When I'm working on a problem,
I never think about beauty. I think
only how to solve the problem. But
when I have finished, if the solution
is not beautiful, I know it is wrong.
Richard Buckminster Fuller

Mechanical Engineering
Lighting Design
Sustainable Design
Electrical Engineering

Copenhagen
London
Sydney
Hong Kong
New York

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BUILDING SERVICES

STEENSEN VARMING

State Significant Development Application SSD 6471 Sea Water Heat Exchange Report

Sydney, October 31 2017
Project No. 14702

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Project	Art Gallery of NSW Expansion - Sydney Modern Project	**Document No**	14702 can020
Subject	Sea Water Heat Rejection Systems	**Revision**	04

1.0 Executive Summary

As part of the Art Gallery of NSW (AGNSW) expansion - Sydney Modern Project, it is proposed to use a sea water heat exchange building cooling system. This type of system is well proven in Sydney and its use will significantly reduce the building's energy and water consumption when compared to a traditional air cooled alternatives. The system is an example of the design initiatives included in the project as part of the Sydney Modern Project's commitment to Ecologically Sustainable Development (ESD) and making the project as 'green' as possible.

This report provides a description of the proposed sea water heat exchange system. It covers the engineering aspects of the mechanical services systems proposed and is not an exhaustive compliance document for all aspects associated with the system.

Regulatory requirements as defined by the relevant authorities namely the NSW Office of Environment and Heritage (OEH) and the Department of Agriculture and Water Resources , place a limit on the maximum temperature differential between the intake and discharge of the sea water system. The design of the system ensures that these limits will not be exceeded.

Regulatory requirements also stipulate that only certain products and treatments can be used as antifouling agents to prevent fouling of the seawater pipework. An anti fouling regime incorporating Mexcel as an antifouling agent in tandem with a freshwater flushing system are proposed.The selected anti fouling agent is approved and licensed by the appropriate regional and national authority.

The design will need to be compliant with the relevant regulatory requirements and will achieve a result that is beneficial to both the environment and the Art Gallery of NSW expansion - Sydney Modern Project.

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2.0 Introduction

This report is provided to cover the proposed sea water heat exchange system as part of the Sydney Modern development. It covers the engineering aspects of the mechanical services systems proposed and is not an exhaustive compliance document for all aspects associated with the system.

The proposed Sydney Modern Project is designed with a number of Ecologically Sustainable Development (ESD) initiatives so as to minimise the overall environmental effects resulting from day to day operation of the building. One of the ESD initiatives to aid in the conservation of water and energy is a seawater heat exchange system to be used as a source of heat rejection for cooling of the developments mechanical plant.

The use of sea water for cooling in an air conditioning system is a tried and proven technology. There are several key examples of this technology in Sydney Harbour - including the following:

- Sydney Opera House
- AMP Building
- Museum of Contemporary Art (MCA)
- Sydney Convention and exhibition centre
- Barangaroo Development

This report has been prepared for submission to the Department of Planning SEARS application and will address the following points:

- Rationale for using a seawater heat exchange system
- Regulatory requirements
- Operational parameters
- Design and installation details

3.0 Description of Project Works

The Art Gallery of NSW proposes to undertake a major expansion of the existing art gallery in the eastern part of the Domain. The expansion is located north of the existing gallery, partly extending over the Eastern Distributor land bridge and includes a disused Navy fuel bunker located to the north east of this land bridge. The new expansion, known as the Sydney Modern Building, comprises a new entry plaza, new exhibition spaces, shop, food and beverage facilities, visitor amenities, art research and education spaces, new roof terraces and landscaping and associated site works and infrastructure, including loading and service areas, services infrastructure and an ancillary seawater heat exchange system.
Development consent is sought for:

- Site preparation works, including:
  - Site clearing, including: demolition of former substation, part of road surfaces, kerbs and traffic islands, pedestrian crossings, foot paths, retaining walls, stairs, and part of disused underground former Navy fuel bunkers;
  - Tree removal;
- Excavation and site earthworks;
- Remediation works;

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- Construction of the Sydney Modern Building comprising:
  - Covered public plaza;
  - Entry pavilion and five building levels following the site topography down to Lincoln Crescent;
  - Retention of part of existing disused underground former Navy fuel bunker for use as gallery space and support spaces;
  - Art gallery spaces;
  - Outdoor terraces;
  - Shop, café and restaurant;
  - Multipurpose space;
  - Education spaces;
  - Ground level loading dock (accessed via Lincoln Crescent) with associated workshops, service parking, plant, and storage areas.
- New open staff and administration visitor carpark to rear of art gallery building;
- Landscaping and public domain improvements including:
  - Continuation of the east-west pedestrian link between the Domain and Woolloomooloo Bay, including dedicated lift structure for disability access~~;~~
  - Hard and soft landscaping to roof terraces;
  - Planter beds and new pathways;
  - Increased landscaped area to forecourt of existing Art Gallery building;
  - Relocation of selected trees to the south-eastern corner of the site;
  - Sound barrier to edge of land bridge;
- Upgrade works to part of Art Gallery Road, Cowper Wharf Road, Mrs Macquaries Road, and Lincoln Crescent, including new pedestrian crossings;
- Provision of vehicle drop off points including a taxi stand, private vehicle drop off and bus/coach drop off, at Art Gallery Road;
- Installation of an ancillary seawater heat exchange system to act as the new building's cooling system, adjacent to and within Woolloomooloo Bay;
- Diversion, extension and augmentation of physical infrastructure and utilities as required.

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4.0 Addressing SEARS requirements

4.1 Rationale for using sea water heat exchange system

The key drivers for the selection of a sea water heat exchange system for Sydney Modern Project are outlined below:

- **ENERGY & CO2 REDUCTIONS**
  The use of Sea Water heat rejection can provide reduced energy consumption over traditional heat rejection systems such as cooling towers or air cooled chillers and therefore provide reduced C02 emissions.

- **WATER USAGE REDUCTION**
  The use of a sea water heat exchange system achieves significant water savings when compared to a conventional cooling tower system.

- **REDUCED RISK OF LEGIONNAIRES DISEASE**
  The environment in a cooling tower provides a fertile breeding ground for various water borne diseases, in particular legionnaire's disease. To prevent contamination cooling towers require strict water treatment regimes. The use of a sea water heat exchange system removes this risk as the system operates as a closed loop system.

- **AESTHETIC CONSIDERATIONS**
  Sydney Modern will be an iconic building in Sydney's landscape, located in a prominent position. As such it forms an integral part of the harbour view for which Sydney is renowned. The use of a sea water heat exchange system removes the need for visible cooling towers or air cooled equipment within the landscape and is more in keeping with the design and commitment to ESD. It also provides an opportunity for the gallery to educate its visitors about ESD initiatives.

- **ACOUSTIC CONSIDERATIONS**
  All components of a sea water heat exchange system would be away from areas and spaces occupied by the public. As a result there will not be the unwanted noise of which would be created by external plant associated with air cooled systems or water cooled cooling towers.

4.2 Regulatory Requirements

Fig 4.2A below shows the parts of SEARS part 12 covered in this report.

12. Drainage and Stormwater

- Prepare a Stormwater and Drainage Assessment to assess the impacts of the proposal on surface and groundwater hydrology and quality.
- Detail any excavation works that would encounter groundwater, the quality of the groundwater to be disturbed and the measures to manage groundwater discharge.
- Identify appropriate water quality management measures focussing on the management of the impacts from the proposed works.
- Detail management techniques, including the use of anti-fouling chemicals, for the maintenance of the seawater heat exchange system.
- Identify the potential impacts associated with the use of anti-fouling chemicals on water quality and marine ecosystems and outline the mitigation measures to manage any potential overdosing.
- Prepare a Water Management Plan. This should include stormwater and wastewater management, including any re-use and disposal requirements, demonstration of water sensitive urban design and any water conservation measures.
- Undertake an assessment of the hydrogeological setting and identify potential impacts associated with any dewatering activities;
- The application must address water quality and water cycle management of the seawater heat exchange system, including information and assessment of:
  - the proposed intake and discharge of sea water, including flow rates, temperatures, plumes, turbidity and deposits;
  - the impacts on water quality and circulation of Sydney Harbour and Woolloomooloo Bay; and
  - how the project will be designed, constructed and maintained and proposed management, monitoring and mitigation measures.

→ *Relevant Policies and Guidelines*

- Australian and New Zealand Water Quality Guidelines for Fresh and Marine Water 2000 (ANZECC, 2000)
- Protection of the Environment Operations Act 1997
- Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (OEH)

Fig 4.2A

The system designed shall be designed in accordance with the following:

- *Australian and New Zealand Environment Conservation Council (ANZECC) Guidelines for Marine and Freshwater Quality (2000).*
- *Protection of the Environmental Operations Act 1997*
- Pesticides Act 1999.
- Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (OEH)

5.0 System Description

The proposed Sea Water heat rejection system shall be an open loop system comprised of the following key elements:

- A harbour water intake below minimum low tide level
- Pipework to and from the building plantroom where associated pumps and heat exchangers will be located
- A discharge point located below the minimum low tide level
- The combined use of an anti fouling agent and freshwater will prevent marine growth in the system.

Please refer to figure 8.0A for plan layout.

6.0 Operating Parameters

Depending on the balance of the heating and cooling loads within the building the system will absorb or reject heat into the sea water via the heat exchangers. The maximum rate of exchange will occur in the summer and will result in an estimated net heat rejection capacity of approximatly 1600 kW.

The temperature difference across the intake and discharge water shall meet the regulation standards. The standards dictate that a temperature difference of no more than 2 degrees shall be acheived from the point of intake and a point of discharge as determined by a thermal discharge model to be carried out by the sea water ecologist.

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7.0 Sea water intake & discharge

The intake from the harbour will incorporate an angled mesh basket set out from the intake foot valve (see fig 7.0A). The foot valve serves to prevent loss of water if the system is shut down. For ease of servicing and inspection this will be able to be rotated upwards. The locations of the sea water intake and discharge are to be confirmed.

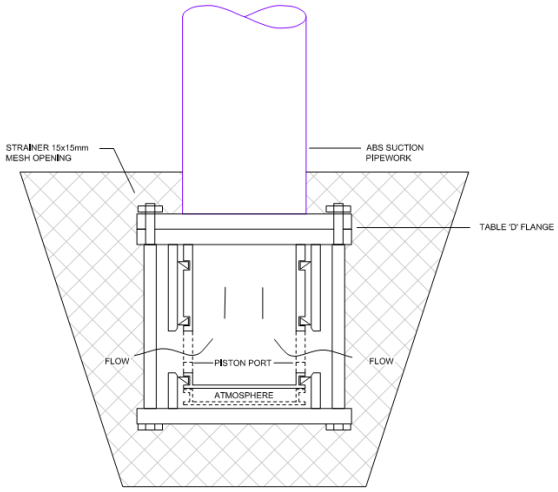

Fig 7.0A

8.0 Pipework route

The intake and discharge for the proposed sea water system will be located within a suitable location in the adjacent wharf (See Fig 8.0A).

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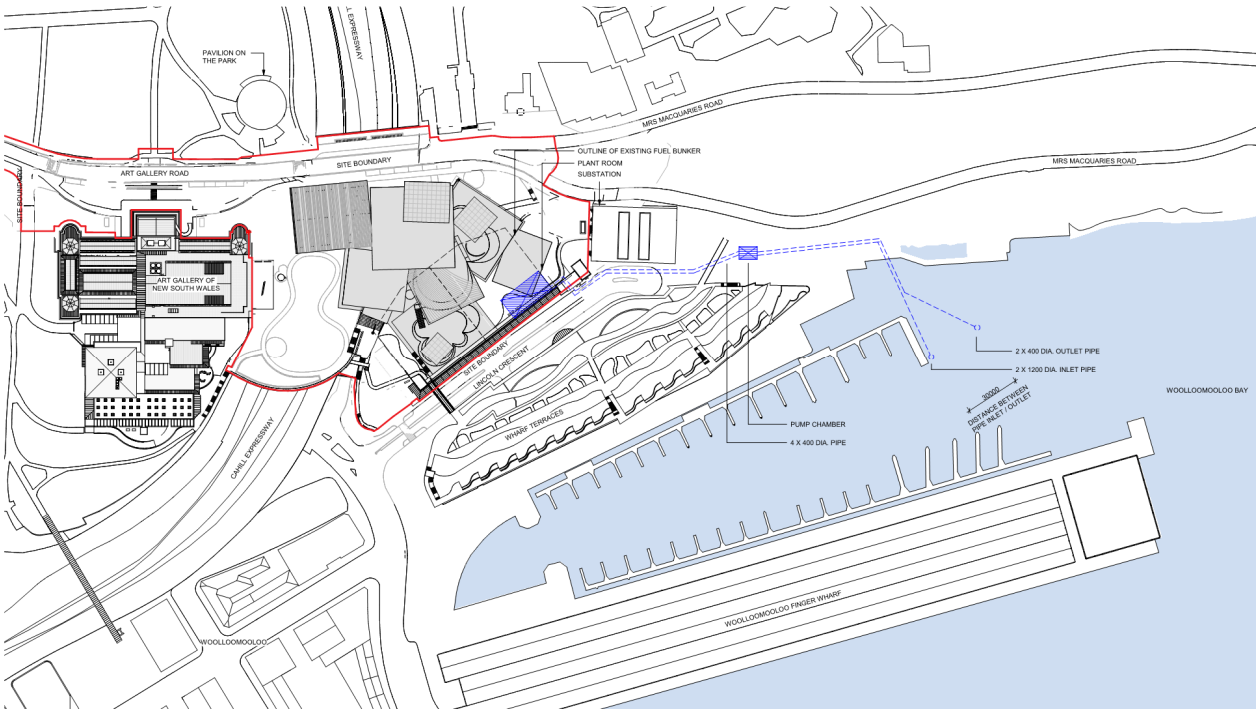

Fig 8.0A – Proposed location of intake and discharge points

To prevent recirculation of the same water the intake and discharge will be separated an approximate distance of 30m -50m as per advice from the sea water ecologist.

The pipework connecting the plant to the open water will be a critical point of failure to the Sydney Modern development. As a result, redundancy will be provided in the form of 2No intake and 2No discharge pipes.

The seawater system pipework will travel below ground from the intake and discharge points to the plant room within the lowest level of the Sydney Modern development through the public walkway to the rear of the existing waterfront dwellings.

9.0 Construction Materials

The sea water heat exchange system will comprise ABS pipework (recognised as the optimal pipework for these kind of systems) with various equipment and fittings constructed out of stainless steel. The sea water heat exchanges which will come into direct contact with sea water will be constructed out of titanium.

For further details of ABS pipework please refer to Appendix A – ABS Pipework Properties.

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10.0 Antifouling Agent

In order to prevent fouling of the pipes it is proposed to use a combination of an anti fouling agent called Mexcel and freshwater. Both systems will act to prevent sea water fauna from attaching to the surface of the pipes. Mexcel is already in use in several of the existing installations in the Sydney Harbour. The selection of this agent has been made in order to meet the Authority and client requirements for the system and is already in use in existing installations in Sydney Harbour. For further information on this antifouling agent please refer to 'Appendix B – Mexcel Material Safety Data Sheet'.

The use of freshwater to control the growth of seawater fauna is also commonly used throughout the Sydney Harbour area systems. It acts by reducing the salinity of the water, causing osmotic shock to the fauna present. The use of freshwater as an antifouling agent are best utilised in systems where segregation for periods is available and flushing can be carried out.

To eliminate the risk of overdosing the seawater with antifouling agent, the dosing system shall be controlled by a monitoring system with controlled releases of mexcel into the system. A further sensor shall be installed downstream of the dosing point to monitor the concerntration of mexcel in the system and shut off the release valve prior to the recomended maximum concerntration levels.

11.0 Conclusion

By ensuring that the design of the Sydney Modern sea water heat exchange system achieves a temperature differential of less than 2 degrees at the calculated boundaries and complies with water quality regulations through the use of an anti fouling agent product, we believe that this system complies with the relevant regulatory requirements and will provide a positive environmental benefit to the Sydney Modern Project.

We note that other reports have been prepared such as sea ecologists / risk assesments/ land owner consents which address separately required regulatory requirements as stipulated by NSW Office of Environment and Heritage and the nominated SEAR's requirements.

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Appendix A – ABS Pipework properties

ABS Material

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ABS Material

INTRODUCTION

Because of a unique balance of properties, modern ABS copolymers are being used on an ever increasing scale for the manufacture of many industrial and domestic products.
The material is very tough and resilient, has high impact strength, good chemical resistance and is non toxic and taint free. These advantageous properties have attracted engineers in many industries to the use of ABS piping systems rather than traditional materials, which do not have these distinctive benefits.
ABS piping systems are replacing many failed piping systems made from other materials.
The Eurapipe ABS system comprises a range of matched pressure pipes and fittings, joined together by a wide variety of methods including cold solvent cement welding or our rubber ring joint system.

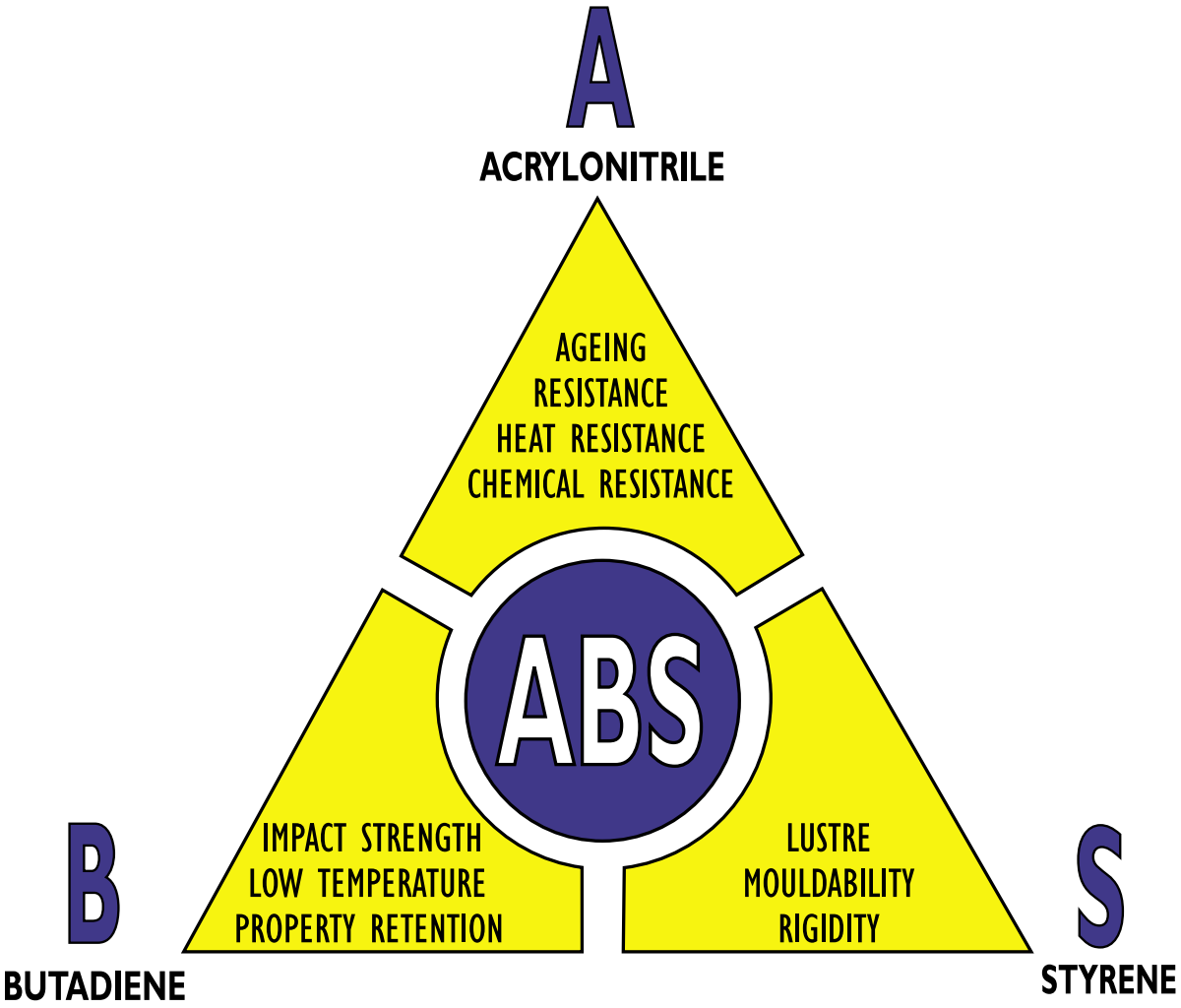
THE MATERIAL

Acrylonitrile - Butadiene - Styrene (ABS) identifies a family of engineering thermoplastics with a broad range of performance characteristics.
The copolymeric system is alloyed to yield the optimum balance of properties suited to the selected end use.

ACRYLONITRILE - imparts chemical resistance and rigidity.

BUTADIENE - endows the product with impact strength, toughness and abrasion resistance.

STYRENE - contributes to the lustre, ease of processing and rigidity.



ABS Material

MATERIALS PROPERTIES

The formulation used by Eurapipe has been developed in conjunction with polymer manufacturers to optimise performance in respect to tensile strength, chemical resistance, ductility, resistance to weathering, heat stability, low toxicity, taint free and ease of processing from raw material to finished product.
ABS is tough and strong over the recommended temperature range of -30°C to +60°C.

The outstanding properties of ABS are:

✔ High impact strength and ductility, which combine to give exceptional toughness.

✔ Good chemical resistance.

✔ Abrasion resistance.

✔ High strength solvent weld jointing which allows efficient system assembly and modification.

✔ Rubber Ring jointing methods, allowing compatible systems jointing techniques.

✔ Nontoxic and non-taint properties.

✔ Withstands aggressive ground waters.

✔ High strain tolerance for buried applications.

✔ Good resistance to ultraviolet light.

✔ Lower celerity and extreme tolerance to water hammer surges.

Property*	Reference Temperature	S.I.Unit	Other Units
Ultimate tensile strength (strain rate 50mm/min) ASTM D638 Type I	20 °C	40 MPa	5800 lbf/in^2
Elongation at break	20 °C	50%	50%
Instantaneous Flexural Modulus	20 °C	2200 MPa	319 072 lbf/in^2
Compressive strength	20 °C	42 MPa	6100 lbf/in^2
Izod impact strength (notched) ASTM D256 (method A)	23 °C	340 J/m notch	6.4 ft lb/in notch
Specific gravity		1.05 x 10^3 Kg/m^3	65.5 x 10^{-3} lb/ft^3
Vicat softening point ASTM D1525		95 °C	203 °F
Coefficient of thermal expansion		10.1 x 10^{-5} m/m°C	5.6 x 10^{-5} ft/ft°F
Maximum operating temperature		60 °C	140 °F
Poisson's ratio		0.35	
Thermal conductivity		0.2 W/m°C	1.3 BTU/ft^2/in/°F
Specific heat		1.47 KJ/Kg°C	0.35 BTU/lbm/°F
Volume resisitivity		3.5 x 10^{16} Ω cm	
Dielectric constant		3.20 @ 60 Hz 3.12 @ 10^3 Hz 2.90 @ 10^6 Hz	

*Test pieces machined from moulded specimens yielded to the above mentioned typical properties

ABS Material

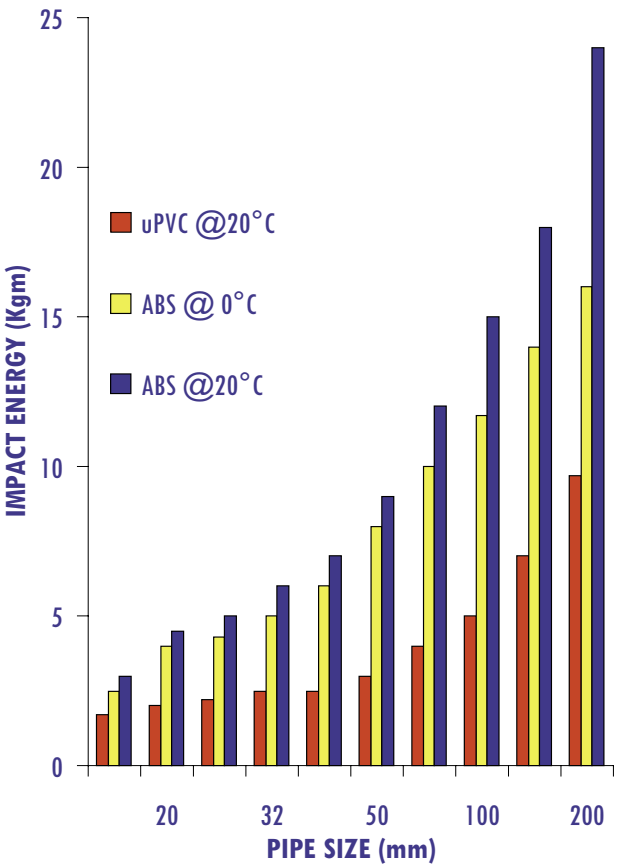
IMPACT STRENGTH

ABS is a relatively ductile thermoplastic, which exhibits very high impact strength compared to other thermoplastics such as uPVC particularly at low temperatures. It is for this reason ABS is used in demanding applications requiring exceptionally high impact strength material such as construction site safety helmets.

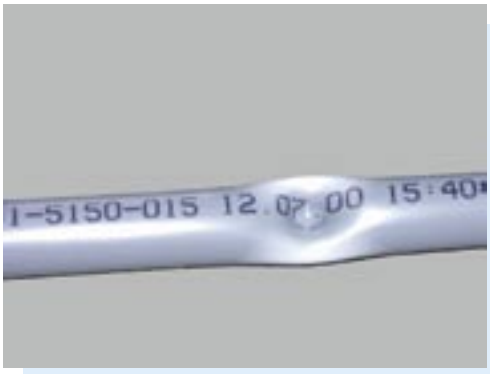
As part of the Eurapipe Quality Assurance programme, sample lengths of pipe are routinely impact tested at 0˚C as required by AS 3518.

ABS is unique in retaining high levels of impact strength at sub zero temperatures and is significantly superior to most other thermoplastics used in pipe systems.

The graph shows the relatively small reduction in impact strength of ABS between 20°C and 0°C compared with another thermoplastic pipe systems.



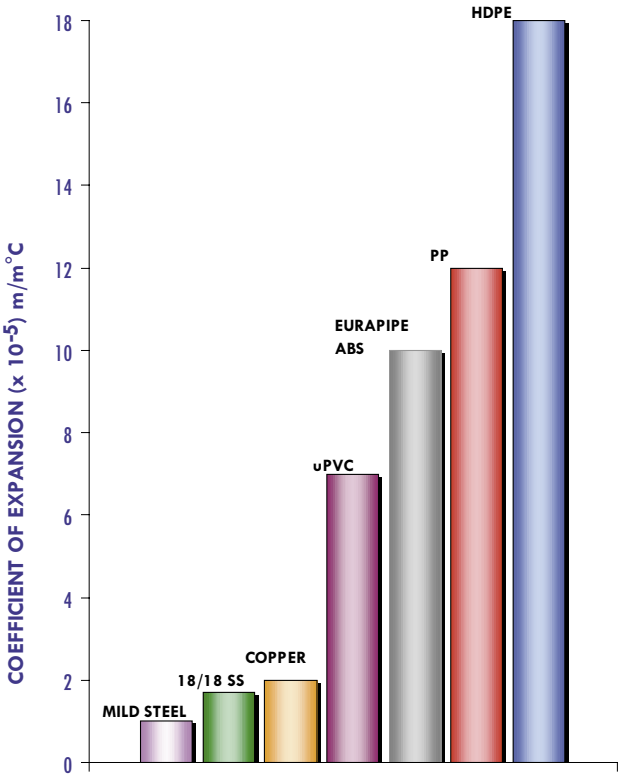
MODE OF FAILURE



ABS is a relatively ductile material and the mode of failure resembles that of soft copper. Failure is by ductile distortion and tearing, the localised nature minimising the loss of pipe contents.

In contrast, crack propagation and hazardous material fragmentation accompany the failure of brittle material.

ABS Material



THERMAL EXPANSION

All thermoplastics expand at a greater rate than metals as shown in the diagram above.
Expansion need not cause undue concern in design or installation of an ABS piping system provided that due recognition is taken at the design stage. The reduced flexural modulus of ABS over that of steel results in reduced loads on supports and equipment arising from thermal strains.
The linear coefficient of thermal expansion of ABS is 10.1 x 10^{-5} m/m °C.

TOXICITY AND TAINT

ABS is **free** from heavy metal stabilisers such as **lead** which are often used in the processing of other thermoplastic materials. Therefore, there is **no** possibility of any toxic heavy metals substances being leached from the ABS pipe material into the fluid being conveyed by the pipe.
Eurapipe ABS conforms to AS4020 and has been safely used for many years with potable water, grade I distilled water for medical use, renal dialysis fluid and many foods and beverages.
ABS is regarded as taint free and has been used for conveying potable water, beer, soft drinks, caramel, wines, sauces, chocolate, custard cream and other similar products. It is recommended that food and drink manufacturers test for taste tainting on their own product before installation commences.

RIGIDITY AND STIFFNESS

ABS is classified as a rigid thermoplastic over its working temperature range -30°C to +60°C.
With increased temperature, pipe rigidity decreases thus necessitating more frequent support.

ABS Material

WEATHERING

Eurapipe ABS piping systems are suitable for external installation under extreme conditions without additional surface protection.
When ABS products are exposed to the weather, they will suffer some minor degradation of the exposed surface. The degradation results in a reduction of surface gloss, and shift in surface colour to light grey. The degradation is confined to the exposed surface only.
The effect of long-term exposure to sunlight over prolonged periods has minimal effect on the physical properties of ABS systems.
Because of the relatively high flexural modulus of ABS, the stresses induced in a component whilst in service result in smaller strains, therefore minimising the possibility of environmental stress cracking of the exposed surface.

This resistance to failure is further improved by the inherently high impact strength of ABS, particularly at low temperatures, and the ability of the polymer to withstand long term heat exposure with little change to physical properties.

ABRASION RESISTANCE

ABS piping systems have long been successfully employed in applications where abrasion resistance is the prime consideration. The conveying of slurries in the mining, food, power generation and waste water industries is a typical example where ABS has been demonstrated to outlast steel and stainless steel pipes previously employed.
The chemical resistance of ABS combined with impact resistance makes it an ideal choice for such corrosive and erosive environments.
It is these conditions which lead to reduced life of metal pipe systems.
The rubber-like butadiene phase in ABS provides this piping material with outstanding resistance to abrasive media.
Eurapipe sales engineers have the experience to advise on the suitability of ABS pipe for slurry or abrasive applications.
For gravity flow systems the long term low surface roughness enables less steep slopes to be used. Lower slopes can mean reduced building heights which has a great effect on capital costs. Additionally, lower slopes reduce transport velocity, which in turn reduces the wearing of the piping material.

ABS Material

CHEMICAL RESISTANCE

The information given on the following pages is based on the recommendations of the manufacturers of the polymers, field experience and subsequent tests by Eurapipe.
The chemical resistance information has been obtained from numerous sources and it is primarily based on plastic material test specimens that have been immersed in the chemical (not combination of chemicals) and on field experience. Under no circumstances is to be assumed that a mixture of individually acceptable chemicals may be safely used with ABS or any other product.

The effect of the combination of chemicals on the ABS components has to be assessed in conjunction with other factors that have a significant impact upon the lifecycle of the system i.e. temperature, internal pressure, flexural stresses, cyclic loads etc. Any chemical attack is increased when temperature or stress are increased or when temperature or stress are varied.
It is the design engineers responsibility to assess the materials and the exposure under such conditions.
Specific data on industrial chemical applications of ABS can be given by the Eurapipe organisation. Such enquiries are invited for applications not shown here.
Under no circumstances is it to be assumed that a mixture of individually acceptable chemicals may be safely used with ABS or any other product.
Absence of notation indicates the substance has not been tested.

QUICK REFERENCE CHEMICAL RESISTANCE	
Chemical	**Resistance**
Weak acids	Good resistance
Strong acids	Limited resistance
Weak alkalis	Good resistance
Strong alkalis	Good resistance
Aggressive soils	Excellent resistance
Metal salts	Good resistance
Sea water	Excellent resistance
Aromatic hydrocarbons	Poor resistance
Organic solvents	Poor resistance

Unless stated, all concentrations are 100% or saturated aqueous solution. Reference to saturated solutions is at 20°C.

Resistance Key Information

1. RESISTANT=Little or no attack

2. CONDITIONAL RESISTANCE=Some attack, however may still be suitable when used with a higher pipe class or reduced service life.

3. NOT RECOMMENDED=Little or no resistance. Not suitable for use with ABS pipe.

4. REFER TO EURAPIPE

The information given here is based upon various sources available at the time this manual was created. We reserve the right to revise this information from time to time in the light of subsequent research and experience. The information is to be used as a general guide and there is no warranty or representation, either expressed or implied, that this data is free from errors.
We shall not be liable for any damages of any kind that may result from the use of this data.

ABS Material

Chemical or Agent	Formula	Concentration (%W/V)	Working temperature	
			20°C	50°C
Acetamide	CH_3CONH_2	%	1	
Acetic Acid	CH_3COOH	Up to 10 10-20 Over 20 (including Glacial)	1 2 3	1 3
Acetone	CH_3COCH_3		3	3
Acetyl Chloride	CH_3COCl		3	3
Alcohols:				
Allyl	$CH_2=CHCH_2OH$		3	3
Amyl	$CH_3(CH_2)_3CH_2OH$		3	3
Benzyl	$C_6H_5CH_2OH$		3	3
Butyl (Butanol)	$CH_3(CH_2)_2CH_2OH$		3	3
Ethyl (Ethanol)	CH_3CH_2OH	Up to 50% aq. soln.	1	1
Ethyl (Ethanol)	CH_3CH_2OH	95% aq. soln.	3	3
Furfuryl	$C_4H_3OCH_2OH$		3	3
Methyl (Methanol)	CH_3OH		3	3
Iso Propyl (propanol)	$(CH_3)_2CHOH$		3	3
Alum	$Al_2(SO_4)_3K_2SO_4.H_2O$		1	1
Aluminium Chloride	$AlCl_3$		1	1
Aluminum Sulphate	$Al_2(SO_4)_3$		1	1
Ammonia Solution	NH_4OH	35%	1	1
Ammonium Carbonate	$(NH_4)_2CO_3$		1	1
Ammonium Molybdate	$(NH_4)_6Mo_7O_2.H_2O$		1	1
Ammonium Nitrate	NH_4NO_3		1	1
Ammonium Sulphate	$(NH_4)_2SO_4$		1	1
Ammonium Thiocyanate	NH_4SCN		1	1
Amyl Acetate	$Ch_3COO(CH_2)_4CH_3$		3	3
Aniline	$C_6H_5NH_2$		3	3
Aromatic Hydrocarbons			3	3
Barium Bromide	$BaBr_2$		1	1
Barium Carbonate	$BaCO_3$		1	1

1=RESISTANT 2=CONDITIONAL RESISTANCE 3=NOT RECOMMENDED 4=REFER TO EURAPIPE

ABS Material

Chemical or Agent	Formula	Concentration (%W/V)	Working temperature	
			20°C	50°C
Barium Chloride	$BaCl_2$		1	1
Barium Hydroxide	$Ba(OH)_2$		1	1
Battery Acid	H_2SO_4		1	1
Benzene	C_6H_6		3	3
Benzoic Acid	B_6H_5COOH		3	3
Boric Acid	H_3BO_3		1	1
Brake Fluids			3	3
Brine	$NaCl_H2O$	Saturated	1	1
Bromic Acid	$HbrO_3$		1	1
Bromine (Gas + Liquid)	Br_2		3	3
Butane Gas	C_4H_{10}		1	1
Butyric Acid	C_3H_7COOH	20% aqueous	3	3
Calcium Compounds	Refer to respective sodium compound			
Carbon Dioxide	CO_2	40% aq. soln.	1	1
Carbon Disulphide	CS_2	95% sq. soln.	3	3
Carbon Monoxide	CO		1	1
Carbon Tetrachloride	CCl_4		3	3
Castor Oil			1	1
Chlorine Gas Dry	Cl_2		2	3
Chlorine Wet			3	3
Chlorine Aqueous Solution		Up to 3% free chlorine	1	1
		Over 3% free chlorine	4	4
Chlorobenzene	C_6H_5Cl		3	3
Chloroform	$CHCl_3$		3	3
Chromic Acid	CrO_3+H_2O	10% 25%	2 3	3 3
Citric Acid	$HOC(COOH)(CH_2COOH)_2H_2O$		1	1
Cresols	$C_6H_4(OH)CH_3$		3	3
Copper Chloride	$CuCl_2$		1	1
Copper Fluoride	CuF_2		1	1
Copper Sulphate	$CuSO_4$		1	1

1=RESISTANT 2=CONDITIONAL RESISTANCE 3=NOT RECOMMENDED 4=REFER TO EURAPIPE

ABS Material

Chemical or Agent	Formula	Concentration (%W/V)	Working temperature	
			20°C	50°C
Creosote			3	3
Cyclohexane	C_6H_{12}		3	3
Detergents			4	4
Dextrose	$C_6H_{12}O_6H_{12}$		1	1
Dichloroethane	CH_2ClCH_2Cl		3	3
Dichloromethane	$CHCl_2$		3	3
Diethylamine	$(C_2H_5)_2NH$		3	3
Diethyl Ether	$C_2H_5OC_2H_5$		3	3
Ethylene Glycol	$HOCH_2CH_2OH$		1	1
Ferric Chloride	$FeCl_3$		3	3
Ferric Nitrate	$Fe(NO_3)_3$		1	1
Ferrous Chloride	$FeCl_2$	Saturated	1	2
Ferrous Sulphate	$FeSO_4$	40% aqueous	1	1
Formaldehyde (Formalin)	HCHO ($+H_2O$)	10%	1	1
Formic Acid	HCOOH	3%	1	3
Freon	R11, R12, R22, R113, R114		4	4
FruitJuices			1	2
Gelatine			1	1
Glucose	$C_6H_{12}O_6$		1	1
Glycerine	$HOCH_2$-CHOH-CH_2OH		1	1
Hydrochloric Acid	HCl HCl HCl	0-10% 10-30% 30%-37% >37%	1 1 1 3	1 1 3 3
Hydrofluoric Acid	HF HF	0-10% >10%	1 3	2 3
Hydrofluorosilicic Acid	H_2SiF_6		3	3
Hydrogen	H_2		1	3
Hydrogen Peroxide	H_2O_2	1% 3% 5% 10% (30 vol)	1 1 1 3	1 2 3 3

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ABS Material

Chemical or Agent	Formula	Concentration (%W/V)	Working temperature	
			20°C	50°C
Iodine Solution in KI	I_2		1	3
Kerosene			3	3
Ketones			3	3
Lanolin			1	1
Lead Acetate	$Pb(CH_3OO)_2$		1	1
Linseed Oil			1	3
Magnesium Compounds	Refer to respsective sodium compound			
Mesityl Oxide	$(CH_3)_2C=CHCOCH_3$		3	3
Methane	CH_4		1	3
Methoxyethanol	$CH_3OCH_2CH_2OH$		3	3
Methyl Acetate	CH_3COOCH_3		3	3
Methyl Cyclohexanone	$C_6H_9CH_3O$		3	3
Methyl Ethyl Ketone	$CH_3COCH_2CH_3$		3	3
Methyl Methacrylate	$CH_2C(CH_3)COOCH_3$		3	3
Methylated Spirits			3	3
Milk			1	1
Mixed Acids Limited resistance Dependent on Concentrations			4	4
Molasses		Commercial	1	1
Nickel Sulphate	$NISO_4$	1%	1	1
Nitric Acid	HNO_3	1% 5%	1 2	3 3
Nitrogen	N_2	3	1	1
Oleic Acid	C_8H_{17}-CO=CH-		1	3
Oxalic Acid	HO_2CCO_2H		1	4
Oxygen	O_2		1	1
Ozone	O_3	20PPM Solution Saturated Solution Gaseous	1 3 3	1 3 3

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ABS Material

Chemical or Agent	Formula	Concentration (%W/V)	Working temperature	
			20°C	50°C
Petrol			3	3
Phenol	C_6H_5OH		3	3
Potassium Compounds Refer to respective Sodium compounds				
Propane	C_3H_8		1	1
Pyridine	C_5H_5N	Trace	3	3
Soap solutions (aqueous)			1	1
Sodium Acetates	$Na(CH_3COO)$		1	1
Sodium Borate	$Na_2B_4O_7$		1	1
Sodium Carbonate	$NaCO_3$		1	1
Sodium Chlorate	$NaClO_3$		1	1
Sodium Chloride	NaCl		1	1
Sodium Chromate	Na_2CrO_4		1	1
Sodium Cyanide	NaCN		1	1
Sodium Ferrocyanide	$Na_4F_e(CN)_6$		1	1
Sodium Fluoride	NaF		1	1
Sodium Hydrogen Carbonate	$NaHCO_3$		1	1
Sodium Hydrogen Sulphate	$NaHSO_4$		1	1
Sodium Hydrogen Sulphite	$NaHSO_3$		1	1
Sodium Hydroxide	NaOH	Saturated	1	1
Sodium Hypochlorite	NaOCl	>3% available chlorine	3	3
Sodium Iodide	NaI		1	1
Sodium Nitrate	$NaNO_3$		1	1
Sodium Permanganate	$NaMnO_4$		3	3
Sodium peroxide	Na_2O_2		3	3
Sodium Persulphate	$Na_2S_2O_8$		1	1
Sodium Phosphate	$Na_4P_2O_7$		1	1
Sodium Salicylate	$NaC_7H_5O_3$		1	1
Sodium Silicate	$NaSiOl_{3.9}H_2O$		1	1

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ABS Material

Chemical or Agent	Formula	Concentration (%W/V)	Working temperature	
			20°C	50°C
Sodium Sulphate	Na_2SO_4		1	1
Sodium Sulphite	Na_2SO_3		1	1
Sodium Sulphide	Na_2S		1	1
Sodium Thiosulphate	NaS_2O_4		1	1
Stannic Chloride	$SnCl_4$		1	3
Stannoous Chloride	$SnCl_2$		1	3
Sulphur Dioxide (Gas) Dry Wet	SO_2		 1 1	 2 2
Sulphuric Acid	H_2SO_4	Under 30% 30%-50% 50%+	1 1 3	1 2 3
Toluene	$C_6H_{3=5}CH_3$		3	3
Trichlorobenzene	$C_6H_3Cl_3$		3	3
Trichloroethylene	$Cl_2C=CHCl_3$		3	3
Triethanolamine	$N(CH_2CH_2OH)_3$		1	3
Triethylene Glycol (Trigol)	$HOCH_2O)_2CH_2CH_2OH$		1	2
Turpentine			3	3
Uric Acid	$CO(NH)_2COC_2CO(NH)_2$		1	2
Urine			1	1
Vegetable Oils			1	2
Vinegar			1	2
Water Chlorinated Deionized Distilled Fresh Sea	H_2O		1 1 1 1 1 1	1 1 1 1 1 1
Wines			1	2
Xylene	$C_6H_4(CH_3)_4$		3	3
Zinc Orthophosphate	$Zn_3(PO_4)_2$		2	2
Zinc Stearate	$Zn(C_{18}H_{35}O_2)_2$		1	1

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Appendix B – Mexcel Material Safety Data Sheet

integra
WATER TREATMENT SOLUTIONS

Material Safety Data Sheet

Product Name:	**Mexel 432**
Issued Date:	**14th May 2009**
Issued by:	**INTEGRA WATER TREATMENT SOLUTIONS**
Reference No:	**Version 14.05.2009**
Replaces:	**Version 08.03.2004**
	Classified as hazardous according to criteria of Worksafe Australia

1. IDENTIFICATION OF THE SUBSTANCE /PREPARATION AND COMPANY

Company Name:	Integra Water Treatment Solutions
Address:	Unit B , 195 Port Hacking Rd Miranda NSW 2228
Telephone:	Tel : (02) 9574 0000
	Fax : (02) 9574 0011
	Emergency No : (02) 9574 0000
Other Information:	This information summarises our best knowledge on the health and safety hazard information of the product and how to safely handle and use the product in the workplace. Each user should read this MSDS and consider the information in the context of how the product will be handled and used in the workplace including in conjunction with other products.
Product Use:	Cooling water mico-organism control and deposit control agent.

2. HAZARDS IDENTIFICATION

R36:	Irritating to eyes.
R38	Irritating to skin.
S25:	Avoid contact with eyes.
S 36/37/39:	Wear suitable protective clothing, gloves and eye/face protection.
S46	If swallowed, do not induce vomiting; seek medical advice immediately and show this container or label.
S51:	Use only in well ventilated areas.
S61:	Avoid release to the environment.

3. COMPOSITION / INFORMATION ON INGREDIENTS

Chemical : Polyamine emulsion

Ingredients:	Name	CAS	Proportion	Hazard Symbol	Risk Phrase
	Octadecyl polypropylene polyamine	94021-90-6	10-30%		R36 R38
	Water	7732-18-5	Balance		

4. FIRST AID MEASURES

Inhalation:	Remove the source of contamination or move the victim to fresh air. Ensure airways are clear and have qualified person give oxygen through a face mask if breathing is difficult. If symptoms develop seek medical attention.
Ingestion:	If swallowed, give 2 glasses of water to drink. IMMEDIATELY call a physician. Never give anything by mouth to an unconscious person.
Skin:	Wash affected skin areas thoroughly with soap and water. Remove and wash contaminated clothing thoroughly. Do not take clothing home to be laundered. Discard contaminated shoes, belts and other articles made of leather.
Eye:	IMMEDIATELY flush eye(s) with copious amounts of water for approximately 15 minutes holding eyelid(s) open. Take care not to rinse contaminated water into the non-affected eye. Seek immediate medical attention.

Advice to Doctor:	Treat symptomatically.

5. FIRE FIGHTING MEASURES

Specific Hazards:	Extinguishing Media: Water, foam, carbon dioxide or dry chemical. Combustion products: Carbon dioxide, carbon monoxide, and oxides of nitrogen. Fire-fighters use self contained breathing apparatus.

6. ACCIDENTAL RELEASE MEASURES

Spills & Disposal:	Prevent spillage from entering drains or water courses. Wear full protective clothing including face shield, face mask and gauntlets. Stop leak if safe to do so, and contain spill. Sweep up and shovel or collect recoverable product into labelled containers for recycling or disposal, and dispose of promptly. After spills, wash area, preventing runoff from entering drains. If a significant quantity of material enters drains, advise emergency services. This material may be suitable for approved landfill. Dispose of only in accordance with all regulations. Advise laundry of nature of contamination when sending contaminated clothing to laundry. See FIRST AID PROCEDURES Section for further information. Protective clothing made of the following material should be worn to avoid skin contact: Plastic rain jackets and pants. - Butyl rubber, Nitrile or other impervious material. Caution: Slippery when wet. For small spills: Absorb onto vermiculite or other non combustible absorbent material. Sweep up and shovel or collect recoverable product into labelled containers for recycling or disposal. After spills, wash area, preventing runoff from entering drains. Confirm with appropriate water authority for large spills. Discharge, treatment and disposal may be subject to federal, state or local laws and these should be consulted before discharge.

7. HANDLING AND STORAGE

Storage:	Store away from oxidizing agents. Store in a dry place avoiding iron containers. In use avoid contact with chemical listed as hazardous reactions. Keep in a cool dry place (0 to 30C). Keep away from sources of ignition. Freezing will affect the physical condition and may damage the material.

8. EXPOSURE CONTROLS , PERSONAL PROTECTION

Exposure Limits:	Use local exhaust if misting occurs. Natural ventilation is adequate in absence of mists. The measures appropriate for a particular worksite depend on how this material is used and on the extent of exposure. Use this general information to help develop specific control measures. Ensure that control systems are properly designed and maintained and comply with occupational, environmental, fire, and other applicable regulations.
Personal Protective Equipment:	Equipment: If engineering controls are not effective in controlling airborne exposure then a half face piece respirator with a replaceable organic vapour filter should be used. Reference should be made to Australian Standards AS/NZS 1715, Selection, Use and maintenance of Respiratory Protective Devices; and AS/NZS 1716, Respiratory Protective Devices, in order to make any necessary changes for individual circumstances. Safety glasses or goggles should be worn as described in Australian Standard AS/ANZ 1337 - Eye Protectors for Industrial Applications. Butyl, neoprene or nitrile gloves are recommended when using this product. Suitable workwear should be worn to protect personal clothing. When large quantities are handled

the use of plastic aprons and rubber boots is recommended.

9.	PHYSICAL AND CHEMICAL PROPERTIES
Appearance:	White emulsion thick liquid
Boiling Point:	Approx 100C
Melting Point:	Not applicable, solid at normal temperatures.
Specific Gravity:	0.09 to 1.0 at 20C approx
pH Value:	10.5 to 11.5
Vapour Pressure:	Negligible
Flash Point:	>100C
Flammability:	Does not ignite
Solubility:	Limited solubility

10.	STABILITY AND REACTIVITY
Hazardous Reaction:	Stable, no hazardous polymerisation will occur. Conditions to avoid: Reacts with oxidising materials and may cause exothermic reaction.

11.	TOXICOLOGICAL INFORMATION
Toxicology Information:	No data available but low in mammal population. Rainbow trout 96hr test 11mg/L Daphnia magna 48hr test 3.4 mg/L
Inhalation:	Inhalation may irritate the nose, throat and lungs.
Ingestion:	Ingestion may produce gastrointestinal irritation, nausea and diarrhoea. Harmful if swallowed.
Skin:	May cause irritation.
Eye:	Causes irritation to the eyes. Will cause discomfort such as stinging pain, watering and redness of the eyes.
Chronic Effects:	Long term exposure may result in dermatitis.

12.	ECOLOGICAL INFORMATION
Environment Protection:	This substance is hazardous to the environment and care should be taken to avoid discharge into rivers and water ways. Other ecological information. Do not allow it to enter water ways. The effects of this product on aquatic organisms are rapidly and significantly mitigated by the presence of dissolved organic carbon in the aquatic environment.

13.	DISPOSAL CONSIDERATIONS
Disposal:	For large quantities notify your local waste management authority for specific regulations. Refer to spills and disposal section.

14.	TRANSPORT INFORMATION

integra
WATER TREATMENT SOLUTIONS

Material Safety Data Sheet

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Reference No:	**Version 14.05.2009**
Replaces:	**Version 08.03.2004**
	Classified as hazardous according to criteria of Worksafe Australia

UN Number:	3082
Class:	9
HazChem Code:	2X
Packaging Group:	III
Proper Shipping Name:	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S
	Classified as a dangerous goods according to the Australian Code for the Transport of Dangerous Goods by Road and Rail (6th Edition).
Storage and Transport:	Store in tightly closed containers in a cool area separate from normal work areas. The storage area should have adequate independent ventilation and have no sources of heat or sparks. Not to be loaded with Class 4.2, 5.1, 5.2, 7

15.	**REGULATORY INFORMATION**
Poison Schedule	Not scheduled
Packaging & Labelling	As required by the ADG Code and Standard for the Uniform Scheduling of Drugs and Poisons

16.	**OTHER INFORMATION**
Abbreviations:	ACGIH- American Conference of Government Industrial Hygienists OSHA- Occupational Safety and Health Information TLV- Threshold Limit Value NOHSC- National Occupational Health and Safety Committee
Contact Person/ Point:	Normal Working Hours – Unit B , 195 Port Hacking Rd Miranda NSW 2228 Tel : (02) 9574 0000 Fax : (02) 9574 0011 Emergency No: (02) 9574 0000

…… END OF MSDS