



**Code of Practice for Health and Safety in
The Manufacture of
Composites Based on
Synthetic Resins
(Fibreglass)**

Published by
Composites Association of New Zealand Inc.
May 1998
ISBN 0-473-05151-6
\$30 + GST

CONTENTS

Foreword	5
Preface	6
Summary of the Health and Safety in Employment Act 1992	7
1. Introduction	11
1.1 Parties involved in production of this code	11
1.2 The purpose of this code	11
1.3 The objectives of this code	11
1.4 Processes discussed in this code	11
1.5 Definitions	12
2. The Raw Materials, Manufacturing Processes and their Hazards	13
2.1 The raw materials and their hazards	13
2.2 The manufacturing processes for composites and their hazards	16
3. Health and Safety Requirements for Composites Process	
Workplaces	18
3.1 General health and safety	18
3.2 Information to be provided to employees	18
3.3 Training and supervision of employees	19
3.4 Building construction	19
3.5 Controlling exposure—ventilation and extraction of vapours	20
3.6 Controlling exposure—health	22
3.7 Personal protection and facilities	22
3.8 Housekeeping, cleaning and removal of waste	25
3.9 Dust	26
3.10 General storage	27
3.11 Installation and use of spray booths	27
4. Dangerous Goods Requirements	28
4.1 Areas where resins of Class 3(b) are used	28
4.2 Relevant legislation and standards	29
4.3 Transportation of dangerous goods	30
4.4 Storage of flammable liquids and isolation distances	31

5. Electrical Requirements	32
5.1 General electrical information	32
5.2 Protection against static electricity	32
5.3 Pouring flammable liquids	32
5.4 Personal electrical equipment	33
5.5 Portable electrical equipment	33
6. New Developments	34
6.1 Updating systems	34
Appendices	
Appendix A: Workplace Exposure Standards	35
Appendix B: Properties and Health Effects of Substances Used in Composite Manufacture	38
Appendix C: Excerpts from the Dangerous Goods Act 1974 and Associated Dangerous Goods Regulations 1985	48
Appendix D: Manufacturing Processes for Composites	58
Appendix E: Reference Material	59



FOREWORD

I commend the Composites Association of New Zealand Incorporated for their initiative in producing this code of practice. It is a comprehensive document that provides practical guidance on managing health and safety in the manufacture of composites based on synthetic resins (fibreglass). Adopting the safe work practices in this code will assist employers to meet their obligations under the Health and Safety in Employment Act 1992. The code will also assist employees to be aware of the health and safety hazards they may encounter at work and how to take the necessary precautions.

The Occupational Safety and Health Service of the Department of Labour encourages the adoption of this code of practice by all those working in the composites industries.



R.J.M. Hill
General Manager
Occupational Safety and Health Service



PREFACE

The Composites Association of New Zealand is concerned about the potential hazards involved in the manufacture of composites based on synthetic resins and the possible injuries and health problems directly attributable to work practices in this industry.

This industry code of practice has been written by the Composites Association of New Zealand Incorporated as a guide to the New Zealand composites industry and offers practical information and advice on managing health and safety in composites workshops.

The Health and Safety in Employment Act 1992 places the responsibility for providing safe and healthy workplaces firmly on the shoulders of employers, and the code has been written with this in mind. The code has been prepared with the best intention to promote safe working practices within the composites industry and makes no attempt to relieve employers or employees from their responsibilities under this Act. It is also intended as a source of information for employees on the hazards they may face in their daily work and to offer assistance in avoiding work-related injury and health problems.

The Composites Association recommends this code for all composites-related industries. The intention is to trial the code in the workplace for a period of one year. After this period the code will be revised, if necessary, with a view to becoming an approved code of practice under the Health and Safety in Employment Act 1992.

We welcome any comments on this code and any suggestions for improving its content.

Glenn Campbell
President
Composites Association of New Zealand Incorporated



SUMMARY OF THE HEALTH AND SAFETY IN EMPLOYMENT ACT 1992

The principal object of the Health and Safety in Employment Act 1992 (hereinafter referred to as the HSE Act) is to prevent harm to employees at work. To do this it imposes duties on, and promotes excellent health and safety management by, employers. It also provides for the making of regulations and codes of practice.

APPROVED CODES OF PRACTICE

“Approved codes of practice” are provided for in section 20 of the HSE Act. They are statements of preferred work practice or arrangements, and may include procedures which could be taken into account when deciding on the practicable steps to be taken. Compliance with codes of practice is not mandatory. However, they may be used as evidence of good practice in court.

EMPLOYER’S DUTIES

Employers have the most duties to perform to ensure the health and safety of employees.

Employers have a general duty to take all practicable steps to ensure the safety of employees at work. (This is set out in section 6 of the HSE Act). In particular, they are required to take all practicable steps to:

- Provide and maintain a safe working environment;
- Provide and maintain facilities for the safety and health of employees at work;
- Ensure that machinery and equipment in the place of work is safe for employees;
- Ensure that working arrangements are not hazardous to employees; and
- Provide procedures to deal with emergencies that may arise while employees are at work.

Taking all “practicable steps” means doing what is reasonably able to be done in the circumstances, taking into account:

- The severity of the injury or harm to health that may occur;
- The degree of risk or probability of that injury or harm occurring;



- How much is known about the hazard and the ways of eliminating, reducing or controlling it; and
- The availability, effectiveness and cost of the possible safeguards.

HAZARD MANAGEMENT

Employers shall identify and regularly review hazards in the place of work (existing, new and potential) to determine whether they are significant hazards and require further action. If an accident or harm occurs that requires particulars to be recorded, section 7(2) of the HSE Act requires employers to investigate it to determine if it was caused by or arose from a significant hazard.

“Significant hazard” means a hazard that is an actual or potential cause or source of:

- Serious harm; or
- Harm (being more than trivial) where the severity of effects on any person depends (entirely or among other things) on the extent or frequency of the person’s exposure to the hazard; or
- Harm that does not usually occur, or usually is not easily detectable until a significant time after exposure to the hazard.

Where the hazard is significant, the HSE Act (section 10) sets out the steps employers shall take:

- Where practicable, the hazard shall be eliminated;
- If elimination is not practicable, the hazard shall be isolated;
- If it is impracticable to eliminate or isolate the hazard, the employer shall minimise the likelihood that employees will be harmed by the hazard.

Where the hazard has not been eliminated or isolated, employers shall, where appropriate:

- Ensure that protective clothing and equipment is provided, accessible and used;
- Monitor employees’ exposure to the hazard;
- Seek the consent of employees to monitor their health; and
- With informed consent, monitor employees’ health.



INFORMATION FOR EMPLOYEES

Before an employee begins work, they shall be informed by their employer of:

- Hazards employees may be exposed to while at work;
- Hazards employees may create which could harm people;
- How to minimise the likelihood of these hazards becoming a source of harm to themselves and others;
- The location of safety equipment; and
- Emergency procedures.

Employers are also required to inform employees of the results of any health and safety monitoring. In doing so, the privacy of individual employees shall be protected.

EMPLOYERS TO INVOLVE EMPLOYEES IN THE DEVELOPMENT OF HEALTH AND SAFETY PROCEDURES

Employers need to ensure that all employees have the opportunity to be fully involved in the development of procedures for the purpose of identifying hazards and dealing with significant hazards or dealing with or reacting to emergencies and imminent dangers (section 14 of the HSE Act).

TRAINING OF EMPLOYEES

Employers shall ensure employees are either sufficiently experienced to do their work safely or are supervised by an experienced person. In addition, employees shall be adequately trained in the safe use of equipment in the place of work, including protective clothing and equipment (section 13 of the HSE Act).

SAFETY OF PEOPLE WHO ARE NOT EMPLOYEES

Employers are also responsible for the health and safety of people who are not employees. Employers shall take all practicable steps to ensure that employees do not harm any other person while at work, including members of the public or visitors to the place of work (section 15 of the HSE Act).



EMPLOYEES' AND SELF-EMPLOYED PERSONS' DUTIES

Employees and self-employed persons have a responsibility for their own health and safety while at work. They shall also ensure that their own actions do not harm anyone else. However, these responsibilities do not detract from the employer's responsibilities.

ACCIDENTS AND SERIOUS HARM (RECORDS AND NOTIFICATION)

The HSE Act requires employers to keep a register of work-related accidents and serious harm. This includes every accident that harmed (or might have harmed):

- Any employee at work;
- Any person in a place of work under the employer's control.

Employers are also required to investigate all accidents and near-misses to determine whether they were caused by or arose from a significant hazard.

Employers are required to notify serious harm that occurs to employees while at work to the Secretary of Labour (in practice, the nearest OSH office), as soon as possible. In addition, the circumstances of the accident shall also be notified in the form prescribed within 7 days. (Suitable forms for notification are available from OSH offices and selected stationers.)

If a person suffers serious harm, the scene of the accident shall not be disturbed unless to:

- Save life or prevent suffering;
- Maintain public access for essential services, e.g., electricity, gas; or
- Prevent serious damage or loss of property.

The OSH office will advise whether it will wish to investigate the accident and what action may be taken in the meantime.



1. INTRODUCTION

1.1 PARTIES INVOLVED IN PRODUCTION OF THIS CODE

This code of practice was produced by the Composites Association of New Zealand Incorporated (CANZ) with the assistance of, and in consultation with, the Occupational Safety and Health Service (OSH), a Service of the Department of Labour. In the process of developing this code, contributions were solicited from the Chief Electrical Inspector of the Ministry of Commerce; the Chief Explosives and Dangerous Goods Inspector of OSH; members of the various representatives from composites manufacturing companies throughout New Zealand; supply houses to the industry; the executive members of CANZ, and various other organisations.

1.2 THE PURPOSE OF THIS CODE

The purpose of this code of practice is to provide practical guidance for the protection of the health and safety of all personnel involved in industrial processes which use synthetic resins for the manufacture of composites.

1.3 THE OBJECTIVES OF THIS CODE

The objectives of this code are:

- To eliminate the long- and short-term health risks to employers and employees in the industry, and to prevent accidents;
- To ensure that workplaces are safe and healthy to benefit not only those in the workplace, but also the wider community and the environment;
- To promote training in safe procedures, work methods and work practices, thereby minimising the risk of injury and accidents, and reducing financial losses to employers caused by fire and damage to stock or equipment.



1.4 PROCESSES DISCUSSED IN THIS CODE

The code discusses the processes and describes the hazards involved in manufacturing composites based on synthetic resins. It provides information on workroom safety requirements, including classification of hazardous areas, cleaning, and dealing with spillages. It also covers work in hazardous areas and the training and supervision of employees. Practicable methods of compliance with the Health and Safety in Employment Act 1992 and the Health and Safety in Employment Regulations 1995 are provided.

1.5 DEFINITIONS

CANZ means the Composites Association of New Zealand Incorporated.

Hazard means an activity, arrangement, circumstance, event, occurrence, phenomenon, process, situation or substance (whether arising or caused within or outside a place of work) that is an actual or potential cause or source of harm; and “hazardous” has a corresponding meaning.

HSE Act means the Health and Safety in Employment Act 1992.

Inspector unless specified means an inspector appointed under section 29(1) of the HSE Act.

LEL means Lower Explosive Limit and this is the level of concentration in percentage by volume in air above which explosion can occur upon ignition in a confined area.

MSDS means Material Safety Data Sheet.

OSH means the Occupational Safety and Health Service of the Department of Labour.

Regulations, unless specified, means the Health and Safety in Employment Regulations 1995.

Shall is used in places where there is a technical requirement to achieve the desired result. It is used to alert the reader to the need for that element to be included.

Should is used as a way of indicating a preference. It does not indicate a mandatory requirement as other alternatives could achieve an equivalent result.

Toxic means injurious to human health when swallowed, inhaled or otherwise absorbed into the body (poisonous).

Workplace Exposure Standard (WES) means any exposure standard listed in the Workplace Exposure Standards publication currently applicable in New Zealand. Workplace exposure standards are defined for both short-term effects (WES ceiling and WES short-term exposure limits) and long-term effects (WES time-weighted average exposure limits).



2. THE RAW MATERIALS, MANUFACTURING PROCESSES AND THEIR HAZARDS

2.1 THE RAW MATERIALS AND THEIR HAZARDS

Resins

The most commonly used resins are unsaturated polyester resins, epoxy and vinyl ester resins. Less frequently used resins include phenolic and furane resins.

Hazards

The resins used in the manufacturing process may give off vapours which may be both harmful to health and flammable over a given range of concentrations. Unsaturated polyester resins before and during initial curing evolve styrene monomer vapour. Some epoxy resin hardeners can cause dermatitis and/or asthma, and may cause sensitisation in susceptible individuals.

Fibres and reinforcements

The resin is normally reinforced by the addition of a fibre, commonly glass fibre, hence the general term “fibre glassing”. Types of glass reinforcements include chopped strand mat, woven mats and cloths, continuous filament mats, rovings and surfacing tissues. Other materials which may be used for reinforcing include carbon fibres, synthetic fibres such as acrylic and polyester, metallic and non-metallic, and polyamide fibres.

Hazards

Inhalation of glass and other reinforcing fibres is to be avoided to prevent possible health problems. Inhalation of glass fibres may exacerbate pre-existing conditions such as asthma and bronchitis, but does not cause them. Skin contact can cause a temporary dermatitis and precautions should be taken. There is no evidence that the glass fibres used in the composite industry are carcinogenic in humans.



Fillers and pigments

In some applications, fillers such as calcium carbonate, talc, aluminium trihydrate, fumed silica and speciality light weight fillers may be used. Pigments may be added for colour.

Hazards

Commonly, fillers are dusty powders which pose a nuisance risk. The product data supplied by the manufacturer should always be consulted with regard to toxic hazards and safe methods of use.

Catalysts/initiators

Unsaturated polyester resins and vinyl ester resins are cured by the action of catalysts/initiators which are normally organic peroxides, the most common one being methyl ethyl ketone peroxide (MEKP). Organic peroxides are classified by the Dangerous Goods Act 1974 as a class 5.2 oxidising substance.

Epoxy resins are cured by mixing with hardeners, which are usually amines or anhydrides. Some of these may be classified as class 8 corrosive.

Hazards

These chemicals are extremely hazardous and contact between them and an organic combustible material may cause a spontaneous or delayed fire, or in some cases, an explosion. All organic peroxides decompose on heating, releasing oxygen and thereby increasing the risk of fire. Peroxides are severe irritants and corrosive to moist tissue (eyes, nose, throat, and airways to the lungs). Skin contact with peroxides can cause burns that do not heal readily. Eye contact is particularly dangerous as severe damage can occur very rapidly.

Promoters/accelerators

There are two major types of promoters/accelerators used to speed up the action of the catalyst/initiator:

- Cobalt-based accelerators (cobalt octoate or cobalt naphthenate); and
- Amine-based accelerators (primarily dimethylaniline).

Hazards

The cobalt-based accelerators are commonly dissolved in mineral turpentine or white spirits. These solutions are all flammable and contact will irritate the skin and eyes. Breathing high concentrations of the vapours will cause irritation of the respiratory system. Cobalt-based accelerators react violently with peroxide catalysts/initiators and this may cause fire as well as releasing toxic fumes.



Dimethylaniline should be regarded as a dangerous material as it is toxic by inhalation and ingestion as well as being readily absorbed through the skin. It will also react violently with peroxide catalysts/initiators and this may cause fire as well as releasing toxic fumes.

Inhibitors

Inhibitors such as hydroquinone or tertiary butyl catechol are used to increase the shelf-life of resins and can be used to slow down the effect of the catalyst/initiator.

Hazards

These are mostly phenolic materials normally dissolved in styrene or glycol. Flammability characteristics will be dependent on the dissolving medium. The inhibitors themselves will cause burns to the skin and are harmful by skin absorption.

Mould-release agents

A number of different mould-release agents are used to facilitate the removal of the cured composite product from its mould. These include waxes, silicones, polyvinyl alcohol, and polymeric films.

Hazards

Some wax type mould-release agents contain flammable solvents. Solutions of polyvinyl alcohol are normally supplied in a mixture of water and methylated spirits and are flammable and toxic by ingestion.

Solvents

A number of solvents may be used in the manufacture of composite products, mainly for cleaning purposes. Examples are acetone and methyl ethyl ketone (MEK).

Hazards

Acetone, or methyl ethyl ketone are Class 3(a) dangerous goods and are highly flammable at low concentration levels. The vapours are heavier than air and can travel considerable distances from the liquid to an ignition source. The vapours are irritant to the respiratory tract and can depress the central nervous system at higher concentrations. Contamination of skin with solvents can cause irritant contact dermatitis.



2.2 THE MANUFACTURING PROCESSES FOR COMPOSITES AND THEIR HAZARDS

The manufacture of composite materials from synthetic resins normally involves placement of resins and reinforcements into moulds or onto or through formers which provide the shape of the article to be produced. This process can consist of hand lay-up, spray lay-up, press moulding, automated moulding, and continuous moulding. Examples of specific moulding processes used in the production of composites are listed in Appendix D: Manufacturing Processes for Composites.

The synthetic resins change from liquids to solids during the manufacture of the composite products. This change is produced by the action of catalysts/initiators or hardeners which are normally introduced into the resins before or during the moulding or other processing operation. In some types of processing, heat is required to speed up the process. Some resins may require the addition of promoters which further increase the rate of action of the catalysts/initiators which are added subsequently.

Often the resins will be used in conjunction with reinforcing fibres (most commonly glass fibres) and in some cases fillers and pigments may be included. These are normally introduced before or during the moulding process.

As the materials used are insoluble in water, organic solvents are normally used to clean equipment used in the moulding process.

Hazards of the Processes

There are five main hazards in the manufacturing process:

1. Fire or explosion risk from the various substances used;
2. Fire or explosion risk from dusts produced during finishing operations. The dust produced from finishing the cured composite articles by processes such as sanding and grinding is combustible and at certain concentrations in air can be explosive. Polyester resin dust has a strong explosibility rating under test conditions. Concentrations of the dust in the air should not exceed allowable limits for inert particulate matter.
3. Health risks to persons from inhalation of dusts and chemicals, and absorption of chemicals through the skin. Repeated skin contact could cause dermatitis in some individuals. For health effects of individual substances see Appendix B: Properties and Health Effects of Substances Used in Composite Manufacture.
4. Fire risk from spontaneous combustion of waste material.



5. There is an explosion risk from mixing different types of catalysts/ initiators together, and this must be done only by trained people following suppliers' specific instructions. Any pre-mixing of these materials shall be done to manufacturer's specific instructions.

NOTE: For storage and mixing areas requirements, see section 4, Dangerous Goods Requirements, and Appendix C.



3. HEALTH AND SAFETY REQUIREMENTS FOR COMPOSITES PROCESS WORKPLACES

3.1 GENERAL HEALTH AND SAFETY

Any production in a place of work should be conducted in a manner which satisfies the requirements of the Health and Safety in Employment Act 1992 and the Health and Safety in Employment Regulations 1995.

Substances used in the manufacture of composites can give rise to chemical dermatitis and some are absorbed through the skin. Suitable protective clothing should be provided and worn for protection.

Exposure to high levels of solvent vapours can cause intoxication. The effects of solvent vapours are generally additive in their health effects, i.e. a mixture of several solvent vapours in the air is a greater hazard to health than each individual solvent vapour (this is discussed further in the Workplace Exposure Standards booklet).

NOTE: See also Appendix A: Workplace Exposure Standards, for further information.

3.2 INFORMATION TO BE PROVIDED TO EMPLOYEES

The employer shall ensure that all employees are provided with information on the hazards posed by substances or products used. Material Safety Data Sheets obtained from the supplier of the products may form the basis of this information, but it is the employer's responsibility to ensure that the information is provided in a form that is likely to be understood by the employee. It is noted that as well as making the information available, the employer shall ensure that training is provided on how to access and interpret the data (see 3.3 below).

All containers used to store products containing solvents or other hazardous substances must be suitable for the purpose and should be clearly labelled to identify the contents and to allow the substances to be used safely.



3.3 TRAINING AND SUPERVISION OF EMPLOYEES

The employer shall ensure that all persons in the place of work are instructed in the hazards likely to arise, and the precautions to be taken in regard to those hazards in accordance with the Health and Safety in Employment Act 1992.

Employees are to be advised, trained or supervised as necessary, and provided with information to ensure a safe and healthy environment is maintained.

Employees should be given instruction and training in the provisions of this code, and in particular employees shall be advised of the following:

1. The Health and Safety in Employment Act 1992, and the Health and Safety in Employment Regulations 1995;
2. Storage and use of Dangerous Goods of Class 3(a) and Class 3(b) as detailed in the Dangerous Goods (Class 3 - Flammable Liquids) Regulations 1985;
3. All identified hazards to which they will be exposed or may create in the course of their employment, and the steps that should be taken to minimise the likelihood of harm to either themselves or other people;
4. The circumstances requiring the use of protective clothing and safety equipment and the correct use and maintenance of that clothing and equipment;
5. Any procedure to be followed in case of an emergency, including the use of all emergency equipment and any special decontamination procedures to be followed;
6. Disposal of unused catalysed resin in wet bins;
7. Cleaning up procedures for spills of catalysts/initiators;
8. The importance of good housekeeping;
9. When and where mechanical ventilation shall be used;
10. Keeping sources of ignition (e.g. smoking, welding and electrical hand tools) out of hazardous areas; and
11. Material Safety Data Sheets (MSDS).

3.4 BUILDING CONSTRUCTION

New buildings or building alterations shall be constructed to the relevant performance levels set by the *Building Code*. Acceptable solution documents published by the *Building Code* provide means of doing this.

Dangerous goods workrooms and storage depots are to comply with the requirements of the Dangerous Goods Regulations. Refer to 4.4.



3.5 CONTROLLING EXPOSURE—VENTILATION AND EXTRACTION OF VAPOURS

There are several approaches that can be taken to control exposure to styrene and other vapours or dusts. While there is currently no substitute for styrene in the resins that are available for composite manufacture, the design and placement of equipment and the use of low styrene emission resins can significantly reduce exposure. Work methods and equipment can be adapted to minimise exposure. For example; the use of long-handled rollers and rollers designed to minimise mist production during hand lay-up can reduce the styrene level in the workers breathing zone.

Good housekeeping practices should be employed to minimise unnecessary evaporation of solvents. When not in use all containers of resin and solvents should be sealed to prevent open containers contributing to background vapour levels.

Even where attention has been given to the design of equipment and sound work practices are used, ventilation will usually still be required to ensure that styrene and other vapour concentrations within the breathing zone of the operator are kept as low as practicable. The prevention of pockets of heavier than air vapour, elimination of dead spots, and a high standard of house keeping throughout the area of operation is essential.

To find out whether exhaust ventilation is needed the employer is to make an assessment of the risk to health to which employees may be exposed and the nature and extent of exposure during their work. In many cases workplace exposure monitoring will be the only effective way of assessing exposure.

Where workplace exposure monitoring shows that exhaust ventilation is necessary the detailed knowledge of the exposure levels will help in the design of an effective system.

Where workplace exposure monitoring has established that the ventilation system is effectively controlling exposure, then checks on the performance of the system may be used as the primary means of monitoring.

The atmospheric concentrations shall be kept as low as practicable at all times. In general it can be assumed that concentrations of contaminant in air that are regularly below 10% of the WES will not present a significant risk to health.

Natural or mechanical air movement through the hazardous areas shall be as uniform as practicable, to ensure adequate cross ventilation. If natural ventilation is provided in any area, all practicable steps shall be taken to ensure that it is effective at all times.

It is essential that any extraction ventilation system used be properly located and installed. The predominant requirement is ventilating the operator's breathing zone by achieving sufficient air movement to carry fumes off, while not causing processing difficulties. To be effective, mechanical exhaust



ventilation in the workplace needs to be installed as near as possible to the point of origin of the fumes given off.

Extraction shall be kept in use at all times hazardous vapours are present in hazardous concentrations and shall in any case be capable of ensuring that under normal working conditions the concentrations of any flammable vapours will not exceed 25% of the lower explosive limit of the respective vapours.

Air extracted from the workroom shall be exhausted to the open air (away from air inlets). All discharges to the outside atmosphere shall comply with any discharge approvals given under section 15 of the Resource Management Act 1992 and not be harmful to the health of persons living or working in the vicinity of the premises or to their workplace operations.

Ventilation should be in operation while depositing equipment is being cleaned with solvents.

The concentration of styrene or other vapours should be kept below 25% of the lower explosive limit (LEL) (see note below) when composites are cured in a curing room. If the articles are placed in or removed manually from the curing room, then the styrene or other vapour levels in the curing room should not exceed the criteria contained in WES booklet.

- NOTES:
1. Solvent should be not sprayed in large quantities to flush depositing guns, one short brief burst is sufficient.
 2. It is recognised that if concentrations of contaminants are kept below the relevant Workplace Exposure Standards (WESs), the LEL will not be exceeded.

Where it is necessary for personnel to work inside a mould, tank, enclosed structure, or other enclosed space, portable exhaust or plenum ventilation shall be provided to remove vapours from inside that space. Vapour concentrations shall be maintained as low as is practicable below the WES Standard (see Appendix A). A venturi ventilation system is an economical method for deep mould ventilation.

When work is carried out in enclosed spaces, and it is not practicable to provide sufficient mechanical extraction and ventilation to stay below WES levels, then suitable air-fed respirators shall be provided and worn. (See Appendix E: Reference Material, for further information on the OSH resource *Safe Working in a Confined Space*).

All permanent ducts, trunks and casing used in connection with the ventilation system require earthing.

NOTE: This provision does not apply to non-metallic temporary flexible ducting.



3.6 CONTROLLING EXPOSURE—HEALTH

It is recommended that where the atmospheric concentrations exceed 50% of the WES for any contaminant, employers should take all practicable steps to obtain the employee's consent to the monitoring of their health and arrange for this to be carried out. This may include a physical examination and a urine or blood test.

Where solvents are easily absorbed through the skin, or where the workers' respiration rate is high, biological monitoring (not available for all solvents) may be required because air monitoring alone may understate the exposure. Biological monitoring can also be used to determine the effectiveness of respirators worn by workers. In the case of styrene, urine or breath levels correlate with exposure to the solvent. Measurement of metabolites in urine such as mandelic acid, which results from styrene exposure, is a useful addition to workplace exposure monitoring. Biological monitoring needs to be closely supervised by a medical practitioner, occupational health nurse or an occupational hygienist so that the results can be correctly interpreted.

Solvents can remove the natural protective barrier from the skin, promoting the penetration and absorption of solvents and other chemicals which may be present. This can cause skin rashes, and repeated or prolonged exposure may result in chronic irritant dermatitis. Cleaning your hands in a solvent can also cause dermatitis, and should be avoided where possible.

3.7 PERSONAL PROTECTION AND FACILITIES

All practicable steps including administrative and engineering controls shall be taken to reduce the concentration of fume, vapour, fibre and dust to the lowest practicable level below the appropriate Workplace Exposure Standard (WES).

Where it is not practicable to control the contaminant at source, or when attending to a spillage, personal protection for employees is to be provided on an individual basis. Refer to Dangerous Goods Regulation 192 - Protective Clothing and Equipment which details requirements where dangerous goods of Class 3 are handled, stored or used. When the use of protective clothing or equipment is necessary, employers shall ensure that it is used. Training in the use and care of protective equipment is essential.

Protective equipment is to be provided where it is necessary to protect employees' health and safety and where appropriate the safety equipment should be stored in a sealed container when not in use. For composites manufacture, employee health and safety protection may be required from the following hazards:



1. Dusts

Eye protection and dust respirators suitable for grinding and trimming operations.

2. Vapours

Solvent filter respirators or air fed helmets to provide protection against airborne vapour:

- (a) Respiratory protection (complying with AS/NZS 1715: 1994 *Selection, Use and Maintenance of Respiratory Protective devices* and AS/NZS 1716: 1994 *Respiratory Protective Devices*) is to be issued on a personal basis and chosen to fit each individual.
- (b) Training at no more than 12-monthly intervals on maintenance, fit testing, storage, and replacement of defective parts is to be provided.
- (c) A filter replacement policy which assures protection is to be adopted for all negative pressure respirators. It should be noted that the replacement of filters is dependent on the concentration and characteristics of the solvents used and the exposure time. To prevent confusion of wearing the wrong respirator for dust and solvents, filters should be capable of removing both dust and solvent vapours.

Alternatively, disposable dust respirators (to the above standard) are acceptable for tasks generating dust, but these offer no protection against solvent vapours.

- (d) Solvent respirators should be stored in air tight containers between uses to extend filter life. Filter life is dependent on the concentration of the vapour during exposure and the total exposure time. Vapour filters on respirators can lose effectiveness suddenly when the charcoal filter is exhausted. It is important to replace the filters immediately when the smell of vapours is detectable. It is recommended that the filters be checked after approximately each 30 minutes of use (practical advice on filter replacement can be obtained from NZS 8409:1995 *Agrichemical Users' Code of Practice*).
- (e) In high vapour concentrations such as in deep moulds where heavy vapours displace atmospheric oxygen, air fed helmets shall be used. The compressed air supply for the respirators shall be taken from an uncontaminated source and be substantially free from carbon monoxide. The supplied air shall also be free from odour and filtered to remove water, dust and oil mist. Filters should be stored in a vapour proof container.



3. Handling Chemicals

Full face visors should be used while repairing pressure lines carrying chemicals and when decanting and mixing chemicals.

Appropriate gloves and aprons, and full face visor should be worn where necessary. Viton is the preferred glove material for styrene, aromatic and aliphatic hydrocarbons, but is not suitable for acetone, methyl ethyl ketone (MEK) or methyl isobutyl ketone (MIBK). Other materials for gloves are cheaper but offer protection for shorter periods of time before styrene permeates through. PVC gloves should be changed at the first sign of cracking or hardening.

To prevent dermatitis, use suitable barrier cream where necessary for extra protection but not as a substitute for protective clothing.

(NOTE: For some small jobs splash protection goggles may be suitable, but the use of full face shields is recommended).

4. Noise

Where noise levels exceed 85 dB(A) ($L_{Aeq,8h}$) suitable hearing protective devices shall be provided and worn. Hearing protection is to be provided during the period where all practicable steps are being taken to eliminate noise, or until the noise has been isolated and is no longer a source or cause of harm to employees. Where elimination or isolation is not practicable, hearing protection is to be provided to minimise the likelihood that the noise will be a source or cause of harm to employees (See Health and Safety in Employment Regulations 1995).

All protective clothing and equipment should be designed and manufactured to the appropriate New Zealand Standard. The guidance on selection of appropriate protective equipment should be sought from a reputable supplier using the product Material Safety Data Sheets as the source of hazard data.

Facilities meeting the requirements of the Health and Safety in Employment Regulations 1995 are to be provided. Eye washing facilities should be located as close as practicable to where chemicals are handled and used. It is recommended that an automatic “head-operated” eye and face shower be provided. In the event of chemicals entering the eye, the eye should be gently and immediately flushed thoroughly for 15 minutes. In the case of peroxide contact, flush continuously until receiving accident and emergency treatment.



3.8 HOUSEKEEPING, CLEANING AND REMOVAL OF WASTE

All practicable steps shall be taken to ensure that every place of work is kept in a clean and hygienic state.

Deposits of combustible materials collecting on the floor of the workroom need to be minimised by regular cleaning.

A covering (lining) for floors and walls of workrooms can be used to facilitate cleaning of deposits. Any covering (lining) needs changing frequently to prevent hazardous accumulations.

All wet waste bins which are to be used solely for the disposal of catalyst/initiator and catalysed resins should be clearly labelled. At least one wet waste bin is needed for the laminating and/or gel-coating area and the distance between operations using catalysed resins and a wet waste bin should not exceed 10 metres.

The water level in each wet bin is to be sufficient to fully submerge all the volume of waste deposited in that bin.

A period of at least eight hours is required between the time the last amount of waste is added to a wet bin and when the bin is emptied. This period allows any resin and catalyst/initiator to react before disposal.

All spillage, including resins, solvents and chemicals, need to be cleaned up in a safe manner immediately. Cleaning rags or materials are to be disposed of properly.

NOTE: Suitable cleanup rags or other cleanup materials should be kept available and properly stored to prevent contamination.

Any spillage of peroxide should be taken up with an inert absorbent such as sand, vermiculite, diatomaceous earth or perlite. Rags, paper or sawdust are **NOT** to be used. Refer to MSDS.

Disposal of resin drums and gel coat containers—refer to MSDS and Regional Authority requirements.

Disposal of MEKP containers—refer to MSDS and Regional Authority requirements.

Disposal of composite process waste—for requirements in relation to the disposal of associated wastes, refer Resource Management Act 1991 and Regional Authority requirements.



3.9 DUST

Control of dusts is a general requirement of section 6 of the Health and Safety in Employment Act 1992.

Where practicable, dusts generated in the process shall be controlled at source. Such controls can include enclosures provided with extraction ventilation, removal at source by local exhaust ventilation and exclusion of sources of ignition. Where practicable, air-driven tools should be used.

Where dust may be generated by sanding or other work, a housekeeping programme using a suitable vacuum method can be provided. Such machines or systems are to be designed for the collection of dust. Where fine dust is formed, the housekeeping programme should include the removal of dust from ledges as well as from the floor. Sanding operations can be confined to defined areas to restrict the hazardous area and simplify the housekeeping process.

Portable vacuum cleaners need not be dust ignition proof providing they are designed for industrial purposes and fitted with a HEPA filter to ensure that the exhaust air passing through the fan and motor housing is essentially free of all dust. The collection bag should be less than 200 litres capacity to ensure that the effects of a possible dust explosion are unlikely to cause harm. Such cleaners must not be used in the presence of flammable vapours unless the motor is certified for use in a Zone 1 hazardous area, defined in AS/NZS 2430.3 Parts 1 to 9.

NOTE: The current New Zealand Standard covering combustible dusts is NZS 6101 Part 2: *Classification of hazardous areas: Combustible dusts*, however a new joint AS/NZS/IEC document is likely to be adopted later this year as an international standard IEC 61241.3.

Explosion venting is required on all fixed explosive dust collection systems. The National Fire Protection Association (NFPA) Code No. 68: *Guide for venting of deflagrations* (1988 edition) should be followed as guidance. Dust collector vessels constructed from various materials must be able to withstand different levels of pressure without bursting and guidelines for the relevant pressures can be found in the appendix of the above NFPA Code.

Where possible, portable tools incorporating dust extraction equipment or other means of dust extraction at source should be used. The equipment is to be designed for use in a hazardous area as defined by NZS 6101 Part 2: *Classification of Hazardous Areas: Combustible Dusts*.



3.10 GENERAL STORAGE

All practicable steps are to be taken to ensure that employees at work are not exposed to hazards arising out of the arrangement, disposal, organisation, storage or use of things in their place of work or near their place of work. The storage of equipment, materials and other items should be such as to ensure the health and safety of employees. Advice on general storage can be obtained from the OSH publication *Safe Stacking and Storage*, see Appendix E.

3.11 INSTALLATION AND USE OF SPRAY BOOTHS

(Recommended—to reduce hazardous area/rating and to minimise styrene vapour concentrations.)

The production of composites differs from normal solvent-based spray coating operations where 60% to 80% of the deposited material evaporates. Composite laminating is a spray (or hand) depositing operation where over 95% of the deposited material forms the item being manufactured and only a small percentage of styrene (Class 3(b) Dangerous Goods) evaporates. Once the resin and catalyst/initiator have gelled, styrene emission drops drastically and very quickly; low styrene emission resins also reduce emissions.

The Spray Coating Regulations 1962 exclude from the definition of spray coating the processes of chopped strand spraying or gel coating. Hand lay-up, employing use of rollers and brushes, is not subject to the Spray Coating Regulations 1962. Spray coating of solvent-based paints is subject to the Spray Coating Regulations 1962.

For requirements for the installation and use of spray booths, refer to the Spray Coating Regulations 1962.

The hazardous classification of spray coating booths is to be done in accordance with AS/NZS 2430.3 Parts 1 to 9.



4. DANGEROUS GOODS REQUIREMENTS

4.1 AREAS WHERE RESINS OF CLASS 3(b) ARE USED

Where resins classified as dangerous goods of Class 3(b) under the Dangerous Goods Act 1974 are used, see 4.2 and Appendix C: Excerpts from the Dangerous Goods Act 1974 and Associated Dangerous Goods Regulations 1985, the following action should be taken:

1. The safety and health provisions contained in this code (see Section 3) should be observed at all times;
2. The explosive vapour levels in any working area shall be kept below 25% of the Lower Explosive Limit (LEL). (Where people are not present, the average vapour levels within any space should be kept below 25% of the LEL);

NOTE: It is recognised that if exposure levels are maintained below the workplace exposure standards, the LEL will not be exceeded in the majority of cases.

3. Where products such as acetone, methyl ethyl ketone (MEK), or any other dangerous goods of Class 3(a), are in use, they shall be kept separated by at least 6 metres from any source of ignition, unless:
 - (a) The work area in which they are kept and dispensed, and the containers in which they are stored, meets the provisions of the Dangerous Goods Act 1974 and Dangerous Goods Regulations 1985 (see Appendix C);
 - (b) Depositing guns are flushed into a flash-proof safety container; and
 - (c) Sanding operations of composite articles which create potentially explosive dust concentrations are to be excluded from the work area by at least a 6 metre separation, see also 3.9.

Where the criteria listed in 4.1 above is met, the area should be classified as non-hazardous for the purposes of AS/NZS 2430.3 Parts 1 to 9. (This rating is for fire/explosion only. Toxic fumes at much lower levels can be still hazardous to health).

Where dangerous goods of Class 3(a) are used other than in accordance with the conditions set out in 4.1 above, then the hazardous area in relation to those operations is defined by AS/NZS 2430.3 Parts 1 to 9.

Where the sanding of composite articles creates potentially explosive dust concentrations, the hazardous area in relation to those operations is defined by



NZS 6101 Part 2: *Classification of Hazardous Areas: Combustible Dusts*, see also, 3.9.

Excluding dangerous goods attached to depositing machines that are normally in use, the maximum quantity of dangerous goods which may be allowed in the dangerous goods workroom at any one time is to be specified on the dangerous goods license issued for the premises. This would normally equate to no more than one day's supply of Class 3(b), plus any other stand-by product where permitted.

There shall be no source of ignition in any defined hazardous area. When material is brought into or removed from the hazardous area by means such as a vehicle or crane capable of providing a source of ignition, the vehicle or crane shall not be activated while in the area unless all operations involving dangerous goods are stopped and the ventilation system is in operation.

Mixing and finishing rooms are included in these provisions. Refer also to AS/NZS 2430.3 Parts 1 to 9 for advice and 3.8, 4.2, 5.1, and Appendix C: Excerpts from the Dangerous Goods Act 1974 and Associated Dangerous Goods Regulations 1985.

Suitable fire extinguishers and/or water hose must be provided and be easily accessible in areas where polyester resin is mixed and used.

Smoking shall be prohibited in all workrooms and hazardous areas.

Notices prohibiting smoking shall be prominently displayed in and at the entrances to hazardous areas or workrooms. All such notices should comply with NZS/AS 1319: *Safety Signs for the Occupational Environment*.

4.2 RELEVANT LEGISLATION AND STANDARDS

Acts, Regulations and Standards are constantly under review, it is important to ensure that you have the relevant legislation and Standards at the date of consideration. Refer Appendix E: Reference Material, for appropriate legislation and Standards denoted with *.

NOTE: Provisions in the Hazardous Substances and New Organisms Act 1996 (HASNO Act) will repeal the Dangerous Goods Act and Regulations in the near future.

Dangerous goods commonly used in the composites industry are classified as either:

1. Class 3: Flammable liquids, mixtures of liquids, liquids containing solids in solution or suspension, and nitrocellulose, being:
 - (a) Class 3(a): Those having a flashpoint lower than 23°C;
 - (b) Class 3(b): Those having a flash point of 61°C or lower, but not lower than 23°C.



2. Class 5: Oxidising substances, and organic peroxides.
3. Class 8: Corrosives.

For characteristics and properties of substances used in the composites industry, refer to Material Safety Data Sheets provided by the supplier of the raw materials.

4.3 TRANSPORTATION OF DANGEROUS GOODS

When transporting any dangerous goods, it is essential to ensure compliance with the Transport Act Amendment 1990. Documentation is to be completed and supplied to the driver and end-user.

Documentation particular to the substance involved:

1. Proper Shipping Name: taken from the NZS 5433: 1988 *Code of Practice for the Transport of Hazardous Substances on Land* as specified in the Transport requirements; and
2. UN (United Nations) Number related to the Proper Shipping Name; and
3. The Hazard Class for the substance being transported; and
4. The Packaging Group for the substance being transported; and
5. The quantity of substance being transported expressed as the number of packages by size.

Labelling is to include:

1. Dangerous Goods Diamond appropriate to the substance; and
2. A correct technical name and trade name if appropriate.

NOTE: The Toxic Substances Regulations have additional requirements regarding wording and letter sizing for some substances.

Placarding of vehicles is to be in accordance with the Transport requirements.

Segregation of dangerous goods is to be in accordance with the Transport requirements. Separation of incompatible goods, also refer to NZS 5433: 1988 *Code of Practice for the Transport of Hazardous Substances on Land*.



4.4 STORAGE OF FLAMMABLE LIQUIDS AND ISOLATION DISTANCES

Definitions

Storage means to retain the dangerous goods on any premises for a period of not less than one hour. If it is retained for more than one hour it shall be stored in a storage depot.

Bulk Storage means containment receptacles of capacity greater than 250 litres. For 250 litres or less capacity it is “otherwise than bulk”.

Storage depots shall be constructed in accordance with the requirements of the relevant sections of dangerous goods and building legislation. Under certain circumstances, storage may be provided by the use of metal cabinets in a suitable area. Advice should be sought from the OSH, Dangerous Goods Inspector or local authority Dangerous Goods Inspector.

NOTE: For further information see Appendix C: Excerpts from the Dangerous Goods Act 1974 and Associated Dangerous Goods Regulations 1985.



5. ELECTRICAL REQUIREMENTS

5.1 GENERAL ELECTRICAL INFORMATION

References: See Appendix E: Reference Material, legislation denoted with **.

All electrical work shall be done in line with the requirements of NZECP 24: 1993: Safety of Electricity in a Hazardous Area.

All electrical work shall be done in accordance with the Electricity Regulations 1997.

All electrical equipment should be installed by a registered electrician and maintained in a safe condition in accordance with the Electricity Regulations 1997.

Electrical installations and electrical appliances associated with delineated hazardous zones shall be inspected and re-certified at intervals of not less than four years for safety and continued compliance with the Electricity Regulations 1993 as detailed in NZECP 24:1993.

5.2 PROTECTION AGAINST STATIC ELECTRICITY

Machinery which produces static electricity shall not be used in hazardous areas unless protected, e.g. belt drives should have antistatic belts.

Refer to AS/NZS 1020: 1995, which deals with control of undesirable static electricity.

5.3 POURING FLAMMABLE LIQUIDS

When dispensing flammable liquids to or from a conductive container, the container should be earthed. If the container and the vessel into which flammable liquids are poured are conductive then a bond wire between containers would be adequate.



5.4 PERSONAL ELECTRICAL EQUIPMENT

Items of personal equipment which are battery-operated (e.g. hearing aids, miniature transistor radios, key ring torches, calculators, cellphones and pagers, etc.), are not to be used in a hazardous area, unless:

1. They have been approved for use in hazardous areas, and comply with explosion-protection requirements.
2. A certificate guaranteeing the absence of an explosive atmosphere has been issued.

NOTE: AS 2380.1: *Electrical Equipment for Explosive Atmospheres—Explosion Protection: General Requirements* specifies that devices whose parameters can never exceed any of the values - 1.2 V, 0.1 A, 20, uJ and 25 mW and are considered safe for use in an explosive atmosphere without further protection, unless they are connected to a device or a storage element of electrical energy which could cause the circuit to exceed these parameters.

5.5 PORTABLE ELECTRICAL EQUIPMENT

All electrical equipment used in hazardous areas should be of approved type in accordance with standards listed in NZECP 24.



6. NEW DEVELOPMENTS

6.1 UPDATING SYSTEMS

The industry is constantly developing, new applications are being evolved with alternative techniques of application, and new products being introduced. While an employer needs to keep up to date with new technology and developments, it is also their responsibility to take all practicable steps to ensure the health and safety of their employees. Employers can obtain assistance and advice prior to introducing new systems or plant from:

1. Local offices of the Department of Labour **Occupational Safety and Health Service** (Health and Safety Inspectors, Dangerous Goods Inspectors, Occupational Health Nurses and Occupational Hygienists), Ministry of Commerce (Electrical Group), Electrical Supply Authority, Building Industry Authority, Regional Authority (Building Inspector and the local authority Dangerous Goods Inspector) and the NZ Fire Service (Fire Safety Officer).
2. In addition to advice from Departmental officers, further advice is available from **Composites Association of New Zealand (Inc.)**.



APPENDIX A: WORKPLACE EXPOSURE STANDARDS

INTRODUCTION TO THE CONCEPT OF WES

In order to have a basis for making decisions on whether or not the concentration of a contaminant in the workroom air is at, or above a level likely to adversely affect the health of persons employed, the concept of a WES value has gained acceptance. WES values have been assigned for a number of common workplace contaminants. The basis for setting the standards varies between substances—some standards are designed to prevent the ill-health after long-term exposure while others are aimed at preventing short-term effects.

It must be stressed that compliance with any particular standard does not guarantee protection from discomfort or possible ill-health for all employees. The aim should always be to reduce exposure to the lowest practicable level below the WES.

Four terms are used in defining the exposure standards:

- Workplace Exposure Standard-Time Weighted Average (WES-TWA): refers to the concentration in the air averaged over an 8-hour day or 40-hour week.
- Workplace Exposure Standard-Short-Term Exposure Limit (WES-STEL): refers to the average concentration in air over a fifteen-minute period.
- WES-Ceiling: refers to a concentration that should not be exceeded during any part of the day
- Biological Exposure Index (BEI): refers to the concentration of a contaminant, or a marker, in a biological fluid that results from exposure equal to the WES level.

All of the above terms are discussed in more detail in the *Workplace Exposure Standard* booklet.



APPLYING THE WES VALUES

Where workplace exposure monitoring is required to determine the level of airborne substances, it is important to ensure that the correct testing procedures are employed. The aim is to estimate as accurately as possible the actual exposure and this is normally achieved by sampling the air from the worker's breathing zone (personal sampling). Monitoring should be carried out and interpreted by a person with adequate training in occupational health or hygiene.

For most substances the method used will be designed to estimate the total exposure received over a working day in order to be able to compare the result with the WES-TWA standard. While a comparison with the current WES value as a measure of the health risk is one aspect, monitoring is also used to determine what control measures are required, the effectiveness of the controls currently in place and the effect that any changes made in the workplace have on exposure. That is, workplace exposure monitoring is to be used as a guide to contaminant control, with the overruling object always being to reduce air contaminant concentrations to the lowest practicable level below the appropriate WES.

The following example illustrates how monitoring results would be compared against the WES-TWA and WES-STEL standards. Note that while a single sample could be taken over the full working day, to get information on the levels associated with different parts of the process, often more than one sample would be taken. In this example results are given for styrene in air monitoring.

Exposure	Time
104 ppm	1 hour
15 ppm	4 hours
5 ppm	4 hours

The 8-hour TWA level would be given by:

$$\frac{104 \text{ ppm} \times 1 \text{ hour} + 15 \text{ ppm} \times 4 \text{ hours} + 5 \text{ ppm} \times 4 \text{ hours}}{8 \text{ hours}}$$

$$= \frac{104 + 60 + 20}{8} \text{ ppm}$$

$$= 23 \text{ ppm}$$

The current exposure standards for styrene are:

WES-TWA 50 ppm (compared with the result above of 23 ppm)

WES-STEL 100 ppm (compared with the 104 ppm level)



The 8-hour TWA level of 23 ppm is then below the WES-TWA of 50 ppm but the WES-STEL of 100 ppm must have been exceeded over the one-hour sampling period.

WORKPLACE EXPOSURE LEVELS IN RELATION TO THE MANUFACTURING PROCESSES FOR COMPOSITES

In the manufacturing processes for composites, all practicable steps shall be taken to maintain the concentration of vapours (and dust) to the lowest practicable level below the appropriate Workplace Exposure Standard (WES).

The Act requires the employer to take all practicable steps to *eliminate* air contaminants. If this is not practicable, the employer is to take all practicable steps to *isolate* the contaminant to ensure that it will not be a source or cause of harm to an employee. Where it is not practicable to either eliminate or isolate the hazard, the employer is required to take all practicable steps to *minimise* the hazard to ensure that it will not become a source or cause of harm.

It is recognised that there may be limited opportunities to eliminate or effectively isolate substances used in composite manufacturing and that in many instances the only practicable steps will involve minimising the level of exposure. For example, styrene is an integral part of the final product and while it may be possible to limit its release by using low styrene emission resins, elimination is not possible using current technology. Engineering and administrative controls are preferred over the use of personal protective equipment for minimising exposure. (See 3.5 to 3.8).

Exposure standards for a number of substances used in the manufacture of composites can be found in the Occupational Safety and Health Service publication *Workplace Exposure Standards and Biological Exposure Indices for New Zealand* (see Appendix A). While the WES standards offer guidance on air concentration levels, it should be noted that they do not guarantee protection to all people because of the wide range of personal susceptibility. The WES standards are revised from time-to-time (invariably lower) and employers should aim to provide controls to reduce atmospheric contaminants to the lowest practicable level below the WES.

Because the processes involved may vary in terms of the environmental conditions and equipment design, it follows that it is more appropriate to use workplace exposure monitoring as an indication of air contamination and consequently of the need for any remedial action, rather than to set an arbitrary standard rate of air movement through the workroom.



APPENDIX B: PROPERTIES AND HEALTH EFFECTS OF SUBSTANCES USED IN COMPOSITE MANUFACTURE

RELEVANT DEFINITIONS

Chemical Abstract Service Numbers (CAS N^o) means a unique number given to each definable chemical.

Flash Point of a substance, means the lowest temperature at which the substance, when tested in a prescribed type of apparatus, liberates vapour at a rate sufficient to produce an explosive mixture with the air that is in immediate contact with the substance.

Note: Flash points may be expressed as ‘closed cup’ or ‘open cup’ temperatures. Where available, closed cup temperatures are quoted for substances used in composite manufacture as listed below.

Explosive Range means the Lower and Upper Explosive Limits (LEL and UEL) of vapour concentrations in air between which the material will explode if an ignition source is present.

Vapour Density means the density of the vapour given off by a substance relative to air which is taken as 1. Most organic vapours are heavier than air. Methane is the only exception.

Vapour Pressure means the pressure of the vapour in equilibrium with the liquid at a given temperature, normally 20°C. When the vapour pressure reaches atmospheric pressure (101.3 kPa) the liquid boils. The vapour pressure of water is 2.3 kPa at 20°C and 101.3 kPa at 100°C.

Vapour pressure data is sometimes expressed in mm Hg—to convert this to kilopascals (kPa), multiply mm Hg by 0.1333.

NOTE: For more detailed information obtain copies of Material Safety Data Sheets (MSDS) from the suppliers.



ACETONE

SYNONYMS:	2-Propanone, Dimethyl ketone
CAS N ^o :	67-64-1
WES-TWA:	500 ppm
WES-STEL:	1000 ppm
BOILING POINT:	56°C
FLASH POINT:	-17°C
EXPLOSIVE LIMITS:	2.9 - 12.8%
VAPOUR DENSITY:	2.0
VAPOUR PRESSURE:	24.0 kPa @ 20°C

Potential Health Effects

Inhalation: At high concentrations (approx. 1000 ppm) slight irritation of the nose and throat occurs. Unusual exposures to very high concentration (in excess of 10,000 ppm) may result in headaches, weakness, drowsiness, nausea, a feeling of drunkenness and vomiting.

Long term exposure to high concentrations (approx. 1000 ppm) has been linked with the development of nose and throat irritation, dizziness and loss of strength.

Skin Contact: Direct contact may cause slight irritation—prolonged or repeated contact may cause defatting of the skin and produce dermatitis. The risk of absorption through intact skin is considered slight.

Fire Risks

Acetone has an extremely low flash point and will give off enough vapour to be easily ignitable. It shall never be used near sources of ignition, e.g. flames, grinding sparks or electric motors.



COBALT OCTOATE (6%) AND COBALT NAPHTHENATE (6%)

SYNONYM:	Cobalt 6
USE:	Promoter for polyester and vinyl ester resins.
BOILING POINT:	150°C
FLASH POINT:	36°C
EXPLOSIVE LIMITS:	0.7%-6.5%
VAPOUR DENSITY:	4.8
VAPOUR PRESSURE:	Below 25 (mm of mercury at 20°C)

Potential Health Effects

Ingestion: This is a major hazard as absorption of this material into the body is potentially fatal. Cobalt Octoate (6%) and Cobalt Naphthenate (6%) contain white spirit and are thus STANDARD POISONS.

Skin Contact: Is to be avoided as skin irritation is likely.

Inhalation: Practically non-toxic. Due to the small quantities of this material in workshops, inhalation is not expected to be a significant concern.

Precautions

1. Store and use in separate part of the building to that used for MEKP.
2. DO NOT STORE WITH MEKP as it reacts violently and can cause fire.
3. Keep away from heat and sources of ignition.
4. Avoid contact with oxidising chemicals.
5. Avoid contact with the skin. Use suitable gloves and goggles.

Fire

Use foam, CO₂, or dry chemical.



DIMETHYLANILINE

SYNONYMS:	Dimethylaminobenzene, N,N-Dimethylaniline
CAS N ^o :	121-69-7
WES-TWA:	5 ppm
WES-STEL:	10 ppm
BOILING POINT:	193°C
FLASH POINT:	63°C
LOWER EXPLOSIVE LIMIT:	1%
VAPOUR DENSITY:	4.17
VAPOUR PRESSURE:	Less than 0.1 kPa @ 20°C

Potential Health Effects

Dimethylaniline can cause depression of the central nervous system and when exposed to high concentrations can cause weakness and possible respiratory failure. Overexposure may also lead to damage to the liver, kidney and other organs, as well as affecting the blood supply (methaemoglobinaemia).

It is readily absorbed through the skin.

Precautions

- Prevent eye contact by wearing chemical goggles.
- Prevent inhalation of vapour by wearing an organic vapour canister respirator.
- Prevent skin contact by wearing protective (impermeable) gloves.
- Remove any contaminated clothing immediately and wash the skin area thoroughly.
- Use only in a well ventilated area.

Fire Risks

Dimethylaniline is hard to ignite but if it does burn it will give off toxic fumes of oxides of nitrogen.

Incompatible Materials

Peroxides and other oxidising agents.



EPOXY RESINS AND HARDENERS

Potential Health Effects

Because there are a wide range of resins and hardeners used in composite manufacture it is not possible to give all the properties.

MSDS should be obtained for each resin and hardener used.

Generally they are skin irritants and sensitisers.

The amine hardener vapours will irritate the airways causing coughing and severe discomfort. They are also corrosive to tissue.

Fire Risks

The finished resin product is inert, however if sanding and grinding take place the dust produced is potentially explosive.

Dust should be collected and disposed of safely.

Vacuuming dust with a household vacuum cleaner could lead to a dust explosion if there is a leak in the bag and the motor is arcing.

If the resin product should ignite beware of the fumes which could be acrid and toxic.

FUMED SILICA (AMORPHOUS SILICA)

WES-TWA: 10mg/m³

Potential Health Effects

Respirators should always be worn when handling dry silica.

Fire Risk

Silica is non-flammable and will not cause dust explosions.



GLASS FIBRE - DUST

WES: 1 respirable fibre per millilitre air, and 5 mg/m³ inspirable dust.

Potential Health Effects

Inhalation: If fibrous glass particles are inhaled it may result in irritation of the mouth, nose and throat.

Skin Contact: Direct contact with glass particles may cause mechanical irritation.

Eye Contact: Airborne glass fibres that come in contact with the eye can cause mechanical irritation.



METHYL ETHYL KETONE

SYNONYMS:	MEK, 2-Butanone, Butan-2-one
CAS N ^o :	78-93-3
WES-TWA:	150 ppm
WES-STEL:	300 ppm
BOILING POINT:	79.6°C
FLASH POINT:	-7°C
EXPLOSIVE LIMITS:	1.8-10%
VAPOUR DENSITY:	2.4
VAPOUR PRESSURE:	10.3 kPa @ 20°C

Potential Health Effects

Inhalation: Concentrations of approximately 350 ppm produce irritation of the nose and throat. Higher exposures may produce central nervous system depression with symptoms such as headaches, nausea, dizziness, drowsiness and confusion.

Prolonged exposure to MEK in combination with other solvents may affect the nervous system.

Skin Contact: Direct contact may cause slight irritation—prolonged or repeated contact may cause defatting of the skin and produce dermatitis.

Fire Risks

MEK has a very low flash point and will always give off enough vapour to be easily ignitable.

It shall never be used near sources of ignition, e.g. flames, grinding sparks or electric motors.



METHYL ETHYL KETONE PEROXIDE

SYNONYMS:	MEKP, 2-Butanone peroxide
CAS N ^o :	1338-23-4
WES CEILING:	0.2 ppm
SELF-ACCELERATING DECOMPOSITION TEMPERATURE:	60°C approximately

Potential Health Effects

Inhalation: Inhalation of mist or vapour can cause irritation of the nose, sore throat, coughing, shortness of breath and breathing difficulty. In extreme cases, life threatening accumulation of fluid in the lungs (pulmonary oedema) can occur.

Skin Contact: Direct contact with the skin will cause irritation, redness, pain and blistering. Permanent scarring may result.

Eye Contact: Direct contact with eyes will cause irritation, redness, pain and blurred vision. Blindness or other permanent damage may result.

It is essential that suitable eye protection be provided and worn. Care should be taken with contact lenses as even the vapours can get behind the lens and react with moisture and corrode tissues, but the risk is minimal provided eye protection is worn.

Fire Risks

MEKP has a high flash point, and is not readily ignited, but it is unstable and could decompose and burn explosively if exposed to heat, shock or contamination. Fight fire with water fog from a safe distance.

It should be kept cool (<30°C) and clean, and handled with care.

Incompatible Materials

Reducing agents, metals and metal salts, amines and other promoters used in unsaturated polyester resins. Spillage may cause delayed ignition of organic materials such as paper or rags.



METHYL METHACRYLATE

Note: Methyl methacrylate is sometimes used as a partial replacement for styrene in some unsaturated polyester resins.

SYNONYMS:	MMA, Methacrylic acid methyl ester
CAS N ^o :	80-62-6
WES-TWA (skin, sens):	100 ppm
BOILING POINT:	101°C
FLASH POINT:	10°C (open cup)
EXPLOSIVE LIMITS:	2.1 - 12.5%
VAPOUR DENSITY:	3.5
VAPOUR PRESSURE:	3.9 kPa @ 20°C

Potential Health Effects

Inhalation: Methyl methacrylate is a strong smelling (low odour threshold) moderately toxic substance. Low concentrations are irritating to the nose and throat. Higher concentrations may cause symptoms of central nervous system (CNS) depression, such as headache, nausea, dizziness, drowsiness and confusion. Repeated or prolonged inhalation may cause respiratory sensitisation and mild CNS disturbances.

Skin Contact: Direct contact with the skin may result in irritation or redness. Repeated or prolonged skin contact can cause allergic skin sensitisation.

Fire Risks

Methyl methacrylate has a low flash point and will give off enough vapour to be easily ignitable. It should never be used near sources of ignition, e.g. flames, grinding sparks or electric motors.



STYRENE

Styrene is the volatile component of unsaturated polyester and vinyl ester resins.

SYNONYMS:	Cinnamene, Ethenylbenzene, Phenylethylene, Vinylbenzene
CAS N ^o :	100-42-5
WES-TWA:	50 ppm
WES-STEL:	100 ppm
BOILING POINT:	145.2°C
FLASH POINT:	31°C
EXPLOSIVE LIMITS:	1.1-6.1%
VAPOUR DENSITY:	3.6
VAPOUR PRESSURE:	0.7 kPa @ 20°C

Potential Health Effects

Inhalation: Relatively low levels of exposure may result in respiratory irritation. Higher concentrations (above 100 ppm) can cause depression of the central nervous system (CNS) with symptoms such as drowsiness, headache, confusion, incoordination and in extreme cases, unconsciousness.

Long term exposure to levels in the order of 100 ppm have been shown to effect the nervous system and produce subtle changes in hearing, balance, colour vision and psychological performance. The significance of these finding and the exposure levels they occur at has been the subject of debate.

Skin Contact: Styrene will defat the skin and repeated or prolonged contact can cause dermatitis (red, itchy dry skin). Styrene can be absorbed through the skin but this will not usually be the major route of exposure.

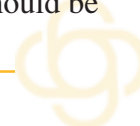
Eye Contact: Splashes to the eye will cause severe irritation. Exposure to vapour at moderate concentrations (approximately 50 ppm) can also result in irritation.

All practicable steps are to be taken to reduce the vapour concentrations to the lowest practical level by engineering controls (ventilation) or by isolating the process.

Fire Risks

The flash point of styrene is greater than the normal ambient temperature (in New Zealand), therefore it will not normally give off enough vapour to be ignitable despite the strong smells associated with it.

If it does ignite it will burn with a thick black smoke. Fire fighting should be with dry powder, CO₂ or water fog.



APPENDIX C: EXCERPTS FROM THE DANGEROUS GOODS ACT 1974 AND ASSOCIATED DANGEROUS GOODS REGULATIONS 1985

1. “Protected work” means:

- (a) Any dwelling house, or any place of worship, public building, university, college, school, hospital, public institution, court, theatre, or other building in which persons are accustomed to assemble; and
- (b) Any factory, workshop, office, store, warehouse, shop or other building where persons are regularly employed for the purpose of any trade or business, and any other building which a licensing authority may consider is of sufficient importance or value to warrant protection; and
- (c) Any wooden-decked wharf (not being a wharf specifically designed for the transfer of dangerous goods) public railway (not being a siding), or timber yard, and any place where it is customary for ships to berth moor, or lie;

but does not include a small office or other building connected with the storage or use of dangerous goods on premises in which such storage or use is a major function.

2. “Public place” means:

A place (other than a protected work) which is freely open to and frequented by the public; including a place where a section of the public may be permitted to assemble; but does not include any public place (being private property) where access to dangerous goods is, in effect, controlled by the licensee.

3. Storage depots:

Depots for the storage of dangerous goods of Class 3 otherwise than in bulk shall be divided into 5 types as follows:

Type A: Depots consisting of a compound of clay or clean binding earth or brick or concrete erected in the open. Such depots may be provided with an approved hardwood or incombustible platform on which to stand containers of dangerous goods and may be protected with a shelter roof having a metal or wooden frame and covered with iron or other approved materials. They may be protected against unauthorised access by means of a barbed wire fence, cyclone mesh fence, or other approved method.

Type B: Depots consisting of a metal or wooden frame building covered externally with iron or other incombustible material and compounded.



Type C: Depots having walls of brick, concrete block or reinforced concrete, with a roof of wood and iron or similar approved construction and compounded.

Type D: Depots with walls of brick, concrete block or reinforced concrete and a roof of reinforced concrete or equivalent approved construction and compounded.

Type E: Such other type of building or storage place as may be approved by an Inspector as being adequate, having regard to the character and the quantity of dangerous goods stored therein, the type of container in which the dangerous goods are packed, the isolation distance from protected works, and any special provision made for fire protection.

For acceptable construction details refer to NZBC Clause F3 as detailed in the New Zealand Building Code contained in the First Schedule of the Building Regulations 1992.

4. Table 1: Isolation distances for depots for Class 3(a) in drums over 60 litres capacity (Ref: Regulation 35 Dangerous Goods (Class 3 - Flammable Liquids) Regulations 1985.)

Every storage depot for storage of Class 3(a) Dangerous Goods (e.g., acetone or MEK) in containers of capacity greater than 60 litres shall be separated from all protected works by not less than the distance laid down in the following table.

Quantity stored			Minimum distance between the depot and the title boundary or protected work. (metres)
Depots Types A and B (litres)	Depots Type C (litres)	Depots Type D (litres)	
Up to 250	Up to 500 2,000	Up to 10,000	Nil
		20,000	2 3 4
1,000	10,000	100,000	6
		200,000	8
		400,000 and over	10
10,000	25,000		15
	40,000		17
20,000	60,000		20
	200,000 and over		25
40,000 60,000 and over			27
			30

Note: Isolation distances may be interpolated for intermediate quantities.



5. Table 2: Isolation distances of depots for dangerous goods of Class 3(b) (all capacities) and Class 3(a) in containers less than 60 litres (Ref: Regulation 36 Dangerous Goods (Class 3 - Flammable Liquids) Regulations 1985.)

Storage depots for storage of Class 3 (b) dangerous goods in containers of all capacities and the storage of Class 3 (a) dangerous goods in containers of less than 60 litres shall be separated from protected works by not less than the distance laid down in the following table:

Quantity stored			Minimum distance between the depot and the title boundary or protected work. (metres)
Depots Types A and B (litres)	Depots Type C (litres)	Depots Type D (litres)	
Up to 250	Up to 1,000	Up to 20,000	Nil
500			1
750	2,000	30,000	2
2,000			3
	10,000	100,000	4
		200,000	5
		400,000 and over	6
10,000	100,000		10
25,000	400,000 and over		15
40,000		17	
60,000 and over		20	

Note: Isolation distances may be interpolated for intermediate quantities.

For higher quantities refer to the Dangerous Goods Regulations.

In Tables 1 and 2, for any quantity intermediate between two quantities laid down in the tables, the required distance will be that which is proportional to the difference in quantity.

For storage of dangerous goods in containers greater than 250 litres, e.g. bulk —refer to the relevant Dangerous Goods Regulations.

6. Storage of Organic Peroxides

“Organic peroxide” includes an organic peroxide which has been phlegmatised or mixed with another substance or substances for safety or for convenience for transport or use. Refer to Regulations 20 to 28 of the Dangerous Goods (Class 4 - Flammable Solids or Substances, Class 5 - Oxidising Substances) Regulations 1985.

Storage requirements are:

- (a) Catalyst/initiators (organic peroxides) in quantities exceeding 25 kg shall be kept in a separate building (depot) having a concrete floor,



walls of brick, concrete or other approved materials and roof of wood and iron or similar light construction; and

- (b) The doors shall be of timber sheathed with flat galvanised iron and of approved construction; and
- (c) The building shall be well ventilated by vents protected with stainless steel wire gauze of not less than 3 meshes to the centimetre and where liquid organic peroxides are to be stored provisions shall be made to prevent outflow in the event of spillage; and
- (d) Shelves and fittings which should be provided shall be of incombustible material which is compatible with organic peroxides. Except with the approval of the Chief Inspector of Explosives, no electric lighting or fittings shall be installed in the building; and
- (e) There shall be displayed in a conspicuous position at the entrance to the building in letters of such size as should be easily read, the warning “Organic Peroxides. Flammable. No Smoking”; and
- (f) The building shall be kept secured against unauthorised entry. Reference Regulation 24 of the Dangerous Goods (Class 5 - Oxidising Substances) Regulations 1985.

Every depot for storing dangerous goods of Class 5(b) shall be isolated from any protected works in accordance with the following table:

Weight of organic peroxide (kg)	Minimum distance from public place (metres)	Minimum distance from protected works (metres)
25	5	10
50	7	15
100	10	20
200	12	25
500	15	35
1000	20	45
2000	25	55
3000	35	80

For quantities in excess of 3000 kg the depot shall be isolated in accordance with requirements of the Chief Inspector.

For storage of quantities not exceeding 25 kg:

Dangerous goods of Class 5(b) stored in quantities exceeding 10 kg but not exceeding 25 kg shall be kept either in a building meeting the requirements of Regulation 24 of the Dangerous Goods Regulations 1985, or in a cabinet constructed, fitted up and maintained as follows—



- (i) The bottom, top and sides of the cabinet shall be constructed of steel sheet not less than 1 mm thick, with double wall construction throughout having a cavity not less than 40 mm thick and all joints shall be welded.
- (ii) The door of the cabinet shall be of construction equivalent to that of the walls and shall be fitted with a friction-type lock which will be effective to permit relief to pressure in the event of explosion, and a sill not less than 50 mm deep shall be fitted beneath the door.
- (iii) There shall be displayed on the door of the cabinet in letters such size as should be easily read the warning—“ORGANIC PEROXIDES, FLAMMABLE, KEEP FIRE AND COMBUSTIBLES AWAY”.
- (iv) Unless it is impractical the cabinet shall be vented to the outside of the building.

7. Depots or cabinets for storage

A depot or cabinet for the storage of dangerous goods of Class 5(b) shall be used only for the keeping of such goods and the containers in which they are packed, and no person shall open any such container or weigh out any such goods in the storage space.

8. Use of flammable liquids—Class 3(a) and 3(b) dangerous goods, and dangerous goods workrooms

“Dangerous goods workroom” means a room constructed from approved fire-resisting materials reserved primarily for such use of dangerous goods of Class 3(a) or 3(b) and ancillary purposes i.e. construction, ventilation, compounding, egress (see Regulations 128-190).

The construction of dangerous goods workrooms shall be of three types, as follows:

- (a) **Type 1:** The walls, floor and (unless otherwise approved under sub-clause 1 of Regulation 134 of the Dangerous Goods Regulations 1985) the ceiling shall be of construction having a minimum fire-resistance rating of one hour.
- (b) **Type 2:** The walls, floor and (unless otherwise approved under sub-clause 1 of Regulation 134 of the Dangerous Goods Regulations 1985) the ceiling shall be of construction having a minimum fire-resistance rating of 2 hours.
- (c) **Type 3:** The walls, floor and (unless otherwise approved under sub-clause 1 of Regulation 134 of the Dangerous Goods Regulations 1985) the ceiling shall be of construction having a minimum fire-resistance rating of 4 hours.



Isolation distances-dangerous goods workrooms

No person shall, without the approval of the Chief Inspector, bring or permit to be brought into any dangerous goods workroom any dangerous goods in excess of the following quantities:

- (a) Dangerous goods of Class 3(a): 7,500 litres.
- (b) Dangerous goods of Class 3(b): 10,000 litres.

Every dangerous goods workroom shall be isolated from any protected work by the distance specified in the tables set out below having regard to the class and quantity of dangerous good permitted in that dangerous goods workroom at any one time.

Dangerous Goods of Class 3(a)			
Distance from nearest protected work			
Quantity (litres)	Type 1 (metres)	Type 2 (metres)	Type 3 (metres)
500	Nil	Nil	Nil
1,750	5	Nil	Nil
3,000	8	5	Nil
7,500	15	8	5

Dangerous Goods of Class 3(b)			
Distance from nearest protected work			
Quantity (litres)	Type 1 (metres)	Type 2 (metres)	Type 3 (metres)
750	Nil	Nil	Nil
2,500	5	Nil	Nil
4,000	8	5	Nil
10,000	15	8	5

Classification and zoning of dangerous goods hazardous areas

Classification is done in accordance with AS/NZS 2430.3 Parts 1 to 9.

This means a dangerous goods inspector will zone the workroom for purposes of ensuring appropriate electrical equipment is installed.



9. Use of dangerous goods (flammable liquids) otherwise than in a workroom regulations 147-151

Regulation 149 permits the use of dangerous goods otherwise than in a workroom, provided that the maximum quantity in any building at any one time does not exceed 60 litres of Class 3(a) or 200 litres of Class 3(b) with the following provisions:

- (a) The building is sole occupancy;
- (b) The dangerous goods work area is of fire resisting construction for a distance of 6 metres, in all directions, from the place at which the dangerous goods are used;
- (c) Adequate ventilation is provided;
- (d) No smoking or source of ignition within 15 metres, if more than 30 litres of 3(a) is used, unless the area is protected by a screen wall;
- (e) Regulations 150 and 151 shall also be considered when assessing use of flammable liquids otherwise than in a workroom.

Regulation 138 prescribes that workrooms shall be at ground level except:

- (a) With the Chief Inspector's approval.
- (b) Where quantities used are less than 60 litres of 3(a) or 100 litres of 3(b).
- (c) In a building of fire resisting construction entirely under one occupancy, and the use is an essential phase of the business conducted in the building.

10. Handling dangerous goods

Packages shall be opened in a work area constructed of fire resistant materials.

Only goods necessary for immediate use are permitted in the work area. Maximum permitted is one day's supply.

No contaminated goods are permitted to be returned to the original container of good for storage.

All practicable steps shall be taken to prevent fire or explosion.

Any spillage or contaminated goods shall be immediately removed and disposed of in an approved manner.

No sources of ignition permitted in the area where goods are being used.

Goods shall be protected from:

- (a) Direct sunlight;
- (b) Impact;
- (c) Friction.



11. Fire protection

Every licensee shall install or maintain fire extinguishing equipment in accordance with the Dangerous Goods Regulations.

Where, under the regulations, there is a requirement for the provision of hand fire extinguishers, any such extinguisher should be one of the following type:

- (a) **Type 1:** Vaporising-type extinguishers, refer Ozone Layer Protection Act 1991.

NOTE: A permit is required to use this type of extinguisher.

- (b) **Type 2:** Foam-producing extinguishers, i.e. extinguishers which generate a foam which can be applied to blanket the surface of burning liquids and other burning substances and which is suitable for the kind of dangerous goods at risk.
- (c) **Type 3:** Extinguishers delivering an inert gas, such as carbon dioxide or other similar approved agent.
- (d) **Type 4:** Dry-powder extinguishers, i.e. extinguishers which expel a powder such as a specially treated sodium bicarbonate by means of a stream of nitrogen, carbon dioxide, or other approved inert gas.
- (e) **Type 5:** Fractionising dry-powder extinguishers, i.e. extinguishers which expel a powder such as specially treated decrepitating potassium salt by means of a stream of nitrogen carbon dioxide or other approved inert gas.

11.1 A single unit of capacity of the extinguisher shall be respectively as follows:

- (a) **Type 1 Extinguishers:** The liquid capacity of the extinguisher shall be not less than 1.8 kg bromotrifluoromethane, bromochlorodifluoromethane, or equivalent approved capacity of other approved fire extinguishing agent.
- (b) **Type 2 Extinguishers:** The liquid capacity of the extinguisher shall be not less than 9 kg.
- (c) **Type 3 Extinguishers:** The extinguisher shall have a capacity of not less than 4.5 kg of carbon dioxide or equivalent weight of other approved inert gas.
- (d) **Type 4 Extinguishers:** The extinguisher shall have a capacity of not less than 2 kg of dry powder.
- (e) **Type 5 Extinguisher:** The extinguisher shall have a capacity of not less than 2 kg of fractionising dry powder.

A fire extinguisher shall be located and supported so that it is not unduly subject to corrosion, is readily accessible and removable and is easily seen.



The type, location and unit capacity of hand-fire extinguisher shall be in accordance with the following:

- (a) Protected work in which goods of Class 3 are stored, one of either type 1, 2, 3, 4 or 5, provided that a licensing authority should require additional extinguishers or extinguishing capacity if warranted by circumstances;
- (b) Depot for goods of Class 3 which open into a protected work, one of either type 1, 2, 3, 4, or 5.

11.2 Use of dangerous goods of Class 3 (a) or Class 3 (b):

- (a) In workrooms, Types 1, 2, 3, 4 or 5 of total capacity equivalent to one unit for each 20 square meters of floor area.
- (b) In workrooms communicating directly to other portions of the building, as for (a) above plus one additional extinguisher.
- (c) In small dip tanks and machines, one either of type 1, 2, 3, 4 or 5.
- (d) In small cabinets, one either type 1, 2, 3, 4 or 5.
- (e) In situations otherwise than workrooms one either of type 1, 2, 3, 4 or 5.
- (f) In containers not exceeding one litre or more, one either of type 1, 2, 3, 4 or 5. If more than one container is used exceeding this capacity, extra extinguishers will be required.
- (g) In open containers not exceeding one square meter of liquid surface area, one either of type 1, 2, 3, 4, or 5 being additional to any other requirement of regulation 153(1).
- (h) In open containers exceeding one square meter of liquid surface area, but not exceeding 2.5 square meters, one either type 1,2,3,4 or 5 of at least two unit capacity, being additional to any other requirement of regulation 153(2).
- (i) In drying rooms, cabinets, or ovens, one either of type 1, 2, 3, 4 or 5.

The Chief Inspector of Dangerous Goods should approve the use of other types of extinguishers subject to such conditions and ratings as he considers appropriate.

Where under the regulations there is any requirement for the provision of a local application fire extinguishing system the system shall of the type prescribed in the regulations.

On a premise where there is a requirement for a provision of a fixed fire extinguishing system the licensing authority may call for a report on the efficiency of the system installed, including its compliance with any standards imposed by the regulations from a Fire Safety Officer



appointed under the Fire Service Act 1975 and the licensing authority should act as it considers fit on any recommendation or adverse comment made in that officers report, except in the case where the Chief Inspector's approval is required, in which event it shall refer the report to the Chief Inspector.

The Fire Safety and Evacuation of Buildings Regulations 1992, require all buildings storing hazardous substances to have a Fire Service-approved evacuation scheme.

NOTE: The Hazardous Substances and New Organisms Act 1996 will revoke the Dangerous Goods Act and Regulations in due course. Until such time, the terms and information given above are still valid.



APPENDIX D: MANUFACTURING PROCESSES FOR COMPOSITES

A variety of processes are available to fabricate composite products. The process may be separated into two basic classes, open and closed moulding. Open moulding includes hand lay-up, spray up, filament winding, and centrifugal casting. Closed moulding includes matched die moulding, injection moulding, continuous laminating and pultrusion.

Gel coats which contain no fibre reinforcing can be pre-applied to the mould by either spraying or brushing to form a thin outer layer of resin. This provides a smooth, non-porous surface finish in whatever colour is required.

Hand lay-up moulding is the oldest method of preparing composite products. Layers of fibreglass reinforcement and resin are laid on the mould until the desired thickness is reached. Rollers and squeegees are used to consolidate the laminate.

In spray-up moulding, chopped glass or other reinforcements, resin and catalyst/initiator are deposited simultaneously on to the mould by the use of special depositor equipment. The mixture is then rolled as for hand lay-up.

In filament winding, continuous filament roving is fed under tension from a reel through a resin bath on to a shaped revolving mandrel so that the reinforcement is applied in the required place and at the correct angle.

Centrifugal casting, used in pipe manufacture, involves depositing catalysed resin and reinforcement inside rotating cylindrical moulds. Centrifugal force is used to consolidate the composite.

Matched die moulding is a hot press process in which pre-made compounds containing resin, catalyst/initiator, reinforcements and fillers are pressed between matched metal dies.

Resin injection or transfer moulding employs matched male and female moulds and the reinforcement is laid in the mould cavity, and the resin injected at a specific point using special dispensing equipment with typical pressures of up to 2 atmospheres.

In continuous laminating, resin impregnated reinforcement supported by a carrier film is pulled through formers and cured by passage through an oven. This process is used to manufacture corrugated roof sheeting.

Pultrusion is the process of pulling resin impregnated fibrous material through a bath of catalysed resin into mandrels or dies that are heated to initiate setting into a continuous profile or tube.



APPENDIX E: REFERENCE MATERIAL

ACTS AND REGULATIONS

- * Dangerous Goods (Class 3 - Flammable Liquids) Regulations 1985
- * Dangerous Goods (Class 4 - Flammable Solids or Substances and Class 5 - Oxidising Substances) Regulations 1985
- * Dangerous Goods (Labelling) Regulations 1978 and amendments
- * Dangerous Goods Act 1974
- * Ozone Layer Protection Act 1996
- * Resource Management Act 1991 and Resource Management Amendment Act 1994
- * Transport Act 1962
- ** Electricity Act 1992
- ** Electricity Regulations 1997
- Building Act 1991
- Fire Safety and Evacuation of Buildings Regulations 1992
- Fire Service Act 1975
- Hazardous Substances and New Organisms Act 1996
- Health and Safety in Employment Act 1992
- Health and Safety in Employment Regulations 1995
- Spray Coating Regulations 1962
- Toxic Substances Act 1979
- Toxic Substances Regulations 1983
- Transport Amendment Act 1990

STANDARDS

- AS 2380: *Electrical equipment for explosive atmospheres - Explosion - protection techniques.*
 - AS 2380.1:1989: *General requirements*
- AS/NZS 1020:1995 *The control of undesirable static electricity*
- AS/NZS 1715:1994 *Selection, use and maintenance of respiratory protective devices*
- AS/NZS 1716:1994 *Respiratory protective devices*
- AS/NZS 2430.3 Parts 1 to 9
- AS/NZS 4114:1995 *Spray painting booths Pt. 1 Design, construction and testing.*
- NZS 4503:1974 *Hand-operated firefighting equipment for use in buildings.*



NZS 5433:1988 *Code of practice for transportation of hazardous substances on land*

NZS 6101: *Classification of hazardous areas*

Part 1:1988: *Flammable gas and vapour atmospheres*

Part 2:1990: *Combustible dusts*

NZS 8409:1995 *Agrichemical users' code of practice*

NZS/AS 1319 *Safety signs for the occupational environment*

OSH PUBLICATIONS

A Guide to Occupational Skin Disease (1995)

A Guide to Respirators and Breathing Apparatus (1992)

Approved Code of Practice for the Management of Substances Hazardous to Health (MOSHH) (1997)

A Practical Guide and Workbook for Completing a MOSHH Assessment in Your Workplace (1997)

Guidelines for the Provision of Facilities and General Safety in Commercial and Industrial Premises (1996)

Health and Safety Guidelines for the Selection and Safe Handling of Synthetic Mineral Fibres (1994)

Practical Guidelines for the Safe Use of Organic Solvents (1992)

Safe Stacking and Storage (1989)

Safe Working in a Confined Space (1997)

Workplace Exposure Standards Effective From 1994

OTHER PUBLICATIONS

** NZECP 24:1993 *Safety of electricity in a hazardous area*

National Fire Protection Association (NFPA) Code 68: *Guide for venting of deflagrations (1988 edition)*

FOR FURTHER ASSISTANCE

The following authorities can provide further information and assistance:

- 1. Occupational Safety and Health Service (OSH), Department of Labour,** branch offices and General Manager's office.

For advice on the Health and Safety in Employment Act and Regulations, Spray Coating Regulations, Dangerous Goods legislation, classification of hazardous areas (spray coating and dangerous goods), and safety and health issues relating to hazard identification and control,



combustible dust, machine guarding, workplace facilities, chemicals, noise, and manual handling.

2. The office of the Chief Electrical Engineer, Energy Inspection, Energy and Resources Division of the Ministry of Commerce.

For advice on electrical safety and electrical equipment for use in hazardous areas.

3. New Zealand Fire Service.

For advice on fire safety and emergency procedures.

4. Building Industry Authority and Regional Authority Building Inspectors.

For advice on building requirements, new and altered buildings, classification of hazardous areas (dangerous goods), and environment protection and waste disposal.

5. Ministry for the Environment.

For advice on environmental protection and waste disposal.

6. Standards Association of New Zealand.

Provide information and advice on industry Standards.

All these authorities can be contacted by reference to the local telephone directory.

The **Composites Association of New Zealand (Inc.)** also provide advice on industry developments and the application of the code.



COMPOSITES ASSOCIATION OF NEW ZEALAND INCORPORATED

This code of practice was developed by, and remains the property of, the Composites Association of New Zealand Incorporated and shall not be reproduced either entirely or in part without written permission from this Association.

Copies of this code and further information on the Association may be obtained from the office of the Association by contacting:

Mr G R Henderson
Executive Director
Composites Association of New Zealand Incorporated
PO Box 54 160
Bucklands Beach
Auckland
New Zealand
Telephone: (09) 535 6494
Fax: (09) 535 6494

