Section 1 Product and Company Identification

(1.1)

Product Identifiers - Substance name: **Molybdenum Disulfide**

Chemical formula: MoS_2

Synonyms/trade names: "Molybdenum disulphide lube grade"; “Molysulfide®* ”; "DAG 325"; "Molybdenum (IV) sulfide lube grade"; “Molykote”; "Mopol M"; "Mopol S"; "Molybdic sulfide"; “Molybdenite”; “Tech.”; “Tech fines”; “Super fine”

Index No. (Regulation (EC) No 1272/2008): None, because not classified.

CAS Numbers: 1317-33-5

EC No.: EC # 215-263-9 [43]

REACH Registration number: Concentrate exemption as per Annex V.

(1.2)

Product Use: Manufacturing of heat resistant lubricants in greases, oil dispersions, resin bonded films, dry powders; hydrogenation catalyst, anti-seize compounds.

(1.3)

Sales restricted to commercial users only.

(1.4)

Company/supplier:
Climax Molybdenum Company
333 North Central Avenue
Phoenix, Arizona 85004, USA

(1.5)

Emergency Information:

Contact:	+01-602-366-8100 (Days only)
CHEMTREC:	+01-800-424-9300 (USA) +01-703-527-3887 (worldwide)
FAX:	+01-602-366-7309
E-mail:	robert_stepp@fmi.com

Distributed By: Huron Industries, Inc.
2301 16th Street
Port Huron, MI 48060, USA

Contact:	810-984-4213
Infotrac:	800-535-5053 (Huron 89770)
FAX:	810-987-4199
E-mail:	neolube@comcast.net

(1.5.1)

Poison Center’s - If in Netherlands: National Poison Information center, University Medical Centre, Utrecht – Postbus 85500

Contact #: (P) +31 88 755 85 61; (F) +31 30 254 15 11; (Em) +31 30 274 88 88; nvic@umcutrecht.nl; www.vergiftigingen.info **(24 hours)** **(**Note – Not available to public, source WHO.)

Poison Centers provide acute toxicity information and do not provide emergency HazMat, over the road, or hazardous environmental information, please call Chemtrec for all information.

(1.5.2)

If in another country, other than the Netherlands: See the WHO web site - http://www.who.int/gho/phe/chemical_safety/poisons_centres/en/index.html

Section 2 Hazards Identification

(2.1)

EU Regulation (EC) No. 1272/2008 [CLP]

(2.1.1)

Classification according to Regulation (EC) No. 1272/2008 (CLP): Not classified. Local codes may apply.

Note – UN GHS CLP: Category 5, Acute Toxicity/No Symbol (note, no category 5 under EU CLP)

(2.1.2)

Classification according to Directive 67/548/EEC: Not classified. Local codes may apply.

(2.2)

Label elements

(2.2.1)

Labelling according to Regulation (EC) No. 1272/2008 (CLP): Molybdenum disulfide is not classified in the CLP regulation and must be self-classified. Local codes may apply.

Pictogram(s):	UN GHS CLP – None	/ EU CLP - None
Signal Word:	UN GHS CLP – Warning	/ EU CLP - None
Hazard Statement(s):	UN GHS CLP – Maybe harmful if swallowed	/ EU CLP – None

Precautionary Statements

Prevention:	**None**	
Response:	**P312**	Call a POISON CENTER or doctor if you feel unwell.
Storage:	**None**	
Disposal:	**None**	

(2.2.2)
Labelling according to Directive 67/548/EEC: Moly disulfide concentrate is not classified in the CLP regulations and must be self- classified. Local codes may apply.

(2.2.2.1)
Risk phrase(s): **None**

(2.2.2.2)
Safety phrase(s): **S 22** Do not breathe dust.
S 46 If swallowed, immediately contact a doctor and show this container or label.

Prevention: Use personal protective equipment as required. Wear respiratory protection. See your supervisor.
Response: If overly exposed or concerned, get medical advice/attention. Immediately call a poison center or doctor/physician. Wash contaminated clothing before reuse.
Storage: Keep container tightly closed.

(2.3)
Other hazards: The substance does not meet the criteria for a PBT or vPvB substance. No environmental, toxicological, or physico-chemical hazards identified.

Section 3 Composition / Information on Ingredients

(3.1)

Component	/ CAS No.	/ EU No.	/ Index No.	Percentage
Molybdenum disulfide (MoS_2)	/1317-33-5	/ 215-263-9	/ Not Classified in CLP	> 99% *

***Note** - Remainder is made up of multiple trace contaminants that are less than 0.1 % each and do not contribute to the classification of the product.

Section 4 First-Aid Measures

Note: The following generic first aid measures should be applied as usual when handling any chemical substance. See Section 8 for normal routine handling.

(4.1)
Description of first aid measures

(4.1.1)
General Advice: First-aid responders should wear suitable personal protective equipment in case of insufficient ventilation or possible inhalation or eye contact.

(4.1.2)
Following Inhalation: If excessive dust is inhaled, exit the contaminated area. Encourage patient to blow nose to ensure a clear breathing passage. Delayed effects; if irritation or discomfort persists seek medical attention.

(4.1.3)
Following skin contact: If excessive skin contact occurs, remove all contaminated clothing, include footwear if necessary. Flush skin and hair with running water (use soap if available). Delayed effects; seek medical attention in event of skin irritation.

(4.1.4)
Following eye contact: Check for and remove any contact lenses. (Note - Removal of contact lenses after an eye injury should only be undertaken by skilled personnel). Otherwise, immediately flush eyes with plenty of water, occasionally lifting upper and lower eyelids, for several minutes. Delayed effect; if pain or irritation persists or recurs seek medical attention.

(4.1.5)
After ingestion: If swallowed do not induce vomiting. If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain open airway and prevent aspiration of vomit into the lungs. Observe the patient carefully. Never give liquid to a person showing signs of being sleepy or with reduced awareness; i.e. becoming unconscious. Give victim water to rinse out mouth, and then provide liquid slowly and as much as can comfortably drink. Seek medical advice.

(4.2)
Most important symptoms and effects, both acute and delayed: Acute or delayed effects are not anticipated for Molysulfide®.

(4.3)
Indication of any immediate medical attention and special treatment needed: No specific treatment expected to be required.

Section 5 Fire Fighting Measures

Note: Molysulfide® will oxidize (burn) at high temperatures. Under standard conditions of temperature and pressure, molybdenum disulfide is slight fire hazard when exposed to heat or flame. **Data from Super Fine testing** completed in 2004 is as follows:

Minimum ignition temperature (5 mm layer)	380^oC
Minimum ignition energy (dust cloud)	>1000 mJ
Minimum ignition temperature (dust cloud)	>1000^oC
Minimum explosive concentration (dust cloud)	125 – 150 g/m^3 (K_s value = 1)

(5.1)
Extinguishing media

(5.1.1)
Suitable extinguishing media: Standard extinguishing media such as water, sand, foam. Use firefighting measures that suit the location and surroundings.

(5.1.2)
Unsuitable extinguishing media: None. Use firefighting measures that suit the location and surroundings.

(5.2)
Special hazards arising from the substance or mixture: Decomposes on heating and produces toxic fumes of sulfur oxides (SO_2) and molybdenum trioxide. Molysulfide® will react violently with hydrogen peroxide. Avoid reaction with hydrogen peroxide, potassium nitrate, and stray oxidizers.

(5.3)
Advice for fire fighters: No acute hazard. Move container from fire area if possible. Avoid breathing vapors or dusts; keep upwind. Use full firefighting turnout gear (bunker gear). Any supplied-air respirator with full face piece and operated in a pressure-demand or other positive-pressure mode in combination with a separate escape air supply. Use any self-contained breathing apparatus with a full face-piece.

Alert fire brigade and indicate hazard location. Wear breathing apparatus plus protective clothing. Cool fire exposed containers with water spray from a protected location. Do not approach containers suspected to be hot. If safe to do so, remove containers from path of fire.

Section 6 Accidental Release Measures

Note: The following generic accidental release measures should be applied as usual when handling any chemical substance. Personal protective equipment advice is contained in Section 8 of the SDS.

(6.1)
Personal precautions, protective equipment and emergency procedures

(6.1.1)
For non-emergency personnel: Avoid dust cloud formation and inhaled dust. Seek to ensure ventilation that maintains airborne concentrations below Occupational Exposure Limits (OELs). Keep unprotected persons away. Although the substance has no or very low acute toxicity hazard, it is advised to avoid contact with skin, eyes, and clothing; wear suitable protective equipment.

(6.1.2)
For emergency responders: Avoid dust cloud formation and dust inhalation. Seek to ensure ventilation that maintains airborne concentrations below OELs. Keep unprotected persons away. Although the substance has no or very low acute toxicity, it is advised to avoid contact with skin, eyes, and clothing – wear suitable protective equipment.

(6.2)
Environmental precautions: Although the substance is not classified as dangerous to the environment, it is advised that in the event of an accidental release the product should be prevented from reaching the sewage system or any water course, and from penetrating the ground/soil. Secure area around spill to prevent material from being tracked into other plant areas. Dispose of spilled material in accordance with the relevant local regulations or codes. See Section 13 for disposal considerations.

(6.3)
Methods and material for containment and cleaning up: Avoid formation and inhalation of dust. Use an appropriate industrial vacuum cleaner, equipped with ULPA or HEPA filters. Collect spilled material in suitable containers or bags for recovery or disposal. In the case of disposal, spilled material or contaminated material should be disposed of as waste as described in Section 13.

(6.4)
Reference to other sections: For more information on exposure controls/personal protection or disposal considerations, check Sections 8 and 13 of this Data Sheet.

Other: As far as we know, the recommended OELs incorporate a large margin of safety in normal handling and storage. Control work areas to below the recommended OEL.

Section 7 Handling and Storage

Note: As far as we know, the recommended OELs incorporate a large margin of safety in normal handling and storage. Control work areas to below the recommended OEL.

(7.1)
Precautions for safe handling

(7.1.1)
Protective measures: Avoid formation of dust cloud, inhalation, and ingestion. General occupational hygiene practice should always be followed (see 7.1.2 below)**...**

(7.1.2)
Advice on general occupational hygiene: Avoid formation of airborne dust, inhalation, and ingestion. General occupational hygiene measures are required to ensure safe handling of this substance. These measures involve good personal and housekeeping practices (i.e. regular cleaning with suitable cleaning devices), no eating, drinking and smoking at the workplace and wearing standard working clothes and shoes unless otherwise stated. Wash hands after contact with the powder or fume. Remove contaminated clothing and protective equipment before entering eating areas. Use showers and change clothes at end of workshift. Do not wear contaminated clothing home. Work clothes should be laundered separately and not at home. Do not blow dust off with compressed air. Avoid contact with skin and eyes. Avoid contact with incompatible materials (see section 10). Use in a well-ventilated area. Avoid physical damage to containers. Keep containers securely sealed when not in use.

(7.2)
Conditions for safe storage, including any incompatibilities: Store in closed container in a dry area. Do not store in open, inadequate, or miss-labelled packaging. Check that containers are clearly labeled. Use metal cans, metal drums, or fiber containers. Product has indefinite shelf life, refer to technical data sheets.

(7.3)
Specific end use(s): See the identified uses in Section 1.2 of this data sheet.

Section 8 Exposure Controls / Personal Protection

(8.1)
Control parameters:

(8.1.1)
US OSHA PEL control parameter for insoluble Molybdenum compounds is an 8-hour TWA of 15.0 mg/m^3. This is only one of many country control limits that are in use worldwide for insoluble molybdenum compounds but not the most restrictive. It is recommended that you consider as a control measure the OEL used in your locality. Additional country and agency control limits are listed in Section 16.7.2 - Other Information. The appropriate collection method is also country OEL related and you must follow the local country's protocols on collection and analysis which change from time to time and may not be codified.

(8.1.2)
PNECs and DNELs: Currently metal alloys and concentrates are materials not requiring PNECs or DNELs**.** Use established OEL limits for nuisance dust or total respirable dust depending on local codes.

(8.2)
Exposure controls: In some circumstances, high airborne dust concentrations may require local or general ventilation to control worker exposure. Where natural or mechanical ventilation is unable to control the workplace dust levels to below the OEL, than respirator controls must be used. Exposure controls specific

to this substance may not be required other than good hygiene practice and adherence to national and regional provisions with regards to exposure to dusts in the workplace. National, regional, or local provisions or limit values may also apply for emissions to air or water. The generic advice on accidental release measures or handling and storage is given in sections 6 and 7 and should be followed to minimize release/exposure.

(8.2.1)

Engineering Controls: Provide local exhaust ventilation as needed to stay below the OEL. If engineering controls fail to control and risk of overexposure still exists to excessive dust or fume, and then wear a properly fitted approved respirator.

(8.2.2)

PPG/PPE protection and selection

(8.2.2.1)

Eye and Face: Use safety glasses with side shields; or as required, chemical goggles. Contact lenses may pose a special hazard (5); soft contact lenses may concentrate irritants. A written policy document, describing the wearing of contact lenses or restrictions on use, should be created for each workplace or task. This should include a review of lens absorption and adsorption for the class of chemicals in use and pass injury experience. Medical and first-aid personnel should be trained in their removal and suitable equipment should be readily available. In the event of chemical exposure, begin eye irrigation immediately and remove contact lens as soon as practicable. Lenses should be removed at the first signs of eye redness or irritation - lenses should be removed in a clean environment only after workers have washed hands thoroughly. Where there is a high potential for eye contact, an eyewash station/unit should be readily available within a 10-second walk. To avoid eye and face contact, use a full-face shield (20 cm, 8 in minimum) but never use as primary eye protection. Alternatively, a full-face respirator may replace both eye glasses and face shields. (4)

(8.2.2.2)

Skin, Hand and Feet: Material may cause slight skin irritation over a prolonged time. Wear ordinary cloth, leatherwork, latex, PVC or laminate gloves with proper material weight or thickness that is suitable for each task type. Use at a minimum 1.0 mm thickness for glove material. For foot, use good quality safety shoes or boots approved by local code.

Other: Use overalls with cloth apron for light duty. Use a disposable protective suit if there is a high potential for skin contact.

(8.2.2.3)

Respirator: If dust generation is excessive, use an appropriate dust-filtering respirator that is properly fit tested to the user. [56]

Respirator Protection factor up to 150 mg/m^3:

(APF = 25) Any supplied-air respirator operated in a continuous-flow mode.
(APF = 25) Any powered, air-purifying respirator with high-efficiency particulate filter.
(APF = 50) Any respirator with a full-face piece and N100, R100, or P100 filters.
(APF = 50) Any air-purifying, full-face piece respirator (gas mask) with a chin- style, front- or back mounted canister having an N100, R100, or P100 filter.
(APF = 50) Any self-contained breathing apparatus with a full-face piece.
(APF = 50) Any supplied-air respirator with a full-face piece

Emergency or planned entry into unknown concentrations or IDLH conditions:

(APF = 10,000) Any self-contained breathing apparatus that has a full-face piece and is operated in a pressure-demand or other positive-pressure mode.
(APF = 10,000) Any supplied-air respirator that has a full-face piece and is operated in a pressure demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus.

Escape:

(APF = 50) Any air-purifying, full-face piece respirator (gas mask) with a chin-style, front- or back mounted canister having an N100, R100, or P100 filter. Any appropriate escape-type, self-contained breathing apparatus.

Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres; use a supplied air respirator if oxygen-deficient.

(8.2.2.4)

Thermal Hazards: None

Section 9 Physical and Chemical Properties

(9.1)

Information about basic physical and chemical properties

(9.2)

State: Powder

(9.3)

(a) Appearance	Gray to Black powder
(b) Odor	Odorless.
(c) Odor threshold	Not applicable as odorless.
(d) pH	Not applicable.
(e) Melting point	1185^{o}C
(f) Initial boiling point and boiling range	Not applicable
(g) Flash point	Not applicable as only relevant for liquids or low melting point solids.
(h) Evaporation rate	Not Applicable
(i)) Flammability (solid, gas)	Not flammable.
(j) Upper/lower flammability or explosive limits	Not explosive.
(k)) Vapor pressure	0.0 kPa @ 20 ^{o}C [45]
(l)) Vapor density	Not applicable
(m) Relative density	4.80 to 5 g/cm^3 @ 14 ^{o}C [45] (natural Molybdenite) or 4.96 +/- 0.03 (re-purified MoS_2)
(n) Solubility(ies)	Immiscible, 0 mg/L @ 20 ^{o}C [45]
(o) Partition coefficient n-octanol/water	Not applicable for inorganic substances.
(p) Auto-ignition temperature	Not applicable
(q) Decomposition temperature	>599^{o}F / >315^{o}C – Begins oxidization to MoO_3
(r)) Viscosity	Not applicable (solid).
(s)) Explosive properties	Minimum explosive concentration (dust cloud) 125 – 150 g/m^3 (K_{st} value = 1) for processed Superfine.
(t) Oxidizing properties	None

(9.3.1)

Other information - General Properties: Does not mix with water. Sinks in water.

Molecular Weight:	160.07
Relative Vapor Density (air=1):	Not applicable
Volatile Component (%vol):	Not applicable
Auto-ignition Temp (^{O}C):	Not available
Auto Flammability (^{o}C):	ca. 290 (layer) and 570 (cloud) (15)

Data from Super Fine testing (2004 internal report)

Minimum ignition temperature (5 mm layer)	380^{o}C
Minimum ignition energy (dust cloud)	>1000 mJ
Minimum ignition temperature (dust cloud)	>1000^{o}C

Section 10 Stability and Reactivity

(10.1)

Reactivity: Stable under ambient temperatures and pressures.

(10.2)

Chemical stability: Stable under ambient temperatures and pressures.

(10.3)

Possibility of hazardous reactions: According to "Bretherick's Handbook" [40] molybdates react violently or explosively when reduced to molybdenum by heating with zirconium. Other hazardous reactions have not been identified. Otherwise, will not react or polymerize.

(10.4)
Conditions to avoid: No specific conditions to avoid have been identified.

(10.5)
Incompatible materials: Hydrogen peroxide, potassium nitrate and most oxidizers. Violent reaction with H_2O_2 (8). Hazardous polymerization will not occur.

(10.6)
Hazardous decomposition products: Upon thermal decomposition may product hazardous Molybdenum trioxide fumes and SO_2 gas when burned.

Section 11 Toxicological Information

(11.1)
Information on toxicological effects: The information provided in this section is consistent with type of information provided in the other molybdenum compound REACH Chemical Safety Reports. For contact details, please refer to Section 16 of this data sheet.

Toxicity endpoints	Description of effects
Toxicokinetics: Absorption, Distribution, Metabolism and Excretion	Molybdenum is an essential element. Up taken Molysulfide® is relatively inert, any dissolved Molysulfide® exists predominantly in the form of the molybdate ion (MoO_4^{2-}). **Oral absorption**: Slow absorption through GI tract. **Inhalation absorption:** Absorption in humans dependent on particle size, deposition/clearance. **Dermal absorption:** Low to negligible. **Metabolism:** No metabolism. Up taken Molysulfide® is relatedly inert, any dissolved Molysulfide® exists predominantly in the form of the molybdate ion (MoO_4^{2-}). **Excretion:** Rapidly eliminated from plasma predominantly via renal excretion (>80%), and faeces (<10%).
(a) acute toxicity	No specific data available. Insoluble molybdenum compounds are characterized by low toxicity. LD_{50} (rat) > 5000 mg/kg
(b) skin corrosion/irritation	Not irritating / not corrosive to the skin. LD_{50} (rat) > 16000 mg/kg
(c) serious eye damage/irritation	Not irritant / not corrosive to the eyes.
(d) respiratory or skin sensitization	Molysulfide® is not sensitizing to the skin.
(e) germ-cell mutagenicity	Not a germ cell mutagen.
(f) carcinogenicity	Not a carcinogen.
(g) reproductive toxicity	There are currently no reliable scientific data available indicating adverse effects on reproduction or fertility.
(h) STOT-single exposure	There are no specific target organ effects after single exposure to diammonium dimolybdate.
(i) STOT-repeated exposure	No reliable scientific data available indicating adverse systemic effects after repeated exposure to molybdenum substances.
(j) aspiration hazard	Not applicable (not an aerosol/mist).

(11.2)
Other information

Molybdenum is an essential trace element required in nitrogen metabolism in the human body. It enhances cell function and is a component in the metabolic process. It is distributed throughout the body, with the greatest concentration in the liver, where it functions as a facilitator for liver detoxification. It is vital for the function and formation of several (at least 3) enzymes in the body, one of which regulates urinary excretion. Molybdenum contributes to the enzymes, which neutralize excess toxic compounds of sulfur in the body; assisting in the production of hemoglobin; and preventing dental caries. It may help to eliminate or neutralize carcinogenic nitrogen compounds, and may play a role in male sexual function. It has been researched for its role in cancer prevention. It also has been associated with a decrease in dental cavities.

Studies report that there is a 30 percent increase in cancer of the esophagus in areas of the United States where there is no molybdenum in the drinking water and in areas where food is grown in molybdenum-poor soils. Low molybdenum intake has been attributed to the high incidence of esophageal cancer in South Africa among the Bantu of Transkei and in Russia but maybe related to a lack of molybdenum in the soil used for farming. Another study of soft and hard drinking water in Taiwan indicated an increase risk of esophageal cancer when drinking soft water. [41] Molybdenum is best known for its role in eradicating esophageal cancer that was prevalent in the Lin Xian region of China for almost 2,000 years [40]. Once the soil was fortified with molybdenum and vitamin C was made available to the population, the occurrence of esophageal cancer has declined dramatically.

Some studies indicate an increased incidence of non-specific symptoms which including headache, weakness, fatigue, anorexia and joint and muscle weakness has been reported to occur in mining and metallurgy workers exposed to 60-600 mg (as Mo). In addition, investigators have attributed gout and elevated uric acid concentration found in some Armenians to result from exposures to Armenian soils rich in molybdenum, and exposure has been implicated as a cause of bone disease amongst Indians. However, US National Research Council believes these reports as being highly speculative. As far as it is known, the recommended OELs incorporate a large margin of safety against potential pulmonary or systemic effects.

The use of vitamin supplements may provide the molybdenum needed to prevent cancer since molybdenum has anti-carcinogenic (anti-cancer) properties in regard to breast cancer in animals, esophageal cancer and stomach cancer in humans, which may be due to the copper-inhibiting effect of molybdenum, or possibility by molybdenum protecting the body from nitrosamine formation as a result of consuming foods high in nitrates or nitrites [46] .Look for molybdenum compounds on vitamin labels.

Section 12 Ecological Information

Note: Data in this section is voluntarily in the U.S.A. but may be required in the EU and/or other countries.

(12.1)

Toxicity

(12.1.1)

Reliable acute aquatic toxicity test results: (read-across from tests with sodium molybdate)

Test Organisms:	End-point	Range of values	References
Freshwater fish: *Pimephales promelas*	96h-LC_{50}	609 – 681.4 mg Mo/L (1,078-1,207 mg $(NH_4)_2Mo_2O_7$/L)	[1]
Freshwater fish: *Oncorhynchus mykiss*	96h-LC_{50}	7600 mg Mo/L	[2]
Freshwater fish: *Oncorhynchus mykiss*	96h-LC_{50}	781 – 1339 mg Mo/L (recalculated – logistic fit)	[3]
Invertebrates: *Daphnia magna*	48h-LC_{50}	1680.4 – 1776.6 mg Mo/L	[1]
Invertebrates: *Daphnia magna*	48h-LC_{50}	2729.4 mg Mo/L	[4]
Invertebrates: *Daphnia magna*	48h-LC_{50}	2847.5 mg Mo/L	[5]
Invertebrates: *Daphnia magna*	48h-LC_{50}	130.9 mg Mo/L (231.9 mg $(NH_4)_2Mo_2O_7$/L)	[6]
Invertebrates: *Ceriodaphnia dubia*	48h-LC_{50}	1005.5 – 1024.6 mg Mo/L	[1]

Invertebrate (aq. worm): *Girardia dorotocephala*	96h-LC$_{50}$	1226 mg Mo/L	[1]
Algae: *Pseudokirchneriella subcapitata*	72h-ErC$_{50}$ (growth rate)	295.0 – 390.9 mg Mo/L 289.2 – 369.6 mg Mo/L Geom. mean: 333.1 mg Mo/L (590 mg $(NH_4)_2Mo_2O_7$/L)	[7] [8]

Tests were conducted according to international test guidelines (e.g., OECD) or scientifically acceptable methods.

(12.1.2)
Reliable chronic toxicity test results: (read-across from tests with sodium molybdate):

Test organisms	**Range of values** (EC$_{10}$ or NOEC)	**References**
Aquatic freshwater toxicity data		
Oncorhynchus mykiss, Pimephales promelas, Pseudokirchneriella subcapitata, Ceriodaphnia dubia, Daphnia magna, Chironomus riparius, Brachionus calyciflorus, Lymnaea stagnalis, Xenopus laevis, Lemna minor	43.3–241.5 mg Mo/L	[1], [4], [7], [8], [9], [10], [11]
Most sensitive species were the fish *O. mykiss* (43.3 mg Mo/L) and *P. promelas* (60.2 mg Mo/L). Symptoms of toxicity were effects on biomass growth, reproduction, (population) growth rate and malformation during development.		
Aquatic marine toxicity data		
Mytilus edulis, Acartia tonsa, Phaeodactylus tricornutum, Cyprinodon variegatus, Americamysis bahia, Crassostrea gigas, Dendraster excentricus, Dunaliella tertiolecta, Ceramium tenuicorne, Strongylocentrotus purpuratus,	4.4–1,174 mg Mo/L	[12], [13], [14], [15], [16], [17], [18], [19]
Most sensitive species were the mussel *M. edulis* (4.4 mg Mo/L) and the copepod *A. tonsa* (7.96 mg Mo/L). Symptoms of toxicity include effects on biomass growth, growth rate, reproduction and malformation during development		
Chronic sediment toxicity		
No reliable acute/chronic sediment data for molybdenum available. PNEC derivation was based on the equilibrium partitioning method, taking into account the PNEC$_{freshwater}$ and the sediment K$_d$ given in section 12.4.		
Chronic terrestrial toxicity test results (values were determined in different topsoils with contrasting properties and spiked with sodium molybdate):		
Annelid worms: *Enchytraeus crypticus, Eisenia Andrei*	7.88 -1661 mg Mo/kg dw (n=11)	[20]
Arthropod: *Folsomia candida*	37.9 – >3,395 mg Mo/kg dw	[20]
Plants: *Hordeum vulgare, Brassica napus, Trifolium pratense, Lolium perenne, Lycopersicon esculentum*	4 – 3,476 mg Mo/kg dw	[21]
Soil micro-organisms (nitrification, glucose-induced respiration, plant residue mineralisation)	10 – 3,840 mg Mo/kg dw	[22]
Plants are most sensitive, with reduced shoot yield being the most first symptoms of toxicity, followed by reduced reproduction of invertebrates. Toxicity of sodium molybdate dihydrate in soils is dependent on the soil type. Sandy soils (e.g., 5% clay) with a low organic carbon content (e.g., 1%), a low iron oxide content (e.g., 0.5 g/kg) and high pH (e.g., 7) are most sensitive, while clay soils (e.g., 30% clay) with a high organic carbon content (e.g., 12%), high iron oxide content (e.g., 10 g/kg) and low pH (e.g., 4.5) are least sensitive.		

Tests were conducted according to international test guidelines (e.g., OECD, ASTM, ISO, EPA).

(12.1.3)
Toxicity data for micro-organisms (for STP) (values were determined using molybdenum trioxide unless indicated otherwise; UV-spectra of aqueous solutions of molybdenum trioxide demonstrated that the only

dissolved molybdenum species, originating directly from molybdenum trioxide is also the molybdate anion):

Test Organisms:	**End-point:**	**Range of values**	**References**
Domestic activated sludge population	3h-EC_{50} (respiration inhibition)	1,926 mg Mo/L	[23]
Domestic activated sludge population	3h-EC_{50} (respiration inhibition)	216.5 mg Mo/L	[23]
Domestic activated sludge population	30 min-NOEC (O_2 utilization)	> 950 mg Mo/L (1)	[24]

(1): test conducted with sodium molybdate

Tests were conducted according to international accepted test guidelines or scientifically acceptable methods.

For an overview of PNECs for the different compartments, see section 8.1.2.

Conclusion on the environmental classification and labelling: **Molysulfide® concentrate (also lube grade) is not hazardous to the aquatic environment** as:

- The lowest acute reference values for fish, invertebrates and algae are > 100 mg Mo/L
- The lowest aquatic NOEC for these three trophic levels is > 1 mg Mo/L (i.e., 43. 2 mg Mo/L for the rainbow trout)
- There is no evidence for bioaccumulation or bio-magnification in the environment

(12.2)

Persistence and degradability: Molysulfide® - when released into the environment - will rapidly dissolve and will be present as the molybdate species under normal environmental conditions.

(12.3)

Bioaccumulative potential: Available BCF/BAF data for the aquatic environment show a distinct inverse relationship with the exposure concentration. This finding demonstrates that molybdenum is homeostatically controlled by these organisms, and this is so up to the milligram range of exposure. Available information on transfer of molybdenum through the food chain indicates that molybdenum does not bio-magnify in aquatic food chains.

Although not homeostatically controlled in terrestrial plants and invertebrates, molybdenum is not largely concentrated from soil into plants or soil to invertebrates. There is no significant concentration increase from diet to mammals or birds. It is concluded that bio-magnification is not significant in the terrestrial food-chain.

(12.4)

Mobility in soil: Molybdate originating from Molysulfide® is soluble in water and with its relatively low K_d value, the molybdate ions are leachable through normal soil and are mobile in sediment. Typical log K_d values of 3.25 and 2.94 have been determined for sediment and soil, respectively.

(12.5)

Results of PBT and vPvB assessment: The PBT and vPvB criteria of Annex XIII to the REACH Regulation do not apply to inorganic substances, such as Molysulfide®. Therefore, a PBT and vPvB assessment is not required.

(12.6)

Other adverse effects: Molybdate originating from Molysulfide® can contribute to the onset of molybdenosis (which is a molybdenum-induced copper deficiency) in ruminants such as cattle, deer, and sheep. The level and bio-availability of copper in the animal diet are critical factors in the onset of molybdenosis. The recommended minimum dietary Cu:Mo mass ratio threshold to prevent molybdenosis is 1.30, i.e. there should be 30% more copper than molybdenum in the diet (note: mass ratio, not molar ratio). Cu & Mo content in the diet can be monitored, and if the ratio is, < 1.3 then provide Cu supplements such as copper sulphate enriched feeds or copper sulphate enriched salt blocks for ruminants to use ad libitum. If there are ruminants in the vicinity of the plant, identify direct and diffuse air emission sources at the plant and carry out and record emission minimisation measures. Have an animal health check programme in place (e.g. blood tests for copper) to verify that the measures are effective.

Molysulfide® is not expected to contribute to ozone depletion, ozone formation, global warming or acidification. Molysulfide® is considered to be environmentally neutral.

Additional adverse effects: Conversely, a lack of molybdenum in the diet of the human population may increase gastrointestinal and esophageal cancer. [40][41]

Acute Aquatic Toxicity: Tests conducted in 1990 at levels up to 750 mg/l of powdered (96 hour) Molysulfide® resulted in zero mortality to rainbow trout (Salmon Gardner). [45]

Other: Persistence, degradability, bioaccumulation, and mobility are unknown.

Section 13 Disposal Considerations

Note: Data in this section is voluntarily in the U.S.A. but may be required in the EU and/or other countries.

(13.1)
Waste Treatment: Waste must be disposed of in accordance with national/federal, state and local environmental control regulations.

Other disposal recommendations: Legislation addressing waste disposal requirements differs by country, state and/ or territory. Each user must refer to local disposal codes in their area. For the safety of persons conducting disposal, recycling or reclamation activities, refer to information in Section 8 – Exposure Controls and Personal Protection. For this product, reclaim and recycle should be considered before any other disposal methods.

Typical common environmental controls measures are:

- By reduction and elimination
- Do not allow wash water from cleaning or process equipment to enter drains.
- Disposal to sewer may be subject to local laws and regulations.
- Decontaminate empty containers. Observe all label safeguards until containers are cleaned and destroyed.
- According to the European Waste Catalogue, waste codes are not product specific but application specific. Waste codes should be assigned by the user based on the application in which the product is used.

For USA Disposal: Waste must be disposed of in accordance with federal, state, and local environmental control regulations.

Section 14 Transportation Information

Note: Data in this section is voluntarily in the U.S.A. but may be required in the EU and/or other countries.

Regulation (abbreviation)	Regulation (title)	transport classification
ADR	European Agreement concerning the International Carriage of Dangerous Goods by **Road**	None
RID	Regulations concerning the International Carriage of Dangerous Goods by **Rail**	None
ADN	European Agreement concerning the International Carriage of Dangerous Goods by **Inland Waterways**	None
IMDG	International **Maritime** Dangerous Goods	None
IATA	Technical Instructions for the Safe Transport of Dangerous Goods by **Air**	None

(14.1)
UN number: None, Not Dangerous for Transport

(14.2)
UN proper shipping name: None, Not Dangerous for Transport

(14.3)
Transport hazard class(es): None, Not Dangerous for transport

(14.4)
Packing group: None, Not Dangerous for Transport

(14.5)
Environmental hazards: None, Not Dangerous for Transport

(14.6)
Special precautions for user: None, Not Dangerous for Transport

(14.7)
Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code: None

(14.8)
Other Transport information: Not regulated by ADR [47]; IATA; IMDG or DOT (USA)

EU/UK Guidance - Transportation: The product is not individually listed in the United Nations/Economic Commission for Europe (ECE) agreement, ADR [47] 2003, Volume I, Table A or B of Chapter 3.2. The user is advised to consider the physical, chemical and physiological properties of the product in light of the classification criteria set out within ADR to ascertain whether the product is considered to be dangerous for carriage under EU/UK laws.

The user is also advised to refer to the HSE/Department of Transport guide 'Working with ADR: an introduction to the carriage of dangerous good by road' and the HSG guide HSG136 "Workplace Transport Safety: Guidance for Employers." Additional help can be found at the web site – www.unece.org/trans/danger/publi/adr/adr_e.html.

US DOT Transportation Data (49 CFR 172.101)
Proper Shipping Name: None
Non-Hazardous for Transport: Non-hazardous. Not regulated.

Canada - Canadian Transportation of Dangerous Goods: No classification assigned.

Section 15 Regulatory Information

Note: Data in this section is voluntarily in the U.S.A. but may be required in the EU and/or other countries.

(15.1)
Safety, health and environmental regulations/legislation specific for the substance or mixture

(15.1.1)
Worldwide Chemical Inventories and lists: See section 16.7.3 for list of countries where you will find Molysulfide® (**CAS: 1317-33-5)** on country chemical inventory or regulatory lists. Molysulfide® is not a SEVESO substance, not an ozone-depleting substance and not a persistent organic pollutant.

(15.1.2)
Other regulatory information: Germany (base on read across) Water Hazard class, WGK = 1 (low hazard to water)

(15.2)
Chemical safety assessment: Molysulfide® is REACH exempt as per Annex V and not required.

(15.3)
Other Information

EU Regulations: This safety data sheet is in compliance with the following EU legislation and its adaptations – as far as applicable - : 67/548/EEC, 1999/45/EC, 76/769/EEC, 98/24/EC, 92/85/EEC, 94/33/EC, 91/689/EEC, 1999/13/EC, as well as the following British legislation: The Control of Substances Hazardous to Health Regulations (COSHH) 2002; COSHH Essentials; The Management of Health and Safety at Work Regulations 1999. See UK HSE Guidance Note "COSHH Essentials: Easy Steps to Control Chemicals."
This material is not subject to the Montreal Protocol, the Stockholm Convention or the Rotterdam Convention.

U. S. Regulatory information

TSCA Inventory Status:	Y
TSCA 12 (b) Export Notification:	Not listed
CERCLA Section 103 (40 CFR 302.4):	N

SARA Section 302 (40 CFR 355.30): N
SARA Section 304 (40 CFR 355.40): N
SARA Section 313 (40 CFR 372.65): N
OSHA Process Safety (29 CFR 1910.119): N
SARA Hazard Categories, SARA Sections 311/312 (40 CFR 370.21) -
  Acute Hazard: N
  Chronic Hazard: N
  Fire Hazard: N
  Reactivity Hazard: N
  Sudden Release Hazard: N

State Regulations: Not listed on the California Proposition 65 list. Does not contain any contaminants or bi-products known to the State of California to cause cancer or reproductive toxicity.

Note – There are no known safety, health or environmental restrictions or prohibitions in any country where this product is produced, imported or marketed.

Section 16 Other Information

(16.1)

Version: **19 Feb 2014** **Creation Date:** 13 **Sept** 2011

(16.1.1)

Reason for Change: New Safety Data Sheet format. The information provided in this SDS is consistent with the information provided in the REACH chemical safety reports for molybdenum compounds submitted to the European Chemicals Agency in 2010. This SDS replaces an older Climax Molybdenum Company MSDS for Molysulfide®. This SDS conforms as close as possible to the United Nations GHS SDS guidelines.

19 Feb 2014 – Add poison center number in section 1 and glove recommendations in section 8. Add warning in section 8.

(16.1.2)

Ratings - Note on the following HMIS (3) Ratings: The end user should verify the suitability in using the supplied HMIS rating for their condition of end use. Rating systems are provided for both HMIS (II), HMIS (III) and NFPA.

HMIS (II) Rating: Health 1; Fire 1; Reactivity 0; Personal Protection D
HMIS (III) Rating: Health 1; Fire 1; Physical Hazard 0; Personal Protection D
NFPA Rating: Health 1; Flammability: 1; Instability: 0

(16.2)

Abbreviations and acronyms that may have been used in this safety data sheet:

APF	Applied Protection Factor
bw	Body weight
CSA	Chemical Safety Assessment
CSR	Chemical Safety Report
DNEL	Derived No Effect Level
ECHA	European Chemicals Agency
(e-)SDS	(Extended) Safety Data Sheet
i	Inhalable
IARC	International Agency for Research on Cancer
OEL	Occupational Exposure Limit
OELV	Occupational Exposure Limit Value
PBT	persistent, bio-accumulative and toxic
PEL	Permissible Exposure Limit
PNEC	Predicted No Effect Concentration
PPE	Personal Protective Equipment
PPG	Personal Protective Gear
r	Respirable dust method
REACH	Abbreviation for regulation (EC) No. 1907/2006 on the Registration, Evaluation, Authorisation and Restriction of Chemicals.
RTECS	Registry of Toxic Effects Of Chemicals Substances
STEL	Short Term Exposure Limit
STOT	Short Term Organ Toxicity
STP	Sewage Treatment Plant
t	Total dust method
T	Thoracic
TWA	Time Weighted Average
vPvB	very Persistent and very Bio-accumulative

WES	Workplace Exposure Standard
WHO	World Health Organization

(16.3)

Literature reference and sources of data: The information provided in this SDS is consistent with the information provided in the REACH chemical safety reports (CSR) for various molybdenum compounds. Molybdenum disulphide itself is exempt from the REACH Regulation. Non confidential data from these REACH registration dossiers is published by the European Chemicals Agency ECHA, see http://apps.echa.europa.eu/registered/registered-sub.aspx [weblink checked 26 July 2011]
The REACH registrations, CSA's and CSR's have been prepared by the REACH Molybdenum Consortium, an initiative of the International Molybdenum Association (IMOA). For further information, please refer to http://www.molybdenumconsortium.org/ and http://www.imoa.info [weblinks checked 2010-12-20].

(16.3.1)

Reference List:

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[2] Huntingdon Research Centre (1994a). The acute toxicity of sodium molybdate dihydrate to rainbow trout (Oncorhynchus mykiss). Testing laboratory: Huntingdon Research Centre ltd. Report no.: IMA 13(b) /920163. Owner company: International Molybdenum Association, 280 Earls Court, London, SW5 9AS, England. Report date: 1994-06-09.

[3] McConnell RP (1977). Toxicity of molybdenum to rainbow trout under laboratory conditions. Molybdenum in the environment vol2. The geochemistry, cycling and industrial uses of molybdenum. New York: Marcel Dekker, pp 725-730.

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[7] De Schamphelaere KAC, Janssen CR (2008). MOLYTOX - Ecotoxicity of molybdate ion (MoO4(2-)) to the freshwater green alga Pseudokirchneriella subcapitata. Final Report, prepared for the International Molybdenum Association. Testing laboratory: Laboratory of Environmental Toxicology and Aquatic Ecology. Owner company: International Molybdenum Association. Report date: 2008-09-01.

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[9] Parametrix Environmental Research Lab (2008a). Early Life Stage Toxicity of Molybdenum to the Rainbow Trout (Oncorhynchus mykiss) Under Flow-Through conditions. Final Report prepared for the International Molybdenum Association. Testing laboratory: PERL (Parametrix Environmental Research Laboratory, 33972 Texas St. SW, Albany, Oregon, 97321. Report no.: 598-5541-001. Owner company: International Molybdenum Association. Report date: 2008-06-05.

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[16] Parametrix Environmental Research Laboratory (2008b). Toxicity of Molybdenum to the sand dollar Dendraster excentricus. Final Report, prepared for the International Molybdenum Association. Testing laboratory: Parametrix Environmental Research Laboratory (PERL), Albany, Oregon, USA. Report no.: Test No. 779-1. Owner company: International Molybdenum Association. Report date: 2008-12-05.

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Environmental Laboratory, AstraZeneca UK Limited, Brixham, Devon, TQ5 8BA, UK. Report no.: Report No BR0146/B. Owner company: International Molybdenum Association. Report date: 2010-03-01.
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[45] IUCLID Dataset CAS # 1309-56-4, EINECS # 215-172-4.
[46] http://www.acu-cell.com, Dr. Ronald Roth, Acu-Cel Nutrition, Copyright© 2000-2008.
[47] "ADR" means the provisions concerning the international carriage of dangerous goods by road which form Annexes A and B to the European Agreement Concerning the International Carriage of Dangerous Goods by Road and are contained in Annexes A and B to Council Directive 94/55/EC (as amended).
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[51] NIOSH Pocket Guide to Chemical Hazards and Other Databases, DHHS (NIOSH) Publication No. 2005-151, September 2005.
[52] Unless otherwise specified, data is extracted from RTECS – Register of Toxic Effects of Chemical Substances. RTEC number QA 4697000
[53] Dangerous Properties of Industrial Materials, N. Irving Sax, 1979
[54] Patty's Industrial Hygiene and Toxicology, a Wiley-Inter-science Publication, John Wiley & Sons, 1979.
[55] "IATA" means the provisions concerning the international transport of dangerous goods by air. 49th Edition of the IATA Dangerous Goods Regulations based on the requirements of Annex 18 to the Convention on International Civil Aviation (Chicago, 1944) and the 2007-2008 Edition of the associated Technical Instructions for the Safe Transport of Dangerous Goods by Air (Doc 9284-AN/905), including addenda to the 2007-2008 Technical Instructions, adopted by the Council of ICAO and published by the ICAO.
[56] **PPE References information**

USA - OSHA Standards - 29 CFR:
personal Protective Equipment - General requirements
ye and face protection
Respiratory Protection
1910.136 - Occupational foot protection
1910.138 - Hand Protection
ANSI
Eye and face protection - ANSI Z87.1
Foot protection - ANSI Z41
Respirators must be NIOSH approved.
Canada - For detailed advice on Personal Protective Equipment, refer to the following Canadian Standards:
CAN/CSA-Z195 - Protective Footwear
Z195.1 - Guideline on Selection, Use, and Care of Protective Footwear
CAN/CSA-Z94.3 - Industrial Eye and Face Protectors
Z94.3.1 - Protective Eyewear User's Guide
CSA-Z94.4 - Selection, Use, and Care of Respirators
CAN/CSA-Z180.1 - Compressed Breathing Air and Systems.
EU
For detailed advice on Personal Protective Equipment, refer to the following EU CEN Standards:
EN 16 Personal eye-protection
EN 340 Protective clothing
EN 374 Protective gloves against chemicals and micro-organisms
EN 13832Footwear protecting against chemicals
EN 133 Respiratory protective devices

(16.4)

Classification procedure for mixtures: Molysulfide® is REACH exempt as defined in Annex V.

(16.5)

R-phrase and/or H-statements: Imbedded in document where applicable.

(16.6)

Advice on any training appropriate for workers to ensure protection of human health and the environment:

Use this SDS as a Hazard Communication tool and provide training to assist in your risk assessment. Be mindful that many factors determine whether the reported hazards are risks in the workplace or other settings. Before handling Molysulfide® workers should receive appropriate training about safe handling conditions as described in this Safety Data Sheet.

(16.7)

Other Information:

(16.7.1)

List of EU Poison Centres.

Country	Telephone Number	Website	Address
Austria - Vienna Vergiftungsinformationszentrale (Poisons Information Centre)	**+ 43 1 40 406 4343**	http://www.meduniwien.ac.at/viz/	Allgemeines Krankenhaus Waehringer Guertel 18-20, Vienna, Austria
Belgium - Centre Anti-Poisons/ Antigifcentrum	**+ 32 70 245 245**	http://www.poisoncentre.be	HÕpital Militaire Reine Astrid, Rue Bruyn, Brussels, B-1120, Belgium
Germany - Berlin Giftberatung Virchow-Klinikum, Medizinische Pakultat der Humboldt-Universitat zu Berlin	**+ 49 30 450 653 565**	http://www.giftnotruf.de	Augustenberger Platz 1 – Berlin 13353, Germany
Italy - Rome Centro Antiveleni (Poisons Centre) Dipartimento di Tossicologia Clinica Universita Cattolica del Sacro Cuore	**+ 39 06 305 4343**	http://www.tox.it	Largo Agostino Gemelli 8 I-00168 Roma

Luxembourg - Uses Belgian service: Centre Anti-Poisons/ Antigifcentrum	**+ 32 70 245 245**	http://www.poisoncentre.be	Hôpital Militaire Reine Astrid, Rue Bruyn, Brussels, B-1120, Belgium
Netherlands - Bilthoven, National Poisons Information Centre, National Institute for Public Health & Environment	**+ 31 30 274 88 88**	https://www.vergiftigingen.info https://www.productnotification.nl	3720 BA Bilthoven
Poland - Warsaw (Warszawa) Warsaw Poison Control & Info Centre, Praski Hospital	**+ 48 22 619 66 54 /** **+ 48 22 619 08 97**	No website available.	Al. Solidarnosci 67, P-03 401 Warszawa
Sweden - Stockholm Giftinformationscentralen (Swedish Poisons Info Centre) Karolinska Hospital	**+ 46 8 33 12 31 (International)** **112 (National)**	http://www.giftinformationscentralen.se	SE 171 76 Stockholm
United Kingdom - National Poison Information Service Centre	**National: 0844 892 0111**	http://www.npis.org	
The International Programme on Chemical Safety (IPCS) – Global Health Observatory (GHO)		http://www.who.int/ipcs/poisons/centre/directory/euro/en/	

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Exposure Controls by country (insoluble materials, total dust = 15 mg (Mo)/m^3):

Australia	OEL TWA	= 10 mg(Mo)/m^3	or 5 mg(Mo)/m^3
Belgium	OEL TWA	= 10 mg(Mo)/m^3	
Bulgaria	OEL TWA	= 10 mg(Mo)/m^3	
Canada-BC	OEL TWA	= 3 mg(Mo)/m^3 (inhalable)	
Canada-Yukon	OEL TWA	= 10 mg(Mo)/m^3	(STEL) 20 mg(Mo)/m^3
Canada-Ontario	OEL TWA	= 3 mg(Mo)/m^3 (inhalable)	
Canada-SK	OEL TWA	= 10 mg(Mo)/m^3	(STEL) 20 mg(Mo)/m^3
China	OEL TWA	= 6 mg(Mo)/m^3	
Finland	OEL TWA	= 5 mg(Mo)/m^3	
France	OEL VME	= 10 mg(Mo)/m^3	or 5 mg(Mo)/m^3
Greece	OEL TWA	= 15 mg(Mo)/m^3	
Ireland	OEL TWA	= 5 mg(Mo)/m^3	(STEL) 10 mg(Mo)/m^3
Korea	OEL TWA	= 5 mg(Mo)/m^3	
New Zealand	OEL TWA	= 5 mg(Mo)/m^3	
Netherlands	OEL TWA	= 10 mg(Mo)/m^3	
Philippines	OEL TWA	= 15 mg(Mo)/m^3	or 5 mg(Mo)/m^3
Poland	OEL MAC(TWA)	= 4 mg(Mo)/m^3	MAC(STEL) 10 mg(Mo)/m^3
Singapore	OEL TWA	= 10 mg(Mo)/m^3	
Spain	OEL TWA	= 10 mg(Mo)/m^3	
Sweden	OEL NGV	= 10 mg(Mo)/m^3 (total dust)	or 5 mg(Mo)/m^3 (resp. dust)
Switzerland	OEL MAK-W	= 10 mg(Mo)/m^3	or 5 mg(Mo)/m^3
Turkey	OEL TWA	= 15 mg(Mo)/m^3	or 5 mg(Mo)/m^3
UK	OEL WELs	= 10 mg(Mo)/m^3	(STEL) 20 mg(Mo)/m^3
US OSHA	PEL - 8Hr TWA	= 15 mg(Mo)/m^3, as total dust	or 5 mg(Mo)/m^3 as resp. dust
US ACGIH	TLV-TWA	= 10 mg(Mo)/m^3 (inhalable)	
US MSHA	8 Hr. TWA	= 5 mg(Mo)/m^3	
US-Hawaii	8 Hr. TWA	= 10 mg/m^3 as total dust (NOC)	or 5 mg/m3 as resp. dust (NOC)
US-Tennessee	8 Hr. TWA	= 10 mg(Mo)/m^3	
US-Idaho	8 Hr. TWA	= 5 mg(Mo)/m^3	
US-Minnesota	8 Hr. TWA	= 10 mg(Mo)/m^3	or 5 mg(Mo)/m^3
US-Washington	8 Hr. TWA	= 10 mg(Mo)/m^3	(STEL) 20 mg(Mo)/m^3

Note: For Argentina, Colombia, Jordan and Vietnam check current ACGIH TLV guide.

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Euro Country OEL's

Type of limit value	Limit value [mg Mo/m^3]	References, Legislation,...	Information on recommended monitoring procedures
Austria: Molybdenum compounds (as Mo), **soluble** compounds, **STEL (Peak),** 2 times per shift, 60 minutes:	20 Inhalable dust fraction	GKV_MAK (Austria 9/2007)	Consult the national authorities about which measurement methodology is suitable to demonstrate respective limit values. Applicable standards for monitoring of inhalable and/or respirable dust may include: HSE-MDHS 14: (10/1989) NIOSH 0500 (15/8/1994) NIOSH 0600 (15/1/1998)
Austria: Molybdenum compounds (as Mo), **soluble** compounds, **8-hour TWA** reference period	10 Inhalable dust fraction	GKV_MAK (Austria 9/2007)	
Belgium: molybdenum compounds (as Mo), **soluble**, in the **respirable** fraction, TLV-TWA	0.5 Respirable dust fraction	Belgian Royal Decree of 11/06/2009 (protection of the employee's health and safety against the risk of chemicals).	

Belgium: Mo compounds (as Mo), **soluble**, TLV-TWA	10 Inhalable dust fraction	Belgian Royal Decree of 11/06/2009 (protection of the employee's health and safety against the risk of chemicals).	BS 1/2/92-KB (18/12/91) Consult the national authorities about which measurement methodology is suitable to demonstrate respective limit values. Applicable standards for monitoring of inhalable and/or respirable dust may include: HSE-MDHS 14: (10/1989) NIOSH 0500 (15/8/1994) NIOSH 0600 (15/1/1998) BS 1/2/92-KB (18/12/91)
Denmark: Molybdenum compounds (as Mo), **soluble**, **8-hour TWA** reference period	5	Arbejdstilsynet (Denmark 3/2008)	
Denmark: Molybdenum compounds (as Mo), **insoluble, 8-hour TWA** reference period	10	Arbejdstilsynet (Denmark 3/2008)	
France: No indicative or mandatory Occupational Exposure Limit (OEL) specifically for molybdenum. **8-hour TWA** reference period to be protective against **long-term** exposure:	10 mg/m^3 Total dust 5 mg/m^3 Respirable fraction		
Germany: No limit value (MAK-value) is defined for Mo or molybdenum trioxide. In the absence of a MAK-value,**8 -hour TWA** limit values for **general dust** should be applied:	10 mg/m^3 Inhalable dust fraction 3 mg/m^3 Respirable dust fraction	Deutsche Forschungsgemeinschaft: List of MAK and BAT values 2010. Commission for the Investigation of Health Hazards of Chemical Compounds in the Workplace, Report no. 46 WILEY-VCH Verlag GmbH & Co, KGaA, Weinheim, ISBN: 978-3-527-32815-4	
Italy: Molybdenum compounds (as Mo), **insoluble** compounds**, 8-hour TWA** reference period:	10 mg/m^3 Inhalable dust fraction 3 mg/m^3 Respirable dust fraction	ACGIH TLV (USA 2/2010)	
Luxembourg: OEL's used in Luxembourg are those used by Germany, unless specific OEL's are provided (none identified for molybdenum)	See Germany		
Netherlands: Employers & employees responsible for setting Occupational Exposure Levels for safe handling since 1-1-2007		http://www.rivm.nl/rvs/normen/werk/grens	
Poland: Molybdenum compounds (as Mo), **insoluble** compounds, **STEL/Peak** for 15 minutes:	10 mg/m^3		
Poland: Molybdenum compounds (as Mo), **insoluble** compounds**, 8-hour TWA** reference period	4 mg/m^3		
Sweden: Molybdenum compounds (as Mo), **insoluble** compounds, 8-hour TWA reference period:	10 mg/m^3 Total dust 5 mg/m^3 Respirable dust fraction	AFS 2005:17 (Sweden 6/2007)	
United Kingdom: molybdenum compounds (as Mo), **insoluble** compounds, **long-term** exposure limit (8-hour TWA reference period)	5 mg/m^3 Inhalable dust fraction	UK HSE List of approved workplace exposure limits (WEL), October 2007, (http://www.hse.gov.uk/cosh h/table1.pdf)	MDHS: Methods for the Determination of Hazardous Substances (MDHS) guidance http://www.hse.gov.uk/pubns/mdhs/
United Kingdom: molybdenum compounds (as Mo), **insoluble** compounds, **short-term** exposure limit (15-minute reference period)	10 mg/m^3 Inhalable dust fraction		
United Kingdom: molybdenum compounds (as Mo), **insoluble compounds**, **long-term** exposure limit (8-hour TWA reference period)	10 mg/m^3 Inhalable dust fraction		
United Kingdom: molybdenum compounds (as Mo), **insoluble** compounds, **short-term** exposure limit (15-minute reference period)	20 mg/m^3 Inhalable dust fraction		
Further source of information: European Agency for Safety & Health at Work:		http://osha.europa.eu/en/topics/ds/oel/members.stm	

Also, See the downloadable list on the MoCon SDS webpage for the OEL values in EU countries that MoCon has been able to source.

Some of the example data shown above was taken from the GESTIS Database on International Limit Values (http://bgia-online.hvbg.de/LIMITVALUE/WebForm_gw.aspx), accessed 2010-11-10

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Other country information; molybdenum disulfide (CAS: 1317-33-5) is found on the following regulatory lists:

Australia Exposure Standards
Australia Inventory of Chemical Substances (**AICS**)
Belgium Occupational Exposure Limits
Bulgaria Limit values for the chemical agents in the air at the working environment
Canada - Alberta Occupational Exposure Limits
Canada - British Columbia Occupational Exposure Limits
Canada - Northwest Territories Occupational Exposure Limits
Canada - Ontario Occupational Exposure Limits
Canada - Quebec Occupational Exposure Limits
Canada - Saskatchewan Occupational Health and Safety Regulations - Contamination Limits
Canada - Yukon Permissible Concentrations for Airborne Contaminant Substances
Canada Domestic Substances List (**DSL**)
China Inventory of Existing Chemical Substances
China Occupational Exposure Limits for Hazardous Agents in the Workplace
Denmark Limit values for air pollutants
EU Directive 2002/72/EC Plastic materials and articles intended to come into contact with foodstuffs - Annex III Section A Incomplete list of additives fully harmonized at Community level.
European Customs Inventory of Chemical Substances – ECICS
European Inventory of Existing Commercial Substances - **EINECS**
European Union - European Inventory of Existing Commercial Chemical Substances (EINECS)
European Union (EU) Restrictions on the Marketing and Use of Certain Dangerous Substances and Preparations
Germany Recommended Exposure Limits - MAK Values
Germany Substances for which no MAK value can be established at present
Greece Occupational Exposure Limits
Hungary Occupational Exposure Limits
India Chemical Accidents Rules - Schedule 1: List of Hazardous Chemicals
India Hazardous Wastes Rules - Schedule 2: List of Wastes Constituents with Concentration Limits
India Manufacture, Storage and Import of Hazardous Chemical Rules - Schedule 1: List of Hazardous and Toxic Chemicals
Ireland Occupational Exposure Limits
Ireland Occupational Exposure Limits - Intended Changes
Japan Chemical Substances Control Law - Existing/New Chemical Substances
Japan Industrial Safety and Health Law (ISHL) - Notifiable Substances
Japan PRTR Law
Korea (South) Existing Chemicals List (**KECL**)
Korea (South) Occupational Exposure Standards
Lithuania Occupational Exposure Limits
Malaysia Permissible Exposure Limits
Mexico Maximum Permissible Exposure Limits
Netherlands Occupational Exposure Limits
New Zealand Transferred List of Single Component Substances
New Zealand Workplace Exposure Standards (WES)
Norway Administrative norms for air contamination in the workplace
OECD Representative List of High Production Volume (HPV) Chemicals
Philippines Inventory of Chemicals and Chemical Substances (**PICCS**)
Philippines Occupational Exposure Limits
Russia Maximum Allowed Concentrations (PDK) of Harmful Substances in the Air of Workplace Zone
Singapore Permissible Exposure Limits of Toxic Substances
Spain Changes Proposed for Occupational Limit Values
Spain Occupational Exposure Limit for Chemical Agents
Sweden Occupational Exposure Limit Values
Switzerland Giftliste (List of Toxic Substances) 1 [**NLV**]
Switzerland Occupational Exposure Limits
UK Workplace Exposure Limits (WELs)
US - California Environmental Health Standards for the Management of Hazardous Waste - List of Inorganic Persistent and Bioaccumulative Toxic Substances and Their STLC & TTLC Values
US - California Occupational Safety and Health Regulations (CAL/OSHA) - Hazardous Substances List
US - California Permissible Exposure Limits for Chemical Contaminants
US - Connecticut Hazardous Air Pollutants
US - Hawaii Air Contaminant Limits
US - Idaho - Limits for Air Contaminants
US - Michigan Exposure Limits for Air Contaminants
US - Minnesota Hazardous Substance List
US - Minnesota Permissible Exposure Limits (PELs)
US - New Jersey Right to Know Hazardous Substances
US - Tennessee Occupational Exposure Limits - Limits For Air Contaminants
US - Vermont Permissible Exposure Limits Table Z-1-A Final Rule Limits for Air Contaminants
US - Vermont Permissible Exposure Limits Table Z-1-A Transitional Limits for Air Contaminants
US - Washington Permissible exposure limits of air contaminants
US - ACGIH Threshold Limit Values (TLV)
US DOE Temporary Emergency Exposure Limits (TEELs)
US OSHA Permissible Exposure Levels (PELs) - Table Z1
US Toxic Substances Control Act (**TSCA**) - Inventory

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REACH Statement and Point of Contact Information

Climax Molybdenum has not pre-registered or registered this substance as it is exempt of the European Union’s Registration, Evaluation, Authorization, and Restriction of Chemicals regulation, EC 1907/2006 (REACH). Additional information is available upon request. Any REACH-related inquiries regarding this substance should be directed to Ir. Aad van Meerkerk, Climax Molybdenum B.V., Rotterdam, The Netherlands, Tel: +31-181-243705; Email: aad_vanmeerkerk@fmi.com.

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Disclaimer

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GHS Safety Data Sheet - Conforms to Regulation (EC) No 1907/2006, Article 31 and UN ANNEX4 Guidance on the Preparation of Safety Data Sheets (SDS).

Appendix A - Different exposure scenarios

Item 1 – Fire exposure scenario – Most industrial workplaces have fixed fire protection systems in place. Each system is designed to control certain types of fires. It is near impossible to know which fire extinguishing material should be used to fight a fire for every customer's workplace.

For example - a customer may store material in an area where combustible greases are used in their process, or an area where combustible oils are used, or in an area where only non-combustible materials are used or stored. Water is not suitable for oil and grease fires but maybe suitable in an area where non-combustible material is stored.

Another example – a customer may store materials in dry storage, which does not need mechanical ventilation. If that area is poorly ventilated and an employee uses a carbon dioxide extinguisher in putting out a fire there, he may displace enough oxygen to cause the worker to pass out. The carbon dioxide extinguisher would be suitable for the oil and grease fire but water would have been a better choice in the dry storage area.

This safety data sheet contains changes from the previous version in sections: New Material Safety Data Sheet format.

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