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พระราชบัญญัติความปลอดภัย อาชีวอนามัย
และสภาพแวดล้อมในการทำงาน พ.ศ. ๒๕๕๔

หมวดที่ 1 บททั่วไป

มาตรา ๖ ให้นายจ้างมีหน้าที่จัดและดูแลสถานประกอบกิจการและลูกจ้างให้มีสภาพการทำงานและสภาพแวดล้อมในการทำงานที่ปลอดภัยและถูกสุขลักษณะ รวมทั้งส่งเสริมสนับสนุนการปฏิบัติงานของลูกจ้างมิให้ลูกจ้างได้รับอันตรายต่อชีวิต ร่างกาย จิตใจ และสุขภาพอนามัย

ให้ลูกจ้างมีหน้าที่ให้ความร่วมมือกับนายจ้างในการดำเนินการและส่งเสริมด้านความปลอดภัยอาชีวอนามัย และสภาพแวดล้อมในการทำงาน เพื่อให้เกิดความปลอดภัยแก่ลูกจ้างและสถานประกอบกิจการ

หมวด ๒ การบริหาร การจัดการ และการดำเนินการด้านความปลอดภัย อาชีวอนามัย และสภาพแวดล้อมในการทำงาน

มาตรา ๒๒ ให้นายจ้างจัดและดูแลให้ลูกจ้างสวมใส่อุปกรณ์คุ้มครองความปลอดภัยส่วนบุคคลที่ได้มาตรฐาน ตามที่อธิบดีประกาศกำหนด

ลูกจ้างมีหน้าที่สวมใส่อุปกรณ์คุ้มครองความปลอดภัยส่วนบุคคลและดูแลรักษาอุปกรณ์ตามวรรคหนึ่งให้สามารถใช้งานได้ตามสภาพและลักษณะของงานตลอดระยะเวลาทำงาน

ในกรณีที่ลูกจ้างไม่สวมใส่อุปกรณ์ดังกล่าว ให้นายจ้างสั่งให้ลูกจ้างหยุดการทำงานนั้นจนกว่าลูกจ้างจะสวมใส่อุปกรณ์ดังกล่าว

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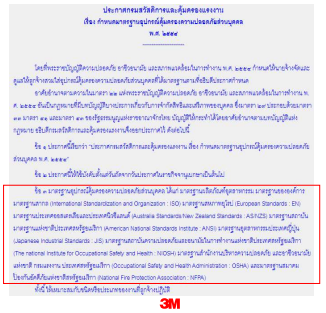
ประกาศกรมสวัสดิการและคุ้มครองแรงงาน
เรื่อง กำหนดมาตรฐานอุปกรณ์คุ้มครองความปลอดภัยส่วนบุคคล พ.ศ. 2554



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Why use protective apparel?

Hazards and effects

Chemicals are one of the biggest hazards to the skin.

Burns | Irritant Contact Dermatitis | Urticaria | Allergic Contact Dermatitis

They can cause a variety of skin conditions.

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Technical overview – standards & tests

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Protection types

Category	Protection Type	3M Products
Protection Levels Chemical Protection CE Category III	❶ **Gas Tight** – Type 1 suits offer a high level of protection against gases, liquids and solid particles.	
	❷ **Non-Gas Tight** - Type 2 suits offer some protection against gases, but unlike Type 1, they are not completely "gas-tight".	
	❸ **Jet Tight** - Type 3 suits are used where there is exposure to liquids under pressure.	3M 4570
	❹ **Spray Tight** - Type 4 suits offer protection against liquid sprays and are used for higher volume, longer duration or more hazardous liquid exposures than Type 6.	3M 4565
	❺ **Particle Protection** – As the name suggests, products certified to Type 5 are generally suitable for dust applications.	3M 4510, 4515, 4520, 4530, 4532+, 4535, 4540+, 4545, 4565, 4570 50198 (AAD)
	❻ **Limited Splash** - Type 6 certified products offer low-level protection against small splashes and light mists.	
CE Category I	**CE Simple** – non-certified.	3M 4500 & 4505, coats & accessories 50425 (AAD)

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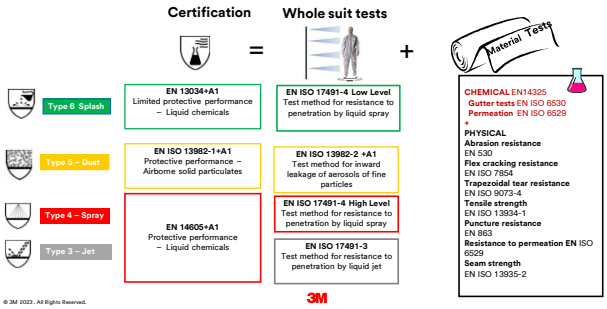
Chemical protective clothing



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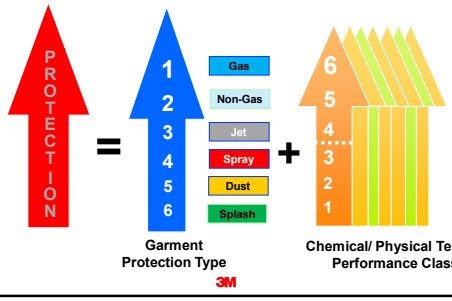
Protection types and performance classes



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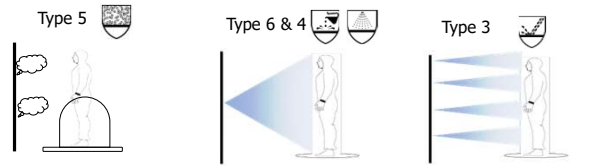
Whole suit testing



Whole suit exposed to **a dry aerosol** of sodium chloride of **0.6µm**, while wearer performs a **sequence of movements** (standing, walking, squatting). Passes when the averaged total inward leakage is **less than 30%.**

Whole suit exposed to an **intense spray** of a water-based liquid. 4.5 or 1.9 litres is sprayed for **1 minute** while **wearer gently moves.** Passes when the stained area inside is **less than 3 times** the size of a calibration stain.

Whole suit exposed to a series of **short jets** of a water-based liquid at a distance of **1m** and with a pressure of **3 bar.** Passes when the stained area inside is **less than 3 times** the size of a calibration stain(produced by 0.02ml of test liquid).

The type does not automatically indicate the level of chemical resistance

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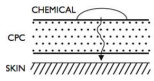
Chemical resistance

3 measures overview

Test methods to measure permeation, penetration and repellency are part of protective coveralls standards and depending on the type of coverall are mandatory.

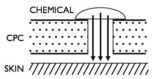
PERMEATION

PERMEATION is a process by which the chemical moves through the CPC material on a molecular (non visible) level.



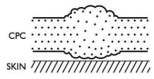
PENETRATION

PENETRATION is the flow of chemical through stitched seams, pinholes, or other imperfections in the CPC material on a nonmolecular level.



REPELLENCY

DEGRADATION is a deleterious change (e.g. swelling) in one or more physical properties of the CPC material caused by the chemical.



Images courtesy of the guide to Chemical Protective Clothing by K. Forsberg

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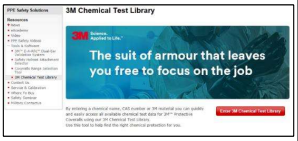
Chemical test results?...3M Chemical Test Library

The extensive list of chemical testing, both permeation and penetration and repellence for EN and ASTM can be found online in the 3M Chemical Test Library.

Other materials detailing performance are:

- User Instructions
- Declarations of Conformity and CE Certification



Comparator | 3M Chemical Test Library (3m-chemical-test-library.com)

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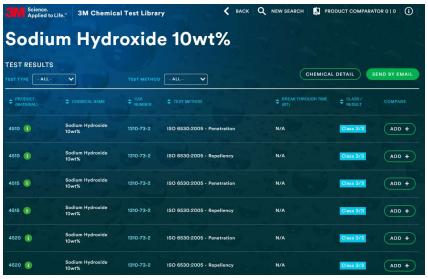
3M Chemical Test Library



Comparator | 3M Chemical Test Library (3m-chemical-test-library.com)

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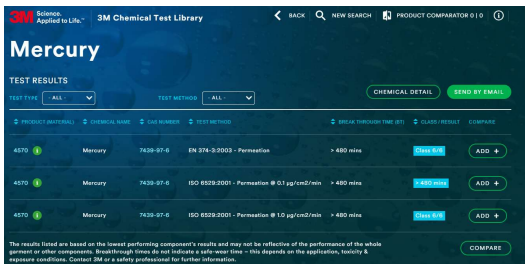
Chemical test library



Comparator | 3M Chemical Test Library (3m-chemical-test-library.com)

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Testing results on our TDS

Below shows a typical Technical Data Sheet and how the tests, standards and results are displayed

Test	Standard/Test Method	Class/ Result
Abrasion resistance (visual assessment)	EN 530:2010	Class 1
Flex cracking (visual assessment)	ISO 7854:1995	Class 5
Tear resistance	ISO 9073-4 :1997	Class 1
Tensile strength	EN ISO 13934-1:1999	Class 1
Puncture resistance	EN 863:1995	Class 1
Resistance to ignition	EN 13274-4:2001	Pass
Seam strength	EN ISO 13935-2:1999	Class 2
Repellency to liquids – 30% H_2SO_4	EN ISO 6530:2005	Class 3 of 3

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Optional standards

Protection against micro-organism hazards	**EN 14126** Protective Performance – Infective Agents
Protection against Nuclear Particles	**EN 1073-2** Protective Clothing – Particulate Radioactive Contamination
Anti-static	**EN 1149** Protective Clothing – Electrostatic Properties – Surface Resistivity
Protection against Heat and Flame	**ISO 14116** Protective Clothing – Heat and Flame

Section 8.4 of standard states –
8.4.1 Garments conforming to this International Standard, which do not confirm to any other standard for heat and flame protection shall not be marked with a graphical symbol or pictogram to depict heat and / or flame protection

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Technical overview – materials & construction

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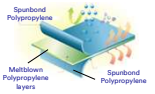
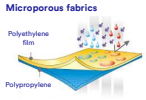
Common coverall materials

SMS Fabrics – Spunbond Meltblown Spunbond



- The Spunbond layers are non-woven **cloth-like** polypropylene and help **improve robustness**.
- The Meltbolwn layer(s) are an intricate non-woven **web of microfibers** that **filter out** many water-based chemicals and dry particulates.
- Typical SMS fabrics offer high levels of breathability and comfort.
- SMS fabrics do not offer a very good barrier to chemicals, but treatment can be added to improve splash protection (e.g 3M 4532+).
- SMS fabrics are sometimes used in combination with Microporous materials to enhance comfort (e.g 3M 4540+)

Microporous fabrics



- Microporous materials consist of a **polyethylene film** laminated onto a non-woven **polypropylene base**. They offer tensile strength, low lint and an effective liquid and particle barrier.
- Pores allow water vapour transmission out but lower levels of breathability vs SMS.
- The size of the pores can be altered on the film to create higher or lower breathability. The weight of the base fabric can vary a lot from one product to another.

N.B. Nonwoven fabrics are made from long fibers, bonded together by chemical, mechanical, heat or solvent treatment (as opposed to woven fabrics made from woven or knitted threads).

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Protective Apparel portfolio

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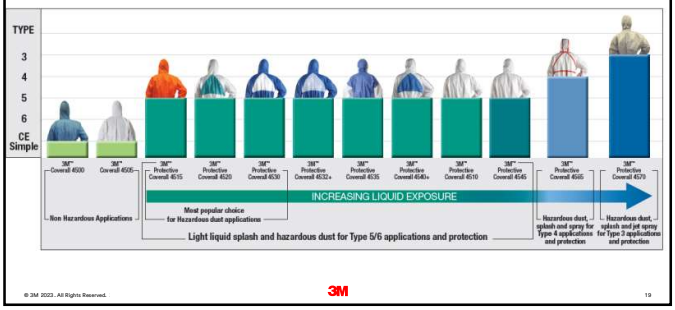
Full range of protection



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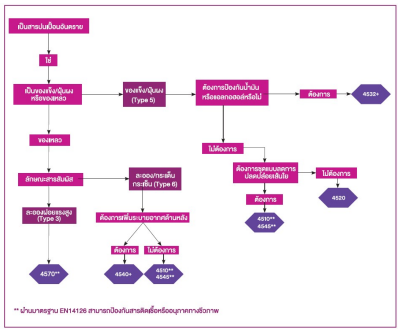
Protective Coverall selection



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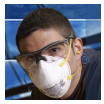
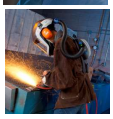
What is a Respirator?

Equipment worn by an individual in the workplace to help protect them from breathing airborne hazards.









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What is NOT a Respirator






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Surgical Mask vs. Respirator

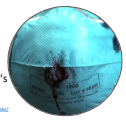
Masks

Help protect the work environment (including patients) from substances expelled by the wearer.


Surgical Masks
Reduce the chance of blood/ other fluids entering the wearer's mouth and nose.

Respirators

Intended to help protect the wearer from substances (airborne particles) in the work environment.

Surgical Respirators/N95s
Also reduces the chance of blood and other bodily fluids entering the wearer's mouth and nose.

https://worksensafety.3m.com/differences-disposable-respirators-surgical-masks/

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Filtering of particulate respirator

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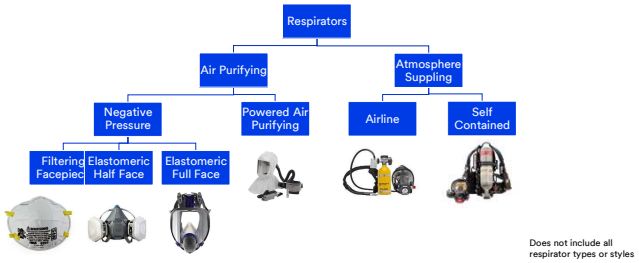
Respirators – Many Options for Various Applications



Does not include all respirator types or styles

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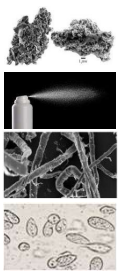
Respiratory Hazards – Types

- Oxygen Deficiency
- Gaseous
  - Gases
  - Vapors

- Particulates
  - Dusts
  - Mists
  - Fumes
  - Fibers
  - Micro-organisms
  - Smoke



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Particle Filtration

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Particulate Hazards

Dust
- Mechanical breakage from grinding, sanding, sawing, etc.

Fumes
- Liquid metal evaporates, cools in air & forms small, solid particles

Biologicals
- Bacteria, protozoa, fungi, algae and viruses

Mist
- Airborne droplets of a substance that is a liquid at room temperature and pressure

Fibers
- Solid particles with length several times as great as their diameter

Smoke
- Solid or liquid particles due to incomplete combustion

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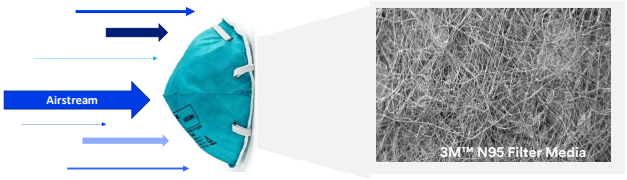
Filtering Facepiece Respirator (FFR)

- Filter fibers are randomly oriented
- Multiple layers of fibers
- Respirator is designed to form a seal on the wearer's face
- Air passes through the filter
- Particles impact the filter fibers
- Very small particles are captured by diffusion



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Non-Powered Air-Purifying Particulate Respirators (42 CFR 84 Subpart K) : TC-84A-XXX approvals

Minimum Filter Efficiency	Resistance to Oil		
	N (No Oil)	R (Oil Resistant)	P (Oil Proof)
95%	N95	R95	P95
99%	N99	R99	P99
100% (99.97%)	N100	R100	P100

N = Not Resistant to Oil Mist

R = Resistant to Oil Mist

P = Oil Mist Proof

HEPA or 100 level filters required by OSHA for lead, asbestos, cadmium, 4,4'-Methylene dianiline (MDA), arsenic

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OUS Particulate Filters

Europe (both solids and liquids) Australia (warn if oil degradation)	China KN (solids) KP (oils) Eg. KN90, KP100	Japan (Solids/Liquids) e.g. RS1, RL3	Korea
P1 (80%)	90 (90%)	1 (80%)	1 (80%)
P2 (94%)	95 (95%)	2 (95%)	2 (94%)
P3 (99.95%)	100 (99.97%)	3 (99.9%)	Special (99.95 %)

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Gas and Vapors Filtration

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Gas & Vapor

Gas

- Fluids that have neither independent shape nor volume and tend to expand indefinitely
- Exposures: Nitrogen, chlorine, carbon monoxide
- Operations: Inerting, water treatment, engine exhaust

Vapor

- Gaseous form of materials which are liquids or solids at room temperature and pressure
- Exposures: Toluene, MEK, mercury
- Operations: Vapor degreasing, painting

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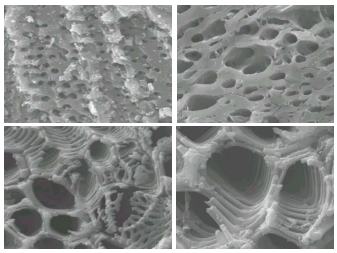
Activated Carbon

- Carbon derived from coconut shells or coal
- Crushed and conditioned at high temperatures, low oxygen levels
- Creates extensive network of internal pores and large internal surface areas
- Not for filtering particles



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Organic Vapor (OV) Cartridges

- Organic liquids (e.g. solvents, gasoline) evaporate to give off organic vapors
- Vapors adsorb (condense) inside carbon pores and held by weak forces (Van der Waals)

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Other Chemical Cartridges

- Cartridges other than OV have chemically "treated" carbon to react with specific gases vapors
- Approved for specific chemicals only as listed on cartridge label
  - "Acid gas" or "Multigas" not always the same chemicals
- Color coding of label required by NIOSH same for all manufacturers


Acid Gas


OV & Acid Gas


Ammonia Methylamine


Formaldehyde/OV


Mercury Vapor


Multi-Gas

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US OSHA Assigned Protection Factors

Increasing Protection Factor

APF 1000	Hoods, Helmets and Full Faces – PAPR or Supplied Air Mode *	
APF 50	Full Face w/ Quantitative Fit or ½ Face SA mode	
APF 25	PAPR / SA Loose Fitting	
APF 10	Half Face	

* For hoods and helmets the employer must have evidence provided by the respirator mfg. that testing of these respirators demonstrates performance at a level of protection of 1,000 or greater to receive an APF of 1000.

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Respirator Selection Guide

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3M Can Help

We have respirators that can help protect against chemicals as well as particulate hazards, including oily mists. We can also help you with your selection process:

The 3M Respirator Selection Guide provides respirator selection criteria for particulate hazards and a wide range of chemical compounds.

3M RESPIRATOR SELECTION GUIDE (PDF, 433K)

Our free 3M™ Select and Service Life Software can help make selecting the appropriate respirators faster and easier. Just enter contaminants and their concentrations and the software analyzes the data and profiles a record of your choices. The software can also help you estimate the service life of 3M™ Respirator Cartridges, which aid in maintaining you OSHA-required cartridge change schedule for gas and vapor cartridges.

3M Select and Service Life Software

For more information about respirator selection, go to our website or call 3M Technical Service at **1-800-243-4630.**

Respirator Selection | Respiratory Protection | 3M - US

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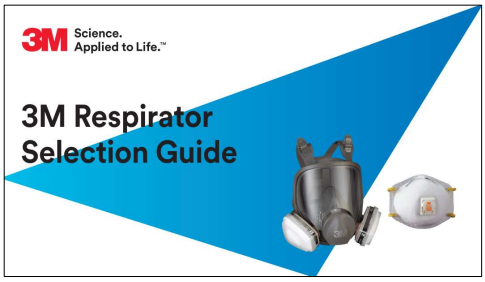
Respirator Selection Guide



Respirator Selection | Respiratory Protection | 3M - US

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Respirator Selection Guide

Contaminant	CAS #	Synonym	Skin?	Respirator	Comments
Sodium borate, decahydrate	1303-96-4	Borascu; Borates, tetrasodium salts, decahydrate; Borax; Borocin; Disodium diborate decahydrate; Disodium tetraborate decahydrate; Sodium pyroborate decahydrate; Sodium tetraborate, decahydrate		N95	
Sodium borate, pentahydrate	12179-04-3	Borates, tetrasodium salts, pentahydrate; Boric acid, pentahydrate; Boron sodium oxide, pentahydrate; Mule team borascu; Sodium tetraborate pentahydrate		N95	
Sodium chloroacetate	3926-62-3	Chloroacetic acid, sodium salt; Monoxone; Sodium monochloroacetate		N95	
Sodium fluoroacetate	62-74-8	1080, SFA, Sodium monofluoroacetate	Y	N95	
Sodium hydroxide	1310-73-2	Caustic soda, Lye, Soda lye		N95	
Sodium hypochlorite	7681-52-9	Hypochlorous acid, sodium salt; Sodium oxychloride		N95	Chlorine may also be present
Sodium metabisulfite	7681-57-4	Sodium pyrosulfite		AG/N95	N95 alone may be suitable if irritation eliminated
Starch	9005-25-8	Corn starch		N95	

Respirator Selection | Respiratory Protection | 3M - US

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Respirator Codes and Descriptions

(F)	Full Facepiece (with appropriate cartridges and filters)
AG	Acid Gas Respirator
AM	Ammonia/Methylamine Respirator
FORM	Formaldehyde Respirator
HF	Hydrogen Fluoride Respirator
Hg	Mercury Vapor Respirator
MG	Multi-gas/Vapor Respirator
N100	N100 Particulate Respirator
N95	N95 Particulate Respirator
OV	Organic Vapor Respirator
OZ	Ozone Respirator
P100	P100 Particulate Respirator
P95	P95 Particulate Respirator
R95	R95 Particulate Respirator
SA	Supplied Air Respirator
SA(F)	Supplied air respirator with full facepiece, helmet, hood or loose fitting facepiece

Note: Respirator abbreviations may be combined. For example, (F)OV/AG/P95 is a full facepiece respirator with an organic vapor/acid gas cartridge and a P95 particulate filter.

3M also offers 3M™ Select Software and 3M™ Service Life Software. Select Software helps you select the most appropriate respirator. Service Life Software estimates service life of 3M gas/vapor cartridges. Both programs are simple, accurate and give printable reports. 3M.com/sls

Respirator Selection | Respiratory Protection | 3M - US

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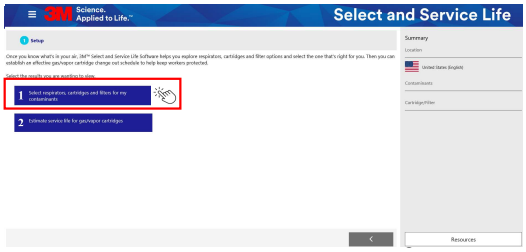
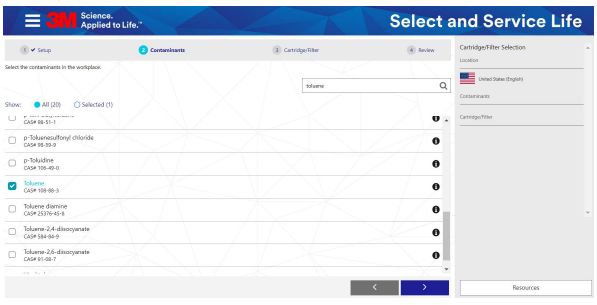
Select and Service life – 3M Software



https://sls.3m.com/

44

Cartridge/Filter Selection

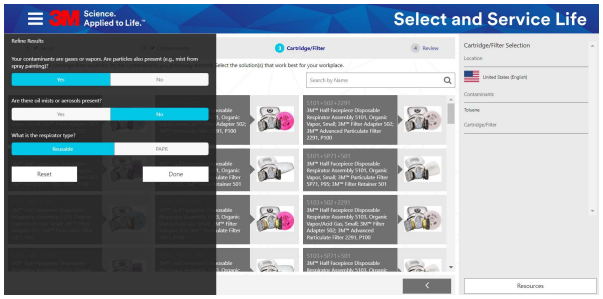


3M

https://sls.3m.com/

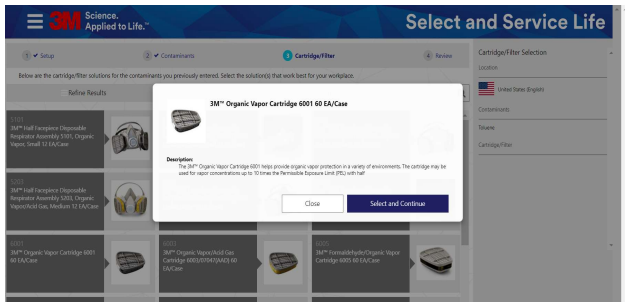
45

Cartridge/Filter Selection



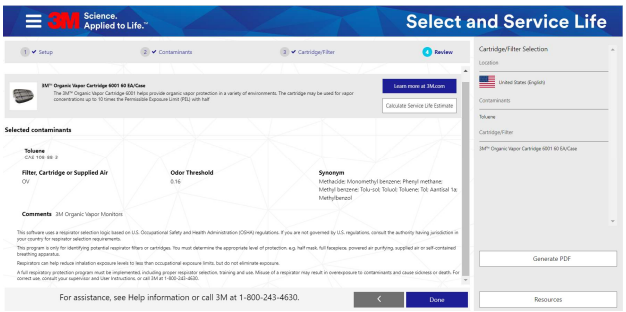
46

Cartridge/Filter Selection



47

Cartridge/Filter Selection



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Estimate Service Life for Respirator Cartridge

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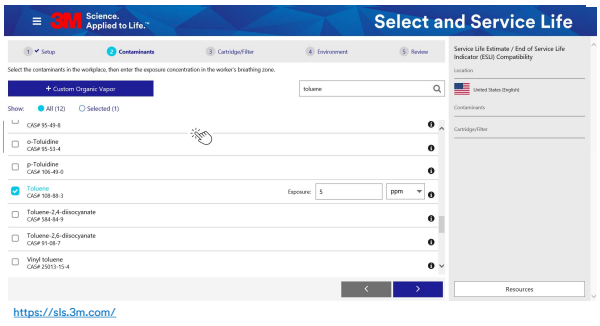
Service Life Calculation



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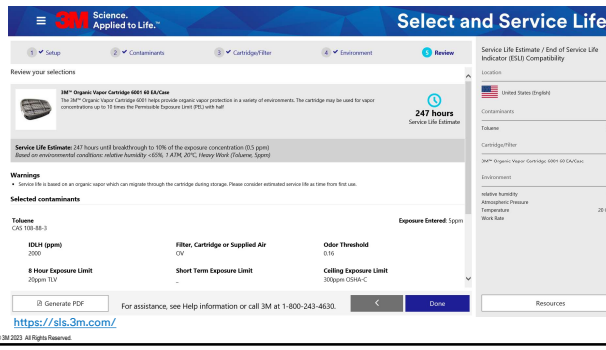
Service Life Calculation



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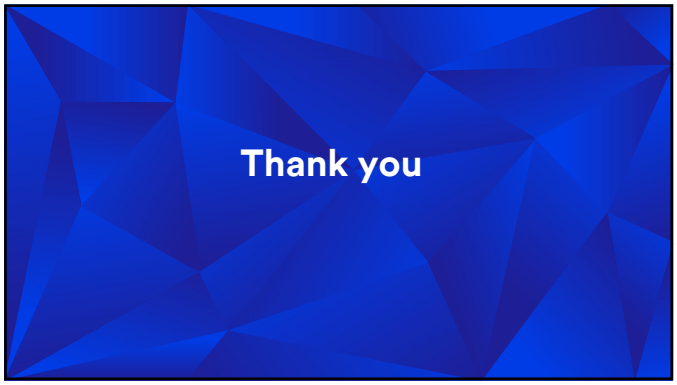

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