Company:	efs Environmental Fluid Systems purasolve tomorrows compliance today
Project:	Graffiti Removal Risk Assessment
Scope:	Removing Graffiti
Date of Review:	25th July 2011
HAZTEK Ref:	10596
Version:	V2.2
Prepared by:	Maurice Barnes Principal Consultant HAZTEK Pty Ltd
Objective:	To assess and compare the risks of exposure to selected graffiti removal products when removing graffiti.

TABLE OF CONTENTS PAGE

Appendix List

1. Risk Assessment Graffiti Enz
2. Risk Assessment Purasolve Graffiti Remover

EXECUTIVE SUMMARY

This report details risk analysis of exposure during graffiti removal activities and a comparative assessment for selected graffiti removal products. Within the context of this assessment the following activities were assessed:

- Graffiti Removal with Graffiti-Enz;
- Graffiti Removal with Purasolve Graffiti Remover.

The assessment was conducted following the guidelines outlined in the Australian Institute of Occupational Hygienists, Simplified Occupational Hygiene Risk Management Strategies.

Chemical graffiti removal products are typically applied by brush, roller or low pressure spray systems. Chemical graffiti removal is mostly conducted in an open environment with good natural ventilation. Occasional tasks may require work to be conducted within an enclosed space or confined space with minimal natural ventilation. Due to the transient nature of the work extraction ventilation is rarely provided. Compliance with recommended Personal Protective Equipment – coveralls, gloves and respirators – is likely to be variable, with potentially low levels of compliance where work is undertaken by individuals or small numbers of workers working in isolation with limited supervision.

Graffiti-Enz contains significant proportions of N-Methyl-2-Pyrrolidone (NMP) a reproductive toxicant. The European Chemical Agency is currently considering the proposal for identification of NMP as a Substance of Very High Concern (SVHC).

The use of hazardous chemicals that are reproductive toxicants should be avoided where reasonably practical. The European Chemical Agency (ECA) recommends that in the absence of extraction ventilation, a respirator (Type A filter or better), chemical resistant gloves and coveralls should be worn when working with products containing NMP. The ECA recommends that for tasks where extensive inhalation and dermal exposure are possible, including spraying and hand application, it is desirable to limit the NMP content and the length of time dedicated to these tasks on an individual shift.

Purasolve Graffiti Remover is a low to moderate irritant. This product or the ingredients are not classified as a carcinogen or reproductive or development toxicants. Prolonged or repeated exposure can dissolve the natural protective oils on your skin and can cause dermatitis. D-Limonene, an ingredient at < 25% of Purasolve Graffiti Remover, readily oxidizes when in contact with air. The oxidized form of d-limonene is a known skin sensitizer. As with all solvents skin and eye contact should be avoided and the use of eye protection and gloves is recommended. Respiratory protection should be considered for very high inhalation exposures. Due to the low volatility of Purasolve Graffiti Remover very high inhalation exposures are not anticipated for typical graffiti removal task.

The assessment showed the exposure risk for graffiti removal to be significantly lower with Purasolve Graffiti Remover then Graffiti-Enz. Detailed hazard identification and risk assessment are provided within the report. A summary of risk findings is provided in table 1 and 2.

Table 1. Graffiti-Enz

Route	Consequence	Likelihood	Health Risk
Eye Contact	Major	Unlikely	Medium
Dermal Contact	Moderate	Possible	Medium
Inhalation	Severe	Unlikely	High

Table 2. Purasolve Graffiti Remover

Route	Consequence	Likelihood	Health Risk
Eye Contact	Minor	Unlikely	Low
Dermal Contact	Moderate	Possible	Medium
Inhalation	Minor	Unlikely	Low

Work Health and Safety Legislation requires that the hierarchy of control be applied when selecting control measures. Given the diversity of the work environment when conducting graffiti removal, engineering controls such as containment and local exhaust ventilation are not usually available. Substitution, replacing with something less harmful, should be considered in all situations a as risk reduction method. Reliance on safe work procedures and Personal Protective Equipment (PPE) has been shown to be unreliable.

The assessment found that a significant risk reduction would be achieved through the substitution of Graffiti-Enz with Purasolve Graffiti Remover. This substitution would also reduce the requirements for detailed safe work procedures, supervision and in most situations respiratory protection.

1 INTRODUCTION

This report details risk analysis of exposure during graffiti removal activities and a comparative assessment for selected graffiti removal products. Within the context of this assessment the following activities were assessed:

- Graffiti Removal with Graffiti-Enz
- Graffiti Removal with Purasolve Graffiti Remover

The aims of this risk assessment were to:

1. Identify chemical hazards from selected graffiti removal products;
2. Analyse the risk in terms of consequence and likelihood;
3. Determine existing controls and analyse risk in terms of consequence and likelihood in the context of those controls;
4. Determine priorities for dealing with the risks identified;
5. Provide suggested risk treatments for dealing with assessed risks.

2 METHODOLOGY

The principles of AS/NZS 4360 were applied using the Australian Institute of Occupational Hygienists, Simplified Occupational Hygiene Risk Management Strategies. The risks were assessed on the principle of what was reasonably foreseeable. The risk controls suggested, follow the approach of risk reduction by likelihood and consequence, using the hierarchy of controls (elimination, substitution / reduction, isolation, engineering controls, procedures, training, and personal protective equipment), refer figure 1 for summary of risk assessment process.

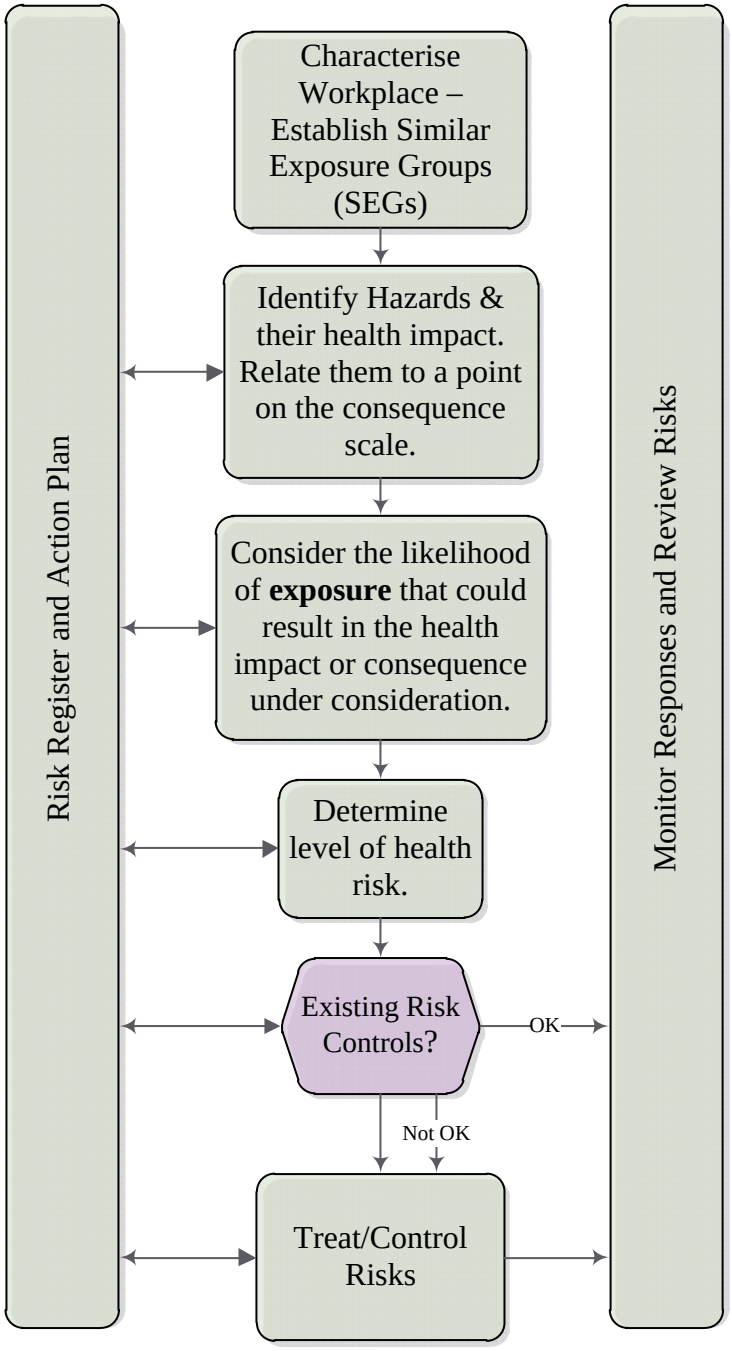
Information from the following sources was used as the primary source of data:

- a review of the assessment reports and toxicological information on selected products;
- a review of graffiti removal work practices and discussions with the representative personnel, including; processes, equipment, materials use, physical environment, products / by-products, etc;
- the hours of work and frequency of exposure e.g. Hours of work greater than an 8 hour day, 5 day week (40 hour week) and range of tasks, both routine and occasional;

In undertaking this assessment the author makes the following concessions:

- The review includes assumptions regarding exposure frequency and implemented work practices. These assumptions are based on typical work schedules and recommended safe work procedures for the selected products. This assessment may not be applicable for all work schedules and practices.

Figure 1: Risk Management Process Schematic (adapted from AS/NZS 4360)*



*** Note:** Australian Institute of Occupational Hygienists, Simplified Occupational Hygiene Risk Management Strategies Guidelines.

3 REFERENCES

(AS 31000) AS/NZS ISO 31000-2009 Risk Management – Principles and Guidelines

(AIOH 2006) Australian Institute of Occupational Hygienist, Simplified Occupational Hygiene Risk Management Strategies Guidelines.

(JACT 1997) Journal of the American College of Toxicology, Vol. 6, No. 1, pages 23-51, 90 1987

(EC 2011) European Commission European Chemicals Agency Proposal for Identification of a Substance as a Category 1A or 1B CMR, PBT, VPVB or a Substance of an Equivalent Level Of Concern, 2011.

(HERM 2009) Human & Environmental Risk Assessment (HERM) on ingredients of European household cleaning products Alcohol Ethoxylates Version 2.0 September 2009

(HERM 2006) Human & Environmental Risk Assessment (HERM) on ingredients of European household cleaning products D-Limonene October 2006.

(HSDB) Hazardous Substance Data Bank D-Limonene.

(NOHSC) National Occupational Health and Safety Commission's, National Code of Practice for the Control of Workplace Hazardous Substances [NOHSC: 2007 (1994)]

(NTP 1990) NTP (National Toxicology Program). 1990. Toxicology and carcinogenesis studies of d-limonene (CAS No. 5989-27-5) in F344/N rats and B6C3F1 mice (gavage studies). NTP Technical Report Series No. 347, NIH PB No. 90-2802, U.S. DHHS, National Institutes of Health.

(NIH 1990) U.S. Department of Health and Human Services Public Health Service, National Institutes Of Health, National Toxicology Program Technical Report Series No. 3474, Toxicology and Carcinogenesis Studies of D-Limonene (CAS No. 5989-27-5) In F344/N Rats and B6C3FI Mice (Gavage Studies) 1990.

4 BACKGROUND

4.1 PROCESS

Chemical graffiti removal products are typically applied by brush, roller or low pressure spray systems. Chemical graffiti removal is mostly conducted in an open environment with good natural ventilation. Occasional tasks may require work to be conducted within an enclosed space or confined space with minimal natural ventilation. Due to the transient nature of the work extraction ventilation is rarely provided. Compliance with recommended Personal Protective Equipment – coveralls, gloves and respirators – is likely to be variable, with potentially low levels of compliance where work is undertaken by individuals or small numbers of workers working in isolation with limited supervision.

5 HAZARDOUS SUBSTANCE RISK ASSESSMENT

Hazardous Substances are regulated through the Queensland Workplace Health and Safety Regulation 2008 Part 16 Hazardous Substances, the regulations are enforceable under the Workplace Health and Safety Act 1995. The regulations require risk assessments, appropriate to the complexity of the risks, to be conducted for hazardous substances. The Australian Institute of Occupational Hygienist developed the Simplified Occupational Hygiene Risk Management Strategies Guidelines to assist industry in meeting their requirements to identify, assess and control risk arising from workplace exposures (AIOH 2006).

5.1 HEALTH HAZARDS

When considering the hazards associated with any workplace, it is essential to understand the relationship between ‘hazard’ and ‘risk’. ‘Hazard’ is the potential for an agent or process to do harm. ‘Risk’ is the likelihood that an agent will produce injury or disease under specified conditions.

Health effects can occur only if a worker is actually exposed to the hazard. The risk of injury or disease usually increases with the duration and frequency of exposure to the agent, and the intensity/concentration and toxicity of the agent. Toxicity refers to the capacity of an agent to produce disease or injury. The evaluation of toxicity takes into account the route of exposure and the actual concentration of an agent in the body.

5.2 EXPOSURE ROUTES

The harmful effects of these chemicals follow inhalation of vapour, eye and skin contact with liquid or vapour, or ingestion, which are described below:

- Inhalation is usually the most significant route of entry by which fumes enter the human body at work.
- Absorption can occur through the skin or cause damage to the skin itself.
- Ingestion is of relatively minor significance in occupational exposure.

Toxic atmospheric contaminants may have local effects if they harm only the part of the body they come in contact with, or systemic effects causing changes to the function of other organs.

6 HEALTH HAZARDS

6.1 GRAFFITI-ENZ HEALTH HAZARDS

The main ingredients listed on the MSDS for Graffiti-Enz are N-Methyl-2-Pyrrolidone (NMP) and Ethoxylated Alcohol. NMP is listed in the Graffiti-Enz MSDSs at various proportions, ranging from < 30% to <60%. Ethoxylated Alcohol is listed at <10% to <30%. The MSDS lists the product as a hazardous substance (Irritant) (according to the Safework Australia Criteria) and not a dangerous good (according to the ADG Code).

N-METHYL-2-PYRROLIDONE (NMP)

The main active ingredient of concern in Gaffiti Enz is NMP. N-Methyl-2-Pyrrolidone is also referred to as 1-Methyl-2-Pyrrolidone. Safework Australia lists risk phrases:

- R36/37/38 - Irritating to eyes, respiratory system and skin
- R42 – May cause sensitisation by inhalation.

The European Chemical Agency is currently considering the proposal for identification of 1-Methyl-2-Pyrrolidone as a Substance of Very High Concern (SVHC).

The European Commission (EC 2011) has assigned the following hazard class and category and hazard codes for use under the Globally Harmonised System:

- Repr. 1B, H360D May damage fertility or the unborn child:
- Eye Irrit. 2 H319 Causes serious eye irritation:
- Skin Irrit. 2 H315 Causes skin irritation:
- STOT Single Exp. 3 H335 May cause respiratory irritation.

The European Commission (EC 2011) have assigned an 8h-TWA limit of 40 mg/m3 and a 15 minute STEL of 80 mg/m3 (with uptake via the skin noted as being possibly significant).

Safework Australia have assigned 1-Methyl-2-pyrrolidone an 8h-TWA limit of 103 mg/m3 (25 ppm) and a 15 minute STEL of 309 mg/m3 (75 ppm) (with a notice that absorption through the skin may be a significant source of exposure) (HSIS).

REPRODUCTIVE SYSTEM

NMP was classified as a 1B reproductive toxicant by the European Commission in 2009 (EC 2009). Under Directive 2009/161/EU, an occupational exposure limit was introduced for NMP. Above specified concentrations, 5% for most uses, the substance and mixtures must also be marked as ‘restricted to professional users’.

NMP caused delayed growth in the offspring of animals exposed during pregnancy in several studies. Some of these effects were seen at exposure levels as low as 116 parts per million (116 “ppm”) of NMP in the air. NMP caused reduced fertility in male rats and increased the time for female rats to become pregnant.

EYES, NOSE, THROAT, AND SKIN

NMP is irritating to the eyes, nose, and throat. It is quickly absorbed into your body through your skin. NMP also dissolves the natural protective oils on your skin and can cause dermatitis (dry, rough, red, cracked skin) (EC 2009).

NERVOUS SYSTEM

Over exposure to NMP can affect the nervous system. Breathing excessive amounts for a short period of time causes headache, nausea, dizziness, clumsiness, drowsiness. Repeated, frequent overexposure to NMP and other solvents over months or years can have long-lasting and possibly permanent effects on the nervous system. The symptoms of these long-term effects include fatigue, sleeplessness, poor coordination, difficulty in concentrating, loss of short-term memory, and personality changes such as depression, anxiety, and irritability (NIH 1990).

CANCER

NMP did not cause cancer when tested in animals. It also did not cause genetic mutations in several tests (EC 2009).

SENSITISATION

NMP has low potential for sensitisation (NIH 1990).

ETHOXYLATED ALCOHOL

Alcohol ethoxylates (AE) are a major class of non-ionic surfactants. A substantial amount of toxicological data and information in vivo and in vitro demonstrates that there is no evidence for Ethoxylated Alcohol's being genotoxic, mutagenic or carcinogenic. No adverse reproductive or developmental effects were observed. AEs are not contact sensitizers (HERM 2009).

Ethoxylated Alcohol may be irritating to eyes and skin (HERM 2009).

6.2 PURASOLVE GRAFFITI REMOVER HEALTH HAZARDS

The active ingredients listed on the MSDS for Purasolve Graffiti Remover are Propylene Carbonate and D-Limonene. Propylene Carbonate is listed in the Purasolve Graffiti Remover MSDS at >75%. D-Limonene is listed at <25%. The MSDS lists risk phrases:

- R36/38 Irritating to eyes and skin;
- R43 May cause sensitisation by skin contact.

The MSDS lists the product as a hazardous substance (Irritant) (according to the Safework Australia Criteria) and not a dangerous good (according to the ADG Code).

PROPYLENE CARBONATE

A substantial amount of toxicological data and information in vivo and in vitro demonstrates that there is no evidence for propylene carbonate being genotoxic, mutagenic or carcinogenic. No adverse reproductive or developmental effects have been observed. Propylene Carbonate is not a contact sensitizer.

Propylene Carbonate is a moderate irritating to the eyes and slightly irritating to the skin. (JACT 1997)

D-LIMONENE

The IARC classifies D-limonene as a Group 3 carcinogen (not classifiable as to its carcinogenicity to humans). D-limonene dissolves the natural protective oils on your skin and can cause dermatitis (dry, rough, red, cracked skin). It readily oxidizes when in contact with air. The oxidized form of d-limonene is a known skin sensitizer. No adverse reproductive or developmental effects have been observed (NTP 1990). A Workplace Environmental Exposure Level has been established by AIHA (American Industrial of 30 ppm). Due to the low volatility of D-Limonene an inhalation risk is not anticipated under normal conditions of use unless sprayed, heated or large volumes used in confined, poorly ventilated areas. (HSDB 2006).

D-Limonene is irritating to eyes and skin. D-Limonene is sensitising to the skin (NTP 1990)

7 RISK ASSESSMENT

The processes involved in conducting risk assessments are to establish the context and hazard of the assessment then analyse these to identify the breakdown event. From this the risk assessment can be conducted using the formula 'Risk = Consequence × Likelihood' to determine the 'Hazard Risk Ranking'. The Australian Institute of Occupational Hygienists, Simplified Occupational Hygiene Risk Management Strategies Guidelines was used to conduct the assessment. The guidelines are for use in the Australian work environment on how to meet the Australasian Safety and Compensation Council's requirements for employers to identify, assess and control risks arising from workplace exposures.

Within the context of this assessment the following activities were assessed;

- Graffiti Removal with Graffiti-Enz
- Graffiti Removal with Purasolve Graffiti Remover

7.1 HAZARD IDENTIFICATION

The first step in the risk assessment process is to identify the hazards and relate them to a point on the consequence scale should the event being examined transpire. The Health Hazard Identification form as detailed in Appendix 1 & 2 was used to inventory identified hazards. A summary of the Health Hazard Identification is provided in table 3 for Purasolve Graffiti Remover and table 4 for Graffiti-Enz.

Table 3. Purasolve Graffiti Remover

Product	Hazardous Ingredients	Percentage Composition	OES 8 hr TWA/15 min STEL/ other
Purasolve Graffiti Remover	Propylene Carbonate	>75%.	Not Specified
	D-Limonene	<25%.	Not Specified

Table 4. Graffiti-Enz

Product	Hazardous Ingredients	Percentage Composition	OES 8 hr TWA/15 min STEL/ other
Graffiti-Enz	N-Methyl-2-Pyrrolidone	< 30% to <60%.	8h-TWA 103 mg/m3 (25 ppm); STEL 309 mg/m3 (75 ppm); (absorption through the skin may be a significant source of exposure). (HSIS)
	Ethoxylated Alcohol	<10% to <30%	Not Specified
	Enzyme protein	<1%	Not Specified

7.2 CONSEQUENCE

Having established the context and hazard, the next step in the risk assessment process is to determine the consequence for each hazard. Consequence was assessed as the potential outcome or impact of a hazard. The inherent capacity of a health hazard to cause harm (consequence) was assessed against the tables as detailed in the Consequence Rating for Hazards Annex A. Risk assessments are detailed at Appendix 1 & 2.

7.3 EXPOSURE CHARACTERISATION & LIKELIHOOD

Likelihood was determined as a product of the probability and frequency of exposure leading to the particular consequence that is associated with the hazard under consideration. In determining likelihood it is necessary to consider the exposure to a hazard and the probability that harm will occur following that exposure. Exposure was determined in terms of frequency, that is, how often or how long one is exposed, and the concentration, or the level, of the contaminant. Risk assessments are detailed at Appendix 1 & 2.

Annex B Chemical hazards table 1 was used when defining in-air exposure potential qualitatively based on the perceived concentration of exposure.

Annex B Chemical hazards table 2 was used when defining qualitative exposure for dermal exposure potential.

7.4 HAZARD / RISK RANKING

To enable risks to be graded against each other (prioritised) a uniform single process for describing the risk level is required. For the determination of risk levels the risk matrix is used, as detailed in the AIOH Simplified Occupational Hygiene Risk Management Strategies was used to determine relative (not absolute) risk, refer AIOH Simplified Occupational Hygiene Risk Management Strategies Guidelines Annex C table 1 and 2. The outcome of risk assessments will determine the action required; this will be implementation, information gathering, a combination of the two or no action. Generally the need for information gathering will be greater if the information that the risk assessment was based upon has a high degree of uncertainty, for example, if there is limited exposure data. A summary of risk ranking is detailed below.

7.5 RISK ASSESSMENT RESULTS

A summary of risk findings is provided at table 5 & 6. Hazard Identification and Risk Assessment are attached as appendix 1 & 2.

Table 5. Purasolve Graffiti Remover

Route	Consequence	Likelihood	Health Risk
Eye Contact	Minor	Unlikely	Low
Dermal Contact	Moderate	Possible	Medium
Inhalation	Minor	Unlikely	Low

Table 6. Graffiti-Enz

Route	Consequence	Likelihood	Health Risk
Eye Contact	Major	Unlikely	Medium
Dermal Contact	Moderate	Possible	Medium
Inhalation	Severe	Unlikely	High

7.6 RISK ASSESSMENT FINDINGS

GRAFFITI REMOVAL USING PURASOLVE GRAFFITI REMOVER

The eye contact risk was found to be **low**; the risk was attributed to the potential for periodic incidental contact to a moderate eye irritant.

The dermal contact risk was found to be **medium**; the risk was attributed to the potential for regular incidental contact to a skin irritant and skin sensitiser.

The inhalation risk was found to be **low**; the risk was attributed to potential exposure to potential exposure to Propylene Carbonate and D-Limonene, both ingredients are low volatility moderate respiratory irritants.

GRAFFITI REMOVAL USING GRAFFITI-ENZ

The eye contact risk was found to be **medium**; the risk was attributed to the potential for periodic incidental contact to a serious eye irritant.

The dermal contact risk was found to be **medium**; the risk was attributed to the potential for regular incidental contact to a skin irritant.

The inhalation risk was found to be **high**; the risk was attributed to potential exposure to N-Methyl-2-Pyrrolidone a reproductive toxicant.

8 DISCUSSION

Work Health and Safety Legislation requires that the hierarchy of control be applied when selecting control measures. Substitution, replacing with something less harmful, should be considered in all situations as a risk reduction method.

Given the diversity of the work environment when conducting graffiti removal engineering controls such as containment and local exhaust ventilation are not usually available. Graffiti removal may require work in enclosed spaces with minimal natural ventilation. Reliance on safe work procedures and Personal Protective Equipment (PPE) has been shown to be unreliable, particularly where people are working alone or in small numbers with little or no supervision.

The assessment showed that with the same level of control measures, safe work procedures and PPE, the exposure risk would be significantly lower with Purasolve Graffiti Remover when compared to Graffiti-Enz.

Graffiti-Enz contains significant proportions of N-Methyl-2-Pyrrolidone (NMP) a reproductive toxicant. The use of hazardous chemicals that are reproductive toxicants should be avoided where reasonably practical. The European Chemical Agency (ECA) recommends that in the absence of extract ventilation, a respirator (Type A filter or better) chemical resistant gloves and coveralls should be worn when working with products containing NMP. The ECA recommends that for tasks where extensive inhalation and dermal exposure are possible, including spraying and hand application, it is desirable to limit the NMP content and the length of time dedicated to these tasks on an individual shift.

Purasolve Graffiti Remover is a low to moderate irritant. Prolonged or repeated exposure can dissolve the natural protective oils on your skin and can cause dermatitis. D-Limonene, an ingredient at < 25% of Purasolve Graffiti Remover, readily oxidizes when in contact with air. The oxidized form of d-limonene is a known skin sensitizer. This product or the ingredients are not classified as a carcinogen or reproductive or development toxicants. As with all solvents skin and eye contact should be avoided and the use of eye protection and gloves is recommended. Respiratory protection may be required is spraying product in a confined space.

9 RECOMMENDATIONS / CONCLUSION

The assessment found that a significant risk reduction would be achieved through the substitution of Graffiti-Enz with Purasolve Graffiti Remover. This substitution would also reduce the requirements for detailed safe work procedures, supervision and in most situations respiratory protection.

If you have any questions in regards to this analysis or to arrange for a meeting to discuss a Continuous Improvement Action Plan please do not hesitate to contact the under signed.

Regards,

Maurice Barnes
Principal Consultant
HAZTEK Pty Ltd
Ph: 1300 55 3001
Mob: 0431 895 972
maurice@haztek.com.au

Annex List

Annex A: Consequence Rating for Hazards
Annex B: Chemical Exposure Rating Descriptors
Annex C: Risk Assessment, Action Identification and Prioritisation

Appendix List

1. Risk Assessment Graffiti-Enz
2. Risk Assessment Purasolve Graffiti Remover

ANNEX A: CONSEQUENCE RATING FOR HAZARDS

The consequence scale is as follows:

5	**Severe**	can cause multiple fatalities or significant irreversible effects.
4	**Major**	can cause a single fatality or irreversible health effects or disabling illness to one or more persons.
3	**Moderate**	can cause severe reversible health effects of concern – could result in a lost time illness
2	**Minor**	can cause reversible health effects of concern that would typically result in a medical treatment with no lost time
1	**Negligible**	can cause reversible health effects of little concern, requiring first aid treatment at most.

Note that a rating of 5 is considered the most serious hazard, while a rating of 1 is least hazardous.

A general description of the health effects for each rating on the consequences scale is provided in the shaded boxes below. Specific agents are listed in Table 2.1 with their respective consequence ratings.

5. Severe - can cause multiple fatalities or significant irreversible effects.

Hazards that can cause the following are considered to be potential sources of a "severe" health impact.

- occupational carcinogens
- reproductive toxins
- chemical asphyxiants (e.g. hydrogen sulphide, hydrogen cyanide, carbon monoxide)
- life-threatening respiratory illness agents
- life-threatening zoonoses (i.e. diseases transmitted by animals to humans)
- viral diseases & vector borne diseases that can be fatal

Occupational Carcinogens (there are about 300-350 substances). The most common cancers resulting from these exposures are cancers of the lung, bladder, skin, mesothelium, liver, haematopoietic tissue, bone and soft connective tissue. Refer to the list below for some of the more common agents. Check with the International Agency for Research on Cancer (IARC) for others (http://www-cie.iarc.fr/monoeval/grlist.html)

Reproductive Toxins in the workplace include around 200-300 chemicals. The reported adverse effects include infertility, spontaneous abortion, foetal death, teratogenesis, mutagenesis, foetal cancer, foetotoxicity and retarded development of the foetus or newborn. Both male and female workers may be affected by the hazards.

4. Major - can cause a single fatality or irreversible health effects or disabling illness to one or more persons.

Hazards that can cause the following are considered to be potential sources of a **"major"** health impact.

- progressive chronic conditions with a known cause
  - noise induced hearing loss (NIHL)
  - dust induced diseases e.g. silicosis
  - chronic obstructive pulmonary diseases
- systemic poisoning following vapour of fume exposure
- occupational asthma caused by exposure to organic dusts and aerosols
- hematologic disturbance agents (that cause anaemia, methaemoglobinaemia)
- skin disease – allergic skin diseases are some of the most prevalent occupational diseases. However, physical, chemical or biological agents may cause skin diseases.
- infectious blood borne diseases that can result in progressive chronic disease
- permanent central nervous system damage
- pulmonary oedema
- cardiac arrhythmia
- chronic/long-term organ toxicity e.g. cumulative lung damage
- acute toxicity – high risk – possibly fatal

3. Moderate - can cause severe reversible health effects of concern – could result in a lost time illness.

Hazards that can cause the following are considered to be potential sources of a **"moderate"** health impact.

- acute toxicity
- short-term physical effects
  - extreme temperature effects (e.g. sunstroke, frostbite)
- mineral acid effects on teeth
- substances that cause elevated irritation of mucous membranes (eyes, nose or throat)
- substances that cause elevated irritation of the skin
- progressive chronic conditions with a known cause
  - musculo-skeletal effects – disorder of muscles, tendons, bones and joints (e.g. back strain and over-use syndrome). Specific work activities or environments can contribute to musculo-skeletal diseases where particular risk factors are present (e.g. rapid or repetitive motion, forceful exertion, awkward postured, vibration).
  - vibration-induced disorders of muscles, tendons, bones, joints, peripheral blood vessels or peripheral nerves.
  - nervous system effects (e.g. cholinesterase inhibition) other than narcosis
- non-fatal infectious air-borne diseases

2. Minor - can cause reversible health effects of concern that would typically result in a medical treatment with no lost time

Hazards that can cause the following are considered to be potential sources of a **"minor"** health impact.

- some temperature effects (e.g. heat rash)
- some travel effects (e.g. sea sickness, jet lag)
- psychological stress (e.g. work carried out at risk of violence)
- sunburn
- narcosis
- moderate irritation of eyes, nose, throat and / or skin

1. Negligible - can cause reversible health effects of little concern, requiring first aid treatment at most.

Hazards that can cause the following are considered to be potential sources of a **"minor"** health impact.

- minor irritations of eyes, throat, nose and / or skin
- offensive smells
- nuisance noises
- minor muscular discomfort
- minor headaches

Table 2.1
Consequence Rating for Specific Hazards
NB These ratings do not take into account additive effects, nor any other combined effects that exposure to more than one chemical or agent may cause.

Agent	Type Of Hazard	Health Impact	Consequence Scale Rating
Aluminium potroom aerosols	Chemical	Occupational asthma	4
Ammonia	Chemical	Eye damage, upper respiratory tract (URT) irritation	4
Anthrax	Biological	Pulmonary disease often fatal	5
Arsenic	Chemical	Carcinogen	5
Asbestos	Chemical	Carcinogen	5
Avian bird flu	Biological	Severe pulmonary disease with high mortality rate	5
Bacteria	Biological	Allergic response	4
Benzene	Chemical	Carcinogen	5
Beryllium and beryllium compounds	Chemical	Carcinogen	5
Cadmium and compounds	Chemical	Carcinogen	5
Carbon disulphide	Chemical	Peripheral nervous system impairment	4
Carbon monoxide	Chemical	Chemical asphyxiant Carboxyhaemoglobin aemia	5
Ceramic fibres, refractory	Chemical	Carcinogen Pulmonary fibrosis	5
Chromium (VI) and compounds	Chemical	Carcinogen	5
Coal tar pitch volatiles	Chemical	Carcinogen	5
Cold temperatures		Hypothermia chilblains, frostbite	2
Cotton dust	Chemical	Asthma	4
Diesel exhaust particulate	Chemical	Carcinogen	5
Ethylene oxide	Chemical	Carcinogen, Central nervous system impairment	5
Falciparum malaria	Biological	Haematological disease with severe systemic symptoms	5
Fluorine	Chemical	Upper respiratory tract, eye & skin irritation	4
Fungi	Biological	Allergic response	4
Heat (heat cramps, prickly heat, dehydration)	Physical	Hyperthermia	2

Table 2.1
Consequence Rating for Specific Hazards
NB These ratings do not take into account additive effects, nor any other combined effects that exposure to more than one chemical or agent may cause.

Agent	Type Of Hazard	Health Impact	Consequence Scale Rating
Hepatitis A virus	Biological	Inflammatory condition of the liver	3
Hepatitis B & C virus	Biological	Severe liver disease	4
HIV/AIDS	Biological	Compromised immune system resulting in severe opportunistic infections	5
Hydrogen cyanide	Chemical	Chemical asphyxiant	5
Hydrogen sulphide	Chemical	Chemical asphyxiant	5
Ionising radiation	Physical	Carcinogen	5
Iron	Chemical	URT & skin irritation	2
Isocyanates	Chemical	Occupational asthma	4
Lead	Chemical	Haematological disturbances	4
Legionella bacteria	Biological	Acute lung disease	4
Leptospirosis	Biological	Renal failure	5
Malaria	Biological	Severe infectious	5
Mercury	Chemical	CNS impairment	4
Mould	Biological	Allergic response	4
Musculo-skeletal injury	Physical	Progressive chronic condition	3
Nickel and compounds	Chemical	Pneumoconiosis, Carcinogen	5
Noise induced hearing loss	Physical	Progressive chronic condition	4
Oil mist, mineral	Chemical	LRT irritation, Suspected Carcinogen	5
Organo-phosphorus pesticides	Chemical	CNS dysfunction	3
Ozone	Chemical	Respiratory tract irritation	3
Phosgene	Chemical	URT irritation, emphysema	3
Q-fever	Biological	Acute febrile illness	3
Radon and its decay products	Chemical	Carcinogen	5
Silica, respirable crystalline	Chemical	Carcinogen	5
Solvents	Chemical	CNS depression	3
Sulphuric dioxide	Chemical	URT & LRT irritation	3
Sulphuric acid mist	Chemical	Suspected Carcinogen	5
Talc containing asbestos fibres	Chemical	Carcinogen	5

Table 2.1
Consequence Rating for Specific Hazards
NB These ratings do not take into account additive effects, nor any other combined effects that exposure to more than one chemical or agent may cause.

Agent	Type Of Hazard	Health Impact	Consequence Scale Rating
Temperature – extreme heat or cold	Physical	Sunstroke, frostbite	3
Thallium	Chemical	Alopecia	4
Travel – long distance	Physical	Jet lag	2
Tuberculosis infections	Biological	Chronic granulomatous infection of the lungs	3
Ultraviolet radiation	Physical	Carcinogen	5
Uranium and compounds	Chemical	Carcinogen	5
UV radiation	Physical	Sunburn	2
Vibration-induced disorder	Physical	Progressive chronic condition	3
Wood dust (oak, beech)	Chemical	Carcinogen	5
Wood dust (western red cedar)	Chemical	Asthma	4

ANNEX B: CHEMICAL EXPOSURE RATING DESCRIPTORS

Table 1

Qualitative exposure descriptor for In-air Exposure Potential

A - Almost Certain	Regular contact with the potential hazard at very high concentrations
B – Likely	Periodic contact with the potential hazard at very high concentrations or Regular contact with the potential hazard at high concentrations
C - Possible	Periodic contact with the potential hazard at high concentrations or Regular contact with the potential at moderate concentrations
D – Unlikely	Periodic contact with the potential hazard at moderate concentrations or Regular contact with the potential at low concentrations
E – Rare	Periodic contact with the potential at low concentrations

Table 2

Qualitative exposure descriptor for In-air Exposure Potential

Based on an Estimate of the Mean of the Exposure Profile for a work group relative to the OES (possible criteria for frequency of air monitoring is included)

A - Almost Certain	Mean > 10 x TWA - OES	Reduce exposure and monitor weekly
B – Likely	Mean: > TWA _ OES but < 10 x TWA – OES	Monitor monthly until exposure reduced
C - Possible	Mean: 50% - 100% TWA - OES	Monitor half yearly to quarterly
D – Unlikely	Mean: 10% - 50% TWA - OES	Monitor Yearly
E – Rare	Mean <10% TWA - OES	Monitoring not required (Provided there is no change to the process, material or controls since the last survey.)

Note: A TWA-OES (time-weighted-average occupational exposure standard) is the maximum acceptable average concentration of a chemical agent.

Table 3

Qualitative exposure descriptor for In-air Exposure Potential

Based on an Estimate of the 95th Percentile for a work group relative to the OES

A - Almost Certain	>5% exceedance of 10 x OES (95th percentile > 10x OES)
B – Likely	>5% exceedance of the OES (95th percentile between 1 and 10 x OES)
C - Possible	>5% exceedance of 0.5 x OES (95th percentile between 0.5 and 1 x OES)
D – Unlikely	>5% exceedance of 0.1 x OES (95th percentile between 0.1 and 0.5 x OES)
E – Rare	Little to no exceedance of 0.1 x OES (95th percentile <0.1 x OES)

Table 4

Qualitative exposure descriptor for Dermal Exposure Potential

A - Almost Certain	Regular immersion of hands in contaminant or saturation of clothing
B – Likely	Periodic immersion of hands in contaminant or splashing on clothing or Regular visible contamination of skin or clothing
C - Possible	Periodic visible contamination of skin or clothing; or Regular incidental contact
D – Unlikely	Periodic incidental contact
E – Rare	Minimal to no opportunity for visible contamination of skin or clothing

Semi- Quantitative exposure descriptor for In-air Exposure Potential **Based on the quantities & volatility or "dustiness" of the chemicals handled and the ventilation control[16]**			
	Amount	**Dustiness/Volatility**	**Ventilation**
A-Almost Certain	Very large amounts (>1000 L or > 1000 kg)	Very dusty (fine light powder) Highly Volatile (boiling point <50°C)	Natural
B-Likely	Medium to large amounts (>200 L <1000 L or 200 kg <1000 kg)	Very dusty (fine light powder) Highly Volatile (boiling point <50°C).	Natural
	Large amounts (>1000 L or >1000 kg)	Dusty (crystalline/granular solids) Moderate volatile (e.g. Boiling point 50°Cor <150°C).	Natural
	As per A#	As per A#	Dilution
C-Possible	Small to medium quantities (>20 l <200 L or >20 kg or <200 kg)	Very dusty (fine light powder) Highly Volatile (boiling point <50°C)	Natural
	Medium to large amounts (>200 L <1000 L or 200 kg <1000 kg)	Dusty (crystalline/granular solids) Moderate volatile (e.g. Boiling point 50°Cor <150°C)	Natural
	Large amounts (>1000 L or >1000 kg)	Low dusting (e.g. Pellet-like solids that don't break up) Low volatility (e.g. boiling point >150°C)	Natural
	As per B#	As per B#	Dilution
	As per A#	As per A#	Extraction
D-Unlikely	Small quantities (>1 L <20 L or >1 kg <20 kg)	Very dusty (fine light powder) Highly Volatile (boiling point <50°C)	Natural
	Small to medium quantities (>20 l <200 L or >20 kg or <200 kg)	Dusty (crystalline/granular solids) Moderate volatile (e.g. Boiling point 50°Cor <150°C)	Natural
	Medium to large amounts (>200 L <1000 L or 200 kg <1000 kg)	Low dusting (e.g. Pellet-like solids that don't break up) Low volatility (e.g. boiling point >150°C)	Natural
	As per C# or	As per C# or	Dilution
	As per B# or	As per B# or	Extraction
	As per A#	As per A#	Fully enclosed
E-Rare	Trace quantities (<1 L or <1 kg)	Very dusty (fine light powder) Highly Volatile (boiling point <50°C)	Natural
	Using small quantities (>1 L <20 L or >1 kg <20 kg)	Dusty (crystalline/granular solids) Moderate volatile (e.g. Boiling point 50°Cor <150°C)	Natural
	Using small to medium quantities (>20 l <200 L or >20 kg or <200 kg)	Low dusting (e.g. Pellet-like solids that don't break up) Low volatility (e.g. boiling point >150°C)	Natural
	As per B# or	As per B# or	Dilution
	As per C# or	As per C# or	Extraction
	As per D#	As per D#	Fully enclosed

The amount and dustiness/volatility is as per specified in the likelihood scale (A,B,C or D) indicated.

Only the ventilation changes.

ANNEX C: RISK ASSESSMENT, ACTION IDENTIFICATION AND PRIORITISATION

Figure 1

Likelihood Rating	Consequence Rating (health effect)				
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe
A Almost Certain	M	H	H	E	E
B Likely	M	M	H	H	E
C Possible	L	M	M	H	H
D Unlikely	L	L	M	M	H
E Rare	L	L	L	M	M

Whether the action needed is control, information gathering, or a combination of the two depends on the extent of the potential health risk and the certainty of the exposure assessment, as indicated by the figure below.

Figure 2

Health Risk Rating	Certain	Uncertain	Highly Uncertain
E	Control Needed	Control & Information Gathering Needed	Control & Information Gathering Needed
H	Proactive Management Needed	Control & Information Gathering Needed	Control & Information Gathering Needed
M	Active Monitoring Needed	Information Gathering Needed	Control & Information Gathering Needed
L	No Action Needed	Information Gathering Needed	Information Gathering Needed

Uncertainty Rating