

Spray painting and powder coating

Code of Practice 2013

This Queensland code of practice has been approved by the Attorney-General and Minister for Justice and commences on 1 December 2013.

This code is based on a national model code of practice developed by Safe Work Australia and approved by the Select Council on Workplace Relations on 13 July 2012 as part of the harmonisation of work health and safety laws.

This code was varied by the Minister for Education and Industrial Relations on 1 July 2018.

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Foreword

This code of practice on managing health and safety risks in spray painting and powder coating is an approved code of practice under section 274 of the Work Health and Safety Act (the WHS Act).

An approved code of practice is a practical guide to achieving the standards of health, safety and welfare required under the WHS Act and the Work Health and Safety Regulation (the WHS Regulation).

From 1 July 2018 duty holders **are** required to comply with an approved code of practice under the Act. Duty holders may, for the subject matter in the code, follow another method, such as a technical or an industry standard, if it provides an equivalent or higher standard of work health and safety to the standard required in the code.

A code of practice applies to anyone who has a duty of care in the circumstances described in the code. In most cases, following an approved code of practice would achieve compliance with the health and safety duties in the WHS Act, in relation to the subject matter of the code. Like regulations, codes of practice deal with particular issues and do not cover all hazards or risks which may arise. The health and safety duties require duty holders to consider all risks associated with work, not only those for which regulations and codes of practice exist.

Codes of practice are admissible in court proceedings under the WHS Act and the WHS Regulation. Courts may regard a code of practice as evidence of what is known about a hazard, risk or control and may rely on the code in determining what is reasonably practicable in the circumstances to which the code relates.

An inspector may refer to an approved code of practice when issuing an improvement or prohibition notice. This may include issuing an improvement notice for failure to comply with a code of practice where equivalent or higher standards of work health and safety have not been demonstrated.

This code of practice has been developed by Safe Work Australia as a model code of practice under the Council of Australian Governments' Inter-Governmental Agreement for Regulatory and Operational Reform in Occupational Health and Safety for adoption by the Commonwealth, state and territory governments.

Scope and application

This code provides practical guidance for persons conducting a business or undertaking on how to manage health and safety risks associated with spray painting or powder coating processes. This code applies to all workplaces covered by the WHS Act where spray painting or powder coating activities are carried out and to all people involved in these activities.

How to use this code of practice

In providing guidance, the word 'should' is used in this code to indicate a recommended course of action, while 'may' is used to indicate an optional course of action.

This code also includes various references to provisions of the WHS Act, the WHS Regulation, the *Electrical Safety Act 2002* (the ES Act) and the *Electrical Safety Regulation 2013* (ES Regulation) which set out the legal requirements. These references are not exhaustive. The words 'must', 'requires' or 'mandatory' indicate that a legal requirement exists and must be complied with.

1 Introduction

1.1 What are spray painting and powder coating?

Spray painting including electrostatic spray painting, is a process by which liquid paint is applied under pressure to an object. Spray painting may be carried out by hand or automatically. There are several methods used to atomise the paint for spraying:

- using a conventional air compressor – air is driven across the mouth of a small outlet under pressure to draw liquid paint out of the container and produce an air-paint mist from the nozzle of the spray-gun
- airless spray painting – the paint container is pressurised pushing the paint to the nozzle where it is atomised by the spray gun, or
- electrostatic spray painting – an electric pump drives the electrostatically charged liquid paint out of the nozzle which is then applied to the object which is earthed.

Powder coating is a process by which electrostatically charged powder is applied onto an earthed object.

Spray painting and powder coating are carried out in a variety of industries. For example, items that are commonly spray painted include motor vehicles, buildings, furniture, white goods, boats, ships, aircraft and machinery.

1.2 Who has health and safety duties in relation to spray painting and powder coating?

A **person conducting a business or undertaking** (PCBU) has the primary duty to ensure, so far as is reasonably practicable, that workers and other people are not exposed to health and safety risks arising from the business or undertaking.

The processes involved in spray painting and powder coating are hazardous due to a combination of factors such as the use, handling and storage of hazardous chemicals and exposure to electrical, noise, manual handling and plant hazards.

A PCBU involved in spray painting or powder coating must eliminate risks associated with this work, or if that is not reasonably practicable, minimise the risks so far as is reasonably practicable.

The WHS Regulation includes more specific requirements to manage the risks of hazardous chemicals, airborne contaminants and plant, as well as other hazards associated with spray painting or powder coating activities such as noise and manual handling.

Designers, manufacturers, importers and suppliers of plant or substances used in spray painting or powder coating activities must ensure, so far as is reasonably practicable, that the plant or substance is without risks to health and safety. This duty includes carrying out testing and analysis as well as providing specific information about the plant or substance.

Officers, such as company directors, have a duty to exercise due diligence to ensure that the business or undertaking complies with the WHS Act and WHS Regulation. This includes taking reasonable steps to ensure that the business or undertaking has and uses appropriate resources and processes to eliminate or minimise risks that arise from spray painting or powder coating.

Workers have a duty to take reasonable care for their own health and safety and must not adversely affect the health and safety of other people. Workers must comply with any reasonable instruction and cooperate with any reasonable policy or procedure relating to health and safety at the workplace. If personal protective equipment (PPE) is provided by the PCBU, the worker must use it in accordance with the information, instruction and training provided.

1.3 What is required to manage risks associated with spray painting and powder coating?

The WHS Regulation requires a PCBU to 'manage risks' associated with specific hazards including noise, hazardous chemicals, plant and electricity.

WHS Regulation sections 32-38: In order to manage risk under the WHS Regulation, a duty holder must:

- a) identify reasonably foreseeable hazards that could give rise to the risk
- b) eliminate the risk so far as is reasonably practicable
- c) if it is not reasonably practicable to eliminate the risk, minimise the risk so far as is reasonably practicable by implementing control measures in accordance with the hierarchy of risk control
- d) maintain the implemented control measure so that it remains effective
- e) review, and if necessary revise all risk control measures so as to maintain, so far as is reasonably practicable, a work environment that is without risks to health and safety.

This Code provides guidance on managing the risks of spray painting and powder coating by following a systematic process that involves:

- identifying the hazards
- if necessary, assessing the risks associated with these hazards
- implementing control measures
- reviewing control measures.

Guidance on the general risk management process is available in the *How to manage work health and safety risks Code of Practice*.

Consulting your workers

Consultation involves sharing of information, giving workers a reasonable opportunity to express views and taking those views into account before making decisions on health and safety matters.

WHS Act section 47: A PCBU must consult, so far as is reasonably practicable, with workers who carry out work for them who are (or are likely to be) directly affected by a work health and safety matter.

WHS Act section 48: If the workers are represented by a health and safety representative, the consultation must involve that representative.

Consultation with workers and their health and safety representatives is required at each step of the risk management process. By drawing on the experience, knowledge and ideas of your workers you are more likely to identify all hazards and choose effective control measures.

Consultation with workers can help you select appropriate control measures including any PPE they may require.

Consulting, co-operating and co-ordinating activities with other duty holders

WHS Act section 46: A PCBU must consult, co-operate and co-ordinate activities with all other persons who have a work health or safety duty in relation to the same matter, so far as is reasonably practicable.

Sometimes you may have responsibility for health and safety together with other business operators who are involved in the same activities or who share the same workplace. In these situations, you should communicate with each other to find out who is doing what and work together in a co-operative and co-ordinated way so that all risks are eliminated or minimised so far as is reasonably practicable.

For example, if you engage a contractor to carry out spray painting at your workplace, then you should work together with the contractor to plan the work, discuss any safety issues that may arise and how the risks associated with spray painting work will be controlled.

Further guidance on consultation is available in the *Work health and safety consultation, co-operation and co-ordination Code of Practice*.

2 The risk management process

2.1 Identifying the hazards

The first step in managing risks associated with spray painting or powder coating activities is to identify all the hazards that have the potential to cause harm.

Potential hazards may be identified in a number of different ways including:

- conducting a walk through assessment of the workplace observing the work and talking to workers about how work is carried out
- inspecting the materials and equipment that will be used during the spray painting or powder coating process
- reading product labels, safety data sheets (SDS) and manufacturer's instruction manuals
- talking to manufacturers, suppliers, industry associations and health and safety specialists
- reviewing incident reports.

Table 1 below lists the common hazards associated with spray painting or powder coating.

Table 1 Examples of common spray painting and powder coating hazards

Hazard	Potential harm	Examples
Hazardous chemicals	<ul style="list-style-type: none">• dermatitis, respiratory illnesses and cancers• some hazardous chemicals are also fire and explosion risks	paints, solvents, adhesives, resins, rust removers, rust converters, lacquers and degreasers

Hazard	Potential harm	Examples
Fire and explosion	serious burns and death, exposure to projectiles and damage to property	flammable paints and solvents in contact with an ignition source combustible dusts used powder coating
Confined spaces	exposure to hazardous chemicals, unsafe oxygen levels, potential for fire, explosion and engulfment	spraying inside the cavity of vehicles, ships, aircraft or tanks
Machinery and equipment	injection injuries, being caught by moving parts of machinery can cause fractures, bruises, lacerations, dislocations, permanent injuries or death	spray booths, sanding, grinding equipment, airless spray equipment, compressed air
Working at height	falling objects, falls, slips and trips of people can cause fractures, bruises, lacerations, dislocations, concussion, permanent injuries or death	spray painting trucks, ships, aeroplanes or bridges
Hazardous manual tasks	overexertion, sustained awkward postures or repetitive movement can cause muscular strain	repetitive spraying action, lifting and pushing objects into place
Electricity or static electricity	<ul style="list-style-type: none"> exposure to electricity can cause shock, burns or death from electric shock electricity and static electricity are also sources of ignition 	the use of electrical equipment, wiring of equipment and electrostatic charges
Heat or high humidity	exposure to heat or high humidity can cause burns, heat stroke and fatigue	wearing impervious PPE or working outdoors or in a poorly ventilated workplace
Noise	exposure to loud noise can cause permanent damage to hearing	noise from pumps, compressors and spray booths

Identifying the chemicals used in the workplace

Exposure to hazardous chemicals is a significant risk in spray painting and powder coating activities including during preparation (preparing surfaces, tinting, mixing and pouring paints), storage, clean-up and disposal. The hazardous chemicals that workers may be exposed to include paints, solvents, powders, lacquers, paint strippers, adhesives, surface preparation products, rust converters and rust removers. In most cases the product label and SDS will identify any hazardous chemicals.

You should also identify any dusts or fumes generated by sanding and surface preparation. For example, sanding of polyurethane paints that are not fully cured can generate dust containing unreacted isocyanates which can lead to long term respiratory problems.

WHS Regulation section 351: A PCBU must manage risks to health and safety associated with using, handling, generating or storing a hazardous chemical at the workplace.

WHS Regulation section 382: The WHS Regulation prohibits and restricts the use of some hazardous chemicals. The following chemicals must not be used, handled or stored for spray painting:

- arsenic
- arsenic compounds
- benzene (benzol), if the substance contains more than 1 per cent by volume
- carbon disulphide (carbon bisulphide)
- lead carbonate
- methanol (methyl alcohol), if the substance contains more than 1 per cent by volume
- tetrachloroethane
- tetrachloromethane (carbon tetrachloride)
- tributyl tin.

Identifying the hazards of the chemicals

The health effects that a worker may experience following exposure to hazardous chemicals can become apparent after a short period of time and include headaches, nausea or vomiting, dizziness, burns to the skin or eyes and irritation to the nose, throat and lungs. Serious long term health effects where the symptoms may not be immediately apparent can also occur. Long term health effects include asthma, dermatitis, kidney or liver damage, cancer and damage to the reproductive system and central nervous system.

Many chemicals used in spray painting or powder coating also have physicochemical hazards. For example, many organic solvents are flammable and some chemicals used for cleaning or surface preparation may be corrosive.

Information about the hazards of chemicals is available from product labels and safety data sheets. A SDS includes information on the health effects, physicochemical properties, safe handling and storage, emergency procedures, and disposal considerations. It also contains information about how hazardous chemicals can enter the body (e.g. by inhalation into the lungs, absorption through the skin and eyes and through swallowing including accidentally ingesting small amounts).

If you don't have a SDS for a hazardous chemical supplied to your workplace, you must obtain one from the manufacturer, importer or supplier of the chemical. You should also consider obtaining a current SDS before you decide to purchase a new chemical as it is useful to identify hazards before you potentially introduce them into your workplace.

Exposure standards

WHS Regulation section 49: A PCBU must ensure that no person at the workplace is exposed to a substance or mixture in an airborne concentration that exceeds the exposure standard for the substance or mixture.

Exposure standards represent the airborne concentration of a particular substance or mixture that must not be exceeded. There are three types of exposure standard:

- 8-hour time-weighted average
- peak limitation
- short term exposure limit.

Exposure standards are based on the airborne concentrations of individual substances that, according to current knowledge, should not cause adverse health effects nor cause undue discomfort to nearly all workers.

Chemicals with workplace exposure standards are listed in the *Workplace Exposure Standards for Airborne Contaminants*. These exposure standards are also available from the Hazardous

Chemicals Information System (HCIS) on the Safe Work Australia website. The HCIS database contains additional information and guidance for many substances. Although exposure standards may also be listed in Section 8 of the SDS, you should always check the *Workplace Exposure Standards for Airborne Contaminants* or HCIS to be certain.

Guidance on interpreting exposure standards is available in the *Guidance on the Interpretation of Workplace Exposure Standards for Airborne Contaminants*.






To comply with the WHS Regulation, monitoring of workplace contaminant levels for chemicals with exposure standards may need to be carried out.

Information on labels and safety data sheets

The purpose of a label is to ensure that the contents of a container can be readily identified. The label also includes information on the hazards of the chemical and precautions to be observed to safely use, handle or store the hazardous chemical. This information on labels and SDS is provided in the form of signal words, hazard pictograms and precautionary statements (see Table 2). Always read the label and the SDS before using a hazardous chemical.

In situations where hazardous chemicals are decanted into another container and it will not be used immediately or it is supplied to someone else for later use, then the container must be labelled in accordance with the *Labelling of workplace hazardous chemicals Code of Practice*. However, if a decanted hazardous chemical will be used immediately, labelling of its container is not required.

Table 2 Examples of hazard information on labels and safety data sheets

Label element	Examples
Signal words	<ul style="list-style-type: none"> • danger • warning
Hazard statements	<ul style="list-style-type: none"> • may cause cancer • fatal if inhaled • flammable liquid and vapour • causes severe skin burns and eye damage • may cause respiratory irritation
Pictograms	<div>    </div> <div> Flammable Acute toxicity Warning </div> <div>   </div> <div> Human health Corrosive </div>

Label element	Examples
Precautionary statements	<ul style="list-style-type: none"> • use explosion proof electrical equipment • do not breathe vapours • do not get in eyes, on skin or clothing • use only outdoors or in a well ventilated area • if on skin, wash with plenty of soap and water

Isocyanates

Isocyanates are commonly found in 2-pack liquid spray paints, varnishes, adhesives and polyurethane plastics. Isocyanate polymers may also be present in paints including:

- polyisocyanate
- isocyanate pre-polymer
- isocyanate polymer
- polymerised isocyanates.

Exposure to isocyanates can occur when aerosols, mists or powder paints containing isocyanates are released into the atmosphere during spraying or powder coating. Exposure to isocyanates can also occur during sanding of polyurethane paint that is not fully cured, as this activity can generate dusts containing un-reacted isocyanates. Further, isocyanate-containing materials may release isocyanates into the atmosphere when heated. Exposure to isocyanates should be considered as high risk.

SDS and labels should be checked to determine if the products you are using contain isocyanates.

Lead

Workers who carry out surface preparation (such as preparing old vehicles for spray painting) could be exposed to lead when removing and sanding lead-based paints.

Paint that contains lead can no longer be purchased in Australia and the use of lead-free paints will eventually eliminate exposure to lead and the associated risks.

The WHS Regulation contains specific requirements for working with lead including the identification of lead risk work and removing a worker from lead risk work in certain circumstances.

Hazardous chemical registers

You must maintain a register of the hazardous chemicals used, handled or stored at the workplace. The purpose of this register is to provide a source of information for both you, your workers and anyone else affected by a hazardous chemical, and to assist in the management of substances used or generated in spray painting or powder coating activities. The register must list all the hazardous chemicals at your workplace and their current SDS (e.g. for any paints, coatings, solvents and thinners, fillers, strippers and cleaning products that are hazardous). The register must be readily accessible to anyone who is likely to be affected by a chemical and workers who are involved in using, handling or storing a chemical in the register.

2.2 Assessing the risks

Hazards have the potential to cause different types and severities of harm, ranging from minor discomfort to a serious injury or death. For example, exposure to spray painting or powder coating chemicals can adversely affect a worker's health in ways ranging from minor illness (e.g. headaches) to major illness (e.g. asthma).

Many liquid paints and powder paints contain flammable substances. Spray painting vapours and mists, as well as powder paints used in powder coating can spread rapidly, particularly in an enclosed space, and create a potentially explosive atmosphere. If the aerosol mist, vapour or powder paint is ignited (e.g. by static electricity, a lit cigarette or spark), it could result in an explosion that could destroy the building and kill or injure anyone nearby. Each of the outcomes involves a different type of harm with a range of severities and each has a different likelihood of occurrence.

Under the WHS Regulation, a risk assessment is not mandatory for spray painting or powder coating, however it is required for specific situations (e.g. when working in confined spaces). In many circumstances, a risk assessment will assist in determining the control measures that should be implemented. It will help to:

- identify which workers are at risk of exposure
- determine what sources and processes are causing that risk
- identify if and what kind of control measures should be implemented
- check the effectiveness of existing control measures.

The following questions may help to assess the risk:

- How often, and for how long, will exposure to the hazard occur?
- In the event of exposure to the hazard, will the outcome be severe, moderate or mild?
- How do workers interact with the hazard (e.g. being exposed to hazardous chemicals by breathing it in or skin contact)?
- Is there evidence of contamination (e.g. dust or fumes visible in the air, chemical odours, spills, splashes)?
- What are the conditions under which spray painting is carried out (e.g. confined space)?
- What are the skills, competence and experience of the operator?

Assessing the risks of hazardous chemicals

Once you have listed all the hazardous chemicals used in each stage of the spray painting or powder coating activity, you should review the information on the relevant labels and SDS to determine the nature and severity of the harm. Depending on the chemical, the severity of the harm could range from minor to major (e.g. from minor skin irritation to chronic lung disease or cancer).

Using information found in the label and SDS, spray painting and powder coating chemicals, mixtures or materials can be put into three hazard categories as provided in Table 3.

Table 3 Hazard categories of spray painting or powder coating substances

Risk	Examples
High risk chemicals	<p>A hazardous chemical should be considered as high risk if it is:</p> <ul style="list-style-type: none"> • a chemical that is carcinogenic • a chemical that is mutagenic, genotoxic or has reproductive hazards • a chemical which affects the central nervous system (which can also affect hearing due to ototoxic effects). That is, they may cause hearing loss or exacerbate the effects of noise. Evaluating the use of these chemicals should be carried out in conjunction with the <i>Managing noise and preventing hearing loss at work Code of Practice</i>. • a skin or respiratory sensitiser or if it is corrosive or has acute irritant effects • a chemical which causes severe effects after a single, repeated or prolonged exposure • a flammable liquid, vapour or aerosols. <p>Many chemicals that are used in spray painting including 2-part polyurethane paints containing isocyanates and toluene (an ingredient in many oil-based paints), and in powder coating, such as triglycidyl isocyanurate, hydrofluoric acid and chromic acid are known to present significant health risks and should be assessed as high risk.</p>
Medium risk chemicals	<p>Medium risk hazardous chemicals include any substances that contain organic solvents that are not already assessed as high risk, or flammable liquids or combustible dusts.</p>
Low risk chemicals	<p>Hazardous chemicals that are low risk include any other substances not already assessed as high or medium.</p>

The level of risk depends not only on the toxicity or flammability of the hazardous chemical but also on the nature of exposure including frequency of use, quantities used, effectiveness of existing controls (such as exhaust or ventilation systems) and the processes involved at the workplace. For example, some spray painting processes may be more suitable than others when attempting to minimise the exposure of a hazardous chemical or the risk of fire (see Table 4).

Further guidance on managing risks associated with hazardous chemicals is available in the *Managing risks of hazardous chemicals in the workplace Code of Practice*.

Table 4 Characteristics of spray painting and powder coating activities

Process	Characteristics
Conventional compressed air (low pressure) spray painting	<ul style="list-style-type: none"> • extensive overspray of potentially hazardous chemicals • bounce of potentially hazardous chemicals in cavities and at corners (rebound)
Airless (high pressure) spray painting	<ul style="list-style-type: none"> • risk of injection injury and static electricity that could cause a spark • less overspray, bounce and aerosol than conventional air spraying • relatively high viscosity paints can be used (less solvent is needed in the paint) • higher capacity (flow rate) and faster application
Air assisted airless spray painting	<ul style="list-style-type: none"> • risk of injection injury • less aerosol and overspray than conventional air spraying
Powder coating	<ul style="list-style-type: none"> • high risk chemicals are used in surface preparation including chromates and hydrofluoric acid • risk of exposure to airborne particulates and static electricity • spray guns are heavier and more difficult to handle
Hot spraying	<ul style="list-style-type: none"> • increase of potential for fire or explosion • uses very little thinner • reduced overspray
Pressure pots	<ul style="list-style-type: none"> • risk from over pressurisation (pressure should be released before opening to refill) • potential for vessels damage and incorrectly fitted hoses and couplings • awkward manual tasks • more solvents used in maintenance

The nature of spray painting or powder coating activities varies according to the object being sprayed. When assessing risk, consider how:

- the object is positioned in relation to the worker and other people
- the size and shape of the object and the direction of the stream of ventilating air influences how coating is applied
- how easy the object is to move and whether work systems and plant could be improved.

Appendix A contains an example of a risk assessment that can be used as guidance when assessing the risks involved with spray painting or powder coating activities including associated activities.

Monitoring airborne contaminant levels

WHS Regulation section 50: A PCBU at a workplace must ensure that air monitoring is carried out to determine the airborne concentration of a substance or mixture at the workplace to which an exposure standard applies if:

- the person is not certain on reasonable grounds whether or not the airborne concentration of the substance or mixture at the workplace exceeds the relevant exposure standard; or
- monitoring is necessary to determine whether there is a risk to health.

The results of air monitoring must be recorded and kept for 30 years after the date the record is made.

Air monitoring is the sampling of workplace atmospheres to obtain an estimate of workers' potential inhalation exposure to hazardous chemicals. Air monitoring can be used:

- when there is uncertainty about the level of exposure
- to indicate whether the exposure standards are being exceeded or approached
- to test the effectiveness of the control measures.

Air monitoring should be carried out by a person such as an occupational hygienist with skills to carry out the monitoring according to standards and to interpret the results. Where monitoring of airborne contaminants is used to determine a person's exposure, the monitoring must be undertaken in the breathing zone of the person.

Results from air monitoring indicate how effective your control measures are (e.g. whether ventilation systems are operating as intended). If monitoring identifies that the exposure standard is being exceeded, the control measures must be reviewed and any necessary changes made.

Air monitoring cannot be used to determine a risk to health via skin contact of airborne chemicals.

Further guidance on exposure standards is available in the publication *Workplace Exposure Standards for Airborne Contaminants*.

2.3 Controlling the risks

The hierarchy of control measures

Some control measures are more effective than others. Control measures can be ranked from the highest level of protection and reliability to the lowest. This ranking is known as the *hierarchy of control*.

You must always aim to eliminate a hazard and associated risk first. If this is not reasonably practicable, the risk must be minimised by using one or more of the following approaches:

- Substitution – for example use a:
 - water-based paint instead of an organic solvent based coating
 - brush or roller instead of a spray gun
 - triglycidyl isocyanurate-free (TGIC) powder coating instead of one containing TGIC
 - high volume low pressure (HVLV) spraying rather than airless spraying
 - low hazard cleaning solvent.
- Isolation – Conduct all spray painting in a spray booth ensures that other workers are not affected by the spray painting.
- Implementing engineering controls – Use control measures such as ventilation systems including spray booths, to reduce exposure to vapours and aerosols.

If risk then remains, it must be minimised by implementing *administrative controls*, so far as is reasonably practicable, for example restricting access to spray painting areas or keeping the quantity of hazardous chemicals to minimum in the spray painting area.

Any remaining risk must be minimised with suitable PPE, for example breathing protection, gloves, aprons and protective eyewear.

Administrative control measures and PPE rely on human behaviour and supervision, and used on their own, tend to be least effective in minimising risks.

A combination of these control measures may be required in order to adequately manage the risks with spray painting and powder coating. You should check that your chosen control measure does not introduce new hazards.

Chapters 3, 4 and 5 of this Code provide information on control measures for spray painting and powder coating activities.

2.4 Reviewing control measures

The control measures that are put in place to protect health and safety should be regularly reviewed to make sure they are effective. This may involve, for example air monitoring to measure the concentration of solvents in the worker's breathing zone where spray booths are not being used, or reviewing paint mist clearance times following the introduction of spray booths. If the control measure is not working effectively it must be revised to ensure it is effective in controlling the risk.

Common review methods include workplace inspection, consultation, testing and analysing records and data.

You can use the same methods as in the initial hazard identification step to check control measures. You must also consult your workers and their health and safety representatives and should consider the following questions:

- Are the control measures working effectively in both their design and operation?
- Have the control measures introduced new problems?
- Have all hazards been identified?
- Have new work methods, new equipment or chemicals made the job safer?
- Are safety procedures being followed?
- Has instruction and training provided to workers on how to work safely been successful?
- Are workers actively involved in identifying hazards and possible control measures? Are they openly raising health and safety concerns and reporting problems promptly?
- Are the frequency and severity of health and safety incidents reducing over time?
- If new legislation or new information becomes available, does it indicate current control measures may no longer be the most effective?

If problems are found, go back through the risk management steps, review your information and make further decisions about risk control.

Health monitoring

WHS Regulation section 368: A PCBU must ensure health monitoring is provided to a worker carrying out work for the business or undertaking if:

- the worker is carrying out ongoing work at a workplace using, handling, generating or storing hazardous chemicals and there is a significant risk to the worker's health because of exposure to a hazardous chemical referred to in Schedule 14, table 14.1, column 2, or
- the person identifies that because of ongoing work carried out by a worker using, handling, generating or storing hazardous chemicals there is a significant risk that the worker will be exposed to a hazardous chemical (other than a hazardous chemical referred to in Schedule 14, table 14.1) and either:
 - valid techniques are available to detect the effect on the worker's health
 - a valid way of determining biological exposure to the hazardous chemical is available and it is uncertain, on reasonable grounds, whether the exposure to the hazardous chemical has resulted in the biological exposure standard being exceeded.

Health monitoring of a person means monitoring the person to identify changes in the person's health status because of exposure to certain substances. It involves the collection of data in order to evaluate the effects of exposure and to determine whether or not that the absorbed dose is within safe levels. This allows decisions to be made about implementing ways to eliminate or minimise the worker's risk of exposure, for example reassigning a worker to other duties that involve less exposure or improving control measures.

Health monitoring, which may include biological monitoring, can assist in:

- establishing whether an identifiable disease or health effect known to be linked to exposure to dust, chemicals or noise has occurred
- determining levels of toxic substances in the body so that informed decisions can be made about the effectiveness of control measures and whether any further action needs to be taken (e.g. a reduction in or cessation of exposure).

Biological monitoring is a way of assessing exposure to hazardous chemicals that may have been absorbed through the skin, ingested or inhaled, therefore, biological monitoring techniques should also be used. For example, workers exposed to lead may require biological monitoring to measure the level of lead in their blood.

Biological monitoring has the specific advantage of being able to take into account individual responses to particular hazardous chemicals. Individual responses are influenced by factors including size, fitness, personal hygiene, work practices, smoking and nutritional status.

A PCBU must ensure that where health monitoring must be provided to a worker, the type of health monitoring referred to in the WHS Regulation is provided unless:

- an equal or better type of health monitoring is available
- the use of that other type of monitoring is recommended by a registered medical practitioner with experience in health monitoring.

Health monitoring is not an alternative to implementing control measures. If the results indicate that a worker is experiencing adverse health effects or signs of exposure to a hazardous chemical, the control measure must be reviewed and if necessary revised.

A PCBU must:

- inform workers and prospective workers about health monitoring requirements
- ensure health monitoring is carried out by or under the supervision of a registered medical practitioner with experience in health monitoring
- consult workers in relation to the selection of the registered medical practitioner
- pay all expenses relating to health monitoring

- provide certain information about a worker to the registered medical practitioner
- take all reasonable steps to obtain a report from the registered medical practitioner as soon as practicable after the monitoring has been carried out
- provide a copy of the report to the worker and the regulator if the report contains adverse test results or recommendations that remedial measures should be taken. Also provide the report to all other PCBU's who have a duty to provide health monitoring for the worker
- keep reports as confidential records for at least 30 years after the record is made (40 years for reports relating to asbestos exposure)
- not disclose the report to anyone without the worker's written consent unless required to under the WHS Regulation.

The WHS Regulation also contains specific requirements relating to health monitoring for lead. If a worker is carrying out lead risk work, health monitoring must be provided to a worker before the worker first commences lead risk work and one month after the worker first commences lead risk work.

Further information on health monitoring can be found in the *Health Monitoring for Exposure to Hazardous Chemicals – Guide for Workers* and *Health Monitoring for Exposure to Hazardous Chemicals – Guide for Persons Conducting a Business or Undertaking*.

3 Controlling the risks of spray painting

3.1 Spray painting in spray booths

Spray booths are enclosed or partially enclosed structures designed to prevent or reduce exposure to hazardous chemicals or vapours. A spray booth should be used when spray painting with a hazardous chemical, except when either:

- the shape, size or weight of an article cannot be easily moved or fit into a spray booth for example painting a building, bridge or a large boat
- the painting involves minor work such as spotting or touch-ups (e.g. painting a scratch or stone chip on a car) (painting a car panel with two-pack polyurethane paint would not be regarded as minor work).

Types of spray booths include:

- **Open-faced spray booths** generally have two walls, roof with air extraction, a filtered rear wall and an open front.
- **Enclosed type batch booth** is a room or large cabinet where the operator enters and spraying is conducted. The airflow is either down draught, cross draught, end draught or any combination thereof.
- **Tunnel or production spray booths** for mass produced items requiring a continuous painting application process. These booths are usually down draught or cross draught and have open ends.
- **Full downdraft spray booths**, where air enters the booth from the ceiling through a filtering system, and moves downwards vertically. Heavy and large objects, like cars, which are not easy to handle are often painted in the down draft spray painting booths.
- **Semi downdraft booths**, where fresh air enters the booth from outside the building, is ducted through the roof intake filters, and is drawn towards the rear exhaust wall of the booth where it is exhausted through filters.

Spray booths should:

- be designed, constructed and installed to comply with AS/NZS 4114.1 *Spray painting booths, designated spray painting areas and paint mixing rooms – Part 1: Design, construction and testing* and AS/NZS 4114.2 *Spray painting booths, designated spray painting areas and paint mixing rooms – Part 2: Installation and maintenance*

- be fitted with an exhaust capture system and a ventilation system that includes a filter for removing airborne contaminants
- have ventilation systems capable of producing a minimum air movement of:
 - 0.3 m/s for a full downdraft booth
 - 0.4 m/s for electrostatic spraying
 - 0.5 m/s for any other booth
- be inspected at regular intervals and maintained according to manufacturer's specifications
- have a sign indicating the time people should allow for chemicals to clear before entering the spray booth.

Spray booth ventilation control systems should operate a pre-purge cycle to remove any residue contaminants and also operate a minimum of a five minute post-purge period following spraying.

Whenever possible, the spray should be directed towards the exhaust air outlet of a booth. For example, when spraying a tall object in a down-draught booth no spraying should be performed above shoulder height. Extension poles or lift platforms should be used so that the operator can get above the object and spray towards the air exhaust outlet in the floor. The spray painter should never be positioned between the spray gun and the exhaust air outlet. See **Figures 1 to 8** below for further guidance.

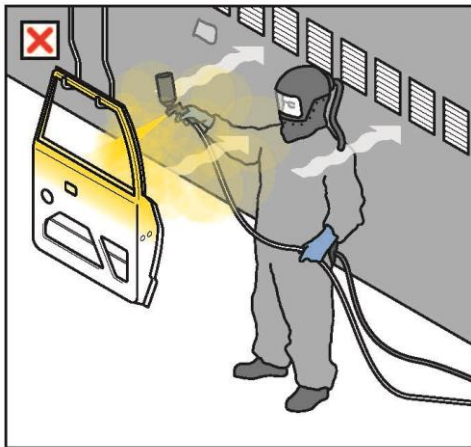


Figure 1 The operator is exposed to overspray because of poor positioning in relation to the airflow.



Figure 2 To avoid overspray, the article should be rotated rather than the operator spraying against the airflow.

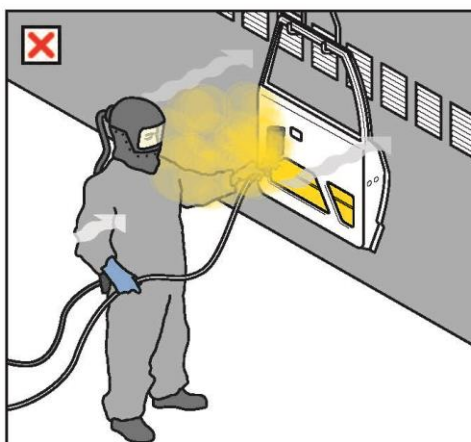


Figure 3 Spraying with a 'short' nozzle may cause overspray of the operator.

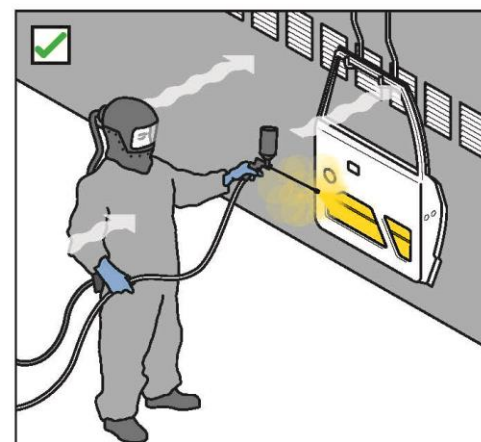


Figure 4 Spraying with a 'long' nozzle avoids overspray of the operator.

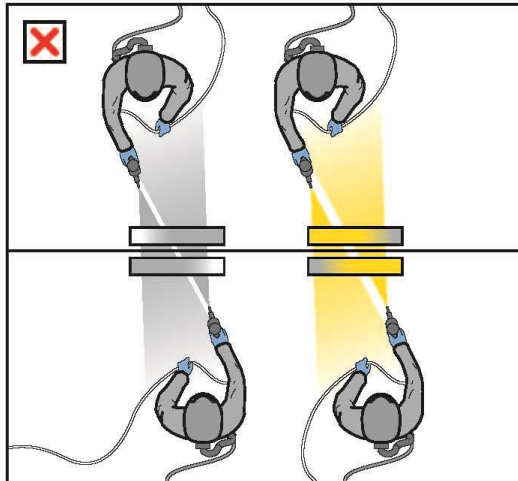


Figure 5 Each operator is exposed to overspray because of their placement opposite each other.

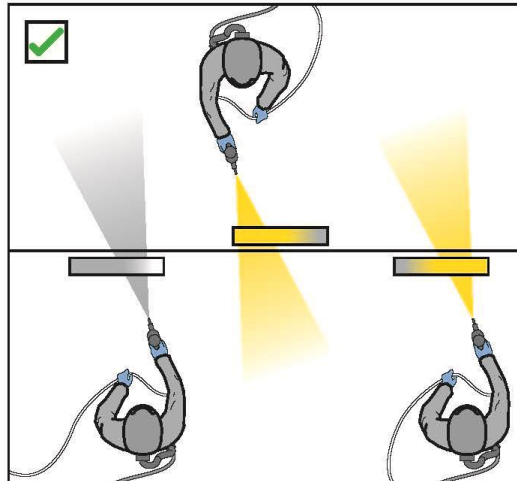


Figure 6 The use of staggered work positions avoids overspray of the operators.

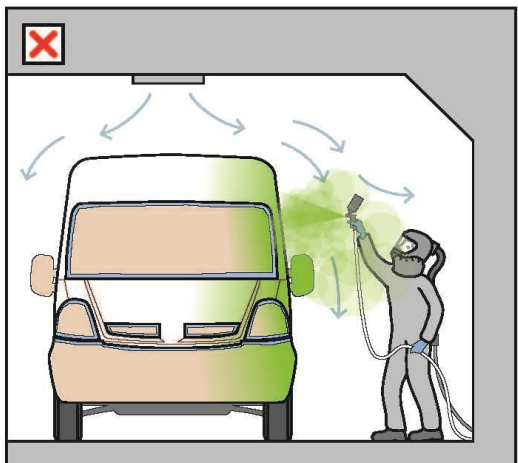


Figure 7 The operator is exposed to overspray and stretching and reaching can cause discomfort and injury.

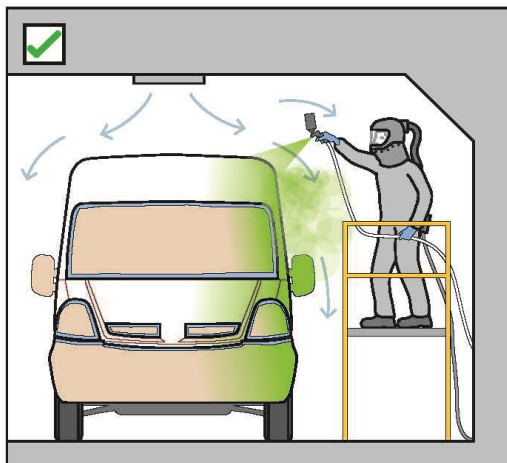


Figure 8 The use of a gantry or lift avoids overspray on to the operator and avoids them having to stretch and reach.

Even with a ventilation system, there is still potential for flammable mists and vapours to accumulate inside the spray booth, which can increase the risk of fire and explosion. Further information to control these risks and ensure equipment and ventilation systems are suitable for use in a potentially flammable atmosphere is available in AS 1482 *Electrical equipment for explosive atmospheres – Protection by ventilation – Type of protection V*, AS/NZS 60079.25 *Explosive atmospheres – Part 25: Intrinsically safe electrical systems* and AS/NZS 60079.14 *Explosive atmospheres – Part 14: Design selection, erection and initial inspection*.

3.2 Ventilation systems

Two common types of ventilation used in spray painting are:

- **Local exhaust ventilation** captures the overspray and solvent vapour as close to the source of release as possible by drawing the contaminants into a capture hood. They should be fitted with a particulate filtration system to filter overspray. Wherever possible, local exhaust ventilation should be used when a spray booth cannot be used. It may be necessary to use it in combination with other control measures. Information on local exhaust ventilation designed for hazardous areas is available in AS 1482: *Electrical equipment for explosive atmospheres – Protection by ventilation – Type of protection V*.
- **Dilution ventilation** dilutes and displaces contaminated air with fresh air which is supplied to the work area by mechanical supply fans or natural air currents through doors, windows or other openings in the building. It can be used to supplement local exhaust ventilation. When using dilution ventilation:
 - the spray painting operator should stay between the air supply inlet and the source of vapours or aerosols generated
 - temporary barriers may be needed to channel the dilution ventilation through the spray zone and to restrict cross currents
 - make sure the contaminated exhaust air does not re-enter the work area
 - use auxiliary mixing fans to disperse the spray painting emissions towards the outlet and to enhance the rate of air dilution.

3.3 Spray painting outside a spray booth

Where it is not reasonably practicable to do the spray painting in a booth and it is carried out in a building or structure other than a confined space, the building or structure should be of open construction or a mechanical exhaust system should be used to prevent the build-up of flammable or toxic fumes.

When spray painting outside a spray booth or outdoors, a spray painting exclusion zone should be designated around the area where the spray painting is carried out. In general, the exclusion zone should, as far as is reasonably practicable, have at least six metres horizontal and two metres vertical clearance above and below the place where the paint is being applied. However, in deciding where to establish an exclusion zone and how big it should be, you should consider:

- the nature of the chemicals, mixture or solvents being sprayed
- the type of process being used
- the workplace environment including wind speed, temperature and humidity
- the location of other people.

Greater vertical clearance may be needed when spray painting in stairwells and other areas which allow vertical movement of vapours. A risk assessment will help determine if an exclusion zone is required for low risk processes (such as painting with water-based paints).

Once a spray paint exclusion zone is established, a number of procedures can be used to control risks including:

- physical barriers and warning signs to prevent unprotected people from entering the exclusion zone
- shrouding the area where spraying is to occur to prevent spray drift in walkways, public areas and air conditioning intake vents
- removing hazardous chemicals that are not needed for spray painting work to reduce unnecessary exposure and fire or explosion risks
- using low hazard chemicals for surface preparation or cleaning

- removing stored wastes, like solvent-soaked rags and waste paint, to control fire or explosion risks
- removing electrical and ignition sources from within the exclusion zone to control fire and explosion risks
- restricting spraying when wind speeds are likely to spread spray drift
- restricting spraying when there is a close proximity to adjacent premises and property.

Only the spray gun and the cables connected to it should be in the exclusion zone. Put all other electrical equipment outside the zone or enclose it separately in a fire-resistant structure unless the equipment is suitably certified for use in an area in which an explosive atmosphere may be present.

Changing, washing and eating areas should be separated from the spray zone to reduce the risk of cross contamination and protect others.

People other than the spray painter should not enter the exclusion zone during a spray painting operation unless equivalent PPE is worn. A sign stating, "SPRAY PAINTING AREA - AUTHORISED PERSONNEL ONLY" should be prominently displayed at the exclusion zone.

Figure 9 illustrates the control measures required when spraying outdoors. Additional information about exclusion zones in different ventilation conditions is available in Appendix B.

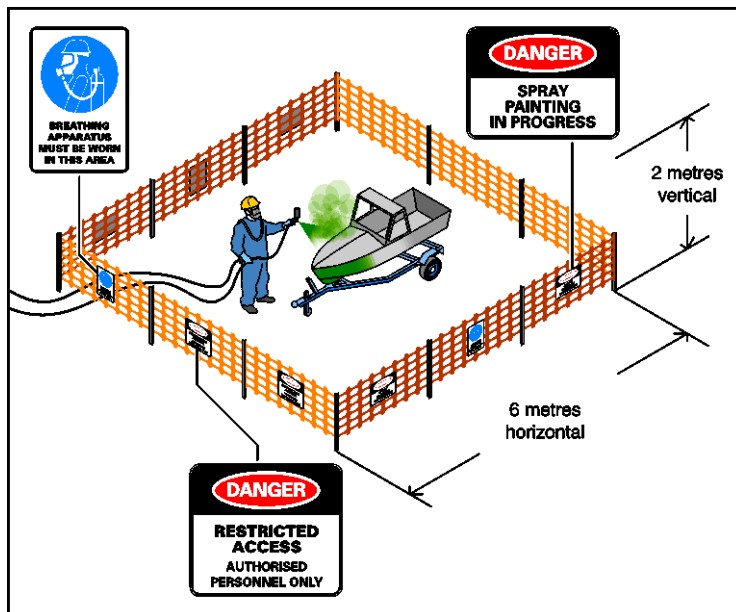


Figure 9 Example of an exclusion zone when conducting outdoor spray painting.

3.4 Maintenance

You should ensure that the plant and equipment used in spray painting or powder coating activities is well maintained, operational and clean. This includes:

- regular visual checks of equipment and plant including engineering controls and ventilation systems
- regular monitoring and testing of ventilation flow rates
- regular servicing of all equipment and plant
- procedures for reporting and repairing faulty equipment
- records of servicing, maintenance, repair and testing of plant and equipment should be kept for future reference.

When undertaking maintenance of equipment, ensure that:

- spraying equipment is regularly cleaned and maintained in accordance with the manufacturer's instructions
- spray guns are tested in a safe manner
- spray booths are cleaned regularly. Cleaning of spray booths is made easier by covering exposed surfaces with non-flammable plastic film, which can be easily removed for cleaning or washing. The use of absorbent material (e.g. paper, cardboards, wooden platforms) should be avoided
- the air filter medium is cleaned according to the manufacturer's instructions. Frequent cleaning or replacement of the filter medium is required to prevent deposits blocking air flow. Never spray paint in the spray booth without an air filter medium
- pressurised paint pots and pressurised spray guns are cleaned in accordance with manufacturer's instructions. Pressure from the gun and the paint pot should be released prior to cleaning. The gun should never be cleaned by covering the nozzle with a cloth or other material held in the hand, as this method of cleaning can result in paint injection injuries when used with airless spray guns.

3.5 Information, training, instruction and supervision

WHS Act section 19: A PCBU must provide workers and other persons with any information, training, instruction, or supervision that is necessary to protect all persons from risks to their health and safety arising from work carried out.

WHS Regulation section 39: A PCBU must ensure that information, training and instruction provided to a worker is suitable and adequate having regard to:

- the nature of the work carried out by the worker
- the nature of the risks associated with the work at the time the information, training or instruction is provided
- the control measures implemented.

The person must also ensure, so far as is reasonably practicable, that the information, training and instruction is provided in a way that is readily understandable to whom it is provided.

Workers who are involved in spray painting or powder coating activities require relevant information, training, instruction or supervision to enable them to carry out their work safely. For example, this should include information on:

- the proper use, wearing, storage and maintenance of PPE
- working in hazardous environments such as confined spaces
- first aid and emergency procedures
- how to access SDSs for workers using, handling or storing hazardous chemicals
- the nature of, and reasons for, any health monitoring if required.

Training should be practical and where relevant include hands-on sessions (e.g. correctly setting up a spray zone or practising emergency procedures).

3.6 Personal protective equipment

WHS Regulation section 44: If PPE is to be used at the workplace, the PCBU must ensure that the equipment is selected to minimise risk to health and safety including by ensuring that the equipment is:

- suitable for the nature of the work and any hazard associated with the work
- a suitable size and fit and reasonably comfortable for the person wearing it
- maintained, repaired or replaced so it continues to minimise the risk,

- used or worn by the worker, so far as is reasonably practicable.

A PCBU who directs the carrying out of work must provide the worker with information, training and instruction in the proper use and wearing of PPE; and the storage and maintenance of PPE equipment.

A worker must, so far as reasonably able, wear the PPE in accordance with any information, training or reasonable instruction and must not intentionally misuse or damage the equipment.

In most cases PPE must be worn by workers when spray painting and powder coating to supplement higher levels of controls (such as ventilation systems or administrative controls).

Where PPE is worn by workers, it should not introduce other hazards to the worker, such as musculoskeletal injuries, thermal discomfort, or reduced visual and hearing capacity.

Table 5 PPE recommended for common spray painting and powder coating hazards

PPE type	Hazards	Recommendation
Eyes, face and head protection	Exposure to hazardous chemicals	<ul style="list-style-type: none"> • Workers should have their eyes, face and head protected whenever spray painting or powder coating. • Guidance is provided in AS/NZS 1336 <i>Face and eye protection - Guidelines</i>.
Hearing protection (e.g. ear muffs and ear plugs)	Hearing loss	<ul style="list-style-type: none"> • If workers are still exposed to noise levels in excess of the exposure standard after higher order control measures have been implemented, ear plugs, ear canal caps and ear muffs or combinations may be required. • Guidance is provided in AS/NZS 1270 <i>Acoustics – Hearing protectors</i> and AS/NZS 1269.3 <i>Occupational noise management – Part 3: Hearing protector program</i>.
Gloves and clothing	Exposure to hazardous chemicals	<ul style="list-style-type: none"> • Gloves and clothing should protect exposed skin. • Guidance is provided in AS/NZS 2161 <i>Occupational protective gloves</i> (series) and AS/NZS ISO 13994 <i>Clothing for protection against chemicals - Determination of the resistance of protective clothing materials to penetration by liquids under pressure</i>.
Foot protection (e.g. boots and shoes)	Trips, slips and exposure to hazardous chemicals	<ul style="list-style-type: none"> • Foot protection should be non-slip and be heat and fire resistant. • Guidance is provided in AS/NZS 2210 <i>Safety, protective and occupational footwear</i> (series).

PPE type	Hazards	Recommendation
Respiratory protective devices (e.g. dust masks, half face respirators and air supplied respirators)	Dusts, aerosols, vapours, gases and oxygen depleted atmospheres	<ul style="list-style-type: none"> Workers carrying out spray painting with two part epoxy or polyurethane paint, or some catalytic acrylic paints should be provided with either a full face piece supplied air respirator or half face piece supplied air respirator. Respirators should be fitted for each person individually. The tightness of all connections and the condition of the face piece, headbands and valves should be checked before each use. Air supplied respirators may be required in some situations (e.g. confined spaces). Select air supplied respirators that generate less noise so the worker can hear warning signals and will not become easily tangled or caught on other objects. Respirators should closely fit the wearer to provide its designed protection, it is essential that an adequate face seal is achieved. They should be cleaned and disinfected with a broad-spectrum disinfectant in accordance with the manufacturer's instructions after each use. They should also be inspected for damage before and after each use. Filters should be changed in accordance with manufacturer's instructions and stored to prevent contaminations, damage and deterioration. Airline filters should be changed as required. For further information refer to: AS/NZS 1715: <i>Selection, use and maintenance of respiratory protective equipment</i> and AS/NZS 1716: <i>Respiratory protective devices</i>.

Two part polyurethane paint

When spraying two part polyurethane paint the sprayer should wear:

- an air-supplied respirator
- full length overalls with hood, appropriate chemically resistant gloves and eye protection.

Alternative respiratory protection may only be used in situations where the use of supplied air respirators increases the risk of injury to the operator due to falls, trips or slips.

Two part epoxy paints and two part catalysed acrylic paint

The respiratory protective equipment required will depend on the toxicity of the paint and the conditions under which the paints are applied. When selecting respirators, the following points should be considered:

- exposure standards for the various paint components. Exposure standards have not been established for some of the hazardous components of these paints (e.g. curing agents)
- the information provided in the manufacturer's SDS
- ventilation in the area where the paint is to be applied
- the level and duration of exposure
- the protection factor of the respirator.

No person should use two part epoxy paint or two part catalysed acrylic paint without first considering the information provided in the SDS for these paints.

When spraying two part epoxy paint or two part catalysed acrylic paint the sprayer should wear:

- respiratory protection that maintains exposures below the exposure standard. Where there is no exposure standard, exposures should be kept as low as reasonably achievable. Half face respirators with combined particulate/organic vapour cartridges may be used in well ventilated areas. Higher protection factors (e.g. full face or powered air purifying respirators) will be required where ventilation is not adequate. When spraying in poorly ventilated or enclosed areas, particular care should be taken to ensure that appropriate PPE is worn in accordance with the recommendations contained in the manufacturer's SDS
- full length overalls, appropriate chemically resistant gloves and eye protection.

Organic solvent and water based paint

When organic solvent or water based paints are being sprayed and the exposure standard is likely to be exceeded, the sprayer should wear:

- a respirator with a combined vapour/particulate filter. Where spraying is carried out in poorly ventilated conditions other types of respirators should be selected as described for two part epoxy paints above
- full length overalls with hood, appropriate chemically resistant gloves and eye protection (appropriate for mists/vapours).

If people entering the spraying area are exposed to vapours and mist they should wear the same protective equipment as worn by the sprayer.

Spray painting in the open environment

When spraying two part polyurethane paint and two part epoxy paint in the open environment the requirements for respiratory protection are the same as two part polyurethane paint and two part epoxy paint above, respectively. For other paints a respirator with a combined vapour/ particulate filter should be worn where the exposure standard is likely to be exceeded.

The sprayer should also wear full length overalls, appropriate chemically resistant gloves and eye protection.

4 Controlling the risks of powder coating

Powder coating is a process by which powder is applied onto a charged object. It is the electrostatic charge on the powder and the object that will make the powder stick onto the surface of the object being sprayed.

It is through powder coating process that workers are more likely to encounter hazards and risks associated with the use of electrical equipment (e.g. static electricity and potential ignition sources). Workers are also more likely to be exposed to triglycidyl isocyanurate and experience adverse health effects.

4.1 Hazardous chemicals

Triglycidylisocyanurate

Triglycidylisocyanurate (TGIC) is classified as a hazardous chemical and is commonly used in powder coating activities. It is:

- a skin sensitiser
- toxic by ingestion and inhalation
- genotoxic
- capable of causing serious eye damage.

You should check SDSs and labels to determine if the product you are using contains TGIC.

Powder coatings containing TGIC are applied by electrostatic process. Workers who may come into direct contact with TGIC powder coatings include people:

- filling hoppers
- manually spraying powder paint including 'touch-up' spraying
- reclaiming powder
- emptying or cleaning industrial vacuum cleaners
- cleaning powder coating booths, filters and other equipment
- cleaning up major spills of powder coating.

Surface preparation chemicals

Hazardous surface cleaning or preparation chemicals are commonly used in the powder coating industry. Active ingredients include:

- potassium or sodium hydroxide (may cause severe burns)
- hydrofluoric acid or hydrogen difluoride salts (may cause severe burns with toxic systemic effects. Skin contact with concentrate may be fatal. Special first aid requirements apply (e.g. calcium gluconate))
- chromic acid, chromate or dichromate solutions (may cause cancer, burns and skin sensation)
- other acids (e.g. sulphuric acid may cause severe burns).

You should check the label and SDS of all surface preparation chemicals and implement systems for safe handling, storage, spill cleanup, first aid and worker training. Eye wash and shower facilities and specific first aid items may also be needed.

4.2 Controlling exposure

Elimination

Choose TGIC-free powder coatings which are readily available.

Engineering controls

The most effective engineering controls for reducing worker exposure are booths, local exhaust ventilation and automation of the powder coating process. In particular:

- application of powder coatings should be performed in a booth (see AS 3754 *Safe application of powder coatings by electrostatic spraying*) where practicable
- local exhaust ventilation should be used when conducting powder coating activities, during filling of hoppers, when reclaiming powder and during clean-up
- use automatic spray guns, feed lines and feed equipment
- prevent unnecessary powder build-up inside powder coating booths by minimising spray gun air pressure to prevent overspray
- interlock the power supply and powder coating feed lines with the air extraction system so that if a fault develops in the ventilation system, the powder coating and power supplies are cut off
- prevent or minimise the generation of dusts by containing the opening of powder coating packages, loading of hoppers and reclaiming of powder
- minimise the generation of dust when filling the hopper by considering the layout of the work station and the size of the hopper opening.

The following should be considered regarding the use of hoppers:

- use spray systems where the container in which the TGIC is supplied can be used as the hopper, thereby avoiding the need to transfer powder
- large hoppers can be used to avoid frequent refilling of smaller units
- powder coatings that are supplied in drums allow for the powder to be transferred mechanically rather than manually.

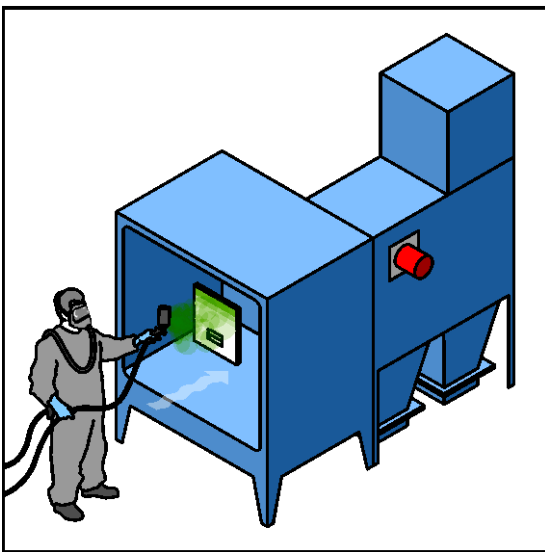


Figure 10 Example of a local exhaust ventilation system suitable for powder coating activities.

Administrative controls

Administrative controls should be used to support other measures in order to reduce exposure of workers to hazards associated with powder coating activities. Administrative controls include:

- work practices designed to avoid the generation of dust
- restricting access to spray areas
- ensuring workers are never between the object to be sprayed and the airflow of contaminated air
- situating the articles to be sprayed sufficiently within the booth to avoid rebound
- ensuring that only spray guns and the cables connected to it are in spray areas or booths. All other electrical equipment should be located outside the booth or area or enclosed in a

separate fire-resistant structure, unless the equipment is suitably designed for a hazardous area – for example it may be installed in accordance with AS/NZS 60079.14 *Explosive atmospheres – Part 14: Design selection, erection and initial inspection* or AS/NZS 3000 *Electrical installations (known as the Australian/New Zealand wiring rules)*. This equipment should be protected against the depositing of paint residues

- implementing good personal hygiene practices, for example powder coating dust should not be allowed to collect on the face, exposed body areas should be thoroughly washed and overalls should be regularly cleaned
- storing powder coating and waste powder in a designated area with restricted access
- cleaning booths and surrounding areas on a regular basis
- promptly cleaning-up spills of powder coatings to reduce the spread of TGIC
- using a vacuum cleaner with a High Efficiency Particulate Air (HEPA) filter for clean-up operations and not using compressed-air or dry sweeping
- vacuuming work clothing as an initial method of decontamination
- emptying vacuum cleaners in the booth and under exhaust ventilation
- taking care to avoid the generation of dust during disposal of waste powder
- baking waste powder in the original box for disposal to landfill as a solid
- ensuring all electrical equipment is switched off before cleaning spray guns
- keeping the quantity of hazardous chemical to a minimum at the workplace
- cleaning spray guns with a solvent that has a high flash point and, have low vapour pressure at the ambient temperature
- ensuring that incompatible chemicals are not stored together (e.g. flammable and oxidising)
- regularly checking that plant and equipment are being cleaned and maintained including ventilation and spray equipment and filters
- proper induction training and general training of workers.

4.3 Electrical safety

Powder coating processes brings with it electrical hazards and additional requirements for safe work practices are required. Electrostatic spray-guns have electrically charged nozzles which transfer the electric charge to droplets of paint which are then attracted to the edges and back of the work piece, an effect known as the 'wrap-around effect'. In some automatic painting processes the objects to be painted are charged. Direct current sources are used and hand guns may be designed with safe nozzles carrying a very low current at high voltage. Automatic guns carry much higher currents which are potentially lethal.

All equipment including spray guns and booths should be earthed. All hooks used to suspend objects to be sprayed should be cleaned prior to re-use in order to maintain effective metal contact. Earthing of equipment, objects being coated and personnel ensures maximum coating efficiency, reduces free dust and prevents build-up of static charges capable of causing ignition.

In an electrostatic spraying system, atomised droplets are charged to a high voltage (at least 60 kilovolt) so that they are attracted to an earthed work piece. Although this process reduces the risk of overspray and ricochet, there is a risk of electric spark ignition both at the spray gun nozzle and at the wetted surface of the work piece.

All equipment and metal surfaces within three metres of the charged head of the spray gun should be earthed. This includes:

- the floor of the exclusion zone – this should be of a material that is electrically conducting to the earthing of the spray gun (clean any overspray from the floor to avoid build-up of an insulating layer)
- the metal housing and handle of the gun or the metal areas on the handle of the gun and any metallic screen of the high voltage cable
- regularly clean earthing hooks to avoid build-up of an insulating layer.

People in the exclusion zone who could receive a charge while working should not wear metal articles including metal watches, non-conductive materials including silk or synthetic fibres that can generate and accumulate static electricity unless regularly treated with an antistatic solution. Workers should also be provided with insulating gloves. Clothing including socks, should not be made from silk or synthetic fibres unless treated with an anti-static solution. Cotton clothing is preferable as it is less prone to generating static electricity.

The use of anti-static or conductive footwear is recommended for powder coating activities. It is recommended that anti-static footwear should have a resistance of:

- not greater than 10×10^7 ohms
- not less than 7.5×10^4 ohms.

Leather-soled footwear may not always stop static build-up. However, any type of footwear can be worn if a conductive garter is used. Strap onto the skin of the wearer's leg and make electrical contact between it and a large area on the sole of the footwear.

Footwear that is worn or has paint, oil or wax on the sole can make the footwear non-conductive and allow build up of electrostatic charge.

5 Other hazards and control measures

5.1 Fire and explosion

The use of flammable materials in spray painting, for example organic solvents, increases the risk of fire and explosion because of the amount of solvent vapour in the air.

Powder paints used in powder coating processes are usually combustible and the accumulation of powders or dusts could lead to a major dust explosion. Consider surfaces that are out of sight where dust may accumulate, for example suspended ceiling and ensure such areas are regularly inspected and cleaned or sealed off to prevent dust accumulation. Ventilation and dust collection systems also require regular inspection and cleaning to remove dust build up.

WHS Regulation section 52: A PCBU must manage risks to health and safety associated with ignition sources in a hazardous atmosphere at the workplace that are not part of a deliberate workplace process or activity.

WHS Regulation section 53: A PCBU must ensure that flammable or combustible substances kept at the workplace are kept at the lowest practicable quantity.

Sources of ignition include:

- open flames including matches, lighters, cigarettes, cutting torches and welding
- hot surfaces including engines, motors and light bulbs
- chemical reactions, mixing hazardous chemicals can generate heat or static and create an ignition source
- sparks from electric equipment, portable electric tools, power points, radios, mobile phones or from the discharge of static electricity from poorly-earthed equipment
- catalytic reactions (e.g. a catalyst speeds the resin hardening process when two-pack epoxy paints are mixed and this creates heat)
- self-heating or spontaneous combustion.

The risk associated with these fuel sources is increased by exposure to an oxygen rich atmosphere. When oxygen comes in contact with oil, grease, other hydrocarbons or oil based substances, it can spontaneously ignite and result in a fire or explosion.

Control measures

Prevent fire and explosion by eliminating ignition sources, correctly earthing equipment and eliminating short circuits. Other control measures include ensuring work areas are well ventilated, which can prevent accumulation of flammable vapours or airborne particles and dusts in the work area, establishing an exclusion zone and ensuring that waste materials including waste chemicals and paint-soaked rags, are disposed of as soon as possible.

Administrative controls include:

- before pouring flammable liquids from one container into another, set both containers down on an earthed surface then bring the containers into contact before pouring and keep them in contact while pouring
- where containers have air lines, always replace the plugs as soon as the air lines are disconnected
- provide suitable fire extinguishers that are readily available
- store and handle flammable or combustible liquids safely, for example:
 - store paints in containers with lids
 - always return unused liquid to a labelled container for that liquid
 - store solvents in covered containers with taps to avoid the need for pouring
 - solvent soaked rags should be stored wet and safely contained after use or removed from the workshop
 - store flammable chemicals, mixtures or materials including unused liquid in tightly closed containers that are correctly labelled
 - store flammable chemicals, mixtures or materials in well ventilated storage areas
 - replace lids of containers after each use
 - do not leave containers of flammable liquid near any heat source or source of ignition or in direct sunlight
 - place warning signs on storage cabinets and outside storage areas.

To prevent the risk of fire and explosion with spray painting, powder coating and electrostatic spray painting, drums of paint and cleaning solvents should be removed from the exclusion zone before spray painting commences. Metal solvent containers should only be used when they are earthed and spray guns should not be cleaned in areas with the high voltage supply switched on.

Further guidance on electrostatic spraying is available in AS 2268 *Electrostatic paint and powder spray guns for explosive atmospheres* and AS 3754 *Safe application of powder coatings by electrostatic spraying*.

5.2 Electrical risks

Electricity used in spray painting poses unique health risks including:

- electrocution from direct or indirect contact with electricity
- burns – flashes and arcing due to short-circuiting may lead to severe tissue burns or the ignition of flammable gases.

Electrical equipment should be kept at a safe distance from spray painting exclusion zones. This includes fans, turntables, drying lamps, fixed lighting and switches, heating equipment, electrical appliances used during cleaning and repairing operations and appliances used to mix paint formulations.

ES Regulation section 11: A PCBU must manage risks to health and safety associated with electrical risks at the workplace.

ES Regulation section 101: This includes ensuring that any unsafe electrical equipment is disconnected from its electricity supply.

Operating electrical equipment that is damaged or not designed to give explosion protection in spray painting and paint mixing areas creates an immediate risk. Further guidance is available in the *Electrical safety Code of Practice – Managing electrical risks in the workplace*.

Static electricity

Static electricity charges can be generated during a spray painting process if two differently charged materials come into contact. A common source of static generation is steam, air or gas containing particulate matter flowing from any opening in a pipe or hose.

Static electricity discharge is most likely to happen during mixing and pouring of hazardous chemicals, specifically when the containers of hazardous chemicals are not correctly earthed.

Static can be dissipated from conducting objects by placing them on earthed conducting or antistatic surfaces. The associated risks of fire and explosion can be managed by removing sources of ignition from the working area to avoid static creating a fire or explosion. Static electricity can exist during the bonding processes. Information on methods of bonding, dissipating charge from installations, and electrical isolation to prevent static discharge can be found in AS/NZS 1020 *The control of undesirable static electricity*.

Static electricity charges can be generated in any spray painting process if two differently charged materials come into contact. It can be generated by:

- touching two metal cans together during decanting
- clothing or synthetic fibres prone to accumulation of static charge including nylon, pure wool, wool blends (unless treated) and non-conducting footwear
- liquid flowing in pipes or vessels
- airless spray painting using high fluid pressure (control this by electrically earthing the airless spray gun and any conductive article that is being sprayed including a container that the flow from the gun is directed into).

For further information on installation and wiring of electrical equipment in a spray painting workshop including those in mixing and storage areas refer to AS/NZS 3000 *Electrical installations (known as the Australian/New Zealand wiring rules)*.

5.3 Hazardous manual tasks

WHS Regulation section 60: A PCBU must manage the risks to health and safety relating to a musculoskeletal disorder associated with a hazardous manual task.

Spray painting can result in musculoskeletal disorders from performing hazardous manual tasks including back strain from lifting or pushing and muscle strain from working in awkward positions.

Strains and sprains are the most common injury. The most injured body parts are the back and the shoulders. Damage can gradually build up through:

- moving vehicles, cartons and equipment
- staying in a fixed posture for a long time (e.g. holding the spray painting gun above shoulder height for a long period)
- repetitive work with the hand and arms (e.g. for example polishing a car or wet-sanding an object)
- gripping and moving heavy or vibrating tools
- pushing or pulling, especially when also twisting, such as moving compressors and pressure pots.

Ways of reducing the risk of musculoskeletal disorders include:

- performing work at height in a manner that allows workers to form a comfortable position
- reducing the amount of force necessary to perform tasks, for example by using rigging to lift heavy work pieces and using trolleys to transport work pieces
- ensuring workers do not have to perform manual tasks in excess of their capability.

Further guidance on how to manage the risks of hazardous manual tasks is available in the *Hazardous manual tasks Code of Practice*.

5.4 Confined spaces

WHS Regulation section 66: A PCBU must manage the risks associated with a confined space including risks of entering, working in, on or in the vicinity of the confined space (including a risk of a person inadvertently entering the confined space).

Hazards that may be encountered in a confined space include:

- chemical agents including combustible gases or vapours, toxic gases or vapours, combustible or toxic liquids or solids, or potentially explosive dusts
- flammable atmospheres, fire or explosion can result from an ignition source such as a sparking or electrical tool
- oxygen deficiency or excess
- physical agents including thermal extremes, radiation, noise or flooding.

Further guidance on how to work safely in confined spaces is available in the *Confined spaces Code of Practice*.

5.5 Heat

Exposure to extreme heat is particularly hazardous when working outdoors in direct sunlight, on hot days, humid environments or in confined spaces. Wearing PPE can restrict air movement and sweat evaporation which can prevent the worker's body from undergoing natural cooling due to sweat evaporation.

Working in a hot environment can be hazardous and can cause heat rash, heat stress, heat stroke and result in permanent injury or death. Heat stress can occur gradually and has a range of symptoms. While discomfort, dehydration and sweating can be easily noticed by a worker, symptoms including lack of concentration, fatigue, lethargy and confusion are less noticeable.

To prevent workers being exposed to extreme heat you should try to minimise the time that work is undertaken outdoors in direct sunlight on hot days or in hot clothing and use ventilation. Workers should dress in lightweight clothing, drink cool drinking water and take regular scheduled rest breaks.

5.6 Noise

WHS Regulation section 57: A PCBU must manage risks to health and safety relating to hearing loss associated with noise. The PCBU must ensure that the noise a worker is exposed to at the workplace does not exceed the exposure standard for noise.

The hearing of workers exposed to noise can be monitored through regular audiometric examinations. Audiometric testing is an important part of managing the risks from noise exposure at the workplace. Starting the audiometric testing before people are exposed to hazardous noise (such as new starters or those changing jobs) provides a baseline as a reference for future

audiometric test results. To be effective, initial audiometric testing should be provided within three months of the worker commencing work with regular follow-up tests at least every two years. These should be undertaken well into the work shift so that any temporary hearing loss can be picked up.

Exposure to high noise levels can cause permanent damage to hearing. Spray painting equipment including pumps and compressors, can generate varying levels and frequencies of noise that may cause workers to be exposed to noise that exceeds the exposure standard. Typical noise levels of plant and work practices used in spray painting range between 82 and 110 dB(A). Typical noise sources at operator ear level are:

- sander (air or electric) 82 – 100 dB(A)
- nine inch angle grinder 97 – 110 dB(A)
- air compressor 85 – 89 dB(A)
- inside a spray booth 75 – 91 dB(A)
- processes involving compressed air 93–110 dB(A).

The exposure standard for noise is defined in the WHS Regulation as an $L_{Aeq,8h}$ of 85 dB(A) or an $L_{C,peak}$ of 140 dB(C). There are two parts to the exposure standard for noise because noise can either cause gradual hearing loss over a period of time or be so loud that it causes immediate hearing loss.

Noise control measures include:

- removing the source of noise completely
- substituting a noisy process or machine, such as an air compressor or extraction fan, with a quieter one
- isolating the source of noise from people by using sound proof enclosures or barriers
- using engineering controls (e.g. sound absorbing materials, mufflers)
- using administrative controls (e.g. limit the amount of time people work in noisy areas)
- using personal hearing protectors to protect workers from any remaining risk.

Further guidance about controlling noise or ototoxic effects in the workplace is available in the *Managing noise and preventing hearing loss at work Code of Practice*.

5.7 Injection injury

Most injection injuries occur through the use of airless spraying equipment which involves high pressure.

Paint injected into the body may initially appear harmless but may cause a lack of blood supply to the area, or cause chemical or thermal burns. Solvents and other substances may be injected in sufficient quantities to cause symptoms affecting the whole body.

All workers with injection injuries should be referred for immediate medical treatment to minimise the possibility of gangrene or tissue destruction, which could result in disability through amputation or death.

Injection injury control measures include:

- using a tip guard on the spray gun
- using a spanner to tighten the tip guard, or when clearing a blocked reversible spray tip
- ensuring that the spray gun has a trigger-lock and it is functional.

Appendix A – Sample risk assessment sheet

Date: 1 February 2012
 Assessor: Ann Person
 Location: Main spray painting and baking line
 Tasks: Paint mixing, colour matching, spraying, baking and cleaning up
 Workers involved: P. Stone and J. Saunders
 Duration of work: Approximately 1.5 hours of preparation and mixing, 5 hours spraying and 1.5 hours cleaning up

Hazards identified	<p>Hazardous chemicals: 2-pack paint containing isocyanates (toxic, possible skin/respiratory sensitisation), thinners containing xylene (harmful by inhalation or through skin, skin irritant).</p> <p>Static electricity: potential contact of flammable solvents with static electricity may result in fire and explosion.</p> <p>Other issues: manual tasks, heat stress, visibility, noise from plant and injection injury.</p>				
Review of control measures	<ul style="list-style-type: none"> • review control measures including work processes and systems of work • review the safety data sheets and label of the products • review induction training (as required) • review inspection and maintenance logs of plant • review notifiable incidents 				
Possible exposure for each task	<p>Paint mixing - conducted on open bench</p> <ul style="list-style-type: none"> • no ventilation • possible static electricity • exposure of skin to paint • inhalation of vapour possible 	<p>Colour matching - conducted indoors</p> <ul style="list-style-type: none"> • no ventilation • intermittent inhalation exposure to spray paint aerosols • hands protected but body unprotected 	<p>Spraying -conducted in spray booth</p> <ul style="list-style-type: none"> • possible inhalation exposure route • skin exposure possible to whole of body • possibility of skin injection injuries • heat stress in hot weather with unbroken work • noise from extraction system and spray gun 	<p>Baking</p> <ul style="list-style-type: none"> • vapours from curing paint and solvents • drying line obstructs access 	<p>Clean up – conducted indoors</p> <ul style="list-style-type: none"> • skin exposure to solvents such as gun washing product • inhalation of cleaning solvent and residual paint vapours • area contaminated by solvent cleaning rags • risk of fire from solvent soaked rags

Existing controls	none	latex gloves	half face (class 2 respirator) latex gloves, spray booth	none	latex gloves
Potential for exposure	<ul style="list-style-type: none"> • skin- high • inhalation – possible vapour 	<ul style="list-style-type: none"> • skin – high • inhalation – high 	<ul style="list-style-type: none"> • skin – high • inhalation – extremely high • noise - moderate 	<ul style="list-style-type: none"> • skin – high • paint inhalation - moderate 	<ul style="list-style-type: none"> • skin – high • paint inhalation - moderate
Recommended control	<ul style="list-style-type: none"> • conduct paint mixing in the spray booth with air supplied respirator or conduct paint mixing in a specially constructed extracted booth • skin protection by chemically resistant gloves required • conduct air monitoring to determine isocyanates and other solvents to determine level of respiratory protection required • use of static spark arrester 	<ul style="list-style-type: none"> • conduct colour matching in the spray booth with air supplied respirator or conduct colour matching in a specially constructed extracted booth • skin protection by chemically resistant gloves required 	<ul style="list-style-type: none"> • use of air supplied respirator is required • full body protection • gloves and eye protection mandatory • boots and boot covers • continued use of spray booth • build extra work breaks into schedule in hot weather • install low noise fan to reduce extraction noise and use quieter nozzle for spray gun • hearing protectors against any remaining noise risks 	<ul style="list-style-type: none"> • if entry is required, wearing of air supplied respirator is preferred • air monitoring may establish the need for Class 3 organic and gas vapour filtering respirator 	<ul style="list-style-type: none"> • skin - hand and arm dermal protection required • Chemically resistant gloves • inhalation protection from solvent vapours using an air supplied respirator, unless air monitoring indicates that a half-face air purifying respirator with a solvent vapour cartridge is adequate • alternatively, conduct all equipment cleaning in an automatic solvent washing system • store solvent soaked rags submerged in water in a lidded metal container
Air and health monitoring	Air monitoring is required during the paint mixing process and also on clean up to determine the need for respiratory protection. Health monitoring by doctor to be provided for all workers who previously worked with insufficient controls (half-face respirator and latex gloves) and to painters on an ongoing basis due to the high hazard of the isocyanates in paint.				

Appendix B – Spray painting exclusion zones and ventilation conditions

Ventilation conditions	Distance	Time factors	Source	Comments
High risk chemicals				
1. Inside closed spray booth that complies with AS/NZS 4114.1 <i>Spray painting booths, designated spray painting areas and paint mixing rooms – Part 1: Design, construction and testing</i>	According to AS/NZS 4114.1, distances regarding ignition do not apply outside a closed spray booth.	At least 5 minutes after spraying with spray booth operating.	AS/NZS 4114.1	<p>The distance and time factors indicated in this table may not be practicable for all conditions. Hazard controls from the risk of explosion and the inhalation of hazardous chemicals will depend on the conditions under which certain types of paints are applied and should always be selected as part of a risk assessment and control process.</p> <p>The hazard control factors of distance and time referred to in this appendix are provided as a guide and are based on AS/NZS 4114.1 <i>Spray Painting Booths designated spray painting areas and paint mixing rooms – Part 1: Design, construction and testing</i> and AS/NZS 60079.10.1 <i>Explosive atmospheres – Part 10.1: Classification of areas – Explosive gas atmospheres</i>.</p>
2. Inside exhaust ventilated enclosed area (e.g. blast unit, closed hangar with exhaust ventilation, temporary enclosure supplied with local exhaust ventilation, for example 'mucksucker'; domestic bathroom with doors and windows sealed and supplied with local exhaust ventilation)	At least 6 metres horizontal and 3 metres vertical.	At least 30 minutes after spraying with ventilation operating.	AS/NZS 60079.10.1	
3. Inside open spray booth that complies with AS/NZS 4114.1	At least 2 metres extending in all directions from any opening or outlet.	At least 5 minutes after spraying with spray booth operating.	AS/NZS 4114.1	

Ventilation conditions	Distance	Time factors	Source	Comments
4. Spray painting indoors without exhaust ventilation	High hazard paints should not be sprayed for any reason without exhaust ventilation, unless other suitable means of safely limiting exposure to those in the area are in place.			
5. Spray painting outdoors	Distances should be determined by conducting a risk assessment.	Until concentration of volatile organic solvent or other volatile components has dropped below exposure standard.	AS/NZS 60079.10.1	<p>Air quality can be monitored to ensure concentrations are not exceeding exposure standards. This may lead to the exclusion zone distances being adjusted (e.g. greater wind speed, higher temperatures and low humidity mean that fumes and vapours spread further and a larger exclusion zone may be required).</p> <ul style="list-style-type: none"> - Risk assessment to determine vertical distance if required. - Administrative and PPE controls should be used for touch up.
Medium risk chemicals				
1. Inside closed spray booth	According to AS/NZS 4114.1, distances regarding ignition do not apply outside a closed spray booth.	At least 5 minutes after spraying with booth operating.	AS/NZS 4114.1	<p>The distance and time factors indicated in this table may not be practicable for all conditions. Hazard controls from the risk of explosion and the inhalation of hazardous chemicals will depend on the conditions under which certain types of paints are applied and should always be selected as part of a risk assessment and control process.</p> <p>The hazard control factors of distance and time referred to in this appendix are provided as a guide and are based on AS/NZS 4114.1 and AS/NZS 60079.10.1.</p>
2. Inside exhaust ventilated enclosed area	At least 6 metres extending in all directions from any opening or outlet.	At least 30 minutes after spraying with ventilation operating.	AS/NZS 60079.10.1	

Ventilation conditions	Distance	Time factors	Source	Comments
3. Inside open spray booth	At least 2 metres extending in all directions from any opening or outlet.	At least 5 minutes after spraying with booth operating.	AS/NZS 4114.1	
4. Indoors without exhaust ventilation	Distances should be determined by conducting a risk assessment.	Until concentration of volatile organic solvent or other volatile components has dropped below exposure standard.	AS/NZS 60079.10.1	Should be avoided unless air monitoring can be used to confirm that all bystanders are not being exposed to vapours exceeding the exposure standards.
5. Spray painting outdoors	Distances should be determined by conducting a risk assessment.	Until concentration of volatile organic solvent or other volatile components has dropped below exposure standard.	AS/NZS 60079.10.1	Air quality can be monitored to determine concentrations are not exceeding exposure standards. This may lead to the exclusion zone distances being adjusted (e.g. greater wind speed, higher temperatures and low humidity mean that fumes and vapours spread further and a larger exclusion zone may be required). - Risk assessment to determine vertical distance if required. - Administrative and PPE controls should be used for touch up.
Low risk chemicals				
1. Inside closed spray booth that complies with AS/NZS 4114.1		At least 5 minutes after spraying with booth operating.	AS/NZS 4114.1	The distance and time factors indicated in this table may not be practicable for all conditions. Hazard controls from the risk of explosion and the inhalation of hazardous chemicals will depend on the conditions under which certain types of paints are applied and should always be selected as part of a risk assessment and control process. The hazard control factors of distance and time referred to in this appendix are provided as a guide and are based on AS/NZS 4114.1 and AS/NZS 60079.10.1.
2. Inside exhaust ventilated enclosed area	At least 6 metres extending in all directions from any opening or outlet.		AS/NZS 60079.10.1	

Ventilation conditions	Distance	Time factors	Source	Comments
3. Inside open spray booth	At least 2 metres extending in all directions from any opening or outlet.	At least 5 minutes after spraying with booth operating.	AS/NZS 4114.1	
4. Indoors without exhaust ventilation		Until concentration of volatile components has dropped below exposure standard.	AS/NZS 60079.10.1	
5. Outdoors	At least 3 metres in all directions.	No time restriction for re-entry.		