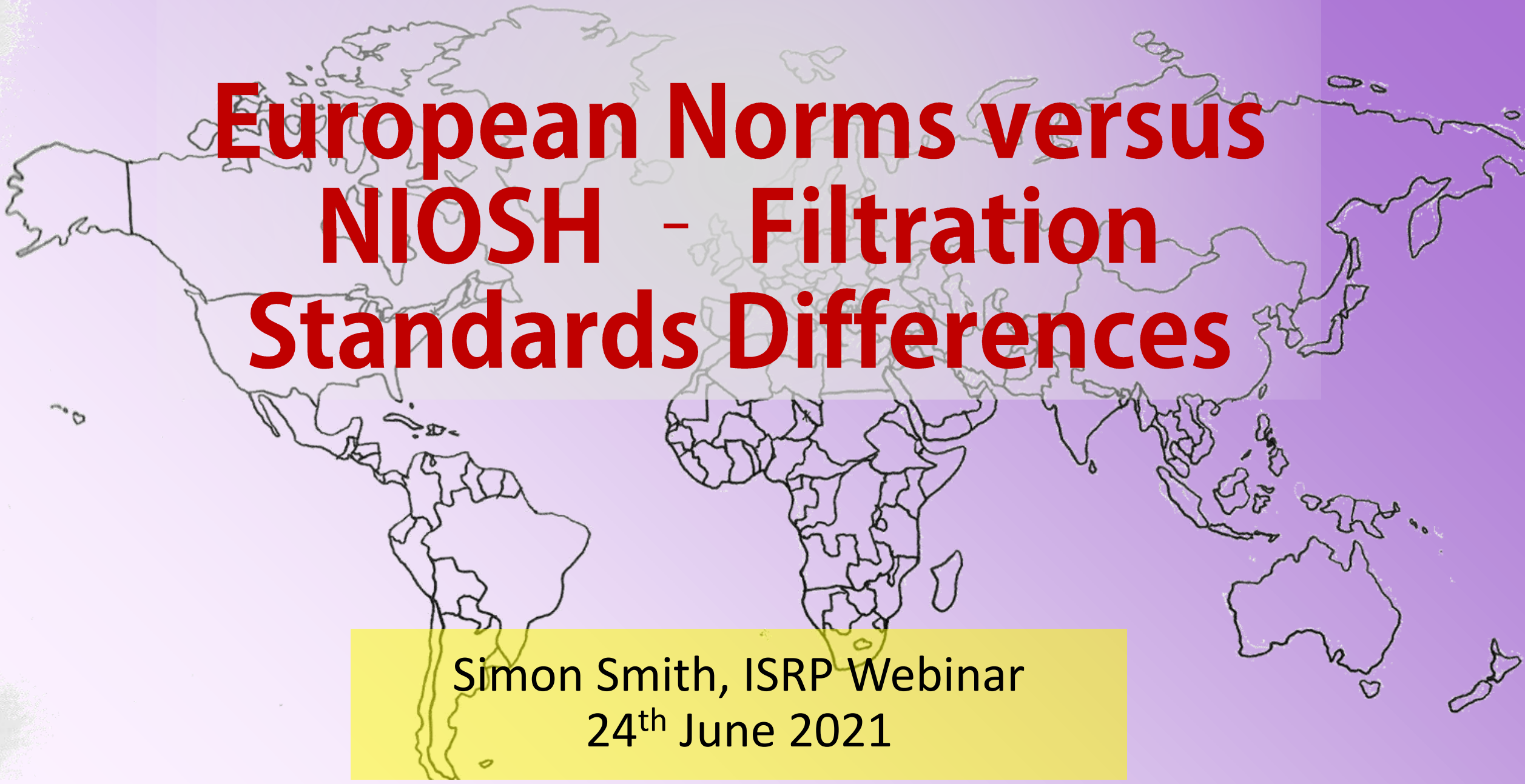


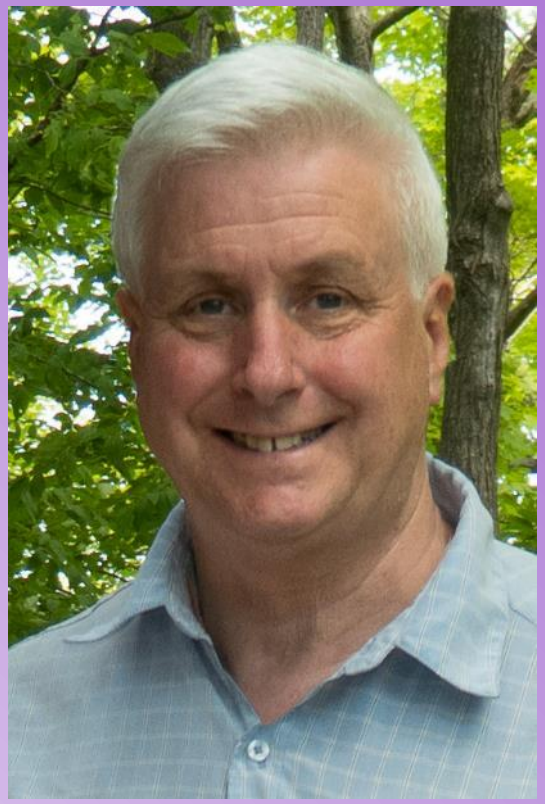
European Norms versus NIOSH - Filtration Standards Differences

Simon Smith, ISRP Webinar

24th June 2021

Simon Smith

- Retired from a career in respirator filter design and testing (Racal/3M)
  - World-wide industrial, military, first responder, healthcare applications
- Contributing to standards development for
  - Canadian Standards Association
  - International Organization for Standardization
  - Institut de recherche Robert Sauvé en santé et en sécurité du travail (Québec)
- Organisational Involvement
  - International Society for Respiratory Protection
  - American Industrial Hygiene Association
  - US National Academies of Sciences, Engineering and Medicine



Contents

- Structure of the Certification Systems and Standards documents
- General aspects
- Non-Powered Respirator filters
  - Particle Filters
  - Gas/Vapour Filters
- Powered Respirator filters
- Escape Devices

"Cautions and Limitations"

- Performance requirements for filters are the focus of this presentation. Various aspects of standards are discussed, but due to time limitations, the content here is far from a complete nor authoritative reference, and the primary standards documents should be consulted

- Requirements for selection, use and maintenance of respirators are covered by different standards or regulations than those addressing performance – for example:
- EN 529 and national regulations in Europe
- OSHA Regulation 1910.134 in USA
- CSA Z94.4 in Canada

Administrative Authorities

Overall Equipment Certification Requirements

Regulation (EU) 2016/425 of the European Parliament and of the Council

Standards Development and Maintenance

CEN:

European Committee for Standardization

CEN, the European Committee for Standardization, an association of the national standardization bodies of 34 European countries.

Recognised in European Union, European Free Trade Association, other countries in Europe plus Russia and South Africa

Both Overall Equipment Certification Requirements and Standards Development and Maintenance

United States
Occupational Health and Safety Act 29 USC 671

NIOSH:

National Institute for Occupational Safety and Health

NIOSH is a branch of the US Centers for Disease Control, itself part of the US Department of Health and Human Services

Recognised in USA, Canada, parts of Latin America and elements appear in other standards

EN Structure of Standards and Certification

Standards Development

Standards Structure Organised by CEN

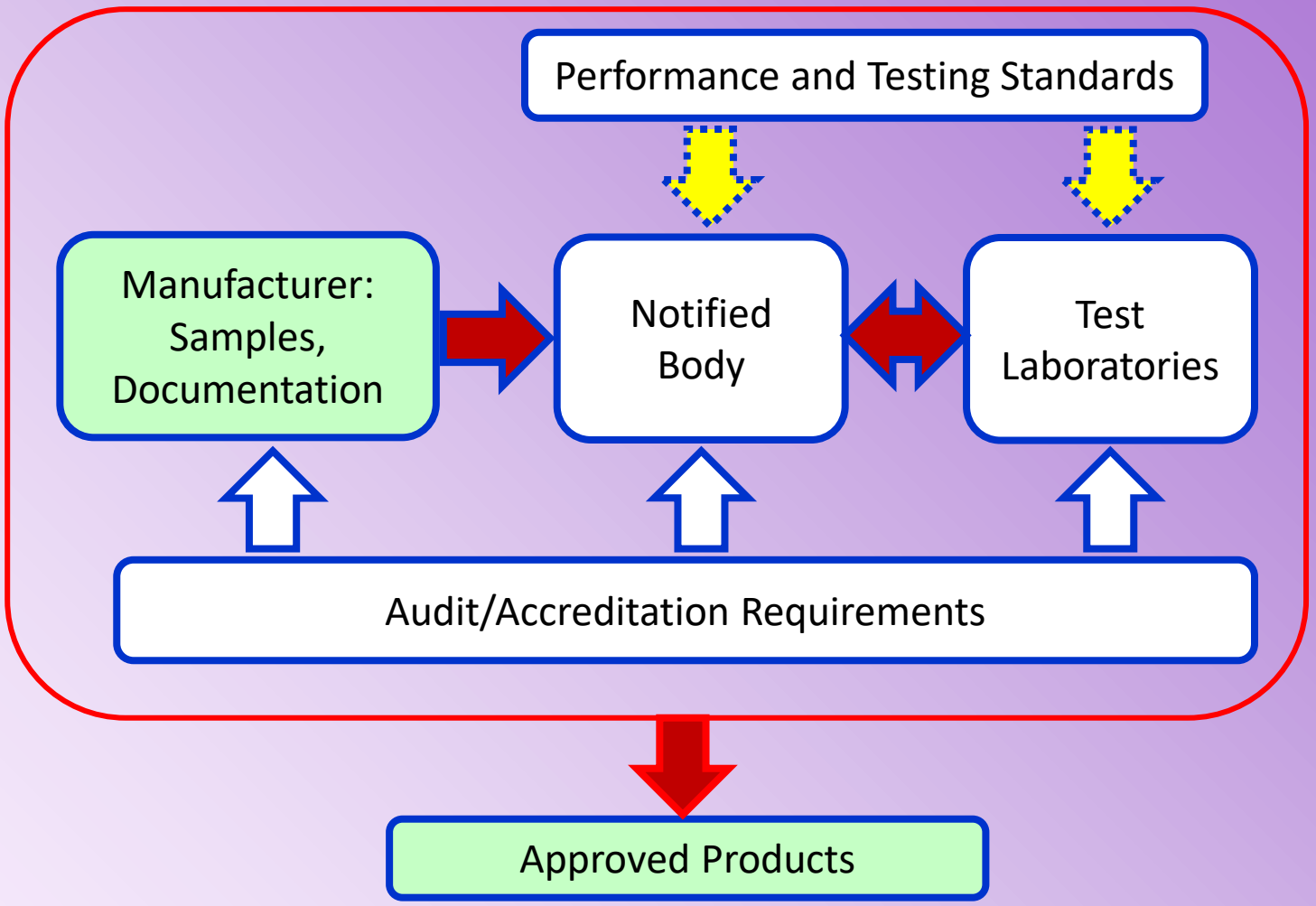
Standards Committee
Input from manufacturers, users, test labs, regulators

Generally a regular update schedule

Product approvals conducted through independent Notified Bodies

Product Approval Overview

Requirements guided by Regulation 2016/425 of the European Parliament



NIOSH Structure of Standards and Certification

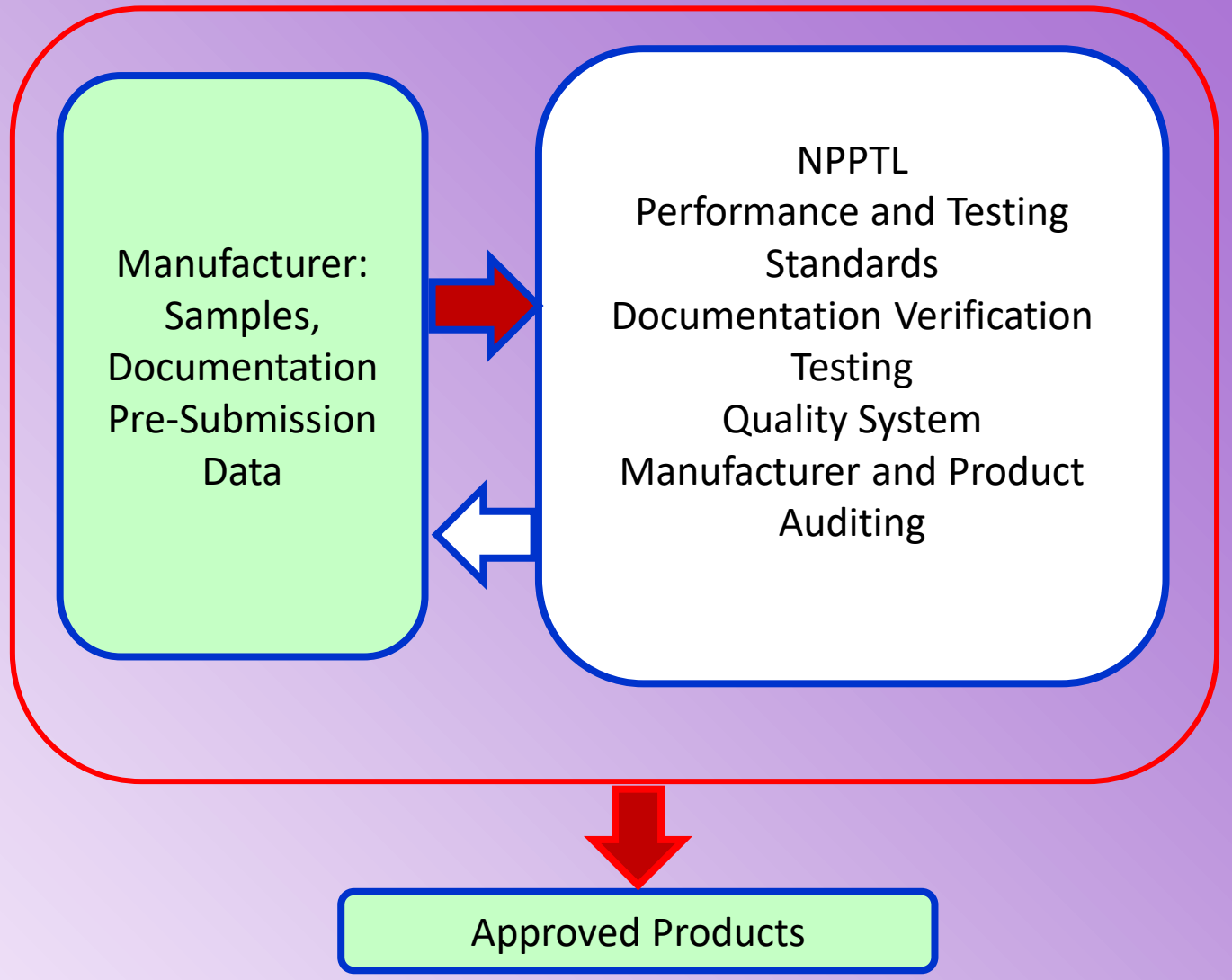
Responsibility

National Institute for Occupational Safety and Health

- Sets standards
- Conducts Approvals Testing
- Reviews designs and mfr quality systems
- Issues Approvals
- Conducts product and manufacturer audits
- Maintains Certified Equipment List
- Conducts extensive health and safety research
- Strong interaction with Centers for Disease Control

Respirator certification undertaken by the
National Personal Protective Technologies Laboratory

Product Approval Overview



Comparison of Systems

	Europe	NIOSH
Positive Features	Standards development input from multiple sources and generally regular update schedule Manufacturer has “market” choice of Notified Bodies to conduct certification	Single “one-stop” agency for standards, approvals and testing, manufacturer and product audits Requires pre-submission testing Maintains Certified Equipment List
But…	No central list of approved products Legislative changes may force re-certification	Requirements are part in legislation, part out, which affects consistency and availability of information Updating is a long process with more limited public input than Europe

REGULATION (EU) 2016/425 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 9 March 2016

on personal protective equipment and repealing Council Directive 89/686/EEC

(Text with EEA relevance)

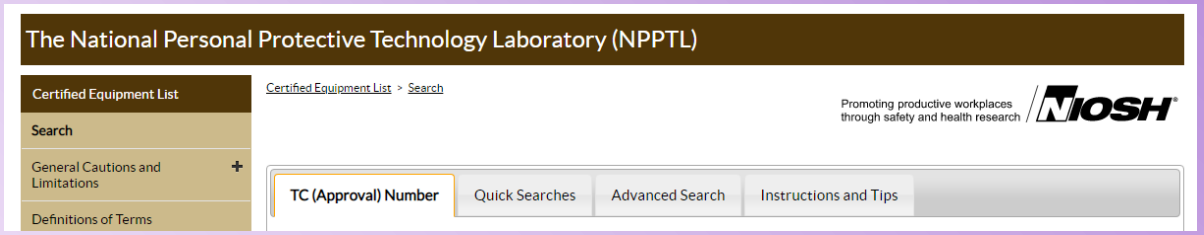
THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty on the Functioning of the European Union, and in particular Article 114 thereof,

Having regard to the proposal from the European Commission,

After transmission of the draft legislative act to the national parliaments,

Having regard to the opinion of the European Economic and Social Committee ([1]),



Organisation of Respirator Performance Standards

Requirements

Test Methods

Europe:
Separate Documents by Respirator Type/Components

European Norms:

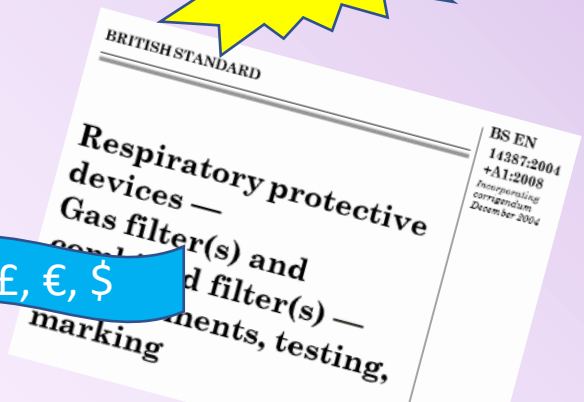
- EN 132 Terminology
- EN 136 Elastomeric Full-Facepiece
- EN 140 Elastomeric Half-Facepiece
- EN 143 Particle Filters
- EN 148 Connectors
- EN 149 Filtering Facepieces
- EN 403 Escape from Fire Devices
- EN 404 Filter Self-Rescuer
- EN 405 Valved filtering half masks
- EN 12941 Loose-Fitting PAPR
- EN 12942 Tight-Fitting PAPR
- EN 14387 Gas & Combined filters

£, €, $

NIOSH:
Single Document for All Requirements + Extras

- NIOSH 42 CFR 84
- Letters to Manufacturers
- CBRN Standards
- Test Selection Guidance

Free!



Europe:
Multi-part standard covering common test protocols

EN 13274:

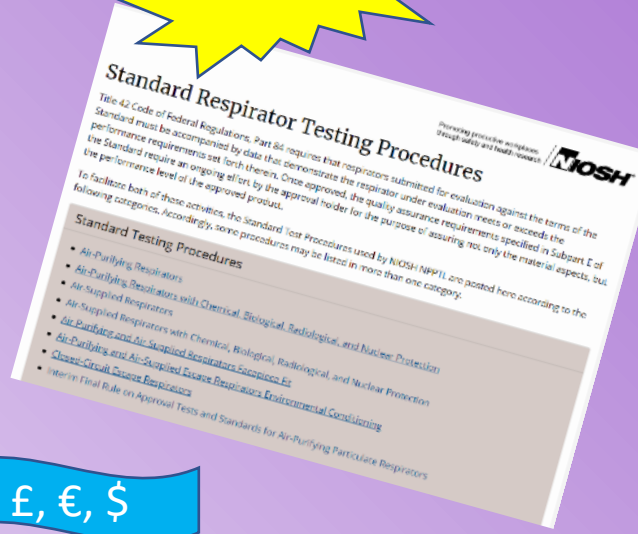
- Part 1: Inward leakage and total inward leakage
- Part 2: Practical performance
- Part 3: Breathing resistance
- Part 4: Flame tests
- Part 5: Climatic conditions
- Part 6: CO_2 in inhalation air
- Part 7: Particle filter penetration
- Part 8: Dolomite dust clogging

£, €, $

NIOSH:
Standard Test Protocols

Laboratory test operation instructions published on NIOSH web pages

Free!



Terminology – some key terms are used differently

Term	Europe	NIOSH
Filter	Air-purifying element for particulate and/or gas/vapour contaminants	Air-purifying element for particulate contaminants only
Cartridge	Term not used in standards (though may be colloquially applied)	Air-purifying element with specific gas/vapour capacity level, limited maximum exposure concentration
Canister	Any gas/vapour or combined gas/vapour and particle air-purifying element	Air-purifying element with specific gas/vapour capacity level, higher than cartridge, permitted for use up to IDLH concentrations
Type	Identifies which kind of airborne contaminant is filtered	Identifies which kind of airborne contaminant is filtered and efficiency/capacity levels
Class	Identifies the efficiency or capacity of certain types of filter (numbers used, e.g. P3, A2)	For filters, term is only used only to distinguish PAPR particle filters

Plus:

Gas Codes	Letters used for main types (A, B, E, K…) and chemical formulae for others	Letter combinations (usually initials) used for test agent except OV ≡ Organic Vapour

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Cartridge	Term not used in standards (tho	Air-purifying element with specific gas/vapour capaci ure concer
Canister	Any part our and	Air-pur vapour capaci rmitted for use
Type	Iden caminant is filt	Identif minant is filtered
Class	Iden f certain type , A2)	For filt inguish PAPR p

"A1 Canister"

https://securabc.com/

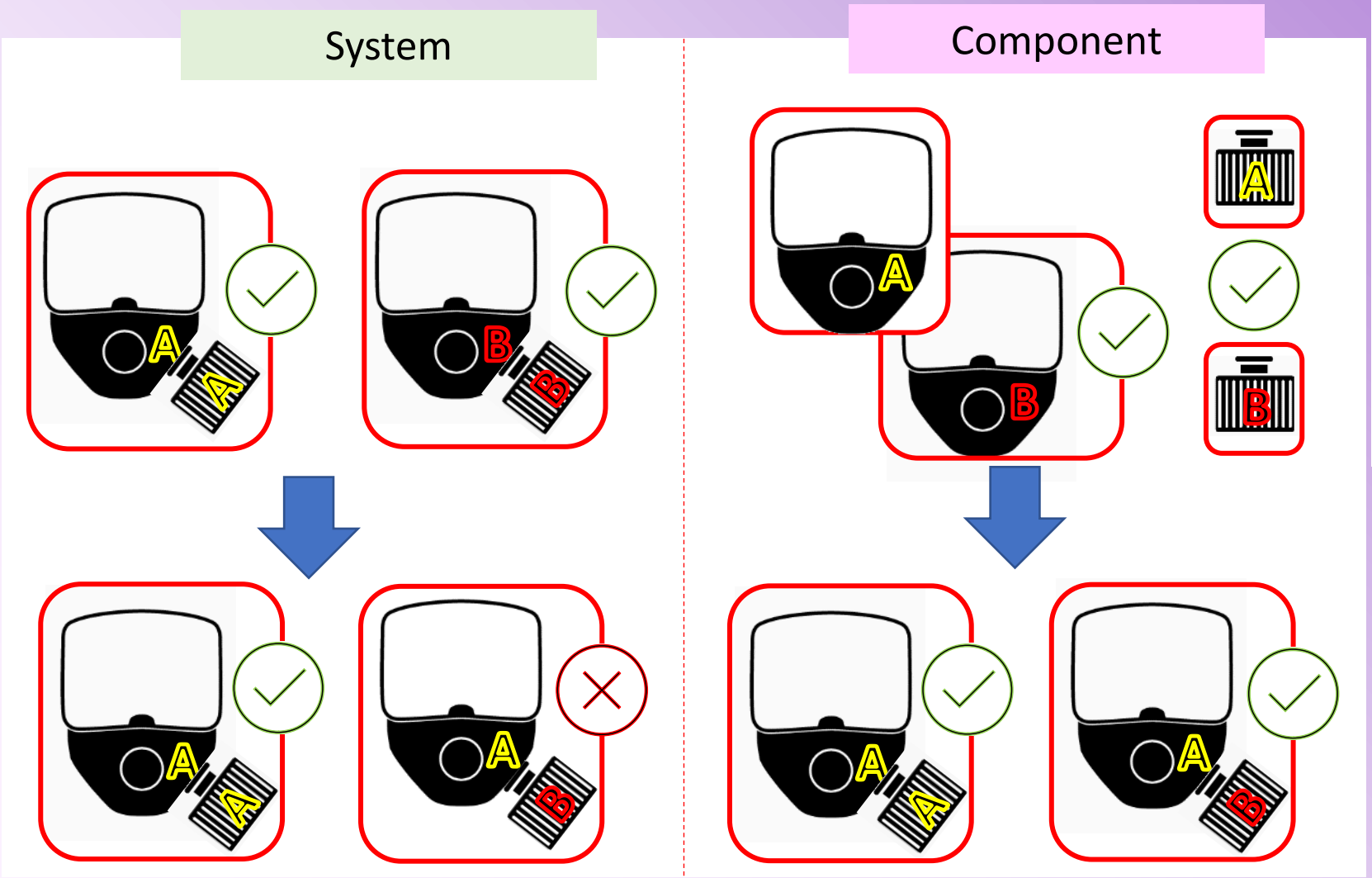
"OV Cartridge"

https://www.honeywellstore.com/

Plus:

Gas Codes	Letters used for main types (A, B, E, K…) and chemical formulae for others	Letter combinations (usually initials) used for test agent except OV ≡ Organic Vapour

“System” versus “Component” Certification



Respirator Type	Europe	NIOSH
Filtering facepieces	“System”	“System”
Negative Pressure Facepieces	Component	System
Negative Pressure Filters	Component	
Powered air-purifying respirators	System	System
Escape Devices	System	System

European Standardized Connector

To enable component interchange, EN 148 Part 1 describes standard connectors for filters and facepieces. Unique connections are also acceptable

Marking – Labels and Colour Codes

Europe

- Identification of manufacturer, particle filtration and gas/vapour type plus pictograms indicating other basic information
- Colour codes for gas type and particle filtration, combined as stripes on filter body where there is capability for more than one type
- Particle filtration marked with a separate white stripe

NIOSH

- Identification of manufacturer, particle filtration and gas/vapour type plus cautions and limitations, simplified for cartridges
- Colour codes for gas type and particle filtration, but combinations have their own colour
- P100 particle filtration has magenta stripe
- Reference to ANSI Z88.7 (currently 2010)

https://int.rsdelivers.com/

Europe

https://www.respiratormaskprotection.com/

NIOSH

Other Filter-Related Requirements

	Europe	NIOSH
Materials and Design	• Sufficiently robust/durable for service • No sharp edges or burrs • Function in any orientation • Withstands internal corrosion by media	• Sufficiently robust/durable for service • Non-irritating materials for skin contact • No hazard to the wearer • Overall device: ready cleaning, inspection repair, component replacement
Mass	• Filter(s) on half-facepiece ≤300 g • Filter(s) on full-facepiece ≤500 g	• No limit quantified
Connections	• Robust and leak-tight • Unique or standardized connectors	• No requirements for filters included
Multiple filters/use in parallel	• If possible to connect a filter singly, full requirements apply • Test airflows can be pro-rated for testing if a specified resistance range of sample set is met	• Where two or more cartridges are used in parallel, their resistance to airflow shall be essentially equal • Test airflows pro-rated for multiple filters
Packaging/ Container	• Filters for sale packaged to protected from damage or contamination	• Respirators require a marked, durable container for storage during use

Particle Filters

https://www.3m.com/

https://www.screwfix.ie/

https://www.respiratorshop.co.uk/

https://www.midlandtool.com/

https://www.tenaquip.com/

Particle Filter Pre-Conditioning Methods

Pre-Conditioning Type		European Norms		NIOSH
		Filtering Facepieces	Reusable Filters	N-Series (Only) Filtering Facepiece & Re-Usable
Simulated Wear (SW)	Conditions	Mount on dummy head, cyclic airflow (25/min, 2 l), 37± 2°C, saturated humidity		
Environmental (EP)	Package Status	Inside Packaging	Inside Packaging	Unpackaged
	Conditions	70 ± 3°C/Dry for 24 h then -30 ± 3°C/Dry for 24 h	70 ± 3°C/Dry for 24 h then -30 ± 3°C/Dry for 24 h	38 ± 2.5°C, 85 ± 5%RH for 25 h
	Other	Rest of 4 h in between and afterwards	Rest of 4 h in between and afterwards	Test within 10 h
Physical (PP)	Conditions	2 cm Raise and Drop, constrained in tray, 100 cycles/minute	2 cm Raise and Drop, constrained in tray, 100 cycles/minute	
	Duration	20 minutes	20 minutes	

Aerosol Penetration/Resistance Test Conditions

	Non-Oil Aerosol Test		Oil Aerosol Test		Unit
	EN	NIOSH	EN	NIOSH	
Test Agent	Sodium Chloride		Hot-nebulized Paraffin Oil	Cold-nebulized, neutralized Di-Octyl Phthalate	
Number of Samples FFP	3-SW, 6 EP&PP*	20 EP*	3-SW, 6 EP&PP*	20 No Pre-Con	
Number of Samples RU	3 EP&PP*	20 EP*	3 EP&PP*	20 No Pre-Con	
Challenge Concentration	8±4	≤200	20±5	≤200	mg/m^3
Mass median diameter	0.6		0.4		µm
Count median diameter	0.058	0.075 ± 0.020		0.185 ± 0.020	µm
Deviation range if given		Geometric SD ≤1.86	Log SD ≤0.26	Geometric SD ≤1.6	
Flow Rate	95	85	95	85	l/min
Aerosol Loading/Duration	120 mg + testing after 24 h ambient storage	200	120 mg + testing after 24 h ambient storage	≥200	mg
Detection	Flame Photometer	Light scattering photometer	Light scattering photometer	Light scattering photometer	
Airflow resistance flow	30, 95	85	30, 95	85	l/min

*Pre-conditioning: SW=Simulated Wear, EP=Environmental Pre-conditioning, PP=Physical Pre-conditioning

Particle Filtration – Negative Pressure

Europe

Minimum Particle Filter Efficiency (%)[a]	Classification	
	Single-Use	**Re-Usable**
Tested With	Sodium Chloride & Paraffin Oil	
80.00	P1 NR	P1 R
94.00	P2 NR	P2 R
99.95	P3 NR	P3 R

NIOSH

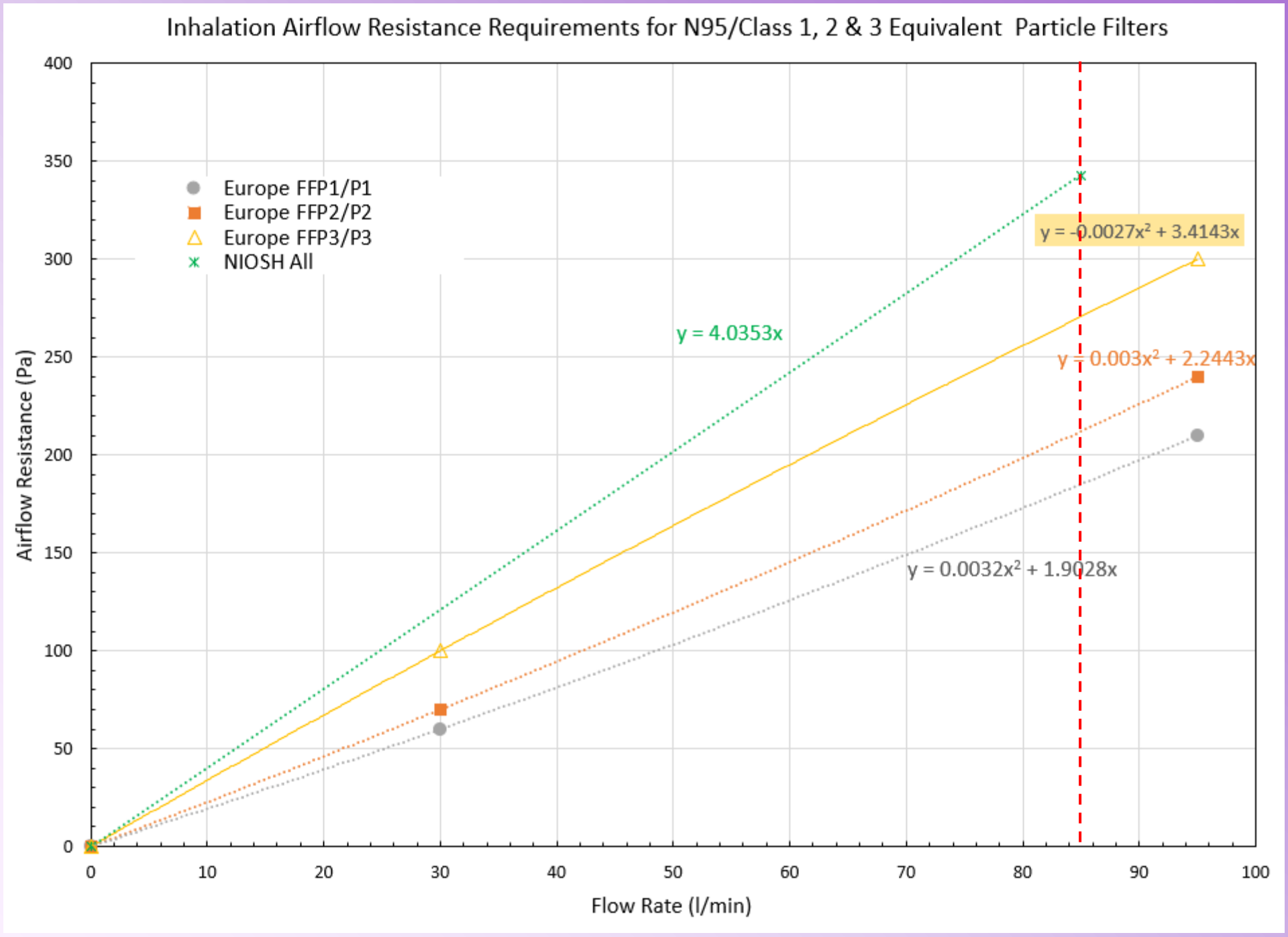
Minimum Particle Filter Efficiency (%)[a]	Classification		
	Non-Oil	**Oil 1-shift**	**Oil indef.**
Tested With	Sodium Chloride	DOP	DOP
95.00	N95	R95	P95
99.00	N99	R99	P99
99.97	N100	R100	P100

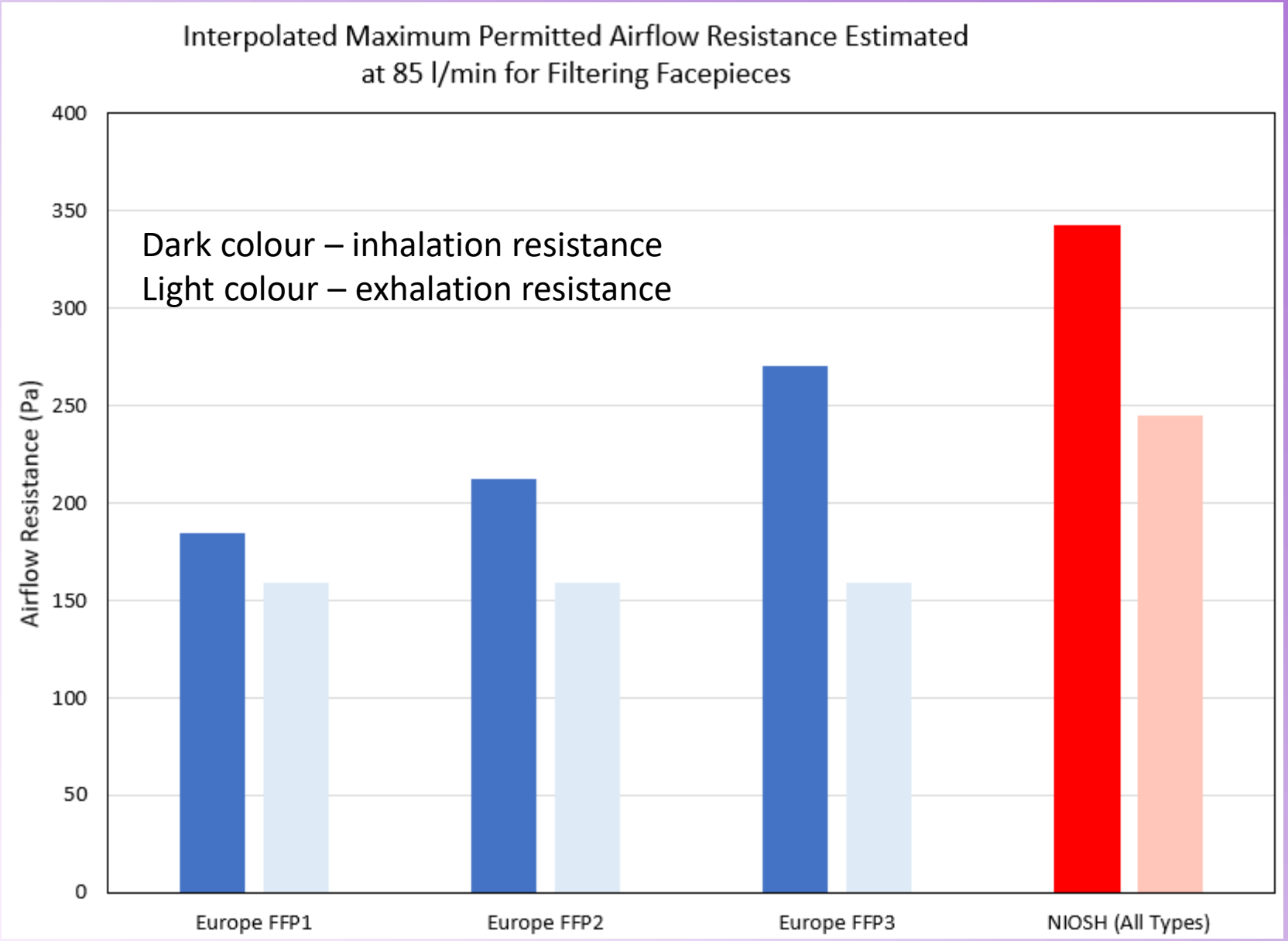
[a] Tested at most penetrating particle size

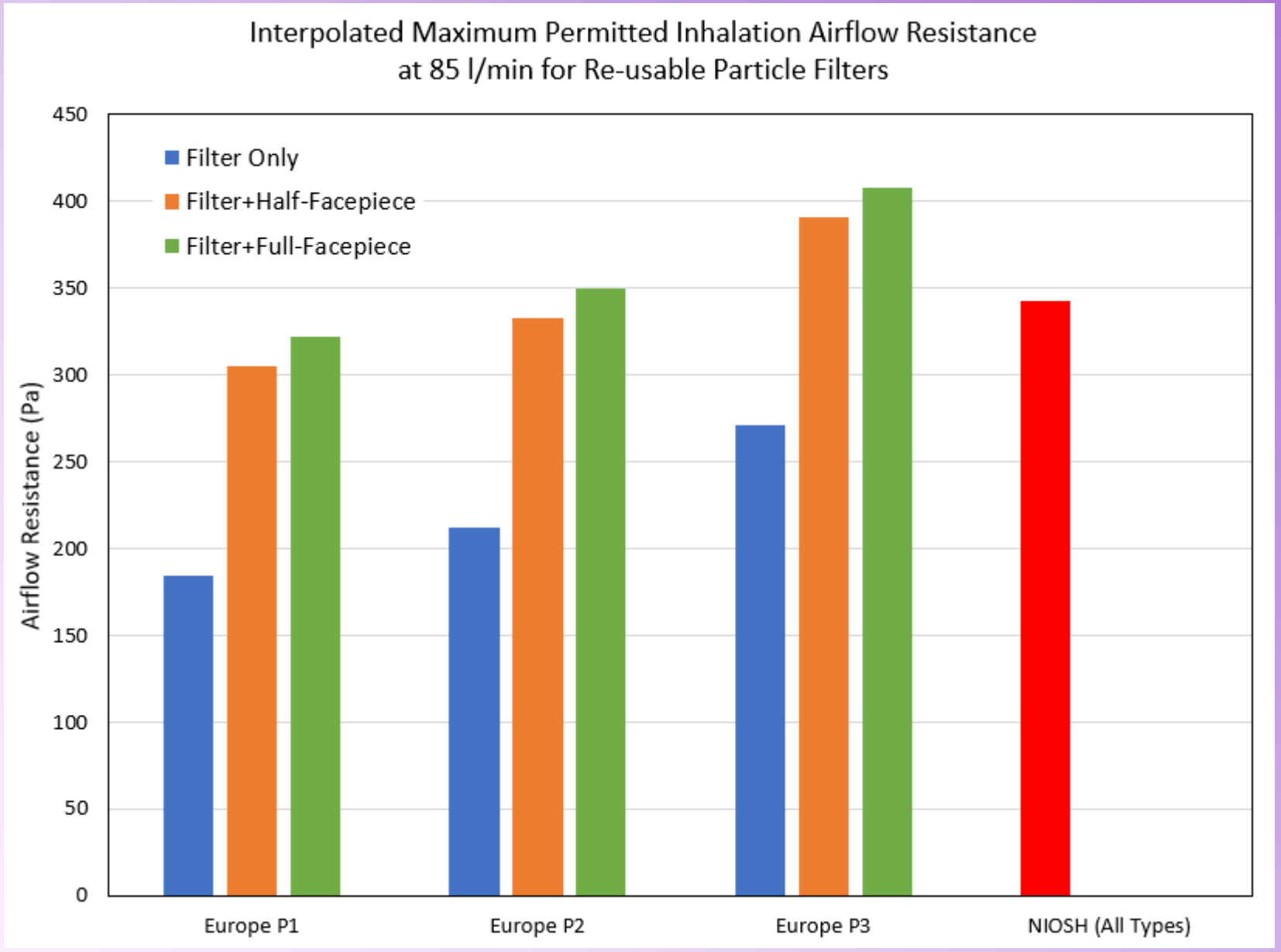
NIOSH+FDA

- Additional Classification – joint NIOSH approval and US Food and Drug Administration Clearance for a "Surgical Respirator"
- Applicable to "N95" type respirators only, with additional testing to a suite of ASTM standards

- Biological aerosols
- Flammability
- Biocompatibility
- Fluid splash resistance


Inhalation Airflow Resistance Requirements for N95/Class 1, 2 & 3 Equivalent Particle Filters
Airflow Resistance (Pa)
Flow Rate (l/min)
0
50
100
150
200
250
300
350
400
0
10
20
30
40
50
60
70
80
90
100
Europe FFP1/P1
Europe FFP2/P2
Europe FFP3/P3
NIOSH All
y = -0.0027x² + 3.4143x
y = 4.0353x
y = 0.003x² + 2.2443x
y = 0.0032x² + 1.9028x


Interpolated Maximum Permitted Airflow Resistance Estimated at 85 l/min for Filtering Facepieces
Dark colour – inhalation resistance
Light colour – exhalation resistance
Airflow Resistance (Pa)
400
350
300
250
200
150
100
50
0
Europe FFP1
Europe FFP2
Europe FFP3
NIOSH (All Types)


Interpolated Maximum Permitted Inhalation Airflow Resistance
at 85 l/min for Re-usable Particle Filters
Airflow Resistance (Pa)
450
400
350
300
250
200
150
100
50
0
Filter Only
Filter+Half-Facepiece
Filter+Full-Facepiece
Europe P1
Europe P2
Europe P3
NIOSH (All Types)

Gas/Vapour Filters

https://www.3mcanada.ca/

https://www.gvs.com/

https://www.grainger.com/

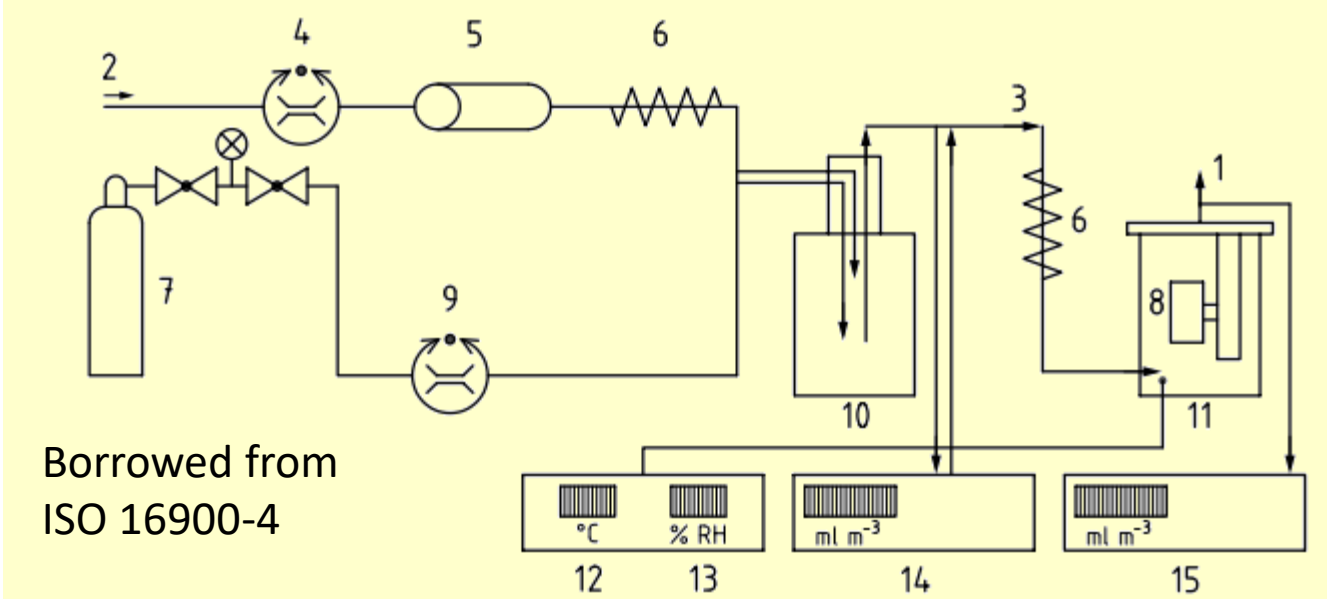
https://www.fishersci.ca/

https://maxisafe.com.au/

https://cas-technik.eu/

Gas and Vapour Testing

- EN and NIOSH tests have the same basic test methods for filter service life
- Generation of a controlled test concentration at a defined air flow rate, temperature and humidity
- This is fed to filter with sampling of the effluent concentration
- Requirements are generally set for a minimum duration to be exceeded before a defined effluent concentration is measured
- Variation for carbon monoxide where cyclic flow profiles and cumulative penetration is assessed



Borrowed from ISO 16900-4

Key

1	exhaust	6	water cooler/thermostat	11	test chamber
2	air	7	challenge gas	12	detector: temperature
3	test gas	8	test specimen	13	detector: relative humidity
4	flow controller	9	flow controller	14	detector: test gas
5	humidifier	10	mixing vessel	15	detector: breakthrough

Gas and Vapour Testing

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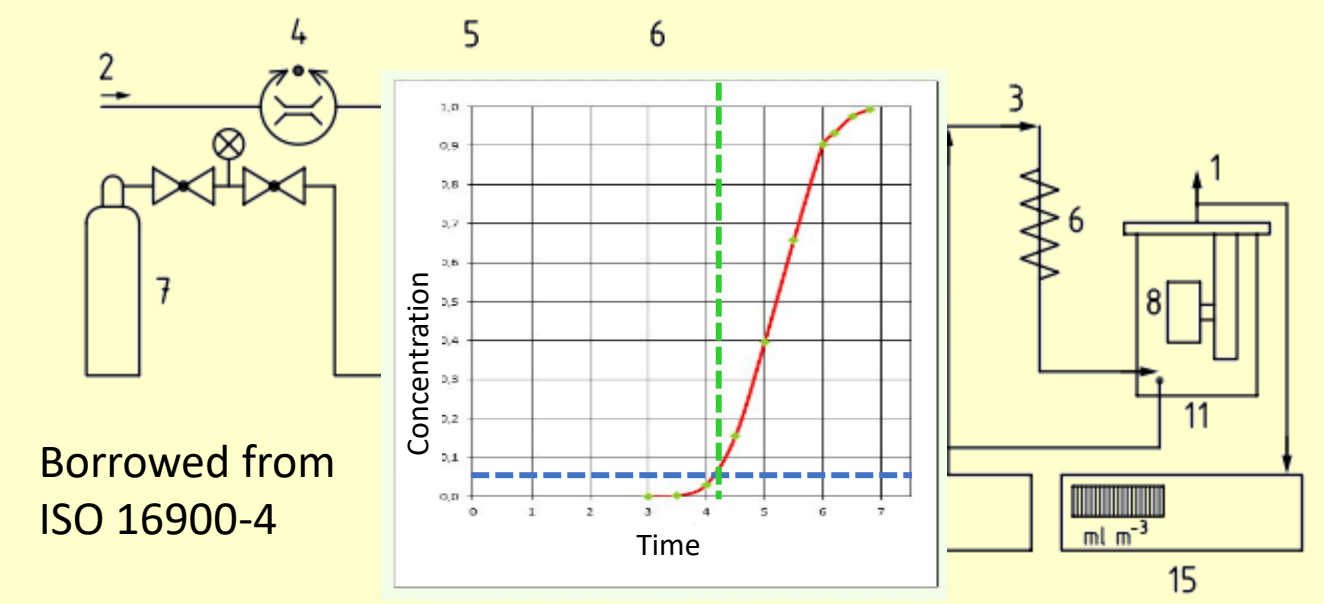

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Test Agents

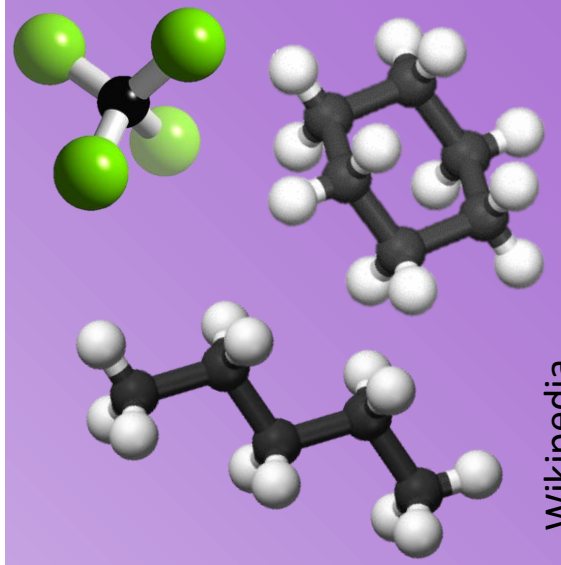
- EN Classes
  - Number indicates how many capacity classes for the agent
  - Where merged, all included agents are required to meet the type approval
- NIOSH Types
  - Individual agent types approved in all cases
  - Cart = Cartridge
  - Can = Canister
  - FB = Front/Back Mounted
  - Cart = subject to requirements modification
- Europe has an additional “specific named compound, SX” type for manufacture-defined test agent

* European NO and Hg-capable filters must include particle filter)

Type	Test Agent	EN		NIOSH	
		No. Classes	Code	Types	Code
Organic Vapour	Carbon Tetrachloride			Cart/Can/FB	OV
	Cyclohexane	3	A		
Inorganic Gas	Hydrogen Cyanide	3	B	Can	HN
	Hydrogen Sulphide			Cart/Can/FB	HS
	Chlorine			Cart/Can/FB	CL
Acid Gas	Sulphur Dioxide	3	E	Cart/Can/FB	SD
	Hydrogen Chloride			Cart/Can	HC
	Hydrogen Fluoride			Cart/Can	HF
	Chlorine Dioxide			Cart/Can	CD
Alkaline Gas	Ammonia	3	K	Cart/Can/FB	AM
	Methylamine			Cart/Can	MA
Low-Boiling Organic Vapour	Dimethyl Ether	1	AX		
	Isobutane				
	Vinyl Chloride			Cart/Can	VC
Nitrogen Oxides	Nitric Oxide	1*	NOP3		
	Nitrogen Dioxide			Cart	ND
Tear Gas	o-Chlorobenzylidene Malononitrile (CS)			Cart/Can	CS
	α-Chloroacetophenone (CN)			Cart/Can	CN
Others	Carbon Monoxide	Escape Prods		Can	CO
	Ethylene Oxide			Can	EO
	Formaldehyde			Cart/Can	FM
	Mercury Vapour	1*	HgP3	Cart	MV
	Phosphine			Can	PH

Organic Vapour Test Agents

- Carbon tetrachloride was the world-wide organic vapour test agent up to mid-1990s
- The 1990 Montreal Protocol on Ozone Depleting Compounds required signatories to phase out its use – world-wide acceptance
- After studies, informal multi-national consensus was reached: cyclohexane chosen as replacement
  - Similar breakthrough times for same test concentrations – only minor adjustment of requirements
  - Sensitive to carbon moisture content like carbon tetrachloride
  - Cheap, available, readily detectable – flammability a disadvantage
- European standards were updated to incorporate cyclohexane
- US adoption of Montreal Protocol restricted production, but not use, of CCl_4, and NIOSH still tests with carbon tetrachloride
- NIOSH studies identified pentane as an alternative, not popular with manufacturers
- A "Letter to Manufacturers" was sent in 1993 allowing alternatives to CCl_4, provided correlation to CCl_4 could be shown

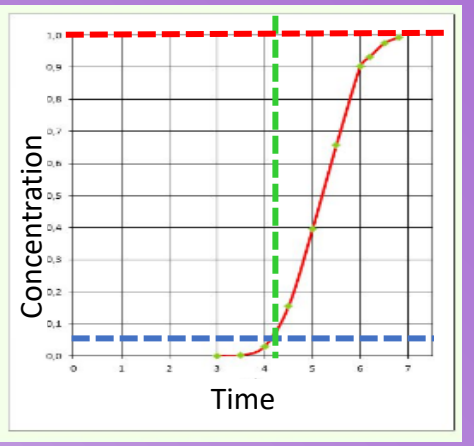


Wikipedia

"Replacement of carbon tetrachloride as an organic vapour respirator filter test agent", S.J. Smith JISRP 14(2), 6-24 (1996).
"Carbon tetrachloride replacement compounds for organic vapor air-purifying respirator cartridge and activated carbon testing - a review", E.S. Moyer, S.J. Smith, G.O. Wood, AIHAJ 62(4):494-507 (2001). doi: 10.1080/15298660108984652.

Gas Test Condition Examples

Code	Gas/Vapour	Pre-Conditioning	Concent-ration	Flow Rate	Humidity	Break Concent-ration	Minimum Service Life	No. Tests
			ml/m³	l/min	%RH	ml/m³	minutes	
A1	Cyclohexane	Mechanical Stress 2 cm/2000 cycles	1 000	30	70	10	70	3
B1	Chlorine	Mechanical Stress 2 cm/2000 cycles	1 000	30	70	0.5	20	3
	Hydrogen Sulphide	Mechanical Stress 2 cm/2000 cycles	1 000	30	70	5	40	3
	Hydrogen Cyanide	Mechanical Stress 2 cm/2000 cycles	1 000	30	70	5	25	3



Etc.

Code	Gas/Vapour	Pre-Conditioning	Concent-ration	Flow Rate	Humidity	Break Concent-ration	Minimum Service Life		No. Tests
							Unmod-ified	Modified	
			ml/m³	l/min	%RH	ml/m³	minutes	minutes	
AM	Ammonia	None	1 000	64	50	50	50	25	3
		25%RH, 25 l/min for 6 h	1 000	32	50	50	50	25	2
		85%RH, 25 l/min for 6 h	1 000	32	50	50	50	25	2
CL	Chlorine	None	500	64	50	5	35	17.5	3
		25%RH, 25 l/min for 6 h	500	32	50	5	35	17.5	2
		85%RH, 25 l/min for 6 h	500	32	50	5	35	17.5	2

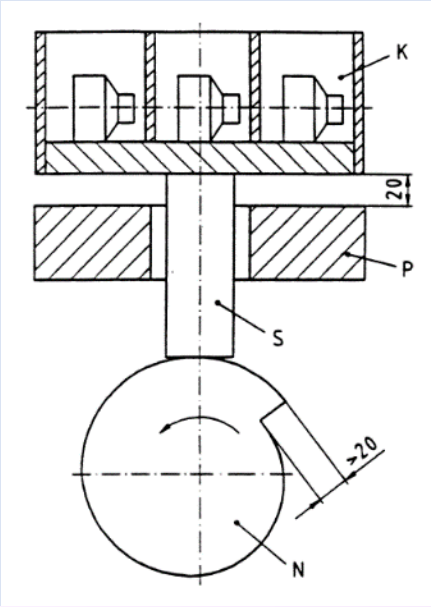
Etc.

Gas/Vapour Filter Test Pre-Conditioning

- Note – this is technically not “equilibration” even though NIOSH protocols often refer to it as such
- It requires complex control systems to achieve properly

Europe

- Mechanical Stress: 2 cm Raise and Drop, constrained in tray, 100 cycles/minute for 20 minutes



NIOSH

- For each gas/vapour test: pre-humidification allocated as:
  - 3 Tested “As Received”
  - 2 after passage of air through filter for 6 hours at 25±5%RH, at 25±2.5°C
  - 2 after passage of air through filter for 6 hours at 85+0/-5%RH at 25±2.5°C
- Negative Pressure:
  - Pre-conditioning air flow rate 25 l/min, test at 32 l/min to full duration requirement
- Powered Air Tight-Fitting
  - Pre-conditioning air flow rate 115 l/min, test at 115 l/min, duration requirements halved
- Powered Air Loose-Fitting
  - Pre-conditioning air flow rate 170 l/min, test at 170 l/min, duration requirements halved

(Duration requirements may be halved again for filters designed for certain combinations of gases, and all flows pro-rated if multiple filters used)

- Filter testing after pre-treatment is either with air at 50%RH or with same humidity of as pre-treatment (AR always 50%RH, for others – depends on if test gas was included in original legislation)

NIOSH Gas/Vapour Requirements Modification

NIOSH:

Certain combinations of gases and vapours trigger a halving of the required break time for each agent

When the filter capability of the gas/vapour in the row is offered in combination with the gas/vapour in the column, modification is applied

This is only indicated as a footnote in tables but has significant consequences for filter design

European standards have no such changes in requirements for combinations of capability

Gas/Vapour whose requirements are modified for negative pressure applications (all others do not change)		When combined with those in the columns:							
		Ammonia	Chlorine	Carbon Monoxide	Carbon Tetrachloride	Hydrogen Chloride	Methylamine	Sulphur Dioxide	AM+CL+CO+OV+SD[a]
Gas/Vapour	Code	AM	CL	CO	OV	HC	MA	SD	N
Ammonia	AM		1	2	1	1		1	3
Chlorine	CL	1		2	1		1		3
Carbon Tetrachloride	OV	1	1	2		1	1	1	3
Hydrogen Chloride	HC	1			1		1		
Methylamine	MA		1	2	1	1		1	
Sulphur Dioxide	SD	1		2	1		1		3

[a] This multiple gas combination filter has been historically termed a “Type N” filter.

1: Cartridge filter requirements change for the gas/vapour in the row.
2: Canister filter requirements change for the gas/vapour in the row.
3: Front/back filter requirements change for the gas/vapour in the row.

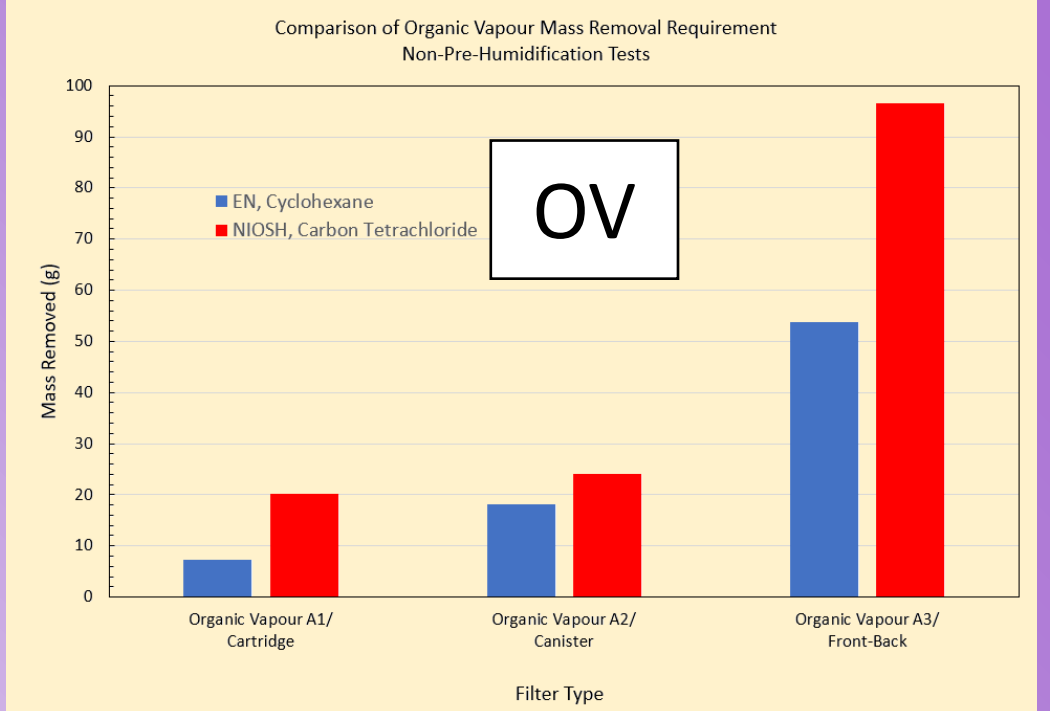
Sulfur dioxide	Equilibrated	SO_2	500	32	4

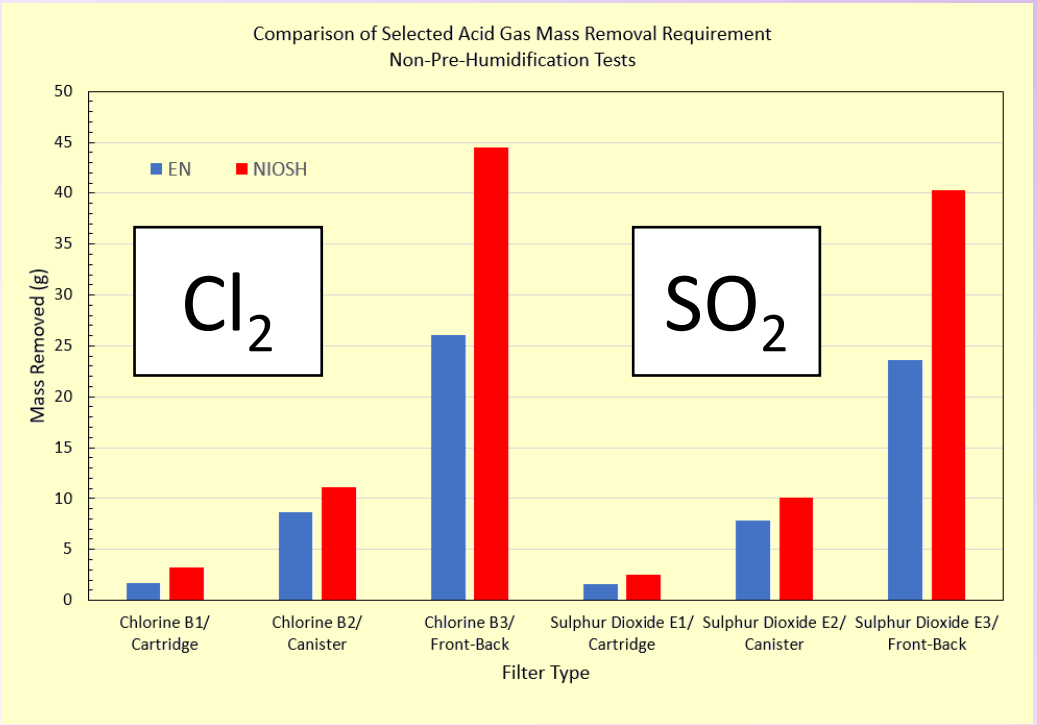
[1]Minimum life will be determined at the indicated penetration.

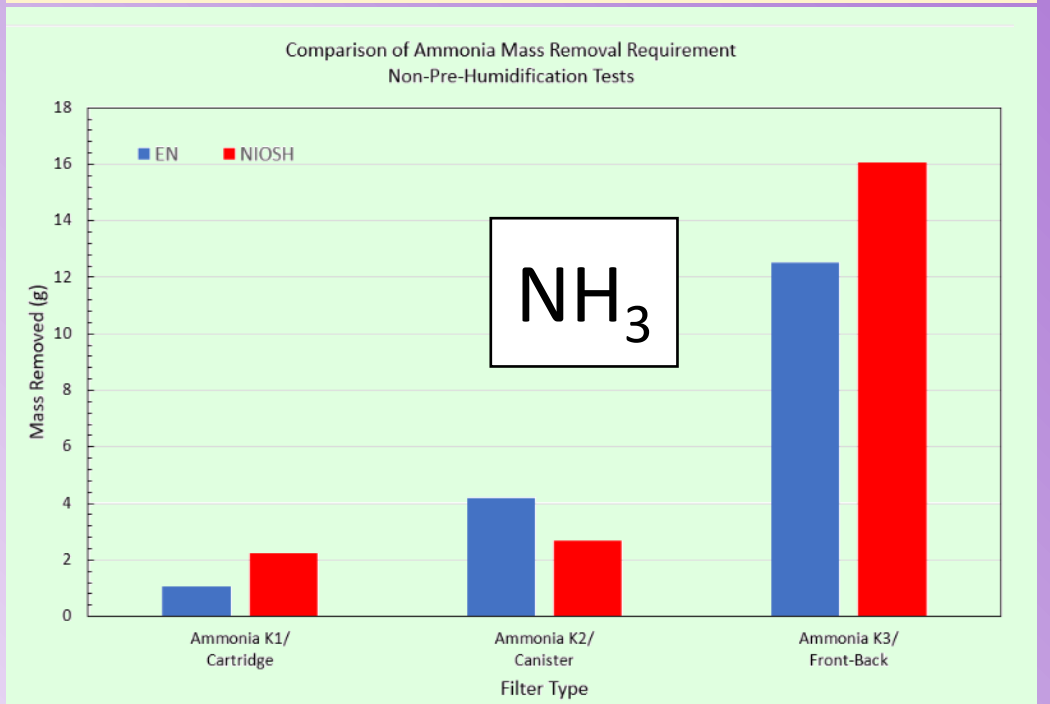
[2]Where a respirator is designed for respiratory protection against more than one type of gas or vapor, as for use in ammonia and in chlorine, the minimum life shall be one-half that shown for each type of gas or vapor. Where a respirator is designed for respiratory protection against more than one gas of a type, as for use in chlorine and sulfur dioxide, the stated minimal life shall apply.

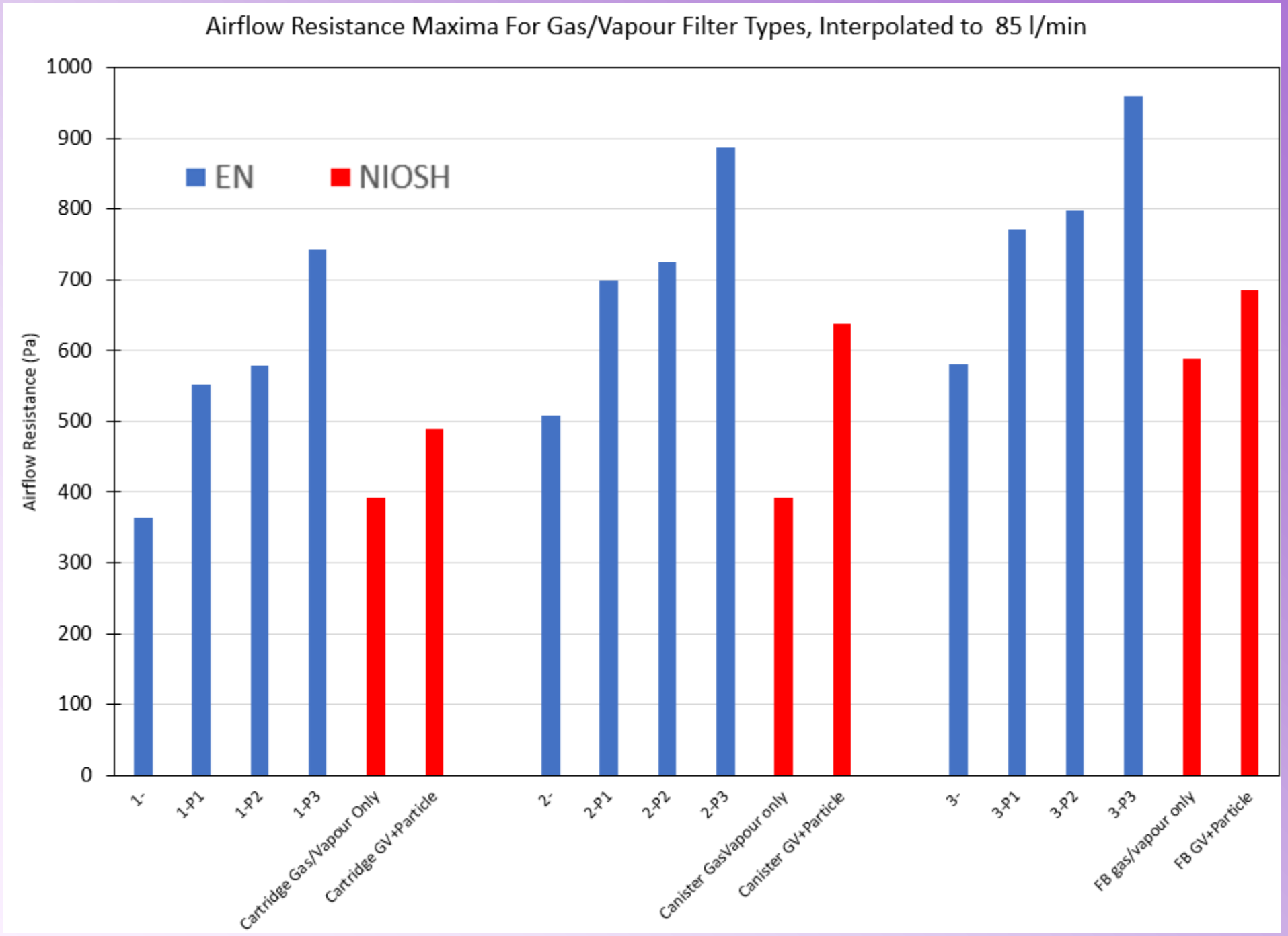
Filter Capacity Comparisons

- Gross capacity comparisons can be made from performance requirements
- Mass Removal Requirement" calculated from:
- Concentration (g m^{-3}) x Flow rate (m^3 min^{-1}) x Minimum duration (min)
- This is only an approximation of capacity observed in use as it ignores kinetic and humidity effects and break concentration





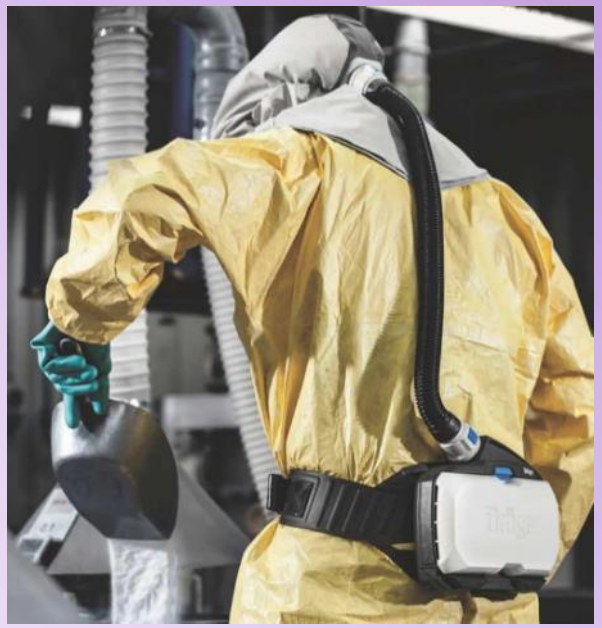



Airflow Resistance Maxima For Gas/Vapour Filter Types, Interpolated to 85 l/min
Airflow Resistance (Pa)
1000
900
800
700
600
500
400
300
200
100
0
EN
NIOSH
1-
1-P1
1-P2
1-P3
Cartridge Gas/Vapour Only
Cartridge GV+Particle
2-
2-P1
2-P2
2-P3
Canister GasVapour only
Canister GV+Particle
3-
3-P1
3-P2
3-P3
FB gas/vapour only
FB GV+Particle

Powered Air Purifying Respirators

https://www.envirosafetyproducts.com/

https://www.srsafety.com/



https://www.draeger.com/

Powered Air Purifying Respirators – Particle Filters

Europe

- Single classification as “P”
- Systems are classified by overall inward leakage capability in protection factor test protocol
- No minimum flow rate requirement but manufacturer specifies minimum flow
- Dolomite dust clogging test – being removed from next update

NIOSH

- Historically, single filter class “HE”
  - Filter penetration/airflow resistance requirements
  - System “clogging” test with silica dust
- April 2020 saw new classes PAPR100-N and PAPR100-P
  - Aerosol type and loading consistent with N and P-type negative pressure tests

Aerosol penetration measured at fixed flow regardless of blower output

- 115 l/min for tight-fitting
- 170 l/min for loose-fitting

Filtration efficiency ≥99.97%

Clogging (System Tests, but Filter is Critical)

- Systems operated in a controlled dust atmosphere for defined period
- Europe – blower flow output measured during exposure
  - Must exceed manufacturers' minimum
  - To be removed in future standard updates
- NIOSH – dust penetration and blower flow output assessed after 4 hours – with minima:
  - 115 l/min for tight-fitting PAPR
  - 170 l/min for loose-fitting PAPR

Dolomite Dust Chamber

Photographed at Spanish Ministry of Labour

Silica Dust Chamber

Photographed at NIOSH Morgantown

Powered Air Purifying Respirators – Gas/Vapour Filters

Europe

- For types where there are three capacity classes for gas/vapour (A, B, E, K), test concentrations are shifted from negative pressure requirements

Type	Class 1	Class 2	Class 3
Negative	1 000	5 000	10 000
PAPR	500	1 000	5 000

- Other types do not change conditions
- Tested at average interactive flow measured on PAPR

NIOSH

- Two capacity classes for some gases, one for others
- “Cartridge” and “Canister” terminology carried over from negative pressure classification
- “Canister” used only on tight-fitting PAPRs so addressing “Fail-Safe” performances if blower power is interrupted
- Tested at fixed flow rates regardless of blower operation
  - 115 l/min for tight-fitting
  - 170 l/min for loose-fitting

Escape Devices

Europe

- EN 403 for hoods with filters for fire escape
  - Dedicated requirements for use in fire
  - Testing with combustion products including acrolein, hydrogen cyanide
- EN 404 for mine self-rescuers
  - Carbon monoxide filtration only
  - Mouthbit-type designs accepted

https://www.kent.fire-uk.org/

NIOSH

- Requirements included in main standard – matching “canister” concentrations
- Manufacturers can select which gases to include
- Mouthbit-type designs accepted

https://sps.honeywell.com

References

- European Regulation https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0425&rid=4
- European Norms in English available from BSI https://shop.bsigroup.com/
- Searchable standards list: https://standards.cen.eu/dyn/www/f?p=CENWEB:105::RESET

- NIOSH Code of Federal Regulations: https://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title42/42cfr84_main_02.tpl
- Standard Test Protocols https://www.cdc.gov/niosh/npptl/stps/respirator_testing.html
- Certified Equipment List https://www.cdc.gov/niosh/npptl/topics/respirators/cel/default.html
- Air-Purifying Test Selection Guide – contact Jeff Peterson: jap3@cdc.gov

Thanks and Questions

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