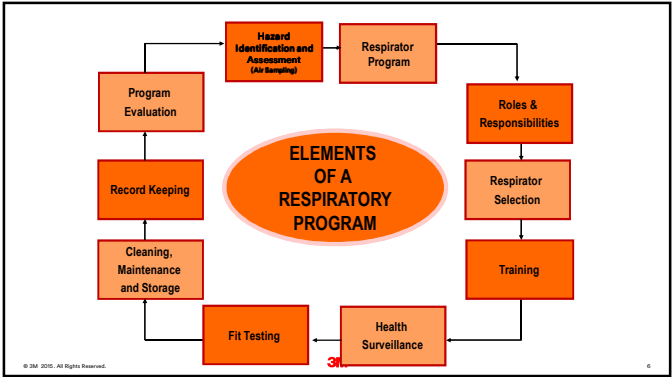


Elements of a Respiratory Protection Program

Hazard Assessment



How do you know if or when respirators are required?

Hazard Assessment

Identify

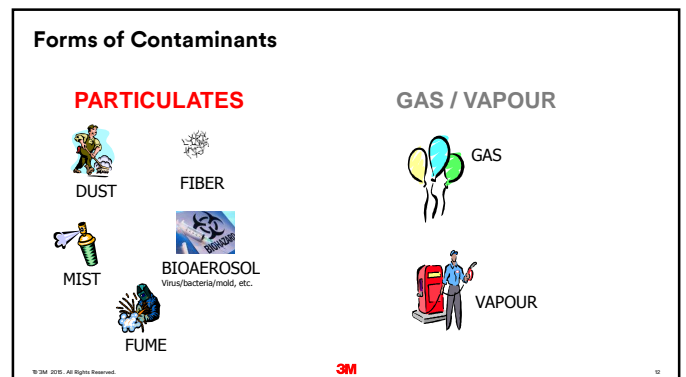
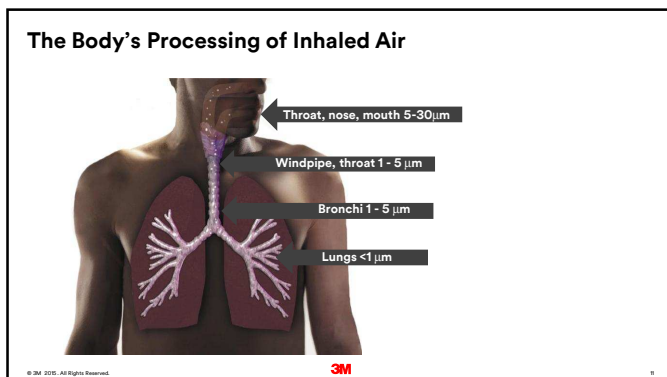
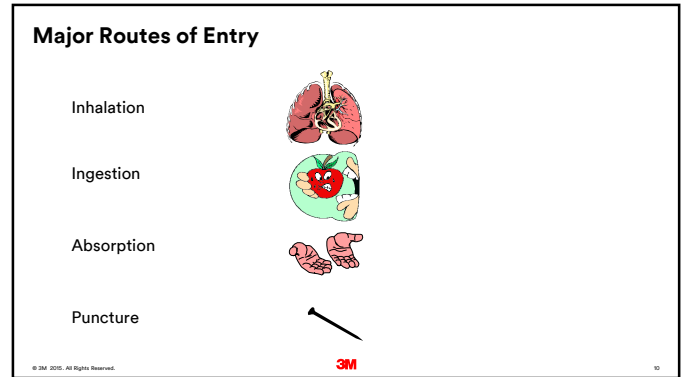
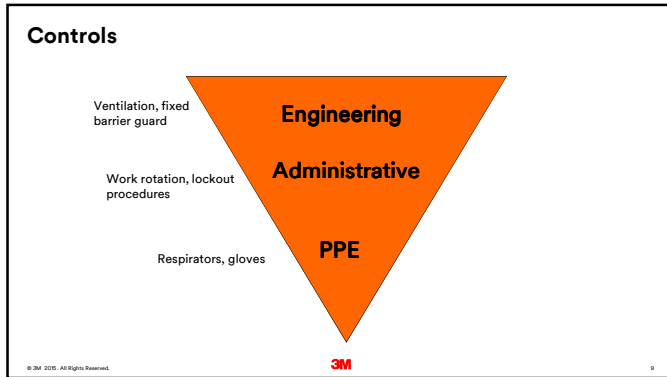
- Form of Hazard
- Who is Exposed
- Concentration

Tools

- MSDS Review
- Task Analysis
- Air Sampling

Note: When the only hazard identified is a bioaerosols, follow the new control banding selection process





Exposure Definitions

OEL	Occupational Exposure Limit
TLV	Threshold Limit Values (ACGIH)
PEL	Permissible Exposure Limits (US OSHA)
TWA	Time Weighted Average (8-hour)
STEL	Short Term Exposure Limits (15 minute)
C	Ceiling (instantaneous)

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OELs for Biological Aerosols

No exposure limits, such as Occupational Exposure Limits (OEL) or Threshold Limit Values® (TLV) are established for biological agents such as mould, fungi and SARS.

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What Level of Respiratory Protection is Required?

APF- Applied Protection Factor:

The anticipated level of respiratory protection that would be provided by a properly functioning respirator or class of respirators to properly fitted and trained users.

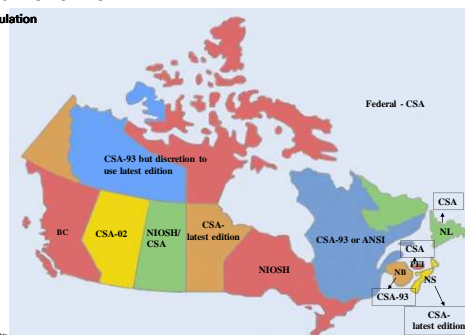
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Canadian Overview

APFs - Regulation



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Assigned Protection Factors

Respirator Type		CSA Z94.4-93	CSA Z94.4-02	CSA Z94.4-11	BC	NIOSH 2004 Selection Logic	OSHA Nov. 2006
Air Purifying	Half Facepiece	10	10	10	10	10	10
	Full Facepiece	100	100 (QLFT 10)	50 (QLFT 10)	50	10 ¹ / 50 ²	50
Powered Air Purifying	Loose-fitting facepiece	25	25	25	25	25	25
	Half facepiece	50	50	50	50	50	50
	Full facepiece	1000	1000	1000	1000 ³ 1000 ⁴	50	1000
	Helmet or hood	1000	1000	25 / 1000 ⁵	25 / 1000 ⁵	25	25 / 1000 ⁵
Air Line	Loose fitting facepiece	25	25	25	25	25	25
	Half facepiece	50	50	50	50	50	50
	Full facepiece	1000	1000	1000	1000	50	1000
	Helmet or hood	1000	1000	25 / 1000 ⁵	1000	25	25 / 1000 ⁵
Air Line Pressure Demand	Half facepiece	50	50	50	50	1000	50
	Full facepiece	1000	1000	1000	1000	2000	1000
	SCBA Full facepiece	X	X	10000 ⁶	10000	10000	10000
	SCBA tight fitting hood	X	X	10000 ⁶	X	X	10000

¹ APF of 10 with full facepiece respirators equipped with N/R/P 95 or 99 class filters.

² APF of 50 with a full facepiece equipped with a class 100 filter. Full facepiece with gas/vapour cartridge and/or equipped with a 100 class pre filter.

³ Manufacturer must demonstrate APF of 1000.

⁴ Must be QNTF

⁵ Full facepiece, powered (PAPR), equipped with HEPA filters for exposure to asbestos

⁶ Full facepiece, powered (PAPR), equipped with HEPA filters and/or sorbent cartridge or canister for exposure to contaminants other than asbestos

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Types of Respiratory Protection Hierarchy of Respiratory Protection

Types of Respirators

Air Purifying

Filtering facepiece

Elastomeric facepiece

Powered air - helmets, hoods, facepiece



Air Supplying

Air line from compressor or cylinder

Self Contained Breathing Apparatus (SCBA)

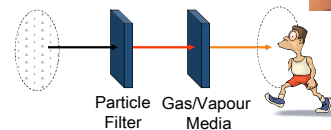


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Negative Pressure Air Purifying Respirator

When inhaling, a **negative pressure** is created in the respirator. Ambient air flows through a filter or cartridge which removes the contaminants. The clean air continues into the respirator and to the lungs.

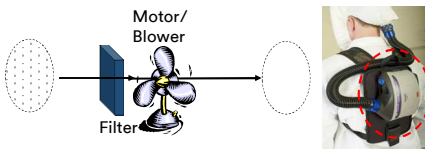


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Positive Pressure Air Purifying Respirators

Motor/blower unit pulls ambient air through a filter or cartridge.
Contaminants are removed
Forces purified air into the breathing zone

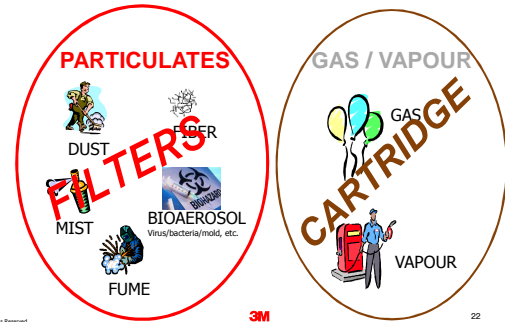


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Filter/Cartridge Protection



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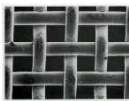
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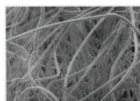
Theory: Filtration for Fibrous Filters

- A filter is NOT a screen or sieve.
 - Particles are NOT collected on "top" of a filter only.



Theory: Depth Filtration

- A filter is an open structure of randomly oriented small fibers with finite depth.
 - Particles are collected throughout the depth of the filter.



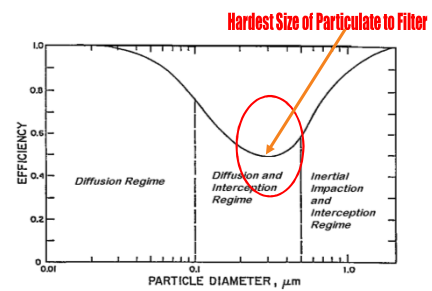
Source: Air Filtration by R.C. Brown, Pergamon Press

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Most Penetrating Size Particle For Filters



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Filters

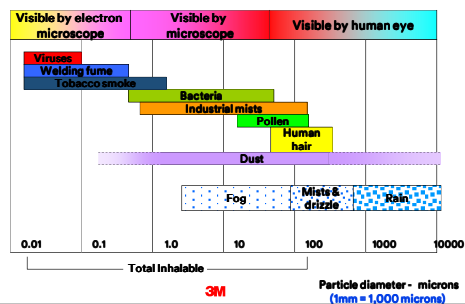
42 CFR 84 Filter Classifications			
Minimum Efficiency	N Class No Oil	R Class Oil Resistant	P Class Oil Proof
95%	N95	R95	P95
99%	N99	R99	P99
100%	N100	R100	P100



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Sizes of Selected Particles



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Examples of Oil Versus Non-oil Aerosols

Oil Aerosols

Mineral Oil
Vegetable Oil
Glycerin
Di-sec-octyl phthalate
PCBs
Triphenyl phosphate

Non-oil Aerosols

Asbestos
Cadmium
Chromic acid
Cotton Dust
Silica
Wood Dust

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Oil Containing Atmospheres in Work Environments

Atmospheres likely to include oil aerosols:

- Coke oven emissions
- Asphalt (petroleum) fumes
- Coal tar pitch volatiles
- Oil/solvent based pesticide sprays

Atmospheres unlikely to include oil aerosols:

- Paint spray
- Water based pesticide sprays

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Color Coding for Chemical Cartridges

Cartridge Type	Colour
Organic Vapour	Black
Acid Gases	White
Organic Vapour/Acid Gases	Yellow
Ammonia / Methylamine	Green
Formaldehyde	Olive Green
Multi-Gas and Vapour	Khaki Green
Mercury Vapour / Chlorine Gas	Orange



ESLI for Hg
ESLI = End of Service Life

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Change-out Procedures, Schedules, and Service Time

- A qualified person shall establish a change out schedule for cartridges
- May be based on:
 - An end of service life indicator (ESLI)
 - Maximum Use Time Calculations (ie. change out schedule)
- Warning properties of the contaminant SHALL NOT be relied upon for cartridge/canister change out
 - Workers shall exit when they detect the odour or experience irritation symptoms
 - Program administrator is informed and shall re-evaluate respirator use

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Replacement Criteria - Filter

- For "N" Series**
 - Physically damaged
 - Unhygienic
 - Increased breathing resistance
 - Employer's change out schedule
- For R and P series, in environments containing oily aerosols, also follow;**
 - R series: every shift (8 hours)
 - P series: according to manufacturer
 - E.g. 3M recommends 30 days or 40 hours use, whichever comes first

Note: For PAPR replace filter when air flow doesn't meet manufacturer's requirements

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Limitations of Air Purifying Respirators

- Not for use** in atmospheres containing less than 19.5% oxygen
- Not for use** in IDLH (Immediately dangerous to life and health) atmospheres
- Not for use** when concentrations exceeds APF x OEL
- Do not use** with facial hair, or other conditions that interfere with the seal between the face and the respirator
- Do not** alter, abuse, or misuse the respirator

Consult CSA Z94.4-11 for full list of limitations

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Limitations of Supplied Air

- Not for use when concentrations exceeds APF x OEL
- Airline respirators provide no protection if the air supply fails
- Airline respirators shall not be used in IDLH atmospheres
- Compressed air cylinder is fully charged with air meeting CSA CAN3-Z180.1.
- Air is supplied through an air hose (not to exceed 300ft but some are only approved for shorter lengths, follow manufacturer approvals)
- Escape route shall be planned to meet your auxiliary air supply

Consult CSA Z94.4-11 for full list of limitations

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Hierarchy of Respiratory Protection - Figure 4

Acceptable level	Air-purifying options	APF	Atmosphere-supplying options
0			
1			
2			
3			
4			
5			
5	No air-purifying option available	10000	SCBA (pressure-demand) full-facepiece SCBA (pressure-demand) tight-fitting hood Multi-functional SCBA/airline
4 to 5	Powered air-purifying full-facepiece Powered air-purifying helmet/hood with SWPP study	1000	Airline (continuous-flow) full-facepiece Airline (pressure-demand) full-facepiece Airline (continuous-flow) helmet/hood with SWPP study
3 to 5	Powered air-purifying half-facepiece Air-purifying (negative-pressure) full-facepiece	50	Airline (pressure-demand) half-facepiece Airline (continuous-flow) half-facepiece
2 to 5	Powered air-purifying loose-fitting facepiece/visor Powered air-purifying helmet/hood without SWPP study	25	Airline (continuous-flow) loose-fitting facepiece/visor Airline (continuous-flow) helmet/hood without SWPP study
1 to 5	Air-purifying (negative-pressure) half-facepiece (including filtering facepieces)	10	No atmosphere-supplying option available
	No respiratory protection required	<1	No respiratory protection required

Notes:

- (1) See Tables 1 and 2 for fit test pass/fail criteria for tight-fitting respirators.
(2) Fit testing is not required for loose-fitting respirators.

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Selection Process for Chemical Exposure

Respiratory Selection

Shall:

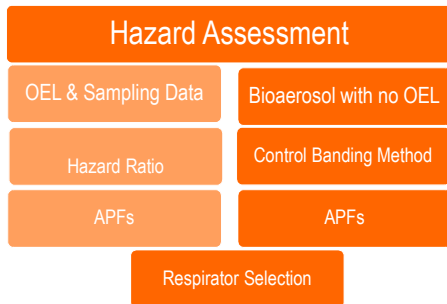
- Based on a systematic review of the hazards
- Knowledge of the standard, regulatory criteria
- Manufacturers information on types of respirators and limitations
- Consider intended conditions of use

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Respirator Selection



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Hazard Ratio

Hazard Ratio (HR): The estimated/measured airborne concentration of a substance divided by the occupational exposure limit.

$$HR = \frac{\text{Airborne Concentration}}{\text{Occupational Exposure Limit}}$$

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Example – Hazard Ratio

A customer measures the amount of toluene in their environment and the results indicate it is 200ppm.

$\begin{aligned} \text{HR of Toluene} \\ \text{HR} &= \frac{200\text{ppm}}{50\text{ppm}} \\ \Delta \text{HR} &= 4 \end{aligned}$	<p>Measured in the worker's environment</p> <p>OEL for Toluene</p>
--	--

Therefore the customer can use ¼ FP/DR for respiratory protection in their work area

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Example – Hazard Ratio

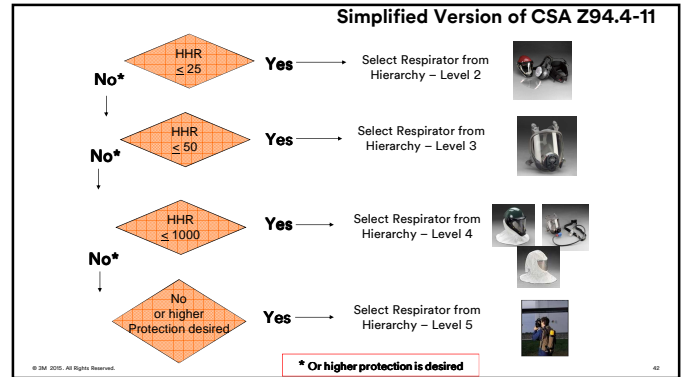
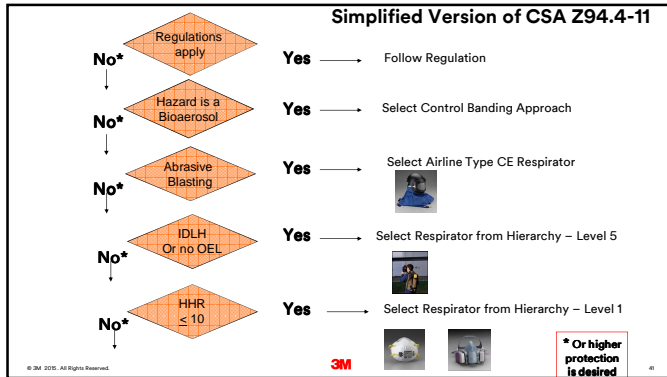
A customer measures the amount of lead dust in their environment and the results indicate it is 0.75mg/m3.

$\begin{aligned} \text{HR of Lead Dust} \\ \text{HR} &= \frac{0.75}{0.05 \text{ mg/m}^3} \\ \Delta \text{HR} &= 15 \end{aligned}$	<p>Measured in the worker's environment</p> <p>OEL for Lead</p>
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Therefore the customer can use > PAPR for respiratory protection in their work area.

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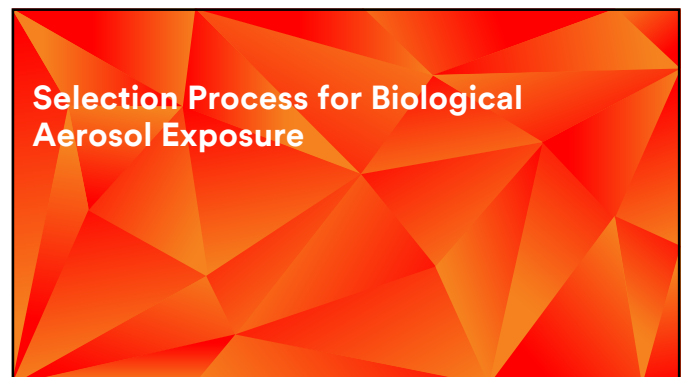


Hierarchy of Respiratory Protection - Figure 4

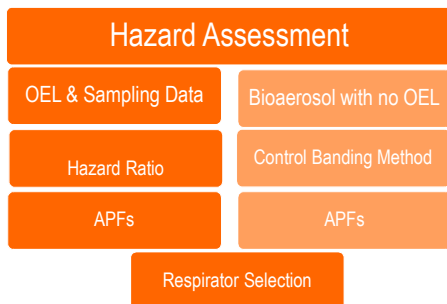
Acceptable level						Air-purifying options	APF	Atmosphere-supplying options
0	1	2	3	4	5			
					5	No air-purifying option available	10000	SCBA (pressure-demand) full-facepiece SCBA (pressure-demand) tight-fitting hood Multi-functional SCBA/airline
				4 to 5		Powered air-purifying full-facepiece Powered air-purifying helmet/hood with SWPF study	1000	Airline (continuous-flow) full-facepiece Airline (pressure-demand) full-facepiece Airline (continuous-flow) helmet/hood with SWPF study
			3 to 5			Powered air-purifying half-facepiece Air-purifying (negative-pressure) full-facepiece	50	Airline (pressure-demand) half-facepiece Airline (continuous-flow) half-facepiece
		2 to 5				Powered air-purifying loose-fitting facepiece/visor Powered air-purifying helmet/hood without SWPF study	25	Airline (continuous-flow) loose-fitting facepiece/visor Airline (continuous-flow) helmet/hood without SWPF study
	1 to 5					Air-purifying (negative-pressure) half-facepiece (including filtering facepieces)	10	No atmosphere-supplying option available
						No respiratory protection required	<1	No respiratory protection required

Notes:
(1) See Tables 1 and 2 for fit test pass/fail criteria for tight-fitting respirators.
(2) Fit testing is not required for loose-fitting respirators.

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Respirator Selection



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Bioaerosol

- liquid droplet (generated for example by coughing, sneezing or a medical procedure such as bronchoscopy) or a solid particle (generated for example by sweeping, shovelling) suspended in the air. Bioaerosols include living or dead microorganisms, fragments, toxins, and particulate waste products from all varieties of living things. They are capable of causing infection, adverse or allergic response.
- Note:** Individual bioaerosols range in size from submicroscopic particles (<0.01 µm) to particles greater than 100 µm in diameter.

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Control Banding Approach

- Control Banding was developed in Great Britain to implement safe and realistic means of control where quantitative risk information was limited.
- Control Banding is a generic technique used to guide the assessment and management of workplace risks.

The general procedure is to derive an appropriate level of respiratory protection by combining ranges or "bands" representing:

- Risk Group** - (nature of the hazard and availability of treatment)
- Generation Rate** (from human release, activities, or equipment)
- Control Level** (e.g., ventilation).

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Control Banding Approach

7.3.2.3.4

The appropriate workplace environment shall be selected in accordance with

- Figure 2 for a health care facility when exposure is related to infectious bioaerosols that are communicable between humans; or
- Figure 3 for general workplace environments [including all settings not defined in item (a)] for all bioaerosols

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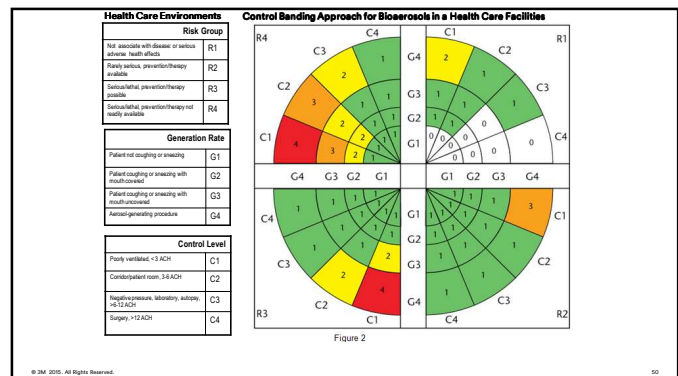
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Health Care Facilities

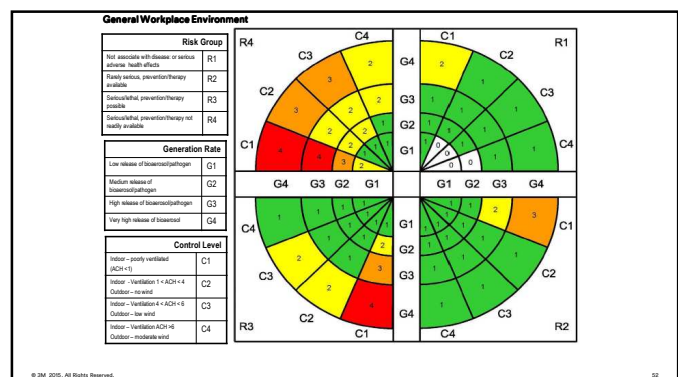
- A facility designed for the provision of health care.
- The health care figure shall be used when exposure is related to infectious bioaerosols that are communicable* between humans
e.g. *mycobacterium tuberculosis*, influenza or varicella
- Note: Refer to Annex N: Additional guidance for qualified persons on respirator selection in health care environments

***Communicable – Contagious**



General Workplace Environments

- The general workplace figure shall be used for all environments/settings not defined for a health care facility
- Examples include: Mold in the workplace, hantavirus in a maintenance shed
- Refer to Annex K for workplace scenario examples



General Workplace: Histoplasmosis

A worker is directed to go into a warehouse that has been occupied by pigeons for many years. Piles of pigeon excrement about a metre deep are found under roosting locations. The cleanup will be done indoors with no additional ventilation.

- Step 1** Identify the bioaerosol
Histoplasma capsulatum
- Step 2** Transmission of disease, infection or adverse effects produced from inhalation of bioaerosol
Yes, histoplasmosis
- Step 3** Select applicable control banding wheel
General Workplace Environment

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General Workplace: Histoplasmosis

Step 4

Determine the bioaerosol risk group(R1-R4)
R3: Agents associated with serious human disease or adverse health effect for which preventative therapy might be available

Risk Group 3 (R3) — Fungal Agents
Coccidioides immitis (sporulating cultures; contaminated soil)
Histoplasma capsulatum, *H. capsulatum* var. *duboisii*

Risk Group	
Not associate with disease; or serious adverse health effects	R1
Rarely serious, prevention/therapy available	R2
Serious/lethal, prevention/therapy possible	R3
Serious/lethal, prevention/therapy not readily available	R4

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General Workplace: Histoplasmosis

- Step 5** Determine the generation rate (G1- G4)
G3: Misting then shoveling

Generation Rate	
Low release of bioaerosol/pathogen	G1
Medium release of bioaerosol/pathogen	G2
High release of bioaerosol/pathogen	G3
Very high release of bioaerosol	G4

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General Workplace: Histoplasmosis

Step 6

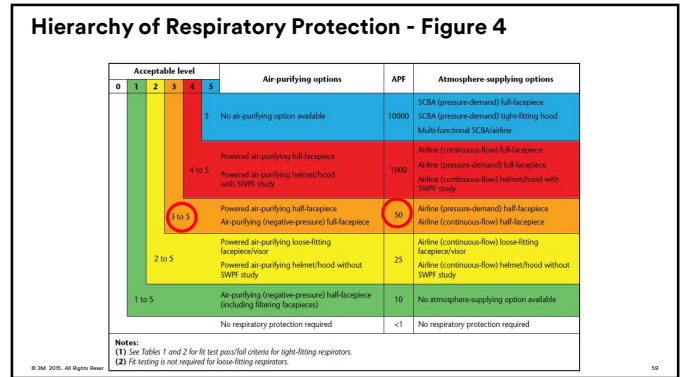
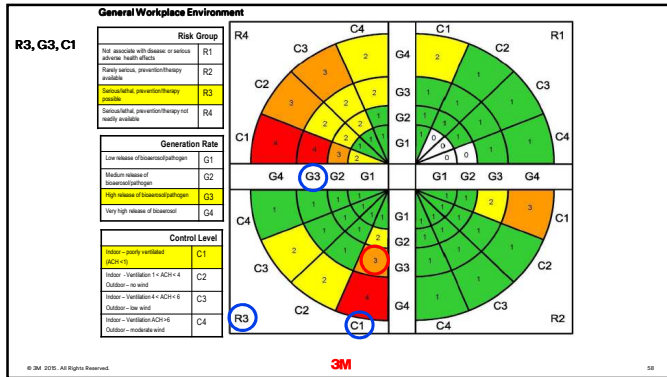
Determine the control level (C- C4)
C1: Indoor, Poorly ventilated ACH ≤ 1

Control Level	
Indoor – poorly ventilated (ACH <1)	C1
Indoor – Ventilation 1 < ACH < 4 Outdoor – no wind	C2
Indoor – Ventilation 4 < ACH < 6 Outdoor – low wind	C3
Indoor – Ventilation ACH >6 Outdoor – moderate wind	C4

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Respirator Selection for Histoplasmosis Exposure

Summary

- R3, G3, C1 = Orange/No. 3
- Orange/No. 3 = APF 50

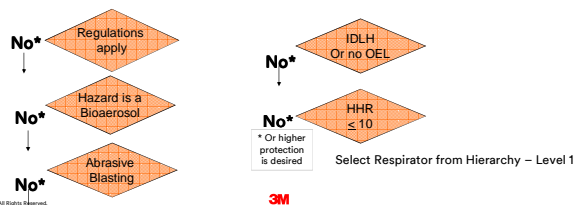
- Air-purifying (negative-pressure) full-facepiece;
- Powered air-purifying half-facepiece;
- Airline (pressure-demand) half-facepiece; or
- Airline (continuous-flow) half-facepiece

Selection Process for Certain Work Activities

Main Task/Activity: Confined space entry – sewer manholes (including sanitary, storm, and combined)

Sub Task/Activity: GENERAL ENTRY AND VISUAL INSPECTION

- Hazard Assessment concludes no airborne (chemical/biological) agents contaminant during general entry/inspection. Oxygen levels are sufficient.



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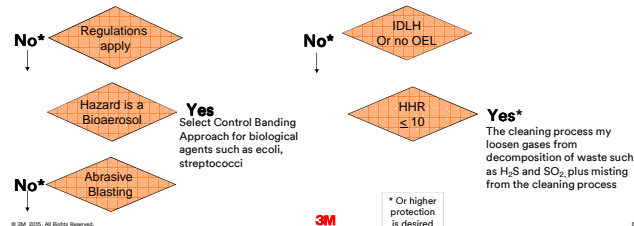
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Main Task/Activity: Confined space entry – sewer manholes (including sanitary, storm, and combined)

Sub Task/Activity: CLEARING / CLEANING (Removing debris; vacuum cleaning/pressure washing and non-chemical cleaning to remove internal debris).

Hazard Assessment concludes biological and chemical exposure is possible. Oxygen levels are sufficient.



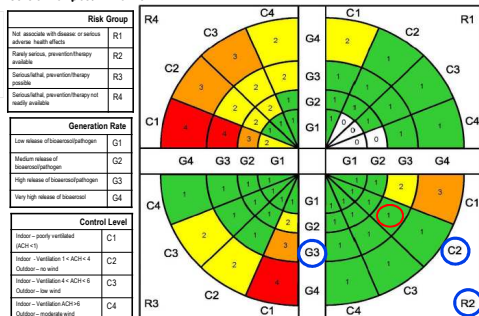
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General Workplace Environment

RG = 2 for ecoli, streptococci
GR = G3
CL = C2



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Main Task/Activity: Confined space entry – sewer manholes (including sanitary, storm, and combined)

Sub Task/Activity: CLEARING / CLEANING (Removing debris; vacuum cleaning/pressure washing and non-chemical cleaning to remove internal debris).

Hazard Assessment concludes biological and chemical exposure is possible. Oxygen levels are sufficient.

Respiratory Selection:

- The control banding method indicated, at a minimum, a respirator with an APF of 10 is indicated – with a particulate filter.
- For the chemical exposure, assuming H₂S and SO₂ exposure are less than 10 X the OEL an acid gas cartridge is recommended with an APF of 10 as the minimum requirement.
- Also, there may be odours from other gases, below the OEL, therefore OV protection will help with the smell.

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Hierarchy of Respiratory Protection - Figure 4

Acceptable level						Air-purifying options	APF	Atmosphere-supplying options
0	1	2	3	4	5			
					5	No air-purifying option available	10000	SCBA (pressure-demand) full-facepiece SCBA (pressure-demand) tight-fitting hood Multi-functional SCBA/airline
					4 to 5	Powered air-purifying full-facepiece Powered air-purifying helmet/hood with SWPP study	1000	Airline (continuous-flow) full-facepieces Airline (pressure-demand) full-facepiece Airline (continuous-flow) helmet/hood with SWPP study
					3 to 5	Powered air-purifying half-facepiece Air-purifying (negative-pressure) full-facepiece	50	Airline (pressure-demand) half-facepiece Airline (continuous-flow) half-facepiece
					2 to 5	Powered air-purifying loose-fitting facepiece/visor Powered air-purifying helmet/hood without SWPP study	25	Airline (continuous-flow) loose-fitting facepiece/visor Airline (continuous-flow) helmet/hood without SWPP study
					1 to 5	Air-purifying (negative-pressure) half-facepiece (including filtering facepieces)	10	No atmosphere-supplying option available
						No respiratory protection required	<1	No respiratory protection required

Notes:
(1) See Tables 1 and 2 for fit test pass/fail criteria for tight-fitting respirators.
(2) Fit testing is not required for loose-fitting respirators.

Task/Activity: IT cable installation in building ceiling space (e.g. asbestos)

The task of installing and pulling cable in and through ceiling spaces in City Hall is considered a "low risk" asbestos procedure (i.e., working in proximity to asbestos containing materials where the work activity does not disturb the asbestos-containing material). One of the reasons this task is considered "low risk" is because the work uses existing wall penetrations. This work **does not include drilling** or any other kind of penetrations into possible asbestos containing materials.



WorkSafe BC OHS Regulation, Part 6, Substance Specific Requirement.

Yes

6.29 Respiratory protection

(1) The employer must supply, and ensure that workers within a designated work area wear, respirators which are adequate for the anticipated level of exposure.
(2) The employer must ensure that a single use respirator is not used for protection against asbestos.
[Amended by B.C. Reg. 312/2010, effective February 1, 2011.]

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Task/Activity: IT cable installation in building ceiling space (eg. asbestos)

Asbestos (all types) maximum use concentration (in fibres per millilitre)	Minimum respirator choice for the specified maximum use concentration	
	Air-purifying respirators with P100 (HEPA) filters	Air-supplying respirators
Up to 1 f/mL	• Half-facepiece respirator • Loose-fitting facepiece or hood, powered (PAPR) • Full-facepiece respirator	—
Up to 5 f/mL	• Powered full-facepiece respirator (PAPR) • Hood or helmet facepiece, powered (PAPR), provided the manufacturer has demonstrated a protection factor of at least 1,000	—
Up to 10 f/mL	—	• Pressure-demand full-facepiece supplied-air respirator (SAR) • Continuous-flow full-facepiece supplied-air respirator (SAR)
Up to 100 f/mL	—	• Pressure-demand self-contained breathing apparatus (SCBA)
Up to 1,000 f/mL	—	—

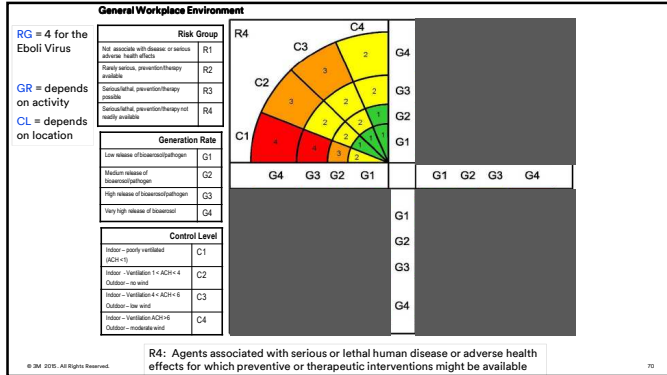
As the asbestos fibre concentration approaches the maximum use concentration for the respirator being used, workers must switch to a respirator with a higher protection factor.

Task/Activity: Ebola Preparedness for Police and Fire

Police and Fire Departments may be involved with patients if Ebola cases are identified in the region. The involvement may include emergency response to patients in the community. If police and fire within the hospital, they follow hospital protocol.

Respiratory protection: consult Z94.2 Control Banding, PHAC and BC Infection Control Guidance Documents.

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In Summary

- A Respiratory Protection Program (RPP) is indicated when a hazard is present and cannot be eliminated through engineering or administrative controls
- When a RPP is indicated, follow the requirements as outlined by WorkSafe BC in conjunction with CSA standards such as CSA Z94.4
- In CSA Z94.4-11 standard, follow the respirator selection process (figure 1) for a chemical exposure and the control banding for biological aerosol exposure.

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Thank You