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June 2014

**NATIONAL INDUSTRIAL CHEMICALS NOTIFICATION AND ASSESSMENT SCHEME  
(NICNAS)**

**PUBLIC REPORT**

**Ethanol, 2,2'-oxybis-, 1,1'-diformate**

This Assessment has been compiled in accordance with the provisions of the *Industrial Chemicals (Notification and Assessment) Act 1989* (the Act) and Regulations. This legislation is an Act of the Commonwealth of Australia. The National Industrial Chemicals Notification and Assessment Scheme (NICNAS) is administered by the Department of Health, and conducts the risk assessment for public health and occupational health and safety. The assessment of environmental risk is conducted by the Department of the Environment.

For the purposes of subsection 78(1) of the Act, this Public Report may be inspected at our NICNAS office by appointment only at Level 7, 260 Elizabeth Street, Surry Hills NSW 2010.

This Public Report is also available for viewing and downloading from the NICNAS website or available on request, free of charge, by contacting NICNAS. For requests and enquiries please contact the NICNAS Administration Coordinator at:

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**Director  
NICNAS**

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## SUMMARY

The following details will be published in the NICNAS *Chemical Gazette*:

ASSESSMENT REFERENCE	APPLICANT(S)	CHEMICAL OR TRADE NAME	HAZARDOUS CHEMICAL	INTRODUCTION VOLUME	USE
STD/1441	Halliburton Australia Pty Ltd	Ethanol, 2,2'-oxybis-, 1,1'-diformate	Yes	< 60 tonnes per annum	Filter cake breaker for off-shore oil and gas well drilling

## CONCLUSIONS AND REGULATORY OBLIGATIONS

### Hazard classification

Based on the available information, the notified chemical is recommended for hazard classification according to the *Globally Harmonised System for the Classification and Labelling of Chemicals (GHS)*, as adopted for industrial chemicals in Australia. The recommended hazard classification is presented in the table below.

<i>Hazard classification</i>	<i>Hazard statement</i>
Skin corrosion – Sub-category 1B	H314 - Causes severe skin burns and eye damage

Based on the available information, the notified chemical is recommended for hazard classification according to the *Approved Criteria for Classifying Hazardous Substances* (NOHSC, 2004) with the following risk phrase:

R34: Causes burns

The environmental hazard classification according to the *Globally Harmonised System for the Classification and Labelling of Chemicals (GHS)* is presented below. Environmental classification under the GHS is not mandated in Australia and carries no legal status but is presented for information purposes.

<i>Hazard classification</i>	<i>Hazard statement</i>
Acute – Category 3	H402: Harmful to aquatic life

### Human health risk assessment

Under the conditions of the occupational settings described, and provided that the recommended controls are adhered to, the notified chemical is not considered to pose an unreasonable risk to the health of workers.

When used in the proposed manner, with appropriate controls to manage accidental release, the notified chemical is not considered to pose an unreasonable risk to public health.

### Environmental risk assessment

On the basis of the PEC/PNEC ratio and the assessed use pattern, the notified chemical is not expected to pose an unacceptable risk to the environment.

### Recommendations

#### REGULATORY CONTROLS

#### Hazard Classification and Labelling

- The notified chemical should be classified as follows:
  - Skin corrosion (Sub-category 1B) - H314 - Causes severe skin burns and eye damage

The above should be used for products/mixtures containing the notified chemical, if applicable, based on the concentration of the notified chemical present and the intended use/exposure scenario.

- Due to the corrosive properties of the notified chemical the notifier should consider their obligations under the Australian Dangerous Goods Code.

#### CONTROL MEASURES

##### Occupational Health and Safety

- A person conducting a business or undertaking at a workplace should implement the following engineering controls to minimise occupational exposure to the notified chemical as introduced and diluted for use:
  - Local exhaust ventilation if the notified chemical is used in an area where vapour build-up is expected
- A person conducting a business or undertaking at a workplace should implement the following safe work practices to minimise occupational exposure during handling of the notified chemical as introduced and diluted for use:
  - Avoid contact with skin and eyes
  - Avoid inhalation of vapour
  - Clean up any spills and drips promptly
- A person conducting a business or undertaking at a workplace should ensure that the following personal protective equipment is used by workers to minimise occupational exposure to the notified chemical as introduced and diluted for use:
  - Impervious gloves
  - Chemical boots
  - Rubber apron or coverall
  - Safety glasses, goggles or face shield
  - Respiratory protection if inhalation exposure may occur
  - A shower and eyewash station or similar facilities should be available, when the notified chemical is being transferred, prior to dilution.

Guidance in selection of personal protective equipment can be obtained from Australian, Australian/New Zealand or other approved standards.

- A person conducting a business or undertaking at a workplace should ensure that sufficient controls are in place to minimise occupational exposure to the breakdown products of the notified chemical, both when generated through the intended use of the notified chemical, or when generated accidentally.
- A copy of the (M)SDS should be easily accessible to employees.
- If products and mixtures containing the notified chemical are classified as hazardous to health in accordance with the Globally Harmonised System for the Classification and Labelling of Chemicals (GHS) as adopted for industrial chemicals in Australia, workplace practices and control procedures consistent with provisions of State and Territory hazardous substances legislation should be in operation.

##### Public Health

- A person conducting a business or undertaking at a workplace should ensure that appropriate controls are in place to minimise public exposure to the notified chemical and its breakdown products, in the case of accidental release.

##### Storage

- The handling and storage of the notified chemical should be in accordance with the Safe Work Australia Code of Practice for *Managing Risks of Hazardous Chemicals in the Workplace* (SWA, 2012) or relevant State or Territory Code of Practice.

## Disposal

- The notified chemical should be treated prior to off-shore disposal, to hydrolyse and subsequently neutralize the acidic hydrolysis product.

## Emergency procedures

- Spills or accidental release of the notified chemicals should be handled by physical containment, collection and subsequent safe disposal.

## Regulatory Obligations

### *Secondary Notification*

This risk assessment is based on the information available at the time of notification. The Director may call for the reassessment of the chemical under secondary notification provisions based on changes in certain circumstances. Under Section 64 of the *Industrial Chemicals (Notification and Assessment) Act (1989)* the notifier, as well as any other importer or manufacturer of the notified chemical, have post-assessment regulatory obligations to notify NICNAS when any of these circumstances change. These obligations apply even when the notified chemical is listed on the Australian Inventory of Chemical Substances (AICS).

Therefore, the Director of NICNAS must be notified in writing within 28 days by the notifier, other importer or manufacturer:

- (1) Under Section 64(1) of the Act; if
  - the chemical is to be used for on-shore gas or oil well drilling;
  - toxicity data for the notified chemical becomes available;
  - the concentration of the chemical used for off-shore drilling applications has increased from 25%, or is likely to increase significantly;or
- (2) Under Section 64(2) of the Act; if
  - the function or use of the chemical has changed from being a filter cake breaker for off-shore oil and gas well drilling, or is likely to change significantly;
  - the amount of chemical being introduced has increased, or is likely to increase, significantly;
  - the chemical has begun to be manufactured in Australia;
  - additional information has become available to the person as to an adverse effect of the chemical on occupational health and safety, public health, or the environment.

The Director will then decide whether a reassessment (i.e. a secondary notification and assessment) is required.

### *(Material) Safety Data Sheet*

The (M)SDS of the notified chemical provided by the notifier was reviewed by NICNAS. The accuracy of the information on the (M)SDS remains the responsibility of the applicant.

## ASSESSMENT DETAILS

### 1. APPLICANT AND NOTIFICATION DETAILS

#### APPLICANT(S)

Halliburton Australia Pty Ltd (ABN: 73 009 000 775)  
Level 10, 12-14 The Esplanade  
PERTH WA 6000

#### NOTIFICATION CATEGORY

Standard: Chemical other than polymer (more than 1 tonne per year)

#### EXEMPT INFORMATION (SECTION 75 OF THE ACT)

Data items and details claimed exempt from publication: use details and import volume.

#### VARIATION OF DATA REQUIREMENTS (SECTION 24 OF THE ACT)

Variation to the schedule of data requirements is claimed as follows: all the physical-chemical endpoints with the exception of partition coefficient and all toxicological endpoints.

#### PREVIOUS NOTIFICATION IN AUSTRALIA BY APPLICANT(S)

None

#### NOTIFICATION IN OTHER COUNTRIES

China and Japan

### 2. IDENTITY OF CHEMICAL

#### MARKETING NAMES

N-FLOW 325  
BDF-325

#### CHEMICAL NAME

Ethanol, 2,2'-oxybis-, 1,1'-diformate

#### OTHER NAME

Diethylene Glycol Diformate

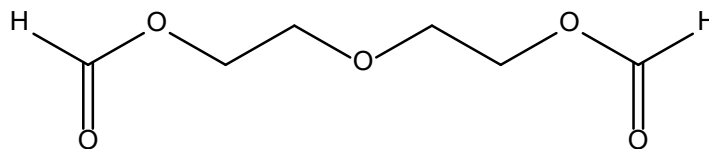
#### CAS NUMBER

120570-77-6

#### MOLECULAR FORMULA

C<sub>6</sub>H<sub>10</sub>O<sub>5</sub>

#### STRUCTURAL FORMULA



#### MOLECULAR WEIGHT

162.14 Da

#### ANALYTICAL DATA

Reference GC-MS spectrum was provided.

**IDENTITIES OF ANALOGUE CHEMICALS****ANALOGUE 1**

CHEMICAL NAME

Ethanol, 2,2'-oxybis-

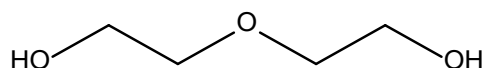
CAS NUMBER

111-46-6

MOLECULAR FORMULA

 $C_4H_{10}O_3$ 

STRUCTURAL FORMULA



MOLECULAR WEIGHT

106.12 Da

HAZARDOUS PROPERTIES

Conc  $\geq$  25%: Xn; R22**ANALOGUE 2**

CHEMICAL NAME

Formic acid

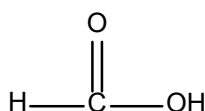
CAS NUMBER

64-18-6

MOLECULAR FORMULA

 $CH_2O_2$ 

STRUCTURAL FORMULA



MOLECULAR WEIGHT

46.02 Da

HAZARDOUS PROPERTIES

Conc.  $\geq$  90%: C; R35 $\geq$  10% Conc. < 90%: C; R34 $\geq$  2% Conc. < 10%: Xi; R36/38**ANALOGUE 3**

CHEMICAL NAME

1,2-Ethanediol, 1,2-diformate

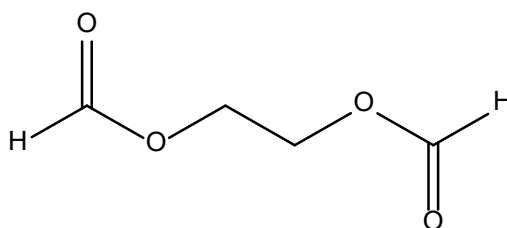
CAS NUMBER

629-15-2

MOLECULAR FORMULA

 $C_4H_6O_4$

## STRUCTURAL FORMULA



MOLECULAR WEIGHT  
118.09 Da

## 3. COMPOSITION

DEGREE OF PURITY 95%

## HAZARDOUS IMPURITIES

<i>Chemical Name</i>	Ethanol, 2-[2-(formyloxy)ethoxy]-		
<i>CAS No.</i>	54229-31-1	<i>Weight %</i>	< 5%
<i>Hazardous Properties</i>	Not listed in HSIS		
<i>Chemical Name</i>	Ethanol, 2,2'-oxybis-		
<i>CAS No.</i>	111-46-6	<i>Weight %</i>	0.1%
<i>Hazardous Properties</i>	Conc ≥ 25%: Xn; R22		
<i>Chemical Name</i>	Formic acid		
<i>CAS No.</i>	64-18-6	<i>Weight %</i>	< 0.5%
<i>Hazardous Properties</i>	Conc ≥ 90%: C; R35 ≥ 10% Conc < 90%: C; R34 ≥ 2% Conc < 10%: Xi; R36/38		

NON HAZARDOUS IMPURITIES/RESIDUAL MONOMERS (> 1% by weight) None

ADDITIVES/ADJUVANTS None

## 4. PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE AT 20 °C AND 101.3 kPa: colourless to pale yellow liquid

Property	Value	Data Source/Justification
Melting Point	< -20 °C	Measured (no study detail provided)
Boiling Point	238 °C at 101.3 kPa	Measured (no study detail provided)
Specific gravity	1.19 at 20 °C	Measured (no study detail provided)
Vapour Pressure	2.0 kPa at 20 °C	MSDS
Water Solubility	Not determined	The notified chemical is considered to be miscible with water, and is expected to react with water to release an organic acid (analogue 2) and another water soluble chemical (analogue 1).
Hydrolysis as a Function of pH	Varies with temperature, from several minutes to over 24 hours	Practical application data provided
Partition Coefficient (n-octanol/water)	Not determined	Measurement has been attempted but failed. The log P <sub>OW</sub> is expected to be low due to the high water solubility and reactivity with water of the notified chemical.



Adsorption/Desorption	Not determined	The notified chemical and the hydrolysis products are not expected to adsorb to soil/sediment based on their high water solubility.
Dissociation Constant	Not determined	The notified chemical does not have a dissociable functional group. However, one hydrolysis product is expected to have a pKa around 3.75.
Flash Point	100 °C at 101.3 kPa	Measured (no study detail provided)
Flammability Limits	Not determined	-
Autoignition Temperature	335 °C	Measured (no study detail provided)
Explosive Properties	Not determined	Contains no functional groups that would imply explosive properties
Oxidising Properties	Not determined	Contains no functional groups that would imply oxidative properties

#### DISCUSSION OF PROPERTIES

For full details of tests on physical and chemical properties, refer to Appendix A.

#### Reactivity

The notified chemical is designed to react with water during the end use to release diethylene glycol (DEG, CAS No.: 111-46-6) and formic acid (CAS No.: 64-18-6) (Todd et al. 2006). The notified chemical reacts exothermically with acids, strong oxidizing reagents and basic solutions, and may generate hydrogen when mixed with strong reducing reagents.

Carbon monoxide (CO) and carbon dioxide (CO<sub>2</sub>) have been identified as hazardous decomposition products of combustion for the notified chemical.

#### Physical hazard classification

Based on the submitted physico-chemical data depicted in the above table, the notified chemical is not recommended for hazard classification according to the *Globally Harmonised System for the Classification and Labelling of Chemicals (GHS)*, as adopted for industrial chemicals in Australia.

While not covered by this risk assessment, any physico-chemical hazards of the breakdown products of the notified chemical should be taken into account in determining the physical hazard classification of the notified chemical.

## 5. INTRODUCTION AND USE INFORMATION

#### MODE OF INTRODUCTION OF NOTIFIED CHEMICAL (100%) OVER NEXT 5 YEARS

The notified chemical will be imported at > 90% purity.

#### MAXIMUM INTRODUCTION VOLUME OF NOTIFIED CHEMICAL (100%) OVER NEXT 5 YEARS

Year	1	2	3	4	5
Tonnes	< 60	< 60	< 60	< 60	< 60

#### PORT OF ENTRY

Adelaide, Melbourne, Brisbane, Perth and Darwin

#### TRANSPORTATION AND PACKAGING

The notified chemical will be imported in 210 kg drums or 1,100 kg intermediate bulk containers. The notified chemical will be stored in warehouses upon arrival and then transported by ship to off-shore drilling sites on shrink-wrapped pallets or in totes.

#### USE

The notified chemical will be used in brine as a filter cake breaker for off-shore oil and gas well operations.

## OPERATION DESCRIPTION

*Storage*

The notified chemical will be temporarily stored at holding warehouses at entry ports. The containers containing the notified chemical will be kept in a cool and well-ventilated area with no oxidising reagents nearby, and will be transported by ship to off-shore drilling sites on shrink-wrapped pallets or in totes. Once on-site, the notified chemical will be stored in totes or in drums in the chemical storage area on the rig. The containers containing the notified chemical will be closed when not in use.

*Application*

On the off-shore oil platform, the containers containing the notified chemical will typically be handled by cranes, forklifts or hoists to be set above one of the pits on the rig for mixing. The notified chemical will be drained by gravity or pumped into the pit, dissolved in the carrier brine of choice at a concentration generally < 25%, and pumped into wells to break the filter cakes. The operations will be performed in ventilated areas, and most handling and use of the notified chemical will occur outdoor.

*Retrieval*

Upon completion of the job, the entire well volume of the liquid will be removed from the well. Although the liquid may contain some unreacted notified chemical, it is stated by the notifier that the amount will not be significant. This liquid will also contain the breakdown products analogues 1 and 2. The fluid will be pumped back into one of the pits on the rig and then discharged into the ocean in batch mode. Any remaining unused notified chemical in the pit will be neutralised with sodium hydroxide (NaOH, caustic soda) and then discharged into the ocean.

**6. HUMAN HEALTH IMPLICATIONS****6.1. Exposure Assessment****6.1.1. Occupational Exposure**

## CATEGORY OF WORKERS

<i>Category of Worker</i>	<i>Exposure Duration (hours/day)</i>	<i>Exposure Frequency (days/year)</i>
Laboratory Technicians	2	24
Blender Operator/Assistant	2	12

## EXPOSURE DETAILS

Exposure of workers to the notified chemical or its breakdown products during transport and storage will only occur in the event of an accidental release.

Dermal, ocular and inhalation exposure to the notified chemical may occur during pumping and mixing the notified chemical with the brine in the pits at the off-shore well sites, prior to pumping down the well. Dermal, ocular and inhalation exposure to the notified chemical at concentrations < 25% may occur when handling the mixture containing the notified chemical during the well operations, including during neutralisation and disposal of un-used material. It is expected that workers will wear PPE including impervious rubber gloves, rubber aprons, chemical goggles and, if necessary, face shields to reduce the potential for exposure. The open air environment at the off-shore well sites, infrequent use and relative short time of handling of the notified chemical by the workers will further reduce the likelihood of exposure.

During the end-use in the well, the notified chemical is expected to breakdown into two hydrolysis products (analogues 1 and 2). After the well treatment, the fluid containing the hydrolysis products of the notified chemical will be pumped back to the surface and workers would have potential for dermal, ocular and inhalation exposure to the hydrolysis products, until final disposal to the ocean occurs. Appropriate PPE is recommended for the workers involved in the fluid recovery and disposal operations to reduce the potential for exposure.

**6.1.2. Public Exposure**

The notified chemical is intended only for use in off-shore oil and gas well drilling and public exposure to the notified chemical or its breakdown products is not expected, unless accidental release of the notified chemical occurs during transport.

## 6.2. Human Health Effects Assessment

No toxicity data were submitted for the notified chemical. The results from toxicological investigations conducted on analogues of the notified chemical are summarised below. Full details of an *in vitro* corrosion study are in Appendix B

### ANALOGUE 1

Analogue 1 is one of the two hydrolysis products of the notified chemical during proposed off-shore application in the oil and gas well operations, and may be a metabolite of the notified chemical.

#### *Toxicokinetics, metabolism and distribution*

In animals, absorption of the analogue after oral administration is rapid and distribution occurs to all organs and tissues. In contrast, dermally administered test substance is slowly and incompletely absorbed. Information on absorption after inhalation is not available.

#### *Acute toxicity*

The analogue is of low acute toxicity in animal studies. Acute toxic doses affect the central nervous system, the kidneys and, to a lesser extent, the liver. Humans are reported to be 10 times more sensitive than animals to the analogue, for acute toxic effects.

#### *Irritation and sensitisation*

Overall, available data indicate that the analogue causes no or only minimal skin and eye irritation. Respiratory depression was reported in mice although the characteristics were reported as atypical.

#### *Repeated Dose Toxicity*

Effects from long-term oral exposure were seen predominantly in the kidney and to a lesser degree in the liver. NOAELs of 100 and 300 mg/kg bw/day were established in separate well-conducted feeding studies.

#### *Mutagenicity/Genotoxicity*

The analogue was shown to be negative in the majority of gene mutation and chromosome aberration studies *in vitro*. Indications of chromosomal damage were seen *in vivo* at high doses.

#### *Carcinogenicity*

Urinary bladder calculus and tumour formations were recorded in some long-term oral studies for the analogue in rat. Bladder tumours were found associated with the formation of bladder stones causing mechanical irritation. In more recent studies, the analogue did not demonstrate carcinogenic effects after oral administration.

#### *Toxicity for reproduction and development*

The analogue has a structural alert for developmental and reproductive toxicity (USEPA, 2010). Based on a number of studies, a NOAEL for fertility and developmental effects was established as close to 3,000 mg/kg bw/day, higher than the NOAELs established for kidney and liver effects.

#### *Observations on Human Exposure*

Incidents of human ingestion of the analogue have caused severe poisoning with typical features of toxicity including metabolic acidosis and acute renal failure. Early mortality and morbidity were high with most deaths occurring within the first 2 weeks post exposure. A small number of cases of neurologic impairment were also reported. There was a single case study reporting skin sensitisation in humans for the analogue.

### ANALOGUE 2

Analogue 2 is an organic acid. It is the second hydrolysis product of the notified chemical that is released slowly when mixed with water and rapidly forms calcium salts when applied to the wells. The notified chemical is not expected to have the same corrosive properties as Analogue 2 for exposure under normal conditions of use. Analogue 2 may also be a metabolite of the notified chemical in humans.

#### *Toxicokinetics, metabolism and distribution.*

The analogue may be absorbed via the oral route. It may generate vapours that can be taken up by inhalation. Information on dermal absorption is not available; however this would be affected by the corrosive nature of the analogue.

*Acute toxicity.*

The acute inhalation LC50 value for vapour of the analogue in rats was established as 7.4 mg/L/ 4 hour, and the inhalation LC50 for salts of the analogue were in the range from > 0.67 to > 5.16 mg/L/4 hour, in studies conducted according to, or similar to, OECD TG 403.

The analogue was not tested for dermal toxicity due to its corrosive nature. Its sodium salt was determined to have an LD50 > 2,000 mg/kg bw in a 24-hour dermal exposure study in rats, under semi-occlusive conditions (OECD TG 402).

The acute oral LD50 of the analogue in the rat was established as 730 mg/kg bw (OECD TG 401). Severe clinical signs and changes in gross pathology were seen. The LD50s of the ammonium and calcium salts of the analogue were determined to be > 2,000 mg/kg bw in rats, in studies performed to OECD protocols.

*Irritation and sensitisation.*

The analogue is corrosive to human skin and assumed to be corrosive to eyes (based on strong acidic properties) while the salts of analogue are neither corrosive nor irritating to skin. The analogue showed respiratory tract irritation. Sodium and calcium salts of the analogue showed transient eye irritation. No evidence of dermal sensitisation was noted for the analogue or a salt, in studies with Guinea pigs (maximisation).

*Repeated Dose Toxicity.*

Almost all the repeated dose studies on the analogue were conducted in rodents, which have high level of specific enzyme and coenzyme allowing them to rapidly metabolize the analogue. Humans have much lower level of the enzyme and coenzyme, and therefore might be more sensitive to the analogue chemical.

Inhalation studies on the analogue established NOAECs ranging from 0.062 mg/L/day in mice to 0.122 mg/L/day in rats, with respiratory tract irritation as the main effect. The oral repeated dose toxicity studies (dietary administration) of a salt form of the analogue showed a range of NOAELs from 50 mg/kg bw/day in rats to 400 mg/kg-bw/day in mice.

*Mutagenicity/Genotoxicity.*

Gene mutation and chromosomal aberration tests for the analogue and its sodium salt were negative based on weight of evidence evaluation. Some positive results *in vitro* were considered equivocal and possibly due to its acidic property and high dosage levels. Based on available data, the salt forms of the analogue were not mutagenic *in vitro* or *in vivo*.

*Reproductive/developmental toxicity*

Reproductive studies are not available. The NOAEL for the analogue in a developmental study in rabbits (OECD TG414) was 1000 mg/kg bw/day, the highest dose tested.

*Observations on Human Exposure.*

Severe corrosion of the lips, tongue, mouth, oesophagus, and stomach, including perforation of the stomach, were seen in several cases of accidental ingestion of products containing the analogue at concentrations of 28 to 85%. In other case reports and numerous literature citations, the analogue was shown to be corrosive to the skin.

## ANALOGUE 3

Analogue 3 is structurally similar to the notified chemical.

*Acute toxicity.*

Only limited non-GLP compliant data are available for the analogue. In an acute oral toxicity study, the LD50 was determined to be 1,510 mg/kg bw. Effects were seen primarily in the kidneys and also in the liver (Smyth et al., 1941).

Based on the analogue data, the notifier classified the notified chemical with the following risk phrase under the *Approved Criteria for Classifying Hazardous Substances* (NOHSC, 2004):

R22 – Harmful if swallowed

*Irritation and sensitisation.*

In an *in vitro* study to OECD Guidelines using Episkin, Analogue 3 was considered to be corrosive, warranting risk phrase R34. A non-GLP compliant study on the eye irritation potential of the analogue was conducted in rabbits. The study revealed evidence of necrosis and severe injury when the undiluted analogue chemical was administered to the centre of the open eye cornea for 1 minute. No further details are available in the study (Carpenter et al., 1946)

#### **Health hazard classification**

Based on the available information on Analogue 3 (Harlan (2012), the notified chemical is recommended for hazard classification according to the *Globally Harmonised System for the Classification and Labelling of Chemicals (GHS)*, as adopted for industrial chemicals in Australia. The recommended hazard classification is presented in the following table.

<b>Hazard classification</b>	<b>Hazard statement</b>
Skin corrosion – Sub-category 1B	H314 – Causes severe skin burns and eye damage

Based on the available information, the notified chemical is recommended for hazard classification according to the *Approved Criteria for Classifying Hazardous Substances* (NOHSC, 2004), with the following risk phrase(s):

R34 – Causes burns

The chemical hydrolyses into two chemicals when in contact with water.

The hydrolysis product Analogue 1 is classified under the *Approved Criteria for Classifying Hazardous Substances* (NOHSC, 2004) as:

R22 – Harmful if swallowed

The hydrolysis product Analogue 2 is classified under the *Approved Criteria for Classifying Hazardous Substances* (NOHSC, 2004) as:

R35 – Causes severe burns

### **6.3. Human Health Risk Characterisation**

#### **6.3.1. Occupational Health and Safety**

The notified chemical is classified as corrosive on the basis of an *in vitro* study on Analogue 3. It has also been classified by the notifier as acutely harmful by ingestion and . As no toxicity data on the chemical are available, other health effects cannot be ruled out. The hydrolysis products of the notified chemical, which may also be metabolites, are classified as hazardous substances.

Dermal, ocular and inhalation exposure to the notified chemical by workers, at concentrations up to 100%, may occur during the well operations involving the use of the notified chemical, or if accidental release occurs during transport or storage.

After treatment of the well with the notified chemical, the fluid containing the hydrolysis products of the notified chemical will be pumped back to the surface and workers involved in the operations will have potential for dermal, ocular and inhalation exposure to the hydrolysis products. Worker exposure to the hydrolysis product analogue 2 may be predominantly in salt form after it is pumped out of the well. Exposure to the hydrolysis products could also occur if there was accidental release of notified chemical under conditions where hydrolysis would occur, e.g. contact with water.

The end-use application of the notified chemical is expected to be conducted off-shore by skilled workers. Safe work practices and use of appropriate PPE would reduce the potential for exposure to the notified chemical and its hydrolysis products. Specifically, dermal and ocular exposure would be limited by the use of impervious gloves, protective clothing and safety glasses/goggles, as well as appropriate first aid facilities in case of accidental worker exposure. Since the operations involving the use of the notified chemical are mostly expected to occur off-shore in open areas, the potential for inhalation exposure would be reduced under these conditions.

The potential for exposure to the notified chemical or its hydrolysis products through accidental release would be reduced by safe work practices and appropriate clean-up procedures.

Under the assessed use pattern, and with appropriate controls in place, the notified chemical is not expected to pose an unreasonable health risk to workers.

### 6.3.2. Public Health

The notified chemical is intended only for use in off-shore oil and gas well drilling and public exposure to the notified chemical and its hydrolysis products is not expected. According to the assessed use pattern, and with appropriate controls in place to manage any accidental releases, the health risk of the notified chemical to the general public is not unreasonable.

## 7. ENVIRONMENTAL IMPLICATIONS

### 7.1. Environmental Exposure & Fate Assessment

#### 7.1.1. Environmental Exposure

##### RELEASE OF CHEMICAL AT SITE

The notified chemical will be imported for end use in off-shore oil and gas well operations. Therefore, no environmental release is expected from the manufacture or reformulation of the notified chemical in Australia. Release from residues in import, storage and shipping containers is expected to be minimal. This is expected to be collected for disposal to landfill with empty containers or treated properly in the container recycling process. Accidental spills of the product are expected to be absorbed with inert absorbent material, swept up and placed into containers and disposed of after appropriate treatment.

##### RELEASE OF CHEMICAL FROM USE

The notified chemical will be used in brine as a filter cake breaker during the completion phase of existing off-shore oil and gas production wells. Up to 21,900 kg of the notified chemical will be used in each well at a concentration of up to 25% and it will be allowed to remain in the well for one to two weeks. During this period, the notified chemical is expected to hydrolyse to form an organic acid (analogue 2) and another organic compound (analogue 1). The analogue 2 then is expected to break down the built-up filter cake in the well by neutralisation reaction with the  $\text{CaCO}_3$  in the cake. After the application, the pumped back liquid will be discharged into the ocean in batch mode. Considering the high concentration of metal ions available in seawater, no significant amount of residual organic acid is expected to be present in the ocean after disposal.

##### RELEASE OF CHEMICAL FROM DISPOSAL

After off-shore application, 100% of the used notified chemical is expected to be released batch-wise to the ocean, in the form of analogue 1 and metal salts of the analogue 2 in solution. Any remaining, unused fluid containing the notified chemical in the pit will be neutralised (using caustic soda) before being discharged into the ocean in the form of analogue 1 and metal salts of the analogue 2.

#### 7.1.2. Environmental Fate

The notified chemical is expected to be pumped down the well in a solution, to hydrolyse first, forming analogue 1 and acidic analogue 2. Analogue 2 will then break down the cake by reacting with  $\text{CaCO}_3$  in the cake and forming metal salt. 100% of the notified chemical is expected to be released, after use, to the ocean in the form of analogue 1 and calcium salt of analogue 2.

The notified chemical is expected to rapidly hydrolyse before it gets the opportunity to biodegrade. The biodegradability test indicates it has potential for ultimate biodegradation in marine environment. The metal salts of analogue 2 are reported as readily degradable (American Chemistry Council, 2001). For the details of the environmental fate studies, refer to Appendix C. No information on the bioaccumulation of the notified chemical is available. Based on its hydrolysability, potential for biodegradation, and the high water solubility, the notified chemical and its hydrolysis products are not expected to be bioaccumulative in aquatic organisms.

In ocean, both analogue 1 and metal salts of analogue 2 are expected to degrade by abiotic and/or biotic degradation processes, forming molecules of water, inorganic metal compounds, and oxides of carbon.

#### 7.1.3. Predicted Environmental Concentration (PEC)

The notified chemical is assumed, based on the hydrolysis reaction equation, to hydrolyse to generate 65% analogue 1 and 80% calcium salt of analogue 2 (after neutralization) that will be released to the ocean. Both chemicals are expected to stay in the water column given their high water solubilities. Since calcium is the main metal ion in well cake, the calculation for the predicted environmental concentration (PEC) for calcium

salt of analogue 2 is made and used for risk assessment purpose. The PEC is calculated using the CHARM model (Thatcher et al., 2005) assuming that the greatest effect of the chemical will occur within a radius (r) of 500 m from the discharge line.

For a worst case assumption of no dilution during use and before discharging of the solution containing the hydrolysis products, the release concentration of the calcium salt of analogue 2 can be calculated as 20% (w/w) (25% × 80%) or 0.20 kg/L assuming a density of 1 kg/L for the solution. Based on CHARM, the PEC in seawater resulting from batch-wise discharge of water-based waste can be calculated using the following equation:

$$PEC = C_{discharge} \times D_{batch}$$

Where

$C_{discharge}$  = Discharge concentration of a chemical;

$D_{batch}$  = Batchwise dilution factor

Using dilution factor of  $7.7 \times 10^{-5}$  for the cleaning process as suggested in CHARM, the PEC can be calculated as  $0.20 \text{ kg/L} \times 7.7 \times 10^{-5} = 1.54 \times 10^{-5} \text{ kg/L} = 15.4 \text{ mg/L}$  for the calcium salt of analogue 2. This is considered to be the most appropriate scenario since the notified chemical is expected to hydrolyse forming analogue 1, and most likely calcium salt of analogue 2 after application.

The PEC for the calcium salt of analogue 2 in the benthic system is not calculated as the salts are considered soluble in water, and limited amount may be adsorbed to the sediment.

## 7.2. Environmental Effects Assessment

The notifier has provided ecotoxicity data for the notified chemical to marine species, and the hydrolysis products analogue 1 and analogue 2, and the metal salts of analogue 2 for fresh water species. Analogue 1 is a water soluble neutral organic chemical, and is considered to be less toxic to the aquatic species based on predicted ecotoxicity data using ECOSAR. The risk assessment is therefore conducted based on the calcium salt of analogue 2. However, as data for the toxicity to marine species are not available, the endpoints for freshwater species have been used for risk assessment purpose. Details of these studies can be found in Appendix C or are contained in relevant public literature.

<i>Endpoint</i>	<i>Result</i>	<i>Assessment Conclusion</i>
<b><i>The notified chemical to marine species</i></b>		
Fish Toxicity	96 h LC50 = 421.7 mg/L	Not harmful to marine fish
Aquatic invertebrates Toxicity	48 h EC50 = 55.7 mg/L	Harmful to marine invertebrates
Algal Toxicity	72 h ErC50 = 315.8 mg/L	Not harmful to marine alga
Sediment re-worker	EC50 > 10000 mg/kg dry sediment	Very slightly toxic to marine sediment re-worker*
<b><i>Acidic hydrolysis product to freshwater species</i></b>		
Fish Toxicity	96 h LC50 = 68 mg/L	Harmful to freshwater fish
Daphnia Toxicity	48 h EC50 = 32.19 mg/L	Harmful to freshwater invertebrates
	21 day NOEC = 10 mg/L	Harmful to freshwater invertebrates with long lasting effects
Algal Toxicity	72 h ErC50 = 30.2 mg/L	Harmful to freshwater alga
	72 h NOEC = 6.25 mg/L	
<b><i>Metal salts of the acidic hydrolysis product to freshwater species</i></b>		
Fish Toxicity (calcium salt)**	96 h LC 50 > 1000 mg/L	Not harmful to fish
Daphnids (sodium salt)**	48 h EC50 > 1000 mg/L	Not harmful to invertebrates
Alga (sodium salt) **	72 h EC50 ~ 1000 mg/L	Not harmful to alga

\* Classified according to Mensink et al. (1995) for toxicity rating for earthworms.

\*\* Endpoints reported in the published document (American Chemistry Council, 2001), no study details are available. Based on the above endpoints, the toxicities of calcium and sodium salts to the aquatic organisms are not considered of significant difference.

The notified chemical is considered to be harmful to marine invertebrates. Based on the notified chemical's acute toxicity to marine invertebrates, the notified chemical is formally classified under the GHS as "Acute

category 3; Harmful to aquatic life". Reflecting this, the notifier classified the notified chemical as "R52: Harmful to aquatic organisms" under the Approved Criteria for Classifying Hazardous Substances (NOHSC, 2004).

The GHS classifications for long-term hazard are based on the acute endpoints due to the lack of chronic endpoints for the notified chemical. Biodegradability test of the notified chemical has been conducted in sea water and generated a degradation degree of up to 57.9%, which is just under the threshold of 60% for ready biodegradability. Noting that the test is not conducted in freshwater, and the hydrolysis product analogue 1 and calcium salt of analogue 2 are reported as readily biodegradable in freshwater, the notified chemical is considered to be readily biodegradable. Under the GHS, based on the acute toxicity endpoints for the notified chemical and the assumed ready biodegradability, the notified chemical is not classified for long-term hazard.

#### 7.2.1. Predicted No-Effect Concentration

Based on the above endpoints, the toxicities of the calcium and sodium salt of the acidic hydrolysis product to the aquatic organisms are not considered to differ significantly. Therefore, the endpoints for the sodium salt can be treated as that for the calcium salt. For calculation of the PNEC for the calcium salt of analogue 2, a safety factor of 100 was used noting that endpoints are considered available for three trophic levels. The acute endpoint of EC50 (1000 mg/L sodium salt) for alga was used.

Predicted No-Effect Concentration (PNEC) for the Aquatic Compartment	
72 h EC50 for alga	1,000 mg/L
Assessment Factor	100
PNEC:	10.0 mg/L

#### 7.3. Environmental Risk Assessment

The initial Risk Quotient (PEC/PNEC) has been calculated based on the PNEC for alga in freshwater (calcium salt of analogue 2) and the PEC for the calcium salt of the analogue 2.

Risk Assessment	PEC	PNEC	Q
Q - Ocean	15.4 mg/L	10.0 mg/L	<b>1.54</b>

The calculated Q value for water column species is above 1, indicating an unacceptable risk. However, the potential risk can be mitigated since the calculated Q value is close to 1 and, based on the following considerations:

- The endpoint used for PNEC prediction is EC50 for alga for a period of 72 hours. In the real situation, the actual concentration of the metal salts in the discharge site of the ocean is expected to be significantly decreased after disposal due to the dilution from the surrounding ocean water.
- The calcium salt (of analogue 2) is reported to be readily biodegradable (American Chemistry Council, 2001), therefore, the actual concentration of the metal salts of analogue 2 is expected to rapidly decrease with time.

Based on the above discussion, the Q value is expected to be decreased rapidly to below 1 after the disposal. Therefore, the potential risk to the aquatic species is considered acceptable based on the assessed use pattern.

The above discussion and conclusion is made based on the worst case consideration assuming the use concentration of 25% and no dilution of the liquid containing the notified chemical/hydrolysis products during and after use. Therefore, the risk may be unreasonable if the notified chemical is used at concentrations above 25%.



**APPENDIX A: PHYSICAL AND CHEMICAL PROPERTIES****Partition Coefficient (n-octanol/water)**      log Pow not established

Method	OECD TG 117 Partition Coefficient (n-octanol/water).
Remarks	HPLC Method was used. No peaks corresponding to the notified chemical could be detected. Therefore, the partition coefficient could not be determined.  Determination of the partition coefficient was also attempted via measurement of solubilities of the notified chemical in water and n-octanol. A solubility of 52.63 g/L in n-octanol was determined. A water solubility of 500 g/L was assumed and a log P <sub>OW</sub> of -0.98 was calculated. However, due to the lack of authoritative data for the water solubility, this value is not considered reliable, and therefore, is not used for risk assessment purposes.
Test Facility	STL Runcorn (2003a)

## **APPENDIX B: TOXICOLOGICAL INVESTIGATIONS**

### **B.1. Irritation – skin (in vitro) human reconstructed EPISKIN**

TEST SUBSTANCE	Analogue 3
METHOD	<i>In Vitro</i> Skin Corrosion in the EPISKIN Reconstructed Human Epidermis Model, performed according to OECD Guideline 431 “ <i>In vitro</i> skin corrosion” adopted 2004.
Vehicle	None
Remarks - Method	<p>The test involved the application of test substance for 3, 60 and 240 minutes to the EPISKIN three-dimensional human skin model, with 240 minutes exposure for the positive and negative controls. Cell viability was measured by mitochondrial dehydrogenase activity, assessed by the reduction of 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl tetrazolium bromide (MTT) to a soluble, coloured formazan product (blue). Duplicate tissues dosed with the test substance and positive/negative controls were rinsed after the exposure period, before incubation with MTT for 3 hours. The formazan is extracted and the optical density of the extractant read at 540 nm.</p> <p>Corrosive and non-corrosive substances are identified by comparing the viability values with the negative control, 0.9% solution of sodium chloride. Glacial acetic acid was used as the positive control. The viability values also distinguish between substances with R34 and R35 classification.</p>

#### RESULTS

<i>Test material</i>	<i>Exposure period (minutes)</i>	<i>Mean OD<sub>540</sub> of triplicate tissues</i>	<i>Relative mean Viability (%)</i>
<i>Negative control</i>	240	0.157	100.0*
<i>Test substance</i>	240	0.031	19.7
	60	0.076	48.4
	3	0.145	92.4
	240	0.009	5.7
<i>Positive control</i>	240	0.009	5.7

OD = optical density; SD = standard deviation

\*The mean viability of the negative control tissues is set at 100%

Remarks - Results	<p>The mean optical density obtained for the positive and negative controls met the criteria for assay acceptance.</p> <p>There was no change in the colour of the test substance/MTT solution, indicating that MTT is not reduced by the test substance.</p> <p>Based on the incubation time of the test substance needed in order to reduce mean viability to &lt;35% (&gt; 60 minutes but &lt; 240 minutes), it was considered to warrant classification as corrosive with risk phrase R34, UN Packing Group II or III, and UN GHS H314, Category 1B or 1C.</p>
CONCLUSION	The notified chemical was corrosive with risk phrase R34, under the conditions of the test.
TEST FACILITY	Harlan (2012)

## **APPENDIX C: ENVIRONMENTAL FATE AND ECOTOXICOLOGICAL INVESTIGATIONS**

### **C.1. Environmental Fate**

#### **C.1.1. Ready biodegradability**

TEST SUBSTANCE	Notified chemical
METHOD	The method detailed in STL Runcorn SOP III.36; OECD TG 306
Inoculum	Marine microorganisms
Exposure Period	28
Auxiliary Solvent	Not applied
Analytical Monitoring	The chemical oxygen demand (COD) was determined. The calculated COD value and dissolved oxygen were processed to derive the percentage (%) degradability of the test material.
Remarks - Method	The test was conducted at 3.0 and 5.0 mg/L by incubation at 18.5 °C in the dark for 28 days following closed bottle procedure. Natural seawater at pH 7.73, salinity 29.5 g l <sup>-1</sup> and dissolved oxygen level 92.0% was used after coarse filtration. Duplicate bottles of each concentration of test material and the reference compound (sodium benzoate at 2.5 mg/L), and triplicate of blank bottles were measured.

#### **RESULTS**

Day	<i>Test substance</i>		<i>Sodium benzoate</i>	
	% Degradation		Day	% Degradation
	3 mg/L	5 mg/L		
7	7.7	5.3	7	65.4
14	27.4	27.0	14	72.1
21	40.1	41.6	21	78.6
28	53.3	57.9	28	79.5

Remarks - Results	<p>The degradability of 79.5% after 28 days for the reference control demonstrated that the inoculum was biologically active.</p> <p>Under the test condition, the test substance showed some potential for degradation (53.3% and 57.9% at day 28) in the marine environment at both 3.00 and 5.00 mg/L. As indicated in the test guideline, the results of the test are not to be taken as indications of ready biodegradability, but are to be used specifically for obtaining information about the biodegradability of chemicals in marine environments.</p> <p>HgCl<sub>2</sub> test was not conducted. It is expected that the notified chemical may rapidly hydrolyse prior to biodegradation. Potential biodegradation in marine environment for the hydrolysed test substance is expected given the ultimate degree of degradation detected (close to 57.9%).</p>
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CONCLUSION	The test substance is likely to hydrolyse prior to biodegradation, and the hydrolysis products have potential for biodegradation in marine water.
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TEST FACILITY	STL Runcorn (2003b)
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### **C.2. Ecotoxicological Investigations**

#### **C.2.1. Acute toxicity to marine fish**

TEST SUBSTANCE	Notified chemical
METHOD	The test was conducted according to the procedures described in the

Species	PARCOM method 1995 and was detailed in STL Runcorn SOP III.6. – Semi-static (not available)
Exposure Period	Juvenile Turbot ( <i>Scophthalmus maximus</i> )
Auxiliary Solvent	96 hours
Salinity	Not used
Analytical Monitoring	31–34.1‰
Remarks – Method	No analytical verification of the test substance concentrations The test was conducted under semi-static conditions with replacement of media every 48 hours. The nominal concentrations tested were 100.0, 177.8, 316.2, 562.3 and 1,000.0 mg/L. Single replicates of 10 litres at each concentration, including the blank control, each containing 7 test fish were set up at a nominal temperature of $15 \pm 1.5$ °C. Artificial seawater was used for the preparation of the test solutions. The dissolved oxygen was maintained at levels between 83.3 - 95.2% of air saturation, the pH value was maintained 7.36 – 8.30, throughout the test period for both the control and treatment groups. The test pH range was in the preferred range recommended in the OECD TG203 for acute fish test.
	Methods for analysis of the test data and calculation of LC50 were not provided.

## RESULTS

Concentration mg/L Nominal	Number of Fish	Mortality (%)			
		24 h	48 h	72 h	96 h
0	7	0	0	0	0
100.0	7	0	0	0	0
177.8	7	0	0	0	0
316.2	7	0	0	0	0
562.3	7	100	100	100	100
1000.0	7	100	100	100	100

LC50	421.7 mg/L at 96 hours.
NOEC	316.2 mg/L at 96 hours.
Remarks – Results	The actual concentrations during the test period were not determined. All other validity criteria for OECD TG 203 are met. The toxicity endpoints obtained may also reflect the toxicity of the neutralised organic acid to the test species.

The LD50 was calculated by the study author to be 421.7 mg/L, which equals the geometric mean value of concentrations corresponding to the highest 0% mortality and the lowest 100% mortality.

Based on the test result, the test substance may be not harmful to the marine fish.

The notified chemical is expected to readily hydrolyse, forming an organic acid, which may lead to significant decrease in the pH of the test medium. However, this was not reported in the study. This is considered reasonable considering the presence of metal ions can neutralise the acid.

CONCLUSION	The test substance is not harmful to the marine fish.
TEST FACILITY	STL Runcorn (2003c)

**C.2.2. Acute toxicity to fish**

TEST SUBSTANCE	Analogue 2 (95.3%)
METHOD	Closely following German Industrial Standard DIN 38412, Part 15

Species	Leuciscus idus (fresh water fish) (not available) - Static
Exposure Period	96 hours
Auxiliary Solvent	Not used
Water Hardness	2.5 mmol/L
Analytical Monitoring	No analytical verification of the test substance concentrations
Remarks – Method	Each test replicates, including the blank control, contained 10 fish and 10 L test water with a loading rate of 2.8 g fish/L. The test was conducted under static conditions at 20 °C. The nominal concentrations tested were 10.0, 21.5, 46.4, and 100.0 mg/L. The dissolved oxygen was maintained at levels between 7.9 – 8.9 mg/L throughout the test period for both the control and treatment groups. The pH value was maintained 7.0 – 7.7 for the control and 10.0, 21.5 mg/L treatment groups. For the 46.4 treatment group, the pH at 1 hour dropped to 4.3 and the 96 hour pH was determined to be 7.2. For the 100 mg/L group, the pH dropped to 3.3 at 1 hour. In a separate test of the 100.0 mg/L group, the pH at 1 hour was adjusted to 7.2, and was determined to be 7.5 at 96 hours.
	Methods for analysis of the test data and calculation of LC50 were not provided.

## RESULTS

Concentration mg/L <i>Nominal</i>	Number of Fish	Mortality (%)				
		1 h	24 h	48 h	72 h	96 h
0	10	0	0	0	0	0
10.0	10	0	0	0	0	0
21.5	10	0	0	0	0	0
46.4	10	0	0	0	0	0
100.0	10	0	100	100	100	100
100.0*	10	0	0	0	0	0

\* after pH adjustment

LC50	68 mg/L at 96 hours for the acid, and > 100 mg/L for the neutralised salt.
NOEC	46.4 mg/L at 96 hours for the acid, and 100 mg/L for the neutralised salt.
Remarks – Results	The actual concentrations during the test period were not determined. All other validity criteria are met.

The test substance in the 100 mg/L group after pH adjustment is considered to be a neutralised salt, instead of the target organic acid.

The LD50 was calculated to be 68 mg/L, which is the geometric mean value of concentrations corresponding to the highest 0% mortality (46.4 mg/L) and the lowest 100% mortality (100 mg/L).

For the neutralised salt form, the LC50 is considered to be > 100 mg/L, and the NOEC = 100 mg/L.

Based on the test result, the test substance is considered harmful to fresh water fish. The neutralised form of the acid is considered not harmful to fresh water fish.

CONCLUSION	The test substance is considered harmful to fresh water fish. The neutralised form of the acid is considered not harmful to fresh water fish.
TEST FACILITY	OECD SIDS Dossier (2009)

**C.2.3. Acute toxicity to aquatic invertebrates**

TEST SUBSTANCE	Analogue 2
METHOD	Directive 79/831/EEC, Annex V, Part C (not available) - Static.

Species	<i>Daphnia magna</i> (Crustacea)
Exposure Period	48 hours
Auxiliary Solvent	Not applied
Water Hardness	2.74 mmol/L
Analytical Monitoring	No analytical verification of the test substance concentrations
Remarks - Method	The study was conducted at nominal concentrations of 0.781, 1.56, 3.12, 6.25, 12.5, 25.0, 50.0 and 100.0 mg/L and 20 - 22 °C. Treated tap water (filtration and hardness adjustment, aeration for oxygen saturation) was used as the dilution water. Four replicates each contain 5 animals were established for each test level including the blank control.
	The oxygen content was determined to be 8.59 – 8.72 mg/L at test start, and 7.73 – 8.78 mg/L at test end. The pH for the control was 8.07 at start and 7.54 at test end.

Moving average (Thompson, 1947) was used for the calculation of EC50.

## RESULTS

Concentration mg/L Nominal	Number of <i>D. magna</i>	Number Immobilised 48 h
Control	20	1
0.781	20	0
1.56	20	0
3.12	20	1
6.25	20	0
12.5	20	1
25.0	20	2
50.0	20	20
100.0	20	20

EC50	32.19 mg/L at 48 hours
NOEC	12.5 mg/L at 48 hours
Remarks - Results	As expected the decrease in pH was observed with the increase of the concentration: 3.74 at test start and 3.59 at the end for the top concentration.
	The study author claimed a NOEC of 25 mg/L. However, the immobility of 10% observed at this test level is considered to be biologically significant, and dose response can also be observed at this level. Therefore, the NOEC is determined to be 12.5 mg/L when 5% of immobility was observed.
	The test substance is considered to be harmful to <i>Daphnia magna</i> based on the test results.

CONCLUSION The test substance is considered to be harmful to *Daphnia magna*.

TEST FACILITY OECD SIDS Dossier (2009)

### C.2.4. Chronic toxicity to aquatic invertebrates

TEST SUBSTANCE	Analogue 2 (99.4%)
METHOD	OECD TG 211.
Species	<i>Daphnia magna</i> (Crustacea)
Exposure Period	21 days
Auxiliary Solvent	Not applied
Analytical Monitoring	No analytical verification of the test substance concentrations
Remarks - Method	The study was conducted at nominal concentrations of 0.0, 1.0, 3.2, 6.25,

10, 32 (neutralised), and 100.0 (neutralised) mg/L and 19.5 – 20.4 °C. Ten replicates each containing 1 animal were established for each test level including the blank control. The test solutions were renewed every 48 hours or 72 hours (Monday, Wednesday and Friday).

The oxygen content was determined to be 8.0 – 9.5 mg/L. The test pH was in the range of 7.0 – 8.3. Artificial light (type warm white) was used for irradiation following a 16 h light/8 hour dark scheme.

Number of young daphnids, mortality, embryos, aborted eggs were recorded on a daily basis. Weight and length of the parent animals were also measured at the test end.

Dunnett's test was used for statistical analysis of the test data and determination of NOEC.

## RESULTS

Concentration mg/L Nominal	Total number of living young per surviving parent after 21 day exposure	
	mean	sd (cv, %)
Control	109.7	15.8 (14.4)
1	102.6	7.5 (7.33)
3.2*	110.2	14.8 (13.4)
10	108.7	19.0 (17.5)
32n	105.5	14.6 (13.8)
100n	110.0	11.9 (10.8)

\*: 1 parent animal died on day 16;

n: neutralised.

EC50 > 10 mg/L at 21 day for the acid, and > 100 mg/L for the neutralised salt.  
 NOEC 10 mg/L at 21 day for the acid, and 100 mg/L for the neutralised salt.  
 Remarks - Results Due to the rapid hydrolysis of the notified chemical, the actual test concentrations were not monitored. All other test validity criteria are considered met.

No significant differences between the treatment and control groups in animal weight and length have been observed during the test. No significant effects can be observed regarding parent mortality and reproduction. However, considering the notified chemical at the two top concentrations have been neutralised, the test outcome for these two groups are not considered to be representative of test substance. Therefore, the NOEC is determined to be 10 mg/L, and the EC50 is considered to be > 10 mg/L.

For the neutralised salt form, the EC50 is considered to be > 100 mg/L and the NOEC = 100 mg/L.

The test substance is considered to not be chronically harmful to *Daphnia magna* based on the NOEC value (i.e. NOEC ≥ 1 mg/L).

CONCLUSION The test substance is considered to not be chronically harmful to *Daphnia magna*.

TEST FACILITY OECD SIDS Dossier (2009)

### C.2.5. Acute toxicity to marine invertebrates

TEST SUBSTANCE Notified chemical

METHOD Draft method ISO 14669: 1999 (E) and as detailed in STL Runcorn SOP

Species	III.14. – Static (not available).
Exposure Period	<i>Acartia tonsa</i>
Auxiliary Solvent	48 hours
Salinity	Not applied
Analytical Monitoring	32.0 g/L
Remarks - Method	No analytical verification of the test substance concentrations
	The study was conducted at nominal concentrations of 20.0, 35.6, 63.2, 112.5, 200.0, and 355.6 mg/L and $15 \pm 2$ °C. Filtered seawater having dissolved oxygen at 95.8% of air saturation and a pH 8 was used for the preparation of the test solutions. A blank (seawater only) and a reference control using 3,5-dichlorophenol (DCP) at 1.0 mg/L were also established. Information regarding the number of animals and replicates per concentration was not provided in the study report.

The EC50 was calculated using a computer programme Toxcalc.

## RESULTS

Concentration mg/L Nominal	Number of <i>Acartia tonsa</i>	Immobilisation (%) 48 h
Control	N/A	10
20.0	N/A	30
35.6	N/A	40
63.2	N/A	50
112.5	N/A	100
200.0	N/A	100
355.6	N/A	100
50.0	N/A	100
DCP 1.0 mg/L	N/A	85

N/A: Not available.

EC50	55.7 mg/L at 48 hours
NOEC	Not established (< 20 mg/L)
Remarks - Results	The study author claimed a NOEC of 25 mg/L. However, the immobility of 10% observed at this test level is considered to be biologically significant, and dose response can also be observed at this level. Therefore, the NOEC is determined to be 12.5 mg/L when 5% of immobility was observed.
	The test substance is considered to be harmful to marine invertebrates <i>Acartia tonsa</i> based on the test results.
	Due to the lack of information indicated above, the study reliability cannot be judged and therefore, the test results need to be taken with caution.

CONCLUSION The test substance is considered to be harmful to marine invertebrates.

TEST FACILITY STL Runcorn (2003d)

### C.2.6. Marine Algal growth inhibition test

TEST SUBSTANCE	Notified chemical
METHOD	The study was conducted according to the procedure described in ISO/DIS 10253 and as detailed in STL Runcorn SOP III.19 (not available).
Species	<i>Skeletonema costatum</i>
Exposure Period	72 hours
Concentration Range	Nominal: 100.0, 177.8, 316.2, 562.3, and 1,000.0 mg/L
Auxiliary Solvent	Not applied
Test media	Gillard's f/2 medium + Si (no detailed information provided)



Analytical Monitoring  
Remarks - Method

No analytical verification of the test substance concentrations  
The study was conducted at five concentrations plus a blank control and a reference control at  $20 \pm 2$  °C, with an initial cell density of 10,000 cells/mL. The reference control used 3,5-dichlorophenol (DCP) at 1.5 mg/L. Six replicates for the blank control and three replicates for all the treatment groups and reference control were established.

The dissolved oxygen in all the test media was maintained at 87.4 – 98.7% of the air saturation, and the pH 8 for the (blank and reference) controls ranged 7.34 – 8.49 throughout the test.

The EC50 was calculated using a computer programme Toxcalc.

RESULTS

<i>Growth</i>	
<i>ErC50 (mg/L at 72 h)</i>	<i>NOEC (mg/L at 72 h)</i>
315.8 (95% fiducial limits 234.7 – 424.8)	< 100

Remarks - Results

Significant decrease in pH values for the treatments was observed with the increase in concentration and exposure time, with a reported pH of 4.53 at 72 hours for the 1,000 mg/L group.

The reference control revealed an inhibition (> 100%) greater than the acceptable tolerance of 80% after 48 and 72 hours. This is not considered an indication for less reliability of the test results considering the control growth (cell increase factor of 141) is acceptable. Other validity criteria cannot be judged since no details for the test data were provided. This may be acceptable since the determined EC50 is highly above 100 mg/L, indicating that the test substance is not harmful to the test species.

The NOEC was considered to be less than the lowest test concentration of 100 mg/L, and therefore, was not established.

CONCLUSION

The test substance is not harmful to marine algae.

TEST FACILITY

STL Runcorn (2003e)

**C.2.7. Algal growth inhibition test**

TEST SUBSTANCE

Analogue 2

METHOD

German Industrial Standard DIN 38412, Part 9 (not available)

Species

Desmodesmus subspicatus

Exposure Period

72 hours

Concentration Range

0.78, 1.56, 3.13, 6.25, 12.5, 25, and 50 mg/L

Auxiliary Solvent

Not applied

Water Hardness

Analytical Monitoring

No analytical verification of the test substance concentrations

Remarks - Method

The study was conducted in non-sealed vessels at seven concentrations plus a blank control at 20 °C. The initial cell density used was 10,000 cells/mL. Six replicates for the blank control and each of the treatment groups were established. Continuous artificial light at about 120 µE/(m<sup>2</sup>·s) was used.

## RESULTS

<i>Biomass</i>		<i>Growth</i>	
<i>EbC50</i> <i>mg/L at 72 h</i>	<i>NOEC</i> <i>mg/L at 72 h</i>	<i>ErC50</i> <i>mg/L at 72 h</i>	<i>NOEC</i> <i>mg/L at 72 h</i>
26.9 (95% CI 24.3 – 35.1)	6.25	30.2	6.25

## Remarks - Results

Significant decrease in pH values for the treatments was observed with the two highest concentrations, with a reported pH of 8.9 for the 25 mg/L and 4.9 for the 50 mg/L group at 96 hours. All other criteria for OECD TG 201 were met.

The test substance is considered to be harmful to fresh water alga based on the determined ErC50.

## CONCLUSION

The test substance is harmful to fresh water alga

## TEST FACILITY

OECD SIDS Dossier (2009)

**C.2.8. Sediment re-worker test**

## TEST SUBSTANCE

Notified chemical

## METHOD

The study was conducted according to the method detailed in STL Runcorn SOP III.33, a procedure based on the protocol published by PARCOM (1995) (not available).

## Species

*Corophium volutator* (freshly dug from the North Wales coast, free of malformation and of good health)

## Exposure Period

10 days

## Auxiliary Solvent

Not applied

## Test Concentrations

0, 1000.0, 1778.3, 3162.3, 5623.4, and 10000.0 mg/kg dry weight of sediment

## Analytical Monitoring

No analytical verification of the test substance concentrations

## Remarks - Method

The test organisms were introduced to sediment containing the test substance over the concentration range of 1,000.0 to 10,000.0 mg/kg dry weight of sediment and exposed for a period of ten days in a static test at 14 - 15 °C. Three replicates were prepared for each test concentration and five replicates for the control. Test organisms were added to the spiked and control sediments at a density of 20 per vessel. Ambient laboratory lighting was used.

Sediment was collected from the same site as the amphipods and sieved to remove organisms and debris. Artificial seawater with a salinity between 25 and 35 ‰ was used as the dilution media.

Test organisms were observed at intervals during the 10 days of the study with regard to swimming, behaviour and mortality. At the end of the study, sediment was resuspended, sieved and mortality data recorded. Organisms which became opaque and were observed lying on the surface of the sediment during the study were recorded as mortalities. Organisms exhibiting no movement and failing to respond to tactile stimulus at the end of the study were recorded as mortalities.

The dissolved oxygen was determined to be above 79.9% of air saturation throughout the test period for all the treatment and control replicates. The pH values were 8.25 – 8.56 for all the vessels at day 10. However, decrease of pH in higher concentration treatments was observed at day 0 (6.65 – 6.86 for the 10,000.0 treatment replicates).

The EC50 together with 95% fiducial limits and a No Observed Effect

Concentration (NOEC) were calculated using Toxcalc.

## RESULTS

Mortality for *Corophium volutator* exposed to the test substance

Concentration (mg/kg)	Total mortality (%)
Control	14
1,000.0	15
1,778.3	5
3,162.3	28
5,623.4	18
10,000.0	32

### Remarks - Results

From this study the 10 day EC50 value was found to be >10,000.0 mg/kg dry weight of sediment.

The No Observable Effect (NOEC) was calculated to be 10,000.0 mg/kg by study author. Since, significantly higher mortality was observed at this top test level, a NOEC of 1778.3 mg/kg dry sediment is determined.

The test substance is considered very slightly toxic to the sediment organisms according to Mensink *et al.* (1995) for toxicity rating for earthworms.

### CONCLUSION

The test substance is very slightly toxic to the sediment re-worker.

### TEST FACILITY

STL Runcorn (2003f)

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