# Qualitative Tier 2 Assessment

## 2-Mercaptoethanol

In accordance with the Chemical Risk Assessment Framework (CRAF), chemicals assigned a Tier 2 designation require a hazard assessment and qualitative assessment of risk.

Consistent with National Industrial Chemicals Notification and Assessment Scheme (NICNAS), the human health hazards for each chemical are characterised by analysing the toxicokinetics (the absorption, distribution, metabolism and excretion of the chemical in humans or laboratory animals), acute toxicity, irritation and corrosivity, repeat dose toxicity, genotoxicity, carcinogenicity, reproductive toxicity, and other health effects. The environmental hazards for each chemical are characterized by analysing the environmental fate properties (such as mobility, persistence, bioavailability and bioaccumulation), acute toxicity and chronic toxicity. In support of the hazard assessment, a risk assessment dossier is prepared for each of the chemicals included in the assessment.

The qualitative assessment of risk evaluates exposure to the vendor chemical that may occur during activities that do not intentionally result in a release to the environment, but where a potential release may occur. For this evaluation, these potential releases primarily are focused on the vendor chemical transported to the well pad site or water management facility (WMF), chemicals utilised in drilling fluid systems that may impact groundwater, residual chemicals that may be present in hydraulic flowback and workover fluids and chemicals and chemicals and residues of chemicals that may be present in water undergoing treatment or beneficially re-used.

Potentially complete exposure pathways (in that a source, a migration pathway, a mechanism for exposure, and a potential receptor are present) are assessed herein to determine the potential for risk (an incomplete pathway precludes an exposure occurring and an associated potential risk). In this context, site setting and management protocols associated with the action are evaluated. Key controls limiting the potential for exposure include:

- Engineering controls (including fencing and secondary containment);
- Storage (drums, totes and storage tanks) constructed in accordance with Australian standards and managed and monitored in accordance with regulatory requirements;
- Maintenance of access control restrictions during site activities that will preclude access by the public, livestock and large native fauna; and,
- Australia SafeWork Place and Santos Occupational Safety Guidance used to minimise human health exposure.

As a result, the assessment for this Tier 2 chemical includes the following components: completing the screening; developing a risk assessment dossier and Predicted No Effect Concentrations (PNECs) for water and soil; and, providing a qualitative discussion of risk. Each of these components is detailed within this memorandum.

# Background

2-Mercaptoethanol (2-ME) is a component in a water treatment product (Champion Bactron SK-4465) used to provide corrosion resistance from microbial influenced corrosion in the steel flowlines and spinelines throughout the Scotia produced water management collection system. A safety data sheet (SDS) for the product is included as **Attachment 1**. Process and usage information for this chemical is included in **Attachment 2** and summarised in **Table 1**.

**Table 1 Water Management Facility Chemicals**

| Proprietary Name | Chemical Name | CAS No. | Use | Percent Weight (%) in Product[1] |
|---|---|---|---|---|
| Champion Bactron SK-4465 | 2-Mercaptoethanol | 60-24-2 | Biocide | 1 |

[1] Mid-point of range provided in SDS.
CAS No = Chemical Abstracts Service Number

The biocide injector systems for dosing of Bactron SK-4465 into the Scotia produced water management collection network are currently maintained at set biocide rates for every unit with a total biocide rate of injection of 9.2 litres per day (L/day). The biocide rate is not adjusted based on microbially influenced corrosion (MIC) score.

The assessment of toxicity of this chemical was used to develop initial screening criteria for human health exposure scenarios and is presented in **Attachment 3**. There are no carcinogenicity studies on 2-ME, and, as a result, only a non-carcinogenic oral reference dose (RfD) was calculated. A detailed discussion of the derivation of the oral RfD and drinking water guideline values is presented in the attachment. **Table 2** provides a summary of the derivation.

**Table 2 Oral Reference Doses and Derived Drinking Water Guidelines**

| Constituent (CAS No.) | Study | Critical Effect/ Target Organ(s) | NOAEL (mg/kg-day) | Uncertainty Factors | Oral Reference Dose (mg/kg-day) | Drinking Water Guideline (mg/L) |
|---|---|---|---|---|---|---|
| 2-Mercaptoethanol (60-24-2) | OECD 422 | Liver, heart, reproductive effects | 15 | 300 | 0.05 | 0.18 |

CAS = Chemical Abstracts Service
mg/kg-day = milligram per kilogram-day
mg/L = milligram per litre
NOAEL = No observed adverse effect level
Refer to **Attachment 3** for information on the key studies selected for oral reference dose and drinking water level development.

For ecological receptors, the assessment utilises the information presented in the dossiers on the relative toxicity of the aquatic and terrestrial flora and fauna to the chemical. This assessment focuses on the aquatic invertebrate and fish species within the surface water resources, and the soil flora and fauna associated with releases to the soil.

The determination of toxicological reference values (TRVs) was conducted according to the PNEC guidance in the *Environmental Risk Assessment Guidance Manual for Industrial Chemicals* prepared by the Australian Environmental Agency (AEA, 2009). PNECs for freshwater and sediment were developed to assess aquatic receptors, and PNECs for soil were developed for terrestrial receptors.

**Table 3** present the chemical, the endpoint, no observable effects concentration (NOEC) (milligrams per litre [mg/L]), assessment factor, and the aquatic PNEC (mg/L). PNECs for sediment and soil are detailed in **Tables 4** and **5,** respectively. Refer to **Attachment 3** and the dossier regarding the development of PNECs, or the rational for PNECs that do not have a calculated PNEC.

**Table 3 PNECs Water – Tier 2 Chemicals**

| Constituents | Endpoint | $EC_{50}$ or NOEC (mg/L) | Assessment Factor | $PNEC_{water}$ (mg/L) |
|---|---|---|---|---|
| 2-Mercaptoethanol (60-24-2) | Chronic *Daphnia* | 0.063 | 50 | 0.0013 |

$EC_{50}$ = effects concentration – 50%
mg/L = milligram per litre
NOEC = no observable effects concentration
PNEC = predicted no effect concentration
Refer to **Attachment 3** for information on the development of PNECs listed above.

**Table 4 PNECs Sediment – Tier 2 Chemicals**

| Constituents | Endpoint | $EC_{50}$ or NOEC (mg/kg wet wt) | Assessment Factor | $PNEC_{sed}$ (mg/kg wet wt) |
|---|---|---|---|---|
| 2-Mercaptoethanol (60-24-2) | [a] | - | - | 0.00085 |

[a]Calculated using equilibrium partitioning method.
$EC_{50}$ = effects concentration – 50%
mg/kg wet wt = milligram per kilogram wet weight
NOEC = no observable effects concentration
PNEC = predicted no effect concentration
Refer to **Attachment 3** for information on the development of PNECs listed above.

**Table 5 PNECs Soil – Tier 2 Chemicals**

| Constituents | Endpoint | $EC_{50}$ or NOEC (mg/kg dry wt) | Assessment Factor | $PNEC_{soil}$ (mg/kg dry wt) |
|---|---|---|---|---|
| 2-Mercaptoethanol (60-24-2) | [a] | - | - | 0.00003 |

[a]Calculated using equilibrium partitioning method
$EC_{50}$ = effects concentration – 50%
mg/kg dry wt = milligram per kilogram dry weight
NOEC = no observable effects concentration
PNEC = predicted no effect concentration
Refer to **Attachment 3** for information on the development of PNECs listed above.

A detailed assessment of the risks posed by this Tier 2 chemical is provided in the following sections.

## General Overview

The molecular structure of 2-ME is presented in **Figure 1**.

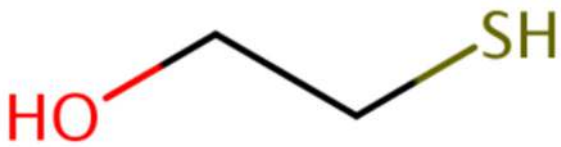



**Figure 1 Molecular Structure of 2-Mercaptoethanol** [1]

After evaporation or exposure to the air, 2-mercaptoethanol will be rapidly degraded by photochemical processes with OH-radicals. Due to the structural properties, hydrolysis is not expected to be an important fate path. Likewise, due to the soil organic carbon partition coefficient (Koc), significant adsorption e.g. to solid soil phase is not expected. 2-ME is considered to be rapidly biodegradable in the environment. It is not expected to bioconcentrate or bioaccumulate.

The Persistent, Bioaccumulative and Toxic (PBT) assessment for 2-ME is included in the dossier provided in **Attachment 3**. Based on physico-chemical properties and screening data detailed below, the overall conclusion was that 2-ME is not a PBT substance.

## Human Health Hazards

2-ME is metabolised to its acetate salt and excreted via urine. 2-ME has moderate acute toxicity by the oral and inhalation routes; and, is more acutely toxic by the dermal route. It is irritating and considered a skin sensitiser.

In repeated dose exposure studies, it is not substantially toxic via the oral route of exposure. No information about repeated dermal toxicity or inhalation toxicity is available. No maternal or developmental toxicity was seen in animals exposed to 2-ME by the oral route. 2-ME is not genotoxic.

Based on a review of an OECD 422 study in male and female rats, TRVs were derived for 2-ME. The drinking water guideline value derived for 2-ME using the non-carcinogenic oral RfD is 0.18 mg/L (see **Table 2**). Description of the oral RFD and calculation of the drinking water guideline value is included in the dossier provided in **Attachment 3**.

The life cycle of chemicals, including 2-ME, used during the treatment of produced water includes the following general categories: transportation of chemicals; beneficial reuse, which is post-treatment transfer (pipeline or trucking) and use of water; and, treated water storage. During the water treatment, water conveyance and beneficial reuse processes, there is the potential for human receptors to be exposed to water treatment chemicals. Based on an assessment of land use and an understanding of the project description provided in the Environmental Impact Statement (EIS) (URS, 2014) and the CRAF developed for the GFD Project Area, potential human receptors include:

[1] Source https://comptox.epa.gov/dashboard/dsstoxdb/results?search=DTXSID4026343

1. Workers at the water management facility (WMF) including operators, maintenance staff and supervisors.
2. Agricultural workers/residents at irrigation areas.

Based on the treatment process described in **Attachment 2**, 2-ME would be present in irrigation storage pond water. Therefore, exposure pathways associated with the beneficial reuse of treated water would be potentially complete. Beneficial reuse of treated water includes project reuse (dust suppression, construction activities, drilling and completions), irrigation and stock watering.

In terms of risks associated with transport of chemicals and wastes, this risk is considered to be managed to a level as low as reasonably practicable. This is because the potential for a release is controlled through implementation of traffic management principles including use of designated trucking routes, vehicle signage, vehicle management systems (to manage speed and driving behaviour/habits) and in the unlikely event of a vehicular accident, implementation of incident and spill response procedures. Given the highly regulated nature of transportation of chemicals (at both a Commonwealth and State level), transport-related scenarios are not evaluated further in this assessment. However, the outcomes of the assessment should be used to inform emergency response actions.

Exposure of potential human receptors to 2-ME is possible via inadvertent spills and leaks. However, chemical exposures to workers are controlled through engineering, management controls and personal protective equipment, which are focused on elimination and mitigation of the potential for dermal contact and potential for incidental ingestion. In addition, Australia SafeWork Place and Santos Occupational Safety Guidance are used to minimise human health exposure. As a result, petroleum workers, are also excluded from assessment. No potentially complete exposure pathways were identified.

The management of chemicals and wastes is conducted using drums, totes and engineered tanks designed to contain the fluids. In the unlikely event of a release to ground, the potential for exposures (other than workers) is limited. The WMF is fenced and access is controlled, which limits access to the public. If water treatment chemicals are spilled to the ground then investigation, remediation and rehabilitation activities would be implemented to address soil impacts.

Exposure of potential receptors (other than workers) is also possible to residual chemicals in areas adjacent to a well lease that have been used for the application of materials for beneficial reuse. The primary land use within the development area is agricultural (grazing on improved or unimproved pastures), and it is sparsely populated. There may be potential for human receptors such as residents and agricultural workers to be exposed to residual chemicals in ponded irrigation water or irrigated soil via direct contact (ingestion and dermal) and inhalation pathways. Relative potential exposure to agricultural workers/residents is considered low due to the remote location of the well leases and the sparse population. In addition, activities are undertaken in operational and controlled areas of the well lease.

However, Environmental Authority (EA) or Beneficial Use Approval conditions regulate project reuse. A plan for the beneficial reuse of materials has been developed by a Suitably Qualified Person (SQP) in accordance with the EA conditions which require materials of a certain quality and controls the maximum volumes that can be applied to land. In addition, the application techniques and location of application are controlled with specific monitoring required. Irrigation areas are designed to manage the risk of pooling and runoff with a general deficit irrigation strategy employed; and, are

fitted with monitoring bores to manage the risk of vertical and horizontal migration. Additional details regarding mitigation and management controls are discussed in the CRAF.

As a result, potential exposures during treatment activities are low due to the employment of mechanical equipment/processes, engineering controls (including secondary containment) and other mitigation and management strategies. Similarly, there is a low potential for human receptors exposed to surface water bodies that may receive runoff from beneficial reuse applications. Finally, the probability of any surface related discharge infiltrating subsurface soils and migrating to groundwater is very low.

## Environmental Hazards

In standard aquatic toxicity tests, 2-ME is overall moderately toxic to aquatic organisms. Acute toxicity towards algae and aquatic invertebrates is of the same order of magnitude. However, *Daphnia magna* was more sensitive (ECHA).

2-ME is readily biodegradable and does not persist in the environment. It is not expected to bioconcentrate or bioaccumulate nor is it expected to pose a substantial toxic concern to environmental receptors.

PNECs for 2-ME are provided in **Tables 3 – 5**. Experimental toxicity data on water organisms was available for three trophic levels to calculate PNECs in water. There are no toxicity data for sediment-dwelling organisms or soil organisms. Therefore, PNECs for sediment and soil were calculated using the equilibrium partitioning method. PNEC calculations and assumptions are included in the dossier provided in **Attachment 3**.

During water treatment, water conveyance and beneficial reuse processes, there is the potential for environmental receptors to be exposed to water treatment chemicals such as 2-ME. Pipelines (where treated water is conveyed) can transect sensitive ecological areas (including Matters of National Environmental Significance [MNES]). At the WMF, the potential for exposure of sensitive receptors (including MNES) is considered low, as these facilities are existing and are operational industrial facilities (and thereby provide no habitat value). The industrial activities and operation of equipment do not make it a setting conducive to incursion of fauna. For instance, the WMF is fenced and access is controlled, which precludes entry by livestock.

Based on the engineering and management controls described in the previous section (Human Health Hazards), there is a low potential for ecological receptors exposed to surface water bodies that may receive runoff from an accidental release. There is also concern that recovered material applied to the land surface could migrate to groundwater or surface water, and therefore result in adverse effects to the environment (e.g., uptake by aquatic receptors). Due to EA conditions regulating land application techniques, the remote nature of the well leases, vertical separation of groundwater and distances to watercourses, the ephemeral nature of the watercourses and the physical and chemical properties of the residual chemicals post treatment or beneficial reuse, these potential exposures are low.

## References

Australian Environmental Agency (AEA). (2009). Environmental Risk Assessment Guidance Manual for Industrial Chemicals, Commonwealth of Australia.

URS. (2014). Santos GLNG Project: Gas Field Development Project Environmental Impact Statement. Available online at: http://www.santosglng.com/environment-and-water/gas-field-development-project-eis.aspx

# Attachment 1 Safety Data Sheet

# Bactron SK-4465; Santos Item No: 202152 (Champion Bactron SK-4465)

**Champion**

Chemwatch Hazard Alert Code: **3**

Chemwatch: **7166-27**
Version No: **4.1.1.1**
Safety Data Sheet according to WHS and ADG requirements

Issue Date: **04/11/2013**
Print Date: **12/03/2016**
S.GHS.AUS.EN

## SECTION 1 IDENTIFICATION OF THE SUBSTANCE / MIXTURE AND OF THE COMPANY / UNDERTAKING

### Product Identifier

| | |
|---|---|
| **Product name** | Bactron SK-4465; Santos Item No: 202152 (Champion Bactron SK-4465) |
| **Synonyms** | Not Available |
| **Proper shipping name** | CORROSIVE LIQUID, TOXIC, N.O.S. (contains glutaraldehyde,tall oil fatty acid/ diethylenetriamine reaction products,tetrakis(hydroxymethyl)phosphonium sulfate,methanol and 2-mercaptoethanol) |
| **Other means of identification** | Not Available |

### Relevant identified uses of the substance or mixture and uses advised against

| | |
|---|---|
| **Relevant identified uses** | Biocides. |

### Details of the supplier of the safety data sheet

| | |
|---|---|
| **Registered company name** | Champion |
| **Address** | 1301 North Euclid Avenue Pnnceton IL 67356 United States |
| **Telephone** | +1 217 222 5400 |
| **Fax** | Not Available |
| **Website** | Not Available |
| **Email** | Not Available |

### Emergency telephone number

| | |
|---|---|
| **Association / Organisation** | Not Available |
| **Emergency telephone numbers** | Not Available |
| **Other emergency telephone numbers** | Not Available |

## SECTION 2 HAZARDS IDENTIFICATION

### Classification of the substance or mixture

**HAZARDOUS CHEMICAL. DANGEROUS GOODS. According to the WHS Regulations and the ADG Code.**

**CHEMWATCH HAZARD RATINGS**

| | | Min | Max |
|---|---|---|---|
| Flammability | 1 | | |
| Toxicity | 2 | | |
| Body Contact | 3 | | |
| Reactivity | 1 | | |
| Chronic | 3 | | |

0 = Minimum
1 = Low
2 = Moderate
3 = High
4 = Extreme

| | |
|---|---|
| **Poisons Schedule** | S6 |

Continued...

| | |
|---|---|
| **Classification [1]** | Flammable Liquid Category 4, Metal Corrosion Category 1, Acute Toxicity (Oral) Category 4, Acute Toxicity (Dermal) Category 4, Acute Toxicity (Inhalation) Category 4, Skin Corrosion/Irritation Category 1B, Serious Eye Damage Category 1, Respiratory Sensitizer Category 1, Skin Sensitizer Category 1, Reproductive Toxicity Category 1B, Acute Aquatic Hazard Category 1, Chronic Aquatic Hazard Category 1 |
| ***Legend:*** | *1. Classified by Chemwatch; 2. Classification drawn from HSIS ; 3. Classification drawn from EC Directive 1272/2008 - Annex VI* |

## Label elements

| | |
|---|---|
| **GHS label elements** |  |
| SIGNAL WORD | **DANGER** |

## Hazard statement(s)

| | |
|---|---|
| **H227** | Combustible liquid |
| **H290** | May be corrosive to metals. |
| **H302** | Harmful if swallowed. |
| **H312** | Harmful in contact with skin. |
| **H332** | Harmful if inhaled. |
| **H314** | Causes severe skin burns and eye damage. |
| **H318** | Causes serious eye damage. |
| **H334** | May cause allergy or asthma symptoms or breathing difficulties if inhaled. |
| **H317** | May cause an allergic skin reaction. |
| **H360** | May damage fertility or the unborn child. |
| **H410** | Very toxic to aquatic life with long lasting effects. |

## Precautionary statement(s) Prevention

| | |
|---|---|
| **P201** | Obtain special instructions before use. |
| **P210** | Keep away from heat/sparks/open flames/hot surfaces. - No smoking. |
| **P260** | Do not breathe dust/fume/gas/mist/vapours/spray. |
| **P271** | Use only outdoors or in a well-ventilated area. |

## Precautionary statement(s) Response

| | |
|---|---|
| **P301+P330+P331** | IF SWALLOWED: Rinse mouth. Do NOT induce vomiting. |
| **P303+P361+P353** | IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower. |
| **P304+P340** | IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. |
| **P305+P351+P338** | IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. |

## Precautionary statement(s) Storage

| | |
|---|---|
| **P403+P235** | Store in a well-ventilated place. Keep cool. |
| **P405** | Store locked up. |

## Precautionary statement(s) Disposal

| | |
|---|---|
| **P501** | Dispose of contents/container in accordance with local regulations. |

# SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS

## Substances

See section below for composition of Mixtures

## Mixtures

| CAS No | %[weight] | Name |
|---|---|---|

**Continued...**

| | | |
|---|---|---|
| 111-30-8 | 10-30 | glutaraldehyde |
| 111-76-2 | 1-10 | ethylene glycol monobutyl ether |
| 61789-71-7 | 1-10 | cocoalkyl dimethylbenzylammonium chloride |
| 61790-69-0 | 1-10 | tall oil fatty acid/ diethylenetriamine reaction products |
| 68909-18-2 | 1-10 | benzyl-C1-2-alkylpyridinium chloride |
| 55566-30-8 | 1-10 | tetrakis(hydroxymethyl)phosphonium sulfate |
| 61791-26-2 | 1-10 | tallow alkylamine, ethoxylated |
| 67-56-1 | <1 | methanol |
| 60-24-2 | <1 | 2-mercaptoethanol |

## SECTION 4 FIRST AID MEASURES

### Description of first aid measures

| | |
|---|---|
| **Eye Contact** | If this product comes in contact with the eyes:<br>▸ Immediately hold eyelids apart and flush the eye continuously with running water.<br>▸ Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids.<br>▸ Continue flushing until advised to stop by the Poisons Information Centre or a doctor, or for at least 15 minutes.<br>▸ Transport to hospital or doctor without delay.<br>▸ Removal of contact lenses after an eye injury should only be undertaken by skilled personnel. |
| **Skin Contact** | If skin or hair contact occurs:<br>▸ Immediately flush body and clothes with large amounts of water, using safety shower if available.<br>▸ Quickly remove all contaminated clothing, including footwear.<br>▸ Wash skin and hair with running water. Continue flushing with water until advised to stop by the Poisons Information Centre.<br>▸ Transport to hospital, or doctor. |
| **Inhalation** | ▸ If fumes or combustion products are inhaled remove from contaminated area.<br>▸ Lay patient down. Keep warm and rested.<br>▸ Prostheses such as false teeth, which may block airway, should be removed, where possible, prior to initiating first aid procedures.<br>▸ Apply artificial respiration if not breathing, preferably with a demand valve resuscitator, bag-valve mask device, or pocket mask as trained. Perform CPR if necessary.<br>▸ Transport to hospital, or doctor. |
| **Ingestion** | ▸ For advice, contact a Poisons Information Centre or a doctor at once.<br>▸ Urgent hospital treatment is likely to be needed.<br>▸ If swallowed do **NOT** induce vomiting.<br>▸ If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain open airway and prevent aspiration.<br>▸ Observe the patient carefully.<br>▸ Never give liquid to a person showing signs of being sleepy or with reduced awareness; i.e. becoming unconscious.<br>▸ Give water to rinse out mouth, then provide liquid slowly and as much as casualty can comfortably drink.<br>▸ Transport to hospital or doctor without delay. |

### Indication of any immediate medical attention and special treatment needed

Any material aspirated during vomiting may produce lung injury. Therefore emesis should not be induced mechanically or pharmacologically. Mechanical means should be used if it is considered necessary to evacuate the stomach contents; these include gastric lavage after endotracheal intubation. If spontaneous vomiting has occurred after ingestion, the patient should be monitored for difficult breathing, as adverse effects of aspiration into the lungs may be delayed up to 48 hours.
Followed acute or short term repeated exposures to ethylene glycol monoalkyl ethers and their acetates:

- Hepatic metabolism produces ethylene glycol as a metabolite.
- Clinical presentation, following severe intoxication, resembles that of ethylene glycol exposures.
- Monitoring the urinary excretion of the alkoxyacetic acid metabolites may be a useful indication of exposure.

[Ellenhorn and Barceloux: Medical Toxicology]

For acute or short term repeated exposures to ethylene glycol:

- Early treatment of ingestion is important. Ensure emesis is satisfactory.
- Test and correct for metabolic acidosis and hypocalcaemia.
- Apply sustained diuresis when possible with hypertonic mannitol.
- Evaluate renal status and begin haemodialysis if indicated. [I.L.O]
- Rapid absorption is an indication that emesis or lavage is effective only in the first few hours. Cathartics and charcoal are generally not effective.
- Correct acidosis, fluid/electrolyte balance and respiratory depression in the usual manner. Systemic acidosis (below 7.2) can be treated with intravenous sodium bicarbonate solution.
- Ethanol therapy prolongs the half-life of ethylene glycol and reduces the formation of toxic metabolites.
- Pyridoxine and thiamine are cofactors for ethylene glycol metabolism and should be given (50 to 100 mg respectively) intramuscularly, four times per day for 2 days.

**Continued...**

- Magnesium is also a cofactor and should be replenished. The status of 4-methylpyrazole, in the treatment regime, is still uncertain. For clearance of the material and its metabolites, haemodialysis is much superior to peritoneal dialysis.

[Ellenhorn and Barceloux: Medical Toxicology]

It has been suggested that there is a need for establishing a new biological exposure limit before a workshift that is clearly below 100 mmol ethoxy-acetic acids per mole creatinine in morning urine of people occupationally exposed to ethylene glycol ethers. This arises from the finding that an increase in urinary stones may be associated with such exposures.
*Laitinen J., et al: Occupational & Environmental Medicine 1996; 53, 595-600*

For acute or short term repeated exposures to strong acids:

- Airway problems may arise from laryngeal edema and inhalation exposure. Treat with 100% oxygen initially.
- Respiratory distress may require cricothyroidotomy if endotracheal intubation is contraindicated by excessive swelling
- Intravenous lines should be established immediately in all cases where there is evidence of circulatory compromise.
- Strong acids produce a coagulation necrosis characterised by formation of a coagulum (eschar) as a result of the dessicating action of the acid on proteins in specific tissues.

INGESTION:

- Immediate dilution (milk or water) within 30 minutes post ingestion is recommended.
- **DO NOT** attempt to neutralise the acid since exothermic reaction may extend the corrosive injury.
- Be careful to avoid further vomit since re-exposure of the mucosa to the acid is harmful. Limit fluids to one or two glasses in an adult.
- Charcoal has no place in acid management.
- Some authors suggest the use of lavage within 1 hour of ingestion.

SKIN:

- Skin lesions require copious saline irrigation. Treat chemical burns as thermal burns with non-adherent gauze and wrapping.
- Deep second-degree burns may benefit from topical silver sulfadiazine.

EYE:

- Eye injuries require retraction of the eyelids to ensure thorough irrigation of the conjuctival cul-de-sacs. Irrigation should last at least 20-30 minutes. **DO NOT** use neutralising agents or any other additives. Several litres of saline are required.
- Cycloplegic drops, (1% cyclopentolate for short-term use or 5% homatropine for longer term use) antibiotic drops, vasoconstrictive agents or artificial tears may be indicated dependent on the severity of the injury.
- Steroid eye drops should only be administered with the approval of a consulting ophthalmologist).

[Ellenhorn and Barceloux: Medical Toxicology]

## SECTION 5 FIREFIGHTING MEASURES

### Extinguishing media

- Alcohol stable foam.
- Dry chemical powder.
- BCF (where regulations permit).
- Carbon dioxide.

### Special hazards arising from the substrate or mixture

| | |
|---|---|
| **Fire Incompatibility** | ‣ Avoid contamination with oxidising agents i.e. nitrates, oxidising acids, chlorine bleaches, pool chlorine etc. as ignition may result |

### Advice for firefighters

| | |
|---|---|
| **Fire Fighting** | ‣ Alert Fire Brigade and tell them location and nature of hazard.<br>‣ Wear full body protective clothing with breathing apparatus.<br>‣ Prevent, by any means available, spillage from entering drains or water course.<br>‣ Use fire fighting procedures suitable for surrounding area. |
| **Fire/Explosion Hazard** | , , , ,<br>‣ Combustible.<br>‣ Slight fire hazard when exposed to heat or flame.<br>‣ Acids may react with metals to produce hydrogen, a highly flammable and explosive gas.<br>‣ Heating may cause expansion or decomposition leading to violent rupture of containers.<br>Combustion products include:<br>carbon dioxide ($CO_2$)<br>aldehydes<br>sulfur oxides (SOx)<br>other pyrolysis products typical of burning organic material. |
| **HAZCHEM** | 2X |

## SECTION 6 ACCIDENTAL RELEASE MEASURES

### Personal precautions, protective equipment and emergency procedures

See section 8

### Environmental precautions

**Continued...**

See section 12

### Methods and material for containment and cleaning up

| | |
|---|---|
| **Minor Spills** | ▸ Clean up all spills immediately.<br>▸ Avoid breathing vapours and contact with skin and eyes.<br>▸ Control personal contact with the substance, by using protective equipment.<br>▸ Contain and absorb spill with sand, earth, inert material or vermiculite. |
| **Major Spills** | ▸ Clear area of personnel and move upwind.<br>▸ Alert Fire Brigade and tell them location and nature of hazard.<br>▸ Wear full body protective clothing with breathing apparatus.<br>▸ Prevent, by all means available, spillage from entering drains or water courses. |

Personal Protective Equipment advice is contained in Section 8 of the SDS.

## SECTION 7 HANDLING AND STORAGE

### Precautions for safe handling

| | |
|---|---|
| **Safe handling** | ▸ **DO NOT** allow clothing wet with material to stay in contact with skin<br>The substance accumulates peroxides which may become hazardous only if it evaporates or is distilled or otherwise treated to concentrate the peroxides. The substance may concentrate around the container opening for example.<br>Purchases of peroxidisable chemicals should be restricted to ensure that the chemical is used completely before it can become peroxidised.<br>▸ A responsible person should maintain an inventory of peroxidisable chemicals or annotate the general chemical inventory to indicate which chemicals are subject to peroxidation.<br>▸ Avoid all personal contact, including inhalation.<br>▸ Wear protective clothing when risk of exposure occurs.<br>▸ Use in a well-ventilated area.<br>▸ Avoid contact with moisture. |
| **Other information** | ▸ Store in original containers.<br>▸ Keep containers securely sealed.<br>▸ Store in a cool, dry, well-ventilated area.<br>▸ Store away from incompatible materials and foodstuff containers. |

### Conditions for safe storage, including any incompatibilities

| | |
|---|---|
| **Suitable container** | ▸ **DO NOT** use aluminium or galvanised containers<br>▸ Check regularly for spills and leaks<br>▸ Lined metal can, lined metal pail/ can.<br>▸ Plastic pail.<br>▸ Polyliner drum.<br>▸ Packing as recommended by manufacturer.<br>For low viscosity materials<br>▸ Drums and jerricans must be of the non-removable head type.<br>▸ Where a can is to be used as an inner package, the can must have a screwed enclosure.<br>For materials with a viscosity of at least 2680 cSt. (23 deg. C) and solids (between 15 C deg. and 40 deg C.):<br>▸ Removable head packaging;<br>▸ Cans with friction closures and<br>▸ low pressure tubes and cartridges<br>may be used. |
| **Storage incompatibility** | ▸ Reacts with mild steel, galvanised steel / zinc producing hydrogen gas which may form an explosive mixture with air.<br>▸ Avoid strong bases.<br>▸ Segregate from alkalies, oxidising agents and chemicals readily decomposed by acids, i.e. cyanides, sulfides, carbonates. |

## SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

### Control parameters

**OCCUPATIONAL EXPOSURE LIMITS (OEL)**

**INGREDIENT DATA**

| Source | Ingredient | Material name | TWA | STEL | Peak | Notes |
|---|---|---|---|---|---|---|
| Australia Exposure Standards | glutaraldehyde | Glutaraldehyde | Not Available | Not Available | 0.41 mg/m3 / 0.1 ppm | Sen |
| Australia Exposure Standards | ethylene glycol monobutyl ether | 2-Butoxyethanol | 96.9 mg/m3 / 20 ppm | 242 mg/m3 / 50 ppm | Not Available | Sk |

**Continued...**

| | | | | | | |
|---|---|---|---|---|---|---|
| Australia Exposure Standards | methanol | Methyl alcohol | 262 mg/m3 / 200 ppm | 328 mg/m3 / 250 ppm | Not Available | Sk |

**EMERGENCY LIMITS**

| Ingredient | Material name | TEEL-1 | TEEL-2 | TEEL-3 |
|---|---|---|---|---|
| glutaraldehyde | Gluteraldehyde | Not Available | Not Available | Not Available |
| ethylene glycol monobutyl ether | Butoxyethanol, 2-; (Glycol ether EB) | 60 ppm | 120 ppm | 700 ppm |
| methanol | Methyl alcohol; (Methanol) | Not Available | Not Available | Not Available |
| 2-mercaptoethanol | Mercaptoethanol, 2- | 0.6 ppm | 3.5 ppm | 29 ppm |

| Ingredient | Original IDLH | Revised IDLH |
|---|---|---|
| glutaraldehyde | Not Available | Not Available |
| ethylene glycol monobutyl ether | 700 ppm | 700 [Unch] ppm |
| cocoalkyl dimethylbenzylammonium chloride | Not Available | Not Available |
| tall oil fatty acid/ diethylenetriamine reaction products | Not Available | Not Available |
| benzyl-C1-2-alkylpyridinium chloride | Not Available | Not Available |
| tetrakis(hydroxymethyl)phosphonium sulfate | Not Available | Not Available |
| tallow alkylamine, ethoxylated | Not Available | Not Available |
| methanol | 25,000 ppm | 6,000 ppm |
| 2-mercaptoethanol | Not Available | Not Available |

## Exposure controls

| | |
|---|---|
| **Appropriate engineering controls** | Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection.<br>The basic types of engineering controls are:<br>Process controls which involve changing the way a job activity or process is done to reduce the risk.<br>Enclosure and/or isolation of emission source which keeps a selected hazard "physically" away from the worker and ventilation that strategically "adds" and "removes" air in the work environment. |
| **Personal protection** |  |
| **Eye and face protection** | ‣ Chemical goggles.<br>‣ Full face shield may be required for supplementary but never for primary protection of eyes.<br>‣ Contact lenses may pose a special hazard; soft contact lenses may absorb and concentrate irritants. A written policy document, describing the wearing of lenses or restrictions on use, should be created for each workplace or task. |
| **Skin protection** | See Hand protection below |
| **Hands/feet protection** | ‣ Wear chemical protective gloves, e.g. PVC.<br>‣ Wear safety footwear or safety gumboots, e.g. Rubber<br>‣ When handling corrosive liquids, wear trousers or overalls outside of boots, to avoid spills entering boots.<br>**NOTE:**<br>‣ The material may produce skin sensitisation in predisposed individuals. Care must be taken, when removing gloves and other protective equipment, to avoid all possible skin contact.<br>‣ Contaminated leather items, such as shoes, belts and watch-bands should be removed and destroyed.<br>The selection of suitable gloves does not only depend on the material, but also on further marks of quality which vary from manufacturer to manufacturer. Where the chemical is a preparation of several substances, the resistance of the glove material can not be calculated in advance and has therefore to be checked prior to the application.<br>The exact break through time for substances has to be obtained from the manufacturer of the protective gloves and.has to be observed when making a final choice.<br>Personal hygiene is a key element of effective hand care. |
| **Body protection** | See Other protection below |
| **Other protection** | ‣ Overalls.<br>‣ PVC Apron.<br>‣ PVC protective suit may be required if exposure severe.<br>‣ Eyewash unit. |
| **Thermal hazards** | Not Available |

**Continued...**

## Recommended material(s)

**GLOVE SELECTION INDEX**

Glove selection is based on a modified presentation of the:
***"Forsberg Clothing Performance Index".***
The effect(s) of the following substance(s) are taken into account in the ***computer-generated*** selection:
Bactron SK-4465; Santos Item No: 202152 (Champion Bactron SK-4465)

| Material | CPI |
|---|---|
| BUTYL | C |
| BUTYL/NEOPRENE | C |
| NAT+NEOPR+NITRILE | C |
| NATURAL RUBBER | C |
| NATURAL+NEOPRENE | C |
| NEOPRENE | C |
| NEOPRENE/NATURAL | C |
| NITRILE | C |
| PE/EVAL/PE | C |
| PVA | C |
| PVC | C |
| PVDC/PE/PVDC | C |
| SARANEX-23 | C |
| SARANEX-23 2-PLY | C |
| TEFLON | C |
| VITON | C |
| VITON/NEOPRENE | C |
| ##ethylene glycol monobutyl | ether |

* CPI - Chemwatch Performance Index
A: Best Selection
B: Satisfactory; may degrade after 4 hours continuous immersion
C: Poor to Dangerous Choice for other than short term immersion
**NOTE**: As a series of factors will influence the actual performance of the glove, a final selection must be based on detailed observation. -
* Where the glove is to be used on a short term, casual or infrequent basis, factors such as "feel" or convenience (e.g. disposability), may dictate a choice of gloves which might otherwise be unsuitable following long-term or frequent use. A qualified practitioner should be consulted.

## Respiratory protection

**Type BKAX-P Filter of sufficient capacity. (AS/NZS 1716 & 1715, EN 143:2000 & 149:2001, ANSI Z88 or national equivalent)**

Where the concentration of gas/particulates in the breathing zone, approaches or exceeds the "Exposure Standard" (or ES), respiratory protection is required.
Degree of protection varies with both face-piece and Class of filter; the nature of protection varies with Type of filter.

| Required Minimum Protection Factor | Half-Face Respirator | Full-Face Respirator | Powered Air Respirator |
|---|---|---|---|
| up to 5 x ES | BKAX-AUS / Class 1 P2 | - | BKAX-PAPR-AUS / Class 1 P2 |
| up to 25 x ES | Air-line* | BKAX-2 P2 | BKAX-PAPR-2 P2 |
| up to 50 x ES | - | BKAX-3 P2 | - |
| 50+ x ES | - | Air-line** | - |

^ - Full-face
A(All classes) = Organic vapours, B AUS or B1 = Acid gasses, B2 = Acid gas or hydrogen cyanide(HCN), B3 = Acid gas or hydrogen cyanide(HCN), E = Sulfur dioxide(SO2), G = Agricultural chemicals, K = Ammonia(NH3), Hg = Mercury, NO = Oxides of nitrogen, MB = Methyl bromide, AX = Low boiling point organic compounds(below 65 degC)

## SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

### Information on basic physical and chemical properties

| | |
|---|---|
| **Appearance** | Brown liquid; mixes with water. |

| | | | |
|---|---|---|---|
| **Physical state** | Liquid | **Relative density (Water = 1)** | 1.04-1.1 @ 25C |
| **Odour** | Not Available | **Partition coefficient n-octanol / water** | Not Available |
| **Odour threshold** | Not Available | **Auto-ignition temperature (°C)** | Not Available |
| **pH (as supplied)** | 3-5 | **Decomposition temperature** | Not Available |
| **Melting point / freezing point (°C)** | Not Available | **Viscosity (cSt)** | 53.5-107 @ 25C |
| **Initial boiling point and boiling range (°C)** | Not Available | **Molecular weight (g/mol)** | Not Applicable |
| **Flash point (°C)** | 93 PMCC | **Taste** | Not Available |
| **Evaporation rate** | Not Available | **Explosive properties** | Not Available |

**Continued...**

| | | | |
|---|---|---|---|
| **Flammability** | Not Applicable | **Oxidising properties** | Not Available |
| **Upper Explosive Limit (%)** | Not Available | **Surface Tension (dyn/cm or mN/m)** | Not Available |
| **Lower Explosive Limit (%)** | Not Available | **Volatile Component (%vol)** | Not Available |
| **Vapour pressure (kPa)** | Not Available | **Gas group** | Not Available |
| **Solubility in water (g/L)** | Miscible | **pH as a solution (1%)** | Not Available |
| **Vapour density (Air = 1)** | Not Available | **VOC g/L** | 323.14 |

## SECTION 10 STABILITY AND REACTIVITY

| | |
|---|---|
| **Reactivity** | See section 7 |
| **Chemical stability** | ▸ Contact with alkaline material liberates heat |
| **Possibility of hazardous reactions** | See section 7 |
| **Conditions to avoid** | See section 7 |
| **Incompatible materials** | See section 7 |
| **Hazardous decomposition products** | See section 5 |

## SECTION 11 TOXICOLOGICAL INFORMATION

### Information on toxicological effects

| | |
|---|---|
| **Inhaled** | Inhalation of vapours may cause drowsiness and dizziness. This may be accompanied by sleepiness, reduced alertness, loss of reflexes, lack of co-ordination, and vertigo.<br>Inhalation hazard is increased at higher temperatures.<br>Corrosive acids can cause irritation of the respiratory tract, with coughing, choking and mucous membrane damage. There may be dizziness, headache, nausea and weakness.<br>Acute effects from inhalation of high vapour concentrations may be chest and nasal irritation with coughing, sneezing, headache and even nausea.<br>Exposure to aldehydes causes neurological symptoms such as headache, drowsiness, dizziness, seizures, depression and coma. Cardiovascular involvement may result in increased heart rate, collapse and low blood pressure; respiratory effects include throat spasms, irritation, difficulty swallowing, pulmonary oedema and an asthma-like condition. |
| **Ingestion** | The material can produce chemical burns within the oral cavity and gastrointestinal tract following ingestion.<br>Accidental ingestion of the material may be harmful; animal experiments indicate that ingestion of less than 150 gram may be fatal or may produce serious damage to the health of the individual. |
| **Skin Contact** | Skin contact with the material may be harmful; systemic effects may result following absorption.<br>The material can produce chemical burns following direct contact with the skin.<br>Repeated exposure may cause skin cracking, flaking or drying following normal handling and use.<br>Skin contact with acidic corrosives may result in pain and burns; these may be deep with distinct edges and may heal slowly with the formation of scar tissue.<br>Entry into the blood-stream, through, for example, cuts, abrasions or lesions, may produce systemic injury with harmful effects. Examine the skin prior to the use of the material and ensure that any external damage is suitably protected. |
| **Eye** | If applied to the eyes, this material causes severe eye damage. |
| **Chronic** | Inhaling this product is more likely to cause a sensitisation reaction in some persons compared to the general population.<br>Skin contact with the material is more likely to cause a sensitisation reaction in some persons compared to the general population.<br>There is ample evidence that this material can be regarded as being able to cause cancer in humans based on experiments and other information.<br>Repeated or prolonged exposure to corrosives may result in the erosion of teeth, inflammatory and ulcerative changes in the mouth and necrosis (rarely) of the jaw. Bronchial irritation, with cough, and frequent attacks of bronchial pneumonia may ensue.<br>Substance accumulation, in the human body, may occur and may cause some concern following repeated or long-term occupational exposure.<br>There is some evidence from animal testing that exposure to this material may result in toxic effects to the unborn baby.<br>Repeated or prolonged exposure to acids may result in the erosion of teeth, swelling and/or ulceration of mouth lining.<br>Irritation of airways to lung, with cough, and inflammation of lung tissue often occurs.<br>Respiratory sensitisation may result in allergic/asthma like responses; from coughing and minor breathing difficulties to bronchitis with wheezing, gasping. |

**Continued...**

| | | |
|---|---|---|
| **Bactron SK-4465; Santos Item No: 202152 (Champion Bactron SK-4465)** | **TOXICITY** | **IRRITATION** |
| | Not Available | Not Available |
| **glutaraldehyde** | **TOXICITY** | **IRRITATION** |
| | dermal (rat) LD50: 1771.2 mg/kg[1] | Eye (rabbit): 0.25mg/24h-SEVERE |
| | Inhalation (rat) LC50: 0.48 mg/L/4hr[2] | Eye (rabbit): 1 mg-SEVERE |
| | Oral (rat) LD50: 770.4 mg/kg[1] | Skin (human): 6 mg/3d-int-SEVERE |
| | | Skin (rabbit): 13 mg open-mild |
| | | Skin (rabbit): 2 mg/24h-SEVERE |
| **ethylene glycol monobutyl ether** | **TOXICITY** | **IRRITATION** |
| | dermal (rat) LD50: >2000 mg/kg[1] | Eye (rabbit): 100 mg SEVERE |
| | Inhalation (rat) LC50: 450 ppm/4hr[2] | Eye (rabbit): 100 mg/24h-moderate |
| | Oral (rat) LD50: 250 mg/kg[2] | Skin (rabbit): 500 mg, open; mild |
| **cocoalkyl dimethylbenzylammonium chloride** | **TOXICITY** | **IRRITATION** |
| | Oral (rat) LD50: 200 mg/kg[2] | Not Available |
| **tall oil fatty acid/ diethylenetriamine reaction products** | **TOXICITY** | **IRRITATION** |
| | Oral (rat) LD50: >4000 mg/kg[1] | Not Available |
| **benzyl-C1-2-alkylpyridinium chloride** | **TOXICITY** | **IRRITATION** |
| | Not Available | Eyes: irritant * Betz-Dearborn |
| **tetrakis(hydroxymethyl)phosphonium sulfate** | **TOXICITY** | **IRRITATION** |
| | Oral (rat) LD50: 248 mg/kg[2] | Eye: moderate-SEVERE * |
| | | Skin: moderate-SEVERE * |
| **tallow alkylamine, ethoxylated** | **TOXICITY** | **IRRITATION** |
| | dermal (rat) LD50: >10000 mg/kg[2] | Eye(rabbit)(Draize): moderate |
| | Oral (rat) LD50: 500 mg/kg[2] | |
| **methanol** | **TOXICITY** | **IRRITATION** |
| | Dermal (rabbit) LD50: 15800 mg/kg[2] | Eye (rabbit): 100 mg/24h-moderate |
| | Inhalation (rat) LC50: 64000 ppm/4hr[2] | Eye (rabbit): 40 mg-moderate |
| | Oral (rat) LD50: >1187-2769 mg/kg[1] | Skin (rabbit): 20 mg/24 h-moderate |
| **2-mercaptoethanol** | **TOXICITY** | **IRRITATION** |
| | Dermal (rabbit) LD50: ca.112ca.224 mg/kg[1] | Eye (rabbit): 1 mg - SEVERE |
| | Inhalation (rat) LC50: 2 mg/L/4h *[2] | Skin (rabbit): 10 mg/24h (open) |
| | Oral (rat) LD50: 32-135 mg/kg[1] | |

| | |
|---|---|
| ***Legend:*** | *1. Value obtained from Europe ECHA Registered Substances - Acute toxicity 2.* Value obtained from manufacturer's SDS. Unless otherwise specified data extracted from RTECS - Register of Toxic Effect of chemical Substances* |

| | |
|---|---|
| **GLUTARALDEHYDE** | The material may cause severe skin irritation after prolonged or repeated exposure and may produce on contact skin redness, swelling, the production of vesicles, scaling and thickening of the skin. Repeated exposures may produce severe ulceration.<br>Animal testing shows that glutaraldehyde has a high acute toxicity through inhalation and it may cause lung damage. It is corrosive to the skin and eyes and exposure to its vapours has caused irritation to the nose and breathing difficulties. It can sensitise skin and irritate the joints in animal testing.<br>Prolonged skin contact can result in absorption through the skin (although absorption rates are low) according to laboratory testing with human skin tissue. |
| **ETHYLENE GLYCOL MONOBUTYL ETHER** | For ethylene glycol monoalkyl ethers and their acetates (EGMAEs):<br>Typical members of this category are ethylene glycol propylene ether (EGPE), ethylene glycol butyl ether (EGBE) and ethylene glycol hexyl ether (EGHE) and their acetates.<br>EGMAEs are substrates for alcohol dehydrogenase isozyme ADH-3, which catalyzes the conversion |

**Continued...**

| | |
|---|---|
| | of their terminal alcohols to aldehydes (which are transient metabolites). Further, rapid conversion of the aldehydes by aldehyde dehydrogenase produces alkoxyacetic acids, which are the predominant urinary metabolites of mono substituted glycol ethers.<br>**Acute Toxicity:** Oral LD50 values in rats for all category members range from 739 (EGHE) to 3089 mg/kg bw (EGPE), with values increasing with decreasing molecular weight.<br>Exposure of pregnant rats to ethylene glycol monobutyl ether (2-butoxyethanol) at 100 ppm or rabbits at 200 ppm during organogenesis resulted in maternal toxicity and embryotoxicity including a decreased number of viable implantations per litter. Slight foetoxicity in the form of poorly ossified or unossified skeletal elements was also apparent in rats. Teratogenic effects were not observed in other species.<br>At least one researcher has stated that the reproductive effects were less than that of other monoalkyl ethers of ethylene glycol.<br>For ethylene glycol:<br>Ethylene glycol is quickly and extensively absorbed through the gastrointestinal tract. Limited information suggests that it is also absorbed through the respiratory tract; dermal absorption is apparently slow. Following absorption, ethylene glycol is distributed throughout the body according to total body water. In most mammalian species, including humans, ethylene glycol is initially metabolised by alcohol.<br>NOTE: Changes in kidney, liver, spleen and lungs are observed in animals exposed to high concentrations of this substance by all routes. ** ASCC (NZ) SDS |
| **COCOALKYL DIMETHYLBENZYLAMMONIUM CHLORIDE** | Alkyldimethylbenzylammonium chlorides are in the list of dangerous substances of council directive, classified as "harmful in contact with skin and on ingestion", and "corrosive and very toxic to aquatic organisms". It can cause dose dependent skin and eye irritation with possible deterioration of vision, possible sensitisation in those with pre-existing eczema. It does not cause cancer, genetic defect, foetal or developmental abnormality.<br>* [Manufacturer] |
| **TALL OIL FATTY ACID/ DIETHYLENETRIAMINE REACTION PRODUCTS** | FND ether amines and FND amines are very similar in structure (length of chain or degree of saturation), function and toxicity. Acute exposure to FND ether amines by oral, dermal and inhalation may produce moderate to slight toxicity but repeated skin contact can be highly irritating. However, exposure did not produce any organ-specific toxicity, genetic, reproductive or developmental defect same as in FND amines. |
| **BENZYL-C1-2-ALKYLPYRIDINIUM CHLORIDE** | Most undiluted cationic surfactants satisfy the criteria for classification as Harmful (Xn) with R22 and as Irritant (Xi) for skin and eyes with R38 and R41. |
| **TETRAKIS(HYDROXYMETHYL)PHOSPHONIUM SULFATE** | for acid mists, aerosols, vapours<br>Data from assays for genotoxic activity in vitro suggest that eukaryotic cells are susceptible to genetic damage when the pH falls to about 6.5. Cells from the respiratory tract have not been examined in this respect. Mucous secretion may protect the cells of the airways from direct exposure to inhaled acidic mists, just as mucous plays an important role in protecting the gastric epithelium from its auto-secreted hydrochloric acid. In considering whether pH itself induces genotoxic events in vivo in the respiratory system, comparison should be made with the human stomach, in which gastric juice may be at pH 1-2 under fasting or nocturnal conditions, and with the human urinary bladder, in which the pH of urine can range from <5 to > 7 and normally averages 6.2.<br>Tetrakis(hydroxymethyl)phosphonium salts (including THPS and THPC) are used as flame retardants. Animal testing showed that it can cause decreased body weight, liver cancers, and skin and eye reactions. High doses can cause congenital eye defects.<br><br>The substance is classified by IARC as Group 3:<br>**NOT** classifiable as to its carcinogenicity to humans.<br>Evidence of carcinogenicity may be inadequate or limited in animal testing.<br>Oral (rat) TDLo: 650 mg/kg/13W-I * Petrolite |
| **TALLOW ALKYLAMINE, ETHOXYLATED** | The material may produce moderate eye irritation leading to inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis.<br>Tallow derivatives used in the manufacture of cosmetic products are safe for consumption when it undergoes- transesterification or hydrolysis at 200°C, under pressure for 20 minutes (for glycerol, fatty acids and esters) ; saponification with 12 M of NaOH (for glycerol and soap) at 95°C for 3 hours; continuous process at 140°C, for about 8 minutes or its equivalent.<br>While it is difficult to generalise about the full range of potential health effects posed by exposure to the many different amine compounds, characterised by those used in the manufacture of polyurethane and polyisocyanurate foams, it is agreed that overexposure to the majority of these materials may cause adverse health effects.<br>▸ Many amine-based compounds can induce histamine liberation, which, in turn, can trigger allergic and other physiological effects, including bronchoconstriction or bronchial asthma and rhinitis.<br>▸ Systemic symptoms include headache, nausea, faintness, anxiety, a decrease in blood pressure, tachycardia (rapid heartbeat), itching, erythema (reddening of the skin), urticaria (hives), and facial edema (swelling). Systemic effects (those affecting the body) that are related to the pharmacological action of amines are usually transient. |
| **2-MERCAPTOETHANOL** | Tremors, convulsion, excitement, spasticity, respiratory depression recorded. Genetic Toxicity: AMES - Negative; Mouse Lymphoma Forward Mutation Assay - Negative; In Vitro Sister Chromatid Exchange - Negative * *Chevron Philips MSDS Genetic toxicity: Results from a number of |

**Continued...**

| | |
|---|---|
| | genotoxicity studies with microorganisms, mammalian cell culture and mammals are available. Taking into account all of the information, there is no indication that the substance is genotoxic. Reproductive toxicity: The results of animal studies gave no indication of a fertility impairing effect. The results were determined in a Screening test (OECD 421/422). Developmental toxicity/teratogenicity: A teratogenic potential cannot be excluded. The results were determined in a Screening test (OECD 421/422). Other information: Skin resorption hazard. ** BASF MSDS |
| **GLUTARALDEHYDE & TALL OIL FATTY ACID/ DIETHYLENETRIAMINE REACTION PRODUCTS & TETRAKIS(HYDROXYMETHYL)PHOSPHONIUM SULFATE & 2-MERCAPTOETHANOL** | The following information refers to contact allergens as a group and may not be specific to this product.<br>Contact allergies quickly manifest themselves as contact eczema, more rarely as urticaria or Quincke's oedema. The pathogenesis of contact eczema involves a cell-mediated (T lymphocytes) immune reaction of the delayed type. Other allergic skin reactions, e.g. contact urticaria, involve antibody-mediated immune reactions. |
| **GLUTARALDEHYDE & COCOALKYL DIMETHYLBENZYLAMMONIUM CHLORIDE & TALL OIL FATTY ACID/ DIETHYLENETRIAMINE REACTION PRODUCTS & TETRAKIS(HYDROXYMETHYL)PHOSPHONIUM SULFATE & TALLOW ALKYLAMINE, ETHOXYLATED & 2-MERCAPTOETHANOL** | Asthma-like symptoms may continue for months or even years after exposure to the material ceases. This may be due to a non-allergenic condition known as reactive airways dysfunction syndrome (RADS) which can occur following exposure to high levels of highly irritating compound. Key criteria for the diagnosis of RADS include the absence of preceding respiratory disease, in a non-atopic individual, with abrupt onset of persistent asthma-like symptoms within minutes to hours of a documented exposure to the irritant. A reversible airflow pattern, on spirometry, with the presence of moderate to severe bronchial hyperreactivity on methacholine challenge testing and the lack of minimal lymphocytic inflammation, without eosinophilia, have also been included in the criteria for diagnosis of RADS. |
| **GLUTARALDEHYDE & TETRAKIS(HYDROXYMETHYL)PHOSPHONIUM SULFATE** | Allergic reactions involving the respiratory tract are usually due to interactions between IgE antibodies and allergens and occur rapidly. Allergic potential of the allergen and period of exposure often determine the severity of symptoms. Some people may be genetically more prone than others, and exposure to other irritants may aggravate symptoms. Allergy causing activity is due to interactions with proteins. |
| **GLUTARALDEHYDE & TETRAKIS(HYDROXYMETHYL)PHOSPHONIUM SULFATE** | Attention should be paid to atopic diathesis, characterised by increased susceptibility to nasal inflammation, asthma and eczema. |
| **GLUTARALDEHYDE & TETRAKIS(HYDROXYMETHYL)PHOSPHONIUM SULFATE** | Exogenous allergic alveolitis is induced essentially by allergen specific immune-complexes of the IgG type; cell-mediated reactions (T lymphocytes) may be involved. Such allergy is of the delayed type with onset up to four hours following exposure. |
| **ETHYLENE GLYCOL MONOBUTYL ETHER & 2-MERCAPTOETHANOL** | The material may produce severe irritation to the eye causing pronounced inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis. |
| **ETHYLENE GLYCOL MONOBUTYL ETHER & METHANOL** | The material may cause skin irritation after prolonged or repeated exposure and may produce on contact skin redness, swelling, the production of vesicles, scaling and thickening of the skin. |

| | | | |
|---|---|---|---|
| **Acute Toxicity** | ✔ | **Carcinogenicity** | ⊘ |
| **Skin Irritation/Corrosion** | ✔ | **Reproductivity** | ✔ |
| **Serious Eye Damage/Irritation** | ✔ | **STOT - Single Exposure** | ⊘ |
| **Respiratory or Skin sensitisation** | ✔ | **STOT - Repeated Exposure** | ⊘ |
| **Mutagenicity** | ⊘ | **Aspiration Hazard** | ⊘ |

***Legend:*** ✘ *– Data available but does not fill the criteria for classification*
✔ *– Data required to make classification available*
⊘ *– Data Not Available to make classification*

## SECTION 12 ECOLOGICAL INFORMATION

### Toxicity

| Ingredient | Endpoint | Test Duration (hr) | Species | Value | Source |
|---|---|---|---|---|---|
| **glutaraldehyde** | LC50 | 96 | Fish | 3.5mg/L | 4 |
| **glutaraldehyde** | EC50 | 48 | Crustacea | 0.75mg/L | 4 |
| **glutaraldehyde** | EC50 | 72 | Algae or other aquatic plants | =0.61mg/L | 1 |
| **glutaraldehyde** | EC20 | 72 | Algae or other aquatic plants | =0.08mg/L | 1 |
| **glutaraldehyde** | NOEC | 96 | Crustacea | <0.089mg/L | 2 |
| **ethylene glycol monobutyl ether** | LC50 | 96 | Fish | 222.042mg/L | 3 |

**Continued...**

| | | | | | |
|---|---|---|---|---|---|
| **ethylene glycol monobutyl ether** | EC50 | 48 | Crustacea | >1000mg/L | 4 |
| **ethylene glycol monobutyl ether** | EC50 | 96 | Algae or other aquatic plants | 1081.644mg/L | 3 |
| **ethylene glycol monobutyl ether** | EC50 | 384 | Crustacea | 51.539mg/L | 3 |
| **ethylene glycol monobutyl ether** | NOEC | 96 | Crustacea | 1000mg/L | 4 |
| **tetrakis(hydroxymethyl)phosphonium sulfate** | LC50 | 96 | Fish | 94mg/L | 4 |
| **tetrakis(hydroxymethyl)phosphonium sulfate** | EC50 | 48 | Crustacea | 15mg/L | 4 |
| **tallow alkylamine, ethoxylated** | LC50 | 96 | Fish | 0.65mg/L | 4 |
| **tallow alkylamine, ethoxylated** | EC50 | 48 | Crustacea | 5.2mg/L | 4 |
| **tallow alkylamine, ethoxylated** | EC50 | 96 | Crustacea | 2mg/L | 4 |
| **methanol** | LC50 | 96 | Fish | >100mg/L | 4 |
| **methanol** | EC50 | 48 | Crustacea | >10000mg/L | 4 |
| **methanol** | BCF | 24 | Algae or other aquatic plants | 0.05mg/L | 4 |
| **methanol** | EC50 | 24 | Algae or other aquatic plants | 0.0246708mg/L | 4 |
| **methanol** | NOEC | 72 | Crustacea | 0.1mg/L | 4 |
| **2-mercaptoethanol** | LC50 | 96 | Fish | 9.125mg/L | 3 |
| **2-mercaptoethanol** | EC50 | 48 | Crustacea | 0.4mg/L | 2 |
| **2-mercaptoethanol** | EC50 | 72 | Algae or other aquatic plants | =12mg/L | 1 |
| **2-mercaptoethanol** | EC0 | 24 | Crustacea | =0.781mg/L | 1 |
| **2-mercaptoethanol** | NOEC | 72 | Algae or other aquatic plants | 1.7mg/L | 2 |
| ***Legend:*** | *Extracted from 1. IUCLID Toxicity Data 2. Europe ECHA Registered Substances - Ecotoxicological Information - Aquatic Toxicity 3. EPIWIN Suite V3.12 - Aquatic Toxicity Data (Estimated) 4. US EPA, Ecotox database - Aquatic Toxicity Data 5. ECETOC Aquatic Hazard Assessment Data 6. NITE (Japan) - Bioconcentration Data 7. METI (Japan) - Bioconcentration Data 8. Vendor Data* | | | | |

Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
Prevent, by any means available, spillage from entering drains or water courses.
**DO NOT** discharge into sewer or waterways.

## Persistence and degradability

| Ingredient | Persistence: Water/Soil | Persistence: Air |
|---|---|---|
| glutaraldehyde | LOW | LOW |
| ethylene glycol monobutyl ether | LOW (Half-life = 56 days) | LOW (Half-life = 1.37 days) |
| methanol | LOW | LOW |
| 2-mercaptoethanol | LOW | LOW |

## Bioaccumulative potential

| Ingredient | Bioaccumulation |
|---|---|
| glutaraldehyde | LOW (LogKOW = -0.1821) |
| ethylene glycol monobutyl ether | LOW (BCF = 2.51) |
| methanol | LOW (BCF = 10) |
| 2-mercaptoethanol | LOW (BCF = 0.3) |

## Mobility in soil

| Ingredient | Mobility |
|---|---|
| glutaraldehyde | HIGH (KOC = 1.094) |
| ethylene glycol monobutyl ether | HIGH (KOC = 1) |

**Continued...**

| | |
|---|---|
| methanol | HIGH (KOC = 1) |
| 2-mercaptoethanol | HIGH (KOC = 1.325) |

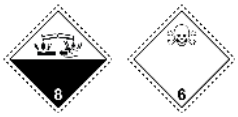
## SECTION 13 DISPOSAL CONSIDERATIONS

### Waste treatment methods

| | |
|---|---|
| **Product / Packaging disposal** | ▸ Containers may still present a chemical hazard/ danger when empty.<br>▸ Return to supplier for reuse/ recycling if possible.<br>Otherwise:<br>▸ If container can not be cleaned sufficiently well to ensure that residuals do not remain or if the container cannot be used to store the same product, then puncture containers, to prevent re-use, and bury at an authorised landfill.<br>▸ Where possible retain label warnings and SDS and observe all notices pertaining to the product.<br>Legislation addressing waste disposal requirements may differ by country, state and/ or territory. Each user must refer to laws operating in their area. In some areas, certain wastes must be tracked.<br>A Hierarchy of Controls seems to be common - the user should investigate:<br>▸ Reduction<br>▸ Reuse<br>▸ Recycling<br>▸ Disposal (if all else fails)<br>This material may be recycled if unused, or if it has not been contaminated so as to make it unsuitable for its intended use.<br>▸ **DO NOT** allow wash water from cleaning or process equipment to enter drains.<br>▸ It may be necessary to collect all wash water for treatment before disposal.<br>▸ In all cases disposal to sewer may be subject to local laws and regulations and these should be considered first.<br>▸ Where in doubt contact the responsible authority.<br>▸ Recycle wherever possible.<br>▸ Consult manufacturer for recycling options or consult local or regional waste management authority for disposal if no suitable treatment or disposal facility can be identified.<br>▸ Treat and neutralise at an approved treatment plant. Treatment should involve: Neutralisation with soda-ash or soda-lime followed by: burial in a land-fill specifically licenced to accept chemical and / or pharmaceutical wastes or Incineration in a licenced apparatus<br>▸ Decontaminate empty containers with 5% aqueous sodium hydroxide or soda ash, followed by water. |

## SECTION 14 TRANSPORT INFORMATION

### Labels Required

| | |
|---|---|
| |  |
| **Marine Pollutant** |  |
| **HAZCHEM** | 2X |

### Land transport (ADG)

| | |
|---|---|
| **UN number** | 2922 |
| **UN proper shipping name** | CORROSIVE LIQUID, TOXIC, N.O.S. (contains glutaraldehyde,tall oil fatty acid/ diethylenetriamine reaction products,tetrakis(hydroxymethyl)phosphonium sulfate,methanol and 2-mercaptoethanol) |
| **Transport hazard class(es)** | Class: 8<br>Subrisk: 6.1 |
| **Packing group** | III |
| **Environmental hazard** | Not Applicable |
| **Special precautions for user** | Special provisions: 223 274<br>Limited quantity: 5 L |

### Air transport (ICAO-IATA / DGR)

| | |
|---|---|
| **UN number** | 2922 |

**Continued...**

| | |
|---|---|
| **UN proper shipping name** | Corrosive liquid, toxic, n.o.s. * (contains glutaraldehyde,tall oil fatty acid/ diethylenetriamine reaction products,tetrakis(hydroxymethyl)phosphonium sulfate,methanol and 2-mercaptoethanol) |
| **Transport hazard class(es)** | ICAO/IATA Class: 8<br>ICAO / IATA Subrisk: 6.1<br>ERG Code: 8P |
| **Packing group** | III |
| **Environmental hazard** | Not Applicable |
| **Special precautions for user** | Special provisions: A3A803<br>Cargo Only Packing Instructions: 856<br>Cargo Only Maximum Qty / Pack: 60 L<br>Passenger and Cargo Packing Instructions: 852<br>Passenger and Cargo Maximum Qty / Pack: 5 L<br>Passenger and Cargo Limited Quantity Packing Instructions: Y841<br>Passenger and Cargo Limited Maximum Qty / Pack: 1 L |

### Sea transport (IMDG-Code / GGVSee)

| | |
|---|---|
| **UN number** | 2922 |
| **UN proper shipping name** | CORROSIVE LIQUID, TOXIC, N.O.S. (contains glutaraldehyde,tall oil fatty acid/ diethylenetriamine reaction products,tetrakis(hydroxymethyl)phosphonium sulfate,methanol and 2-mercaptoethanol) |
| **Transport hazard class(es)** | IMDG Class: 8<br>IMDG Subrisk: 6.1 |
| **Packing group** | III |
| **Environmental hazard** | Marine Pollutant |
| **Special precautions for user** | EMS Number: F-A, S-B<br>Special provisions: 223 274<br>Limited Quantities: 5 L |

### Transport in bulk according to Annex II of MARPOL and the IBC code

Not Applicable

## SECTION 15 REGULATORY INFORMATION

### Safety, health and environmental regulations / legislation specific for the substance or mixture

**GLUTARALDEHYDE(111-30-8) IS FOUND ON THE FOLLOWING REGULATORY LISTS**

Australia Exposure Standards
Australia Inventory of Chemical Substances (AICS)
Australia Hazardous Substances Information System - Consolidated Lists

**ETHYLENE GLYCOL MONOBUTYL ETHER(111-76-2) IS FOUND ON THE FOLLOWING REGULATORY LISTS**

Australia Exposure Standards
Australia Inventory of Chemical Substances (AICS)
Australia Hazardous Substances Information System - Consolidated Lists
International Agency for Research on Cancer (IARC) - Agents Classified by the IARC Monographs

**COCOALKYL DIMETHYLBENZYLAMMONIUM CHLORIDE(61789-71-7) IS FOUND ON THE FOLLOWING REGULATORY LISTS**

Australia Inventory of Chemical Substances (AICS)

**TALL OIL FATTY ACID/ DIETHYLENETRIAMINE REACTION PRODUCTS(61790-69-0) IS FOUND ON THE FOLLOWING REGULATORY LISTS**

Australia Inventory of Chemical Substances (AICS)

**BENZYL-C1-2-ALKYLPYRIDINIUM CHLORIDE(68909-18-2) IS FOUND ON THE FOLLOWING REGULATORY LISTS**

Australia Inventory of Chemical Substances (AICS)

**TETRAKIS(HYDROXYMETHYL)PHOSPHONIUM SULFATE(55566-30-8) IS FOUND ON THE FOLLOWING REGULATORY LISTS**

Australia Inventory of Chemical Substances (AICS)
International Agency for Research on Cancer (IARC) - Agents Classified by the IARC Monographs

**Continued...**

**TALLOW ALKYLAMINE, ETHOXYLATED(61791-26-2) IS FOUND ON THE FOLLOWING REGULATORY LISTS**

Australia Inventory of Chemical Substances (AICS)

**METHANOL(67-56-1) IS FOUND ON THE FOLLOWING REGULATORY LISTS**

Australia Exposure Standards | Australia Inventory of Chemical Substances (AICS)

Australia Hazardous Substances Information System - Consolidated Lists

**2-MERCAPTOETHANOL(60-24-2) IS FOUND ON THE FOLLOWING REGULATORY LISTS**

Australia Inventory of Chemical Substances (AICS)

| National Inventory | Status |
|---|---|
| Australia - AICS | Y |
| Canada - DSL | Y |
| Canada - NDSL | N (2-mercaptoethanol; methanol; tallow alkylamine, ethoxylated; tall oil fatty acid/ diethylenetriamine reaction products; tetrakis(hydroxymethyl)phosphonium sulfate; cocoalkyl dimethylbenzylammonium chloride; ethylene glycol monobutyl ether; benzyl-C1-2-alkylpyridinium chloride; glutaraldehyde) |
| China - IECSC | Y |
| Europe - EINEC / ELINCS / NLP | Y |
| Japan - ENCS | N (tallow alkylamine, ethoxylated; tall oil fatty acid/ diethylenetriamine reaction products; cocoalkyl dimethylbenzylammonium chloride; benzyl-C1-2-alkylpyridinium chloride) |
| Korea - KECI | Y |
| New Zealand - NZIoC | Y |
| Philippines - PICCS | N (benzyl-C1-2-alkylpyridinium chloride) |
| USA - TSCA | Y |
| ***Legend:*** | *Y = All ingredients are on the inventory*<br>*N = Not determined or one or more ingredients are not on the inventory and are not exempt from listing(see specific ingredients in brackets)* |

## SECTION 16 OTHER INFORMATION

### Other information

### Ingredients with multiple cas numbers

| Name | CAS No |
|---|---|
| tetrakis(hydroxymethyl)phosphonium sulfate | 55566-30-8, 58591-11-0, 65257-04-7 |

Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.
A list of reference resources used to assist the committee may be found at:
www.chemwatch.net
The SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings. Risks may be determined by reference to Exposures Scenarios. Scale of use, frequency of use and current or available engineering controls must be considered.

### Definitions and abbreviations

PC—TWA: Permissible Concentration-Time Weighted Average
PC—STEL: Permissible Concentration-Short Term Exposure Limit
IARC: International Agency for Research on Cancer
ACGIH: American Conference of Governmental Industrial Hygienists
STEL: Short Term Exposure Limit
TEEL: Temporary Emergency Exposure Limit。
IDLH: Immediately Dangerous to Life or Health Concentrations
OSF: Odour Safety Factor
NOAEL :No Observed Adverse Effect Level
LOAEL: Lowest Observed Adverse Effect Level
TLV: Threshold Limit Value
LOD: Limit Of Detection
OTV: Odour Threshold Value
BCF: BioConcentration Factors
BEI: Biological Exposure Index



**Continued...**

**end of SDS**

# Attachment 2 Vendor WMF Chemicals and Exposure Point Concentration

**Attachment 2**
**Summary of Exposure Point Concentration Development**
**(Water Treatment Chemicals)**

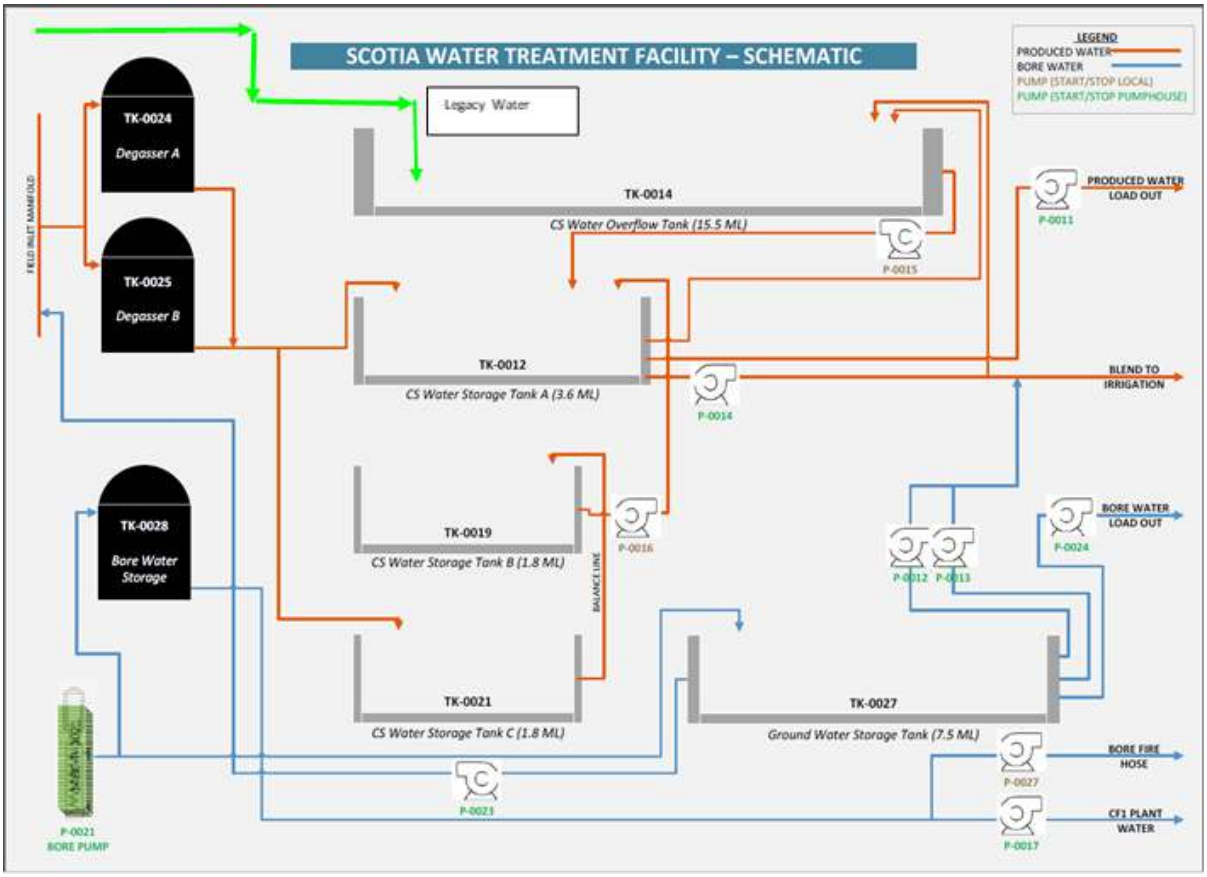
## Mass Balance

The biocide injector systems for dosing of Bactron SK-4465 into the Scotia produce water management collection network are currently maintained at set biocide rates for every unit with a total biocide rate of injection of 9.2 litres per day (L/day). The biocide rate is not adjusted based on microbially influenced corrosion (MIC) score. The following is the individual biocide injection rate across operable units:

| Unit | Biocide Rate (litres per day) |
|---|---|
| Scotia 3 | 1 |
| Scotia 7 | 1.5 |
| Scotia 9 | 0.2 |
| Scotia 11 | 1 |
| Scotia 14 | 0.5 |
| Scotia 15 | 0.5 |
| Scotia 19 | 0.5 |
| Scotia 21 | 0.7 |
| Scotia 25 | 1 |
| Scotia 28 | 0.3 |
| Man A/B | 1 |
| Man C | 1 |

The biocide injection rate or Bactron SK-4465 dosage scenario for the Scotia produce water management collection network currently treats legacy water that is collected within the Scotia water treatment facility in intermediate tank TK-0014 as shown in the Scotia Water Treatment Facility Process Flow Diagram (PFD) below. Legacy wells currently produce approximately 140 billion barrels per day (bbl/day) of produced formation water (PFW) to TK-0014, which is the combined output from the operable units in the above table. Future produce water management includes diversion of legacy wells to comingle with PFW from CF1 wells, with a PFW production of 1,240 bbl/day from CF1 wells collected in TK-0012 in the PFD. This would result in a combined PFW volume of approximately 1,380 bbl/day. The combined PFW volume is further blended for beneficial irrigation use with bore water per irrigation specifications for a ratio of approximately 60/40 combined PFW to bore water. The total combined PFW/bore water volume available for irrigation is approximately 2,300 bbl/day. The retention time in the Scotia irrigation water storage pond is approximately 5 to 10 days depending on the volume of combined PFW/bore water in the pond at the time of discharge to the irrigation areas.

**Attachment 2**
**Summary of Exposure Point Concentration Development**
**(Water Treatment Chemicals)**




Approximately 413 milligrams per litre (mg/L) of Bactron SK-4465 is being dosed (9.2 litres [L] of Bactron SK-4465 added to approximately 1,380 bbl or 2.2 x $10^5$ litres of legacy/CF1 PFW). The COPC legacy/CF1 PFW concentrations are calculated based on the product dose that is apportioned between the COPCs based on the COPC percent weight in the product (composition information in the SDS). The concentration of the COPCs in the Scotia irrigation water storage pond influent (representative of treatment of combined produced water from legacy/CF1 PFW and bore water) was based on the combined dilution from 2,300 bbl/day.

On this basis, the concentration of COPCs in the Scotia irrigation water storage pond influent are calculated as follows:

| COPC | CAS Number | Percent Weight Product | COPC Legacy/CF1 PFW (mg/L) | Scotia Irrigation Storage Pond Influent (mg/L) |
|---|---|---|---|---|
| 2-Mercaptoethanol | 60-24-2 | 1 | 2.1E-05 | 1.4E-10 |

CAS = Chemical Abstracts Service
COPC = constituent of potential concern
mg/L = milligrams per litre
PFW = produced formation water

# Attachment 3 Risk Assessment Dossier

# 2-MERCAPTOETHANOL

This dossier on 2-mercaptoethanol (2-ME) presents the most critical studies pertinent to the risk assessment of its use in drilling muds, hydraulic fracturing fluids and water treatment systems. No sufficient data exist for this particular substance. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from The National Industrial Chemicals Notification and Assessment Scheme (NICNAS, 1994) and the ECHA database that provides information on chemicals that have been registered under the European Union (EU) REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

Screening Assessment Conclusion – 2-Mercaptoethanol was not identified in chemical databases used by NICNAS as an indicator that the chemical is of concern and is not a PBT substance. 2-Mercaptoethanol was assessed as a tier 1 chemical for acute toxicity of fish and algae, a tier 3 chemical for acute toxicity of invertebrates based on a limited single acute toxicity study and a tier 2 chemical for chronic toxicity. Based on its potential for rapid degradation in the environment, it is not expected to pose a substantial toxic concern to environmental receptors. Therefore, 2-mercaptoethanol is classified overall as a **tier 2** chemical and requires a hazard assessment and qualitative assessment of risk.

## 1 BACKGROUND

2-ME is expected to rapidly degrade in the environment. It is not expected to bioconcentrate or bioaccumulate. 2-ME is metabolised to its acetate salt and excreted via urine. It is irritating and considered a sensitiser. 2-ME is not genotoxic nor is it substantially toxic via the oral route of exposure. Overall, 2-ME is moderately toxic to aquatic organisms.

## 2 CHEMICAL NAME AND IDENTIFICATION

**Chemical Name (IUPAC):** 2-sulfanylethanol
**CAS RN**: 60-24-2
**Molecular formula**: $C_2H_6OS$
**Molecular weight**: 78.14 g/mol

**Synonyms**: 2-mercaptoethanol, Mercaptoethanol, Beta-Mercaptoethanol, Thioglycol, Ethanol, 2-mercapto-,2-Sulfanylethanol

## 3 PHYSICAL AND CHEMICAL PROPERTIES

Key physical and chemical properties for the substance are shown in Table 1.

**Table 1 Overview of Physico-Chemical Properties of 2-ME**

| Property | Value | Klimisch score | Reference |
|---|---|---|---|
| Physical state at 20°C and 101.3 kPa* | Water-white liquid | 1 | ECHA |
| Melting Point | -100°C @ 101.3 kPa | 1 | ECHA |
| Boiling Point | 155.8°C @ 101.3 kPa | 1 | ECHA |
| Density | 1100 kg/$m^3$ @ 20°C | 1 | ECHA |

| Property | Value | Klimisch score | Reference |
|---|---|---|---|
| Vapour Pressure | 130 Pa @ 20°C | 1 | ECHA |
| Partition Coefficient (log $K_{ow}$) | -0.056 @ 25°C | 1 | ECHA |
| Water Solubility | 1,000 g/L @ 20°C | 1 | ECHA |
| Dissociation Constant (pKa) | 9.72 @ 25°C | 1 | ECHA |
| Viscosity | 3.22 mPa s @ 20°C | 1 | ECHA |

## 4 DOMESTIC AND INTERNATIONAL REGULATORY INFORMATION

A review of international and national environmental regulatory information was undertaken (Table 2). This chemical is listed on the Australian Inventory of Chemical Substances – AICS (Inventory). No conditions for its use were identified. No specific environmental regulatory controls or concerns were identified within Australia and internationally for 2-ME.

**Table 2 Existing International Controls**

| Convention, Protocol or other international control | Listed Yes or No? |
|---|---|
| Montreal Protocol | No |
| Synthetic Greenhouse Gases (SGG) | No |
| Rotterdam Convention | No |
| Stockholm Convention | No |
| REACH (Substances of Very High Concern) | No |
| United States Endocrine Disrupter Screening Program | No |
| European Commission Endocrine Disruptors Strategy | No |

## 5 ENVIRONMENTAL FATE SUMMARY

### A. Summary

2-ME is expected to degrade in the environment. It has a low potential for adsorption to soil or sediment and is not expected to bioconcentrate or bioaccumulate.

### B. Partitioning

2-ME is highly soluble in water. Volatilization from moist soil surfaces or water is not expected to be an important fate process based upon an estimated Henry's Law constant of $1.8X10^{-2}$ Pa-$m^3$/mole. 2-ME may volatilize from dry soil surfaces based upon its vapor pressure. Hydrolysis is not expected to be an important environmental fate process since this compound lacks functional groups that hydrolyze under environmental conditions (PubChem).

### C. Biodegradation

In an OECD 310 test, biodegradation was 69% after 60 days (ECHA) [Kl. score = 1]. In an OECD 301A test, biodegradation was <10% after 28 days (ECHA) [Kl. score = 1]. In an OECD 301C test,

biodegradation was >15% and <21% after 28 days (ECHA) [Kl. score = 2]. In an OECD 302 C test, biodegradation was 90% after 28 days (ECHA) [Kl. score = 2].

In an OECD 309 test, the mineralisation of 2-ME in surface water was determined in a GLP-compliant study following OECD guideline 309. Mineralisation was a significant route of degradation and activity recovered as carbon dioxide (CO2) increased to >60% after 14 days of incubation at two different test concentrations. Three major transformation products were detected which exceeded 10% of applied activity at both test concentrations. A transformation product reached a maximum of 26% after 4 hours (0.17 days) at the low-test concentration and a maximum of 13% after 8 hours (0.33 days) at the high test concentration, and then decreased to non-detectable amounts after 6 days of incubation (both concentrations). A transformation product reached a maximum of 36% (low test concentration) and 30% (high test concentration) after 2 days and then decreased to 14% after 9 days of incubation (low test concentration) and to <5% after 14 days of incubation (high test concentration). Another transformation product reached a maximum of 41% (low test concentration) and 39% (high test concentration) after 4 hours (0.17 days) and then decreased to non-detectable amounts after 6 days of incubation. It was concluded that 2-ME degrades quickly in water, with a half-life of 0.079 days, and no parent compound was detected in the water layers of both test concentrations after 1 day of incubation. Based on the results of the OECD 309 study, the substance degrades in the aquatic environment to a level of >70% within a 28-day period and therefore, the substance is considered to be rapidly biodegradable (ECHA) [Kl. score = 1].

If a chemical is found to be readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

### D. Environmental Distribution

As calculated using KOCWIN v2.00, the $K_{oc}$ of 2-ME is 1.904 (corrected log $K_{oc}$ = 0.2798). After exposure to soil, significant adsorption to solid soil phase (e.g. clay) is not expected (ECHA) [Kl Score=2]. Based upon this $K_{oc}$ value, if released to soil, 2-ME is expected to have very high mobility. If released into water, based on its high water solubility, it is also not expected to adsorb to suspended solids and sediment in water.

No fugacity calculations were performed as the substance has limited persistence.

### E. Bioaccumulation

No bioconcentration studies have been conducted on 2-ME. 2-ME is not expected to bioaccumulate based on the measured low experimental log $K_{ow}$ value of -0.056 at pH 7 (ECHA) [Kl. score = 2].

## 6 HUMAN HEALTH HAZARD ASSESSMENT

### A. Summary

2-ME is metabolised to its acetate salt and excreted via urine. It is irritating and considered a skin sensitiser. 2-ME is not genotoxic nor is it substantially toxic via the oral route of exposure.

### B. Acute Toxicity

The oral $LD_{50}$ values in rats are 98-169 mg/kg based on sodium-2-mercaptoethanol (CAS No. 37482-11-4) (ECHA) [Kl. score = 1].

BASF reported an oral $LD_{50}$ value of < 112 mg/kg for rabbits (study from 1967) and an oral $LD_{50}$ value of 336 mg/kg for rats (study from 1964) (ECHA) [Kl. Scores = 2].

The 4-hour whole body inhalation $LC_{50}$ in rats is 2000 mg/$m^3$. Findings indicate effects on central nervous system, respiratory and circulatory systems and possibly on the liver. (ECHA). [Kl. score 2]

The dermal $LD_{50}$ values in rabbits are 112 - 224 mg/kg, respectively. All animals (3/3) died in the high dose group with no specific resorptive intoxication symptoms. One animal (1/3) died in the mid dose group showing apathy, local reddening and edema as clinical signs. No animal (0/3) died in the low dose group showing apathy and local inflammation. (ECHA). [Kl. score = ]

**C. Toxicokinetics**

The chemical structure and the observed systemic effects after exposure via different application routes clearly indicate absorption and distribution after oral and dermal administration of 2-ME. In mammals, 2-ME is rapidly excreted via urine. 2-Mercaptoacetate was detected as the main metabolite in the urine of a person who died from ingesting 2-ME. The available in vitro and in vivo data suggest metabolism of 2-ME via formation of 2-mercaptoacetate through the combined effects of alcohol dehydrogenase and aldehyde dehydrogenase. The effects after repeated oral administration of 2-ME and sodium 2 -mercaptoacetate are similar at comparable doses, thus giving additional evidence of 2-mercaptoacetate formation as the main metabolic pathway of 2-ME.

**D. Irritation**

Application of 2-ME to the skin of rabbits for 4 hours under occlusive conditions was considered irritating (ECHA) [Kl. score = 2]. Instillation of 2-ME into the eyes of rabbits was corrosive when the eyes were not rinsed and irritating when the eyes were rinsed (ECHA) [Kl. scores = 2].

**E. Sensitisation**

2-ME was considered a skin sensitiser when tested in a guinea pig maximisation test (ECHA) [Kl. score = 2].

**F. Repeated Dose Toxicity**

2-ME was tested in a combined repeated dose toxicity study with a reproduction/developmental toxicity screening (OECD TG 407 and 422) test. Male and female Sprague Dawley (SD) rats were dosed by oral gavage with 0, 15, 50, or 75 milligrams per kilogram (mg/kg) 2-ME over a study period of about 7 weeks. No toxic effects were recorded in the 15 mg/kg animals. A slightly higher body weight gain and food consumption was seen in the >50 mg/kg females (not significant, also at higher dose levels), whereas the >50 mg/kg males showed a significant lower body weight gain (-11 to -24%) compared to controls. Ptyalism was observed in both genders at >50 mg/kg. The >50 mg/kg males showed paleness and accentuated lobular pattern of the liver at necropsy, and minimal to marked vacuolated hepatocytes was seen in the histopathologic examination accompanied by lower blood cholesterol and triglyceride. The 75 mg/kg males had significantly increased absolute and relative liver weight (22 and 36%, respectively) and minimal to slight hypertrophy of hepatocytes. In the >50 mg/kg females, absolute and relative liver weight were significantly increased, and paleness of the liver was detected at termination; histopathological examinations showed minimal to slight liver cell hypertrophy, and increased incidence and severity of vacuolated hepatocytes. The incidence and severity of cardiomyopathy was increased in the 75 mg/kg males and in the >50

mg/kg females. There were no effects seen in the hematology, seminology and urine analysis. The no observed adverse effect level (NOAEL) is 15 mg/kg-day (ECHA) [Kl. score = 1].

## G. Genotoxicity

*In Vitro* Studies

The *in vitro* genotoxicity studies on 2-ME are presented in **Table 3.**

**Table 3 *In vitro* Genotoxicity Studies on 2-ME**

| Test System | Results | | Klimisch Score | Reference |
|---|---|---|---|---|
| | -S9 | +S9 | | |
| Bacterial reverse mutation (*S. typhimurium* strains | - | - | 2 | ECHA |
| Mammalian cell gene mutation (mouse lymphoma L5178Y cells) | - | - | 2 | ECHA |
| Chromosomal aberrations (human lymphocytes) | - | - | 2 | ECHA |

*+, positive; -, negative

*In Vivo* Studies

Male and female mice were given a single intraperitoneal injection of 0, 50, 100 or 300 mg/kg 2-ME. The 300 mg/kg dose resulted in clinical signs of toxicity. The >100 mg/kg males had a decrease in the ratio of polychromatic to normochromatic erythrocytes, indicating bone marrow toxicity. The 300 mg/kg males showed a slight, but statistically significant, increase in the frequency of micronucleated polychromatic erythrocytes (MPE), but data generated in the additional analysis (further 2,000 polychromatic erythrocytes per animal evaluated) showed no significant difference between the 300 mg/kg males and the controls. There were no other increases in MPE in the other treated groups. Thus, it was concluded that 2-ME was not genotoxic in this study (ECHA) [Kl. score = 1].

## H. Carcinogenicity

No studies are available.

## I. Reproductive Toxicity/Developmental Toxicity

2-ME was tested in a combined repeated dose toxicity study with a reproduction/developmental toxicity screening (i.e., OECD TG 422) test. Male and female SD rats were dosed by oral gavage with 0, 15, 50 or 75 mg/kg 2-ME. Males were treated 5 weeks before mating, during mating and post-mating period until sacrifice after approximately 7 weeks. Females were treated 5 weeks before mating, during mating and pregnancy and lactation until day 21 post-partum inclusive except at the mid and high dose when treatment was interrupted from days 19 and 20 post coitum (PC) until delivery due to toxic effects (see below); all females were sacrificed on day 21 post-partum. There were no treatment-related effects on mating and fertility parameters at any dose level. Seminology in males revealed no effects on sperm count, motility and morphology. The estrous cycle, mating

and fertility indices, and pre-coital time were not affected, and no treatment-related effects were detected in reproductive organs on macro- or microscopic examination. Maternal toxicity was evident with deaths of pregnant females at >50 mg/kg (six dead or sacrificed on PC days 19-23 at 75 mg/kg, three dead on PC day 21 or day 2 post-partum at 50 mg/kg). Surviving females in the mid- and high-dose groups showed higher body weight gain (>52 %) and food consumption (14%; statistically significant in the high-dose group) during the pre-mating period and lactation, while those in the top-dose group had reduced body weight gain (-47% in last week of pregnancy). Effects on body weight gain and food consumption were considered by the investigators to be treatment related.

At 75 mg/kg, the duration of gestation was increased (22.3 days v 21.5 days in controls) and the number of live born pups/litter was significantly decreased due to one dam with only one live born pup. The number of females with live-born pups was reduced in the mid- and high-dose groups (7/10 and 4/10 versus 8/9 in controls; statistically significant at the high dose). Gestation indices were given as 78% and 40% in the mid- and high-dose groups compared to 100% in the low-dose group and the controls. There was no effect on sex ratio.

The primary treatment-related effect on reproduction in the TG 422 study was prolonged labour and dystocia at dose levels of >50 mg/kg. Certain aliphatic thiol compounds, including 2-ME, have been shown to act as antagonists to the neuropeptide oxytocin, blocking the contractile response of oxytocin on the rat uterus in vitro (Martin and Schild, 1965). Oxytocin is secreted primarily by the posterior pituitary gland and is critical to the normal progress of parturition and sustaining sufficient uterine contractions during labour to expel the foetus(es) and to ligate severed blood vessels within the contracted myometrium after the placenta separates, thus preventing haemorrhage. It is possible that oral administration of 2-ME to pregnant rats in the TG 422 study was sufficient to disrupt the normal oxytocin-mediated progression of parturition by diminishing uterine contractions and prolonging labour.

Slightly higher pup body weights were noted at birth in the 75 mg/kg group, probably as a result of the slight increase in the length of pregnancy. However, despite these higher pup weights at birth, mean pup body weight at 75 mg/kg was lower than control values throughout the remainder of the lactation period as a result of significantly lower pup body weight gain beginning on postnatal day 4. It is not clear whether the effects on pup body weight and survival at 75 mg/kg are the result of direct exposure to the test article in utero or via the milk or perhaps secondary to maternal care issues related to the condition of the dams or an effect on maternal milk production. Oxytocin is known to play an important role, not only in parturition, but also in milk production during lactation. Given the potential antagonistic effects of 2-ME on oxytocin, it is possible that maternal exposure to 2-ME during lactation may hinder milk production and consequently pup growth and viability.

In addition to the effects on parturition and pup body weight, mean live litter size was significantly ($p<0.5$) lower in the 75 mg/kg group compared to the control group (10.0 versus 14.9 pups). The smaller litter size at 75 mg/kg was primarily attributed to one dam (out of 4 surviving dams) that delivered a single pup. This reduction in mean live litter size correlated with higher post-implantation loss and decreased pup survival at the same dose level. However, the small number of surviving dams/litters available for evaluation at 75 mg/kg (n=3 or 4 dams) is a potential major confounding factor in establishing a relationship between these endpoints (live litter size and pup survival) and test article administration. No apparent effects on mating or fertility indices or on male reproductive parameters were observed at any dose level evaluated. The NOAELs for reproductive toxicity are 75 and 15 mg/kg-day for males and females, respectively. The NOAEL for parental

systemic toxicity is 15 mg/kg-day. The NOAEL for developmental toxicity is 15 mg/kg-day (ECHA) [Kl. score = 1].

A reproductive/developmental toxicity screening (OECD TG 421) study was conducted on sodium mercaptoacetate. 2-ME is metabolised in the body to 2-mercaptoacetate. Male and female SD rats were dosed by oral gavage with 0, 20, 40 or 80 mg/kg sodium mercaptoacetate (0, 16, 32 or 64 mg/kg mercaptoacetic acid). In the 80 mg/kg group, there were two males and one female that were found dead during the pre-mating or mating periods with no clinical signs observed before death and no relevant post-mortem findings. On gestation day (GD) 23 PC, 3/11 surviving 80 mg/kg females were found dead, all having delivered pups, although one female had one foetus in the vagina and still had 11 dead foetuses in the uterine horns at necropsy. Another pregnant female with dead and live foetuses in the uterine horns was sacrificed on GD 23 because of poor clinical condition. One additional 80 mg/kg female was prematurely sacrificed on lactation day (LD) 1 because all the pups were dead, and another female was found dead on LD 2. One 40 mg/kg female was found dead on GD 22, pregnant with dead foetuses in the uterine horns. Ptyalism [excess saliva] was observed in the > 40 mg/kg animals and may have been related to the taste of the test material. Mean body weight gains and generally feed consumption were unaffected by treatment. Vaginal cyclicity was unaffected by treatment. There were no effects on male or female mating behaviour or fertility; embryo-foetal development was considered unaffected by treatment. The 80 mg/kg females had a significantly longer gestation period (22.8 vs. 21.6 days, controls). Mean pup body weight gain was significantly lower between post-natal day (PND) 1 and 5 in the >40 mg/kg groups, but there was no treatment-related clinical signs or post-mortem findings. Sperm morphology, motility and counts were unaffected by treatment. The mean liver and kidney weights were slightly but statistically significantly higher for the 80 mg/kg males. The higher liver weights correlated with a trend towards increased glycogen content at this dose level, an effect that was considered to be toxicologically important. There were no corresponding histopathological changes for the kidney weight changes. The mean absolute seminal vesicle weights were significantly lower for the >20 mg/kg males and were dose-related; this correlated with a slight decrease in secretory content in the seminal vesicles observed microscopically of the 80 mg/kg males. The NOAEL for male reproductive toxicity is 64 mg/kg-day as mercaptoacetic acid. The NOAEL for female reproductive toxicity is 16 mg/kg-day as mercaptoacetic acid, based on deaths in late gestation and delayed delivery. NOAEL for parental toxicity is 16 mg/kg-day as mercaptoacetic acid, based on mortality. The NOAEL for offspring toxicity is 32 mg/kg-day as mercaptoacetic acid based on the dead litter at 64 mg/kg-day (ECHA) [Kl. score = 1].

Pregnant female Wistar rats were dosed by oral gavage with 0, 5, 15 or 25 mg/kg 2-ME on gestational days 6 to 19. There was no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity is 25 mg/kg-day, the highest dose tested (ECHA) [Kl. score = 1].

**J. Derivation of Toxicological Reference and Drinking Water Guidance Values**

The toxicological reference values developed for 2-ME follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

An OECD 422 study was conducted on 2-ME. Males were treated 5 weeks before mating, during mating and post-mating period until sacrifice after ca. 7 weeks. Females were treated 5 weeks before mating, during mating and pregnancy and lactation until day 21 post-partum inclusive except at the mid and high dose when treatment was interrupted from days 19 and 20 PC until delivery due to toxic effects; all females were sacrificed on day 21 post-partum. The NOAEL for female

reproductive toxicity and parental systemic toxicity is 15 mg/kg-day. The NOAEL of 15 mg/kg-day will be used to derive the oral reference dose.

*Oral Reference Dose (oral RfD)*

Oral RfD = NOAEL / ($UF_A$ x $UF_H$ x $UF_L$ x $UF_{Sub}$ x $UF_D$)

Where:
$UF_A$ (interspecies variability) = 10
$UF_H$ (intraspecies variability) = 10
$UF_L$ (LOAEL to NOAEL) = 1
$UF_{Sub}$ (subchronic to chronic) = 3
$UF_D$ (database uncertainty) = 1

Oral RfD = 15/(10 x 10 x 1 x 3 x 1) = 15/300 = 0.05 mg/kg-day

*Drinking water guidance value*

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

where:
Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)
Drinking water guidance value = (0.05 x 70 x 0.1)/2 = 0.18 mg/L

**K. Human Health Hazard Assessment Of Physico-Chemical Properties**

2-ME does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

## 7 ENVIRONMENTAL EFFECTS SUMMARY

### A. Summary

Overall, 2-ME is moderately toxic to aquatic organisms as noted below.

### B. Aquatic Toxicity

**Table 4** lists the results of acute aquatic toxicity studies on salts of 2-ME.

**Table 4 Acute Aquatic Toxicity Studies on Salts of 2-ME**

| Test Species | Endpoint | Results (mg/L) | Klimisch score | Reference |
|---|---|---|---|---|
| *Leuciscus idus* | 96-hr $LC_{50}$ | 37 | 2 | ECHA |
| *Daphnia magna* | 48-hr $EC_{50}$ | 0.4 | 2 | ECHA |
| *Desmodesmus subspicatus* | 96-hr $EC_{50}$<br>NOEC | 19<br>1.7 | 1 | ECHA |

The 21-day no observed effect concentration (NOEC) from a *Daphnia* reproduction test was determined to be >0.063 mg/L with a lowest observed effect concentration (LOEC) of 0.1264 mg/l (ECHA) [Kl. score = 1]. No other chronic toxicity studies were available.

### C. Terrestrial Toxicity

No studies are available.

### D. Calculation of PNEC

The predicted no effect concentration (PNEC) calculations for 2-ME follow the methodology discussed in DEWHA (2009).

$PNEC_{water}$: Experimental results are available for three trophic levels. Acute $EC_{50}$ values are available for fish (37 mg/L), *Daphnia* (0.4 mg/L) and algae (19 mg/L). Results from chronic toxicity studies are available for invertebrates (>0.063 mg/L) and algae (1.7 mg/L). On the basis that the data consists of short-term results from three trophic levels and long-term results from two trophic levels, an assessment factor of 50 has been applied to the lowest reported NOEC value of 0.063 mg/L for *Daphnia*. The $PNEC_{water}$ is 0.0013 mg/L.

PNEC sediment

There are no toxicity data for sediment-dwelling organisms. Moreover, the substance is not expected to substantially partition to sediments. Nonetheless, a $PNEC_{sed}$ was calculated using the equilibrium partitioning using the experimental data for $K_{ow}$ provided in **Table 1**. The $PNEC_{sed}$ is 0.00085 mg/kg sediment wet weight.

The calculations are as follows:

$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$
$= 0.836/1280 \times 1000 \times 0.0013$
$= 8.5 \times 10^{-4}$ mg/kg

Where:
$K_{sed\text{-}water}$ = suspended matter-water partition coefficient ($m^3/m^3$)
$BD_{sed}$ = bulk density of sediment ($kg/m^3$) = 1,280 [default]
$PNEC_{water}$ = 0.0013 mg/L

$K_{sed\text{-}water} = 0.8 + [(0.2 \times Kp_{sed})/1000 \times BD_{solid}]$
$= 0.8 + [(0.2 \times 0.076/1000 \times 2400]$
$= 0.836\ m^3/m^3$

And:
$Kp_{sed}$ = solid-water partition coefficient (L/kg)
$BD_{solid}$ = bulk density of the solid phase ($kg/m^3$) = 2,400 [default]

$Kp_{sed} = K_{oc} \times f_{oc}$
$= 1.94 \times 0.04$
$= 0.076$ L/kg

Where:
$K_{oc}$ = organic carbon normalised distribution coefficient (L/kg). The $K_{oc}$ was calculated via the MCI method to be 10 L/kg.
$f_{oc}$ = fraction of organic carbon in sediment = 0.04 [default].

PNEC soil

There are no $EC_{10}$ or NOEC values for terrestrial receptors. Therefore, the $PNEC_{soil}$ was calculated using the equilibrium partitioning method. The $PNEC_{soil}$ is 0.00003 mg/kg soil dry weight.
The calculations are as follows:

$PNEC_{soil} = (Kp_{soil}/BD_{soil}) \times 1000 \times PNEC_{water}$
$= (0.038/1500) \times 1000 \times 0.0013$
$= 3 \times 10^{-5}$ mg/kg

Where:
$Kp_{soil}$ = soil-water partition coefficient ($m^3/m^3$)
$BD_{soil}$ = bulk density of soil ($kg/m^3$) = 1,500 [default]
$PNEC_{water}$ = 0.0013 mg/L

And:
$Kp_{soil} = K_{oc} \times f_{oc}$
$= 1.904 \times 0.02$
$= 0.038\ m^3/m^3$

Where:
$K_{oc}$ = organic carbon normalised distribution coefficient (L/kg). The $K_{oc}$ was calculated via the MCI method to be 10 L/kg.
$f_{oc}$ = fraction of organic carbon in soil = 0.02 [default].

## 8 CATEGORISATION AND OTHER CHARACTERISTICS OF CONCERN

### A. PBT Categorisation

2-ME is readily biodegradable in the aquatic environment; thus, it does not meet the screening criteria for persistence.

No bioconcentration studies are available for 2-ME. The measured log $K_{ow}$ for 2-ME is -0.056; thus, 2-ME does not meet the screening criteria for bioaccumulation.

The chronic toxicity data on 2-ME show a NOEC of <0.1 mg/L. Thus, 2-ME meets the criteria for toxicity.

The overall conclusion is that 2-ME is not a PBT substance.

### B. Other Characteristics of Concern

No other characteristics of concern were identified for 2-ME.

## 9 SCREENING ASSESSMENT

| Chemical Name | CAS No. | Overall PBT Assessment [1] | Chemical Databases of Concern Assessment Step | | Persistence Assessment Step | | Bioaccumulative Assessment Step | Toxicity Assessment Step | | | Risk Assessment Actions Required[3] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Listed as a COC on relevant databases? | Identified as Polymer of Low Concern | P criteria fulfilled? | Other P Concerns | B criteria fulfilled? | T criteria fulfilled? | Acute Toxicity [2] | Chronic Toxicity[2] | |
| 2-Mercaptoethanol | 60-24-2 | Not a PBT | No | No | No | No | No | Yes | 1 (fish and algae), 3 (invert) | 2 | 2 |

**Footnotes:**

1 - PBT Assessment based on PBT Framework.

2 - Acute and chronic aquatic toxicity evaluated consistent with assessment criteria (see Framework).

3 - Tier 2 - Hazard Assessment and Qualitative Assessment Only. Develop toxicological profile and PNECs for water and soil and provide qualitative discussion of risk.

**Notes:**

PBT = Persistent, Bioaccumulative and Toxic

B = bioaccumulative

P = persistent

T = toxic

## 10 REFERENCES, ABBREVIATIONS AND ACRONYMS

### A. References

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

Department of the Environment, Water, Heritage and the Arts (DEWHA). (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia.e

Department of the Environment and Energy [DoEE]. (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra.

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances.

enHealth Human Risk Assessment [HHRA]. (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

Martin, PJ., and Schild, H.O. (1965). The antagonism of disulphide of polypeptides by thiols. Brit. J. Pharmacol. 25: 418-431.

NICNAS. (1994). National Industrial Chemicals Notification and Assessment Scheme (NICNAS), AGPS, Canberra, Australia.

PubChem.

### B. Abbreviations and Acronyms

| | |
|---|---|
| °C | degrees Celsius |
| AICS | Australian Inventory of Chemical Substances |
| COC | constituent of concern |
| DEWHA | Department of the Environment, Water, Heritage and the Arts |
| EC | effective concentration |
| ECHA | European Chemicals Agency |
| EU | European Union |
| g/L | grams per litre |

| | |
|---|---|
| GD | gestation day |
| GLP | Good Laboratory Practices |
| hPa | hectopascal |
| IUPAC | International Union of Pure and Applied Chemistry |
| kg | kilogram |
| kg/$m^3$ | kilograms per cubic metre |
| KI | Klimisch scoring system |
| KOCWIN™ | USEPA organic carbon partition coefficient estimation model kPa kilopascal |
| L | litre |
| L/kg | litres per kilogram |
| LC | lethal concentration |
| LD | lactation day |
| LOAEL | lowest observed adverse effect level |
| $m^3$ | cubic metre |
| MCI | molecular connectivity index |
| mg/kg | milligrams per kilogram |
| mg/kg-day | milligrams per kilogram per day |
| mg/L | milligrams per litre |
| mPa · s | millipascal second |
| MPE | micronucleated polychromatic erythrocyte |
| NICNAS | The National Industrial Chemicals Notification and Assessment Scheme |
| NOAEL | no observed adverse effect level |
| NOEC | no observed effects concentration |
| OECD | Organisation for Economic Co-operation and Development |
| Pa | pascal |
| Pa $m^3$/mol | Pa cubic meter per mol |
| PBT | Persistent, Bioaccumulative and Toxic |
| PC | post coitum |
| PND | post-natal day |
| PNEC | Predicted No Effect Concentration |
| REACH | Registration, Evaluation, Authorisation and Restriction of Chemicals |

| | |
|---|---|
| RfD | reference dose |
| SD | Sprague Dawley |
| SGG | Synthetic Greenhouse Gases |
| TG | Test Guideline |
| USEPA | United States Environmental Protection Agency |