

Australian/New Zealand Standard™

Selection, use and maintenance of respiratory protective equipment



AS/NZS 1715:2009

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee SF-010, Occupational Respiratory Protection. It was approved on behalf of the Council of Standards Australia on 2 December 2008 and on behalf of the Council of Standards New Zealand on 18 December 2008.
This Standard was published on 6 February 2009.

The following are represented on Committee SF-010:

Accident Compensation Corporation, New Zealand
Association of Accredited Certification Bodies
Australasian Fire Authorities Council
Australian Chamber of Commerce and Industry
Australian Industry Group
Australian Institute of Occupational Hygienists
Composites Institute of Australia
Curtin University of Technology
Department of Defence, Australia
Department of Labour, New Zealand
Department of Primary Industries, Mine Safety, NSW
NSW Mines Rescue
Safety Institute of Australia
Sydney Water Corporation
TestSafe Australia
The University of New South Wales
United Firefighters Union of Australia
Victorian WorkCover Authority

Keeping Standards up-to-date

Standards are living documents which reflect progress in science, technology and systems. To maintain their currency, all Standards are periodically reviewed, and new editions are published. Between editions, amendments may be issued. Standards may also be withdrawn. It is important that readers assure themselves they are using a current Standard, which should include any amendments which may have been published since the Standard was purchased.

Detailed information about joint Australian/New Zealand Standards can be found by visiting the Standards Web Shop at www.standards.com.au or Standards New Zealand web site at www.standards.co.nz and looking up the relevant Standard in the on-line catalogue.

Alternatively, both organizations publish an annual printed Catalogue with full details of all current Standards. For more frequent listings or notification of revisions, amendments and withdrawals, Standards Australia and Standards New Zealand offer a number of update options. For information about these services, users should contact their respective national Standards organization.

We also welcome suggestions for improvement in our Standards, and especially encourage readers to notify us immediately of any apparent inaccuracies or ambiguities. Please address your comments to the Chief Executive of either Standards Australia or Standards New Zealand at the address shown on the back cover.

This Standard was issued in draft form for comment as DR 05157.

Australian/New Zealand Standard™

Selection, use and maintenance of respiratory protective equipment

Originated in Australia as AS CZ11—1960.
Originated in New Zealand as part of NZS 1586:1961.
Previous edition AS/NZS 1715:1994.
Fifth edition 2009.

COPYRIGHT

© Standards Australia/Standards New Zealand

All rights are reserved. No part of this work may be reproduced or copied in any form or by any means, electronic or mechanical, including photocopying, without the written permission of the publisher.

Jointly published by Standards Australia, GPO Box 476, Sydney, NSW 2001 and Standards New Zealand, Private Bag 2439, Wellington 6020

PREFACE

This Standard was prepared by the Joint Australia/New Zealand Standards Committee SF-010, Occupational Respiratory Protection, to supersede AS/NZS 1715:1994, *Selection, use and maintenance of respiratory protective devices*.

The objective of this revision is to take into account changes to AS/NZS 1716, *Respiratory protective devices*, and problems of interpretations that have arisen since AS/NZS 1715 was last published in 1994. It also aims to provide some guidance for respirator use by emergency service personnel for special response HAZMAT incidents.

As most readers will not need to refer to the performance and testing specification, the listings of definitions and referenced Standards have been expanded to include several new definitions and Standards to aid the reader's understanding of the text. Requirements for the performance and testing of respiratory protective devices are specified in AS/NZS 1716.

The main changes to this edition of the Standard are an increased, formalized emphasis of the risk management approach and systems management. To achieve this, the sequence of the text has been re-ordered.

The list of advisory authorities has been deleted. It is considered such information is quickly out of date so any such list may become misleading. Similar information on state advisory OHS bodies can be accessed electronically at the website of the Office of the Australian Safety and Compensation Council (ASCC)— <http://www.ascc.gov.au>

Throughout the text, examples of types of chemicals or other technical concepts have been expanded. Additional warnings about the possible misuse of respirators have also been included. Qualitative facial fit testing has been retained as a suitable means of monitoring a respiratory protection program.

It has been the aim of the Committee to further explain that the provision of an item of respiratory protective equipment (RPE) is only part of ensuring an overall system of respiratory protection for all employees.

Additional relevant Standards that may assist with the selection, care and use of respiratory devices have been listed under the heading of 'Related documents' (Clause 1.4).

The terms 'normative' and 'informative' have been used in this Standard to define the application of the appendix to which they apply. A 'normative' appendix is an integral part of a Standard, whereas an 'informative' appendix is only for information and guidance.

CONTENTS

	<i>Page</i>
SECTION 1 SCOPE AND GENERAL	
1.1 SCOPE	5
1.2 OBJECTIVE.....	5
1.3 REFERENCED DOCUMENTS	5
1.4 RELATED DOCUMENTS.....	6
1.5 DEFINITIONS	7
1.6 GENERAL PRINCIPLES.....	14
1.7 HAZARD IDENTIFICATION, RISK ASSESSMENT AND CONTROL	14
SECTION 2 RESPIRATORY PROTECTION PROGRAM	
2.1 RESPIRATORY PROTECTION PROGRAM.....	17
2.2 APPOINTMENT OF PROGRAM ADMINISTRATOR	17
2.3 SELECTION OF RPE	17
2.4 RPE TRAINING.....	18
2.5 ISSUE OF RPE.....	18
2.6 FITTING OF RPE	19
2.7 WEARING OF RPE	19
2.8 MAINTENANCE	19
2.9 RECORD KEEPING	20
2.10 PROGRAM EVALUATION	21
SECTION 3 ENTRY OF CONTAMINANTS INTO THE BODY	
3.1 GENERAL	22
3.2 INHALATION OF AIRBORNE CONTAMINANTS.....	22
3.3 SKIN AND EYE ABSORPTION	23
3.4 INGESTION	24
3.5 HEALTH EFFECTS OF AIRBORNE CONTAMINANTS	24
3.6 PARTICLES.....	25
3.7 OXYGEN DEFICIENCY	27
SECTION 4 SELECTION OF RPE	
4.1 FACTORS IN SELECTION.....	29
4.2 SELECTION FACTORS—CONTAMINANT-RELATED	31
4.3 SELECTION FACTORS—TASK-RELATED	42
4.4 SELECTION FACTORS—OPERATOR-RELATED.....	44
4.5 SELECTION FACTORS—EQUIPMENT LIMITATIONS.....	46
4.6 SELECTION OF RPE FOR SPECIAL RESPONSE HAZMAT INCIDENTS BY EMERGENCY SERVICE PERSONNEL.....	50
SECTION 5 TYPES OF RPE AND THEIR LIMITATIONS	
5.1 GENERAL	52
5.2 AIR-PURIFYING RPE.....	53
5.3 SUPPLIED-AIR RPE	60
5.4 OTHER DEVICES	68
SECTION 6 MEDICAL AND PHYSICAL CONSIDERATIONS	
6.1 MEDICAL ASSESSMENT	69
6.2 SPECIFIC FACTORS AFFECTING PERFORMANCE	69

SECTION 7 TRAINING

7.1	GENERAL	70
7.2	FORMAT	70
7.3	INSTRUCTIONS TO TRAINEES.....	70
7.4	EMPLOYEE TRAINING PROGRAM GUIDE.....	71

SECTION 8 TYPICAL RPE FIT TESTS AND CHECKS

8.1	GENERAL	75
8.2	FREQUENCY OF FIT TESTS	75
8.3	FACIAL HAIR IN RPE FITTING.....	75
8.4	EYE CORRECTION IN RPE FITTING	75
8.5	FIT TEST METHODS.....	76
8.6	FACTORS THAT AFFECT FACIAL FIT.....	80

SECTION 9 MAINTENANCE REQUIREMENTS

9.1	GENERAL	81
9.2	CLEANING AND DISINFECTION.....	81
9.3	INSPECTION	82
9.4	REPAIR AND REPLACEMENT OF COMPONENTS	83
9.5	REPLACEMENT OF FILTERS	86
9.6	STORAGE OF EQUIPMENT	87

APPENDICES

A	REQUIREMENTS FOR AIR QUALITY (COMPRESSORS OR CYLINDERS) FOR SUPPLIED-AIR RESPIRATORS.....	88
B	FACIAL SEAL OF RESPIRATORS	89
C	PROCEDURES FOR CLEANING AND DISINFECTING RPE.....	91
D	CHECKPOINTS FOR RESPIRATORY PROTECTION PROGRAM— ADMINISTRATION AND OPERATION.....	92
E	RESPIRATOR SELECTION EXAMPLES	95
F	SOURCES OF AIR FOR AIR-LINE RPE.....	97

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard**Selection, use and maintenance of respiratory protective equipment**

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard sets out the principles of respiratory protection, requirements and recommendations for the selection, use and maintenance of personal respiratory protective equipment (RPE) in the workplace.

This Standard does not deal with military applications for RPE, but includes special needs of personnel involved in a special response hazardous material (HAZMAT) incident where respiratory concerns need to be addressed.

This Standard does not deal with the special circumstances associated with the use of RPE in diving and underwater breathing (see AS/NZS 2299 and AS 2815), the use of RPE in aircraft, or the use of life support respirators for medical or resuscitation purposes (see AS 2488).

1.2 OBJECTIVE

The objective of this Standard is to assist users with the selection use and maintenance of suitable RPE to protect the body against atmospheres deficient in oxygen or against dusts, mists, fumes, smokes, gases, vapours, micro-organisms or combinations of these substances which could enter the body through the respiratory system.

1.3 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS	
1210	Pressure vessels
1319	Safety signs for the occupational environment
1345	Identification of the contents of pipes, conduits and ducts
2030	The verification, filling, inspection, testing and maintenance of cylinders for the storage and transport of compressed gases
2030.1	Part 1: Cylinders for compressed gases other than acetylene
2337	Gas cylinder test stations
2337.1	Part 1: General requirements, inspections and tests—Gas cylinders
2488	Resuscitators intended for use with humans
2815	Training and certification of occupational divers (series)
3848	Filling of portable gas cylinders—Filling of portable cylinder for self-contained underwater breathing apparatus (SCUBA) and non-underwater self-contained breathing apparatus (SCBA)
3848.2	Part 2: Safe procedures
MP 69	Explosion-protected electrical equipment—Certification scheme—Policy

AS/NZS

- 1020 The control of undesirable static electricity
- 1716 Respiratory protective devices
- 1801 Occupational protective helmets
- 2243 Safety in laboratories
- 2243.3 Part 3: Microbiological aspects and containment facilities
- 2299 Occupational diving operations (series)
- 2865 Safe working in a confined space
- 60079 Explosive atmospheres
- 60079.1 Part 1: Equipment protection by flameproof enclosures 'd'
- 60079.11 Part 11: Equipment protection by intrinsic safety 'i'

AS/NZS ISO

- 6529 Protective clothing—Protection against chemicals—Determination of resistance of protective clothing materials to permeation by liquids and gases

ISO

- 7708 Air quality—Particle size fraction definitions for health-related sampling
- 16976 Respiratory protective devices—Human factors
- 16976-1 Part 1: Metabolic rates and respiratory flow rates

- NOHSC* Adopted National Exposure standards for atmospheric contaminants in the occupational environment (NOHSC: 3008)

1.4 RELATED DOCUMENTS

The following documents provide guidance to assist with the selection, care and use of respiratory devices:

AS

- 2985 Workplace atmospheres—Method for sampling and gravimetric determination of respirable dust
- 3640 Workplace atmospheres—Method for sampling and gravimetric determination of inhalable dust
- 3848 Filling of portable gas cylinders—Decant filling of medical air and oxygen into portable cylinders
- 3848.1 Part 1: Safe procedures

AS/NZS

- 2986 Workplace air quality—Sampling and analysis of volatile organic compounds by solvent desorption/gas chromatography
- 2986.1 Part 1: Pumped sampling method
- 2986.2 Part 2: Diffusive sampling method
- 4804 Occupational health and safety management systems—General guidelines on principles, systems and supporting techniques

EN

- 27243 Hot environments. Estimation of the heat stress on working man, based on the WBGT-index (wet bulb globe temperature)

* National Occupational Health and Safety Commission. All NOHSC exposure standards and amendments can be found in the Australian Safety and Compensation website at <http://www.ascc.gov.au>

BS

4275 Guide to implementing an effective respiratory protective device programme

ASTRAND, PO and RODAHL, K. *Textbook of Physiology*. New York, McGraw-Hill. 1970, 1977 and 1986 eds.

1.5 DEFINITIONS

For the purpose of this Standard, the definitions below apply.

1.5.1 Aerosol

A suspension of fine solid or liquid particles in a gas, e.g. smoke, fog, or mist.

1.5.2 Air-hose respirator

A device, used with a facepiece or a head covering, through which clean air from a source remote from the workplace is made available to the wearer through an air-hose at near atmospheric pressure.

1.5.3 Air-line

Tubing used to provide breathable air from a source of compressed air at a maximum pressure of 10 bar.

1.5.4 Air-line respirator

A device capable of providing breathing air to the wearer from a source of compressed air at greater than atmospheric pressure by means of an air-line.

1.5.5 Air-purifying respirator

A device that filters contaminants from inhaled air.

1.5.6 Atmospheric contaminant

Any substance, either gaseous or particulate, that is not a constituent of the normal atmosphere, or that is present in a concentration greater than that found in the normal atmosphere.

1.5.7 Biological material

Any preparation of living organisms or the products of living organisms.

1.5.8 Blouse

An extended part of a head covering that includes sleeves and extends to the waist. It is generally elasticized at the waist and cuffs.

1.5.9 Breathing tube

A flexible tube connected to a facepiece or head covering through which breathable gas enters at a pressure slightly above or below atmospheric pressure.

1.5.10 Body temperature pressure saturated (BTPS)

A standard condition for the expression of ventilation parameters. Body temperature (37°C), atmospheric pressure (1013.25 hPa) and saturated air.

1.5.11 Chemical, Biological, Radiological, Nuclear (CBRN)

See 'Special response HAZMAT incident'.

1.5.12 Chemical oxygen (KO₂) self contained self-rescuer

A device that generates oxygen by means of a chemical reaction for use by a wearer during escape from a contaminated atmosphere or one lacking in oxygen.

NOTE: This does not include devices for work, rescue or diving applications.

1.5.13 Cleaning

The removal of contaminants and the reduction in the number of micro-organisms from a surface, by the process of washing in water and detergent without prior processing.

1.5.14 Combination filter respirator

A device combining the filtration capabilities of gas or vapour and particulate filters. The filters may be a single unit (integral) or consist of separate filters in series to form one unit (combination).

1.5.15 Demand valve

A device for the controlled release of air or oxygen actuated by a reduction in pressure created by the action of inhalation. The regulation may be such that the pressure inside the facepiece is maintained above atmospheric pressure (positive pressure type) or falls below atmospheric pressure (negative pressure type) during inhalation phase.

1.5.16 Disinfection

The reduction of non-sporing micro-organisms by chemical means.

1.5.17 Disposable respirator

A respiratory protective device for which maintenance is not intended and which is designed to be discarded after excessive resistance, sorbent exhaustion, physical damage or end of service-life renders it unsuitable for use.

1.5.18 Dusts

Solid particles generated and dispersed into the air by, for example, handling, crushing, grinding of organic or inorganic materials such as rock, ore, coal, wood and grain.

1.5.19 Equivalent Aerodynamic Diameter (EAD)

The diameter of a spherical particle of unit density (1 g/cm^3) which exhibits the same aerodynamic behaviour as the particle in question.

1.5.20 Emergency Breathing Device (EBD)

Also known as an auxiliary protection system. However, when used as an EBD the equipment is intended to provide protection when the primary respirator fails e.g. the air supply to an air-line respirator is interrupted.

1.5.21 Escape type respirator

A device for emergency escape from a respiratory hazard, e.g. fire. The device may either be fitted with P3, gas or combination P3 filters or supply breathable gas as required for the given environment.

NOTE: Each of these alternatives is used in special situations following risk assessment.

1.5.22 Exposure standard

An exposure standard as defined by NOHSC, represents an airborne concentration of a particular substance in the worker's breathing zone, exposure to which, according to current knowledge, should not cause adverse health effects nor cause undue discomfort to nearly all workers. The exposure standard can be of three forms: peak limitation, Time-Weighted Average (TWA), or Short Term Exposure Limit (STEL), see NOHSC 3008.

1.5.23 Exposure standard—peak limitation

A maximum or peak airborne concentration of a particular substance determined over the shortest analytically practicable period of time which does not exceed 15 min.

1.5.24 Exposure standard—Short Term Exposure Limit (STEL)

A 15 min TWA exposure which should not be exceeded at any time during a working day even if the eight-hour TWA average is within the TWA exposure Standard. Exposure at the STEL should not be longer than 15 min and should not be repeated more than four times per day. There should be at least 60 min between successive exposures at the STEL.

1.5.25 Exposure standard—Time-Weighted Average (TWA)

The average airborne concentration of a particular substance when calculated over a normal eight-hour working day, for a five-day working week.

1.5.26 Extended usage period

The time, in minutes that a chemical oxygen self-contained self-rescuer (when tested on a closed-circuit breathing machine) continues to produce oxygen past the rated duration, when tested and assessed in accordance with this Standard.

1.5.27 Facial fit check

A simple check to ensure the respirator fits each time it is worn.

1.5.28 Facial fit test

A validated method of matching a respirator to an individual.

1.5.29 Filtration type escape respirator

A device incorporating filters which removes certain particulates and gases or vapours from the air inhaled by the wearer for a limited time during escape from a respiratory hazard.

1.5.30 Flow regulator

A device for controlling air flow.

1.5.31 Full facepiece

A close fitting device to cover the eyes, nose and mouth and be secured in position by suitable means.

1.5.32 Fume

Extremely fine particles, usually less than 1.0 μm in diameter, formed from a volatilized solid that has condensed in cool air. In most cases the hot vapour reacts with air to form an oxide. Fume is often associated with molten metals especially in processes such as welding. At high fume concentrations, agglomeration of particles may result in particles with much larger dimensions.

1.5.33 Gases

Formless fluids that expand to occupy the space or enclosure in which they are confined. Examples are nitrogen, oxygen and carbon dioxide.

1.5.34 Gas filter respirator

A device consisting of a half facepiece, full facepiece, head covering or mouthpiece with a filter that removes certain gases or vapours from the air to be inhaled by the wearer for a limited period of time. It may also incorporate a filter to remove particulates.

1.5.35 Half facepiece

A close fitting device to cover the nose, mouth and chin and be secured in position by suitable means.

1.5.36 HAZMAT

Hazardous material such as radioactive, flammable, explosive, corrosive or poisonous material that is to be handled, stored or transported.

1.5.37 HAZMAT incident

An incident, such as a spillage, involving hazardous material.

1.5.38 Head and face covering

A hood, faceshield, visor or helmet covering all or part of the head and extending where appropriate to the shoulders or waist. It is secured in position by suitable means and may include sleeves.

NOTE: Head and face coverings are commonly called 'head coverings'.

1.5.39 Immediately Dangerous to Life and Health (IDLH)

A situation that poses a threat of exposure to airborne contaminants when that exposure is likely to cause death or immediate permanent adverse effects on health or prevent escape from such an environment.

1.5.40 Material Safety Data Sheet (MSDS)

A detailed information bulletin prepared by the manufacturer or importer of a chemical that describes its physical, environmental and chemical properties, health hazards, routes of exposure, precautions for safe handling and use, emergency and first-aid procedures, and control measures.

1.5.41 Micro-organism

Any microscopic entity capable of carrying on living processes. Examples include protozoa, fungi, bacteria or viruses.

1.5.42 Minimum Protection Factor (MPF)

The level of respiratory protection that an item of properly functioning respiratory protective equipment (RPE) or class of RPE would be expected to provide to properly fitted, and trained users in the workplace when used in accordance with the manufacturer's information and instruction. The MPF takes into account all expected sources of facepiece penetration (e.g. face seal protection, valve leakage).

1.5.43 Minute ventilation

The volume of air exchanged in the lungs during 1 min, VE in L/min BTPS. Also known as usage rate or sometimes, minute flow or minute volume.

1.5.44 Mists

Mists are suspended liquid droplets generated by condensation of vapour back to liquid state or by breaking up as a liquid into a dispersed state such as by splashing, spraying or atomising. Mist is the term applied to a finely divided liquid suspended in the atmosphere. Examples are an oil mist produced during cutting and grinding operations, acid mists from electroplating, acid and alkali mists from pickling operations and the condensation of water vapour to form a fog.

1.5.45 Mouthpiece

A device, designed to be held in the mouth, through which all air passes.

1.5.46 Nominal Effective Life (NEL)

The time in minutes, for a compressed air self-contained breathing apparatus to provide protection to the wearer at a usage rate of 40 L/min and at cylinder pressures above 1 MPa as described in AS/NZS 1716.

1.5.47 Nominal duration

The time, in minutes, that a chemical oxygen self-contained self-rescuer is effective, as specified by the manufacturer.

1.5.48 Nose clip

A device designed to occlude the nostrils to prevent air inhalation. Used in conjunction with a mouthpiece.

1.5.49 Nuisance dust mask

A lightweight mask that does not meet the requirements of AS/NZS 1716 with a filter intended only for extremely coarse non-toxic particulates. These masks do not give protection against gases or vapours.

1.5.50 Nuisance odour mask

A lightweight mask that does not meet the requirements of AS/NZS 1716 with a filter intended only for nuisance odours. These masks do not give protection against particulates, gases or vapours.

1.5.51 Particles

A generic term used to describe airborne solid or liquid substances in the finely divided state, i.e. particulate aerosols, such as dusts, mists, fumes, fibres, and fog as well as micro-organisms.

1.5.52 Particulate filter respirator

A device consisting of a half facepiece, full facepiece or head covering with particulate filter which removes finely divided solids or liquid matter from the air to be inhaled by the wearer. The filter medium may be replaceable or be an integral part of the construction.

1.5.53 Peak inspiratory flow

Also known as peak inhalation rate. Instantaneous flow rate during the inhalation phase of a breath cycle in L/s BTPS. L/s is the preferred unit as the flow takes place only during a short fraction of the breath cycle.

1.5.54 Personal Protective Equipment (PPE)

Any device or equipment designed to be worn or held by a person on its own, or as part of a system, to protect against one or more health and safety hazards.

1.5.55 Powered Air-Purifying Respirator (PAPR)

A device incorporating a half facepiece, full facepiece or head covering which provides the wearer with air filtered through a powered filtering unit, comprising a filter or filters, and an electrically operated blower unit. The respirator is referred to as a PAPR.

1.5.56 Protection factor

A measure of the degree of protection afforded by the respirator, defined as the ratio of the concentration of contaminant outside the respirator to that inside the respirator.

1.5.57 Qualitative fit test

A facial fit test giving pass/fail results and relying on the subject's response to a test agent.

1.5.58 Quantitative fit test

A facial fit test giving numerical results and not relying on the subject's response to a test agent.

1.5.59 Rated duration

The time, in minutes that a chemical oxygen self-contained self-rescuer is able to deliver breathable gas to a wearer within a suitable range of temperature, humidity, breathing resistance, and carbon dioxide and oxygen content, when tested and assessed in accordance with AS/NZS 1716.

1.5.60 Regulator

A device for controlling air flow.

1.5.61 Regulatory authority

A minister of the Crown, a government department or commission, or a statutory or public authority having power to issue regulations, orders or other instructions having the force of law in respect of any subject covered by this Standard.

1.5.62 Required minimum protection factor

The protection factor required to reduce exposure to an accepted level. It is expressed as a ratio of the measured ambient airborne concentration of a contaminant to an acceptable exposure level or standard.

1.5.63 Respirable air

Air of quality intended to be suitable for human respiration. This is also sometimes called breathable air or breathing air.

1.5.64 Respirable dust

The proportion of airborne particulate matter that, when inhaled, penetrates to the unciliated airways. This fraction is further described in ISO 7708 as the percentage of inhalable matter collected by a device conforming to a sampling efficiency curve which passes through the points shown in Table 1.

Alternatively it can be described by a cumulative log-normal distribution with a median EAD of 4.25 μm and a geometric standard deviation of 1.5 μm .

TABLE 1
RESPIRABLE DUST

Equivalent aerodynamic diameter, μm	Respirability %
0	100
1	100
2	97
3	80
4	56
5	34
6	20
7	11
8	6
10	2
12	0.5
14	0.2
16	0.1
18	0

1.5.65 Respiratory protective equipment (RPE)

A personal respiratory protective equipment that is designed to prevent the inhalation of contaminated air. The term replaces and is identical to 'respiratory protective device' or 'respirator'.

1.5.66 Safety coupling/connector

An air-line coupling/connector that requires at least two deliberate actions to separate the coupling or connector.

1.5.67 Self-Contained Breathing Apparatus (SCBA)

A portable respirator that supplies oxygen, air or other respirable gas from a source carried by the user.

1.5.68 Shall

Indicates that a statement is mandatory.

1.5.69 Should

Indicates a recommendation.

1.5.70 Single use low-boiling point filter

A category of filter intended to be used solely against low boiling point organic compounds during a single eight-hour shift, where the total logged period of use does not exceed the minimum specified absorption time of the filter. It is intended that the filter be discarded after such a period of use.

1.5.71 Smoke

Smoke consists of carbon or soot particles or tarry droplets less than 0.1 micrometer in size, and suspended in air, which results from the incomplete combustion of carbonaceous materials such as wood, coal, oil or paper.

NOTE: Normally, the combustion process producing smoke also produces gases.

1.5.72 Special response HAZMAT incident

A hazardous materials incident that has occurred with deliberate intent to contaminate the public or emergency service personnel and their property. It may include one or a combination of a warfare type chemical, industrial chemical, biological material and radioactive contaminant. Such an incident will often involve a large number of casualties or potential casualties.

1.5.73 Supplied-air RPE

A device that supplies air to the wearer from a source other than the ambient atmosphere.

1.5.74 Supplied-oxygen RPE

A device that supplies oxygen from a source of liquid or compressed oxygen carried by the wearer.

NOTE: Liquid oxygen sets, which supply oxygen from a source of liquid oxygen carried by the wearer are no longer covered by the requirements of AS/NZS 1716 and so are no longer recommended for use in this Standard.

1.5.75 Thermally generated particulates

See 'fume' and 'smoke'.

1.5.76 Usage rate

See 'minute ventilation'.

1.5.77 Vapour

Vapour is the gaseous form of a substance which is normally in the solid or liquid state at room temperature and pressure.

1.5.78 Work sets

Self contained breathing apparatus designed for general entry to or working in an area with airborne contaminants or oxygen deficiency.

1.6 GENERAL PRINCIPLES

No person should be exposed to potentially harmful atmospheres without suitable protection. Personal exposures should not exceed occupational exposure standards. The following principles should be observed in the protection of the body against the effects of harmful substances:

- (a) Where the workplace atmosphere is unknown and may be harmful, testing by a properly trained and responsible person using suitable equipment should be undertaken.
- (b) Every effort should be made to prevent the release of harmful substances into the working environment. This may be achieved through the design of buildings, plant and equipment; or by work procedures and controls (e.g. extraction systems) to obviate the need for RPE, and other PPE as required.
- (c) If measures to prevent or control the hazard at the source are inadequate, suitable RPE and other PPE as required should be provided and used.

In emergencies where contaminants may be released into the atmosphere, suitable RPE should be available for use.

1.7 HAZARD IDENTIFICATION, RISK ASSESSMENT AND CONTROL

1.7.1 General

The effective management of risks to health is achieved by identifying the hazards, assessing the risk associated with those hazards and controlling the risks to health.

Airborne contaminants generated during various processes may present a risk to a person's health through inhalation.

1.7.2 Hazard identification

The identification of airborne hazards/contaminants requires knowledge of the following:

- (a) Work processes.
- (b) Substances used, their physical form and properties.
- (c) Intermediates or products formed.

Further information can be obtained by observing the process in operation, talking to operators, supervisors and referring to material safety data sheets (MSDS) and manufacturers or importers of the substances. In observing the process, the effectiveness of any controls, such as local exhaust ventilation, would also need to be evaluated as part of the risk assessment process. Some processes produce dusts that may be readily seen in the general work environment or the operator's breathing zone. However, other processes may produce dusts that are not visible but are respirable and can cause harm. Therefore the absence of significant visible dust does not necessarily mean that the atmosphere is safe and free of dust particles of respirable size.

1.7.3 Risk assessment of airborne contaminants

A risk assessment is the process of determining the likelihood of a person's health (consequences) being affected by exposure to atmospheric contaminants. The risk assessment may also be used to determine whether the controls currently in place are adequate and whether additional controls, such as respiratory protection, are required.

A risk assessment of airborne contaminants needs to take into account the substance and nature of the work. The nature of the substances and work would not only affect the level and duration of exposure but also affect the route of exposure.

Measurements of the concentration of airborne contaminants or the level of oxygen in the workplace atmosphere can be used to establish the degree of risk associated with an airborne hazard by reference to current exposure standards (see Clause 3.1). Evaluation of a person's exposure may involve both personal and biological monitoring as follows:

(a) *Personal monitoring*

The exposure of a person through inhalation is estimated by measuring the concentration of an airborne substance in the person's breathing zone (air near the nose and mouth) and the duration of the exposure.

(b) *Environmental (static) monitoring*

Measuring air contaminants in the working environment can give an indirect estimate of a person's exposure and indicate the existence of a potential risk to health.

(c) *Biological monitoring*

Biological monitoring involves the measurement of the levels of chemical substances, their metabolites, or other biochemical indicators in the appropriate biological medium of the body (e.g. urine, blood or exhaled air). Biological monitoring takes all routes of exposure into account and can also be used to indicate the effectiveness of worker protection programs. Such monitoring can, in some circumstances, detect unexpected exposure of a person who was not suspected of being in contact with the particular chemical substance.

1.7.4 Controls of risks

Where there is a risk to people's health, such a risk should be controlled.

An effective way of controlling any risk to health associated with the use of hazardous substances is to apply the hierarchy of controls. The hierarchy of controls, which is often adopted in legislation, is a preferred order of control measures to be implemented in eliminating or controlling (minimizing) people's exposure. Elimination is considered the most effective measure, while PPE is regarded as the least effective. Administrative controls and PPE are regarded as being less effective because there is more reliance on human behaviour and these types of controls do not remove or contain the contaminant at the source. In practice, however, a combination of control measures are often required to effectively control risks to health.

The hierarchy of controls, shown in the preferred order, is described below.

(a) *Elimination*

Elimination is a permanent solution and should be attempted in the first instance. The hazard is eliminated altogether, e.g. eliminating the use of a hazardous substance by changing the process. Unless a particular hazard is removed, the potential risk associated with the hazard can never be completely removed.

(b) *Substitution*

Substitution involves eliminating or minimizing the risk to health by substituting the process, equipment or using a less hazardous substance or using a substance in a less hazardous form. Examples of substitution type controls are:

- (i) Substituting a dry cutting process by a wet cutting process to minimize or eliminate the generation of dust.
- (ii) Manually cutting a product instead of using power saws, which generate a lot of fine dust.

- (iii) Using a water-based cleaner instead of a solvent based one.
- (iv) Using a more dilute product or less hazardous form of the product (e.g. using a product that is in a pellet or paste form instead of a dusty fine powder.)

(c) *Isolation*

Isolation involves separating people from the substance to prevent or minimize exposure.

Isolation may be achieved by—

- (i) installation of a physical barrier between the hazardous operation and the operator;
- (ii) locating the operator further away from the processes; or
- (iii) using a time delay so that the operator does not need to be in attendance while the process is in operation.

(d) *Engineering controls*

Engineering controls are physical controls that eliminate or reduce the generation of substances, suppress or contain substances or limit the area of contamination in the event of spills and leaks. Engineering controls may include full or partial enclosures, exhaust ventilation or automation of processes. Examples of engineering controls include:

- (i) The use of robotics for spray painting.
- (ii) Spray booths.
- (iii) Fully enclosed processing systems.

(e) *Administrative controls*

Administrative controls are systems of work or safe work practices which help to reduce employee exposure or the duration of exposure. Examples of administrative controls include:

- (i) Job rotation to reduce the duration of employee exposure.
- (ii) Reducing the number of employees that may be potentially exposed.
- (iii) Prohibiting eating, smoking and drinking in contaminated areas.
- (iv) Keeping lids on containers to reduce evaporation of solvents.

(f) *Personal protective equipment (PPE)*

PPE is used to prevent inhalation and contact with hazardous substances. It includes equipment such as protective clothing, gloves, goggles and RPE.

High order controls (i.e. elimination, substitution, isolation and engineering controls) shall be adopted as far as practicable to eliminate or minimize people's exposure and reduce the need for or the reliance on administrative type controls and PPE.

SECTION 2 RESPIRATORY PROTECTION PROGRAM

2.1 RESPIRATORY PROTECTION PROGRAM

Where RPE is required to be worn, a respiratory protection program shall be established.

The program shall develop procedures in relation to the following:

- (a) Appointment of program administrator.
- (b) Selection of RPE.
- (c) Medical screening of users of RPE.
- (d) Training.
- (e) Issue of RPE.
- (f) Fitting of equipment.
- (g) Wearing of RPE (where required).
- (h) Maintenance of RPE.
- (i) Disposal of equipment.
- (j) Record keeping.
- (k) Program evaluation.

2.2 APPOINTMENT OF PROGRAM ADMINISTRATOR

Management shall designate an individual to head the program. This person shall have background enabling him or her to make sound decisions based on an evaluation and understanding of workplace hazards. The individual should be an OHS professional such as safety engineer, occupational hygienist, or occupational physician. In a small company, especially where RPE usage is limited, the program may be directed by the employer, foreperson, or other supervisory personnel. Regardless of who assumes responsibility for the program, the responsible person shall have the full support of management.

2.3 SELECTION OF RPE

RPE selection needs to consider the following:

- (a) Conformance with the requirements of AS/NZS 1716.
- (b) Medical evaluation of wearers for psychological and physical suitability (see Clause 5.1).
- (c) Contaminant factors including toxicity, exposure standards, skin absorption etc.
- (d) Operator factors, including comfort, other PPE, vision, communication etc., (see Section 4).
- (e) Task factors, including mobility, harsh environments etc., (see Section 4).
- (f) RPE maintenance requirements including cleaning and availability of appropriate equipment and spare parts.

Section 4 provides guidance for selection of the appropriate RPE while Section 5 describes the various RPE types.

All RPE shall conform with the requirements of AS/NZS 1716 where there is an appropriate category. RPE selection shall be based on requirements of this Standard and limitations of Australian and New Zealand legislation and regulations.

Where a recommendation is not available from Australian or New Zealand authorities information governing the use of RPE may be drawn from recognized international authorities or standardization bodies.

NOTES:

- 1 Recognized international authorities include:
 - (a) National Institute for Occupational Safety and Health (NIOSH) and Mine Safety and Health Administration (MSHA) in the USA.
 - (b) Health and Safety Executive (HSE) in the UK.
- 2 Standardization bodies include:
 - (a) International Organization for Standardization (ISO).
 - (b) European Committee for Standardization (CEN).

RPE is designed and tested as a system. To ensure that RPE provides the intended protection, all RPE shall be purchased and maintained as a system. Mixing and matching components such as filters and facepieces may not only invalidate any manufacturer's warranty but may not provide the respiratory protection required. Substitution of components is not acceptable unless the components have been tested as a whole, comply with AS/NZS 1716 and there is an ongoing quality assurance program to ensure that relevant performance requirements continue to be met.

2.4 RPE TRAINING

Occupational health and safety legislation requires employees to be trained and supervised to carry out their work safely.

Where RPE is to be used, training shall be provided in the safe use and limitations of the RPE. Training shall be provided at the commencement of employment, and at routine intervals thereafter. The frequency of retraining will depend on the complexity of the program and the degree of the hazard, but as a minimum shall be considered at least annually.

Supervisors also shall be trained in their responsibilities in ensuring the correct use of RPE and other established safe work procedures as required.

Training shall take into account employees who do not speak English or those whose English is poor to ensure that instructions are fully understood. Practical demonstrations or the use of interpreters is suggested in such cases.

A suggested format for a RPE training program is given in Section 7.

2.5 ISSUE OF RPE

Where practicable, RPE shall be issued for a wearer's exclusive use. Records of RPE issue and usage as specified in Clause 2.9, shall be established and maintained.

Where equipment is issued to an individual, each RPE should bear an identifying mark, which may be the user's name, initials, employee number or other similar identification.

Filters that are to be re-used shall be permanently marked with the date of issue. Non-PAPR filters shall be individually issued, and also marked with the user's identification.

RPE not issued on a personal basis, for example SCBA, shall be cleaned and disinfected after each use. Prior to re-issue, RPE shall be inspected in accordance with the manufacturer's instructions to ensure correct operation.

2.6 FITTING OF RPE

For RPE with a close fitting facepiece to provide its designed protection, it is essential that an adequate face seal is achieved, i.e. it be properly fitted to the wearer.

There are two types of facial fit test—qualitative and quantitative. Qualitative tests are usually simple and fast but may be influenced by the wearer. The quantitative test is not subjective but requires the purchase of special equipment, and a trained operator.

Clause 8.5 describes the various types of fit test. The program administrator shall ensure a suitable fit test is carried out for all users of RPE with a close fitting facepiece.

2.7 WEARING OF RPE

The respiratory protection program shall require that RPE is used in accordance with the manufacturer's instructions, and to be worn at all times in specified areas and during specified tasks. See also Clause 4.4.3.2.

2.8 MAINTENANCE

2.8.1 General

Maintenance shall be carried out following the manufacturer's instructions and include—

- (a) cleaning and disinfection of equipment;
- (b) inspection;
- (c) repair and replacement of components (including replacement of filters); and
- (d) storage and disposal.

Improperly maintained RPE provides wearers with a false sense of security. The life of a wearer may be dependent on the effective operation and ready availability of a suitable respirator. RPE is more likely to be worn if it is clean and functional.

For further details see Section 9.

2.8.2 Cleaning and disinfection

RPE shall be cleaned after each use. The cleaning procedure should be according to the manufacturer's instructions or, where these are not available, refer Appendix C.

A centralized cleaning operation can ensure that properly cleaned and disinfected RPE are available for use. However, where respirator use is infrequent or where the number of RPE in use is small, central facilities may be inappropriate.

Cleaning and disinfecting equipment, supplies, facilities and time for the job to be done shall be provided, ensuring that cleaning and, where required, disinfection is done properly and that only properly cleaned and disinfected RPE are used.

Disinfection shall be performed where one or both of the following usage conditions exist:

- (a) The respirator or facepiece will be used by more than one person.
- (b) There is a chance of the respirator or facepiece being contaminated with biological materials.

Disinfection should be carried out after cleaning of the RPE.

Disinfection may be achieved by using a broad-spectrum disinfectant. The choice of disinfectant should be made based on recommendations of the RPE manufacturer and medical authorities. Such advice may also assist where protection against the transmission of a specific pathogen is required. Use disinfectants in accordance with the manufacturer's instructions, e.g. dilution, temperature, and exposure time.

2.8.3 Inspection

Inspection and testing are both important parts of RPE maintenance to identify damaged or malfunctioning RPE.

All RPE should be inspected—

- (a) before and after each use; and
- (b) during cleaning.

Some types of RPE require periodic testing (e.g. equipment designated for emergency use) in accordance with the manufacturer's or regulatory requirements. See also Section 9.

2.8.4 Repair and replacement of components

2.8.4.1 General

Repair shall be carried out in accordance with the manufacturer's recommendations. See Clause 9.

2.8.4.2 Replacement of filters

Filters shall be regularly replaced in accordance with the filter replacement schedule.

Advice shall be sought from the manufacturer of the RPE in conjunction with an OHS professional, e.g. an occupational hygienist, on an acceptable change-over time based on likely exposure patterns so that an adequate safety margin is allowed.

2.8.5 Storage and disposal of equipment

RPE shall be stored to prevent contamination, damage and deterioration and should be located as close as practicable to where it is required. See Clause 9.6.

Respirator filters that have been utilized for potential or actual responses to toxic or harmful substances shall be considered as being contaminated with that substance and be disposed of in a safe manner so as to prevent possible exposure to others. Unused filters that are out of date shall not be used and shall be disposed of, to prevent re-use.

Where legislative requirement exist or there are relevant manufacturers' or suppliers' guidelines for appropriate disposal of contaminated filters, these should be followed.

2.9 RECORD KEEPING

Records for a respiratory protection program shall include records related to:

- (a) Issue of RPE (non-disposable)
 - (i) Date.
 - (ii) Identifying mark (where used).
- (b) User records
 - (i) Training.
 - (ii) Fit test.
 - (iii) Medical screening.
- (c) Maintenance
 - (i) Filter replacement schedule.
 - (ii) RPE maintenance schedule.
 - (iii) Supplied air RPE maintenance records.

- (d) Program records
 - (i) Procedures.
 - (ii) Audits/evaluations.
 - (iii) Atmospheric monitoring records.
 - (iv) Health surveillance.

Records need not be kept for disposable RPE or for filters used in half or full facepiece RPE where these are changed regularly. (See Clause 9.5).

2.10 PROGRAM EVALUATION

To ensure the continued effectiveness of the respiratory protection program, it shall be audited.

The respiratory protection program should be evaluated at least annually, with adjustments made as appropriate, to reflect the evaluation results. Evaluation of the respiratory protection program should include a review of the risk assessment and the results of any biological or atmospheric monitoring.

NOTE: Appendix D contains a checklist to assist in conducting and evaluating the program.

SECTION 3 ENTRY OF CONTAMINANTS INTO THE BODY

3.1 GENERAL

Employees may be exposed to a variety of airborne substances which may be in the form of gases, vapour, dust, mists, fume and smoke. Not all substances that are present in the working environment have been tested for their toxicological effects; however, all substances may be capable of causing harm if exposure is sufficiently high.

The Australian Safety and Compensation Council (ASCC), formerly the National Occupational Health and Safety Commission (NOHSC) publishes occupational exposure standards for atmospheric contaminants. These standards represent levels of airborne contaminants which according to current knowledge, are considered to neither impair the health of, nor cause undue discomfort to, most persons. These or other standards may be included in state legislation or codes of practice.

Individuals vary in their susceptibility to a given contaminant and exposure of some persons to contaminant concentrations at or even well below the exposure standard may result in discomfort, aggravation of a pre-existing condition or development of an occupational illness. The adverse effect of exposure to one contaminant may be increased or enhanced if the person is exposed to another. For example, the effects of asbestos are exacerbated by tobacco smoke.

The aim is to minimize any potential risk by keeping concentrations of all airborne contaminants as low as is reasonably practicable regardless of whether they are known to present a health hazard and irrespective of their assigned exposure standard.

The major routes of entry of substances into the body are inhalation, skin absorption and ingestion.

3.2 INHALATION OF AIRBORNE CONTAMINANTS

Inhalation is by far the most common means by which contaminants enter the body. The main anatomical features of the respiratory system are shown in Figure 3.1. Air inhaled through the nose and mouth is warmed and moistened. The large airways, or bronchi, are protected by a thick layer of mucus which is moved to the throat by millions of hair-like projections called cilia.

The small airways or bronchioles have attached to them three to six clusters of extremely small sacs called alveoli. There are approximately 300 million alveoli in the lungs, providing a very large surface area. The air in the alveoli is separated from blood capillaries by a thin membrane (0.2 μm), which allows almost instantaneous transfer of gases to and from the bloodstream.

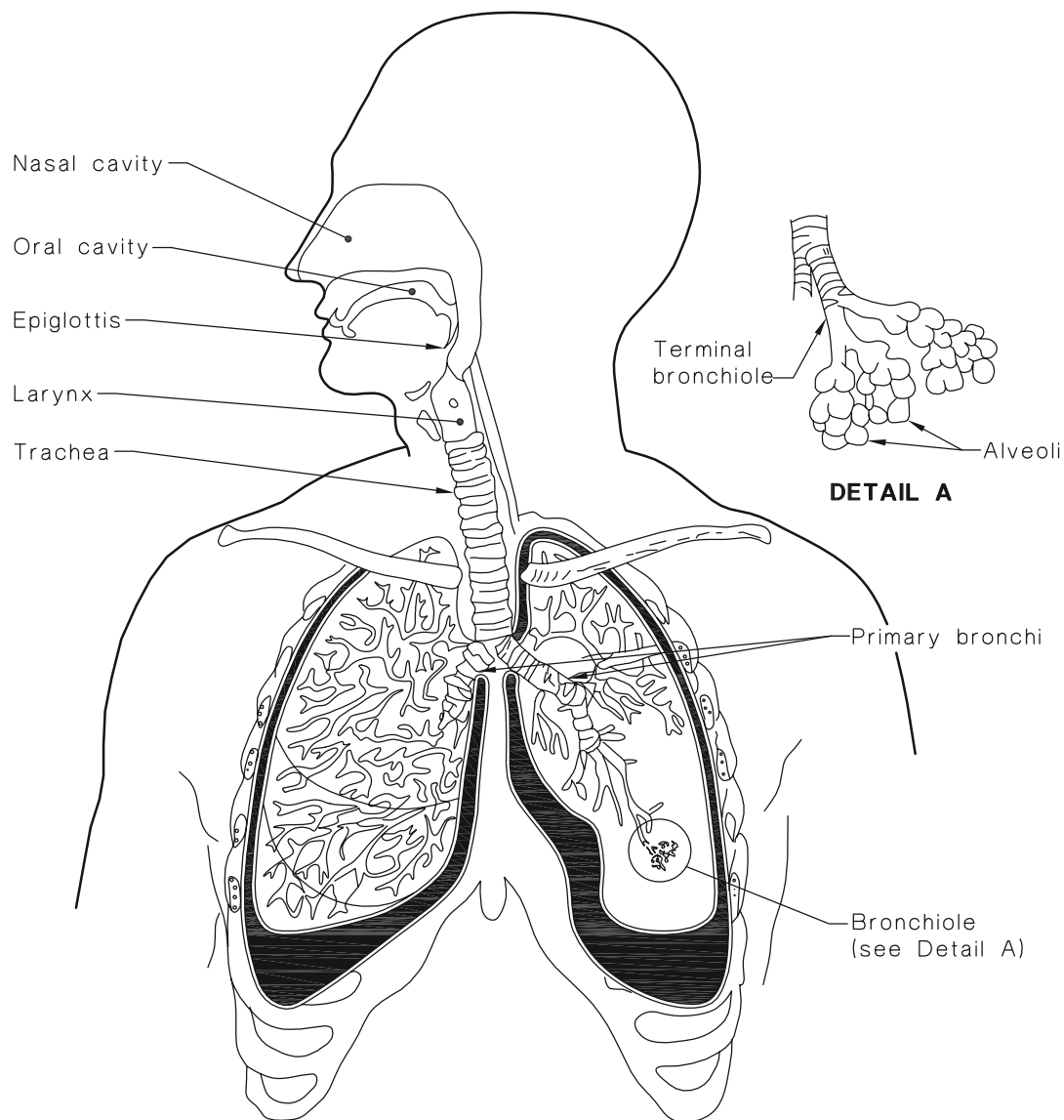


FIGURE 3.1 THE HUMAN RESPIRATORY SYSTEM

3.3 SKIN AND EYE ABSORPTION

3.3.1 Skin absorption

The intact skin normally acts as the primary barrier to many substances entering the body. However, some substances, may enter through the intact skin, e.g. parathion, styrene, tetraethyl lead, xylene, while others enter only through abraded skin, e.g. methomyl. These types of absorption may make a significant contribution to overall exposure.

3.3.2 Eye absorption

The effects of exposure of the eye to substances can vary from minor irritation of the eye to total loss of vision, depending on the substance and extent of exposure. Some substances that do not cause irritation following contact with the eye can be absorbed into the body in sufficient amounts to cause systemic poisoning, e.g. hydrogen cyanide, sodium cyanide.

3.4 INGESTION

Ingestion is the process by which substances enter the body through the mouth (by swallowing). Depending on its physical and chemical properties, an ingested substance may exert its effect on the tissue of the digestive tract or may be absorbed and enter the bloodstream. A toxic substance may be ingested while eating, drinking or smoking in contaminated areas or by transfer to the mouth with contaminated hands. Inhaled particles that have been deposited on the mucus in the respiratory tract will be ingested if the mucus is swallowed.

3.5 HEALTH EFFECTS OF AIRBORNE CONTAMINANTS

Airborne contaminants may cause immediate (acute) or long term (chronic) effects. These effects may occur at the site of contact (local effects) or they may be absorbed into the body and cause an effect (systemic) at a site other than the initial site of contact.

Airborne contaminants may affect various organs or cause a range of health effects depending on the level of (atmospheric concentration) and the duration of exposure. These health effects may include the following:

(a) *Irritation*

Irritants are readily water soluble and can cause irritation of the nose and upper respiratory tract, for example ammonia (NH_3) and hydrogen chloride (HCl). Alternatively, irritant gases which are relatively water insoluble, e.g. nitrogen dioxide (NO_2), will reach deeper into the lungs where irritation and absorption into the bloodstream will occur.

Upper respiratory tract irritants generally have some warning properties—they are immediately noticed and the worker will usually leave the area promptly. Lower respiratory tract irritants, however, are difficult to perceive initially. Often the exposed worker is unaware of their presence, as symptoms may not become apparent until hours later.

(b) *Nuisance particulates and nuisance odours*

Produce no tissue changes but may cause discomfort or minor irritation, e.g. limestone. Large quantities, however, may overwhelm the lung protection mechanisms and, in the long term, produce injury by blocking the bronchioles.

(c) *Asphyxiation*

Asphyxiants act by interfering with the supply or use of oxygen by the body. They may be simple asphyxiants which act by diluting the available oxygen, e.g. nitrogen (N_2). Alternatively, they may be chemical asphyxiants that, even in low concentration, will be absorbed by the blood in preference to oxygen, e.g. carbon monoxide (CO) and hydrogen cyanide.

(d) *Sensitization*

Inhalation of sensitizing agents, such as toluene di-isocyanate (TDI), may cause severe allergic reactions in some individuals who may or may not have been previously exposed. Once an individual has become sensitized, even very low levels of exposure to the sensitizer would induce a reaction, e.g. asthmatic condition. The process is seldom reversible. Allergic type reactions may also be caused by moulds and pollen.

(e) *Central nervous system effects*

Anaesthetics result in the partial or complete loss of sensation. Their effects are similar to alcohol as such gases depress the central nervous system, initially causing mild intoxication with dizziness and loss of coordination. Continued exposure causes unconsciousness and may lead to respiratory paralysis and death. Examples include many common organic solvents, e.g. methyl ethyl ketone; trichloroethylene; n-hexane, which can affect the nerves of the fingers and toes (peripheral neuropathy); organophosphorous insecticides, which are readily absorbed through inhalation and skin absorption and affect the nervous system.

(f) *Cancer*

Cancer of various organs, e.g. mesothelioma caused by inhalation of asbestos; liver cancer caused by vinyl chloride monomer gas.

(g) *Fever*

Fever producing particles cause chills followed by intense fever or influenza-like symptoms. Such effects may be delayed for several hours after exposure, e.g. fumes evolved by welding of zinc and copper giving rise to 'metal fume fever'

(h) *Infection*

Infections may occur as a result of exposure to micro-organisms.

(i) *Effects on the lungs*

Lung-damaging particles reduce lung capacity by causing physical changes in the lung structure. Such particles may act by giving rise to scar tissue which is not capable of gas exchange, e.g. silica and asbestos particles.

(j) *Other organ effects (liver, kidneys, etc.)*

Systemic poisons, once absorbed into the blood, target specific organs or body systems.

For example, carbon tetrachloride (CCl₄), which causes liver damage; lead can also cause kidney, nerve and brain damage.

3.6 PARTICLES

3.6.1 General

Particles are much larger than individual molecules and their inhalation and damage causing properties depend on physical and chemical characteristics such as size, shape and density. The visibility of particles is a function of many factors including size, concentration and ambient lighting conditions.

3.6.2 Particle size

Particles may be dusts, mists, fumes or fibres. These may range in size depending on the nature of the substances (e.g. fine powder or granular) or the nature of the process that generated these contaminants. Particles may be mechanically generated (e.g. grinding and spraying) or they may be thermally generated (e.g. welding fumes and bushfire smoke). Thermally generated particulates are much smaller than mechanically generated particles. This needs to be taken into account in the selection of respiratory protection.

Large particles that are up to 100 µm in size are referred to as inspirable or inhalable particles. Small particles (<10 µm) are referred to as respirable particles. Refer to Figure 3.2 for further information on the size range of common particulates.

Inspirable particles do not enter the lungs as deeply as respirable ones but they may be associated with sensitization (e.g. animal protein) or systemic poisoning after being absorbed into the blood (e.g. lead dust).

Particles in the respirable range can penetrate deep into the lungs. Depending on the substance, they may dissolve and be absorbed into the blood stream or they may remain in the lungs if they cannot be cleared by the lungs defence and clearance mechanisms (see Figure 3.2). Respirable particles are of particular importance when considering respiratory protection. It was generally considered that very small particles (less than $0.1\ \mu\text{m}$) are inhaled and exhaled and may not be retained anywhere in the lungs, but new evidence indicates some physiological hazard may be posed by such 'ultra-fine' particulates.

Respiratory protection for ultra-fines or nanoparticles raises the question of the performance of particulate filters meeting AS/NZS 1716 against such a contaminant.

Ultra-fine particles are generally defined as particles with aerodynamic diameters less than 100 nanometres ($1\ \text{nm} = 1/1000\text{th}$ of a micrometre). Many industrial processes produce particles in this size range e.g. welding, diesel emissions, gas cooking.

Little work has been done to quantify the performance of respirator filters against ultra-fine particles but it is still widely accepted that the efficiency of filters complying with AS/NZS 1716 requirements will be high. The need for respiratory protection for all ultra-fines has not been established, however RPE can be used to help reduce risk by lowering exposure. At this time there is no evidence to suggest that filter performance will be limiting factor in the use of air-purifying RPE against ultra-fines. Rather, proper fit testing and wearing the RPE during all times of exposures will continue to be the more significant consideration for reducing exposure.

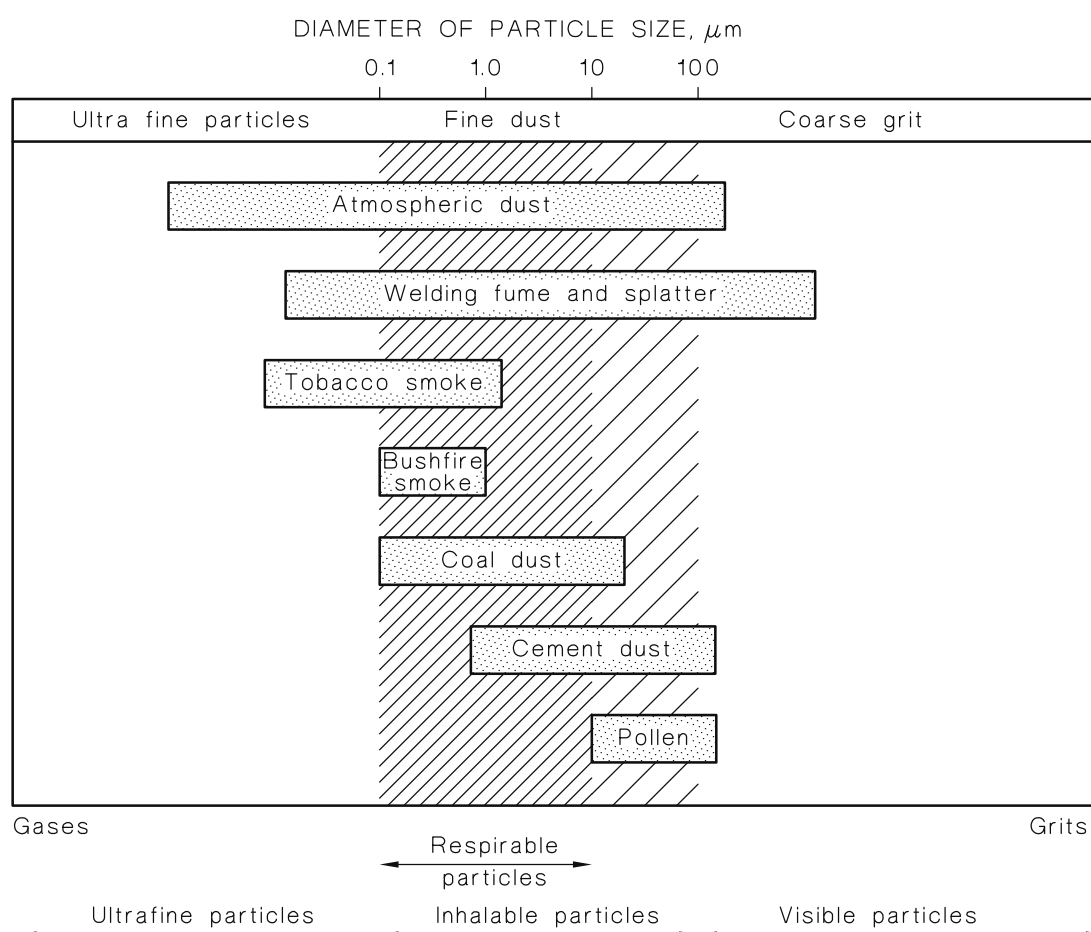


FIGURE 3.2 SIZE RANGE OF COMMON PARTICULATES

3.6.3 Micro-organisms

While most micro-organisms are harmless and pose no threat, there are some that are infectious to humans resulting in ill health. These infective micro-organisms have been classified into different risk groups by various international groups. These classifications are based on the following criteria:

- (a) Is the organism pathogenic i.e. disease-producing in man?
- (b) Is it a hazard to workers?
- (c) Is it transmissible in the community?
- (d) Is effective prophylaxis and treatment available?

There are four hazard groups:

- (i) Risk group 1 (low individual and community risk)—a micro-organism that is unlikely to cause human disease.
- (ii) Risk group 2 (moderate individual risk, limited community risk)—a pathogen that can cause human disease and which might be a hazard in occupational environments but is unlikely to spread in the community. Occupational exposures rarely produce specific infection and effective preventative and treatment measures are readily available.
- (iii) Risk group 3 (high individual risk, limited community risk)—a pathogen that may cause severe human disease and may be a serious hazard in occupational environments. It could present a risk if spread to the community, but there are usually effective preventative or treatment measures available.
- (iv) Risk group 4 (high individual and community risk)—a pathogen that usually produces life threatening human disease, and is a serious hazard in occupational environments. It is readily transmissible into the community and effective preventative and treatment measures are not usually available.

Further details covering microbiological safety specific to laboratories can be found in AS/NZS 2243.3. Information concerning micro-organisms may be available from regulatory authorities or recognized experts in the field.

3.7 OXYGEN DEFICIENCY

3.7.1 General

Entry into or work in oxygen-deficient atmospheres (ODA) is dangerous. Such atmospheres may exist in confined spaces, e.g. as a result of a chemical reaction or displacement. These conditions generally exist in areas with limited ventilation, e.g. tanks, vats, reaction vessels, wells, tunnels, pipes, conduits, access holes, silage pits and deep earthen trenches.

Safe procedures for working in confined spaces are not covered in this Standard. These are specified in AS/NZS 2865.

There are four basic mechanisms by which oxygen-deficient atmospheres, or their equivalent, may occur. These are:

- 1 Ascending to altitude.
- 2 Chemical reaction with solid products, e.g. the formation of rust or other corrosion products.
- 3 Chemical reaction gaseous, e.g. respiration, fire.
- 4 Displacement (dilution) by some other gas or vapour.

Of these, only the first two may result in an oxygen deficiency without the introduction of, or an increase in concentration of, some other gas or vapour. In the latter two cases, a significant oxygen deficiency will usually be caused with the simultaneous production of a toxic concentration of such a gas or vapour.

3.7.2 Atmospheric composition

At high altitudes, although oxygen percent by volume remains constant, the amount of oxygen available for breathing is reduced owing to the lower pressure. This may produce effects similar to those of lack of oxygen by action of a simple asphyxiant.

Earth's atmosphere has an essentially fixed composition of the gases shown in Table 3.1.

TABLE 3.1
TYPICAL COMPOSITION OF
EARTH'S ATMOSPHERE
(DRY STATE CONDITION)

Gas	Composition by volume %
Nitrogen	78.09
Oxygen	20.95
Carbon dioxide	0.04
Other gases	0.92

Other gases present in small amounts include neon, helium, and krypton. Water vapour, an important constituent of the normal atmosphere, may be present up to 5% of the total volume.

No single definition (value) of an oxygen-deficient atmosphere has been universally accepted. Where a definition is required however, local legislation should be followed.

A safe oxygen range is defined in AS/NZS 2865.

3.7.3 Symptoms of oxygen deficiency

The symptoms of oxygen deficiency depend on the oxygen concentration present.

It is difficult for the exposed person to realize the effect of oxygen deficiency. Lack of oxygen can cause gradual depression of the central nervous system. This affects powers of discrimination, logic and hearing, with attendant muscular weaknesses and lack of coordination. Extremely low levels of oxygen will lead to death in minutes without intervention.

SECTION 4 SELECTION OF RPE

4.1 FACTORS IN SELECTION

Many factors need to be considered when selecting a suitable respirator for a particular situation. It is important to ensure that only RPE complying with AS/NZS 1716 be used and, where there is any doubt, expert occupational hygiene advice should be sought.

To protect effectively, RPE needs to be worn whenever the person is exposed to excessive levels of the contaminant.

The selection of RPE will be influenced by the following factors:

- (a) Contaminant.
- (b) Task.
- (c) Operator.
- (d) Equipment limitations.
- (e) Special response HAZMAT incidents.

Figure 4.1 is a work-through flow chart to determine which table to use for a given situation. Selection guides based on identified and quantified contaminants are given in Tables 4.1 to 4.6. Tables 4.2 to 4.6 recommend RPE for specific contaminants based on the level of protection required. Table 4.1 specifically covers micro-organisms.

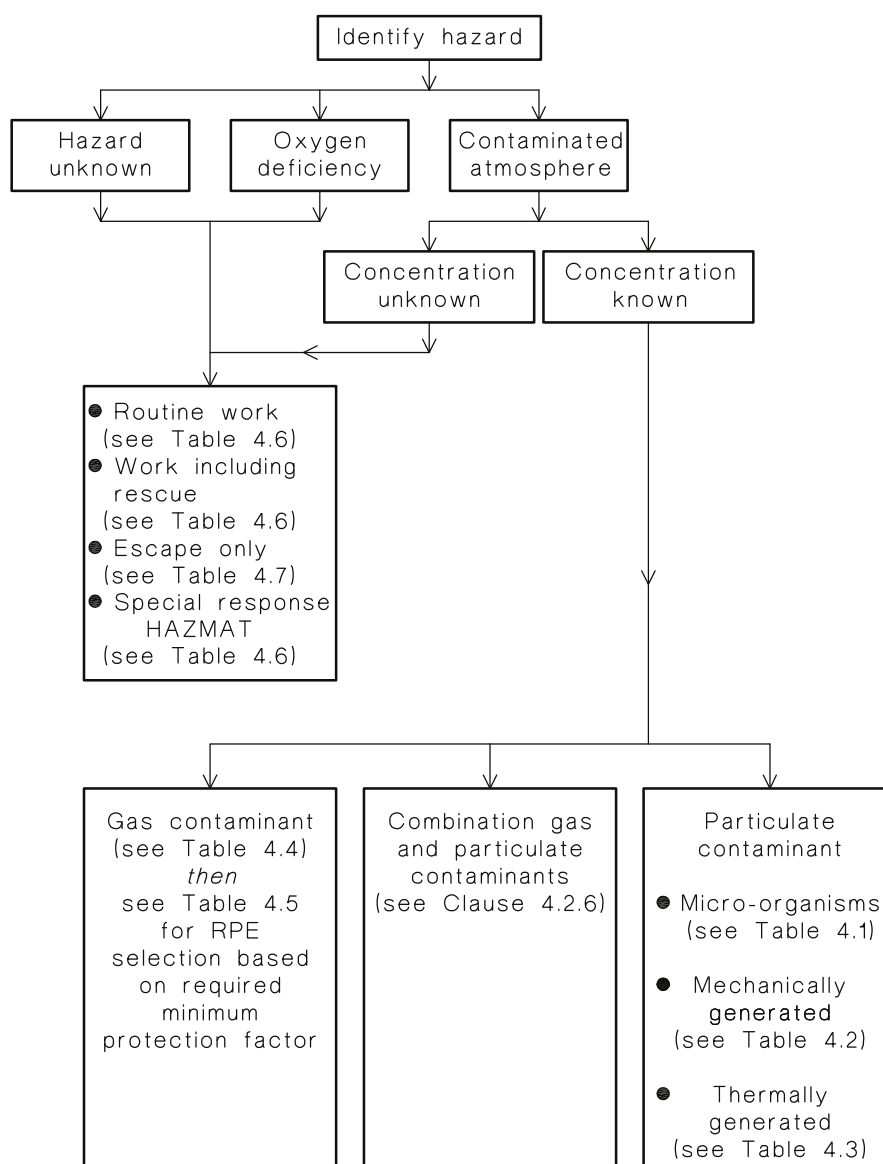


FIGURE 4.1 FLOW CHART FOR RPE SELECTION

Further explanation of the recommendations is given in the rest of this Standard and should be read in conjunction with Tables 4.1 to 4.6. Where there is doubt about the correct selection, expert advice should be sought from persons experienced in respiratory protection.

The devices selected should be suitably matched to individual wearers, their duties, the likely duration of wear and the nature of the environments e.g. personal characteristics, physical fitness, work rate, posture, space restrictions, ambient temperature, relative humidity. The selected devices should not impose unacceptable discomfort on the wearers.

The device selected should be compatible with any items of PPE, which may have to be worn simultaneously with the RPE.

This section provides guidance on selection of adequate protection. The information should not be viewed as minimum protection requirements. Over-specifying is warned against as generally this will result in increased body burden without any improvement in protection, e.g. for mechanically generated particulates such as silica dust and chrysotile, a P1 respirator will provide adequate protection. Recommendation of a P2 respirator will provide little or no improvement in filtration of these dusts but may have a higher breathing resistance and therefore may force the wearer to work harder for no additional protection.