International Cadmium Association

INFORMATION ON USES AND RELATED WORKER EXPOSURE OF CADMIUM AND ITS INORGANIC COMPOUNDS IN THE EU

ICdA, November 2020

CADMIUM Working Towards a Sustainable Future

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I. INTRODUCTION

The International Cadmium Association (ICdA) brings together companies involved in the mining, smelting, refining, transforming, using and recycling of cadmium and compounds. A key objective of the Association is to assist members in ensuring a high level of worker protection against the adverse effects of cadmium and its compounds.

For this purpose, since 2006 ICdA has progressively roll out a program for all members consisting of three pillars:

- In 2006, ICdA has issued a detailed Guidance (the ICdA – Eurometaux Guidance on the Management of the Risks related to Chronic Occupational Exposure to Cadmium and its Compounds) sharing best practice on how to reduce cadmium exposure of workers stemming from inhalation and ingestion through adequate equipment, organizational strategies as well as good hygiene practice . A series of training sessions has been deployed by ICdA through its Health and Safety Committee to assist with the proper dissemination and implementation of this Guidance,
- In 2008, the first stage of an industry observatory was set up: the biomarker observatory ("OCdBIO") was launched,
- In 2014, a second stage followed with the creation of the air quality observatory ("OCdAIR").

The purpose of this two-pronged observatory is to document industry progress and to allow all members to benchmark their facilities with the aggregated industry performance.

This comprehensive strategy and the sustained effort of all members over the past 15 years has allowed industry to make measurable and significant progress.
ICdA is happy to share with ECHA the results of its program. The International Cadmium Association (ICdA) brings together companies involved in the mining, smelting, refining, transforming, using and recycling of cadmium and compounds. A key objective of the Association is to assist members in ensuring a high level of worker protection against the adverse effects of cadmium and its compounds.

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This Guidance has been updated in 2013 and 2018 to capture new scientific findings and build on employers' experience.

It has allowed industry to make regular progress over the past 15 years. This has been thoroughly documented by the Association with the help of all members.

II. USES OF CADMIUM AND CADMIUM COMPOUNDS

(1) Main markets

The market for cadmium and compounds used by EU-28 industry is estimated at 2500t, plus a net export of 900t of CdO.

The industrial sectors which have been using cadmium are rather limited and have been stable over the past years, as most uses of cadmium have been substituted. The only sectors which currently use cadmium are those for which no adequate substitute has been identified.

These uses are as follows (along with their size relative to 2500t):

- Manufacture of industrial Ni-Cd batteries: 80%
- Manufacture of yellow and orange pigments: 12%
- Manufacture of Cd containing alloys for neutron moderator bars, contact materials, specialty wires, brazing sticks: 4%
- Thin film PV panels, frits/glass/ceramics and Infra-Red detectors: 4%

Moreover, actors involved in the manufacture of CdO export approximately 900t of this material for use outside of the EU.

(2) Use in industrial Ni-Cd batteries

As shown above, the largest share of cadmium market feeds the manufacture of industrial Ni-Cd batteries. These serve several narrow but demanding segments of the battery market.

Industrial Ni-Cd batteries withstand harsh environments (temperature, vibrations, mechanical shocks, electrical abuse) and demonstrate superior reliability and durability. These batteries can be easily monitored for aging so predictive maintenance can be conducted. Moreover, they do not suffer from the "sudden death" syndrome like Pb/acid batteries.

Based on these unique properties, they are the product of choice for back-up power of mission-critical assets, when people's lives are at stake, or when maintenance is complex and costly. Therefore, industrial Ni-Cd batteries are the reference product for commercial and military aircrafts (Airbus, Boeing and Embraer) as well as train rolling stock and underground metros. They are also the preferred solution to provide energy safety for complex assets such as nuclear power stations, oil platforms, refineries. Other uses are back-up power for trackside rail signalling systems in Scandinavian countries, for lighthouses along the North Sea coastline, for pipe and gas lines and related stations in remote areas.

Approximately 80% of EU batteries manufactured in the EU are directly or indirectly exported for use outside of Europe.

(3) Use in cadmium pigments

The manufacture of cadmium-based pigments in Europe is conducted by two companies only, both located in the UK.

Whereas cadmium and cadmium oxide are classified as carcinogenic, it should be noted that Cadmium zinc sulphide (yellow) and cadmium sulfo selenide (orange) pigments are not carcinogenic and are hence not regulated by CMD.

It should be noted that besides the sectors listed above in which cadmium is "used", there are several industries in which cadmium is an undesired impurity.

Based on the current participation to the biomarkers and workplace air quality observatories presented below, the workforce is split evenly between the two categories.

III. INTEGRATED EXPOSURE CAPTURED BY EXPOSURE BIOMARKERS

ICdA has been assisting its members in providing their workforce with a healthy workplace. As part of its assistance, ICdA has been running for over a decade the Observatory of Cadmium Biomonitoring ("OCdBIO"), in which all participating companies' occupational doctors send anonymized biomonitoring data to ICdA in full compliance with RGDP, which then publishes a yearly consolidation as well as a time series across the whole EU industry.

(4) Participating companies

The number of industrial sites from participating companies has been growing steadily, from 15 in 2008 to 35 in the most recent 2019 reporting round. Whilst at the onset of this initiative, participating industries were essentially producers, transformers, users or recyclers of cadmium and compounds (see list of uses on previous page), companies which joined over the more recent years belong to industries in which cadmium is not voluntarily used but is rather an impurity.

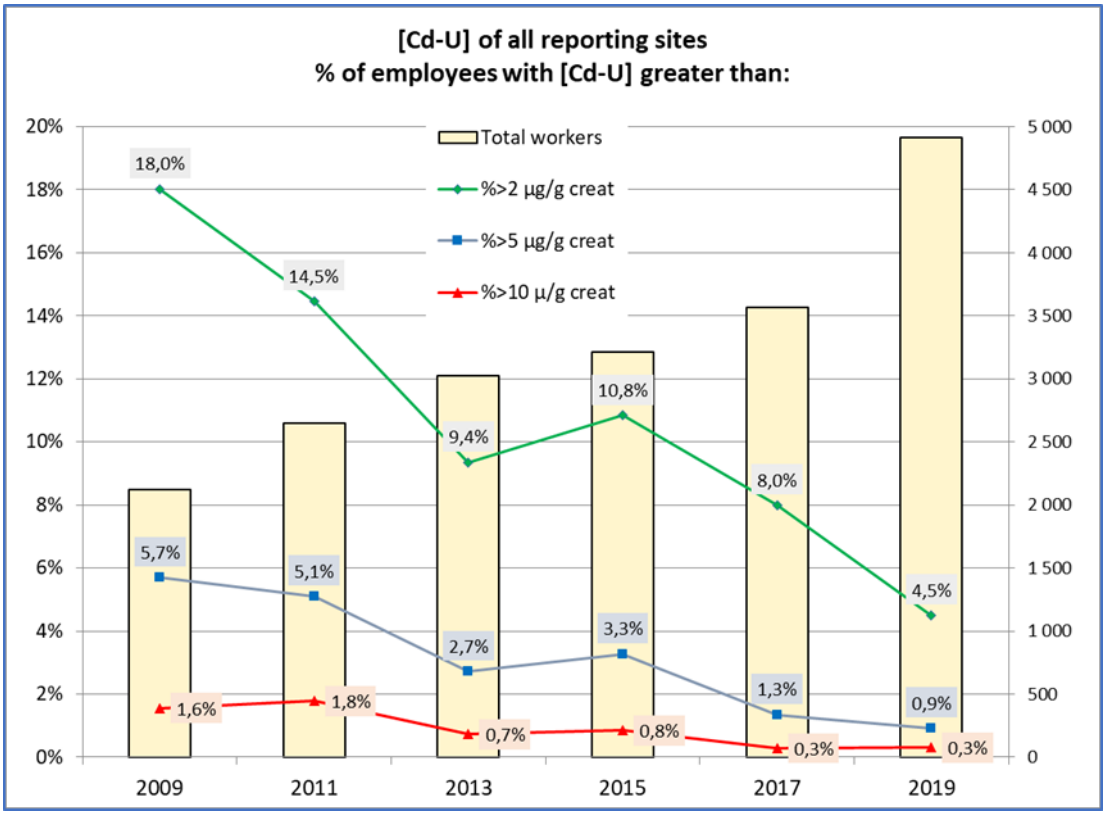
(5) Biomarkers

Two exposure biomarkers are reported. These are urinary Cd (Cd-U) and blood Cd (Cd-B).

Cd-U (Cd concentration in urine) [expressed in µg Cd/g creatinine] is a biomarker which reflects cumulative exposure of the worker (the half-life of cadmium in the human body is commonly assumed to be in excess of 20 years). Cd-U integrates exposure from both ingestion and inhalation. There is a direct proportion between urinary clearance of cadmium and cadmium load in the kidney, which above certain levels may induce tubular dysfunction.

Cd-B (Cd concentration in blood) [expressed in µg Cd/L whole blood] is a biomarker which is influenced both by recent exposure (over the past 3 months) and by cumulative exposure (integrated over 20 years), arising from both ingestion and inhalation. However, the variation of Cd-B over two consecutive dates, if less than a year apart, reflects recent exposure, and its sensitivity to recent exposure (both up and down) is quite high.

(6) Cd-U biomarker results and Interpretation



The number of workers in excess of the biological urinary limit value recommended in many MS until 2019 (BLV: 5 µg Cd/g creatinine) has been reduced from 121 (5.7% of the initial population) to 45 (0.9% of the final population) between 2009 to 2019.

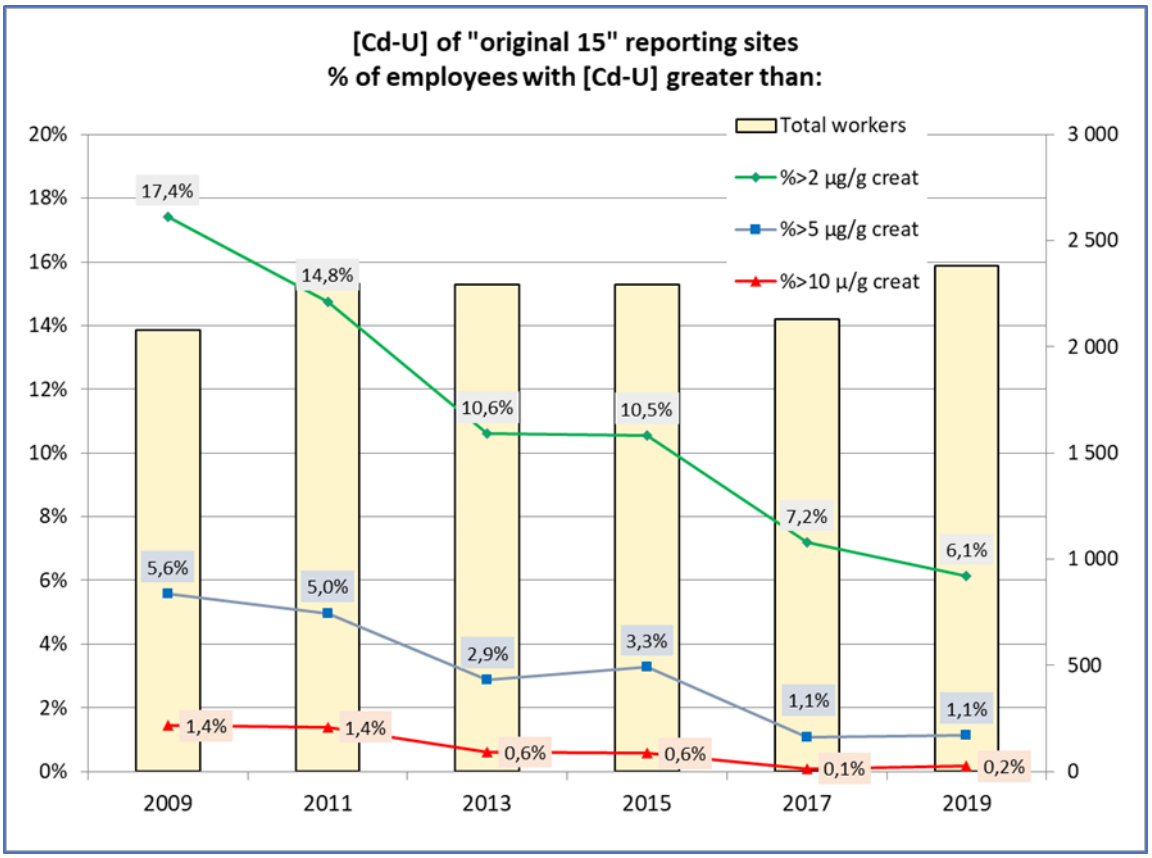
Likewise, the number of workers in excess of the recently set BLV of 2 µg Cd/g creatinine has been reduced from 383 (18.0% of the initial population) to 221 (4.4% of the final population) over the same 10-year time span.

Over the same 10-year period, the number of employees reporting Cd-U in OCdBIO has increased from 2125 to 4916.

It should be noted that due to the very long half-life of cadmium in the human body (estimated to be in the range of 20 years), workers with historical exposure with urinary cadmium in excess of 2 µg Cd/g creatinine will need to be assigned to a non-exposed workplace for many years to allow for a reduction of their urinary cadmium below the newly set BLV of 2 µg Cd/g creatinine.

(7) Cd-U biomarker – no dilution

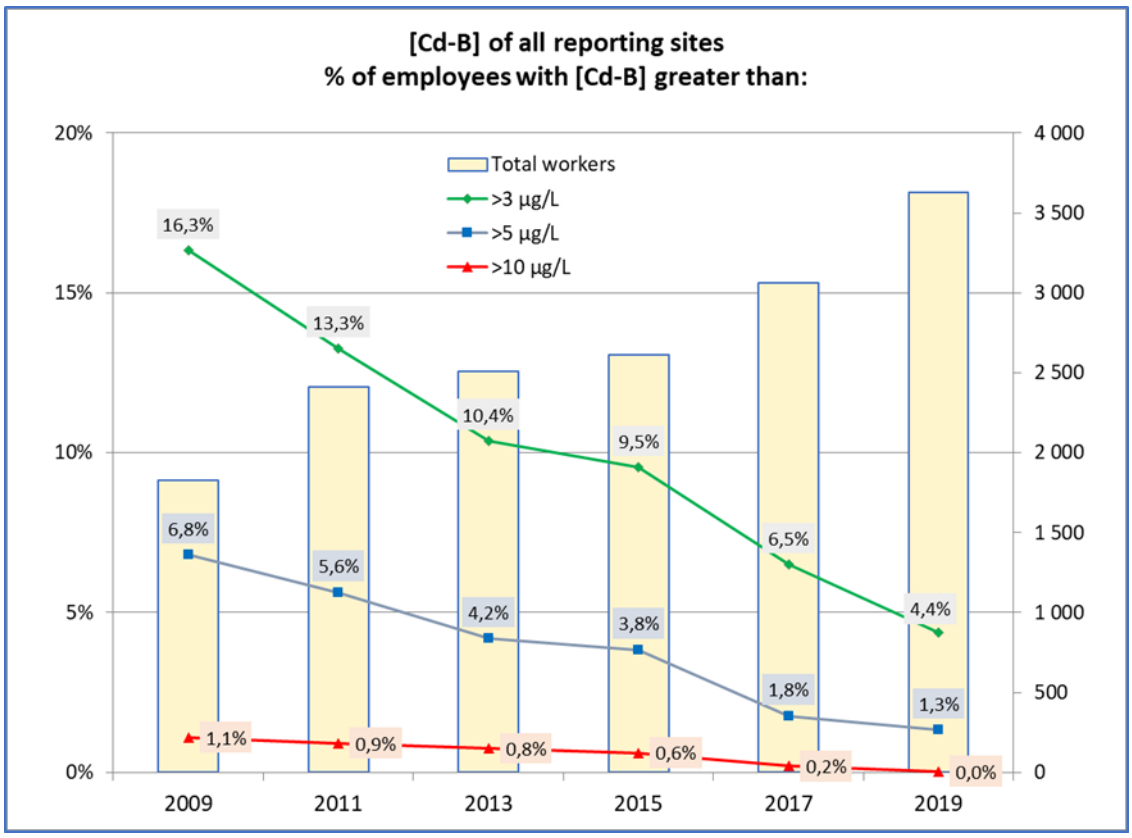
Due to the increasing number of participating plants over the years, a “same 15 reporting plants” statistics has been developed (see below) for Cd-U to show the evolution of Cd-U distribution over the very same 15 plants which have been participating to OCdBIO since its onset. It demonstrates that the improvement shown in the previous graph is not a statistical artefact due to dilution.



(8) Cd-B biomarker results and interpretation

As a marker influenced by recent exposure, the trend in Cd-B can help assess the future trend of Cd-U results. The number of workers in excess of 5 µg Cd/L blood (the recommended not to exceed level in several MS) has been reduced from 124 (6.8% of the initial population) to 48 (1.3% of the final population) between 2009 and 2019.

Over the same 10-year period, the number of employees reporting Cd-B to OCd-BIO has increased from 1825 to 3631.



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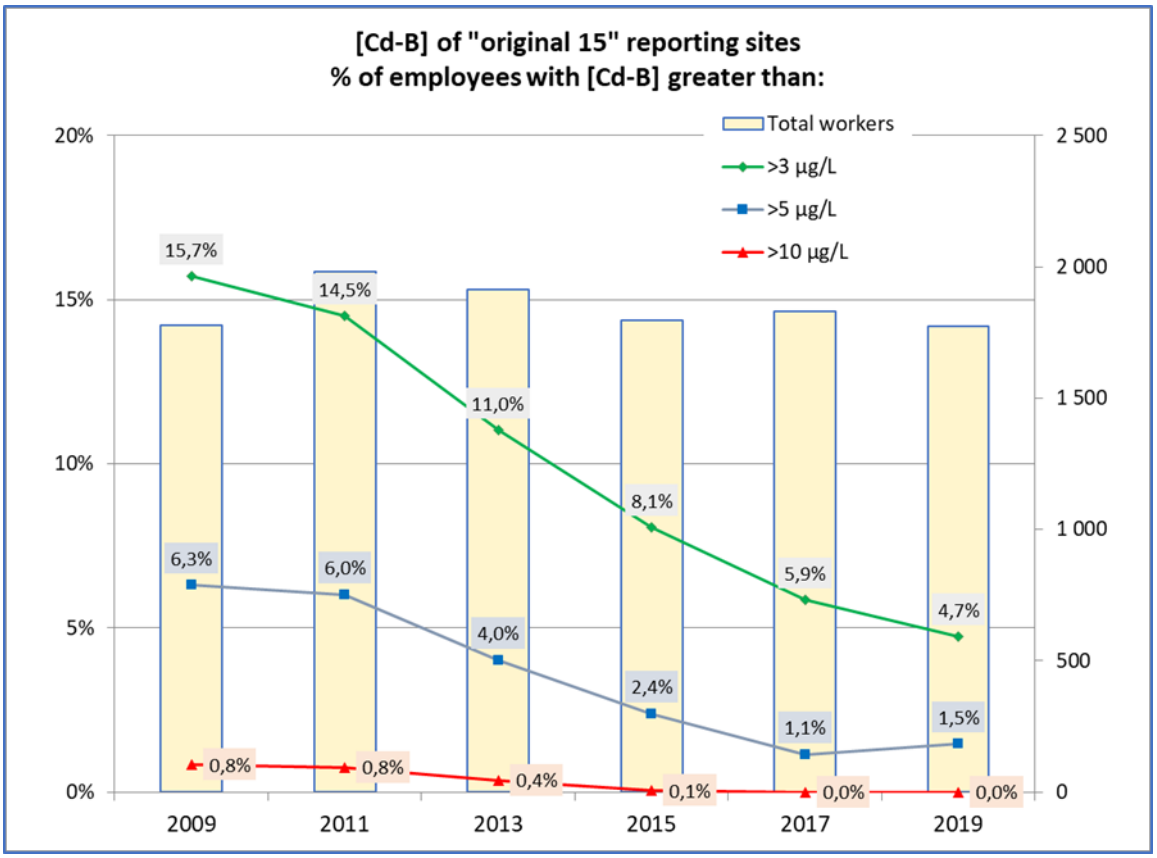


(10) Conclusion on biomonitoring

The widespread implementation of best practice across ICdA members over the years has allowed a steady reduction of exposure which is demonstrated by exposure biomarkers, which integrate exposure from both inhalation and ingestion.

IV. INHALATION EXPOSURE CAPTURED BY WORKPLACE AIR MEASUREMENTS

ICdA has been assisting its members in providing its workforce with a healthy workplace. As part of its assistance, ICdA has been running several years the Observatory of Cadmium Air Exposure ("OCdAIR)", in which all participating companies report to ICdA anonymous workplace air exposure information following a very strict protocol.

(11) Methodological differences between "exposure monitoring within industrial facilities" and "exposure scenario assessment in the context of REACH"

a) Exposure monitoring within industrial facilities:

Across industrial facilities within the 27 EU Members States, workplace air monitoring is conducted to answer the question: "Can management ensure that workers in a facility are exposed to air whose quality complies (for a specific agent) with a (pre-set) binding, indicative or self-imposed OEL (for that agent)?".

Although this process is not fully harmonized across all 27 EU Member States, generally accepted rules and principles are commonly used by EHS managers and usually recommended by national Worker Protection Agencies. In a few countries, these rules are even embedded in national regulation.

These rules recommend that:

- workplace air compliance assessment be conducted on a regular basis (and repeated if working conditions are changed),
- workers should be grouped along Similar Exposure Groups for statistical analysis purposes,
- a compliance methodology should be selected (typically based a lognormal distribution hypothesis and a cut-off value, usually the 90^{th} or 95^{th} percentile of the distribution, possibly with a confidence interval),

Compliance is a combination of ensuring that the selected percentile is below the OEL, enough measurements are obtained, and the lognormal distribution hypothesis is verified.

Therefore, even with all samples well below the OEL, several SEGs (and associated workers) will typically fall in a "non-conclusive" category due to statistical considerations.

b) Exposure scenario assessment within REACH:

An exposure scenario assessment is conducted to answer the question: "Do workers across several facilities, which work in a similar environment with identical risk management measures in place, operate in a safe environment?"

The grouping of workers from different facilities into an exposure scenario is a theoretical construct in which workers which operate in activities which share the same set of use

descriptors are grouped together. This grouping approach is very different from the hands-on SEG-based grouping methodology described below and yields different results.

The purpose is not to check compliance with a pre-set DNEL, but to ensure that the exposure of workers within that specific exposure scenario, taking into consideration risk management measures, is within the limits of safe use (RCR < 1).

(12) Similar exposure groups (SEGs)

All participating plants are required to use Similar Exposure Groups (SEGs) which bring together workers with the same general exposure profile for the chemical agent being studied.

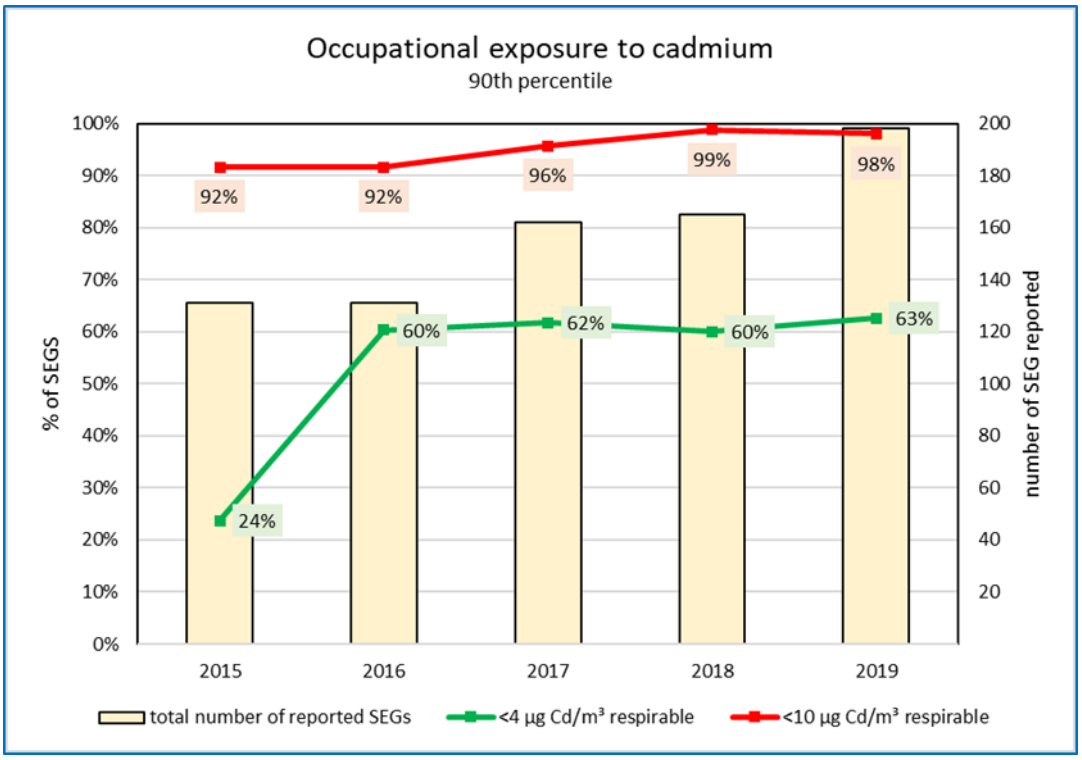
(13) Testing for compliance: the 90th percentile

Compliance testing is conducted using the 90th percentile of measured values for each SEG. This 90th percentile value is calculated and **compared with the 4 µg Cd/m^3 respirable fraction** which is to be considered in combination with the 2 µg Cd/g creatinine exposure biomarker.

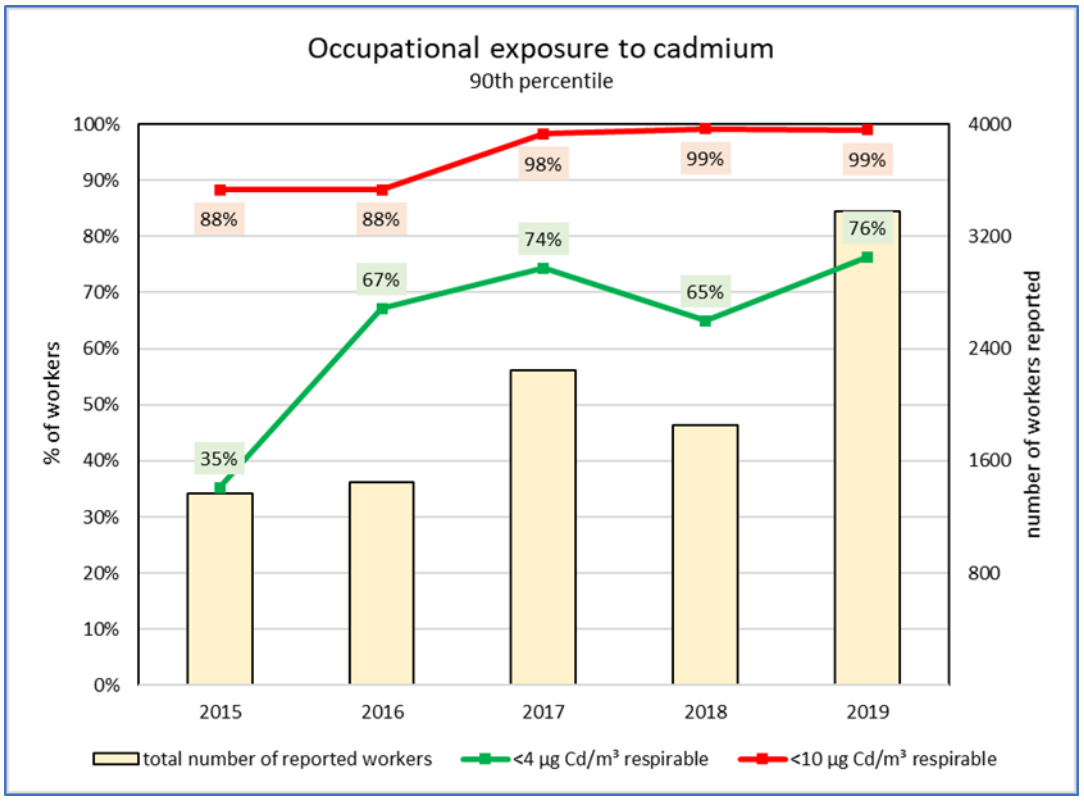
(14) Fraction measured

Building on the SCOEL conclusions of 2010 and 2017, the fraction reported to ICdA is the respirable fraction, as defined by EN 481. Equipment used to capture the respirable fraction is selected by participating companies. There are instances of companies reporting inhalable fraction data which, as it encompasses the respirable fraction and therefore yields a higher value, are taken as such in OCdAIR database and treated as respirable data.

(15) SEG distribution



(16) Worker distribution



(17) Results and interpretation

The total number of workers reported to OCdAIR has been increasing over the past years from 1369 to 3379. Likewise, the number of SEGs has increased from 131 to 198.

The number of workers who belong to compliant SEGs (assessed by comparing the 90th percentile of each SEG with 4 µg Cd/m3 - respirable fraction) has risen from 483 (35% of the initial population) to 2579 (76% of the final population).

Moreover, the number of workers who belong to a SEG in excess of 10 µg Cd/m3 respirable fraction (i.e. its 90th percentile is greater than 10 µg Cd/m3 - respirable fraction) has decreased from 143 individuals (10% of the initial population) to 36 individuals (1% of the final population).

(18) Conclusion on air monitoring

The data presented above demonstrate that industry has been successful in increasing the number of workers for which workplace air is regularly monitored as well as the number of workers who belong to SEGs which comply with the OEL of 4 µg Cd/m^3 (respirable fraction).

Although today many national limit values are higher than 4µg Cd/m³ respirable, only 5% of the workers are exposed to higher Cd in air values. Moreover, industry has been successful in almost eliminating workers who belong to SEGs with exposure above 10 µg Cd/m^3 (less than 1% using the 90th percentile methodology).

V. GENERAL CONCLUSION ON CADMIUM MONITORING

The combination of workplace air monitoring and biomonitoring has been very effective in identifying exposure to cadmium and taking the appropriate steps to reduce such exposure and in enhancing worker protection. These results could not have been reached by implementing only air monitoring or only biomonitoring.

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