUS GASES (CARBON MONOXIDE AND HYDROCARBONS).
Hazardous Polymerization Indicator: NO

Toxicological Information

Toxicological Information: DATA NOT YET AVAILABLE.

Ecological Information

Ecological: DATA NOT YET AVAILABLE. WILL COLOR STREAMS AND RIVERS TO A MILKY WHITE. HAS PRACTICALLY NO BIOLOGICAL DEMAND BUT WILL SETTLE OUT AND FORM SLUDGE OR FILM.

MSDS Transport Information

Transport Information: CONTACT BANGS LABORATORIES, INC FOR TRANSPORTATION INFORMATION.

Regulatory Information

Other Information

Other Information: MFR'S FAX NUMBER: 317-570-7034.

HAZCOM Label

Product ID: POLYSTYRENE OR POLYSTYRENE SURFACTANT FREE
Cage: TO292
Assigned IND: Y
Company Name: BANGS LABORATORIES, INC
Street: 9025 TECHNOLOGY DRIVE
City: FISHERS IN
Zipcode: 46038
Health Emergency Phone: 317-570-7020
Label Required IND: Y
Date Of Label Review: 10/25/1999
Status Code: A
Origination Code: F
Chronic Hazard IND: Y
Eye Protection IND: YES
Skin Protection IND: YES
Signal Word: CAUTION
Respiratory Protection IND: YES
Health Hazard: Slight
Contact Hazard: Slight
Fire Hazard: None
Reactivity Hazard: None
Hazard And Precautions: ACUTE: EYES: MILD IRRITATION. SKIN CONTACT: CONTACT MAY CAUSE SLIGHT IRRITATION. SHORT EXPOSURE: NO IRRITATION. SKIN ABSORPTION: NOT

LIKELY TO BE ABSORBED IN TOXIC AMOUNTS INGESTION: LOW SINGLE DOSE TOXICITY.

INHALATION: NO GUIDE ESTABLISHED. CONSIDERED TO BE LOW IN HAZARD FROM INHALATION. SYSTEMIC AND OTHER EFFECTS: NONE KNOWN. HUMAN EFFECTS NOT ESTABLISHED. CHRONIC: POSSIBLY WEAK SENSITIZER. S KIN: REPEATED PROLONGED EXPOSURE, ESPECIALLY IF CONFINED; MILD IRRITATION, POSSIBLY A MILD SUPERFICIAL BURN.

===

MSDS Number: **P5631** * * * * * *Effective Date:* ***11/02/01*** * * * * * *Supercedes:* ***11/17/99***

POTASSIUM CHLORIDE

1. Product Identification

Synonyms: Potassium monochloride
CAS No.: 7447-40-7
Molecular Weight: 74.55
Chemical Formula: KCl
Product Codes:
J.T. Baker: 3040, 3045, 3046, 3052, 4001, 4920, 5596
Mallinckrodt: 0865, 0890, 3279, 3610, 3619, 3925, 4251, 4687, 4858, 4910, 5480, 6156, 6205, 6230, 6275, 6307, 6335, 6363, 6788, 6801, 6838, 6841, 6842, 6845, 6849, 6858, 7207, 7535, 7590, 7618, 7769, V483

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Potassium Chloride	7447-40-7	100%	Yes

3. Hazards Identification

Emergency Overview

CAUTION! MAY BE HARMFUL IF SWALLOWED. MAY CAUSE IRRITATION TO SKIN, EYES, AND RESPIRATORY TRACT.

J.T. Baker SAF-T-DATA$^{(tm)}$ Ratings (Provided here for your convenience)

Health Rating: 0 - None
Flammability Rating: 0 - None
Reactivity Rating: 0 - None
Contact Rating: 1 - Slight
Lab Protective Equip: GOGGLES; LAB COAT
Storage Color Code: Orange (General Storage)

Potential Health Effects

Inhalation:

Inhalation of high concentrations of dust may cause nasal or lung irritation.
Ingestion:
Large quantities can produce gastrointestinal irritation and vomiting. May produce weakness and circulatory problems. May affect heart. In severe cases, ingestion may be fatal.
Skin Contact:
Contact may cause irritation or rash, particularly with moist skin.
Eye Contact:
Potassium chloride is moderate eye irritant. Redness, tearing, possible abrasion can occur.
Chronic Exposure:
No information found.
Aggravation of Pre-existing Conditions:
Persons with impaired kidney function may be more susceptible to the effects of the substance.

4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen.
Ingestion:
Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Call a physician.
Skin Contact:
Remove any contaminated clothing. Wash skin with soap and water for at least 15 minutes. Get medical attention if irritation develops or persists.
Eye Contact:
In case of contact, immediately flush eyes with plenty of water for at least 15 minutes, lifting upper and lower eyelids occasionally. Call a physician if irritation persists.

5. Fire Fighting Measures

Fire:
Not considered to be a fire hazard.
Explosion:
Not considered to be an explosion hazard.
Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Pick up and place in a suitable container for reclamation or disposal, using a method that does not generate dust.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

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8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
- OSHA Permissible Exposure Limit (PEL):
15 mg/m3 total dust, 5 mg/m3 respirable fraction for nuisance dusts.
- ACGIH Threshold Limit Value (TLV):
10 mg/m3 total dust containing no asbestos and < 1% crystalline silica for Particulates Not Otherwise Classified (PNOC).

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded and engineering controls are not feasible, a half facepiece particulate respirator (NIOSH type N95 or better filters) may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest.. A full-face piece particulate respirator (NIOSH type N100 filters) may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency, or respirator supplier, whichever is lowest. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.
Skin Protection:
Wear protective gloves and clean body-covering clothing.
Eye Protection:
Use chemical safety goggles and/or full face shield where dusting or splashing of solutions is possible. Maintain eye wash fountain and quick-drench facilities in work area.

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9. Physical and Chemical Properties

Appearance:
White crystals or powder.
Odor:
Odorless.
Solubility:
28.1 g/100g of water @ 0C.
Density:
1.987
pH:
ca. 7 Saturated aq. sl. @ 15C
% Volatiles by volume @ 21C (70F):
0
Boiling Point:
1500C (2732F) Sublimes.
Melting Point:
772C (1422F)
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
No information found.

Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
Oxides of the contained metal and halogen, possibly also free, or ionic halogen.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Bromine trifluoride; potassium permanganate plus sulfuric acid.
Conditions to Avoid:
No information found.

11. Toxicological Information

Oral rat LD50: 2600 mg/kg; irritation eye rabbit (standard Draize): 500 mg/24 hr mild; investigated as a mutagen.

```
  --------\Cancer Lists\---------------------------------------------------
-
                                         ---NTP Carcinogen---
  Ingredient                             Known    Anticipated    IARC
Category
  ------------------------------------   -----    -----------    ------------
-
  Potassium Chloride (7447-40-7)          No           No             None
```

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

```
  --------\Chemical Inventory Status - Part 1\-------------------------------
--
  Ingredient                                       TSCA  EC   Japan  
Australia
  -----------------------------------------------  ----  ---  -----  --------
-
  Potassium Chloride (7447-40-7)                    Yes  Yes   Yes      Yes

  --------\Chemical Inventory Status - Part 2\-------------------------------
--
                                                          --Canada--
  Ingredient                                       Korea  DSL   NDSL  Phil.
  -----------------------------------------------  -----  ---   ----  -----
  Potassium Chloride (7447-40-7)                    Yes   Yes   No     Yes

  --------\Federal, State & International Regulations - Part 1\--------------
--
                                             -SARA 302-    ------SARA 313----
--
  Ingredient                                 RQ    TPQ     List  Chemical  
Catg.
  -----------------------------------------  ---   -----   ----  ------------
--
  Potassium Chloride (7447-40-7)             No    No      No         No

  --------\Federal, State & International Regulations - Part 2\--------------
--
                                                        -RCRA-    -TSCA-
  Ingredient                                 CERCLA     261.33     8(d)
  -----------------------------------------  ------     ------    ------
  Potassium Chloride (7447-40-7)             No         No         No


Chemical Weapons Convention:  No     TSCA 12(b):  No     CDTA:  No
SARA 311/312:  Acute: Yes      Chronic: No   Fire: No  Pressure: No
Reactivity: No          (Pure / Solid)
```

Australian Hazchem Code: None allocated.
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: **1** Flammability: **0** Reactivity: **0**
Label Hazard Warning:
CAUTION! MAY BE HARMFUL IF SWALLOWED. MAY CAUSE IRRITATION TO SKIN, EYES, AND RESPIRATORY TRACT.
Label Precautions:
Avoid breathing dust.
Keep container closed.
Use with adequate ventilation.

Avoid contact with eyes, skin and clothing.
Wash thoroughly after handling.

Label First Aid:

If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. If irritation develops call a physician. If inhaled, remove to fresh air. Get medical attention for any breathing difficulty.

Product Use:

Laboratory Reagent.

Revision Information:

MSDS Section(s) changed since last revision of document include: 8.

Disclaimer:

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Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

MSDS Number: **P5884** * * * * * *Effective Date:* ***10/31/00*** * * * * * *Supercedes:* ***11/24/97***

POTASSIUM HYDROXIDE

1. Product Identification

Synonyms: Caustic potash; potassium hydrate
CAS No.: 1310-58-3
Molecular Weight: 56.11
Chemical Formula: KOH
Product Codes:
J.T. Baker: 3140, 3141, 3146, 3150, 5685
Mallinckrodt: 6964, 6976, 6984, 7704, 7815

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Potassium Hydroxide	1310-58-3	85 - 90%	Yes
Water	7732-18-5	10 - 15%	No

3. Hazards Identification

Emergency Overview

POISON! DANGER! CORROSIVE. CAUSES SEVERE BURNS TO SKIN, EYES, RESPIRATORY TRACT, AND GASTROINTESTINAL TRACT. MATERIAL IS EXTREMELY DESTRUCTIVE TO ALL BODY TISSUES. MAY BE FATAL IF SWALLOWED. HARMFUL IF INHALED.

J.T. Baker SAF-T-DATA$^{(tm)}$ Ratings (Provided here for your convenience)

Health Rating: 3 - Severe (Poison)
Flammability Rating: 0 - None
Reactivity Rating: 2 - Moderate
Contact Rating: 4 - Extreme (Corrosive)
Lab Protective Equip: GOGGLES; LAB COAT; VENT HOOD; PROPER GLOVES
Storage Color Code: White Stripe (Store Separately)

Potential Health Effects

Inhalation:
Severe irritant. Effects from inhalation of dust or mist vary from mild irritation to serious damage of the upper respiratory tract, depending on the severity of exposure. Symptoms may include coughing, sneezing, damage to the nasal or respiratory tract. High concentrations can cause lung damage.
Ingestion:
Toxic! Swallowing may cause severe burns of mouth, throat and stomach. Other symptoms may include vomiting, diarrhea. Severe scarring of tissue and death may result. Estimated lethal dose: 5 grams.
Skin Contact:
Corrosive! Contact with skin can cause irritation or severe burns and scarring with greater exposures.
Eye Contact:
Highly Corrosive! Causes irritation of eyes with tearing, redness, swelling. Greater exposures cause severe burns with possible blindness resulting.
Chronic Exposure:
Prolonged contact with dilute solutions or dust of potassium hydroxide has a destructive effect on tissue.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or eye problems or impaired respiratory function may be more susceptible to the effects of the substance.

---

4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.
Ingestion:
If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. Get medical attention immediately.
Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

---

5. Fire Fighting Measures

Fire:
Not combustible, but contact with water or moisture may generate enough heat to ignite combustibles.
Explosion:
Can react with chemically reactive metals such as aluminum, zinc, magnesium, copper, etc. to release hydrogen gas which can form explosive mixtures with air.
Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire.
Special Information:
Solution process causes formation of corrosive mists. Hot or molten material can react violently with water. In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

---

6. Accidental Release Measures

Ventilate area of leak or spill. Keep unnecessary and unprotected people away from area of spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Pick up and place in a suitable container for reclamation or disposal, using a method that does not generate dust.
Do not flush caustic residues to the sewer. Residues from spills can be diluted with water, neutralized with dilute acid such as acetic, hydrochloric or sulfuric. Absorb neutralized caustic residue on clay, vermiculite or other inert substance and package in a suitable container for disposal.
US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker NEUTRACIT®-2 or BuCAIM® caustic neutralizers are recommended for spills of solutions of this product.

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7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Isolate from incompatible substances. Protect from moisture. Addition to water releases heat which can result in violent boiling and spattering. Always add slowly and in small amounts. Never use hot water. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

---

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
- OSHA Permissible Exposure Limit (PEL):
2 mg/m3 Ceiling
- ACGIH Threshold Limit Value (TLV):
2 mg/m3 Ceiling

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded, a half-face dust/mist respirator may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. A full-face piece dust/mist respirator may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency, or respirator supplier, whichever is lowest. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.
Skin Protection:
Rubber or neoprene gloves and additional protection including impervious boots, apron, or coveralls, as needed in areas of unusual exposure.
Eye Protection:

Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
White deliquescent solid
Odor:
Odorless.
Solubility:
52.8% in water @ 20C (68F)
Specific Gravity:
2.04
pH:
13.5 (0.1 molar solution)
% Volatiles by volume @ 21C (70F):
0
Boiling Point:
1320C (2408F)
Melting Point:
360C (680F)
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
1.0 @ 714C (1317F)
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
Carbon monoxide when reacting with carbohydrates, and hydrogen gas when reacting with aluminum, zinc and tin. Thermal oxidation can produce toxic fumes of potassium oxide (K2O).
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Contact with water, acids, flammable liquids and organic halogen compounds, especially trichloroethylene, may cause fire or explosion. Contact with nitromethane and other similar nitro compounds cause formation of shock sensitive salts. Contact with metals such as aluminum, tin and zinc causes formation of flammable hydrogen gas.
Conditions to Avoid:
Heat, moisture, incompatibles.

11. Toxicological Information

For potassium hydroxide: Oral rat LD50: 273 mg/kg; Investigated as a mutagen. Skin Irritation Data (std Draize, 50 mg/24 H): Human, Severe; Rabbit, Severe. Eye Irritation Data(Rabbit, non-std test,1 mg/24 H, rinse): Moderate.

```
  --------\Cancer Lists\-----------------------------------------------------
-
                                         ---NTP Carcinogen---
  Ingredient                             Known    Anticipated    IARC
Category
  ------------------------------------   -----    -----------    ------------
-
  Potassium Hydroxide (1310-58-3)         No          No            None
  Water (7732-18-5)                       No          No            None
```

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
Potassium Hydroxide: TLm: 80 ppm/Mosquito fish/ 24 hr./ Fresh water

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: POTASSIUM HYDROXIDE, SOLID
Hazard Class: 8
UN/NA: UN1813
Packing Group: II
Information reported for product/size: 110LB

International (Water, I.M.O.)

Proper Shipping Name: POTASSIUM HYDROXIDE, SOLID
Hazard Class: 8
UN/NA: UN1813
Packing Group: II
Information reported for product/size: 110LB

International (Air, I.C.A.O.)

Proper Shipping Name: POTASSIUM HYDROXIDE, SOLID
Hazard Class: 8
UN/NA: UN1813
Packing Group: II
Information reported for product/size: 110LB

15. Regulatory Information

```
  --------\Chemical Inventory Status - Part 1\-------------------------------
--
  Ingredient                                       TSCA  EC   Japan
Australia
  ----------------------------------------------   ----  ---  -----  --------
-
  Potassium Hydroxide (1310-58-3)                   Yes  Yes   Yes      Yes
  Water (7732-18-5)                                 Yes  Yes   Yes      Yes

  --------\Chemical Inventory Status - Part 2\-------------------------------
--
                                                          --Canada--
  Ingredient                                       Korea  DSL   NDSL  Phil.
  ----------------------------------------------   -----  ---   ----  -----
  Potassium Hydroxide (1310-58-3)                   Yes   Yes   No     Yes
  Water (7732-18-5)                                 Yes   Yes   No     Yes

  --------\Federal, State & International Regulations - Part 1\--------------
--
                                             -SARA 302-    ------SARA 313----
--
  Ingredient                                 RQ    TPQ     List  Chemical
Catg.
  -----------------------------------------  ---   -----   ----  ------------
--
  Potassium Hydroxide (1310-58-3)            No    No      No         No
  Water (7732-18-5)                          No    No      No         No

  --------\Federal, State & International Regulations - Part 2\--------------
--
                                                        -RCRA-    -TSCA-
  Ingredient                                 CERCLA     261.33     8(d)
  -----------------------------------------  ------     ------    ------
  Potassium Hydroxide (1310-58-3)            1000       No         No
  Water (7732-18-5)                          No         No         No


Chemical Weapons Convention:  No     TSCA 12(b):  No     CDTA:  No
SARA 311/312:  Acute: Yes      Chronic: Yes  Fire: No  Pressure: No
Reactivity: Yes         (Mixture / Solid)
```

Australian Hazchem Code: 2R
Poison Schedule: S6
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

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16. Other Information

NFPA Ratings: Health: **3** Flammability: **0** Reactivity: **1**
Label Hazard Warning:
POISON! DANGER! CORROSIVE. CAUSES SEVERE BURNS TO SKIN, EYES, RESPIRATORY TRACT, AND GASTROINTESTINAL TRACT. MATERIAL IS EXTREMELY DESTRUCTIVE TO ALL BODY TISSUES. MAY BE FATAL IF

SWALLOWED. HARMFUL IF INHALED.
Label Precautions:
Do not get in eyes, on skin, or on clothing.
Do not breathe dust.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.
Label First Aid:
If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. If inhaled, remove to fresh air. If not breathing give artificial respiration. If breathing is difficult, give oxygen. In all cases get medical attention immediately.
Product Use:
Laboratory Reagent.
Revision Information:
No changes.
Disclaimer:
****
****

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****

Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

MSDS Number: **S0722** * * * * * *Effective Date:* ***09/14/00*** * * * * * *Supercedes:* ***02/23/99***

SAND, WASHED AND DRIED

1. Product Identification

Synonyms: Agate; Onyx; Quartz; Silica, crystalline quartz; Silicon dioxide
CAS No.: 14808-60-7
Molecular Weight: 60.08
Chemical Formula: SiO_2
Product Codes:
J.T. Baker: 3382, 7023
Mallinckrodt: 7062

2. Composition/Information on Ingredients

```
  Ingredient                                 CAS No          Percent
Hazardous
  ---------------------------------------   ------------    ------------    ---
------

  Quartz                                     14808-60-7        90 - 100%
Yes
```

3. Hazards Identification

Emergency Overview

WARNING! HARMFUL IF INHALED. OVEREXPOSURE MAY CAUSE LUNG DAMAGE. MAY CAUSE EYE IRRITATION. INHALATION CANCER HAZARD. CONTAINS QUARTZ WHICH CAN CAUSE CANCER. Risk of cancer depends upon duration and level of exposure.

J.T. Baker SAF-T-DATA$^{(tm)}$ Ratings (Provided here for your convenience)

Health Rating: 3 - Severe (Cancer Causing)

Flammability Rating: 0 - None
Reactivity Rating: 0 - None
Contact Rating: 1 - Slight
Lab Protective Equip: GOGGLES; LAB COAT; VENT HOOD; PROPER GLOVES
Storage Color Code: Orange (General Storage)

Potential Health Effects

Inhalation:
Acute pneumoconiosis from overwhelming exposure to silica dust has occurred. Coughing and irritation of throat are early symptoms.
Ingestion:
No adverse health effects expected.
Skin Contact:
No adverse effects expected.
Eye Contact:
May cause irritation, redness and pain.
Chronic Exposure:
Inhalation of quartz is classified as a human carcinogen. Chronic exposure can cause silicosis, a form of lung scarring that can cause shortness of breath, reduced lung function, and in severe cases, death.
Aggravation of Pre-existing Conditions:
Inhalation may increase the progression of tuberculosis; susceptibility is apparently not increased. Persons with impaired respiratory function may be more susceptible to the effects of this substance. Smoking can increase the risk of lung injury.

4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.
Ingestion:
If large amounts were swallowed, give water to drink and get medical advice.
Skin Contact:
Wash exposed area with soap and water. Get medical advice if irritation develops.
Eye Contact:
Wash thoroughly with running water. Get medical advice if irritation develops.

5. Fire Fighting Measures

Fire:
Not considered to be a fire hazard.
Explosion:
Not considered to be an explosion hazard.
Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Sweep up and containerize for reclamation or disposal. Vacuuming or wet sweeping may be used to avoid dust dispersal.

---

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Use dustless systems for handling, storage, and clean up so that dust does not exceed the PEL. Use adequate ventilation and dust collection. Practice good housekeeping. Do not allow dust to collect on walls, floors, sills, ledges, machinery, or equipment. Maintain, clean and test respirators in accordance with OSHA regulations. Maintain and test ventilation and dust collection equipment. Wash clothing that has become dusty; do not breathe the dust from clothing. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

---

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
-OSHA Permissible Exposure Limit (PEL):
Total dust: 30mg/m3/(%SiO2 + 2)
Respirable Fraction: 10 mg/m3/(%SiO2 + 2)

-ACGIH Threshold Limit Value (TLV):
0.05 mg/m3 (TWA) respirable dust, A2 -Suspected Human Carcinogen.

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded and engineering controls are not feasible, a half-face high efficiency particulate respirator (NIOSH type N100 filter) may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. A full-face piece high efficiency particulate respirator (NIOSH type N100 filter) may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres. Where respirators are required, you must have a written program covering the basic requirements in the OSHA respirator standard. These include training, fit testing, medical approval, cleaning, maintenance, cartridge change schedules, etc. See 29CFR1910.134 for details.

Skin Protection:
Wear protective gloves and clean body-covering clothing.

Eye Protection:
Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

---

9. Physical and Chemical Properties

Appearance:
Fine, off-white granules.
Odor:
Odorless.
Solubility:
Insoluble in water.
Specific Gravity:
2.65
pH:
No information found.
% Volatiles by volume @ 21C (70F):
0
Boiling Point:
2230C (4046F)
Melting Point:
1710C (3110F)
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
10 @ 1732C (3150F)
Evaporation Rate (BuAc=1):
Not applicable.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
At higher temperatures, can change crystal structure to form tridymite or cristobalite, which have greater health hazards.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Strong alkalis, hydrofluoric acid, powerful oxidizers and fluorine containing compounds.
Conditions to Avoid:
Dusting and incompatibles.

11. Toxicological Information

Toxicological Data:
No LD50/LC50 information found relating to normal routes of occupational exposure.
Investigated as a tumorigen and mutagen.

Carcinogenicity:
Quartz: NIOSH considers this substance to be a potential occupational carcinogen.

```
  --------\Cancer Lists\---------------------------------------------------
-
                                         ---NTP Carcinogen---
  Ingredient                             Known    Anticipated    IARC
Category
  ------------------------------------   -----    -----------    ------------
-
  Quartz (14808-60-7)                     Yes         No               1
```

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

```
  --------\Chemical Inventory Status - Part 1\-------------------------------
--
  Ingredient                                       TSCA  EC   Japan
Australia
  -----------------------------------------------  ----  ---  -----  --------
-
  Quartz (14808-60-7)                               Yes  Yes   Yes      Yes

  --------\Chemical Inventory Status - Part 2\-------------------------------
--
                                                             --Canada--
  Ingredient                                       Korea  DSL   NDSL  Phil.
  -----------------------------------------------  -----  ---   ----  -----
  Quartz (14808-60-7)                               Yes   Yes   No     Yes

  --------\Federal, State & International Regulations - Part 1\-------------
--
                                             -SARA 302-    ------SARA 313----
--
  Ingredient                                 RQ    TPQ     List  Chemical
Catg.
  -----------------------------------------  ---   -----   ----  ------------
--
  Quartz (14808-60-7)                        No    No      No         No

  --------\Federal, State & International Regulations - Part 2\-------------
--
                                                          -RCRA-    -TSCA-
  Ingredient                                 CERCLA     261.33     8(d)
  -----------------------------------------  ------     ------    ------
  Quartz (14808-60-7)                        No         No         No


Chemical Weapons Convention:  No     TSCA 12(b):  No     CDTA:  No
```

```
SARA 311/312:  Acute: Yes      Chronic: Yes  Fire: No  Pressure: No
Reactivity: No          (Pure / Solid)
```

WARNING:
THIS PRODUCT CONTAINS A CHEMICAL(S) KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER.

Australian Hazchem Code: None allocated.
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

---

16. Other Information

NFPA Ratings: Health: **2** Flammability: **0** Reactivity: **0**
Label Hazard Warning:
WARNING! HARMFUL IF INHALED. OVEREXPOSURE MAY CAUSE LUNG DAMAGE. MAY CAUSE EYE IRRITATION. INHALATION CANCER HAZARD. CONTAINS QUARTZ WHICH CAN CAUSE CANCER. Risk of cancer depends upon duration and level of exposure.
Label Precautions:
Do not get in eyes, on skin, or on clothing.
Do not breathe dust.
Keep container closed.
Use only with adequate ventilation.
Minimize dust generation and accumulation.
Wash thoroughly after handling.
Label First Aid:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention. In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention if irritation develops or persists.
Product Use:
Laboratory Reagent.
Revision Information:
MSDS Section(s) changed since last revision of document include: 8, 11.
Disclaimer:
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****

Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

JOHNSON MATTHEY ALFA AESAR -- 88220 STRONTIUM OXIDE

MSDS Safety Information

FSC: 6810
NIIN: 01-446-9934
MSDS Date: 08/01/1994
MSDS Num: CFRLZ
Product ID: 88220 STRONTIUM OXIDE
MFN: 01
Responsible Party
Cage: 0MMA6
Name: JOHNSON MATTHEY ALFA AESAR
Address: 30 BOND STREET
City: WARD HILL MA 00000
Info Phone Number: 508-521-6300
Emergency Phone Number: 800-424-9300 CHEMTREC
Preparer's Name: UNKNOWN
Review Ind: Y
Published: Y

Contractor Summary

Cage: 0MMA6
Name: ALFA AESAR (A JOHNSON MATTHEY CO)
Address: 30 BOND STREET
City: WARD HILL MA 01835-0747
Phone: 978-621-6300

Item Description Information

Item Manager: S9G
Item Name: STRONTIUM OXIDE
Specification Number: NONE
Type/Grade/Class: NONE
Unit of Issue: BT
Quantitative Expression: 10000000025GM
UI Container Qty: 0
Type of Container: UNKNOWN

Ingredients

Cas: 1314-11-0
Name: STRONTIUM OXIDE
% Wt: 100
Other REC Limits: NONE RECOMMENDED
OSHA PEL: NOT ESTABLISHED
ACGIH TLV: NOT ESTABLISHED

Health Hazards Data

LD50 LC50 Mixture: NO DATA
Route Of Entry Inds - Inhalation: YES
Skin: YES
Ingestion: YES
Carcinogenicity Inds - NTP: NO
IARC: NO

OSHA: NO

Effects of Exposure: EXPOSURE MAY CAUSE EYE, SKIN & RESPIRATORY TRACT IRRITATION OR BURNS. INGESTION CAUSES IRRITATION OR BURNS OF THE MOUTH, THROAT & GI TRACT.

Explanation Of Carcinogenicity: NO INGREDIENT OF A CONCENTRATION OF 0.1% OR GREATER IS LISTED AS A CARCINOGEN OR SUSPECTED CARCINOGEN.

Signs And Symptions Of Overexposure: SKIN-IRRITATION, BURNS. EYES-IRRITATION, BURNS. INHALED-IRRITATION, BURNS. INGESTED-BURNS/IRRITATION OF MOUTH, THROAT, GI TRACT.

Medical Cond Aggravated By Exposure: NONE KNOWN.

First Aid: EYES-FLUSH WITH WATER FOR 15 MINUTES, LIFT LIDS. GET IMMEDIATE MEDICAL ATTENTION. SKIN-REMOVE CONTAMINATED CLOTHES. FLOOD AREA WITH WATER. GET IMMEDIATE MEDICAL ATTENTION. INHALED-REMOVE TO FRESH AIR. GET IMMEDIATE MEDICAL ATTENTION. INGESTED-GET IMMEDIATE MEDICAL ATTENTION.

Handling and Disposal

Spill Release Procedures: WEARING FULL PROTECTIVE EQUIPMENT, COVER SPILL WITH DRY SAND OR VERMICULITE. MIX WELL AND CAREFULLY TRANSFER TO A CLEAN, DRY CONTAINER.

Neutralizing Agent: NONE SPECIFIED BY MANUFACTURER.

Waste Disposal Methods: DISPOSE OF IN ACCORDANCE WITH LOCAL, STATE AND FEDERAL ENVIRONMENTAL REGULATIONS.

Handling And Storage Precautions: KEEP CONTAINER TIGHTLY CLOSED. STORE IN A COOL, DRY, WELL-VENTILATED AREA. WASH THOROUGHLY AFTER USE.

Other Precautions: NONE SPECIFIED BY MANUFACTURER.

Fire and Explosion Hazard Information

Extinguishing Media: DRY CHEMICAL EXTINGUISHING AGENTS, DRY SAND, DRY DOLOMITE. NO WATER OR CO2 UNLESS MASSIVE FIRE OR ADVANCED.

Fire Fighting Procedures: NORMAL PROCEDURES SUCH AS WEARING SELF-CONTAINED BREATHING APPARATUS AND CHEMICAL RESISTANT CLOTHING.

Unusual Fire/Explosion Hazard: NONE SPECIFIED BY MANUFACTURER.

Control Measures

Respiratory Protection: IF ENGINEERING CONTROLS FAIL OR NON-ROUTINE USE OR AN EMERGENCY OCCURS; WEAR AN MSHA/NIOSH APPROVED RESPIRATOR WITH HEPA CARTRIDGE OR AN AIR-SUPPLIED RESPIRATOR OR SCBA, AS REQUIRED. USE IAW 29 CFR 1910.134.

Ventilation: GLOVE BAG OR BOX WITH DRY, INERT ATMOSPHERE.

Protective Gloves: RUBBER.

Eye Protection: ANSI APPROVED SAFETY GOGGLES.

Other Protective Equipment: LAB COAT & APRON, FLAME & CHEMICAL RESISTANT COVERALLS, EYE WASH STATION & SAFETY SHOWER, HYGIENIC WASHING FACILITIES.

Work Hygienic Practices: WASH HANDS AFTER HANDLING AND BEFORE EATING, DRINKING, OR SMOKING. LAUNDER CONTAMINATED CLOTHES BEFORE REUSE.

Physical/Chemical Properties

HCC: B2
B.P. Text: 5432F,3000C
M.P/F.P Text: 4406F,2430C
Vapor Pres: 40
Spec Gravity: 4.7
Solubility in Water: SLIGHT
Appearance and Odor: GREY-WHITE POWDER; ODORLESS.
Percent Volatiles by Volume: 0

Reactivity Data

Stability Indicator: YES
Stability Condition To Avoid: THERMAL DECOMPOSITION, INCOMPATIBLES. IN THE PRESENCE OF WATER, MATERIAL MAY EVOLVE ENOUGH HEAT TO IGNITE COMBUSTIBLES.
Materials To Avoid: ACIDS, CARBON DIOXIDE, ALUMINUM, MAGNESIUM, WATER.
Hazardous Decomposition Products: STRONTIUM HYDROXIDE.
Hazardous Polymerization Indicator: NO
Conditions To Avoid Polymerization: WILL NOT OCCUR.

Toxicological Information

Ecological Information

MSDS Transport Information

Regulatory Information

Other Information

Transportation Information

Responsible Party Cage: 0MMA6
Trans ID NO: 137173
Product ID: 88220 STRONTIUM OXIDE
MSDS Prepared Date: 08/01/1994
Review Date: 11/18/1997
MFN: 1
Tech Entry NOS Shipping Nm: CONTAINS STRONTIUM OXIDE
Net Unit Weight: 0.05 LB
Multiple KIT Number: 0
Review IND: Y
Unit Of Issue: BT
Container QTY: 0
Type Of Container: UNKNOWN
Additional Data: PSN IS BEST GUESS BY DLA- STAFF.

Detail DOT Information

DOT PSN Code: DYB
Symbols: G
DOT Proper Shipping Name: CORROSIVE SOLID, BASIC, ORGANIC, N.O.S.
Hazard Class: 8

```
UN ID Num: UN3263
DOT Packaging Group: II
Label: CORROSIVE
Packaging Exception: 154
Non Bulk Pack: 212
Bulk Pack: 240
Max Qty Pass: 15 KG
Max Qty Cargo: 50 KG
Vessel Stow Req: B
=======================================================
Detail IMO Information
=======================================================
IMO PSN Code: ETD
IMO Proper Shipping Name: CORROSIVE SOLID, BASIC, INORGANIC, N.O.S. o
IMDG Page Number: 8150-1
UN Number: 3262
UN Hazard Class: 8
IMO Packaging Group: I/II/III
Subsidiary Risk Label: -
EMS Number: 8-15
MED First Aid Guide NUM: 760
=======================================================
Detail IATA Information
=======================================================
IATA PSN Code: HMH
IATA UN ID Num: 3262
IATA Proper Shipping Name: CORROSIVE SOLID, BASIC, INORGANIC, N.O.S. *
IATA UN Class: 8
IATA Label: CORROSIVE
UN Packing Group: II
Packing Note Passenger: 814
Max Quant Pass: 15KG
Max Quant Cargo: 50KG
Packaging Note Cargo: 816
=======================================================
Detail AFI Information
=======================================================
AFI PSN Code: HNC
AFI Symbols: *
AFI Proper Shipping Name: CORROSIVE SOLID, BASIC, INORGANIC, N.O.S.
AFI Hazard Class: 8
AFI UN ID NUM: UN3262
AFI Packing Group: II
Special Provisions: P5
Back Pack Reference: A12.4
=======================================================
HAZCOM Label
=======================================================
Product ID: 88220 STRONTIUM OXIDE
Cage: 0MMA6
Company Name: ALFA AESAR (A JOHNSON MATTHEY CO)
Street: 30 BOND STREET
City: WARD HILL MA
Zipcode: 01835-0747
Health Emergency Phone: 800-424-9300 CHEMTREC
Label Required IND: Y
Date Of Label Review: 11/18/1997
```

Status Code: C
Label Date: 11/18/1997
Year Procured: 1997
Origination Code: F
Eye Protection IND: YES
Skin Protection IND: YES
Signal Word: DANGER
Respiratory Protection IND: YES
Health Hazard: Moderate
Contact Hazard: Severe
Fire Hazard: None
Reactivity Hazard: Slight
Hazard And Precautions: CORROSIVE! EXPOSURE MAY CAUSE EYE, SKIN & RESPIRATORY TRACT IRRITATION OR BURNS. INGESTION CAUSES IRRITATION OR BURNS OF THE MOUTH, THROAT & GI TRACT. TARGET ORGANS: SKIN, EYES, LUNGS, GI TRACT. FIRST AID: EYES-FLUSH WITH WATER FOR 15 MINUTES, LIFT LIDS. GET IMMEDIATE MEDICAL ATTENTION. SKIN-REMOVE CONTAMINATED CLOTHES. FLOOD AREA WITH WATER. GET IMMEDIATE MEDICAL ATTENTION. INHALED-REMOVE TO FRES H AIR. GET IMMEDIATE MEDICAL ATTENTION. INGESTED-GET IMMEDIATE MEDICAL ATTENTION.

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