

50025

CROWN ALLOYS COMPANY

MATERIAL SAFETY DATA SHEET

Section 1 - COMPANY AND MATERIAL IDENTIFICATION

PRODUCT TYPE: Silver-copper-tin alloys for soldering (S) or brazing (B).

TRADE NAME: SIL-COP 0, SIL-COP 5, SIL-COP 6, SIL-COP 15, SIL 35, SIL 45, SIL 50 Ni, SIL 55, SIL 45 FC, SIL 55 FC, CROWN 95, CROWN 95 SFCK, ROYAL 1000

SPECIFICATION: AWS A5.8 (Except Crown 95, Crown 95 SFCK and Royal 1000)

CLASSIFICATION: BCuP-2, BCuP-3, BCuP-4, BCuP-5, BAg-35, BAg-5, BAg-24, BAg-7

VENDOR: Crown Alloys Company

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DATE: December 26, 2003

Emergency 24 hour telephone #
CHEMTREC (800) 424-9300

Section 2 - HAZARDOUS INGREDIENTS

IMPORTANT! This section covers the material from which these products are manufactured. The fumes and gases produced when welding with normal use of these products are covered in Section 5 & 6.

Ingredient	CAS No.	OSHA - TWA PEL, mg/m ³	(ACGIH - TWA) ² TLV, mg/m ³	IDLH ¹ mg/m ³	Wt. %
Acrylic Resin ²	108-65-6	NE	NE	NE	30.0 - 50.0
Copper	7440-50-8	0.1 Fume 1.0 Dusts & Mists	0.2 Fume 1.0 Dusts & Mists	100	80.0 - 93.0 ³ 19.0 - 33.0 ⁴ 4.0 max. ⁵
Nickel ⁶	7440-02-0	1.0 Metal & Insoluble Compounds as Ni 0.1 as Ni soluble	1.5 as Metal (inhalable fraction) 0.1 as Ni soluble	10	1.5 - 2.5
Phosphorous ³	7723-14-0	0.1	0.1	5.0	4.8 - 7.5
Potassium Fluoborate ²	14075-53-7	2.5 (as F)	2.5 (as F)	NE	60.0 - 80.0
Rosin ⁷	8050-09-7	N/A	N/A	NE	2.5 - 3.0
Silver	7440-22-4	0.01 (Dust & Fume)	0.01 (Dust & Fume)	10	15.5 max. ³ 34.0 - 57.0 ⁴ 0.5 - 3.5 ⁵
Tin	7440-31-5	2.0	2.0	100	4.5 - 5.5 ⁸ 95.5 - 96.5 ⁵
Zinc ⁴	7440-66-6	5.0 (Fume), 5.0 (Total Dust), 15.0 (Dust, Respirable Dust), 5.0 (Dust, Respirable Dust, Vacated 1989 PEL), 10.0 Fume (STEL, Vacated 1989 PEL)	5.0 Fume 10.0 Dust 10.0 Fume (STEL)	500	15.0 - 35.0

¹Immediately Dangerous to Life and Health - This level represents a concentration from which one can escape within 30 minutes without suffering escape-preventing or permanent injury. NE - Not Established. Single values shown are maximum.

²Flux Constituent. These ingredients are present in SIL 45 FC and SIL 55 FC only! The Weight Percent values are for the flux coating only.

³SIL-COP 0, SIL-COP 5, SIL-COP 6 and SIL-COP 15 Only.

⁴SIL 35, SIL 45, SIL 50 Ni, SIL 55, SIL 45 FC and SIL 55 FC Only.

NIOSH classifies welding fumes as carcinogens.

⁵CROWN 95, CROWN 95 SFCK and ROYAL 1000 Only.

⁶SIL 50 Ni Only.

⁷Flux Constituent. This ingredient is present in CROWN 95 SFCK Only. Rosin may decompose during heating to form about 5% turpentine. (TLV = 100ppm)

⁸SIL 55 and SIL 55 FC Only.

⁹The ACGIH has an established exposure limit for Welding Fumes, Not Otherwise Classified. That Threshold Limit Value is 5 mg/m³.

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Section 3 - PHYSICAL and CHEMICAL CHARACTERISTICS

APPEARANCE AND COLOR:

- **Sil-Cop 0, Sil-Cop 5, Sil-Cop 6 and Sil-Cop 15:** Copper-colored rods. No odor.
- **Crown 95, Crown 95 SFCK and Royal 1000:** Lustrous, silver metal wire wrapped on spools. No odor.
- **Sil 35, Sil 45, Sil 50 Ni and Sil 55:** Light-gold rods or wire. No odor.
- **Sil 45 FC:** Blue flux coating over a light-gold rod at room temperature. It has a vanilla odor.
- **Sil 55 FC:** Orange flux coating over a light-gold rod at room temperature. It has a vanilla odor.

The following information is for copper, a main component of these products (except Crown 95 and Crown 95 SFCK):

SPECIFIC GRAVITY @ 20°C (water = 1): 8.94 g/cc **FREEZING/MELTING POINT:** 1981°F (1083°C)
SOLUBILITY IN WATER: Insoluble **BOILING POINT @ 24 mm Hg:** 4703°F (2595°C)

The following information is for silver, a main component of these products (except Sil-Cop 0):

SPECIFIC GRAVITY @ 20°C (water = 1): 10.49 g/cc **FREEZING/MELTING POINT:** 1760.9°F (960.5°C)
SOLUBILITY IN WATER: Insoluble **BOILING POINT @ 24 mm Hg:** Approx. 4014°F (2212°C)

The following information is for tin, a main component of Crown 95, Crown 95 SFCK, Royal 1000, Sil 55 and Sil 55 FC.

SPECIFIC GRAVITY @ 20°C (water = 1): N/A **FREEZING/MELTING POINT:** 450°F (232°C)
SOLUBILITY IN WATER: Insoluble **BOILING POINT @ 24 mm Hg:** Approx. 4120°F (2270°C)

The following information is for zinc, a main component of Sil 35, Sil 45, Sil 50 Ni, Sil 55, Sil 45 FC and Sil 55 FC only!

SPECIFIC GRAVITY @ 20°C (water = 1): 7.14 g/cc **FREEZING/MELTING POINT:** 786°F (419°C)
SOLUBILITY IN WATER: Insoluble **BOILING POINT @ 24 mm Hg:** Approx. 1665°F (907°C)

Section 4 - FIRE and EXPLOSION HAZARD DATA

FLAMMABLE PROPERTIES: Non-flammable as *shipped*. Brazing flame, welding arc and sparks can ignite combustibles and flammables. Refer to American National Standard Z49.1 "Safety in Welding and Cutting" and "Safe Practices" Code: SP, published by the American Welding Society for fire prevention during the use of welding, brazing and allied procedures.

FLAMMABLE LIMITS (in air by volume, %): Lower (LEL): Not Applicable Upper (UEL): Not Applicable

FLASH POINT: Not Flammable

AUTOIGNITION TEMPERATURE: Not Flammable

FIRE EXTINGUISHING MATERIALS: Water Spray: YES (Large fires may be flooded with water from a distance)

Carbon Dioxide: YES / Halon: YES / Foam: YES / Dry Chemical: YES / Other: Any "ABC" Class

UNUSUAL FIRE AND EXPLOSION HAZARDS: When involved in a fire, this product may generate irritating fumes and a variety of metal compounds. The flux coating on the flux coated rods may decompose to release toxic and corrosive fluoride compounds and oxides of carbon, boron, fluorine and potassium. The molten material can present a significant thermal hazard to firefighters. Finely divided dust (from Crown 95, Crown 95 SFCK and Royal 1000) may form an explosive mixture with air.

NEVER DROP WATER OR LIQUIDS INTO MOLTEN SOLDER! DO NOT PLUNGE DAMP OR WET SOLDER PIECES INTO MOLTEN SOLDER!

The Crown 95 SFCK is flux cored with rosin which may decompose during heating to form about 5% turpentine. (TLV = 100ppm).

SPECIAL FIRE-FIGHTING PROCEDURES: Structural firefighters must wear Self-Contained Breathing Apparatus and full protective equipment. Chemical resistant clothing may be necessary. If possible, prevent run-off water from entering storm drains, bodies of water or other environmentally sensitive areas.

Section 5 - STABILITY AND REACTIVITY DATA

STABILITY: Stable

HAZARDOUS POLYMERIZATION: Will not occur.

CONDITIONS TO AVOID: Uncontrolled exposure to extreme temperatures and incompatible materials.

DECOMPOSITION PRODUCTS: Thermal decomposition products can include copper, zinc, phosphorous, silver, nickel compounds, a variety of metal oxides and oxides of carbon, boron, fluorine and potassium. The Crown 95 SFCK will decompose small amounts of turpentine. It may emit hydrogen chloride fumes (0.5% of flux) during soldering.

MATERIALS WITH WHICH THESE ALLOYS IS INCOMPATIBLE: Strong acids, strong oxidizers, acetylene, ammonium nitrate, sulfur, potassium, alkali carbonates, alkali hydroxides, glass (and other silica-based compounds), acid chlorides and some halogenated compounds and mercury.

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Section 5 - STABILITY AND REACTIVITY DATA (continued)

Hazardous Decomposition Products

Brazing/soldering fumes and gases can not be classified simply. The composition and quantity of both are dependent upon the metal being soldered/brazed and the rods used. Coatings on the metal being soldered/brazed (such as paint, plating, or galvanizing), the number of welders, the volume of the work area, the quality and the amount of ventilation, the position of the welder's head with respect to the gas plume, the presence of contaminants in the atmosphere (such as chlorinated hydrocarbon vapors from cleaning and degreasing activities), the process and procedures, as well as the soldering/brazing consumables.

When these soldering/brazing alloys are consumed, the fume and gas decomposition products generated are different in percent and form from the ingredients listed in Section 2. Decomposition products of normal operation include those originating from the volatilization, reaction, or oxidation of the materials shown in Section 2, plus those from the base metal, coatings, etc., as noted above. Gaseous reaction products may include carbon monoxide and carbon dioxide. Ozone and nitrogen oxides may be formed by the radiation from an arc, in addition to the shielding gases like argon and helium, whenever they are employed.

One recommended way to determine the composition and quantity of fumes and gases to which workers are exposed is to take an air sample inside the welder's helmet if worn or in the worker's breathing zone. See ANSI/AWS F1.1 "Method for Sampling Airborne Particles Generated by Welding and Allied Processes" and "Characterization of Arc Welding Fume" available from the American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

Reasonably expected decomposition products from normal use of these products include a **complex of the oxides of the materials listed in Section 2, as well as carbon monoxide, carbon dioxide, ozone (TLV 0.1 ppm ceiling and PEL 0.1 ppm), nitric oxide (TLV 25 ppm and PEL 25 ppm) and nitrogen dioxide (TLV 3, 5 ppm STEL and PEL 5 ppm ceiling). The fume limit for copper, silver, tin, nickel and/or zinc may be reached before the general limit for welding fumes (TLV 5 mg/m³) is reached.**

Section 6 - HEALTH HAZARD DATA

- **Medical conditions aggravated by exposure to this product:** Skin, respiratory, pancreas, kidney and liver disorders may be aggravated by prolonged *overexposure* to the dusts or fumes generated by these products.
- **EYES:** Contact with the rod form of these products can be physically damaging to the eye (i.e., foreign object). Fumes generated during brazing operations can be irritating to the eyes. Contact with the molten metal will burn the contaminated eyes. Eye contact with dusts or particulates generated by the flux coating on the flux coated products will cause irritation, pain, tearing and reddening. Brief contact may cause eye damage and prolonged contact may cause permanent damage.
- **SKIN:** Contact of the rod form of these products with the skin is not anticipated to be irritating. Rare cases of allergic contact dermatitis have been reported in people working with **copper dust**. Fumes generated during brazing operations can be irritating to the skin. Symptoms of skin *overexposure* may include irritation and redness. Prolonged or repeated skin *overexposure* may lead to allergic contact dermatitis. Depending on the duration of *overexposure*, skin contact with dusts or particulates generated by the **flux coating** on the flux coated products may cause irritation and burns. *Chronic overexposure* to dusts or particulates generated by the **flux coating** may cause borism (dry skin, eruptions and gastrointestinal disturbances) or pustular dermatitis (visible collections of pus). In some situations, one of the decomposition products of the flux coating may be **hydrogen fluoride**. **Hydrogen fluoride** can penetrate the skin and produce burns that may not be immediately painful or visible; the burns impact the lower layers of skin and bone tissue. **Hydrogen fluoride** exposures involving 20% of the body or more can be fatal through systemic fluoride poisoning. *Chronic* skin contact with **silver** can result in Argyria (this condition is marked by a blue-gray discoloration of the skin, mucous membranes and eyes). Contact with molten metal will burn contaminated skin. Skin absorption is not known to be a significant route of *overexposure* for any component of these products.
- **INGESTION:** Severe ingestion *overexposure* to **copper** may be fatal. If particulates or fumes, generated during brazing operations, are *ingested* (i.e., through poor hygiene practices), nausea, vomiting, diarrhea, stomach ache, degeneration of blood and liver cells, gastrointestinal bleeding, decreased urine output, listlessness, rapid heartbeat, convulsions, and coma may occur. If dusts or particulates generated by the flux coating are swallowed, they may burn the mouth, throat, esophagus and other tissues of the digestive system. *Chronic ingestion* of the **fluoride component** of the flux coating may cause osseous fluorosis (increased radiographic density of the bones). Symptoms of *chronic ingestion* of dusts or particulates generated by the flux coating may include kidney damage, asthma, and pain in the joints and muscles. *Severe ingestion overexposure* may be fatal.
- **INHALATION:** During brazing and soldering operations, the most significant route of overexposure is via inhalation of fumes. Some of the health effects are listed below:
 - **SHORT TERM (ACUTE):** Inhalation of large amounts of particulates generated by the rods during metal processing operations may be physically irritating and cause deposits of dust in nasal passages. Inhalation of dusts of **silver** (a constituent of these products) can cause discoloration of eyes, nasal septum, throat and skin. Inhalation of dusts and fumes of **copper** and **zinc** can cause metal fume fever. Typically metal fume fever begins four to twelve hours after sufficient exposure to freshly formed fumes. Symptoms can include a metallic or sweet taste in the mouth, sweating, shivering, headache, throat irritation, fever, chills, thirstiness, muscle aches, nausea, vomiting, weakness, fatigue and shortness of breath. The syndrome usually runs its course in 24-48 hours. Hypersensitivity to **nickel** is common, and can cause pulmonary asthma and pneumonitis.
 - **LONG TERM (CHRONIC):** Repeated *overexposure* to the dusts or fumes generated by these products during brazing operations may have adverse effects on the lungs with possible pulmonary edema and emphysema (life threatening lung injuries). Chronic overexposure to **copper** dust may cause tiredness, stuffiness, diarrhea, vomiting and kidney and liver disorders. The U.S. National Toxicology Program has listed **nickel** and seven **nickel compounds** as reasonably anticipated to be a carcinogen based on the production of injection-site tumors in experimental animals. **Nickel compounds** are listed as carcinogenic to humans by the IARC.

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Section 7 - PRECAUTIONS FOR SAFE HANDLING & USE/APPLICABLE CONTROL MEASURES

VENTILATION AND ENGINEERING CONTROLS: Maintain exposures below the acceptable exposure levels (see Section 2). Use industrial hygiene air monitoring to ensure that your use of these products does not create exposures that exceed the recommended exposure limits. Always use exhaust ventilation in user operations such as high temperature cutting, grinding, welding, brazing and soldering. Train the welder to keep his head out of the fume plume. Confined spaces require adequate ventilation and/or air supplied respirators. Read and understand the manufacturer's instructions and the precautionary label on the product. See American National Standard Z49.1, *Safety in Welding, Cutting, and Allied Processes*, published by the American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126 and OSHA Publication 2206 (29CFR1910), US Government Printing Office, Washington, D.C. 20402 for more details on many of the following.

RESPIRATORY PROTECTION: Use respirable fume respirator or air supplied respirator when welding in confined space or where local exhaust or ventilation does not keep exposure below TLV's (see Section 2). Use only NIOSH approved respirators in accordance with 29 CFR 1910.134 – Respiratory Protection. Oxygen levels below 19.5% are considered IDLH by OSHA. In such atmospheres, use of a full-facepiece pressure/demand SCBA or a full facepiece, supplied air respirator with auxiliary self-contained air supply is required under OSHA's Respiratory Protection Standard (1910.134-1998).

NIOSH respiratory protection recommendations for copper dusts and mists (as Cu) concentrations in air:

CONCENTRATION

Up to 5 mg/m³
 Up to 10mg/m³

Up to 25 mg/m³
 Up to 50mg/m³

Up to 100 mg/m³
 Emergency or Planned Entry into Unknown
 Concentrations or IDLH Conditions:

Escape:

RESPIRATORY EQUIPMENT

Dust and mist respirator
 Dust and mist respirator except single-use and quarter-mask respirator (if not present as a fume); or a Supplied Air Respirator (SAR).
 Powered air-purifying respirator with dust and mist filter; or SAR operated in a continuous-flow mode.
 Full-facepiece respirator with high-efficiency particulate filter; or full-facepiece Self-Contained Breathing Apparatus (SCBA); or full-facepiece SAR; or powered air-purifying respirator with tightfitting facepiece and high-efficiency particulate filter.
 Positive pressure, full facepiece SAR.

Positive pressure, full-facepiece SCBA; or positive pressure, full-facepiece SAR with an auxiliary positive pressure SCBA.

Full-facepiece respirator with high-efficiency particulate filter(s); or escape-type SCBA.

NIOSH/OSHA respiratory protection recommendations for silver (metal dust and soluble compounds, as silver) concentrations in air:

Up to 0.25 mg/m³

Up to 0.5 mg/m³

Up to 10 mg/m³
 Emergency or Planned Entry into Unknown
 Concentrations or IDLH Conditions:

Escape:

Supplied Air Respirator (SAR) operated in a continuous-flow mode or powered air-purifying respirator with high-efficiency particulate filter.

Full-facepiece respirator with high-efficiency particulate filter(s), full-facepiece (SCBA), or full-facepiece SAR.

Positive pressure, full-facepiece SAR.

Positive pressure, full-facepiece SCBA or positive pressure, full-facepiece SAR with an auxiliary positive pressure SCBA.

Full-facepiece respirator with high-efficiency particulate filter(s) or escape-type SCBA.

NIOSH/OSHA respiratory protection recommendations for zinc oxide concentrations in air:

Up to 50 mg/m³
 Up to 125 mg/m³

Up to 250 mg/m³

Up to 500 mg/m³
 Emergency or Planned Entry into Unknown
 Concentrations or IDLH Conditions:

Escape:

Dust, mist and fume respirator or SAR.

Powered air-purifying respirators with dust, mist and fume filter(s) or SAR operated in a continuous flow mode.

Full-facepiece air-purifying respirator with high-efficiency particulate filter(s), powered air-purifying respirator with tight fitting facepiece and high efficiency particulate filter(s), SAR with a tight-fitting facepiece operated in a continuous flow mode, full-facepiece SCBA, or full-facepiece SAR.

Positive pressure SAR.

Positive pressure, full-facepiece SCBA or positive pressure, full-facepiece SAR with an auxiliary positive pressure SCBA.

Full-facepiece air-purifying respirator with high-efficiency particulate filter(s) or escape-type SCBA.

FOR MAXIMUM SAFETY, BE CERTIFIED FOR AND WEAR A RESPIRATOR AT ALL TIMES WHEN WELDING OR BRAZING!

EYE PROTECTION: Ensure eyewash/safety shower stations are available near areas where these products are used. Wear safety glasses, goggles or face-shield with filter lens of appropriate shade number (per ANSI Z49.1-1988, "Safety in Welding and Cutting").

PROTECTIVE CLOTHING: Wear head, hand, and body protection which help to prevent injury from radiation, sparks, and electrical shock. See ANSI Z49.1. As a minimum this includes welder's gloves, protective face shield, dark substantial clothing, and may include arm protectors, aprons, hats, and shoulder protection.

WORK PRACTICES AND HYGIENE PRACTICES: As with all chemicals, avoid getting these products ON YOU or IN YOU. Wash hands after handling these products. Do not eat or drink while handling these products. Do not smoke or apply cosmetics in areas where exposures exist.

WASTE DISPOSAL METHOD: Prevent waste from contaminating surrounding environment. Discard any product, residue, disposable container or liner in an environmentally acceptable manner, in full compliance with federal, state and local regulations. However, alloy wastes are normally collected to recover metal values.

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Section 8 - FIRST AID MEASURES

- **EYE EXPOSURE:** Flush eyes with plenty of water or saline for at least 15 minutes. Consult a physician.
- **SKIN EXPOSURE:** Wash thoroughly with soap and water. Consult a physician if irritation persists.
- **INHALATION EXPOSURE:** Remove to fresh air. Check for clear airway, breathing and presence of pulse. Provide CPR for persons without pulse or respirations. Consult a physician immediately.
- **INGESTION EXPOSURE:** Ingestion is not a likely route of exposure for these rods. If the flux is swallowed, CALL PHYSICIAN OR POISON CONTROL CENTER FOR MOST CURRENT INFORMATION. DO NOT INDUCE VOMITING, unless directed by medical personnel. Have victim rinse mouth with water, if conscious. Never induce vomiting or give diluents (milk or water) to someone who is unconscious, having convulsions, or unable to swallow.
- **RECOMMENDATIONS TO PHYSICIANS:** Treat symptoms and eliminate overexposure.

Section 9 - TOXICOLOGICAL INFORMATION

TOXICITY DATA: Presented below are human toxicological data available for the components of these products present in concentration greater than 1%. Other data for animals are available for the components of these products, but are not presented in this MSDS.

ACRYLIC RESIN: LD ₅₀ (oral, rat) = 8532 mg/kg COPPER: TDLo (oral, human) = 120 µg/kg - gastrointestinal tract effects	NICKEL OXIDE: LD ₅₀ (subcutaneous, mouse) = 50 mg/kg PHOSPHOROUS: LDLo (unreported, man) = 4412µg/kg SILVER: TCLo (inhalation, human) = 1 mg/m ³ ; skin effects	ZINC: SkinIrritancy (human)=300µg/3days intermittent; mild TCLo(inhalation,human)=124mg/m ³ 50 minutes; pulmonary system, skin effects
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- **SUSPECTED CANCER AGENT:** Components of these products are listed as follows:
 - **Copper:** EPA-D (Not Classifiable as to Human Carcinogenicity)
 - **Nickel, Elemental Metal:** IARC-2B (Possibly Carcinogenic to Humans), MAK-1 (Substances which Cause Cancer in Man), NIOSH-X (Carcinogen Defined with no Further Categorization), NTP-R (Reasonably Anticipated to be a Human Carcinogen), ACGIH TLV-A5 (Not Suspected as a Human Carcinogen)
 - **Phosphorus:** EPA-D (Not Classifiable as to Human Carcinogenicity)
 - **Silver:** EPA-D (Not Classifiable as to Human Carcinogenicity)
 - **Zinc:** EPA-D (Not Classifiable as to Human Carcinogenicity – inadequate human and animal evidence of carcinogenicity or no data available.
- The other components of these products are not found on the following lists: FEDERAL, OSHA Z LIST, NTP, IARC and CAL/OSHA and therefore are neither considered to be nor suspected to be cancer-causing agents by these agencies.

Section 10 – REGULATORY INFORMATION

U.S. SARA REPORTING REQUIREMENTS: The components of these products are subject to the reporting requirements of Sections 302, 304 and 313 of Title III of the Superfund Amendments and Reauthorization Act, as follows:

CHEMICAL NAME	SARA 302 (40 CFR 355 Appendix A)	SARA 304 (40 CFR Table 302.4)	SARA 313 (40 CFR 372.65)
Copper	No	Yes	Yes
Nickel	No	Yes	Yes (fume or dust)
Phosphorous	Yes	Yes	Yes (yellow or white)
Silver	No	Yes	Yes
Zinc	No	Yes	Yes (fume or dust)

U.S. SARA THRESHOLD PLANNING QUANTITY: There are no specific Threshold Planning Quantities for the components of these products. The default Federal MSDS submission and inventory requirement filing threshold of 10,000 lbs (4,540 kg) therefore applies, per 40 CFR 370.20.

CALIFORNIA PROPOSITION 65: WARNING: This product contains or produces a chemical known to the State of California to cause cancer and birth defects (or other reproductive harm). (California Health & Safety Code 25249.5 et seq.)

Section 11 – DEFINITIONS OF TERMS

CAS No. - Chemical Abstracts Service Number PEL - Permissible Exposure Level TLV - Threshold Limit Value
 TWA - Time Weighted Average STEL - Short Term Exposure Limit IARC – International Agency for Research on Cancer
 NIOSH – National Institute of Occupational Safety and Health OSHA – U.S. Occupational Safety and Health Administration
 TDLo – the lowest dose to cause a symptom TCLo – the lowest concentration to cause a symptom
 TDo, LDLo, and LDo, or TC, TCo, LCLo, and LCo – the lowest dose (or concentration) to cause lethal or toxic effects.
 SARA – Superfund Amendments and Reauthorization Act ACGIH – American Conference of Governmental Industrial Hygienists
 LD₅₀ & LC₅₀ – These values are the amount of a substance given to the stated species that causes 50% of that species to die.

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