



RISK MANAGEMENT MEASURES FOR NANOMATERIALS

To what extent does engineered and personal protection equipment reduce exposure to manufactured nanomaterials in the work environment?

TNO innovation
for life

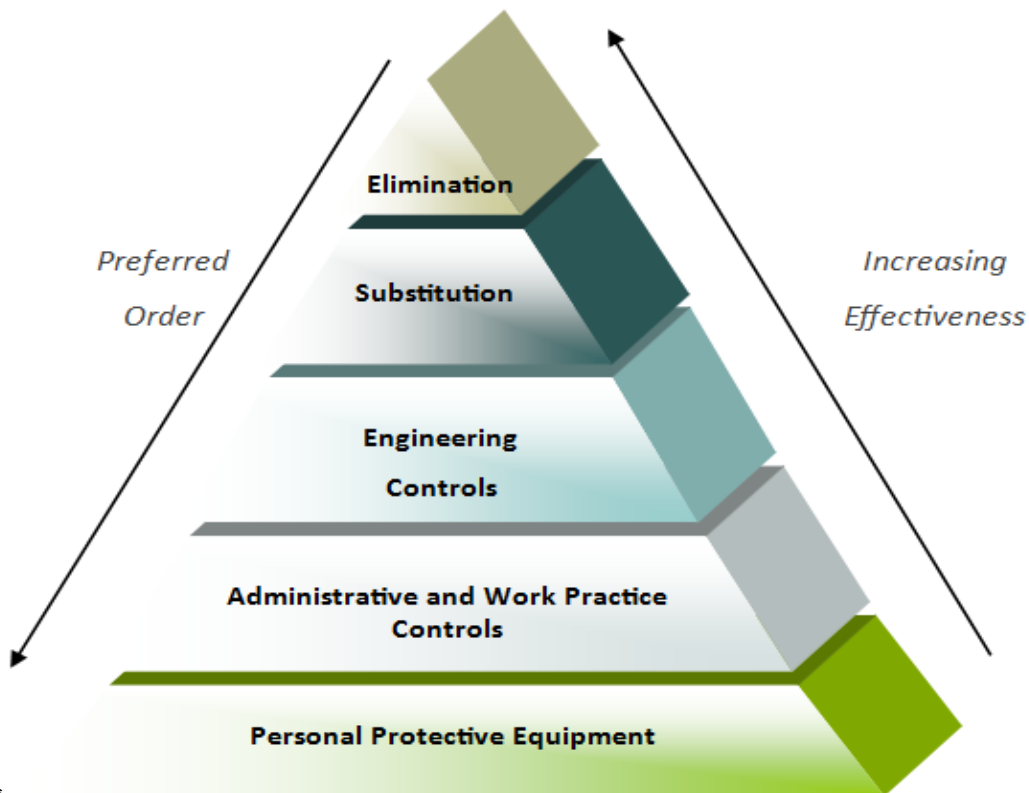


EXPOSURE TO ENM



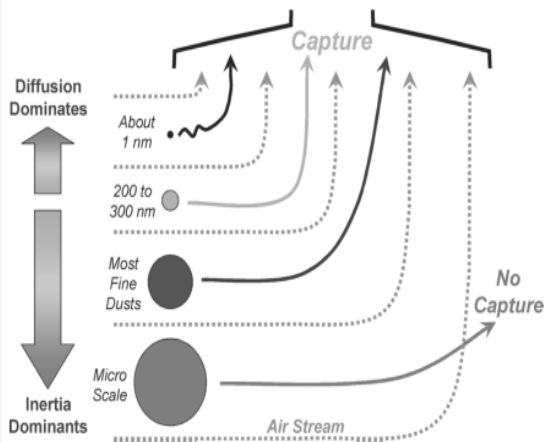
Emission Source	NPs Type	Measured levels range
Primary / SD1		
Liquid-phase reaction	PGNP	4.0×10^4 to 11.0×10^6
Flame spraying	PGNP	4.7×10^3 to 1.0×10^6
CVD	PGNP	Non-significant
Top-down (milling)	ENPs / PGNP	3.0×10^3 to 1.0×10^6
Secondary NP aerosol / SD2		
Weighing of powders	ENPs	2.0×10^4 to 7.0×10^4
Harvesting	ENPs	2.0×10^4 to 5.0×10^4
Manual packaging (Bagging)	ENPs / PGNP	20.0×10^4
Bag emptying of powders	ENPs	Significant increase
Melt Blending	ENPs / PGNP	$> 1.0 \times 10^5$
SD3a / SD3b		
Spraying of liquid	ENPs	2.0×10^8
Spraying (gas)	ENPs	1.6×10^5 to 2.0×10^{10}
Injection Molding	ENPs	$> 8.0 \times 10^5$
Brushing and rolling	ENPs	$> 6.0 \times 10^5$
Sonication of nanodispersions	ENPs	$> 8.0 \times 10^6$
Tertiary NP aerosol / SD4		
Abrasion of nanoproducts	PM / EMNP	8.0×10^3 to 2.0×10^4
Drilling	PM / EMNP	4.0×10^4
Grinding	PM / EMNP	3.0×10^3 to 1.0×10^6

HIERARCHY OF RISK MANAGEMENT MEASURES



SOME KEY PRINCIPLES

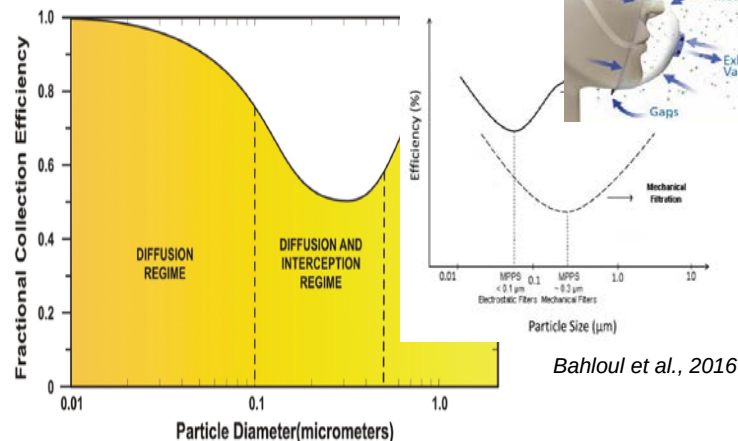
Ventilation



Schulte et al., 2008

For particles < 200nm diffusion dominates & capture efficiency expected to decrease

Respirators

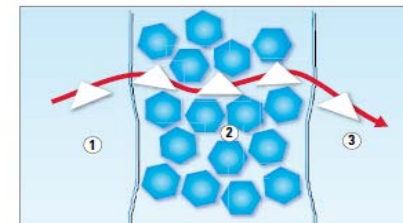


Lee and Liu, 1980

Small particles are bombarded by air molecules and cause particles to deviate from the airstream and trapped on filter media more efficiently (*single fibre filtration theory*)

Electrostatically charged filters increase the filtration efficiency

Clothing / gloves



Normalized breakthrough time at a permeation rate of 1.0 $\mu\text{g}/(\text{cm}^2\cdot\text{min})$ in minutes	EN Class
> 10	1
> 30	2
> 60	3
> 120	4
> 240	5
> 480	6

* EN 14325: Protective clothing against chemicals - test methods and performance classification of chemical protection

Nano-sized particles may under certain conditions more easily permeate and penetrate through some types of protective materials / textiles / fabrics

RMM FOR EXPOSURE / RISK ASSESSMENT

Stoffenmanager Nano module 1.0

Stoffenmanager Nano module Community portal

You are here: Home

Home
Educational Information
Disclaimer

The Stoffenmanager Nano Module

Welcome to the S

This module allows you to quantify exposure to Manufactured Nanomaterials (MNO) selected or included in the Ac

For more information on exposure assessment, see:

- [Factsheets good practices](#)
- [PIMEX-moves exposure](#)

You can use the Safety Data products to determine whether the [background page](#) for an MNO is likely.

If after consulting the data/information of MNO, but you suspect that it is still possible to use Stoffenmanager Nano applies

- Particles are not [water-soluble](#)
- The particles are purpose-by-product, such as the by-product, and
- The size of the primary particles of a nanopowder is likely to be smaller than 100 nm
- It concerns single particles

If your particle does not meet the criteria, it is not suitable to assess your substance with Stoffenmanager 4.5.

Log in
E-mail:
Password:
Log in

WELCOME
Introduction

What is this CCAR Nano module?

The CCAR Nano module is a tool to help you to assess the exposure to Manufactured Nanomaterials (MNO) selected or included in the Ac

For more information on exposure assessment, see:

- [Factsheets good practices](#)
- [PIMEX-moves exposure](#)

You can use the Safety Data products to determine whether the [background page](#) for an MNO is likely.

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Synthesis

Formulation

Use

End of Life

TIER 1

TIER 2

Risk Control (RC) module

MCDA ba integrati

NanoSafer Control Banding Report for Airborne Occupational Exposure Assessment

version 1.1

Assessment prepared by

Name:
Address:
Phone:
E-mail:
Date: Monday, Mar 27, 2017

Assessment of

Material assessed: TiO2
Producer:
Classified as nanomaterial consisting of: Nanomaterial

Work situation assessed: Powder transfer
Process type: Powder Handling

Router Log off

GUIDEnano Home Cases Active case About Contact

Sprayer

General Exposure pathways Hazard scenario(s) Available Protective Controls Risk Assessment

Indirect through zone(s) Direct contact

Indirect:

exposure zone(s)	route(s)	exposure relevant material
Indoor air entire, indoor air	☒ inhalation ☐ dermal ☐ oral	Environ-X TiO2 Titanium dioxide

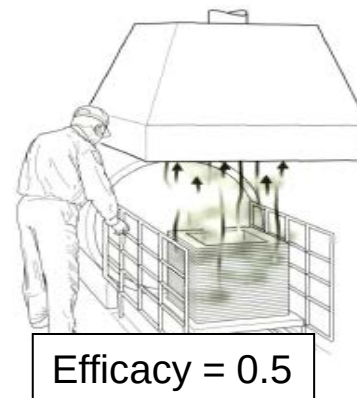
Inhalation | exposure entire, indoor air (Titanium dioxide)

Agent material presence	source	route	peak conc.	long-term conc.	unit	use	PPE efficacy	peak estimate	long-term estimate
Target population presence	Measured data	inhalation	10000000.0	10000.0	particles/m3	☒ 20% reduction	62400000.0 particles/m3	8000.0 particles/m3	
Protective equipment used	ART	inhalation	5000.0	50.0	mg/m3	☐ 20% reduction			
Concentration estimate(s)	+ select--								

route? (material?)

LOCALIZED CONTROLS

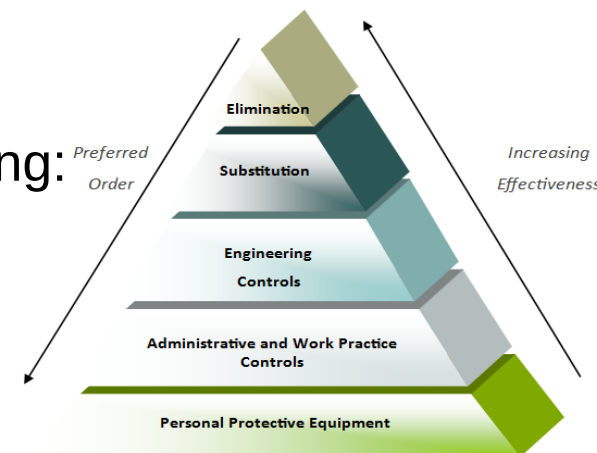
- › Suppression techniques
 - › Wetting at the point of release
 - › Knockdown suppression
- › Containment (non-extracted)
- › Local ventilation systems
 - › Receiving hoods
 - › Canopy hoods (hot processes)
 - › Other receiving hoods
 - › Capturing hoods
 - › Fixed
 - › Movable
 - › On-tool (integrated) extraction
 - › Enclosing hoods
 - › Glove box
 - › Fume cupboard
 - › LEV systems with partial enclosure (no front cover)



REVIEW THE EFFICIENCY OF RMM

› Derive quantitative effectiveness values for modeling:

- › Differences in the effectiveness of RMM for nanomaterials versus conventional materials?
- › Adjust existing effectiveness values of RMM relevant for conventional substances? If so, what is the rationale and evidence we base these values on?



› Selected RMM:

- › Engineering controls
- › Respiratory Protective Equipment (RPE)
- › Skin Protective Equipment (SPE) – gloves and clothing

METHODOLOGY

- › Review of published literature (2005 to 2016), incl. experimental studies performed in Guidenano (WP8) and other EU funded projects
- › Derive conservative values for modelling purposes → 90% CI of the 5% percentile
- › Evaluation included nano-specific and conventional data; and agglomerated / aggregated particles
- › Considering all available information, incl. existing models, databases, experimental data, literature and regulatory bodies

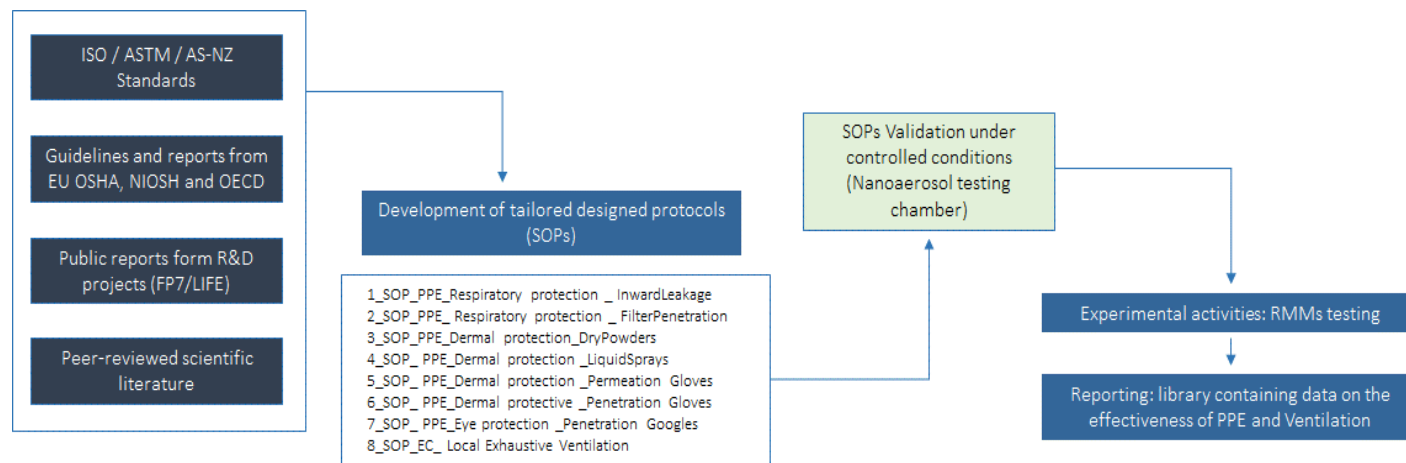
AVAILABLE DATA

RMM	Studies (data points)*	Remarks
Engineering controls	12 (75)	- o 10 types of controls (<i>based on ART categories</i>) - o Range of NMs, e.g. TiO₂, CNT, SiO₂, graphene; mostly ~5 to 560 nm tested - o Cross-sectional & (semi-) experimental methods
Respiratory Protective Equipment	15 (365)	- o 9 types of respirator types (<i>based on OSHA Regulation , 29 CFR1910</i>) - o Mostly NaCl, also SiO₂, TiO₂, etc; <100nm (mono-/polydisperse) tested - o Majority experimental studies, static or dynamic tests
Skin Protective Equipment - Clothing - Gloves	7 (163) 2 (31)	- o 7 types of protective clothing, 8 glove types (<i>based on Directive 89/686/EEC</i>) - o Mostly NaCl, SiO₂, TiO₂, etc; gloves (colloidal aerosol 20-110nm); clothing (solid & colloidal aerosol 20-300nm) - o Experimental, various test methods, static & dynamic

* 36 of the ~90 pre-screened studies (incl. experimental data) could be used to derive quantitative effectiveness values

RMM TESTING APPROACHES (SOPS)

- Evaluation of RMM effectiveness requires the definition of reliable, robust and reproducible testing approaches



DEFINITION OF TESTING APPROACHES (SOPS)

- › ITENE exposure chamber prototype, developed within the EU NanoRisk and EU GuideNano.
- › Validation of developed SOPs
- › Development of experimental set-ups
- › Protocols were revisited and when necessary, adapted to the limitations of the experimental tests.



ENGINEERING CONTROLS

Control measure		Efficiency (%)		
		<i>Nano dataset^A</i>	Proposed [*]	Specific sources ^B
Physical containment	Low to high level	50 – 99.999	85-99.9	ART/ECEL, Tsai et al., 2008/2012
Receiving hoods	Canopy hoods	-	50	ART/ECEL, Lo et al., 2012; Methmer et al., 2012
	Other receiving hoods	-	80	ART/ECEL
Capturing hoods	Fixed	75 – 100	90	Lee et al., 2007, Methmer 2008
	Movable	46 – 97	50	Methmer 2008, Frijns et al., 2016
	On-tool	-	90	ART/ECEL
Enclosing hoods	Fume cupboard	57 – 95	90	ART/ECEL; Tsai et al., 2008/9
	Horizontal / downward laminar flow booth, other	-	90	ART/ECEL
Glove bags	Non ventilated	-	99	ART/ECEL
	Ventilated or kept under negative pressure	-	99.9	ART/ECEL
Glove boxes	Low to high specification	~97–98 (n=2)	98 – 99.99	ART/ECEL, Debia et al., 2013
Suppression techniques	Wetting at release point	68 – 99	90	ART/ECEL, Bello et al., 2009
	Knockdown suppression	-	30	ART/ECEL

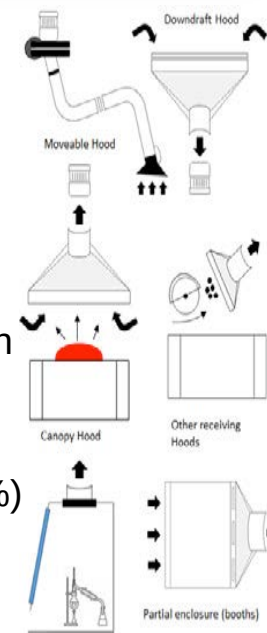
- * Proposed value based on all sources
A Based on reviewed nano dataset (min-max)
B Specific sources that determined the proposed value

ENGINEERING CONTROLS



Exposure Control Efficacy Library

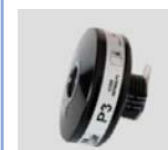
- › Generally, very small datasets available. Most data on fixed capturing hoods (n=26).
- › Deviations from existing values (of conventional substances) as proposed by ART/ECEL include:
 - › More conservative values for containment (85 – 99.9%) considering increased diffusion and escape of NPs
 - › Fume cupboards assigned with less effective value (90%) (Tsai et al., 2008/9)
 - › More conservative values for low and medium specification glove boxes (98% & 99.9%)
- › Consider various confounding factors when more data become available, e.g. location of measurements, types of nanoparticles



RESPIRATORY PROTECTIVE EQUIPMENT (RPE)

Control measure	Efficiency (%)		Specific sources ^B
	<i>Nano dataset^A</i>	Proposed [*]	
Filtering half mask (disposable)	FFP1	~43 - 95	APFs (EN 529, 2005 from 5 countries - Finland, Denmark, Italy, Sweden, United Kingdom), OSHA 29 CFR 1910.134 (2006), NIOSH Decision Logic (2004) ANSI Z88.2 (1992) BS 4275 (1997) Shaffer & Rengasamy, 2009 Stoffenmanager-nano
	FFP2	~50 – 99.999	
	FFP3	~78 – 99.9999	
Filtering half mask, unpowered (elastomeric face piece)	Half mask + P2	~47 – 99.997	
	Half mask + P3	~50 – 99.9999	
Filtering full mask, unpowered (elastomeric face piece)	Full Mask + P2	~98–99.9 (<i>n</i> =2)	85 90 98 (TH1, TH2, TH3)
	Full mask + P3	~99.5–99.9998	
Powered Air Purifying Respirator (PAPR)	Helmet / hood	(>99.9999)	

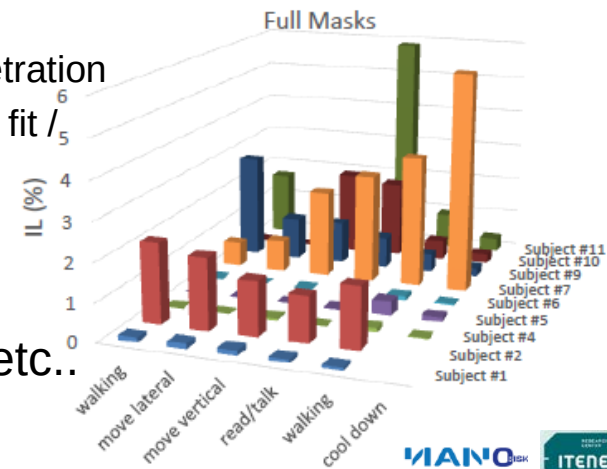
- * Proposed value based on all sources
 A Based on reviewed nano dataset incl. experimental data obtained in EU projects
 B Specific sources that determined the proposed value



RESPIRATORY PROTECTIVE EQUIPMENT (RPE)



- › Most data available on filtering (disposable) half masks under experimental conditions. No or limited data available on other respirator types
- › Similar findings compared with conventional substances:
 - › In some cases experimental tests show an increased efficiency of respirators for nanoparticles compared to their certified protection values
 - › Total inward leakage (TIL) is by seal leakage rather than filter penetration
 - › conservative values and worst case simulations (non-optimal fit / simulated leaks) were also considered to propose values
- › Available data difficult to interpret considering different test types (static/dynamic), test conditions, leakage/fit, etc..



PROTECTIVE CLOTHING

Control measure		Efficiency (%)		
		Nano dataset ^A	Proposed [*]	Specific sources ^B
Woven materials	Laboratory (cotton) coat	~40 – 64	40 (s) 25 (l)	Park et al., 2011 Rengasamy et al., 2010
	Polypropylene, frocks (Cat I, Type 6)	~70 – 99	70 (s) 50 (l)	Gao et al., 2010
Non-woven materials	Protective clothing (e.g. Tyvek, Cat III, Types 3B, 4B, 5B & 6B; Tychem, Types 5B and 6B)	~92 – 99.9	95 (Type 3, liquid-tight) 90 (Type 4, spray tight) 90 (Type 5, particle) 85 (Type 6, lim. spray tight)	TNsGs 2007, 2010; OECD, 2009 Gao et al., 2010 Spaan et al., 2013 Ling et al., 2012
	Protective clothing (double-side PVD coated Nylon, Cat III Type 4)	40	(40)	-
	Self-ventilated / overpressure suit (Cat III, Type 1)	99.999 – 99.9999	99.9 (s/l)	-

- * Proposed value based on all sources
 A Based on reviewed nano dataset, incl. experimental data obtained in EU projects
 B Specific sources that determined the proposed value



GLOVES

Control measure		Efficiency (%)		
		Nano dataset ^A	Proposed [*]	Specific sources ^B
Disposable protective gloves	Nitrile Thin	~41 – 99.96	70 (s/l)	Vinches et al, 2014; Dolez et al., 2013
	Nitrile Thick	~48 – 99.99	95 (new double gloves) 90 (s) 85 (l)	TNsGs 2002, 200; OECD, 2009 Dolez et al. (2013) Vinches et al (2014) Spaan et al., 2013
	Vinyl	-		
	Non powder Vinyl	-		
	Non powder Latex	~77 – 99.99		
Reusable	Neoprene / Natural Latex	~77 – 99.99	70 (s/l)	Vinches et al, 2014 ; Dolez et al., 2013; Delpivo et al., 2016
	PVC	~68 – 97		
	Butyl	~49 – 99.99		

- * Proposed value based on all sources (if correct selection/guidance applies)
 A Based on reviewed nano dataset, incl. experimental data obtained in EU projects
 B Specific sources that determined the proposed value

								
LAMINATE FILM	NITRILE	UNSUPPORTED NEOPRENE	SUPPORTED POLYVINYL ALCOHOL	POLYVINYL CHLORIDE (Vinyl)	NATURAL RUBBER	NEOPRENE/ NATURAL RUBBER BLEND	BUTYL UNSUPPORTED	VITON/BUTYL UNSUPPORTED
BARRIER™	SOL-VEX®	29-SERIES	PVA™	SNORKEL®	*CANNERS AND HANDLERS™	*CHEMI-PRO®	CHEMTEK™ BUTYL	CHEMTEK™ VITON/BUTYL

PROTECTIVE CLOTHING & GLOVES

- › Limited number experimental (static & dynamic) studies currently available on a limited number of clothing types & gloves
- › Protection values proposed based on experimental findings and values from Technical Notes (TNsGs) for conventional substances and other sources:
 - › Very high protection values measured experimentally, more conservative values proposed for protective clothing, e.g. Tyvek, Cat III, Types 3B, 4B, 5B & 6B (85-95%)
 - › For thin nitrile gloves and butyl gloves, a lower protection value is proposed (70%) compared with other gloves (Vinches et al, 2014 ; Dolez et al., 2013)
- › Issues of concern for evaluation purposes:
 - › Different test methods & conditions (e.g. through-diffusion & filtration-based test bench studies, static manikin and dynamic subject test protocols in chambers)
 - › Different types of nanomaterials (NaCl, Ag, Fe₃O₄, TiO₂, SiO₂)

www.stofvrijwerken.tno.nl

www.ecellibrary.com



DUST-FREE

Fine particulate matter, carcinogens like respirable nickel. Workers coming to work in a responsible, safe way.

For TNO, it is essential to reduce dust exposure – and to develop more system solutions.

Together with Bosch, DeWalt, Hitachi and other equipment manufacturers, effective management systems for dust extraction, which can reduce exposure times. The resulting "dust-free" tool is TNO Performance Test.

Every tool or system has its own test protocol. Dust exposure to harmful substances passed its test do not exceed the cumulative exposure limits for PM (GSW TGG-89; weighted average). Moreover, such use is approved by the Dutch labour inspectorate, as constituted by the TNO Performance Test.

ADDRESS

Schoemakerstraat 97K
2628 VK Delft
T 088 866 30 00
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RSS FEED

► RSS Feed

MAKITA VACUUM CLEANER VC2512L AND DRILLS > DUST-FREE WORKING

IN COMBINATION WITH SEVERAL DRILLS



Bosch dustfree system GDE 36



Several drills

Makita vacuum cleaner VC2512L with 2.5 meter Ø 32 mm hose (or optional)

More information is available on www.makita.nl
Responsible use: 2000 tonnes per 8-hour working day in sand time blocks



Responsible use: 2000 tonnes per 8-hour working day in concrete / brick



CONTACT
For details on the use of this label and its interpretation refer to the TNO website below:

DUSTFREEWORKING.TNO.NL

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SEARCH

CONTACT FORM

You are signed in as robert.transman@tno.nl
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Exposure Control Efficacy Library

Industry		Task	
RMM group		Substance	
RMM sub-group		Route	
Optimization		Study type	
Combined RMM			

[RESET](#)

industry	risk management strategy		task	substance	route	study	efficacy
Agriculture	Personal enclosure / separation	Not specified; personal enclosure / separation	Spraying	Cephan	Inhalation	Cross-sectional (a priori design)	0.28
Asphalt processing	Suppression techniques	Stabilisation by changing product properties	Mopping	Benzene	Inhalation	Experimental study	0.49
Asphalt processing	Suppression techniques	Stabilisation by changing product properties	Mopping	Total organic matter	Inhalation	Experimental study	0.52
Asphalt processing	Suppression techniques	Stabilisation by changing product properties	Handling of objects	Total particulate	Inhalation	Experimental study	0.94
Asphalt processing	Suppression techniques	Stabilisation by changing product properties	Mopping	Inhalable particulate	Inhalation	Experimental study	
Asphalt processing	Suppression techniques	Stabilisation by changing product properties	Handling of objects				

ECEL CARD

Use Road, GMA, Kleene, J. Effect of additive in spraying water of asphalt milling machine on the dust and quartz exposure of workers. TNO report voor Toekomstige subsidieaanpak (2007), no. 1 en 2.

Reference	Industry	Task	Substance
Asphalt processing	Asphalt processing	Stabilisation by changing product properties	Asphalt dust
Exposure route	Exposure route	Exposure route	Exposure route
Exposure form	Exposure form	Exposure form	Exposure form
Task description	Task description	Task description	Task description
Combined data	Combined data	Combined data	Combined data
Activity	Activity	Activity	Activity
Emission potential	Emission potential	Emission potential	Emission potential
Risk management strategy	Risk management strategy	Risk management strategy	Risk management strategy
Suppression technique	Suppression technique	Suppression technique	Suppression technique
Situation before	Situation before	Situation before	Situation before
Asphalt milling with only a cooling water system	Asphalt milling with only a cooling water system	Asphalt milling with only a cooling water system	Asphalt milling with only a cooling water system
No 3 - Exposure 2.4 mg/m ³	No 3 - Exposure 2.4 mg/m ³	No 3 - Exposure 2.4 mg/m ³	No 3 - Exposure 2.4 mg/m ³
Total N = 7	Total N = 7	Total N = 7	Total N = 7
Efficacy value	Efficacy value	Efficacy value	Efficacy value
Statistical analysis	Statistical analysis	Statistical analysis	Statistical analysis
Measure of variability	Measure of variability	Measure of variability	Measure of variability
Statistical significance	Statistical significance	Statistical significance	Statistical significance
Abstract	Abstract	Abstract	Abstract
Operators of asphalt milling machines are exposed to respirable quartz dust that frequently exceeds the occupational exposure limit. A small scale field study was conducted in the Netherlands to determine the effect of a newly developed emission reduction system, on the exposure of the operators. This system reduces the emission of dust and quartz by spraying atomized water with an additive on the material. The results show that this new dust emission reduction system may reduce the respirable crystalline quartz concentration in the breathing zone of the operators to a level that is well below the Dutch occupational exposure limit of 75 µg/m ³ . Further studies are recommended to clarify whether this holds for all milling and weather conditions that operators of asphalt milling machines may face throughout the year.	Abstract	Abstract	Abstract
Asphalt milling machine (Deltalift SP202)	Asphalt milling machine (Deltalift SP202)	Asphalt milling machine (Deltalift SP202)	Asphalt milling machine (Deltalift SP202)

Asphalt milling machine equipped with new dust emission reduction system

CONSTRUCTION INDUSTRY



> 500 x OEL



100 - 500 x OEL



50 - 100 x OEL



1 - 50 x OEL



Prevention factor: 90x

GUIDANCE



LIFE12 ENV/ES/178

Welcome to the NanoRISK Risk Management Measures Library

Guidance

Open / Refine Study

Start New Study

Library of Individual Measures

Sector / Process related RMMs

References



GUIDANCE ON RECOMMENDED MEASURES AND CONTROLS FOR MITIGATING RISK POSED BY ENGINEERED NANOMATERIALS

LIFE NanoRISK

Best practices effectiveness, prevention
protection measures for control of risk
by engineered nanomaterials



Instruction sheets

Respiratory protection equipment



TYPES

- FFR- Particulate Filtering Face piece Respirators (Filtering half mask)
- Half Mask Respirators (Filters: P1/P2/P3)
- Full Face Masks (Filters: P1/P2/P3)
- Particulate filters (Cartridges)

CERTIFICATION AND TESTING

- EN 13274-1:2001. Respiratory protective devices. Methods of test. Determination of total inward leakage
- EN 13274-7:2008 Respiratory protective devices. Methods of test. Determination of inward penetration
- EN 149 / EN 140 / EN 136 / EN 143

MAINTENANCE AND CLEANING

- Inspect respirators for cleanliness and damage before each use.
- Filtering face piece respirators can be reused by the same worker, but only if the filter properly, its shape remains unchanged, and the filter material is not physically damaged.
- A respirator inspection must include a check of the respirator's ability to work properly, hoses, and the condition of the various parts, such as the face piece, headband, and any cartridges, canisters, or filters.
- Store respirator in sealed bag in a clean, dry, non-contaminated area.
- Replace respirator and/or cartridge or filter if it is damaged, distorted, a proper seal cannot be achieved, or breathing becomes difficult.
- If your respirator fails an inspection or is defective, your employer must remove it from service either repair it or discard it.

RECOMMENDED RPE AGAINST ENMS

- Half Mask Respirators (Filters: P3)
- Full Face Masks (Filters: P3)

Perform a negative or positive seal check each time before entering a contaminated area.

Local Exhaustive Ventilation (LEV)



TYPES

- a) Enclosing Hoods
 - Laboratory Glove Box (complete enclosure)
 - Down flow room (complete enclosure)
 - Horizontal/downward laminar flow booth
 - Laboratory Hood (partial enclosure)
 - Walk-in booths
 - Paint spray booth (partial enclosure)
- b) Capturing Hoods
 - Movable LEV systems (extendable arms)
 - HEPA Filtered down flow booth
 - Fixed Capturing Hoods
 - On tool extraction
- c) Receiving hoods

CERTIFICATION AND TESTING

- EN 14175-4:2005 Fume cupboards. Part 4. On-site test methods
- ASHRAE 52 2007. Method of testing general ventilation air-cleaning devices for removal efficiency by particle size.

MAINTENANCE AND CLEANING

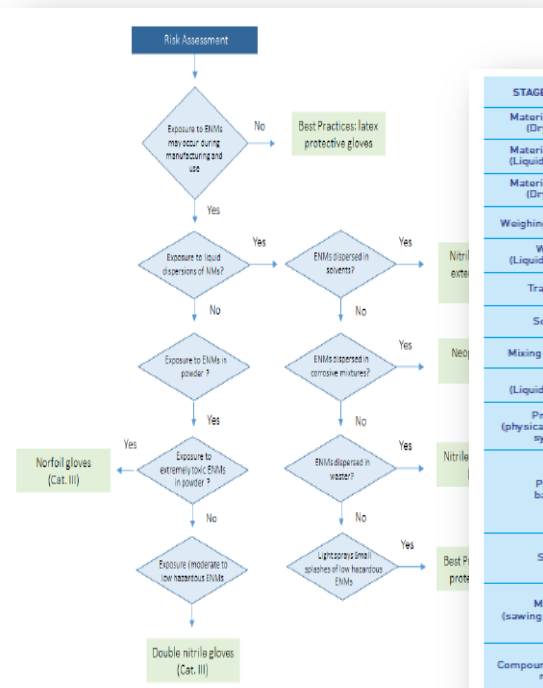
- Maintenance Opening: The entire mechanical and electrical equipment of the ventilation system should be accessible via a secure and suitable opening.
- A fume cupboard function display should be installed to definitely indicate the correct functioning of the ventilation system should
- Routine checks on LEV systems must be undertaken by appropriately trained employees. The frequency of such checks will be determined by making reference to the manufacturer's recommendations, risk assessment findings, previous maintenance history, etc and should be recorded in the systems logbook.
- Before use, thorough visual examination to verify the LEV is in efficient working order, in good repair and in a clean condition.
- When installing LEV, use a reputable supplier, with experience of the type of control that is needed who can demonstrate that their system will adequately control potential contaminants.

RECOMMENDED RPE AGAINST ENMS

- Local exhaust enclosure (Glove Box)
- Ventilated Laboratory Hood (partial enclosure)
- HEPA filtered down flow booth
- Ventilated Laboratory Hood + built-in water wash down systems (sprays)
- Movable LEV systems (extendable arms)
- Receiving hood (that process)

LIFE12 ENV/ES/000178

GUIDANCE AND RELEVANCE OF RMM IN THE WORKPLACE



STAGE / PROCESS	LABORATORY	PILOT PLANTS	INDUSTRIAL SETTINGS (MEDIUM SCALE PRODUCTION)	INDUSTRIAL SETTINGS (LARGE SCALE PRODUCTION)
Material Unpacking (Dry Powder)	Ventilated Laboratory Hood (partial enclosure) Local exhaust enclosure (Glove Box)	HEPA filtered down flow booth	Custom-fabricated enclosures HEPA filtered down flow booth	Custom-fabricated enclosures HEPA filtered down flow room
Material Unpacking (Liquid dispersions)				
Material Unpacking (Dry Powder)	Ventilated Laboratory Hood (partial enclosure)			
Weighing (Dry Powder)	Ventilated Laboratory Hood (partial enclosure) Local exhaust enclosure (Glove Box) Biological safety cabinet			
Transferring				
Sonicator	Ventilated Laboratory Hood (partial enclosure)			
Mixing (Dry Powder)	Ventilated Laboratory Hood (partial enclosure) Local exhaust enclosure (Glove Box)			
Mixing (Liquid dispersions)				
Production (physical and chemical synthesis)	Ventilated Laboratory Hood (partial enclosure)			
Packing / bag filling	Ventilated Laboratory Hood (partial enclosure)			
Spraying	Ventilated Laboratory Hood + built-in water wash down systems			
Machining (sawing, grinding, etc)	Ventilated Laboratory Hood (partial enclosure) Movable LEV systems (extendable arms)			
Compounding / injection molding	Custom-fabricated Movable LEV systems			

	VENTILATED TECHNICAL MEASURES								NON VENTILATED TECHNICAL MEASURES	
	Laboratory fume hood or cupboard	Local exhaust enclosure (Glove Box)	Receiving hood (hot process)	Movable LEV systems	Walk-in hood / booth	HEPA filtered down flow booth	Ventilated collar-type exhaust hoods	HEPA filtered down flow rooms	Custom-fabricated enclosures (fully - partial)	Continuous liver product off-loading system *
Material Unpacking	X	X				X		X	X	
Weighing (Dry Powder and liquid dispersions)	X	X			X	X	X	X		
Transferring	X				X				X	
Sonicator	X								X	
Mixing (Dry Powder and liquid dispersion)	X	X		X	X			X		
Synthesis (Dry/ liquid)	X		X						X	
Packing / bag filling	X					X	X	X	X	X
Spraying					X	X				X
Machining	X			X	X				X	
Compounding / injection molding			X							

ARE CURRENT RMMS EFFICIENT AGAINST ENMS ?

- › If engineering controls (ECs) are **well designed**, they will be effective in limiting environmental release and workplace exposure
- › Existing ECs need to be **supplemented by good practices** and the use of appropriate personal protective equipment (PPE)
- › A key parameter to ensure the effectiveness of respiratory protective equipment is the **face seal**
- › The use of **double gloves** is recommended. **Latex / nitrile** gloves when handling nano-powders and nanoparticles in water suspension. **Butyl rubber** gloves recommended when handling ENMs dispersed in solvents.
- › The use of materials made of **non-woven high density polyethylene textile** offers excellent barrier protection for sub-micron particles



CONCLUSIONS

- › A challenge to propose efficiency values considering the large scope in test methods, test conditions, materials, etc.
- › More nano-specific data required for all RMMs to evaluate their efficiency (e.g. to apply a 5th perc) and consider confounding factors involved
- › For exposure / risk assessment
 - › Converge all the available evidence
 - › Apply conservative estimate including potential variability in safe use
- › More data needed of (simulated) workplace conditions to also obtain more realistic data

ACKNOWLEDGEMENTS

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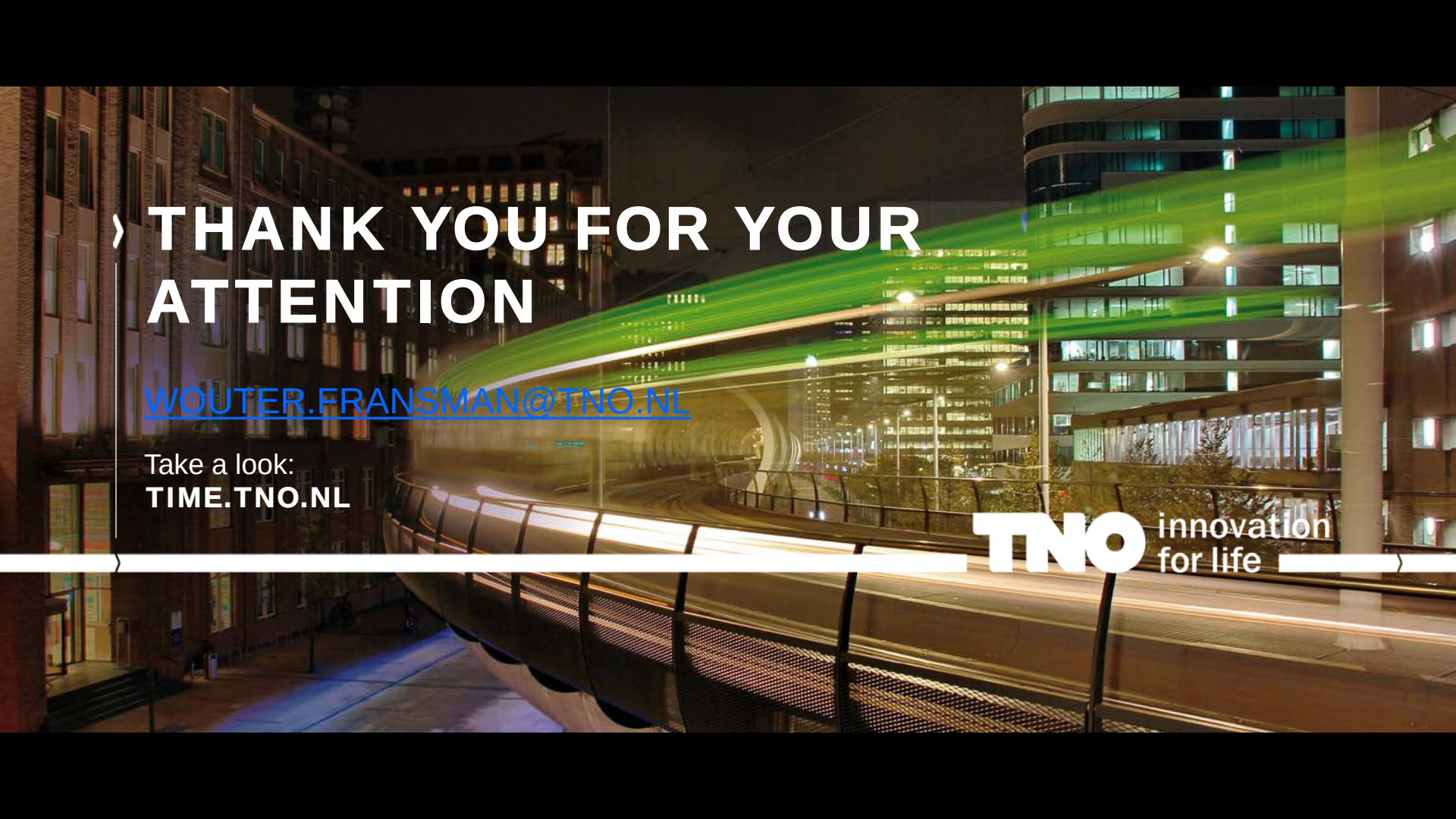
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Sustainable Nanotechnologies Project



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