

IMA-Europe 2024 OSH Seminar
Dust Exposure Monitoring and Health and Safety in the Digital Age
13 November 2024, Sassuolo, Italy

INAIL

Silica Exposure Database



Marco Mecchia

*INAIL, National Institute for Insurance against Accidents at Work
CTSS - Technical Consultancy Department for Health and Safety*

INAIL and crystalline silica monitoring

Law No. 455 of 12 April 1943 extended the compulsory insurance against occupational diseases to silicosis.

The payment to INAIL of an additional insurance premium was due when workers were exposed to the risk of contracting silicosis.

In the 1980s, INAIL began to use personal sampling of respirable dust to assess exposure in the workplace, with the general approach still used today.

Act No. 145 of 30 December 2018: since 1 January 2019, the silicosis premium no longer has to be paid.

Today, the monitoring carried out by INAIL is aimed at raising awareness and supporting employers in the assessment of chemical risks.

Act No. 44 of 1 June 2020: work involving exposure to respirable crystalline silica dust generated by a work process was included in the carcinogens list and a limit value for occupational exposure was set at 0.1 mg/m^3

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Forum della prevenzione "Made in Inail"

Ventitré tappe territoriali per innovare le strategie sulla salute e sicurezza sul lavoro



All the measurements of worker exposure to respirable crystalline silica and respirable dust carried out by INAIL between 2000 and present have been collected in a database

Attività di prevenzione dei rischi lavorativi,

Tutela dei lavoratori contro i danni fisici ed

Erogazione di prestazioni economiche,

Attività di ricerca, studio, sperimentazione

The database is freely accessible on the INAIL portal:

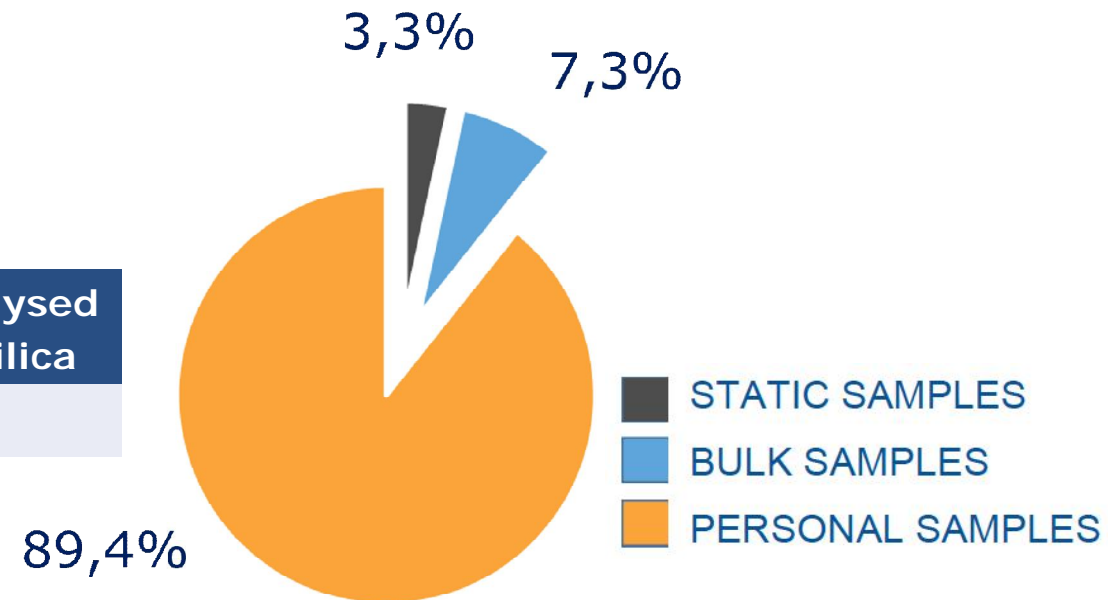
<https://www.inail.it/portale/prevenzione-e-sicurezza/it/come-fare-per/conoscere-il-rischio/banca-dati-esposizione-silice.html>



INAIL Silica Exposure Database

<https://www.inail.it/portale/prevenzione-e-sicurezza/it/come-fare-per/conoscere-il-rischio/banca-dati-esposizione-silice.html>

No. factories / construction sites	No. samples collected	No. samples analysed for crystalline silica
1064	8244	7927



A feature of the INAIL database is the uniformity of sampling protocol and analysis method and consequently the comparability of the measurement results

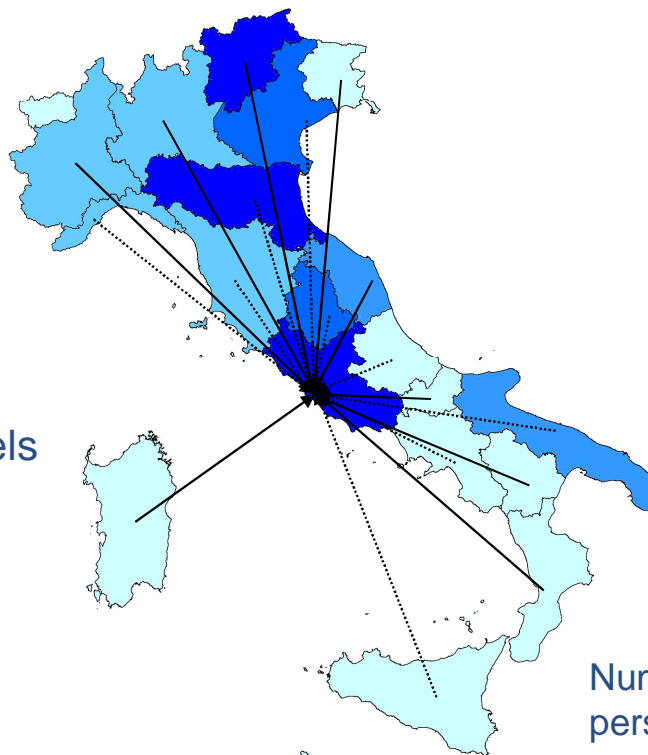


Sampling

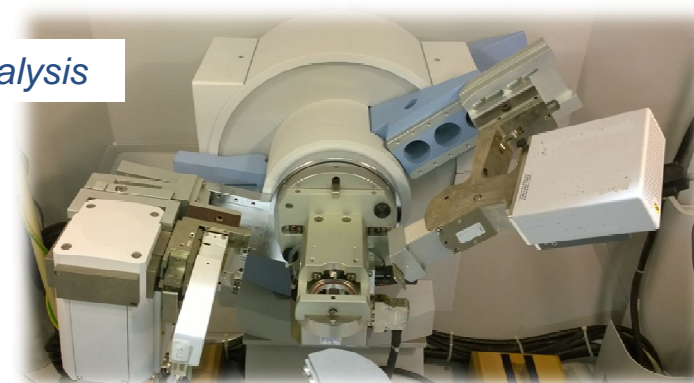
All samplings were carried out by INAIL professionals, following the same sampling strategy and using the same sampler models



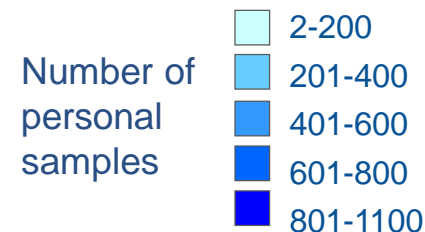
Sampler models



Analysis



All analyses were performed by X-ray diffraction in a single laboratory (INAIL CTSS in Rome)



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INAIL SILICA EXPOSURE DATABASE

INAIL

REPORT 2000-2019

2022

COLLANA RICERCHE

Report 2000-2019

A dataset of 7161 personal sample measurements of exposure, 273 static samples and quartz concentration in 594 bulk samples collected in the workplaces during INAIL inspections conducted between 2000 and 2019 have been used to prepare this Report

download at:

<https://www.inail.it/portale/it/inail-comunica/pubblicazioni/catalogo-generale/catalogo-generale-dettaglio.2022.02.silica-exposure-database-report-2000-2019-.html>

QUARRYING AND MINING

B1 - QUARRYING OF MARBLE, GRANITE and other... 102

B2 - 70

B3 - QUARRYING OF CLAYS, POZZOLANA AND FELDSPAR 24

B4 - 19

C1 - 171

C2 - PAINTS, GLUES AND ADHESIVES 14

C3 - 79

C4 - GLASS 56

C5 - REFRACTORIES

C6 - 263

C7 - BRICKS

C8 -

C9 - 84

C10 - CEMENT 241

C11 - CONCRETE PRODUCTS

C12 - 4

C13 - 133

C14 - FOUNDRY SAND CORES

C15 -

C16 - 63

C17 - TREATMENT OF METALS 21

C18 - 120

C19 - JEWELLERY 4

C20 - 8

C21 - 296

F1 - CONSTRUCTION

F2 - 48

F3 - 11

F4 -

MANUFACTURING

CONSTRUCTION

INAIL
SILICA
EXPOSURE
DATABASE

NUMBER of
SAMPLES
COLLECTED
(November 2024)

CONTARP 2016
classification of industries
in which exposure to RCS
might be a risk

example

C14 FOUNDRY SAND CORES: Production of foundry sand cores and moulds

Contarp 2016 classification

WORK PHASE-DEPARTMENT / JOB TITLE	Job definition
C14.01 - Management and office work	
	Carries out the management and/or operational functions involving production department coordination and control (e.g. head of production unit, lab manager and supervisor). In small companies, these tasks are often handled by the company holder (partner or owner fulfilling both administrative and operating tasks).
	Performs clerical or technical tasks in the office. Duties may include a variety of roles and responsibilities. Occasionally, may be required to work in the production departments.
C14.02 - Core making	
C14.02.01 - Mixer	Loads the automatic (kneading) mixing machine, controlling the mixture of sand, catalyst, resin and aggregate. If necessary, carries the mixture to the core maker by wheelbarrow.
C14.02.02 - Hand core maker	Prepares sand-cores by hand. Takes the mixture of sand, catalyst, resin and aggregate from a bucket and forces it into specially shaped hollow forms.
C14.02.03 - Semi-mechanised core making operator	Prepares sand-cores by using a machine that fills the specially shaped hollow forms with the mixture of sand, catalyst, resin and aggregate, then smooths it by hand.

Contarp 2016 classification

WORK PHASE-DEPARTMENT / JOB TITLE	Job definition
C14.03 - Pattern making	
C14.03.01 - Pattern maker	Makes patterns (models) of cores and moulds used to reproduce the object. The pattern can be made of wood, metal, plaster, concrete or synthetic resin. Finishes the pattern, if required.
C14.04 - Handling of materials and products	
C14.04.01 - Forklift operator	Operates material handling equipment (hand or battery operated pallet truck, reach truck, forklift) to move, pack and store raw materials and finished products.
C14.05 - Warehousing and packaging	
C14.05.01 - Warehouse operator	Handles duties pertaining to the processing, organising, packaging and shipping of materials, equipment and other items that are sent to warehouse or storage yard. Drives forklift to pick up incoming stock or deliver materials to designated area.
C14.06 - Various workspaces	
C14.06.01 - Polyvalent worker	Performs a wide and diverse range of duties that generally involve repeated procedures or handiwork. Assists other workers in various work assignments as needed or fills in for absent workers. Also called multipurpose worker. May also include forms of on-the-job training or apprenticeship.
C14.07 - Mechanical and electrical maintenance / cleaning	
- Maintenance mechanic / electrician	Maintains, repairs and assembles machines and/or electrical and auxiliary parts of electronic equipment both in the mechanical workshop and in the factory departments. The job title includes both foreman / maintenance manager and other workers.
- Workplace cleaner	Keeps working areas and courtyards in clean and in an orderly condition, performing sweeping, vacuum cleaning and washing of floors. May use scrubbers, sweepers and manual cleaning equipment.

CONTARP 2016 classification of job titles in industries in which exposure to RCS might be a risk

designed with the aim of getting to a definition closer to the SEG definition, making the use of RCS exposure measurement data more effective in the risk assessment process

C14.02.06 - Core-shooting machine tool assembler	Fits and assembles core-shooting machine parts and components according to specifications for products.
C14.02.07 - Sand core finishing / deburring operator	Carries out manual finishing of sand cores with files. May perform the gluing of the parts making up the sand core.
C14.02.08 - Core painting operator	Applies water-based with dipping or brush painting over core surfaces to be treated.
C14.02.09 - Dryer operator	Operates the sand core dryers. Loads the cores on trays and places them in the dryer. At the end of the drying phase, moves them to storage and unloads the cores.

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IMA-Europe 2024 OSH Seminar

Marco Mecchia

13 November 2024

- > Panoramica principale
- > Campioni personali
 - > Dati generali
 - > **Dati rilevati**
 - > Territorio e stagione

FILTRA PER

Ente

Inail

Analita

Quarzo

Anno

Da

1999

a

2021

Macroarea

--Seleziona valore--

Regione

EMILIA-ROMAGNA

Provincia

--Seleziona valore--

Attività aziende Contarp 2016

- ☒ C05 - REFRATTARI : Fabbricazione di prodotti refrattari
- ☒ C06 - PIASTRELLE IN CERAMICA : Fabbricazione di piastrelle in ceramica
- ☒ C07 - LATERIZI : Fabbricazione di mattoni, tegole ed altri prodotti per l'edilizia
- ☒ C08 - CERAMICA ARTISTICA : Fabbricazione di prodotti in ceramica artistica
- ☒ C09 - SANITARI IN CERAMICA : Fabbricazione di articoli sanitari in ceramica
- ☐ C10 - CEMENTO : Produzione di cemento
- ☐ C11 - PRODOTTI IN CALCESTRUZZO : Fabbricazione di prodotti in calcestruzzo
- ☐ C12 - LAVORAZIONE LAPIDEI : Taglio, modellatura e finitura di pietre

Concentrazione media di polveri silicotigene, per attività secondo la classificazione Contarp 2016

...browsing the database...

PERSONAL SAMPLES
Data collected

Concentrazione media di polveri silicotigene



Attività aziende Contarp 2016	Polvere respirabile			Quarzo cristallino		
	Campioni analizzati	Media geometrica mg/m³	Deviazione geometrica standard mg/m³	Campioni analizzati	Media geometrica mg/m³	Deviazione geometrica standard mg/m³
Totale complessivo	391	0,369	2,066	391	0,029	2,925
C05 - REFRATTARI : Fabbricazione di prodotti refrattari	24	0,575	2,315	24	0,018	4,671
C06 - PIASTRELLE IN CERAMICA : Fabbricazione di piastrelle in ceramica per pavimenti e rivestimenti	347	0,363	1,996	347	0,031	2,754
C07 - LATERIZI : Fabbricazione di mattoni, tegole ed altri prodotti per l'edilizia in terracotta	14	0,276	3,063	14	0,016	5,127
C08 - CERAMICA ARTISTICA : Fabbricazione di prodotti in ceramica artistica, per usi domestici e ornamentali	6	0,308	1,664	6	0,017	1,552

NUMERO RIGHE TOTALI: 4

Esporta

IMA-Europe 2024 OSH Seminar

Marco Mecchia

13 November 2024

> Panoramica principale

> Campioni personali

> Dati generali

> **Dati rilevati**

> Territorio e stagione

Analita

Quarzo

Anno

Da

1999

a

2021

Macroarea

--Seleziona valore--

Regione

EMILIA-ROMAGNA

Provincia

--Seleziona valore--

Attività aziende Contarp 2016

- ☒ C05 - REFRATTARI : Fabbricazione di prodotti refrattari
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FILTRO PER:

Ente: Inail

Analita: Quarzo

Anno: 1999,2021

Macroarea: Tutte le macroaree

Regione: EMILIA-ROMAGNA

Provincia: Tutte le province

... browsing the database ...

C06 - LATERIZI : Fabbricazione di prodotti refrattari,C06 -

- LATERIZI : Fabbricazione di mattoni, tegole ed altri prodotti per l'edilizia in terracotta,C08 -

CERAMICA ARTISTICA : Fabbricazione di prodotti in ceramica artistica, per usi domestici e ornamentali,C09 - SANITARI IN CERAMICA :

Fabbricazione di articoli sanitari in ceramica

Mansione Contarp 2016: Tutte le mansioni

PERSONAL SAMPLES
Data collected
Job title (Occupation)

Mansioni nelle attività aziende Contarp 2016	Polvere respirabile			Quarzo respirabile		
	Campioni analizzati	Media geometrica mg/m³	Deviazione geometrica standard mg/m³	Campioni analizzati	Media geometrica mg/m³	Deviazione geometrica standard mg/m³
Totale complessivo	391	0,369	2,066	391	0,029	2,925
C05.02.01 - Addetto alla macinazione e vagliatura	2	1,554		2	0,008	
C05.03.01 - Addetto alla preparazione impasto	4	0,843	1,432	4	0,013	1,000
C05.05.01 - Addetto al colaggio stampi	2	0,687		2	0,071	
C05.06.01 - Addetto allo stampaggio alla pressa	4	0,448	4,151	4	0,011	9,128
C05.08.01 - Addetto alla smaltatura	2	0,399		2	0,033	
C05.09.01 - Addetto alla rifinitura	6	0,687	1,717	6	0,030	4,766
Addetto al montaggio	2	0,264		2	0,023	
Manutentore meccanico/elettricista	2	0,253		2	0,007	
Posizione organizzativa di "ile"	9	0,336	1,823	9	0,018	4,081

- > Dati generali
- > **Dati rilevati**
- > Territorio e stagione
- > Campioni ambientali
- > Campioni massivi
- > Strumenti
- > Confronto
- [Consulta la guida](#)

FILTRA PER

Ente

Analita
Quarzo

Anno
Da 1999 a 2021

Macroarea
--Seleziona valore--

Regione
EMILIA-ROMAGNA

Provincia
--Seleziona valore--

Campioni personali: valori puntuali di tutte le misure di concentrazione di polvere e di silice libera respirabili effettuate per le attività e/o le mansioni selezionate

... browsing the database ...

Numero	Polvere respirabile mg/m³	Quarzo respirabile mg/m³	Tenore di quarzo
1	0,106	0,004	3,5%
2	0,126	0,010	8,3%
3	0,135	0,027	20,3%
4	0,223	0,009	4,0%
5	0,262	0,016	6,1%
6	0,351	0,060	17,2%
7	0,352	0,032	9,0%
8	0,410	0,013	3,2%
9	0,411	0,062	15,1%
10	0,424		

PERSONAL SAMPLES
Data collected
Job title (Occupation)
Details

RIGHE 1 - 10

NUMERO RIGHE TOTALI: 31

Esporta

- Formattato
- Dati

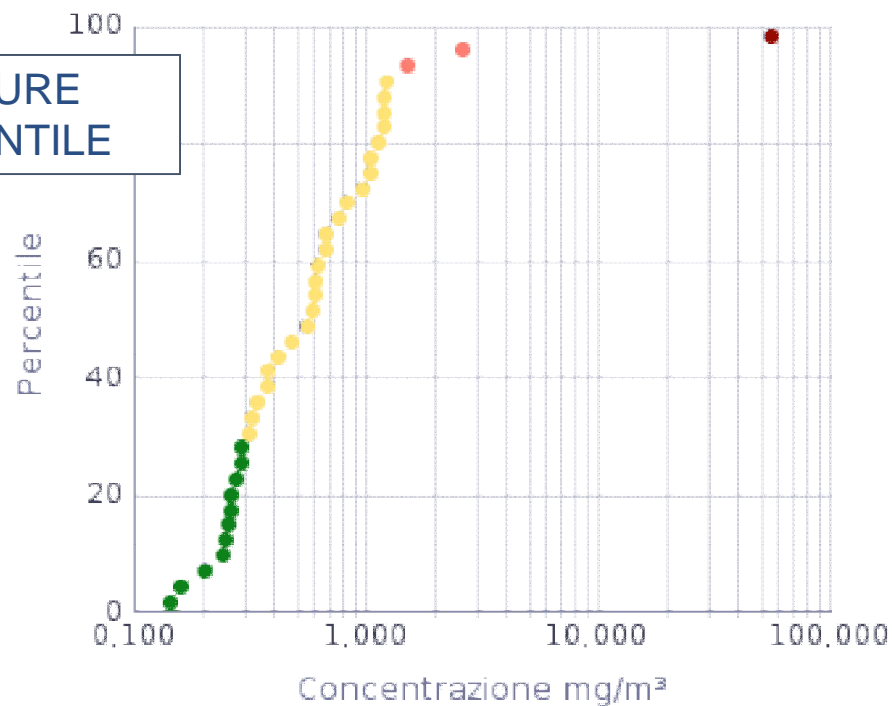


Tenore di quar. respirabili (tutti i dati)

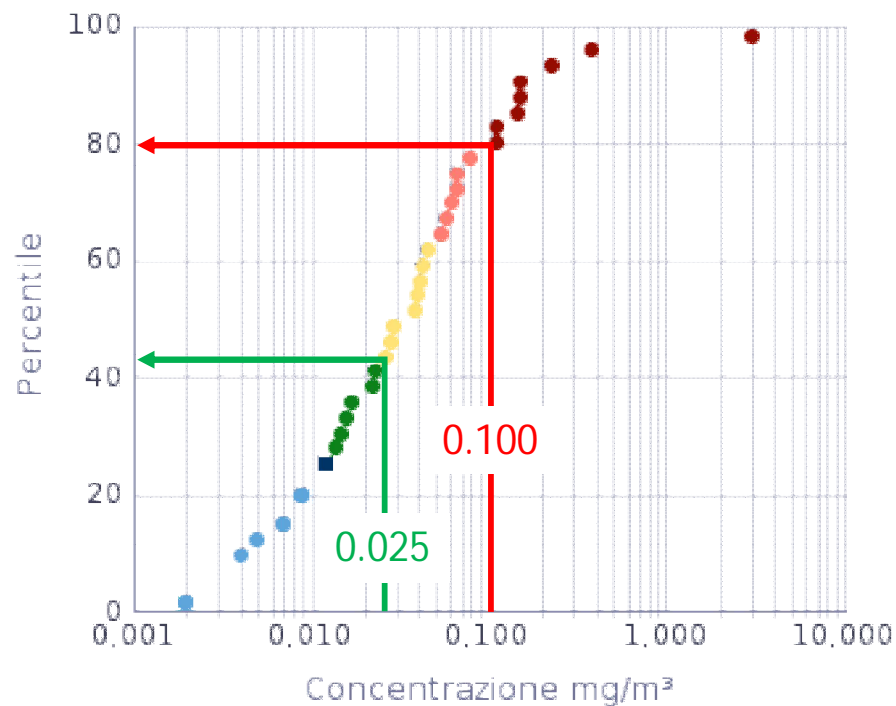
C16 - FOUNDRIES

C16.07.02 - Furnace operator

Respirable dust concentration
guide value recommended by ACGIH= **3 mg/m³**



Respirable quartz concentration
OELV = **0.1 mg/m³**



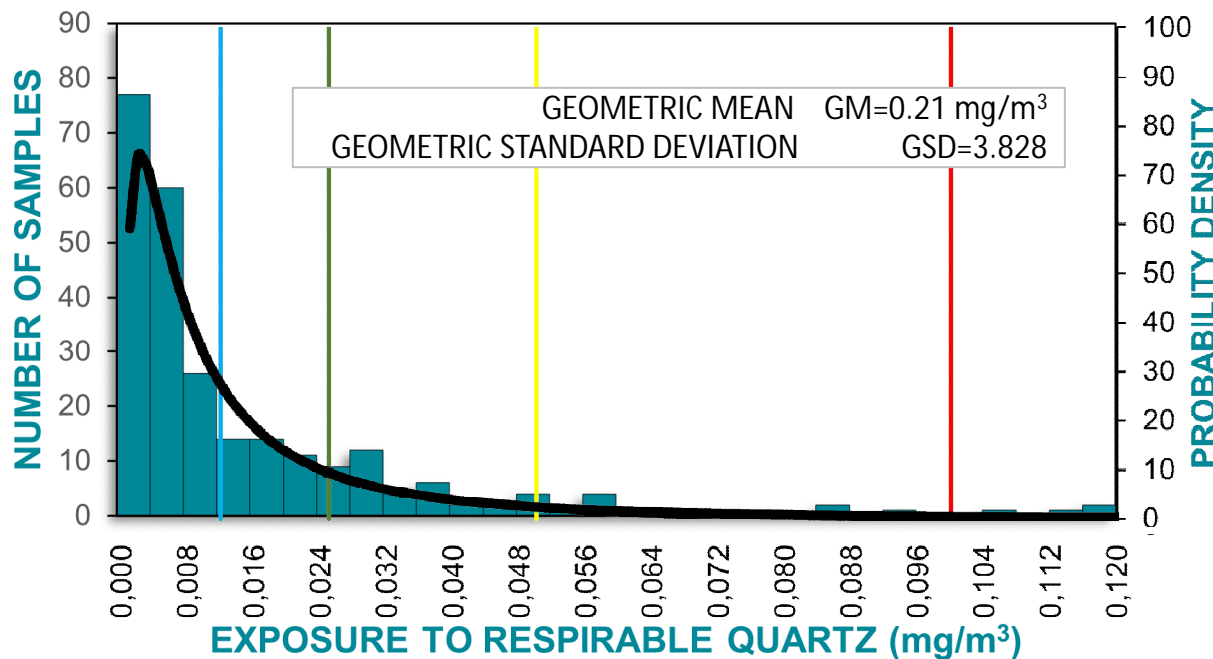
... browsing the database...

THE MEASUREMENT RESULTS THAT REPRESENT A
SIMILAR EXPOSURE GROUP (SEG)
ARE EXPECTED TO APPROXIMATE TO A LOG-NORMAL DISTRIBUTION

Log-normal distribution of exposure data, by SEG

CONSTRUCTION

F1.07.03 Power-shovel / loader operator



$$GM = \sqrt[n]{x_1 \cdot x_2 \cdot \dots \cdot x_n}$$

$$GSD = \exp \sqrt{\frac{\sum_{i=1}^n (\ln(x_i) - \ln(GM))^2}{n-1}}$$

$$f = \frac{1}{x \cdot \ln(GSD) \cdot \sqrt{2\pi}} \cdot \exp \left(-\frac{(\ln(x) - \ln(GM))^2}{2 \cdot \ln^2(GSD)} \right)$$

EN 689: 2018

Workplace exposure - Measurement of exposure by inhalation to chemical agents -
Strategy for testing compliance with occupational exposure limit values

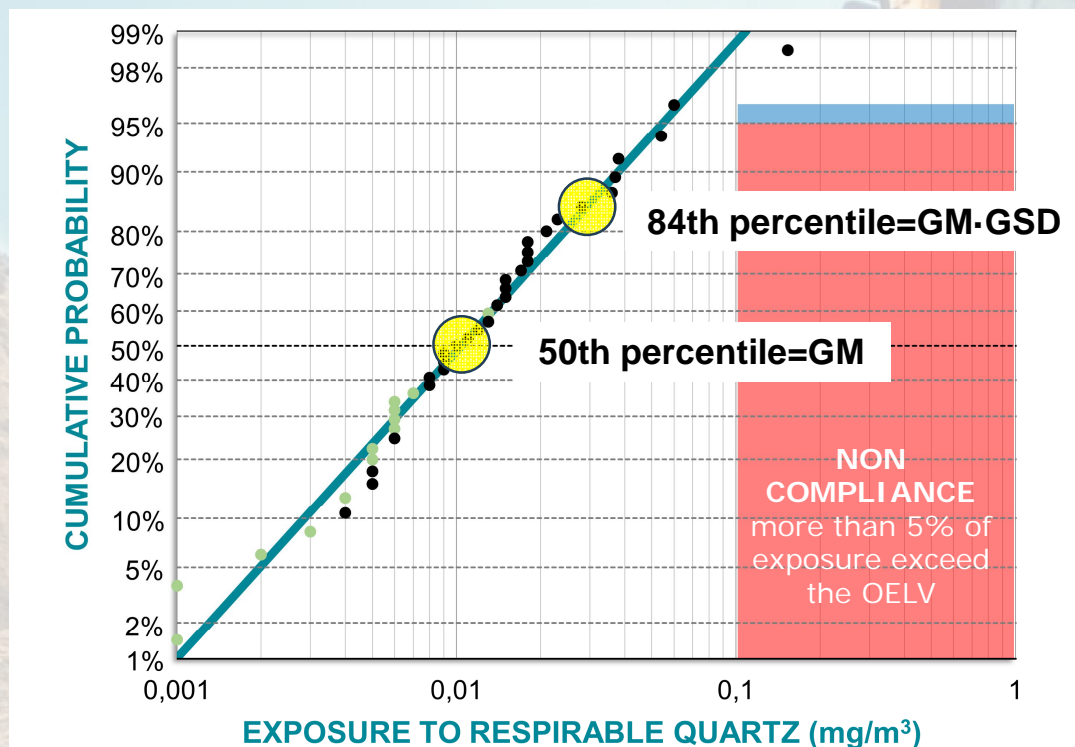
STATISTICAL TEST

to check whether the exposure of a SEG complies with the OELV

- At least 6 measurements of exposure should be made
- COMPLIANCE: The test shall measure, with at least 70% confidence, whether less than 5% of exposures in the SEG exceed the OELV

Log-probability graph

$$P_k = \frac{k - 3/8}{n + 1/4}$$

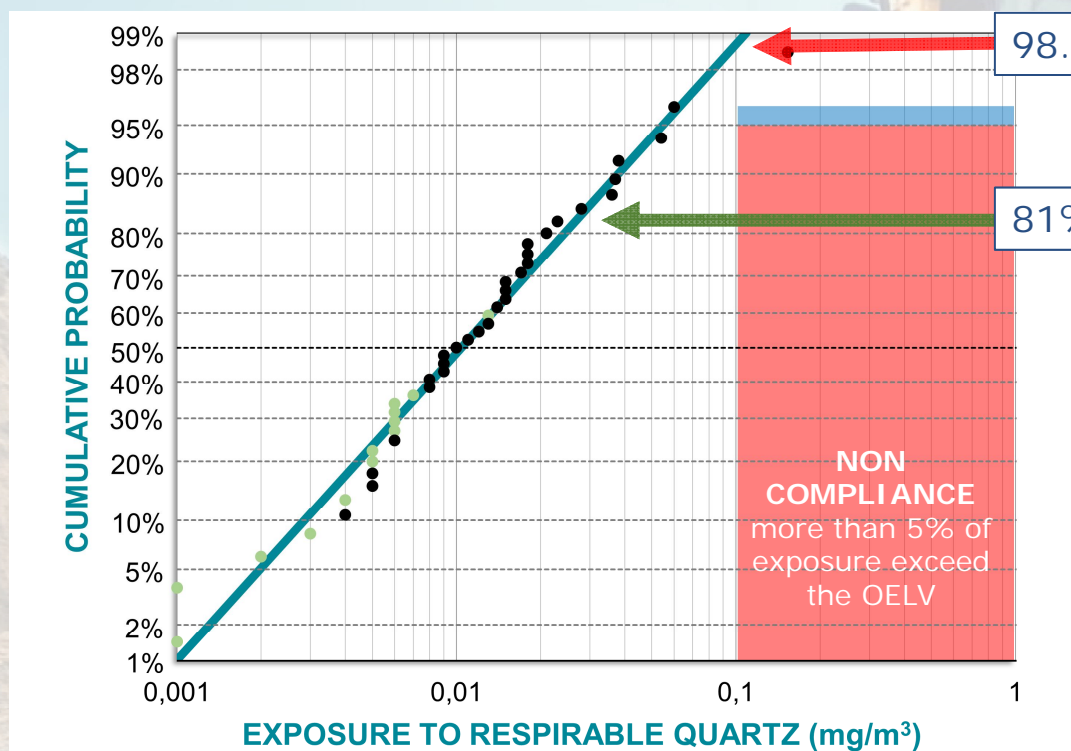


k	X _i (mg/m ³)	P _k	k	X _i (mg/m ³)	P _k
1	0,001	1,4%	22	0,010	50,0%
2	0,001	3,8%	23	0,011	52,3%
3	0,002	6,1%	24	0,012	54,6%
4	0,003	8,4%	25	0,013	56,9%
5	0,004	10,7%	26	0,013	59,2%
6	0,004	13,0%	27	0,014	61,6%
7	0,005	15,3%	28	0,015	63,9%
8	0,005	17,6%	29	0,016	66,2%
9	0,005	19,9%	30	0,017	68,5%
10	0,005	22,3%	31	0,017	70,8%
11	0,006	24,6%	32	0,018	73,1%
12	0,006	26,9%	33	0,018	75,4%
13	0,006	29,2%	34	0,019	77,7%
14	0,006	31,5%	35	0,020	80,1%
15	0,007	33,8%	36	0,021	82,4%
16	0,007	36,1%	37	0,022	84,7%
17	0,008	38,4%	38	0,023	87,0%
18	0,008	40,7%	39	0,024	89,3%
19	0,009	43,1%	40	0,025	91,6%
20	0,009	45,4%	41	0,026	93,9%
21	0,009	47,7%	42	0,027	96,2%
			43	0,153	98,6%

1 – List the exposure data X_i in ascending order

2 – Calculate the probability P_k of not exceeding the exposure value

Log-probability graph



COMPLIANCE WITH EN OELV

98.7% of measurements are lower than 0,1 mg/m³

NON COMPLIANCE WITH ACGIH TLV

81% of measurement are lower than 0.025 mg/m³

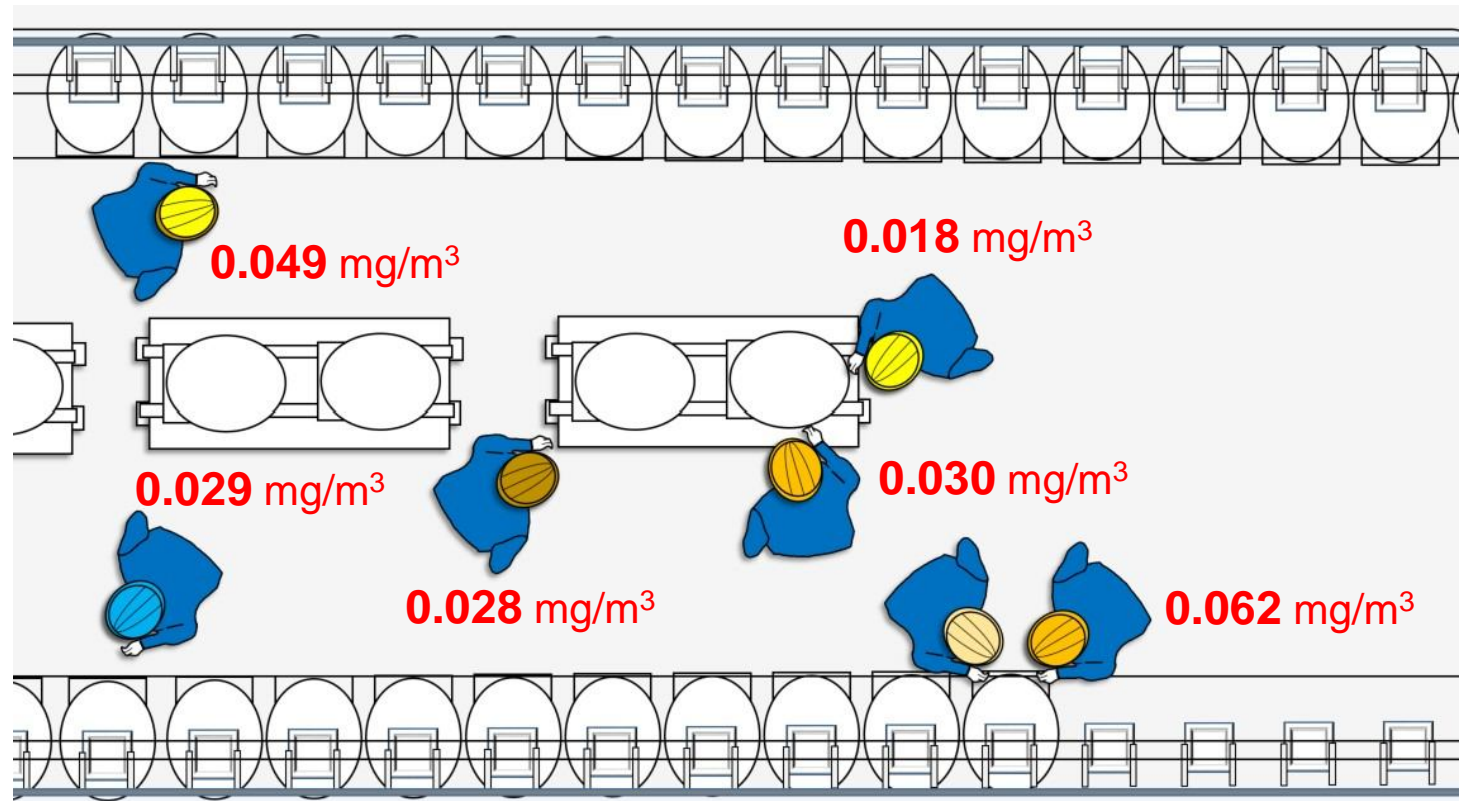
NON
COMPLIANCE
more than 5% of
exposure exceed
the OELV

C9. MANUFACTURE OF CERAMIC SANITARY FIXTURES



FACTORY A

C9.03.02 Casting machine operator



Example of sampling for exposure assessment

C9. MANUFACTURE OF CERAMIC SANITARY FIXTURES

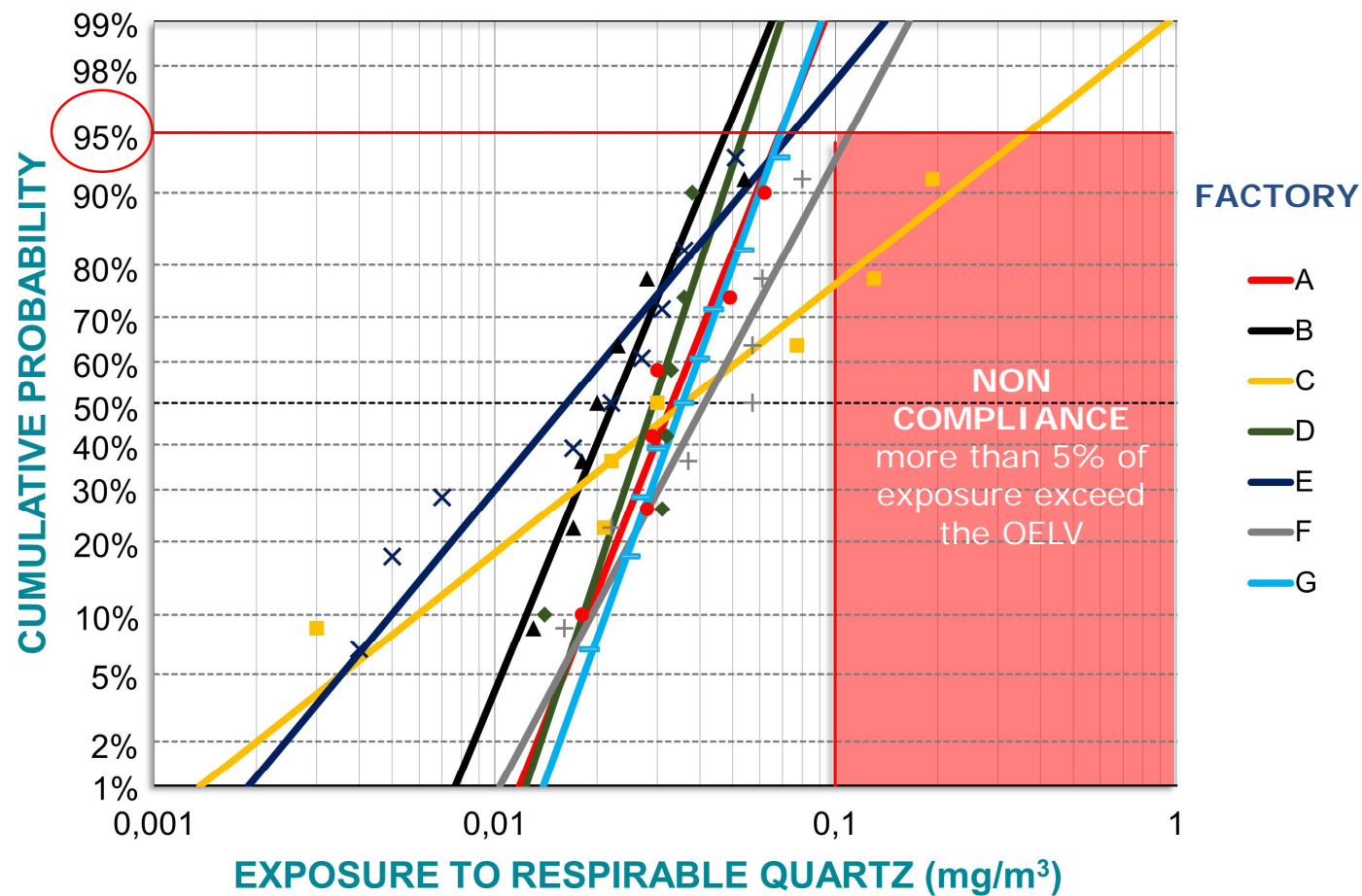


Exposure probability

INAIL



C9.03.02 Casting machine operator



C9. MANUFACTURE OF CERAMIC SANITARY FIXTURES

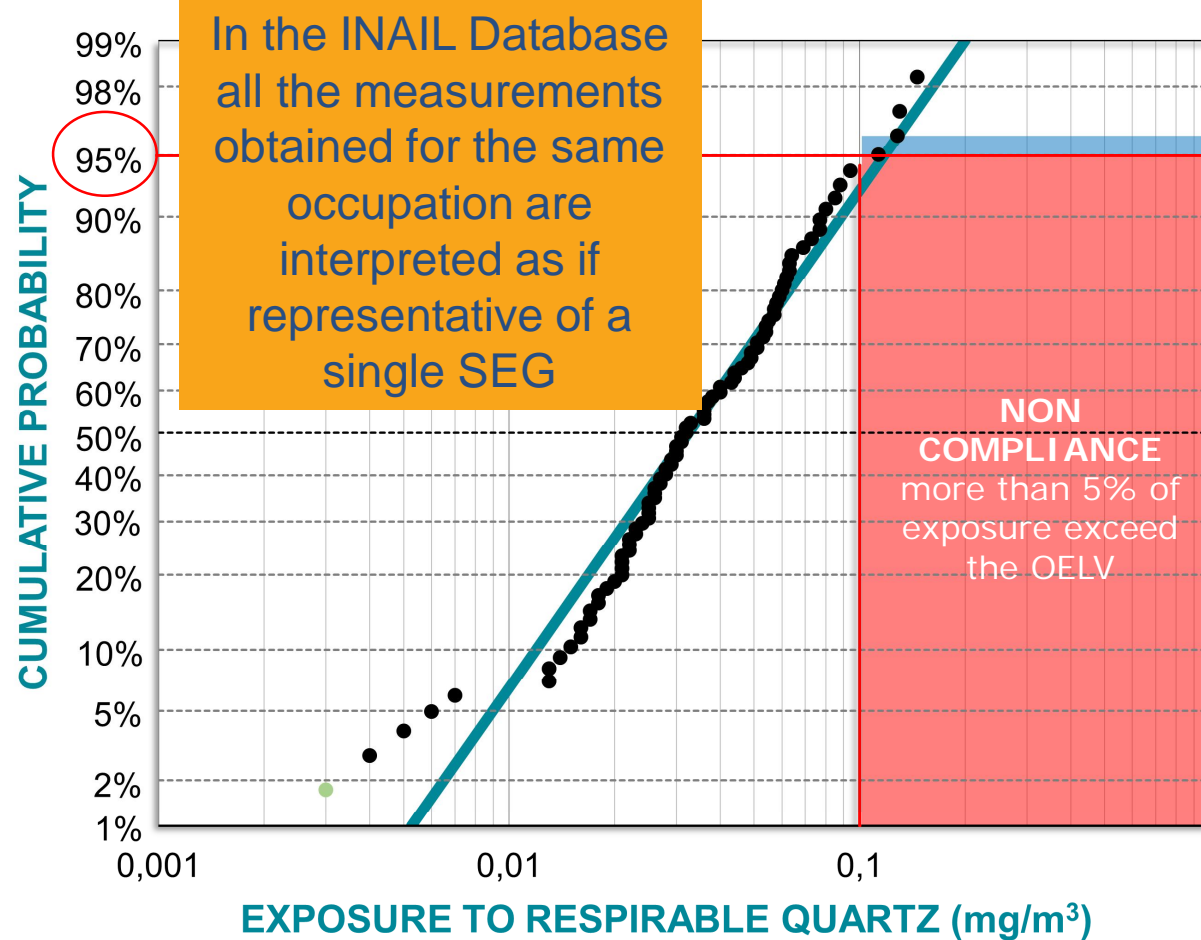


Exposure probability

INAIL



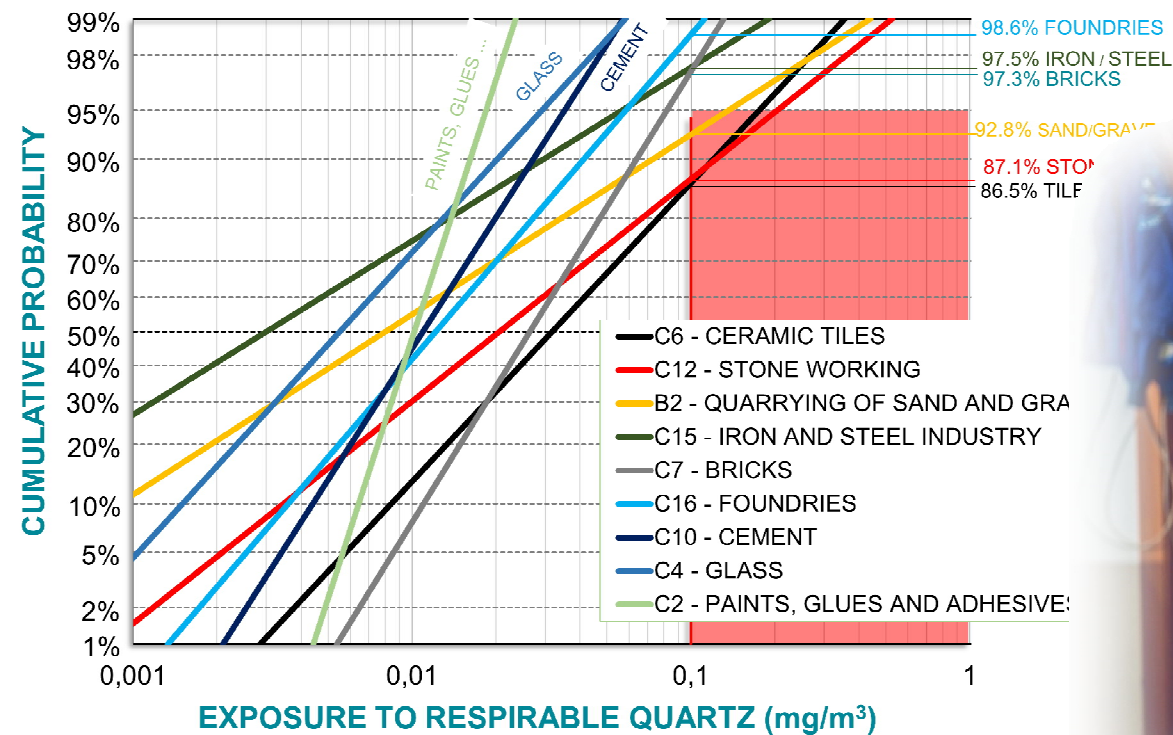
C9.03.02 Casting machine operator



COMPARISON OF EXPOSURE TO CRYSTALLINE SILICA
FOR THE SAME OCCUPATION IN DIFFERENT INDUSTRIES

Comparison of exposures for the same occupation in different industries

Maintenance
mechanic / electrician

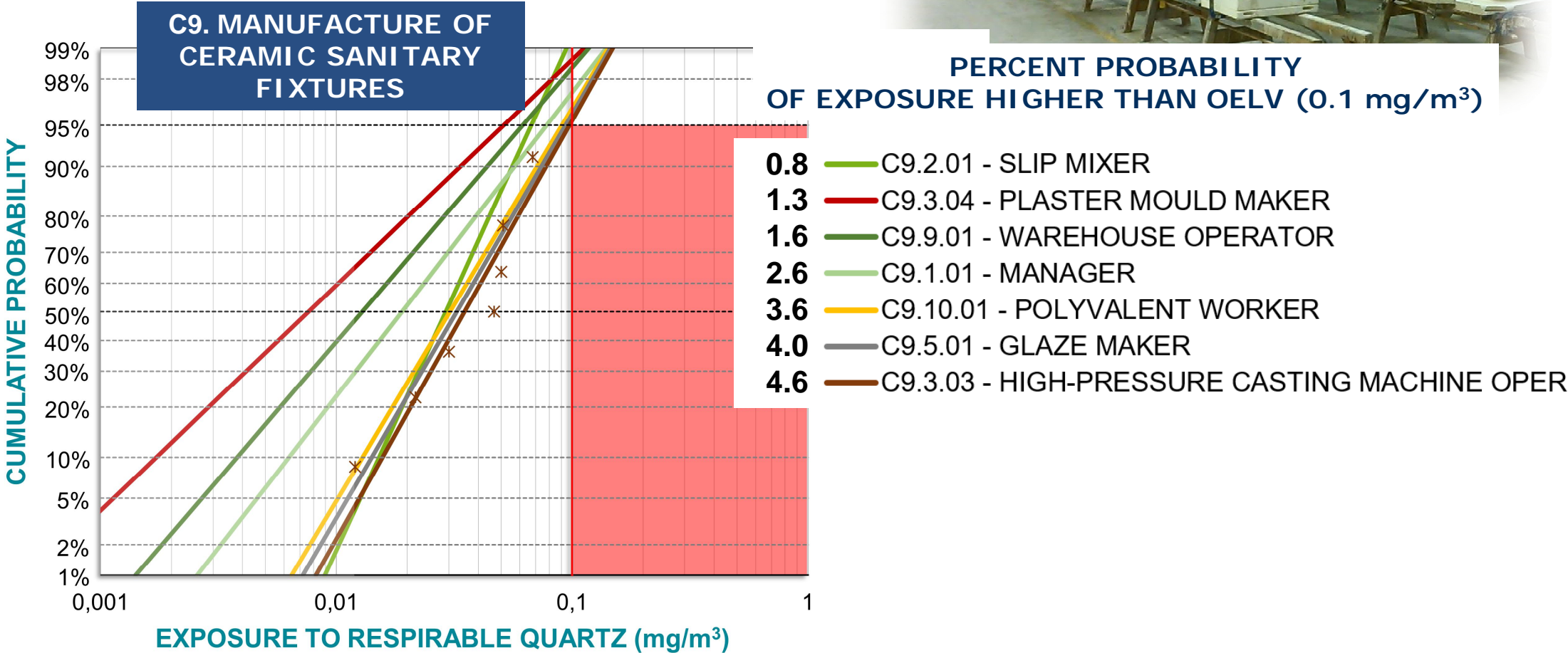


ASSESSMENT OF RISK OF SILICA DUST EXPOSURE IN AN INDUSTRY

-

ALL OCCUPATIONS

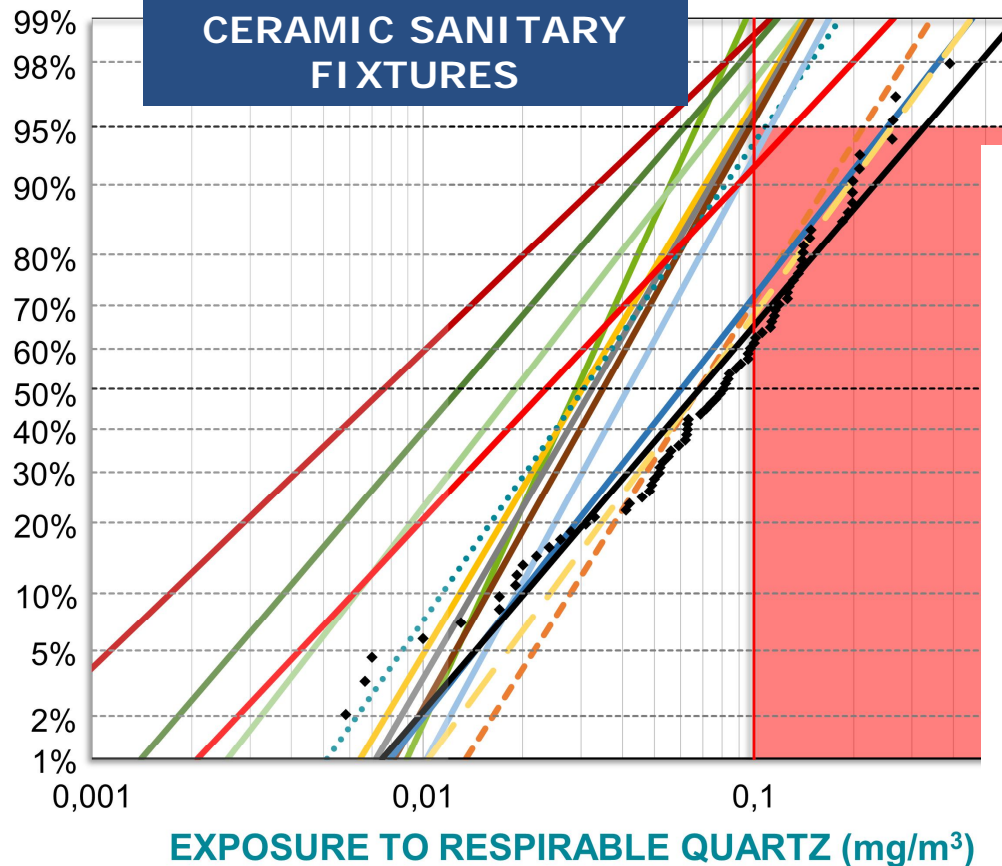
Probability of exposure to crystalline silica
for all the occupations in an industry sector



Probability of exposure to crystalline silica for all the occupations in an industry sector



C9. MANUFACTURE OF CERAMIC SANITARY FIXTURES



PERCENT PROBABILITY OF EXPOSURE HIGHER THAN OELV ($0.1 \text{ mg}/\text{m}^3$)

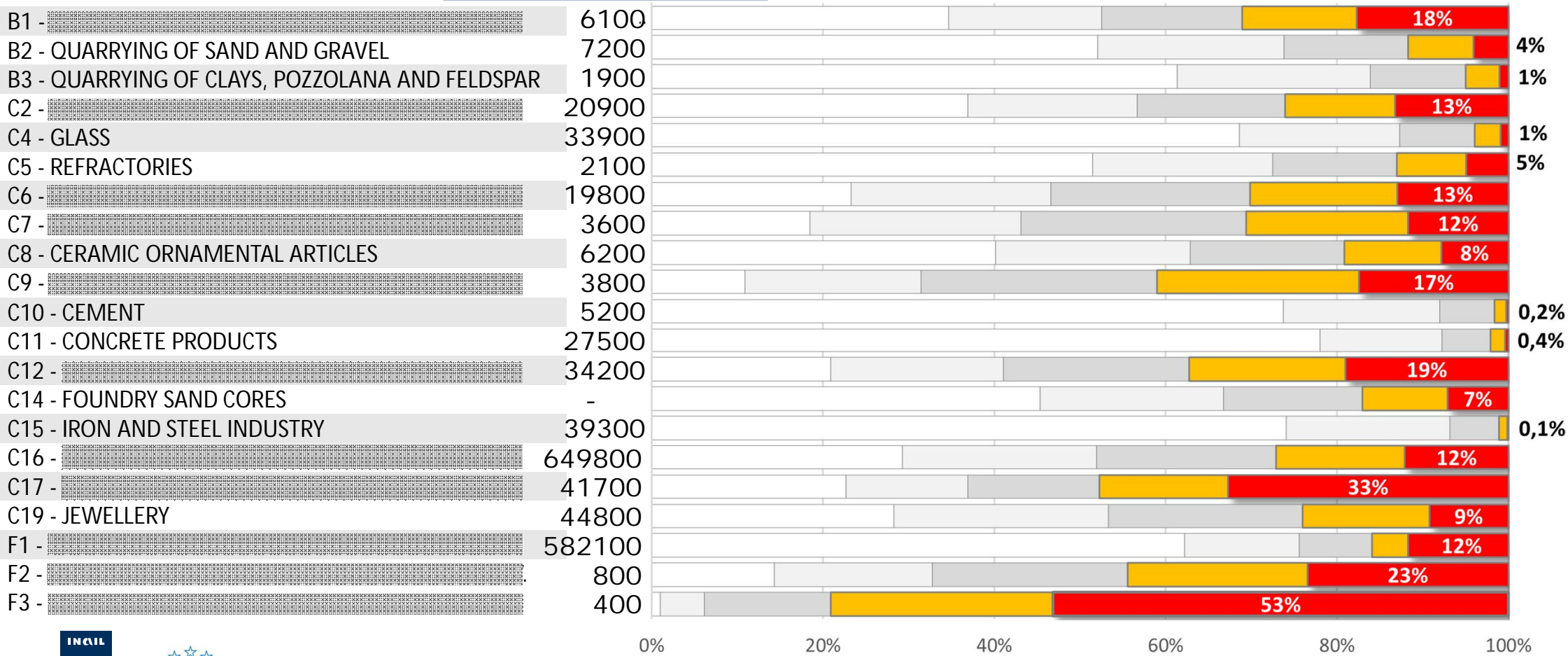
- 0.8** — C9.2.01 - SLIP MIXER
- 1.3** — C9.3.04 - PLASTER MOULD MAKER
- 1.6** — C9.9.01 - WAREHOUSE OPERATOR
- 2.6** — C9.1.01 - MANAGER
- 3.6** — C9.10.01 - POLYVALENT WORKER
- 4.0** — C9.5.01 - GLAZE MAKER
- 4.6** — C9.3.03 - HIGH-PRESSURE CASTING MACHINE OPER.
- 6.1** — C9.3.02 - CASTING MACHINE OPERATOR
- 7.2** — C9.3.01 - MANUAL CASTING OPERATOR
- 8.2** — C9.7.01 - KILN LOADING OPERATOR
- 28.1** — C9.4.01 - WARE FINISHER
- 29.0** — C9.5.03 - GLAZING ROBOT OPERATOR
- 32.1** — C9.5.02 - MANUAL GLAZING OPERATOR
- 34.5** — C9.4.03 - WARE TESTING OPERATOR



OVERVIEW OF CRYSTALLINE SILICA EXPOSURE BY INDUSTRY

Number of employees
in active enterprises
(ISTAT 2018)

RED BARS:
limit value (0.1 mg/m³) exceedances



CONCENTRATION THRESHOLD EXCEEDANCES

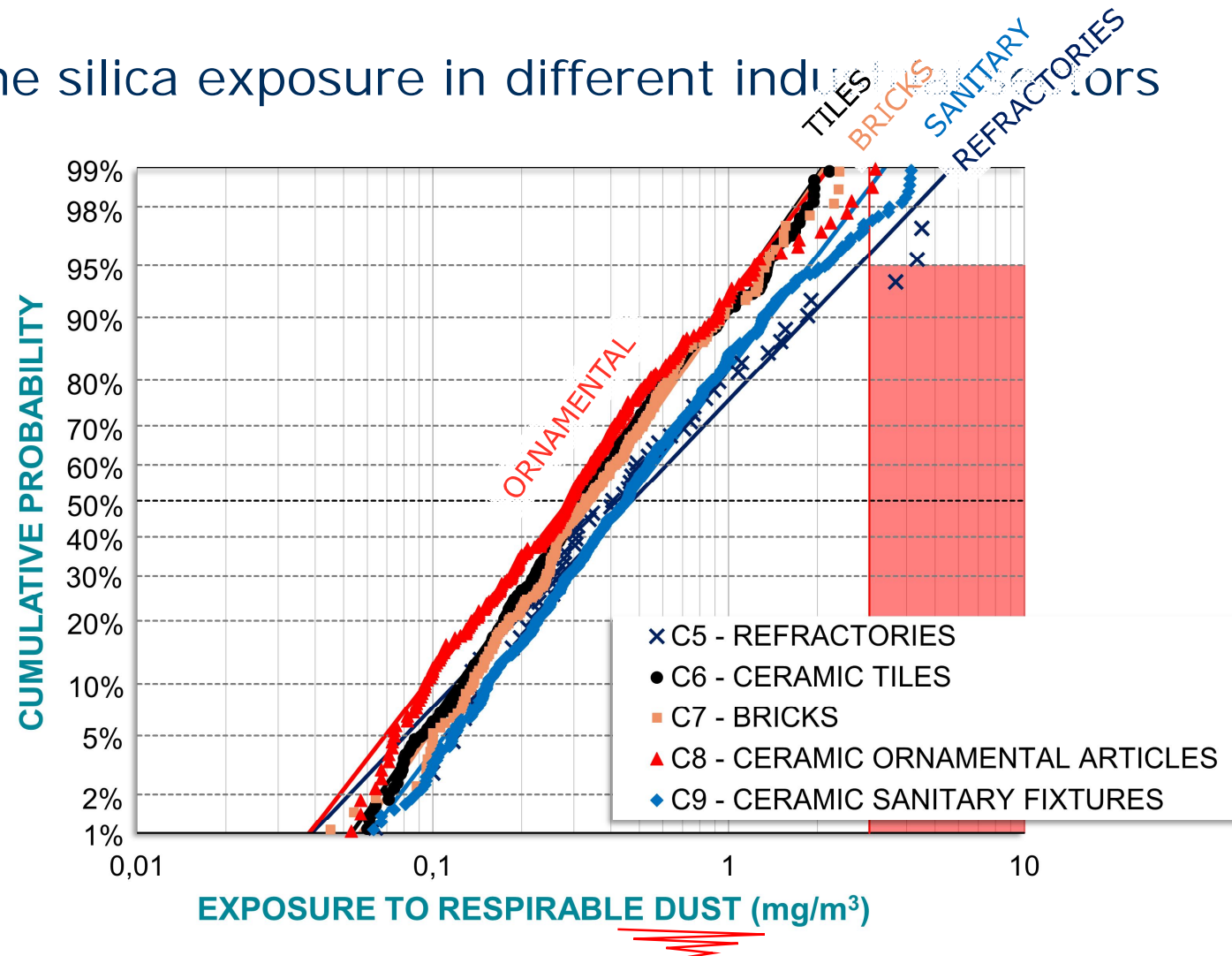
☐ less than 0.012 mg/m³
☐ 0.012-0.025
 ☐ 0.025-0.05
 ☐ 0.05-0.1
 ☐ more than 0.1 mg/m³

Comparison of crystalline silica exposure in different industries

CERAMIC INDUSTRY

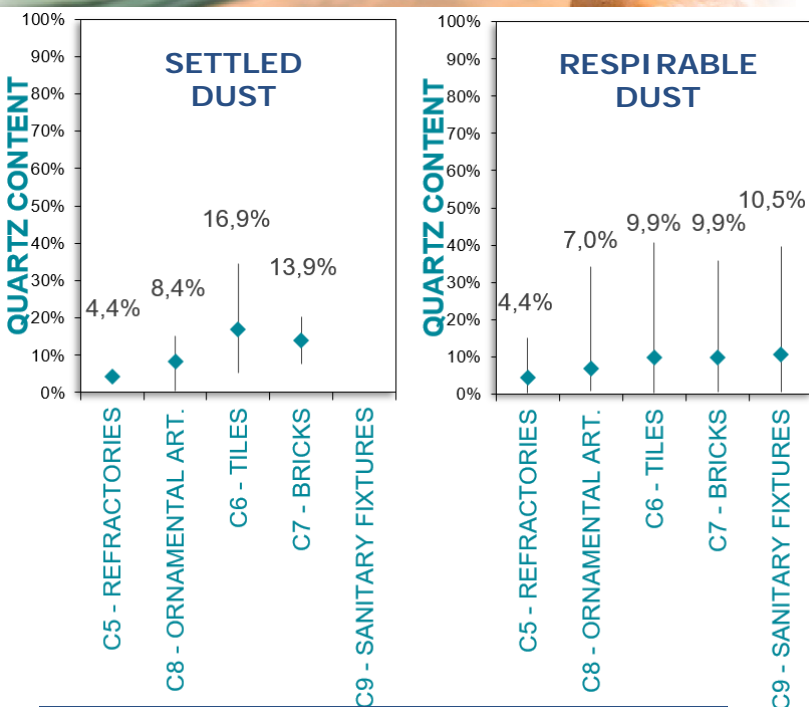


C5 – REFRACTORIES
C6 – CERAMIC TILES
C7 – BRICKS
C8 – ORNAMENTAL ARTICLES
C9 – SANITARY FIXTURES

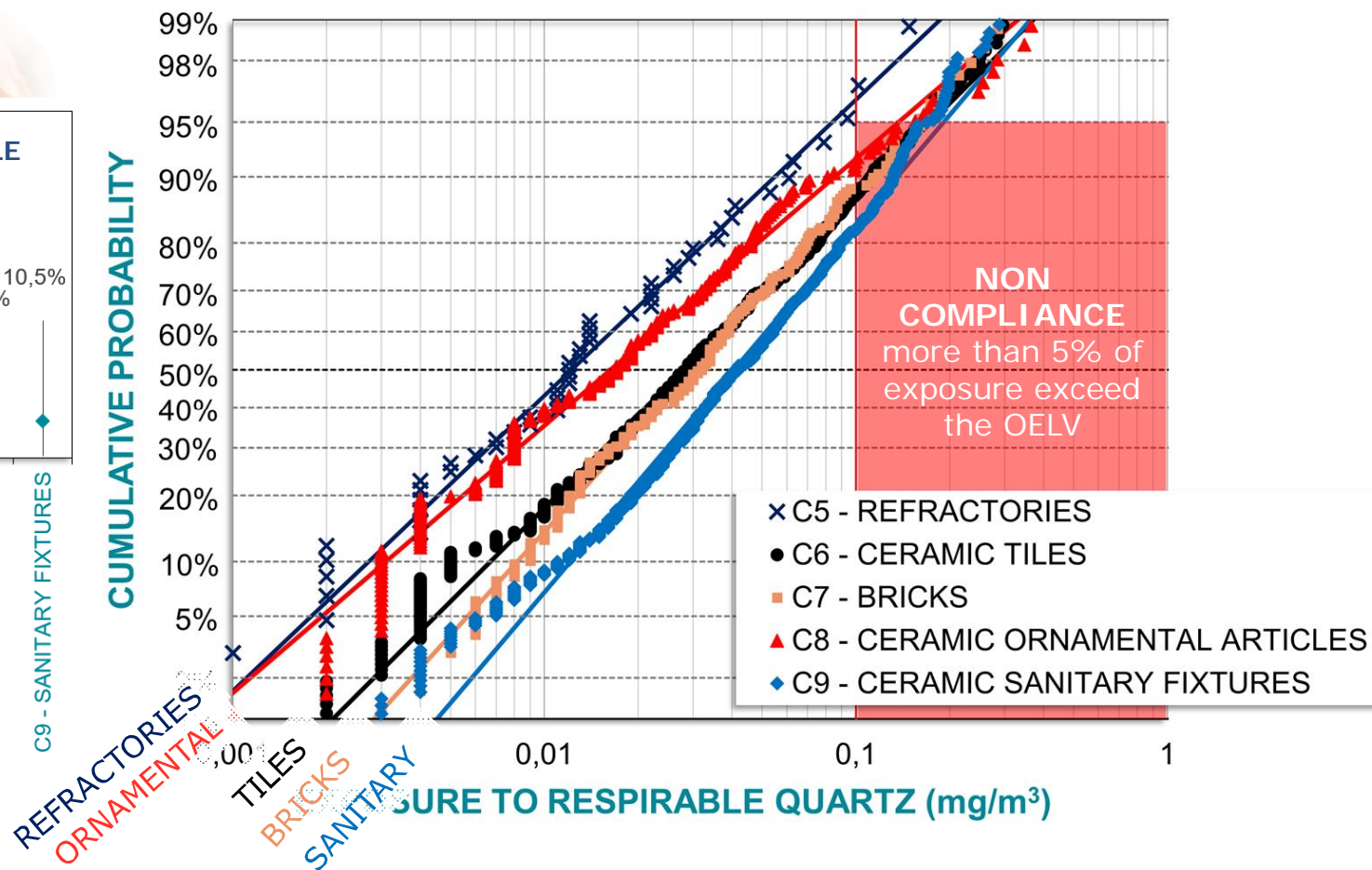


Comparison of crystalline silica exposure in different industrial sectors

CERAMIC INDUSTRY

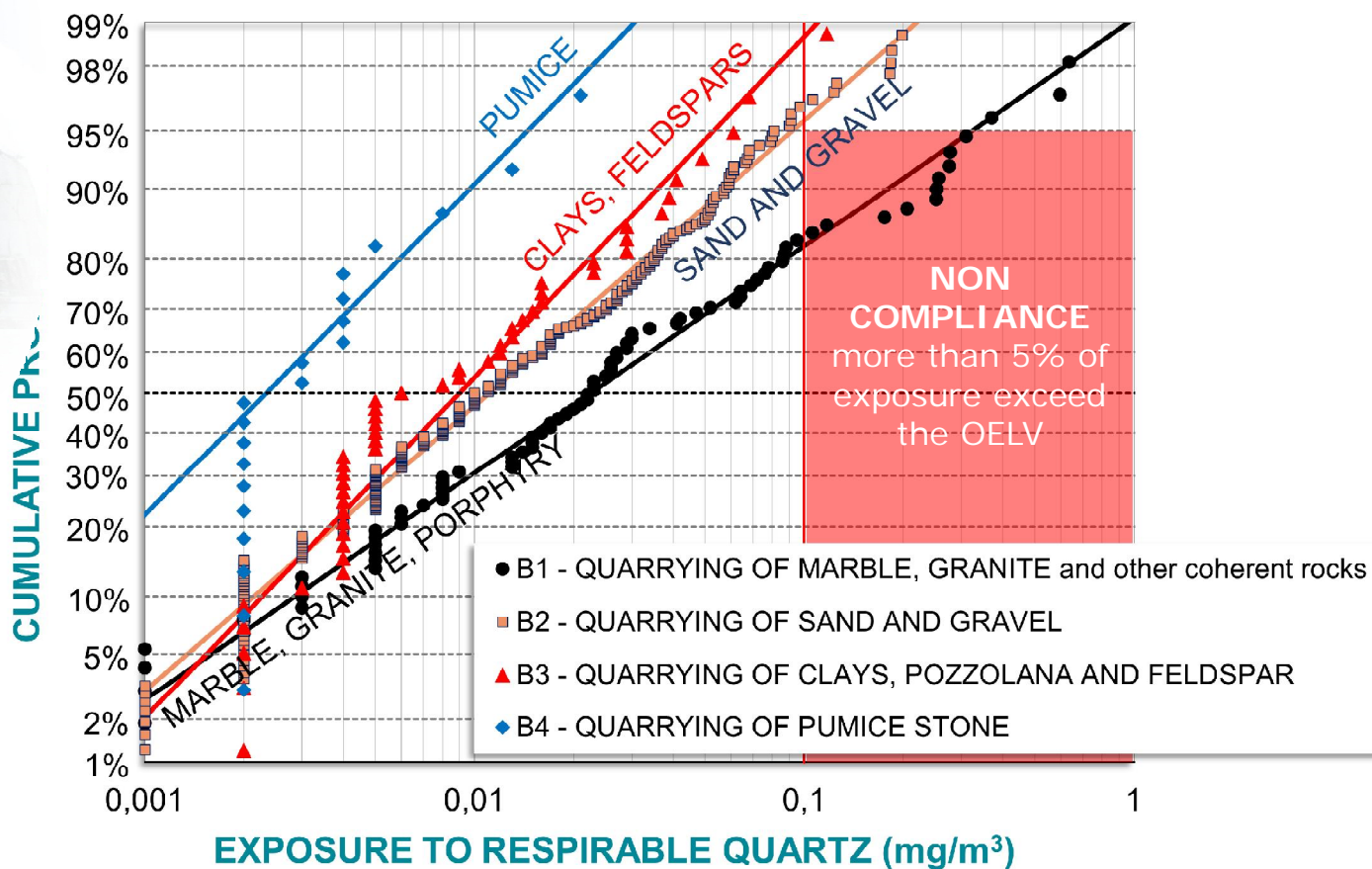
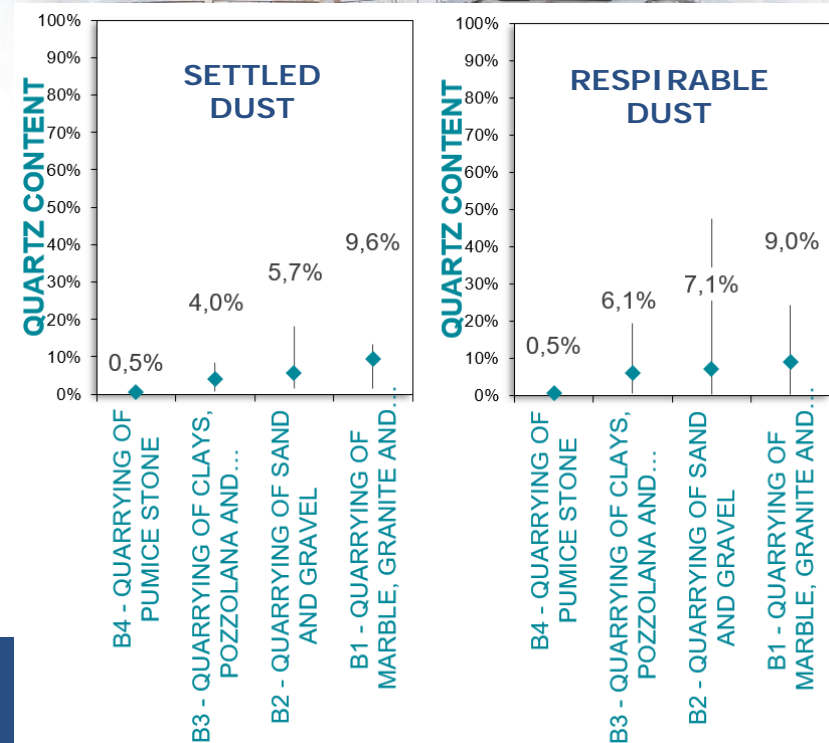


C5 – REFRACTORIES
C6 – TILES
C7 – BRICKS
C8 – ORNAMENTAL ARTICLES
C9 – SANITARY FIXTURES



Comparison of crystalline silica exposure in different industrial sectors

B – MINING AND QUARRYING



SILICA EXPOSURE DATABASE: POSSIBLE USES

EPIDEMIOLOGIC STUDIES

Occupation exposure described in terms of arithmetic mean of measured concentrations

Cumulative exposure is determined as the sum of the products of the arithmetic averages of the concentrations in the various occupations carried out by the worker and the relevant years of employment

RISK ASSESSMENT

Probability of exposure of the occupation described in terms of geometric mean and geometric standard deviation of measured concentrations

Compliance of the occupation with the limit value is assessed on the basis of a given probability of exceeding the limit value, assuming that the distribution of exposure measurements is log-normal

INAIL Silica Exposure Database



If you need any further information, feel free to contact me at
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