European Agency for Safety and Health at Work

Occupational cancer risk factors in Europe – Overview of the findings of the Workers' Exposure Survey

Report

European Agency for Safety and Health at Work

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Table of Contents

List of Figures and Tables

Glossary

Air-supplied respirator: A type of respirator providing clean breathing air from a source independent of the work area. An air-supplied respirator protects users from airborne contaminants (particles, gases and vapours) and, in certain cases, from oxygen-deficient atmospheres.

Booth (extracted or ventilated): A ventilated enclosure with local exhaust ventilation to contain dust and airborne contaminants from spreading.

Control measures: Measures put in place to reduce and manage risks existing in the workplace. They include protection measures. The use of the relevant measure should be done according to the hierarchy of prevention and control measures. It requires that the employer should first try to implement measures to 'avoid the risks or eliminate the hazards', then if not possible, to consider measures to 'reduce or minimize hazards' and 'separate hazards' from the workers, with the following order of prioritisation: technical, organisational and personal measures. The latter include the use of personal protective equipment (PPE).

Computed tomography scan (CT scan): A medical imaging technique that combines X-ray measurements taken from different angles to deliver tomographic (cross-sectional) images (or 'slices') of a body. It enables the user to see inside the body without cutting. This method provides more details than a regular X-ray.

Fluoroscopy: An imaging technique that uses X-rays to obtain real-time moving images of the interior of an object. In medical imaging, a fluoroscope allows a physician to see the internal structure and function of a patient, such as the pumping action of the heart or the motion of swallowing. This is used both for diagnosis and therapy.

Fully closed system or machine: It refers to isolating the system or machine emitting the hazardous contaminant from the outside environment and includes the use of fully enclosed machines, as well as working in a sealed or glove box.

Gammagraphy (or gamma radiography): An imaging technique that uses gamma rays (which are more penetrative than X-rays) present both in industrial and medical settings. In industries, it is a control and testing technique used to search for defects and ensure the integrity and safety of critical infrastructure. In medical settings, gammagraphy is a diagnostic test used in nuclear medicine.

Hood (exhaust): A type of local exhaust ventilation that captures and collects airborne contaminants.

High-efficiency particulate absorbing and high-efficiency particulate arresting (HEPA) filter: An efficiency standard of air filtering. Filters meeting the HEPA standard must satisfy certain levels of efficiency. HEPA filters capture pollen, dirt, dust, moisture, bacteria (0.2-2.0 micrometres), virus (0.02-0.3 micrometres), and submicron liquid aerosol (0.02-0.5 micrometres).

International Agency for Research on Cancer (IARC): The specialised agency of the World Health Organisation for cancer. One of its core elements of activities is the IARC Monographs programme that consists of the evaluation and dissemination of evidence of the carcinogenicity of specific exposures.

Local exhaust ventilation (LEV): An extract ventilation system that takes airborne contaminants such as dusts, mists, vapour or fumes out of the workplace air to ensure that they cannot be breathed in. It captures dusts, vapours and fumes at their source, away from the workers' breathing area, thus minimising the risk of workers breathing in contaminated air.

Different types of local exhaust ventilation are mentioned in this report, for example: on-tool extraction, welding/spray/ventilated/extracted booths, exhaust hood, or laboratory fume hood/cupboard, multiple slot hood and ventilated bench (specific to chemical or pharmaceutical products manufacturing, and any type of scientific or pathology laboratory), or locally exhausted dissection tables (in gross anatomy laboratory).
Medium-density fibreboard (MDF): A type of engineered wood product.
Metal inert gas (MIG): A subtype of gas metal arc welding.
On-tool extraction: A type of local exhaust ventilation system that is fitted directly onto the tool.
Personal protective equipment (PPE): An equipment worn to minimise exposure to hazards that cause serious workplace injuries and illnesses. According to the hierarchy of prevention and control measures, the use of PPE should be the last resort.
Powered air-purifying respirator (PAPR): A type of respirator used to protect workers from contaminated air by filtering a sufficient proportion of pollutants/pathogens from the ambient air to deliver clean air to the user's face/mouth.
Radioisotope: An unstable form of chemical element that releases radiations as it breaks down and becomes more stable. It can be both natural and human-made and used in medical settings for imaging tests and treatment.
Respiratory protective equipment (RPE): A type of personal protective equipment (PPE) used to protect the user against the inhalation of hazardous substances in the workplace air. This includes, for example, powered air-purifying respirator (PAPR), self-contained breathing apparatus (SCBA), rubber face mask fitted with a filter or a cartridge, filtering face piece mask (FFP) or dust mask, and welding helmet with a separate air supply attached.
Rubber face mask with a filter or a cartridge: A type of respirator that removes airborne contaminants from breathing air using a filter for particles or a cartridge for gases and vapours.
Sealed (or glove) box: A sealed enclosure used to handle hazardous materials while isolating contaminants from the outside environment, often equipped with attached gloves. The box can be ventilated.
Self-contained breathing apparatus (SCBA): A type of atmosphere-supplying respirator protecting the user from airborne contaminants and oxygen-deficient atmospheres with a tight-fitting elastomeric facepiece covering the user's face. It supplies air from a cylinder of compressed breathing air carried by the user. It is typically used in firefighting and industry.
Tungsten inert gas (TIG): A type of arc welding process.
Water (dust) suppression: The prevention or reduction of the dispersion of dust into the air, for example, by water sprays.
Wet leather processing: In leather tanning-related jobs, it refers to the process of shaving or splitting hides or skins while wet in order to reduce the amount of dust.

Executive summary

This report presents key findings from the large-scale Workers' Exposure Survey (WES), which estimated probable exposure to 24 known cancer risk factors among workers, including industrial chemicals, process-generated substances, mixtures and physical risk factors.

The survey was conducted in six EU Member States — Germany, Ireland, Spain, France, Hungary and Finland — using the OccIDEAS tool. A total of 24,402 telephone interviews were conducted between September 2022 and February 2023. The probability of exposure was estimated and quantified as low, medium and high, and data were weighted for representativeness of 98.5 million European workers.

For each risk factor, the report details the main circumstances of exposure, the proportion of workers affected, and the use of control measures (such as personal protective equipment, ventilation and enclosed systems).

47.3% of workers were probably exposed to at least one cancer risk factor in their last working week. This extrapolates to about 46.6 million workers in the six countries. The most common exposures were to solar ultraviolet radiation, diesel engine exhaust emissions, benzene, respirable crystalline silica (RCS) and formaldehyde. High-level exposures were most frequent for RCS, diesel exhaust, wood dust, benzene and formaldehyde.

Many workers faced multiple exposures in the same week, especially in sectors like metalworking, where co-exposure to metals such as cadmium, cobalt and nickel was observed. Self-employed and temporary workers often had higher exposure rates to certain risk factors.

WES data provide valuable insights for prevention strategies, policy development, and possible future amendments to EU directives on carcinogens, mutagens or reprotoxic substances at work.

1 Introduction

The European Agency for Safety and Health at Work (EU-OSHA) has conducted a large worker survey, the Workers' Exposure Survey on cancer risk factors in Europe (WES), in six EU Member States: Germany, Ireland, Spain, France, Hungary and Finland.

The aim of this publication is to present main findings from the survey and provide a non-exhaustive overview of the type of information that can be obtained from the complex data available from WES. In drafting this report, we followed the approach of the *New Zealand Carcinogens Survey 2021 overview* (WorkSafe, 2023). This report covers exposures to the 24 cancer risk factors included in WES, but for more detailed and specific information, we encourage the reader to use the dataset that is available for research purposes at GESIS.[1]

WES estimates probable exposure of workers during the last working week to 24 known cancer risk factors, including industrial chemicals (such as formaldehyde and ethylene oxide), process-generated substances (such as diesel engine exhaust emissions, silica dust) and mixtures (such as solutions, solvents, inks and paints containing one or several of the 24 cancer risk factors), and physical risk factors (such as radiation). The complete list is as follows:

- **Industrial chemicals:** 1,3-butadiene, acrylamide, diethyl/dimethyl sulphate, epichlorohydrin, ethylene oxide, formaldehyde and ortho-toluidine
- **Inorganic dusts or fibres:** asbestos and respirable crystalline silica (RCS)
- **Organic dusts:** leather dust and wood dust
- **Metals:** arsenic, cadmium, cobalt, chromium VI, lead and inorganic compounds, and nickel
- **Oils:** mineral oils (as mists)
- **Products of combustion:** diesel engine exhaust emissions (DEE)
- **Solvents:** benzene and trichloroethylene

[1] Available at: https://doi.org/10.7802/2818

- **Radiation:** ionising radiation, artificial ultraviolet (UV) radiation (including ocular exposure), and solar UV radiation (including ocular exposure)

Many of these risk factors are addressed in European worker protection legislation. WES data complement other data sources, such as workplace measurements, and provide information on the workers exposed and the most frequent circumstances of exposure, to enable better prevention at workplaces. WES results provide additional valuable data in the context of possible future amendment proposals to the carcinogens, mutagens or reprotoxic substances at work directive [2] and thereby contribute to the fight against work-related cancer. Updated information on occupational exposures to selected cancer risk factors, comparable across countries, also supports one of the key objectives of the EU Strategic Framework on Health and Safety at Work 2021-2027 on improving the prevention of work-related diseases, in particular cancer, and contributes to Europe's Beating Cancer Plan and the EU Roadmap on Carcinogens initiative.

As pointed out above, this report shows the main findings of interest from WES. A detailed description of the methodology is provided elsewhere (EU-OSHA, 2024a) as well as the criteria for inclusion of the 24 cancer risk factors (EU-OSHA, 2024b).

WES methodology in short

- WES is a telephone survey, based on the Australian Work Exposures Study (AWES), that estimates probable exposure of workers during the last working week to 24 known cancer risk factors, including industrial chemicals, process-generated substances and mixtures, and physical risk factors.
- The survey covers a representative selection of the working population from six European countries: Germany, Ireland, Spain, France, Hungary and Finland. The questions were translated from English to national languages. EU-OSHA developed an English glossary of technical terms to support accurate translation, using the best terminology known to workers.
- A random, population-based sample of workers aged 15 years or older participated in each country, including both employed and self-employed, and covering all the occupations and sectors of economic activity,[3] as well as those employed in public administration.
- The sampling strategy was based on a random digit dialling strategy targeting only mobile phones. In order to over-sample occupations with an expected higher risk of exposure to the selected cancer risk factors, the agreed approach was to under-sample the occupations with an expected lower risk (e.g. office workers), which allows for robust survey estimates across all occupations, as well as subsequent granular analysis of results.
- Workers answered detailed questions about the tasks they completed at work during the last working week and information on the prevention measures applied. Based on their responses, the probability of exposure to cancer risk factors was automatically estimated using the Occupational Integrated Database Exposure Assessment System (OccIDEAS) tool.
- WES has been thoroughly adapted by EU-OSHA and occupational safety and health experts from the survey countries, in terms of the questions and the exposure assessment logics used by OccIDEAS, to be relevant to the EU context and considering the EU legislation related to the 24 cancer risk factors.

[2] Directive 2004/37/EC. See: https://eur-lex.europa.eu/eli/dir/2004/37

[3] Except private households (NACE T), extraterritorial organisations (NACE U) and armed forces (ISCO sector 0).

- Estimation of exposure in WES is provided in terms of probability of exposure to the selected cancer risk factors. Probable exposure is further divided into three categories that are approximately related to EU occupational exposure limits (OELs) for the chemical risk factors considered (high, medium and low levels).[4]
- Interviews were conducted by trained local interviewers using CATI (Computer Assisted Telephone Interviewing) between September 2022 and February 2023. The total interview duration differed for each worker, as it depends on the job and the specific tasks carried out in the last working week.
- Survey data were subject to several steps of quality control, and they were weighted to account for the socio-demographic structure and the total working population of each country included, as well as potential multiple ownership of mobile phones.
- After completion of fieldwork and several quality control stages, weighted data from 24,402 valid interviews have become available for analysis.
- For additional details on the methodology, see 'Occupational cancer risk factors in Europe - methodology of the Workers' Exposure Survey' (EU-OSHA, 2024a) and summary (EU-OSHA, 2023a).

2 General WES findings

2.1 Overall exposure to cancer risk factors in Europe

47.3% of workers were probably exposed to at least one of the 24 cancer risk factors considered in WES in their last working week, at any level, which means that approximately 46.6 million workers could be exposed to at least one cancer risk factor at work in the six countries covered.

The most frequently assessed occupational exposures among the 24 cancer risk factors considered in the survey were: solar UV radiation, DEE, benzene, RCS and formaldehyde, followed by hexavalent chromium, lead and its inorganic compounds, and wood dust (EU-OSHA, 2023b).

If looking at the level of exposure, **11.1%** of the workers are exposed to at least one cancer risk factor at a high level. The most frequent exposures at a high level are RCS (3.3%), DEE (2.1%), wood dust (1.6%), benzene (1.4%) and formaldehyde (1.3%).

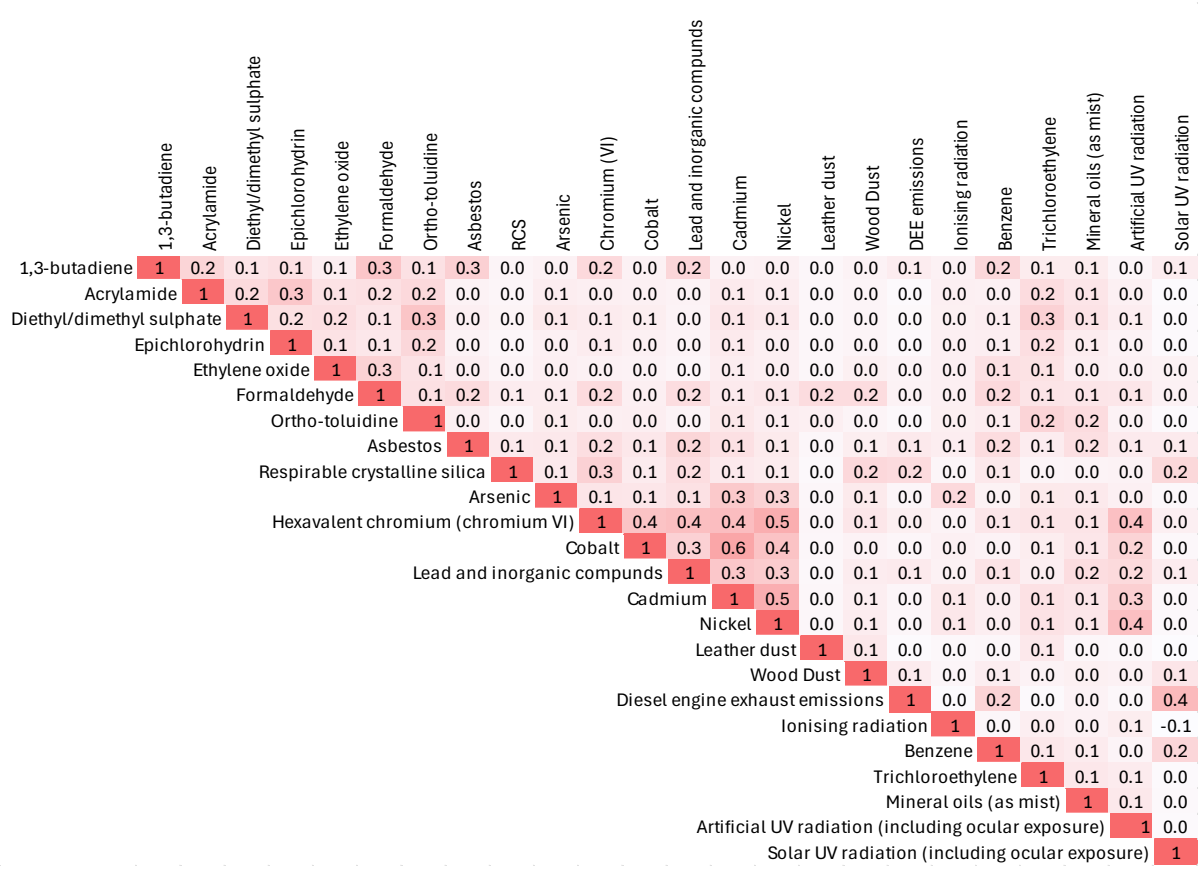
2.2 Multiple exposures within the same week

WES also provides information on workers' exposure to more than one cancer risk factor during the last working week. Workers probably exposed to at least two cancer risk factors were considered as having multiple exposures (26.1%), although exposures may not necessarily occur at the same time and through the same work process. Addressing multiple exposures is an important issue for prevention of exposures to cancer risk factors. Indeed, combined exposure to both chemical (including process-generated substances and mixtures) and physical risk factors may warrant very different prevention measures at the workplace level. Protection from exposure to solar UV radiation, for example, calls for very different measures than the prevention of exposure to DEE (EU-OSHA, 2023b).

Figure 1 shows the co-exposure to cancer risk factors among workers using a "correlation heatmap". Most of the correlations are low (less than 0.2), meaning the probability of co-exposure is low. However, there are moderate correlations of exposure to cadmium and cobalt (0.6), nickel and chromium VI (0.5), and nickel and cadmium (0.5). Most co-exposures to metals were reported in metalworking industries.

[4] The three levels are defined as follows: high level – exposure at or around the OEL; medium level – exposure between about 10% and 80% of the OEL; and low level – exposure that is higher than the general community, but less than about 10% of the OEL, based on the EU OELs or occupational dose limits set in pertinent directives (EU-OSHA, 2024a).

Figure 1: Correlation heatmap between the 24 cancer risk factors covered by WES



Note: In this matrix the correlations values range from -0.1 to 1, where 0 indicates no correlation (no co-exposure), 1 indicates perfect positive correlation (it only happens between the cancer risk factor and itself), and negative values might suggest mutually exclusive exposures. The darker the colour, the higher the correlation.
Source: WES 2023, EU-OSHA; calculations: José Ignacio Díez Ruiz, EU-OSHA.

3 Occupational exposure to 24 cancer risk factors in Europe

This section describes the main exposure circumstances and the use of control measures for the 24 cancer risk factors covered in the survey by category of exposures, starting from radiation.

The tables include the exposure circumstances that concern at least 2% of the workers exposed to a given cancer risk factor. In these tables, the column total could be higher than 100%, as exposed workers could do multiple tasks (or exposure circumstances) in the same working week.

The other tables include the reported control measures for each circumstance if they were asked[5] and if there were at least 30 exposed respondents working in this circumstance. In these tables, the row total could be higher than 100%, as workers could report several control measures for the same exposure circumstance. In addition, the column titles are kept to a minimum. They generally include specific types of control measures, such as the following:

- LEV includes local exhaust ventilation and on-tool extraction by default, as well as exhaust hood, multiple slot hood, laboratory fume hood or cupboard, extracted booth, welding booth or ventilated bench when relevant.[6]

[5] EU-OSHA systematically included questions on the use of control measures across the survey, where relevant. In a few cases, EU-OSHA prioritised getting information on exposures over control measures, and the questions were not asked: if the number of respondents was expected to be low, and/or if the duration of the questionnaire was already planned to be long.
[6] Refer to the Glossary section for more details.

- Relevant respiratory protective equipment (RPE) includes air-supplied respirator or self-contained breathing apparatus (SCBA), powered air-purifying respirator (PAPR), and rubber face mask with a filter or a cartridge by default, as well as a welding helmet with a separate air supply attached when relevant.[7]
- Fully closed system (or machine) includes working in a sealed box or a glove box when relevant.[8]

In all the tables, the percentages have no decimal; they are rounded up to the nearest whole number.

3.1 Occupational exposure to radiation

3.1.1 Solar UV radiation

Three types of UV radiation exist, namely UVA, UVB and UVC. While UVB and UVC are mostly absorbed by ozone, water vapour, oxygen and carbon dioxide, UVA is not absorbed as much (World Health Organization, 2016). The sun is the strongest source of UV radiation in our environment.

When interpreting the survey data, it is important to take into account the time of the year the survey took place (September 2022 to February 2023) as it plays a role in the exposure.

Among all workers in all six countries, solar UV radiation was the most common probable exposure in the last working week at any level with **20.8%** of all workers concerned. Solar UV radiation was also a common co-exposure such as with DEE, among others.[9] Interestingly, the exposure to solar UV radiation was mostly at a low (5.7%) or a medium level (14.9%).

The occupational exposure to solar UV radiation occurs mostly via the dermal route, but also through ocular exposure.

- **Main circumstances of exposure**

Exposure to solar UV radiation can occur in many sectors and occupations, particularly those involving outside activities. As such, the most common exposure circumstance associated with solar UV radiation exposure was working outside during the day in the open (63% of those exposed), followed by working with or near reflective surfaces (40%).

Table 1: Most common circumstances of exposure among the workers exposed to solar UV radiation

Exposure circumstances	Proportion of exposed workers working in each circumstance
Working outside during the day in the open	63%
Working with or near reflective surfaces (sand, glass, roofing iron, water, concrete or cement, plastic, snow)	40%
Working outside during the day under partial shade (at least 1 hour/day[1])	33%
Working outside during the day in a vehicle with the windows down (at least 1 hour/day[1])	23%

[1] A minimum duration of potential exposure to solar UV radiation has been included here, in order to exclude all the workers who do these tasks, but not often enough to get exposed.
Source: WES 2023, EU-OSHA; reference population: workers exposed to solar UV radiation in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed. Workers can be exposed through multiple tasks in the same working week.

[7] Refer to the Glossary section for more details.
[8] Refer to the Glossary section for more details.
[9] Refer to the Workers' Exposure Survey on cancer risk factors in Europe – first findings for more details.

- **Use of control measures**

The most reported control measure was wearing clothing covering most of the body (i.e. trousers and shirts or t-shirts with sleeves). Meanwhile, the least used protection measure was sunscreen: only 11 to 15% of workers exposed to solar UV radiation using sunscreen, depending on the circumstance of exposure. This may be explained by the use of full cover clothing, and by the period in which the survey was conducted (September to February), which is generally a colder and less sunny season across the six countries.

Furthermore, given the inclusion of ocular exposure to solar UV radiation, eye protection, namely sunglasses, was also considered. The use of sunglasses was lower in the case of working exclusively with or near snow (6%) compared to working with or near any type of reflective surfaces (including snow) (38%). In general, less than half of the workers used this protection measure per each exposure circumstance respectively. Again, this may be explained by the period in which the survey was conducted (September to February) when hours of sunlight are fewer, in particular in Finland.

Table 2: Information on workers' use of control measures when performing tasks with probable exposure to solar UV radiation

Exposure circumstances	Eye protection[1]	Full cover clothing[2]	Sunscreen	Sun protection head cover	None
Working outside during the day in the open	22%	87%	13%	49%	9%
Working with or near reflective surfaces (sand, glass, roofing iron, water, concrete or cement, plastic, snow)	38%	not asked	not asked	not asked	62%
Working outside during the day under partial shade (at least 1 hour/day)	29%	89%	15%	44%	6%
Working outside during the day in a vehicle with the windows down (at least 1 hour/day)	46%	88%	11%	not asked	7%

[1] Sunglasses.

[2] Clothing that covered most of the body (i.e. trousers and shirts or t-shirts with sleeves).

Source: WES 2023, EU-OSHA; reference population: workers exposed to solar UV radiation in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed.

3.1.2 Artificial UV radiation

Artificial UV radiation is a non-ionising type of radiation that, unlike solar UV radiation, comes from human-made sources like tanning beds and welding torches.

The survey reveals that among all workers in all six countries, **2.9%** are probably exposed to artificial UV radiation in the last working week.

The occupational exposure to artificial UV radiation occurs mostly via the dermal route, but also through ocular exposure.

- **Main circumstances of exposure**

The main exposure circumstance, representing two-thirds of the workers exposed to artificial UV radiation, is welding, torching, brazing, cutting or lasering metals.

Table 3: Most common circumstances of exposure among the workers exposed to artificial UV radiation

Exposure circumstances	Proportion of exposed workers working in each circumstance
Welding, torching, brazing, cutting or lasering metals (not specific to any job), including:	66%
Working in an area where there were at least four other welders	*33%*
Using UV light for sterilisation (not specific to any job)	9%
Using UV lamps for nail polish curing (as beauty therapist/beautician)	8%
Applying metal thermal spray coating to the metal products (in metal plating-, coating- or other finishing-related jobs)	4%
Using UV light to cure or fix samples, or for other reasons related to lab work tasks (in any type of scientific laboratory)	4%
Administering UV treatment for skin or other conditions (hospital, clinic or doctor's office), including:	4%
Administering UV treatment for skin or other conditions in a hospital	*2%*
Using UV lamps for drying paints, varnishes, stains, polishes or lacquers (not specific to any job)	3%
Administering UV light for skin care treatments (as beauty therapist/beautician)	3%
Operating solarium lamps for tanning (as beauty therapist/beautician)	3%
Using UV light to cure materials in manufacturing	2%
Supervising other welders	2%

Source: WES 2023, EU-OSHA; reference population: workers exposed to artificial UV radiation in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed. Workers can be exposed through multiple tasks in the same working week.

- **Use of control measures**

The highest use of protection measure was for tasks involving welding where 82% of the workers exposed report wearing clothing that completely covered the skin (i.e. long pants, long shirt, gloves, etc.).

Among the main exposure circumstances listed in Table 3, using UV lamps for nail polish curing had the highest percentage of workers reporting none of the control measures listed (68%), followed by operating solarium lamps for tanning where 52% of the workers reported no protection measure to protect from UV light.

Given the inclusion of ocular exposure to artificial UV radiation, eye protection was also considered, although its use was not substantial (less than half of the workers for all exposure circumstances).

Table 4: Information on workers' use of control measures when performing tasks with probable exposure to artificial UV radiation

Exposure circumstances	Fully enclosed / contained UV units[1]	Equipment unopenable when switched on	Equipment time delay[2]	Eye protection[3]	Full cover clothing[4]	None
Welding, torching, brazing, cutting or lasering metals, including:	not asked	not asked	not asked	34%	82%	14%
Working in an area where there were at least four other welders	*not asked*	*not asked*	*not asked*	*31%*	*91%*	*6%*
Using UV lamps for nail polish curing (as beauty therapist/beautician)	20%	7%	6%	8%	not asked	68%
Using UV light to cure or fix samples, or for other reasons related to lab work tasks	35%	25%	26%	29%	not asked	26%
Administering UV light for skin care treatments (as beauty therapist/beautician)	40%	not asked	not asked	48%	not asked	41%

[1] UV units fully enclosed or contained behind glass or plexiglass screens.
[2] Time delay before the equipment could be opened after switching it off.
[3] Safety goggles or glasses, welding goggles, welding helmet including goggles or welding shield.
[4] Clothing that completely covered the skin (i.e. long trousers and shirts, gloves).
Source: WES 2023, EU-OSHA; reference population: workers exposed to artificial UV radiation in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed.

3.1.3 Ionising radiation

Ionising radiation, in contrast to non-ionising radiation such as UV radiation, is another type of radiation present in workplaces. It consists of the transfer of energy in the form of particles (such as alpha and beta particles) or electromagnetic waves (such as X-rays and gamma rays). It comes both from natural and human-made sources.

Ionising radiation has uses in industry, such as energy production, manufacturing, medicine and research (OSHwiki, 2013). For example, X-rays are used in many medical applications that include diagnostic examinations and therapy, such as X-ray therapy, CT scanning and fluoroscopy.

Workers can be exposed to ionising radiation in a multitude of industrial processes, during nuclear power production and fuel recycling, as well as during military activities, flying and medical procedures (EU-OSHA, 2024b).

2.5% of the workers are probably exposed to ionising radiation in the last working week at any level.

- **Main circumstances of exposure**

The main circumstances of exposure among the workers exposed to ionising radiation are taking any flights for work with more than six hours duration (over the last month) (36% of those exposed), working with or near machines that used X-rays for purely diagnostic purposes in a medical facility (23%), working with radioisotopes or caring for patients who received radioisotopes (17%), and working with or near machines that used X-rays for interventional radiography in a medical facility (12%). Most of the workers

are exposed at a low or medium level, except when using equipment for quality assurance in industrial situations for which the proportion of workers exposed at a high level is larger.

Table 5: Most common circumstances of exposure among the workers exposed to ionising radiation

Exposure circumstances	Proportion of exposed workers working in each circumstance
Taking any flights for work with more than six hours duration (over the last month)[1] (in air transport and office work), including:	36%
Flying over South/North Pole for work (over the last month)	*2%*
Working with or near machines that used X-rays for purely diagnostic purposes in a medical facility (e.g. plain X-rays, mammography, general CT) (not specific to any job)	23%
Working with radioisotopes or caring for patients who received radioisotopes (not specific to any job)	17%
Working with or near machines that used X-rays for interventional radiography in a medical facility (e.g. fluoroscopy, angioplasty) (not specific to any job)	12%
Administering radiotherapy, such as brachytherapy, in a medical facility (not specific to any job)	8%
Semiconductors or transformers made, assembled, processed or repaired at workplace (in industrial manufacturing, assembly and repair-related jobs)	7%
Using X-ray equipment or linear accelerators for quality assurance (not specific to any job, outside a medical facility or a scientific laboratory)	6%
Working with mobile X-ray or gammagraphy equipment for quality assurance (not specific to any job, outside a medical facility or a scientific laboratory)	6%
Working with or near radiation-producing machines in a laboratory/research laboratory (e.g. X-ray machines, X-ray analysis apparatus)	5%
Any work that may have the risk of higher ionising radiation exposure (in nuclear energy/waste management)	4%
Using X-rays for sterilisation	4%
Using gammagraphy equipment for quality assurance (not specific to any job, outside a medical facility or a scientific laboratory)	3%

[1] There may be a limitation of the survey here. Indeed, few office workers were interviewed during fieldwork, but their weighting after fieldwork may have led to an overestimation of the percentage of workers exposed to ionising radiation and taking flights with more than six hours duration over the last month.

Source: WES 2023, EU-OSHA; reference population: workers exposed to ionising radiation in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed. Workers can be exposed through multiple tasks in the same working week.

- **Use of control measures**

If asked, protection measures were reported by a high percentage of workers for all assessed exposure circumstances. Indeed, at least 80% of workers probably exposed to ionising radiation and working in a medical facility (with or near machines using X-rays or administering radiotherapy) or with radioisotopes were using radioprotective shields and at least 68% reported wearing radioprotective garments.

When using X-ray equipment or linear accelerators for quality assurance, the share of workers not using any of the protection measures was the highest (32%).

Table 6: Information on workers' use of control measures when performing tasks with probable exposure to ionising radiation

Exposure circumstances	Radio-protective shields[1]	Radio-protective garments[2]	None
Working with or near machines that used X-rays for purely diagnostic purposes in a medical facility	85%	68%	3%
Working with radioisotopes or caring for patients who received radioisotopes	85%	85%	9%
Working with or near machines that used X-rays for interventional radiography in a medical facility (e.g. fluoroscopy, angioplasty)	81%	88%	1%
Administering radiotherapy, such as brachytherapy, in a medical facility	80%	85%	11%
Using X-ray equipment or linear accelerators for quality assurance	55%	53%	32%
Any work that may have the risk of higher ionising radiation exposure (in nuclear energy/waste management)	not asked	75%	25%
Using gammagraphy equipment for quality assurance	70%	72%	23%

[1] Such as lead or plexiglass shields, structural shields, lead partition or wall.
[2] Such as lead aprons, gloves, thyroid guards, leaded glasses, whole protection suit.
Source: WES 2023, EU-OSHA; reference population: workers exposed to solar ionising radiation in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed.

3.2 Occupational exposure to diesel engine exhaust emissions

Diesel exhaust is a process-generated mixture that originates from combustion in fuel-powered equipment and vehicles such as trucks, buses, trains, construction and farm equipment, generators, ships and some cars which use diesel fuel in their engines (EU-OSHA, 2024b).

DEE are the second most common probable exposure with **19.9%** of workers exposed at any level in the last working week. Among the 24 cancer risk factors assessed in WES, DEE are the second most common probable exposure at a high level. Indeed, 2.1% of all workers are exposed to DEE at a high level. DEE were often co-exposures, such as with solar UV radiation, concerning 11% of all workers, or with benzene (almost 6%).

▪ Main circumstances of exposure

The main exposure circumstance is driving, maintaining or travelling in diesel-powered vehicles as 71% of workers exposed to DEE were doing this task.

Table 7: Most common circumstances of exposure among the workers exposed to DEE

Exposure circumstances	Proportion of exposed workers working in each circumstance
Driving, maintaining or travelling in diesel-powered vehicle, including:	71%
Performing any maintenance work on diesel-powered vehicles, including:	*11%*
Tune ups, exhaust pipe work, or engine overhauls on diesel-powered vehicles	*4%*
Driving a diesel-powered vehicle inside a building (as part of work)	*5%*
Working in an area with diesel-powered vehicles running	40%
Working in a full-service petrol station (worker fills up the vehicles for the customer)	6%
Working in an area with diesel-powered generators or other type of non-portable generators running	3%
Working on a diesel-powered ship/boat	3%
Working around diesel-powered trains	3%
Working in a self-service petrol station (customers fill up their own vehicles)	*3%*
Using or repairing any diesel-fuelled equipment	2%

Source: WES 2023, EU-OSHA; reference population: workers exposed to DEE in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed. Workers can be exposed through multiple tasks in the same working week.

▪ Use of control measures

Control measures were not reported by a high percentage of workers exposed to DEE. The tasks for which workers seem to use control measures the most are for engine-specific tasks, namely the tune-ups, exhaust pipe work, or engine overhauls on diesel-powered vehicles (51% reported using LEV) or working in the engine room of a diesel-powered ship/boat (63% reported a general ventilation system). For the remaining tasks, more than two-third of the exposed workers did not report any control measures.

Table 8: Information on workers' use of control measures when performing tasks with probable exposure to DEE

Exposure circumstances	LEV	General ventilation system	None
Performing any maintenance work on diesel-powered vehicles, including:	16%	24%	67%
Tune-ups, exhaust pipe work or engine overhauls on diesel-powered vehicles[1]	*51%*	*29%*	*41%*
Working in an area with diesel-powered vehicles running	6%	9%	87%

Exposure circumstances	LEV	General ventilation system	None
Working in an area with diesel-powered generators or other type of non-portable generators running	14%	21%	69%
Working in the engine room of a diesel-powered ship/boat	12%	63%	33%
Using or repairing any diesel-fuelled equipment	8%	14%	81%

[1] When performing tune-ups, exhaust pipe work or engine overhauls on diesel-powered vehicles, 45% of workers exposed to DEE reported the specific use of a hose attached to the exhaust pipe of the vehicle to lead the exhaust fumes outside, and 18% reported the use of other type of LEV or on-tool extraction.

Source: WES 2023, EU-OSHA; reference population: workers exposed to DEE in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed.

3.3 Occupational exposure to inorganic dust

3.3.1 Asbestos

Asbestos is the generic term for a group of naturally occurring mineral silicate fibres. These include the serpentine mineral chrysotile (also known as 'white asbestos') and the five amphibole minerals: actinolite, amosite (also known as 'brown asbestos'), anthophyllite, crocidolite (also known as 'blue asbestos') and tremolite (IARC, 2012).

Nowadays, despite the ban on asbestos products in all EU in 2005, asbestos-related risks persist given its intensive commercial use for over 100 years. In fact, it remains one of the main causes of work-related cancers due to the long average latency of the cancers caused by asbestos (OSHwiki, 2012).

1.7% of the workers are probably exposed to asbestos in the last working week, most of them at a low level (1.1%).

- **Main circumstances of exposure**

Major occupational exposure sources include maintenance work on potentially asbestos-containing vehicles (29% of those exposed), working in potentially asbestos-containing tunnels (22%) and frontline firefighting (19%).

Table 9: Most common circumstances of exposure among the workers exposed to asbestos

Exposure circumstances	Proportion of exposed workers working in each circumstance
Servicing, repairing, or replacing brakes or clutches on vehicles older than [different date according to the country[1]]	29%
Working in tunnels of buildings constructed before [different date according to the country[1]], including:	22%
Working in tunnels of buildings that have pipes with fibrous or crumbly lagging or insulation	*7%*
Frontline firefighting in any types of fire, including:	19%
Frontline firefighting in residential or commercial fires	*9%*
Working with any asbestos-containing material, including:	15%

Exposure circumstances	Proportion of exposed workers working in each circumstance
Repair or maintenance tasks involving asbestos-containing material (except removal)	*9%*
Removal of asbestos-containing materials	*7%*
Overhaul, clean-up or sifting through the remains of a fire	6%
Working in an engine room of a boat built before 2011	5%
Maintenance activities at a power station built before 2002	3%

[1] According to national legislation (Finland and Germany: 1993, France: 1997, Ireland: 2000, Spain: 2002, Hungary: 2005).

Source: WES 2023, EU-OSHA; reference population: workers exposed to asbestos in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed. Workers can be exposed through multiple tasks in the same working week.

- **Use of control measures**

Main control measures asked about were the use of ventilation or relevant RPE, depending on the exposure circumstance. For tasks where ventilation seemed relevant, the use of general ventilation (41-61%) seemed to be prioritised over the use of LEV (14-24%). For frontline firefighting and the repair or maintenance of asbestos-containing material, the use of control measures was rather low with less than a third of workers using relevant RPE, at best.

Table 10: Information on workers' use of control measures when performing tasks with probable exposure to asbestos

Exposure circumstances	LEV	General ventilation	Relevant RPE	None
Servicing, repairing, or replacing brakes or clutches on vehicles older than [different date according to the country[1]]	23%	41%	not asked	40%
Working in tunnels of buildings constructed before [different date according to the country[1]]	24%	60%	not asked	27%
Frontline firefighting in any types of fire, including:	not asked	not asked	17%	83%
Frontline firefighting in residential or commercial fires	not asked	not asked	32%	68%
Repair or maintenance tasks involving asbestos-containing material (except removal)	not asked	not asked	27%	73%
Working in an engine room of a boat built before 2011	14%	61%	not asked	31%

[1] According to national legislation (Finland and Germany: 1993, France: 1997, Ireland: 2000, Spain: 2002, Hungary: 2005).

Source: WES 2023, EU-OSHA; reference population: workers exposed to asbestos in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed.

Given the strict legislation pertaining to the removal of asbestos-containing materials, the control measures for this task are identified separately in the table below.

Table 11: Information on workers' use of control measures when doing removal of asbestos-containing materials

Control measures	Proportion of exposed workers doing removal of asbestos-containing material
Work done inside an enclosure under negative pressure	11%
Decontamination unit on site	40%
Complete protective clothing: gloves, footwear, overalls, apron and goggles/glasses	19%
Shower before removing personal protective equipment (PPE)	20%
Last PPE item removed: RPE	5%
Use of an air-supplied respirator or SCBA	17%
Use of other RPE (rubber face mask with P3 filter, PAPR or FFP3 mask)	67%
None	1%

Source: WES 2023, EU-OSHA; reference population: workers exposed to asbestos in Germany, Ireland, Spain, France, Hungary and Finland and doing removal of asbestos-containing material.

In addition, 74% of the workers exposed to asbestos and doing removal of asbestos-containing material reported they receive specific training related to asbestos removal.

3.3.2 Respirable crystalline silica

Because of the extensive natural occurrence of RCS and the wide uses of the materials in which it is a constituent, workers may be exposed to RCS in a large variety of industries and occupations. Some industries involving silica exposure include mines and quarries, foundries and other metallurgical operations, ceramics and related industries, construction (including road construction and maintenance), crushed stone (including granite) and related industries, sandblasting of metal surfaces and agriculture (IARC, 2012).

WES shows that **8.4%** of workers are probably exposed to RCS in the last working week.

- **Main circumstances of exposure**

When considering the workers exposed to RCS, the most common exposure circumstances include driving in a construction site, a mine or a quarry (26% of those exposed), drilling or making holes in walls (16%), working with concrete, stone, artificial stone, slate, ceramic tiles or bricks (14%), mixing concrete or cement (13%), and ploughing, harrowing or otherwise disturbing soil (e.g. among crop and livestock farm workers) (8%). One out of five workers exposed to RCS were working in the presence of sand dust on the working site in construction trades (20%).

The main circumstances resulting in probable exposure to RCS at a high level were inappropriate ways of cleaning sand dust at the work site, mixing concrete or cement, working with artificial stone (cutting, grinding, etc.), and inappropriate protection measures when working with natural stone, concrete or bricks (cutting, grinding, etc.) (EU-OSHA, 2023b).

Table 12: Most common circumstances of exposure among the workers exposed to RCS

Exposure circumstances	Proportion of exposed workers working in each circumstance
Driving in a construction site, a mine or a quarry (not specific to any job)	26%
Presence of sand dust on working site (in construction trades)	20%
Drilling or making holes in walls (in construction trades)	16%
Working with concrete, stone, artificial stone, slate, ceramic tiles or bricks (not specific to any job), including:	14%
Working with ceramic tiles	*3%*
Working with artificial stone	*3%*
Mixing concrete or cement (in construction trades)	13%
Ploughing, harrowing or otherwise disturbing soil (in crop and livestock farm workers)	8%
Ground construction, or preparing road surface for paving	5%
Road paving and/or sealing	4%
Demolitions or teardowns (in construction trades)	4%
Handling or coming in contact with sand as animal bedding	4%
Manufacturing crowns, false teeth or bridges	3%
Mixing asphalt, tarmac or bitumen	3%
Working at the tip face or pit of a tip/landfill or waste transfer station	2%
Working in mine yards or in open pits or quarries	2%
Plastering (in construction trades)	2%
Working with horses on sand	2%

Source: WES 2023, EU-OSHA; reference population: workers exposed to RCS in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed. Workers can be exposed through multiple tasks in the same working week.

- **Use of control measures**

Workers use several control measures when working with concrete, stone, artificial stone, slate, ceramic tiles or bricks. These include water dust suppression (30%), LEV (30%), or the use of a filtering or air-supplied respirator (35%). Overall, four out of 10 workers reported the absence of these three types of control measures asked about for this task.

The presence of sand and other dust in the workplace is reduced by water suppression (30%) as well as other cleaning measures like vacuum cleaning (with or without HEPA filter) or mopping the working area with water (40%). Water dust suppression is also used during demolitions or teardowns by 31% of the workers concerned, or by 16% of the workers when working with horses on sand. Around 45% of workers ploughing, harrowing or otherwise disturbing soil reported working in an enclosed cabin.

Overall, the percentage of workers not using any of the control measures remain high in any of the exposure circumstances, and even above half of the exposed workers in five out of nine exposure circumstances (Table 13), except for the manufacturing of crowns, false teeth or bridges (4%).

Table 13: Information on workers' use of control measures when performing tasks with probable exposure to RCS

Exposure circumstances	Water dust suppression	Enclosed box, system or cab	LEV	Relevant RPE	None
Presence of sand dust on working site	30%	not asked	not asked	not asked	70%
Drilling or making holes in walls	not asked	not asked	37%	not asked	63%
Working with concrete, stone, artificial stone, slate, ceramic tiles or bricks, including:	30%	not asked	30%	35%	44%
Working with ceramic tiles	*36%*	*not asked*	*47%*	*34%*	*36%*
Working with artificial stone	*24%*	*not asked*	*35%*	*44%*	*48%*
Ploughing, harrowing or otherwise disturbing soil	not asked	46%	not asked	not asked	54%
Demolitions or teardowns	31%	not asked	not asked	not asked	69%
Manufacturing crowns, false teeth or bridges	not asked	73%	84%	3%	4%
Working with horses on sand	16%	not asked	not asked	not asked	84%

Source: WES 2023, EU-OSHA; reference population: workers exposed to RCS in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed. Workers could use more than one protection measure.

3.4 Occupational exposure to organic dust

3.4.1 Leather dust

Leather dust is a dust produced from different industrial processes occurring throughout the leather and footwear manufacturing supply chain (EU-OSHA, 2024b). Leather dust is a common exposure for workers in shoemaking or those involved in the production of leather goods.

0.7% of all workers from all six countries are probably exposed to leather dust at any level in the last working week.

More than three-quarters of the workers exposed to leather dust and working in manufacture and repair of shoes or finished leather goods were exposed at a high level. They also more often wore none of the protection measures mentioned (34-35%). In comparison, only 10% or less of the workers exposed and working in leather tanning-related jobs reported using none of the protection measures listed.

- **Main circumstances of exposure**

The main circumstances of exposure were working with leather or suede in the upholstery industry (36% of those exposed), followed by tasks in the manufacturing and repair of shoes and leather goods, with 30% of exposed workers working with leather and 24% making or repairing leather shoe heels or soles, and doing leather tanning-related tasks.

Table 14: Most common circumstances of exposure among the workers exposed to leather dust

Exposure circumstances	Proportion of exposed workers working in each circumstance
Working with leather or suede (in upholstery industry)	36%
Working with leather (in manufacture and repair of shoes or finished leather goods), including:	30%
Roughing, scouring, finishing or cutting the leather	*24%*
Working in an area where there was leather dust	*18%*
Making or repairing leather shoe heels or soles (in manufacture and repair of shoes or finished leather goods)	24%
Working in the area where leather was dried, set out, stretched and softened (in leather tanning-related jobs)	24%
Working in the area where tanned hides and skins were split and shaved (in leather tanning-related jobs)	21%
Sanding, grinding or buffing leather (in leather tanning-related jobs)	17%

Source: WES 2023, EU-OSHA; reference population: workers exposed to leather dust in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed. Workers can be exposed through multiple tasks in the same working week.

- **Use of control measures**

The use of control measures seems to be differentiated by the job category. Indeed, for tasks in leather tanning-related jobs, the use of control measures is high, with the use of a general ventilation system being the most used option (55-60%). 7 to 10% of the exposed workers in these exposure circumstances declared not using any control measures. On the other hand, more than half of those working in manufacture and repair of leather goods declared using a general ventilation system but still around 35% reported not using any control measures.

Table 15: Information on workers' use of control measures when performing tasks with probable exposure to leather dust

Exposures circumstances	Water dust suppression, wet leather processing	LEV	General ventilation system	Relevant RPE	None
Working with leather (in manufacture and repair of shoes or finished leather goods), including:	not asked	9%	53%	14%	35%
Roughing, scouring, finishing or cutting the leather	not asked	*8%*	*55%*	*14%*	*35%*
Working in an area where there was leather dust	*12%*	*8%*	*57%*	*10%*	*31%*
Making or repairing leather shoe heels or soles (in manufacture and repair of shoes or finished leather goods)	not asked	10%	52%	13%	34%

Exposures circumstances	Water dust suppression, wet leather processing	LEV	General ventilation system	Relevant RPE	None
Working in the area where leather was dried, set out, stretched and softened (in leather tanning-related jobs)	not asked	39%	58%	28%	10%
Working in the area where tanned hides and skins were split and shaved (in leather tanning-related jobs)	20%	43%	55%	31%	7%
Sanding, grinding or buffing leather (in leather tanning-related jobs)	not asked	35%	60%	37%	8%

Source: WES 2023, EU-OSHA; reference population: workers exposed to leather dust in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed.

3.4.2 Wood dust

Wood dust is a process-generated mixture that workers may be exposed to when wood or wood-containing materials are processed, for example, in construction and furniture-making. Workers in the wood working industry, furniture manufacturing and construction sectors are the most likely to be exposed to hardwood dust in their workplaces (EU-OSHA, 2024b).

3.2% of all workers in all six countries were assessed to be probably exposed to wood dust in the last working week. This stands out from most other cancer risk factors included in the survey, as half of exposed workers were exposed at a high level (1.6%).

- **Main circumstances of exposure**

The most common exposure circumstance was chopping, cutting, sawing, sanding or working with wood as it concerns 53% of the workers exposed to wood dust.

Table 16: Most common circumstances of exposure among the workers exposed to wood dust

Exposure circumstances	Proportion of exposed workers working in each circumstance
Chopping, cutting, sawing, sanding or working with wood, including:	53%
Using power tools to work with wood	*38%*
Handling or coming in contact with wood chips as animal bedding	12%
Doing demolitions or teardowns, including of wooden structures (in construction trades)	10%
Working in furniture upholstery or reupholstery	10%
Loading or unloading materials containing hardwood such as wood chips and pellets	9%
Sanding wood, chipboard, MDF, plywood or pressed wood, including:	6%
Using a power sander or polisher	*5%*

Exposure circumstances	Proportion of exposed workers working in each circumstance
Cleaning up wood dust (the worker themself, or anyone near them) (in cleaning-related jobs)	5%
Laying wood flooring (in construction trades)	5%

Source: WES 2023, EU-OSHA; reference population: workers exposed to wood dust in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed. Workers can be exposed through multiple tasks in the same working week.

- **Use of control measures**

Water spraying and suppression is the most effective measure to use against wood dust (when relevant), but it was not the most reported measure. Indeed, less than a third of workers in relevant tasks adopted this measure. LEV is the most used control measure with 33 to 64% of workers exposed to wood dust using this method. In the most common exposure circumstance, more than half of the exposed workers reported none of the control measures (54%).

Table 17: Information on workers' use of control measures when performing tasks with probable exposure to wood dust

Exposure circumstances	Water dust suppression	LEV	Relevant RPE	None
Chopping, cutting, sawing, sanding or working with wood, including:	16%	33%	17%	54%
Using power tools to work with wood	*19%*	*38%*	*18%*	*50%*
Doing demolitions or tear downs, including of wooden structures (in construction trades)	31%	not asked	not asked	69%
Sanding wood, chipboard, MDF, plywood, or pressed wood, including:	not asked	59%	36%	31%
Using a power sander or polisher	*not asked*	*64%*	*42%*	*24%*

Source: WES 2023, EU-OSHA; reference population: workers exposed to wood dust in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed.

3.5 Occupational exposure to mineral oils (as mists)

Mineral oils (also known as base oils, mineral oils or lubricant base oils) are chemical substances prepared from naturally occurring crude petroleum oil. They are used in a wide range of products including lubricants, such as engine oils, transmission fluids, gear oils, hydraulic fluids and metalworking fluids (or metal-removal fluids), and 'non-lubricant' products such as agricultural spray oils, printing inks and tyre oils (EU-OSHA, 2024b).

2.0% of the workers are probably exposed to mineral oils (as mists) in the last working week at any level.

- **Main circumstances of exposure**

The main circumstances of exposure were using straight cutting oils (33% of those exposed), followed by lab work tasks (27%). The other circumstances were diverse, from working in printing-related tasks to working in an engine room of a boat, for example.

Table 18: Most common circumstances of exposure among the workers exposed to mineral oils

Exposure circumstances	Proportion of exposed workers working in each circumstance
Using straight cutting oils (clear and feels oily) when working with metals, wood, etc., including:	33%
Using straight cutting oils with hand tools	*19%*
Using straight cutting oils with a fixed machine	*17%*
Handling or coming in contact with mineral oils during lab work tasks (in any type of scientific laboratory)	27%
Working in a specific engine room of a boat or ship	11%
Brakes, brake parts, engines or engine parts of vehicles, trains or airplanes, including radiators, etc., repaired at the workplace	8%
Working in the areas of extruding or rolling metals, or casting ingots (in smelting and refining operations)	7%
Using mineral oil-based inks when doing letterpress or relief printing	4%
Working primarily in press/printing (while using lithography, planographic or offset as printing processes)	4%
Doing maintenance on forestry machinery while working in a forest location	3%
Working with mineral oils while manufacturing machinery, medical devices or metal products	3%
Mineral oils applied to the wool or to the fibres/yarn (in manufacture of natural or synthetic textiles, fabric, yarn or finished goods such as clothes)	2%

Source: WES 2023, EU-OSHA; reference population: workers exposed to mineral oils (as mists) in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed. Workers can be exposed through multiple tasks in the same working week.

- **Use of control measures**

The control measures asked about were working in a fully closed system or machine, the use of ventilation or relevant RPE, depending on the exposure circumstance. When using straight cutting oils with a fixed machine, 65% of the workers exposed to mineral oils reported using an enclosed machine. Working in a fully closed system (or glove box) was less often reported during lab work tasks (28%).

For tasks where ventilation seemed relevant, the use of general ventilation (46-72%) seemed to be prioritised over the use of LEV or on-tool extraction, except for workers using straight cutting oils with a fixed machine who reported both measures in close proportions (56% and 49%, respectively). When working in printing-related tasks, workers were only asked about the use of relevant RPE, but three-quarters or more of those exposed to mineral oils (as mists) reported none of the control measures.

Table 19: Information on workers' use of control measures when performing tasks with probable exposure to mineral oils

Exposure circumstances	Fully closed system or machine	LEV	General ventilation system	Relevant RPE	None
Using straight cutting oils (clear and feels oily) when working with metals, wood, etc., including:	not asked	32%	47%	26%	31%

Exposure circumstances	Fully closed system or machine	LEV	General ventilation system	Relevant RPE	None
Using straight cutting oils with hand tools	not asked	24%	46%	23%	41%
Using straight cutting oils with a fixed machine[1]	65%	49%	56%	37%	5%
Handling or coming in contact with mineral oils during lab work tasks (in any type of scientific laboratory)	28%	26%	65%	26%	3%
Working in a specific engine room of a boat or ship	not asked	15%	72%	not asked	19%
Using mineral oil-based inks when doing letterpress or relief printing	not asked	not asked	not asked	25%	75%
Working primarily in press/printing (while using lithography, planographic or offset as printing processes)	not asked	not asked	not asked	11%	89%

[1] When using straight cutting oils with a fixed machine, 9% of the workers exposed to mineral oils reported allowing time for the mist or droplets to settle before opening the machine.

Source: WES 2023, EU-OSHA; reference population: workers exposed to mineral oils (as mists) in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed.

3.6 Occupational exposure to solvents

3.6.1 Benzene

Benzene is a colourless flammable liquid with a characteristic sweet smell known for its stability and reactivity. It is a natural component of crude oil and natural gas/natural gas liquids. It is primarily used in the production of polystyrene, but also in producing ethylbenzene, cumene, cyclohexane and other chemical compounds. Occupational exposure essentially occurs via inhalation given the high volatility of benzene. Yet, workers can also be exposed via dermal absorption. Benzene is present in many workplaces as it is used in several industries and sectors, including the production and refining of oil and gas, and the distribution or the sale and use of petroleum products as well as being commonly used as a solvent in chemical and pharmaceutical industries (EU-OSHA, 2024b).

12.8% of workers are probably exposed to benzene in the last working week at any level,[10] around two-thirds of them at a low level (8.7%).

- **Main circumstances of exposure**

Exposure circumstances are quite diverse for workers exposed to benzene. Most of the exposed workers were involved in tasks related to petrol-powered vehicles, equipment or generators, and/or in tasks involving solvent-based mixtures (paints, thinners or cleaners). The two most common exposure circumstances were fuelling vehicle with petrol (36% of those exposed), followed by working in an area with petrol-powered vehicles running (30%).

[10] In comparison to a previous publication, a slight error has been corrected, which impacts the assessment of exposure to benzene from 13.0% (EU-OSHA, 2023b) to 12.8% of the workers in the six countries (after correction).

Table 20: Most common circumstances of exposure among the workers exposed to benzene

Exposure circumstances	Proportion of exposed workers working in each circumstance
Fuelling vehicle with petrol (not specific to any job)	36%
Working in an area with petrol-powered vehicles running (not specific)	30%
Performing any maintenance work on petrol-fuelled vehicles (not specific), including:	9%
Tune-ups, exhaust pipe work or engine overhauls on petrol-fuelled vehicles	*5%*
Draining fuel tanks or changing fuel filters on petrol-fuelled vehicles	*4%*
Working in a full-service petrol station (worker fills up the vehicles for the customer)	9%
Frontline firefighting	5%
Working in a self-service petrol station (customers fill up their own vehicles)	4%
Opening shipping containers imported from overseas (not specific)	4%
Using solvent-based cleaners to clean stains from fabrics (e.g. petroleum distillates/hydrocarbon dry cleaners) (not specific)	3%
Refuelling equipment with petrol (not specific)	3%
Cleaning painting equipment with oil or solvent-based thinners (not specific)	3%
Using solvent-based cleaners for dry cleaning of clothes (e.g. petroleum distillates/hydrocarbon dry cleaners)	3%
Using nitrocellulose, oil or solvent-based paints with a brush or roller (not specific)	3%
Using oil or solvent-based thinners to mix or thin paints (not specific)	3%
Driving a petrol-fuelled vehicle inside a building (as part of work) (not specific)	3%
Working in an area with petrol-powered generators running (not specific)	2%

Source: WES 2023, EU-OSHA; reference population: workers exposed to benzene in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed. Workers can be exposed through multiple tasks in the same working week.

- **Use of control measures**

The use of LEV was not commonly reported among the workers exposed to benzene, except when performing tune-ups, exhaust pipe work or engine overhauls on petrol-fuelled vehicles, where 67% of them reported the specific use of a hose attached to the exhaust pipe of the vehicle to lead the exhaust fumes outside, and 22% the use of other type of local exhaust ventilation or on-tool extraction (73% reported one and/or the other, see Table 21). General ventilation was mostly reported by workers using

solvent-based cleaners to clean fabrics (63%) or for dry cleaning (76%). Most of the exposed workers who were working in an area with petrol-powered vehicles or generators running or performing maintenance work on petrol-fuelled vehicles reported none of the control measures (87%, 58% and 62%, respectively).

Table 21: Information on workers' use of control measures when performing tasks with probable exposure to benzene

Exposure circumstances	LEV	General ventilation system	Relevant RPE	None
Working in an area with petrol-powered vehicles running	6%	10%	Not asked	87%
Performing any maintenance work on petrol-fuelled vehicles, including:	15%	29%	Not asked	62%
Tune-ups, exhaust pipe work or engine overhauls on petrol-fuelled vehicles	*73%[1]*	*41%*	*Not asked*	*19%*
Draining fuel tanks or changing fuel filters on petrol-fuelled vehicles	*22%*	*43%*	*Not asked*	*45%*
Frontline firefighting	Not asked	Not asked	63%	37%
Using solvent-based cleaners to clean stains from fabrics (e.g. petroleum distillates/hydrocarbon dry cleaners)	28%	63%	Not asked	28%
Using solvent-based cleaners for dry cleaning of clothes (e.g. petroleum distillates/hydrocarbon dry cleaners)	8%	76%	5%	20%
Using oil or solvent-based thinners to mix or thin paints	Not asked	Not asked	63%	37%
Working in an area with petrol-powered generators running	13%	34%	Not asked	58%

[1] When performing tune-ups, exhaust pipe work or engine overhauls on petrol-fuelled vehicles, 67% of workers exposed to benzene reported the specific use of a hose attached to the exhaust pipe of the vehicle to lead the exhaust fumes outside, and 22% reported the use of other type of local exhaust ventilation or on-tool extraction.

Source: WES 2023, EU-OSHA; reference population: workers exposed to benzene in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed.

3.6.2 Trichloroethylene

Trichloroethylene (or TCE) is a clear, colourless non-flammable liquid with a sweet smell commonly used as an industrial solvent given its effectiveness in cleaning metals. In the past, trichloroethylene was used as an anaesthetic, a stain remover in dry-cleaning, an ingredient in paints, adhesives and cleaners, for degreasing metal parts and producing chlorinated chemicals. Nowadays, it is mostly used in intermediate applications as well as in metal cleaning and in the adhesives industries. Occupational exposure mainly occurs by inhalation. Workers involved in the degreasing of metals and other materials may particularly be exposed (EU-OSHA, 2024b).

1.0% of workers are probably exposed to trichloroethylene in the last working week at any level.

- **Main circumstances of exposure**

The most common exposure circumstance was during lab work tasks with 27% of workers exposed to trichloroethylene performing this task. Using trichloroethylene as a dry-cleaning chemical in dry-cleaning tasks accounted for a large proportion of workers exposed to trichloroethylene at a high level. Workers using trichloroethylene to degrease manually were exposed at a high level as well.

Table 22: Most common circumstances of exposure among the workers exposed to trichloroethylene

Exposure circumstances	Proportion of exposed workers working in each circumstance
Using trichloroethylene during lab work tasks (in any type of scientific laboratory)	27%
Working with trichloroethylene in chemical or pharmaceutical products manufacturing	22%
Transferring dry-cleaned clothing from the washer to the dryer and using trichloroethylene as a dry-cleaning chemical	17%
Pressing clothes and using trichloroethylene as a dry-cleaning chemical	14%
Transferring dry-cleaning chemicals manually from a storage tank to a washing machine and using trichloroethylene as a dry-cleaning chemical	11%
Using trichloroethylene to degrease (neither by hand nor manually) (not specific to any job)	11%
Working in the finishing process of the making of shoes or boots (in manufacture and repair of shoes or finished leather goods)	10%
Using trichloroethylene to degrease by hand or by spraying parts manually (not specific to any job)	9%
Cleaning dry-cleaning equipment and using trichloroethylene as a dry-cleaning chemical	5%

Source: WES 2023, EU-OSHA; reference population: workers exposed to trichloroethylene in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed. Workers can be exposed through multiple tasks in the same working week.

- **Use of control measures**

The share of workers using at least one of the protection measures is the highest for the exposure circumstances with the highest proportion of workers exposed, meaning using trichloroethylene during lab work tasks (98%) and working with trichloroethylene in chemical or pharmaceutical products manufacturing (100%). The most frequently used protection measure is the use of a general ventilation system; 46% to 78% of workers exposed use it across different exposure circumstances.

Table 23: Information on workers' use of control measures when performing tasks with probable exposure to trichloroethylene

Exposure circumstances	Fully closed system	LEV	General ventilation system	Relevant RPE	None
Using trichloroethylene during lab work tasks (in any type of scientific laboratory)	20%	55%	46%	33%	2%
Working with trichloroethylene in chemical or pharmaceutical products manufacturing[1]	56%	23%	not asked	38%	0%
Transferring dry-cleaned clothing from the washer to the dryer and using trichloroethylene as a dry-cleaning chemical	not asked	12%	66%	13%	26%
Pressing clothes and using trichloroethylene as a dry-cleaning chemical	not asked	8%	78%	11%	16%
Transferring dry-cleaning chemicals manually from a storage tank to a washing machine and using trichloroethylene as a dry-cleaning chemical	not asked	8%	65%	4%	33%
Using trichloroethylene to degrease (neither by hand nor manually)	not asked	not asked	not asked	60%	40%
Working in the finishing process of the making of shoes or boots	not asked	27%	59%	11%	26%
Using trichloroethylene to degrease by hand or by spraying parts manually	not asked	not asked	not asked	83%	17%

[1] When working with trichloroethylene in chemical or pharmaceutical products manufacturing, 36% of workers exposed to trichloroethylene reported working in a fully closed system, and 21% of them working in a partially enclosed system.

Source: WES 2023, EU-OSHA; reference population: workers exposed to trichloroethylene in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed.

3.7 Occupational exposure to industrial chemicals

3.7.1 1,3-butadiene

1,3-butadiene is a colourless, flammable gas with a mild gasoline-like odour made from the processing of petroleum. This chemical is essentially used to make synthetic rubber, which is widely used for tyres on car and trucks, but also to make plastics; and a small amount can also be found in gasoline (EU-OSHA, 2024b).

1.3% of workers are probably exposed to 1,3-butadiene in the last working week at any level.

- **Main circumstances of exposure**

The most common exposure circumstances were frontline firefighting with more than half of those exposed to 1,3-butadiene performing this task (51% of those exposed), followed by lab work tasks (15%).

Table 24: Most common circumstances of exposure among the workers exposed to 1,3-butadiene

Exposure circumstances	Proportion of exposed workers working in each circumstance
Frontline firefighting	51%
Handling or coming in contact with 1,3-butadiene during lab work tasks (in any type of scientific laboratory)	15%
Taking part or being involved in any firebreak constructing, preventive burning or controlled burning	9%
Overhaul, clean-up and/or sifting through the remains of a fire	7%
Working in a workplace where styrene-butadiene, polybutadiene, styrene-butadiene rubber (SBR), butadiene rubber (BR) or polyvinyl acetate (PVAc/PVAcA) was made or processed	7%
Working on samples in the laboratory in a rubber, plastics or resins industry	6%
Working in a tank farm in a rubber, plastics or resins industry	5%
Working with 1,3-butadiene in chemical or pharmaceutical products manufacturing	5%
Cleaning out reactors in a rubber, plastics or resins industry	4%

Source: WES 2023, EU-OSHA; reference population: workers exposed to 1,3-butadiene in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed. Workers can be exposed through multiple tasks in the same working week.

- **Use of control measures**

Main control measures asked about were working in a fully closed system and the use of ventilation or relevant RPE, depending on the exposure circumstance. For tasks where ventilation seemed relevant, the use of general ventilation (65-83%) seemed to be mainly prioritised over the use of LEV or on-tool extraction, apart from workers working in a tank farm in a rubber, plastics or resins industry that reported it more often (52%).

Except for firefighting-related tasks, the reported use of control measures is high among workers exposed to 1,3-butadiene (93-100% using at least one).

Table 25: Information on workers' use of control measures when performing tasks with probable exposure to 1,3-butadiene

Exposure circumstances	Fully closed system	LEV	General ventilation system	Relevant RPE	None
Frontline firefighting	not asked	not asked	not asked	63%	37%
Handling or coming in contact with 1,3-butadiene during lab work tasks (in any type of scientific laboratory)	32%	32%	73%	17%	7%
Taking part or being involved in any firebreak constructing, preventive burning or controlled burning	not asked	not asked	not asked	28%	72%
Overhaul, clean-up and/or sifting through the remains of a fire	not asked	not asked	not asked	72%	28%
Working in a workplace where styrene-butadiene, polybutadiene, styrene-butadiene rubber (SBR), butadiene rubber (BR) or polyvinyl acetate (PVAc/PVAcA) was made or processed	not asked	36%	72%	13%	1%
Working on samples in the laboratory in a rubber, plastics or resins industry	not asked	30%	72%	26%	0%
Working in a tank farm in a rubber, plastics or resins industry	not asked	52%	65%	31%	0%
Working with 1,3-butadiene in chemical or pharmaceutical products manufacturing[1]	41%	22%	not asked	44%	0%
Cleaning out reactors in a rubber, plastics or resins industry	not asked	19%	83%	7%	0%

[1] When working with 1,3-butadiene in chemical or pharmaceutical products manufacturing, 36% of workers exposed to 1,3-butadiene reported working in a partially enclosed system.

Source: WES 2023, EU-OSHA; reference population: workers exposed to 1,3-butadiene in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed.

3.7.2 Acrylamide

Acrylamide is a white odourless solid, soluble in water and in several organic solvents. Workers may be exposed to acrylamide when involved in: chemical production; construction and maintenance involving pipe grouting and sealing; soil, tunnel and dam stabilisation; water and wastewater treatment; and preparation of polyacrylamide gels in the laboratory (EU-OSHA, 2024b).

0.7% of workers are probably exposed to acrylamide in the last working week at any level.

- **Main circumstances of exposure**

The most common exposure circumstance was working in a workplace where acrylic plastic or resin, acrylonitrile butadiene styrene (ABS) or PVAc/PVAcA were made or processed (43% of those exposed), followed by lab work tasks (34%).

Table 26: Most common circumstances of exposure among the workers exposed to acrylamide

Exposure circumstances	Proportion of exposed workers working in each circumstance
Working in a workplace where acrylic plastic or resin, acrylonitrile butadiene styrene (ABS) or polyvinyl acetate (PVAc/PVAcA) were made or processed	43%
Handling or coming in contact with acrylamide during lab work tasks (in any type of scientific laboratory)	34%
Working with acrylamide in chemical or pharmaceutical products manufacturing, including:	14%
Loading or unloading substances into/from the process or for storage, and involving acrylamide	*7%*
Taking samples from the process or from delivery, and involving acrylamide	*5%*
Process cleaning and routine maintenance tasks, e.g. substitution/cleaning of filters, and involving acrylamide	*3%*
Moulding acrylic plastic or resin, or acrylonitrile butadiene styrene (ABS) while machining plastic or synthetic resin parts	9%

Source: WES 2023, EU-OSHA; reference population: workers exposed to acrylamide in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed. Workers can be exposed through multiple tasks in the same working week.

- **Use of control measures**

In general, the use of control measures is very common among the workers exposed to acrylamide in the three most common exposure circumstances (94-100% reported at least one).

Table 27: Information on workers' use of control measures when performing tasks with probable exposure to acrylamide

Exposure circumstances	Fully closed system	LEV	General ventilation system	Relevant RPE	None
Working in a workplace where acrylic plastic or resin, acrylonitrile butadiene styrene (ABS) or polyvinyl acetate (PVAc/PVAcA) were made or processed	not asked	25%	82%	23%	4%
Handling or coming in contact with acrylamide during lab work tasks (in any type of scientific laboratory)	41%	43%	43%	31%	6%
Working with acrylamide in chemical or pharmaceutical products manufacturing[1]	57%	30%	not asked	30%	0%

[1] When working with acrylamide in chemical or pharmaceutical products manufacturing, 13% of workers exposed to acrylamide reported working in a partially enclosed system.

Source: WES 2023, EU-OSHA; reference population: workers exposed to acrylamide in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed.

3.7.3 Diethyl sulphate and dimethyl sulphate

Diethyl sulphate is a colourless, oily liquid with a faint peppermint odour that is corrosive to tissue and metals. It is used mainly as an intermediate in the manufacture of dyes, pigments and textile chemicals, as well as in textile production (EU-OSHA, 2024b).

Dimethyl sulphate is also a colourless oily liquid practically odourless with a faint onion-like odour that is corrosive to metals and tissue. It is very toxic by inhalation and is a combustible liquid. It is mainly used in the manufacturing process of dyes, perfumes and pharmaceuticals, the separation of mineral oils and the analysis of automobile fluids (EU-OSHA, 2024b).

0.4% of workers are probably exposed to diethyl sulphate and/or dimethyl sulphate in the last working week.

- **Main circumstances of exposure**

The most common exposure circumstance among the workers exposed to diethyl sulphate and/or dimethyl sulphate was lab work tasks (71% of those exposed).

Table 28: Most common circumstances of exposure among the workers exposed to diethyl and/or dimethyl sulphate

Exposure circumstances	Proportion of exposed workers working in each circumstance
Handling or coming in contact with diethyl and/or dimethyl sulphate during lab work tasks (in any type of scientific laboratory)	71%
Working with diethyl and/or dimethyl sulphate in chemical or pharmaceutical products manufacturing, including:	29%
Loading or unloading substances into/from the process or for storage, and involving diethyl and/or dimethyl sulphate	*12%*
Taking samples from the process or from delivery, and involving diethyl and/or dimethyl sulphate	*11%*
Process cleaning and routine maintenance tasks, e.g. substitution/cleaning of filters, and involving diethyl and/or dimethyl sulphate	*7%*

Source: WES 2023, EU-OSHA; reference population: workers exposed to diethyl sulphate and/or dimethyl sulphate in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed. Workers can be exposed through multiple tasks in the same working week.

- **Use of control measures**

The use of control measures is very common among the workers exposed to diethyl sulphate and/or dimethyl sulphate in the most common exposure circumstances (98% reported at least one).

Table 29: Information on workers' use of control measures when performing tasks with probable exposure to diethyl and/or dimethyl sulphate

Exposure circumstances	Fully closed system	LEV	General ventilation system	Relevant RPE	None
Handling or coming in contact with diethyl and/or dimethyl sulphate during lab work tasks (in any type of scientific laboratory)	28%	52%	56%	34%	2%
Working with diethyl and/or dimethyl sulphate in chemical or pharmaceutical products manufacturing[1]	75%	5%	NA	25%	2%

[1] When working with diethyl and/or dimethyl sulphate in chemical or pharmaceutical products manufacturing, 19% of workers exposed to diethyl and/or dimethyl sulphate reported working in a partially enclosed system.

Source: WES 2023, EU-OSHA; reference population: workers exposed to diethyl and/or dimethyl sulphate in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed.

3.7.4 Epichlorohydrin

Epichlorohydrin is a highly electrophilic compound that appears as a colourless liquid with a garlic-like odour. It is used in different industries, including in the production of glycerol, plastics, epoxy glues and resins, epoxy diluents and elastomers. In the workplace, workers can be exposed through inhalation or via the dermal route (EU-OSHA, 2024b).

0.4% of workers are probably exposed to epichlorohydrin in the last working week at any level.

- **Main circumstances of exposure**

The workers exposed to epichlorohydrin are equally spread among three main exposure circumstances: working in chemical or pharmaceutical products manufacturing (34% of those exposed), working in a workplace where synthetic rubber was made or processed (34%), and during lab work tasks (33%).

Table 30: Most common circumstances of exposure among the workers exposed to epichlorohydrin

Exposure circumstances	Proportion of exposed workers working in each circumstance
Working with epichlorohydrin in chemical or pharmaceutical products manufacturing, including:	34%
Loading or unloading substances into/from the process or for storage, and involving epichlorohydrin	*15%*
Taking samples from the process or from delivery, and involving epichlorohydrin	*17%*
Process cleaning and routine maintenance tasks, e.g. substitution/cleaning of filters, and involving epichlorohydrin	*9%*
Working in a workplace where synthetic rubber was made or processed and where epichlorohydrin was used	34%
Handling or coming in contact with epichlorohydrin during lab work tasks (in any type of scientific laboratory)	33%

Source: WES 2023, EU-OSHA; reference population: workers exposed to epichlorohydrin in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed. Workers can be exposed through multiple tasks in the same working week.

- **Use of control measures**

In all three exposure circumstances, the majority of the exposed workers were using at least one of the listed control measures (98-100%).

Table 31: Information on workers' use of control measures when performing tasks with probable exposure to epichlorohydrin

Exposure circumstances	Fully closed system	LEV	General ventilation system	Relevant RPE	None
Working with epichlorohydrin in chemical or pharmaceutical products manufacturing[1]	44%	26%	not asked	41%	2%
Working in a workplace where synthetic rubber was made or processed and where epichlorohydrin was used	not asked	37%	73%	31%	2%
Handling or coming in contact with epichlorohydrin during lab work tasks (in any type of scientific laboratory)	51%	27%	56%	23%	0%

[1] When working with epichlorohydrin in chemical or pharmaceutical products manufacturing, 27% of workers exposed to epichlorohydrin reported working in a partially enclosed system.

Source: WES 2023, EU-OSHA; reference population: workers exposed to epichlorohydrin in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed.

3.7.5 Ethylene oxide

Ethylene oxide is a flammable gas with a slightly sweet odour used in different industries. It is used for the production of detergents, thickeners, solvents, plastics, and various organic chemicals, notably ethylene glycol, but also as a sterilising agent, fumigant and insecticide in its gaseous form. Workers might experience negative health effects due to inhalation or exposure via the dermal or ocular route (EU-OSHA, 2024b).

WES results show that **1.8%** of workers are probably exposed to ethylene oxide in the last working week at any level.

- **Main circumstances of exposure**

The most common exposure circumstances among the workers exposed to ethylene oxide were opening shipping containers imported from overseas (27% of those exposed) and using ethylene oxide gas for sterilisation (24%).

Table 32: Most common circumstances of exposure among the workers exposed to ethylene oxide

Exposure circumstances	Proportion of exposed workers working in each circumstance
Opening shipping containers imported from overseas	27%
Using ethylene oxide gas for sterilisation	24%
Using herbicides or insecticides containing ethylene oxide	16%

Exposure circumstances	Proportion of exposed workers working in each circumstance
Handling or coming in contact with ethylene oxide during lab work tasks (in any type of scientific laboratory)	15%
Working with ethylene oxide in chemical or pharmaceutical products manufacturing	8%
Applying or mixing fumigants containing ethylene oxide (to kill pests on stored crops)	7%
Working in a workplace where polyethylene glycol (PEG) was made or processed	2%

Source: WES 2023, EU-OSHA; reference population: workers exposed to ethylene oxide in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed. Workers can be exposed through multiple tasks in the same working week.

- **Use of control measures**

The use of control measures differs depending on the exposure circumstances. While most of the workers exposed to ethylene oxide use at least one of them when doing sterilisation or lab work tasks, or when working in chemical or pharmaceutical products manufacturing (89-100%), almost half of them reported using none of the protection measures when using herbicides or insecticides containing ethylene oxide (48%).

Table 33: Information on workers' use of control measures when performing tasks with probable exposure to ethylene oxide

Exposure circumstances	Fully closed system	LEV	General ventilation system	Relevant RPE	None
Using ethylene oxide gas for sterilisation	not asked	35%	67%	26%	11%
Using herbicides or insecticides containing ethylene oxide	not asked	12%	20%	42%	48%
Handling or coming in contact with ethylene oxide during lab work tasks	24%	32%	62%	42%	5%
Working with ethylene oxide in chemical or pharmaceutical products manufacturing[1]	50%	30%	not asked	37%	0%
Applying or mixing fumigants containing ethylene oxide[2]	not asked	not asked	not asked	37%	33%

[1] When working with ethylene oxide in chemical or pharmaceutical products manufacturing, 20% of workers exposed to ethylene oxide reported working in a partially enclosed system.
[2] When applying or mixing fumigants containing ethylene oxide (to kill pests on stored crops), 65% of workers exposed to ethylene oxide reported that the fumigation area is always sealed from other areas.
Source: WES 2023, EU-OSHA; reference population: workers exposed to ethylene oxide in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed.

3.7.6 Formaldehyde

Formaldehyde is a naturally occurring colourless and flammable gas that is an important precursor to many other materials and chemical compounds. For example, formalin, a water-based solution of formaldehyde, is one such substance commonly used as an intermediate in the manufacturing of other substances, as a disinfectant for industrial and professional uses, and as a preservative in funeral homes and medical labs (EU-OSHA, 2024b).

Formaldehyde is used in a wide array of sectors and industries, including among others, agriculture, forestry, fishing, health, food, scientific research and development, textile, construction and automotive, and manufacture of basic pharmaceutical products, leather and related products, wood and wood products, electrical equipment, paper and paper products. Workers can be exposed through inhalation, ingestion or dermal absorption given the different forms in which formaldehyde is used in workplaces (EU-OSHA, 2024b).

6.4% of workers are probably exposed to formaldehyde in the last working week at any level.

- **Main circumstances of exposure**

Unlike exposure to other industrial chemicals, exposure to formaldehyde is quite widespread among the working population, and the circumstances of exposure are quite diverse. Two of them concern 15% and 11% of the exposed workers: using two-part glue or plastic resin wood glue, and frontline firefighting, respectively. The rest of the exposure circumstances include working with plywood, particle or MDF board or marine ply (9% of the exposed workers), opening shipping containers imported from overseas (7%) and using foam blocks as a florist (7%) as well as working in a gross anatomy lab (6%), applying lacquers (6%), or using formaldehyde or formaldehyde solution (formalin) for sterilisation (6%)(see Table 34 for the full list).

Table 34: Most common circumstances of exposure among the workers exposed to formaldehyde

Exposure circumstances	Proportion of exposed workers working in each circumstance
Using epoxy two-part glue or plastic resin wood glue (also called urea-formaldehyde resin)	15%
Frontline firefighting	11%
Working with plywood, particle board, marine ply or MDF board	9%
Opening shipping containers imported from overseas, including:	7%
Entering the shipping containers imported from overseas	*3%*
Using foam blocks as a florist	7%
Working in a gross anatomy lab, including:	6%
Carrying out anatomical dissections with biological tissues stored in formalin (formaldehyde solution)	*3%*
Carrying out autopsies	*2%*
Applying lacquers	6%
Using or coming in contact with formaldehyde during lab work tasks (in any type of scientific laboratory)	6%
Using formaldehyde or formaldehyde solution (formalin) for sterilisation	6%
Doing manicures or pedicures	5%
Handling formaldehyde, specimens preserved in formaldehyde solution (formalin) or waste containing formaldehyde when working in a pathology lab	5%
Carrying out macroscopy or grossing of specimens preserved in formaldehyde solution (formalin) when working in a pathology lab	4%

Exposure circumstances	Proportion of exposed workers working in each circumstance
Applying finishes to fabrics or finished products to make them resistant to wrinkles, flame, shrinkage or water (in upholstery)	3%
Coming in contact with formaldehyde/formalin as a film processing chemical	2%

Source: WES 2023, EU-OSHA; reference population: workers exposed to formaldehyde in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed. Workers can be exposed through multiple tasks in the same working week.

- **Use of control measures**

Most of the workers exposed to formaldehyde reported using at least one of the control measures when using formaldehyde for sterilisation (86%), working in a gross anatomy lab (88%) or in a pathology lab (76% and 89%, depending on the task), or during lab work tasks (97%). On the other hand, two out of five workers reported using none of the protection measures when using glue, frontline firefighting, or working with plywood or particle/MDF board.

Table 35: Information on workers' use of control measures when performing tasks with probable exposure to formaldehyde

Exposure circumstances	LEV	General ventilation system	Relevant RPE	None
Using epoxy two-part glue or plastic resin wood glue	18%	44%	23%	40%
Frontline firefighting	not asked	not asked	63%	37%
Working with plywood, particle board, marine ply or MDF board	53%	not asked	27%	40%
Working in a gross anatomy lab, including:	27%	73%	15%	12%
Carrying out anatomical dissections with biological tissues stored in formalin	*31%*	*72%*	*27%*	*8%*
Using or coming in contact with formaldehyde during lab work tasks[1]	46%	56%	34%	3%
Using formaldehyde or formaldehyde solution (formalin) for sterilisation	30%	67%	23%	14%
Handling formaldehyde, specimens preserved in formaldehyde solution (formalin) or waste containing formaldehyde when working in a pathology lab	70%	not asked	36%	24%
Carrying out macroscopy or grossing of specimens preserved in formaldehyde solution (formalin) when working in a pathology lab[2]	83%	not asked	33%	11%

[1] When using or coming in contact with formaldehyde during lab work tasks, 25% of the workers exposed to formaldehyde reported that the work was carried out in a sealed/glove box.
[2] When carrying out macroscopy or grossing of specimens preserved in formaldehyde solution (formalin), 66% of the workers exposed to formaldehyde reported that the specimens or waste were in sealed containers when not in use.
Source: WES 2023, EU-OSHA; reference population: workers exposed to formaldehyde in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed.

3.7.7 Ortho-toluidine

Ortho-toluidine (or o-toluidine) is a high-production-volume chemical, appearing as a colourless liquid. It is used in the manufacture of rubber chemicals, herbicide intermediates, dye intermediates and some drugs like the local anaesthetic prilocaine. In addition to manufacturing, it is also used in clinical laboratories as an ingredient in a reagent for glucose analysis, and for tissue staining. Exposure can occur both in the production and use of ortho-toluidine and other chemicals manufactured from it and might take place through inhalation or dermal contact (EU-OSHA, 2024b).

0.4% of workers are probably exposed to ortho-toluidine in the last working week at any level.

- **Main circumstances of exposure**

The most common exposure circumstances among the workers exposed to ortho-toluidine was during lab work tasks (64% of those exposed).

Table 36: Most common circumstances of exposure among the workers exposed to ortho-toluidine

Exposure circumstances	Proportion of exposed workers working in each circumstance
Handling or coming in contact with ortho-toluidine during lab work tasks (in any type of scientific laboratory)	64%
Working in the vulcanisation or curing area (in rubber, rubber goods, plastic or resin manufacture)	17%
Working with ortho-toluidine in chemical or pharmaceutical products manufacturing	13%

Source: WES 2023, EU-OSHA; reference population: workers exposed to ortho-toluidine in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed. Workers can be exposed through multiple tasks in the same working week.

- **Use of control measures**

The most commonly reported measures were the use of general ventilation during lab work tasks (59%) and the use of LEV or on-tool extraction while working in the vulcanisation or curing area (53%).

Table 37: Information on workers' use of control measures when performing tasks with probable exposure to ortho-toluidine

Exposure circumstances	Fully closed system	LEV	General ventilation system	Relevant RPE	None
Handling or coming in contact with ortho-toluidine during lab work tasks	31%	34%	59%	23%	6%
Working in the vulcanisation or curing area	not asked	53%	46%	46%	10%

Source: WES 2023, EU-OSHA; reference population: workers exposed to ortho-toluidine in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed.

3.8 Occupational exposure to metals

3.8.1 Arsenic

Arsenic is a metal that exists in several oxidation states and different chemical forms (organic, inorganic and arsine gas). Arsenic is manufactured in and/or imported to the European Economic Area, at ≥ 100 to < 1,000 tonnes per year.[11]

0.5% of workers are probably exposed to arsenic in the last working week at any level.

- **Main circumstances of exposure**

Workers in the semiconductor industry are those more likely exposed to arsenic compounds (34% of those exposed). Other activities that show exposure to arsenic were those involving lab work tasks (18%), the manual cleaning of furnaces (14%), using treated wood with the preservative copper arsenate (10%), mining of copper or gold (6%), and maintenance activities at coal/peat-fired, biomass or biodegradable waste power plants (6%).

Table 38: Most common circumstances of exposure among the workers exposed to arsenic

Exposure circumstances	Proportion of exposed workers working in each circumstance
Semiconductors or transformers made, assembled, processed or repaired at the workplace	34%
Using or coming in contact with arsenic or compounds during lab work tasks (in any type of scientific laboratory)	18%
Manually cleaning out ash or scale from the furnace	14%
Applying chromated copper arsenate (CCA) (gives wood a green-brown colour) themselves, as a preservative for wood	10%
Using wood that was treated with chromated copper arsenate (CCA) (gives wood a green-brown colour) as a preservative	10%
Lead acid batteries manufactured, assembled, processed or repaired at the workplace	9%
Copper or gold mined or quarried at the workplace	6%
Undertaking maintenance activities at a coal, peat-fired or forest biomass power plant/station or at a plant or station using solid recovered fuels (biodegradable waste)	6%
Working with arsenic while manufacturing machinery, medical devices or metal products	4%

Source: WES 2023, EU-OSHA; reference population: workers exposed to arsenic in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed. Workers can be exposed through multiple tasks in the same working week.

- **Use of control measures**

To prevent exposure during the manual cleaning of furnaces, water dust suppression was the most reported measure (100%). In addition, 81% reported using appropriate cleaning measures (vacuum cleaning or mopping with water). When handling treated wood, 33% of workers used a relevant RPE. Specifically, a PAPR was used by 18% of workers, an air-supplied respirator or SCBA by 9%, and a rubber

[11] European Chemicals Agency (ECHA), substance infocard – Arsenic. Available at: https://echa.europa.eu/es/substance-information/-/substanceinfo/100.028.316

face mask fitted with a filter or a cartridge by 6%. 67% reported not to use any of the protection measures included in the questionnaire.

Table 39: Information on workers' use of control measures when performing tasks with probable exposure to arsenic

Exposure circumstances	Water dust suppression	Relevant RPE	None
Manually cleaning out ash or scale from the furnace	100%	35%	0%
Using wood that was treated with chromated copper arsenate (CCA) as a preservative	not asked	33%	67%

Source: WES 2023, EU-OSHA; reference population: workers exposed to arsenic in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed.

3.8.2 Cadmium

Cadmium is a heavy metal with low melting temperature and high thermal and electrical conductivity. It is widely used in the manufacture of batteries. Exposure occurs via inhalation of dust and fumes. Some uses of cadmium are restricted in the EU.

1.6% of workers are probably exposed to cadmium in the last working week at any level.

- **Main circumstances of exposure**

Exposure to cadmium is frequent during welding, cutting or brazing of cadmium-plated steel or hard metal alloys (24% of those exposed), stripping paint (12%), working with circuit boards (12%) and machining of metal alloys (11%). The recycling of e-waste can also result in exposure (9%).

Table 40: Most common circumstances of exposure among the workers exposed to cadmium

Exposure circumstances	Proportion of exposed workers working in each circumstance
Welding, cutting or brazing cadmium-plated steel or hard metal alloys (e.g. tungsten carbide, stellite), including:	24%
Types of welding, cutting or brazing – Shielded metal arc, stick or manual arc, flux core	*13%*
Grinding welds	*12%*
Types of welding, cutting or brazing – MIG/gas metal arc, TIG/tungsten arc, plasma arc	*11%*
Types of welding, cutting or brazing – Oxyacetylene	*7%*
Types of welding, cutting or brazing – Brazing	*7%*
Stripping old paint, which was likely to have been applied before 2001, including:	12%
Using sanding, blasting or grinding methods to strip old paint from existing surfaces	*11%*
Circuit boards or other computer parts made, assembled, processed or repaired at the workplace	12%

Exposure circumstances	Proportion of exposed workers working in each circumstance
Machining cadmium-plated steel or hard metal alloys (e.g. tungsten carbide, stellite)	11%
Involved in recycling/dismantling electronics (e-waste)	9%
Using or coming in contact with cadmium or compounds during lab work tasks (in any type of scientific laboratory)	7%
Working with cadmium or cadmium compounds in chemical or pharmaceutical products manufacturing	6%
Manually cleaning out ash or scale from the furnace	5%
Using cadmium for metal plating (in metal plating, coating or other finishing-related jobs)	4%
Types of metal that were cast at their workplace – cadmium-plated steel, brass or bronze	3%
Grinding or polishing cadmium-plated steel or hard metal alloys (e.g. tungsten carbide, stellite) before plating or coating	3%
Handling or coming in contact with silver solder containing cadmium	2%
Nickel-cadmium batteries manufactured, assembled, processed or repaired at the workplace	2%

Source: WES 2023, EU-OSHA; reference population: workers exposed to cadmium in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed. Workers can be exposed through multiple tasks in the same working week.

- **Use of control measures**

Welding is the most frequent activity where exposure occurs and 64% of workers reported using a welding helmet with a separate air supply attached (under relevant RPE in Table 41).

When stripping paint, a wider variety of control measures were reported with 42% of exposed workers using LEV or on-tool extraction (under LEV), 27% using general ventilation and 46% using relevant RPE.

Table 41: Information on workers' use of control measures when performing tasks with probable exposure to cadmium

Exposure circumstances	Water dust suppression / wet sanding, blasting or grinding	LEV	General ventilation system	Relevant RPE	None
Welding, cutting or brazing cadmium – plated steel or hard metal alloys (e.g. tungsten carbide, stellite), including:	not asked	9%	not asked	64%	27%
Grinding welds	*not asked*	*7%*	*not asked*	*70%*	*24%*
Types of welding, cutting or brazing – Shielded metal arc, stick or manual arc, flux core	*not asked*	*8%*	*not asked*	*61%*	*31%*
Types of welding, cutting or brazing – Oxyacetylene	*not asked*	*5%*	*not asked*	*74%*	*22%*

Exposure circumstances	Water dust suppression / wet sanding, blasting or grinding	LEV	General ventilation system	Relevant RPE	None
Types of welding, cutting or brazing – MIG/ gas metal arc, TIG/tungsten arc, plasma arc	*not asked*	*6%*	*not asked*	*77%*	*17%*
Types of welding, cutting or brazing – Brazing	*not asked*	*17%*	*not asked*	*45%*	*38%*
Stripping old paint that was likely to have been applied before 2001, including:	not asked	42%	27%	36%	28%
Using sanding, blasting or grinding methods to strip old paint from existing surfaces	*34%*	*69%*	*28%*	*40%*	*6%*
Machining cadmium-plated steel or hard metal alloys (e.g. tungsten carbide, stellite)[1]	not asked	74%	not asked	not asked	18%
Working with cadmium or cadmium compounds in chemical or pharmaceutical products manufacturing[2]	not asked	30%	not asked	36%	0%
Manually cleaning out ash or scale from the furnace	67%	not asked	not asked	35%	15%
Using cadmium for metal plating (in metal plating, coating or other finishing-related jobs)	not asked	81%	not asked	47%	19%

[1] When machining cadmium-plated steel or hard metal alloys (e.g. tungsten carbide, stellite), 57% of workers exposed to cadmium reported working with a completely enclosed machine.

[2] When working with cadmium or compounds in chemical or pharmaceutical products manufacturing, 54% of workers exposed to cadmium reported working in a fully closed system or in a glove box, and 16% of them working in a partially enclosed system.

Source: WES 2023, EU-OSHA; reference population: workers exposed to cadmium in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed.

3.8.3 Cobalt

Cobalt is a heavy metal widely used for the manufacture of catalysts and magnets. Cobalt alloys are used in jet turbines and gas turbine generators, where high-temperature strength is important. Exposure occurs via inhalation of dusts or fumes.

1.0% of workers are probably exposed to cobalt in the last working week at any level.

- **Main circumstances of exposure**

Exposure to cobalt occurs mostly during welding, cutting or brazing tasks (36% of those exposed) and to a lesser extent during the machining of metals (17%). Nearly 14% of workers were exposed during recycling of e-waste.

Table 42: Most common circumstances of exposure among the workers exposed to cobalt

Exposure circumstances	Proportion of exposed workers working in each circumstance
Welding, cutting or brazing cobalt or cobalt alloys or hard metal alloys (e.g. tungsten carbide, stellite), including:	36%
Types of welding, cutting or brazing – Shielded metal arc, stick or manual arc, flux core	*19%*
Grinding welds	*18%*
Types of welding, cutting or brazing – MIG/ gas metal arc, TIG/tungsten arc, plasma arc	*17%*
Types of welding, cutting or brazing – Brazing	*9%*
Types of welding, cutting or brazing – Oxyacetylene	*8%*
Machining cobalt or cobalt alloys or hard metal alloys (e.g. tungsten carbide, stellite)	17%
Involved in recycling/dismantling electronics (e-waste)	14%
Cobalt or cobalt alloys or hard metal alloys (e.g. tungsten carbide, stellite) were produced at the workplace (in metal refining/smelting)	11%
Using or coming in contact with cobalt or compounds during lab work tasks (in any type of scientific laboratory)	7%
Using cobalt for metal plating (in metal plating, coating or other finishing-related jobs)	5%
Handling or coming in contact with pigments that contained cobalt (in ceramics production)	5%
Grinding or polishing cobalt or cobalt alloys or hard metal alloys (e.g. tungsten carbide, stellite) before plating or coating	4%
Working with cobalt while manufacturing machinery, medical devices or metal products	3%
Using cobalt for thermal spray coating (for metal coating)	2%

Source: WES 2023, EU-OSHA; reference population: workers exposed to cobalt in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed. Workers can be exposed through multiple tasks in the same working week.

- **Use of control measures**

As in the case of exposure to cadmium, the most common exposure control measure for welding tasks is the use of a welding helmet with a separate air supply attached (under relevant RPE in Table 43) (60%). For machining operations, 54% of the exposed workers reported using a completely enclosed machine, and 71% reported using LEV or on-tool extraction (under LEV in Table 43).

Table 43: Information on workers' use of control measures when performing tasks with probable exposure to cobalt

Exposure circumstances	LEV	Relevant RPE	None
Welding, cutting or brazing cobalt or cobalt alloys or hard metal alloys (e.g. tungsten carbide, stellite), including:	11%	60%	29%
Types of welding, cutting or brazing – Shielded metal arc, stick or manual arc, flux core	*15%*	*53%*	*32%*
Grinding welds	*8%*	*71%*	*20%*
Types of welding, cutting or brazing – MIG/ gas metal arc, TIG/tungsten arc, plasma arc	*13%*	*68%*	*20%*
Types of welding, cutting or brazing – Brazing	*12%*	*55%*	*33%*
Types of welding, cutting or brazing – Oxyacetylene	*9%*	*58%*	*33%*
Machining cobalt or cobalt alloys or hard metal alloys (e.g. tungsten carbide, stellite)[1]	71%	not asked	18%

[1] When machining cobalt or cobalt alloys or hard metal alloys (e.g. tungsten carbide, stellite), 54% of workers exposed to cobalt reported working with a completely enclosed machine.
Source: WES 2023, EU-OSHA; reference population: workers exposed to cobalt in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed.

3.8.4 Hexavalent chromium (chromium VI)

Hexavalent chromium or chromium VI refers to the sixth oxidation state of the metallic element chromium. Hexavalent chromium compounds are used in electroplating, stainless steel production, leather tanning, textile manufacturing and wood preservation. In addition, workers may be exposed to chromium VI formed during hot processes, such as welding. Chromium III under certain conditions can oxidise to chromium VI.

4.7% of workers are probably exposed to chromium VI in the last working week at any level.

- **Main circumstances of exposure**

The main circumstances of exposure to hexavalent chromium are welding, cutting or brazing tasks (27% of those exposed) and mixing plaster, concrete or cement in construction trades (26%).

Table 44: Most common circumstances of exposure among the workers exposed to chromium VI

Exposure circumstances	Proportion of exposed workers working in each circumstance
Welding, cutting or brazing stainless steel, chromium-plated steel, mild, ordinary or construction steel, or hard metal alloys (e.g. tungsten carbide, stellite), including:	27%
Grinding welds	*13%*
Types of welding, cutting or brazing – Shielded metal arc, stick or manual arc, flux core	*11%*

Exposure circumstances	Proportion of exposed workers working in each circumstance
Types of welding, cutting or brazing – MIG/ gas metal arc, TIG/tungsten arc, plasma arc	*11%*
Types of welding, cutting or brazing – Oxyacetylene	*6%*
Types of welding, cutting or brazing – Brazing	*5%*
Mixing plaster, concrete or cement (in construction trades)	26%
Machining stainless steel, chromium-plated steel, mild, ordinary or construction steel, or hard metal alloys (e.g. tungsten carbide, stellite)	10%
Frontline firefighting – residential, commercial or industrial fires, or fires involving hazardous materials	9%
Stripping old paint that was likely to have been applied before 2001, including:	4%
Using sanding, blasting or grinding methods to strip old paint	*4%*
Working with chromium VI compounds in chemical or pharmaceutical products manufacturing (such as chromic acid, potassium dichromate, chromium trioxide, ammonium dichromate and potassium chromate)	4%
Involved in recycling/dismantling electronics (e-waste)	3%
Applying grout while laying tiles as flooring (in construction trades)	3%
Using or coming in contact with chromium or compounds during lab work tasks (in any type of scientific laboratory)	3%
Using zinc chromate or other chromate primers while applying a primer or undercoat prior to painting	3%
Using chromium for metal plating (in metal plating, coating or other finishing-related jobs)	2%
Working on basic oxygen, blast or electric furnace (in metal smelting and refining operations)	2%
Grinding or polishing stainless steel, chromium-plated steel or hard metal alloys (e.g. tungsten carbide, stellite) before plating or coating	2%
Types of metal that were cast at their workplace – stainless steel, chromium-plated steel	2%
Using ceramic glazes that contained chromic acid or chromium pigments	2%
Overhaul, clean-up and/or sifting through the remains of a fire	2%

Source: WES 2023, EU-OSHA; reference population: workers exposed to chromium VI in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed. Workers can be exposed through multiple tasks in the same working week.

- **Use of control measures**

For welding tasks, the most common exposure control measure is the use of a welding helmet with a separate air supply attached (under relevant RPE in Table 45) (52%). For machining operations, 54% of the exposed workers reported using a completely enclosed machine, and 64% reported using LEV or on-tool extraction (under LEV in Table 43). The use of control measures is the highest for exposure circumstances in the chemical and pharmaceutical industry and during lab work tasks, with respectively 100% and 99% of workers using at least one control measure.

Table 45: Information on workers' use of control measures when performing tasks with probable exposure to chromium VI

Exposure circumstances	Fully closed system or machine	LEV	General ventilation system	Relevant RPE	None
Welding, cutting or brazing stainless steel, chromium-plated steel, mild, ordinary or construction steel, or hard metal alloys (e.g. tungsten carbide, stellite), including:	not asked	11%	not asked	52%	36%
Grinding welds	*not asked*	*13%*	*not asked*	*56%*	*31%*
Types of welding, cutting or brazing – Shielded metal arc, stick or manual arc, flux core	*not asked*	*12%*	*not asked*	*58%*	*30%*
Types of welding, cutting or brazing – MIG/ gas metal arc, TIG/tungsten arc, plasma arc	*not asked*	*14%*	*not asked*	*57%*	*29%*
Types of welding, cutting or brazing – Oxyacetylene	*not asked*	*11%*	*not asked*	*52%*	*38%*
Types of welding, cutting or brazing – Brazing	*not asked*	*15%*	*not asked*	*51%*	*34%*
Machining stainless steel, chromium-plated steel, mild, ordinary or construction steel, or hard metal alloys (e.g. tungsten carbide, stellite)	54%	64%	not asked	not asked	25%
Frontline firefighting – residential, commercial or industrial fires, or fires involving hazardous materials	not asked	not asked	not asked	75%	25%
Stripping old paint that was likely to have been applied before 2001, including:	not asked	42%	27%	36%	28%
Using sanding, blasting or grinding methods to strip old paint[1]	*not asked*	*69%*	*28%*	*40%*	*6%*
Working with chromium VI compounds[2] in chemical or pharmaceutical products manufacturing[3]	53%	19%	not asked	51%	0%
Using or coming in contact with chromium or compounds during lab work tasks (in any type of scientific laboratory)	29%	63%	62%	22%	1%
Using chromium for metal plating (in metal plating, coating or other finishing-related jobs)	not asked	68%	not asked	48%	32%
Grinding or polishing stainless steel, chromium-plated steel or hard metal alloys (e.g. tungsten carbide, satellite) before plating or coating	not asked	not asked	not asked	47%	53%

[1] When using sanding, blasting or grinding methods to strip old paint, 34% of workers exposed to chromium VI reported doing wet sanding, blasting or grinding.

[2] Such as chromic acid, potassium dichromate, chromium trioxide, ammonium dichromate and potassium chromate.

[3] When working with chromium VI compounds in chemical or pharmaceutical products manufacturing, 28% of workers exposed to chromium VI reported working in a partially enclosed system.

Source: WES 2023, EU-OSHA; reference population: workers exposed to chromium VI in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed.

3.8.5 Lead and inorganic compounds

Lead is a heavy metal used in multiple industries. Some examples include the production of batteries, glass and explosives. Lead is also part of non-ferrous metal alloys like aluminium, copper and zinc alloy.

3.8% of workers are probably exposed to lead and inorganic compounds in the last working week at any level.

- **Main circumstances of exposure**

Exposure mostly occurs through inhalation of dust during abrasive activities like plumbing work (18% of those exposed) or firing of guns (14%) or through inhalation of fumes during welding, cutting or brazing tasks (10%) or frontline firefighting (11%).

Table 46: Most common circumstances of exposure among the workers exposed to lead and inorganic compounds

Exposure circumstances	Proportion of exposed workers working in each circumstance
Doing plumbing work (in construction trades)	18%
Instructing on or practicing firing a gun at a firing range	14%
Frontline firefighting – residential, commercial or industrial fires, or fires involving hazardous materials	11%
Welding, cutting or brazing brass or bronze, lead or lead alloys, lead-plated or leaded steel, including:	10%
Types of welding, cutting or brazing – Shielded metal arc, stick or manual arc, flux core	*5%*
Types of welding, cutting or brazing – Brazing	*4%*
Types of welding, cutting or brazing – MIG/ gas metal arc, TIG/tungsten arc, plasma arc	*3%*
Grinding welds	*3%*
Types of welding, cutting or brazing – Oxyacetylene	*2%*
Handling or coming in contact with lead-containing solder	10%
Stripping old paint that was likely to have been applied before 2001, including:	5%
Using sanding, blasting or grinding methods to strip old paint	*5%*
Machining brass or bronze, lead or lead alloys, lead-plated or leaded steel	4%
Working in the areas of extruding or rolling metals, melting scrap or casting ingots (in smelting and refining operations)	4%
Involved in recycling/dismantling electronics (e-waste)	4%
Handling lead flashing when doing roofing (in construction trades)	3%
Stripping lead-based paint from existing surfaces, including:	3%
Using sanding, blasting or grinding methods to strip lead-based paint	*3%*
Engines or engine parts of vehicles, trains or airplanes, including radiators etc., repaired at the workplace	3%

Exposure circumstances	Proportion of exposed workers working in each circumstance
Using red lead while applying a primer or undercoat prior to painting, including:	3%
Applying red lead as primer or undercoat prior to painting with a spray/gun	*2%*
Overhaul, clean-up and/or sifting through the remains of a fire	3%
Removing lead-based road markings (in jobs related to road construction and maintenance)	3%
Cleaning firing ranges	2%
Types of metal that were cast at their workplace – brass or bronze, lead or lead alloys, lead-plated or leaded steel	2%

Source: WES 2023, EU-OSHA; reference population: workers exposed to lead and inorganic compounds in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed. Workers can be exposed through multiple tasks in the same working week.

- **Use of control measures**

When firing a gun, most workers exposed reported not to use any of the control measures asked about (90%). When exposed to fires, most workers (75%) used an air-supplied respirator or SCBA (under relevant RPE in Table 47), although 25% reported not to use any control measure.

For welding tasks, as in other cases, 42% of the exposed workers used a welding helmet with a separate air supply attached (under relevant RPE in Table 47) and 14% used a welding booth, exhaust hood or other type of local exhaust ventilation (under LEV).

When performing other tasks such as being in contact with lead-containing solder, stripping paint (included lead-based paint), machining metals or manually cleaning a furnace, between 15 and 28% of exposed workers reported not to use any of the protection measures included in the survey.

In addition, when manually cleaning out ash or scale from the furnace, 68% of the workers exposed to lead were using appropriate cleaning measures (vacuum cleaning or mopping with water).

Table 47: Information on workers' use of control measures when performing tasks with probable exposure to lead and inorganic compounds

Exposure circumstances	Water dust suppression / wet sanding, blasting or grinding	LEV	General ventilation system	Relevant RPE	None
Instructing on or practicing firing a gun at a firing range	not asked	not asked	not asked	10%	90%
Frontline firefighting – residential, commercial or industrial fires, or fires involving hazardous materials	not asked	not asked	not asked	75%	25%
Welding, cutting or brazing brass or bronze, lead or lead alloys, lead-plated or leaded steel, including:	not asked	14%	not asked	42%	44%
Types of welding, cutting or brazing – Shielded metal arc, stick or manual arc, flux core	not asked	*19%*	not asked	*49%*	32%

Exposure circumstances	Water dust suppression / wet sanding, blasting or grinding	LEV	General ventilation system	Relevant RPE	None
Types of welding, cutting or brazing – Brazing	not asked	*19%*	not asked	*35%*	45%
Types of welding, cutting or brazing – MIG/ gas metal arc, TIG/tungsten arc, plasma arc	not asked	*19%*	not asked	*42%*	39%
Grinding welds	not asked	*13%*	not asked	*63%*	24%
Handling or coming in contact with lead-containing solder	not asked	31%	40%	43%	28%
Stripping old paint that was likely to have been applied before 2001, including:	not asked	42%	27%	36%	28%
Using sanding, blasting or grinding methods to strip old paint	34%	*69%*	*28%*	*40%*	*6%*
Machining brass or bronze, lead or lead alloys, lead-plated or leaded steel[1]	not asked	68%	not asked	not asked	18%
Stripping lead-based paint from existing surfaces	not asked	45%	35%	45%	18%
Using sanding, blasting or grinding methods to strip lead-based paint	*15%*	*88%*	*34%*	*51%*	*2%*
Manually cleaning out ash or scale from the furnace	67%	not asked	not asked	35%	15%

[1] When machining brass or bronze, lead or lead alloys, lead-plated or leaded steel, 57% of workers exposed to lead and compounds reported working with a completely enclosed machine.

Source: WES 2023, EU-OSHA; reference population: workers exposed to lead and inorganic compounds in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed.

3.8.6 Nickel

Nickel is a heavy metal used as a metallic nickel or in compounds in many industrial and commercial applications, including use in stainless steel and other nickel alloys, catalysts, batteries, pigments and ceramics. In the workplace, workers can be exposed through inhalation or via the dermal route.

2.3% of workers are probably exposed to nickel in the last working week at any level.

- **Main circumstances of exposure**

A third of the workers are exposed to nickel fumes during welding operations (33%), with fewer numbers being exposed in the semiconductor industry by inhalation of dust (13%) or during machining or sanding metal, or stripping old paint (11%, 10% and 9%, respectively).

Table 48: Most common circumstances of exposure among the workers exposed to nickel

Exposure circumstances	Proportion of exposed workers working in each circumstance
Welding, cutting or brazing nickel or nickel alloys, or stainless steel, including:	33%
Grinding welds	*16%*
Types of welding, cutting or brazing – Shielded metal arc, stick or manual arc, flux core	*15%*
Types of welding, cutting or brazing – MIG/ gas metal arc, TIG/tungsten arc, plasma arc	*13%*
Types of welding, cutting or brazing – Oxyacetylene	*8%*
Types of welding, cutting or brazing – Brazing	*8%*
Semiconductors, transformers, circuit boards or other computer parts made, assembled, processed or repaired at the workplace	13%
Machining stainless steel, nickel or nickel alloys	11%
Sanding metal or metal objects	10%
Stripping old paint that was likely to have been applied before 2001, including:	9%
Using sanding, blasting or grinding methods to strip old paint	*7%*
Involved in recycling/dismantling electronics (e-waste)	6%
Working with nickel or nickel compounds in chemical or pharmaceutical products manufacturing	5%
Using or coming in contact with nickel or compounds during lab work tasks (in any type of scientific laboratory)	5%
Types of metal that were cast at their workplace – nickel or nickel alloys, or stainless steel, including:	5%
Working at the casting station	*3%*
Using nickel for metal plating (in metal plating, coating or other finishing)	3%
Using nickel, stainless steel, nichrome or nickel aluminide for thermal spray coating (for metal coating)	3%
Grinding or polishing nickel, stainless steel before plating or coating	4%

Source: WES 2023, EU-OSHA; reference population: workers exposed to nickel in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed. Workers can be exposed through multiple tasks in the same working week.

- **Use of control measures**

For welding tasks, 57% of the exposed workers used a welding helmet with a separate air supply attached (under relevant RPE in Table 49), while 11% used a welding booth, exhaust hood or other type of local exhaust ventilation (under LEV). Machining operations were carried out in a fully enclosed machine (54%), and 61% of the exposed workers used LEV or on-tool extraction, although 25% reported not to use any of the control measures in this exposure circumstance. When sanding metal, 60% of exposed workers reported using LEV or on-tool extraction to remove dust or fumes.

Table 49: Information on workers' use of control measures when performing tasks with probable exposure to nickel

Exposure circumstances	Fully closed system or machine	LEV	General ventilation system	Relevant RPE	None
Welding, cutting or brazing nickel or nickel alloys, or stainless steel, including:	not asked	11%	not asked	57%	33%
Grinding welds	*not asked*	*12%*	*not asked*	*63%*	*25%*
Types of welding, cutting or brazing – Shielded metal arc, stick or manual arc, flux core	*not asked*	*9%*	*not asked*	*66%*	*25%*
Types of welding, cutting or brazing – MIG/ gas metal arc, TIG/tungsten arc, plasma arc	*not asked*	*12%*	*not asked*	*67%*	*22%*
Types of welding, cutting or brazing – Oxyacetylene	*not asked*	*12%*	*not asked*	*45%*	*43%*
Types of welding, cutting or brazing – Brazing	*not asked*	*16%*	*not asked*	*53%*	*31%*
Machining stainless steel, nickel or nickel alloys	54%	61%	not asked	not asked	25%
Sanding metal or metal objects	not asked	60%	not asked	34%	26%
Stripping old paint that was likely to have been applied before 2001, including:	not asked	42%	27%	36%	28%
Using sanding, blasting or grinding methods to strip old paint[1]	*not asked*	*69%*	*28%*	*40%*	*6%*
Working with nickel or nickel compounds in chemical or pharmaceutical products manufacturing[2]	47%	34%	not asked	47%	0%
Using nickel for metal plating (in metal plating, coating or other finishing)	not asked	63%	not asked	49%	37%
Using nickel, stainless steel, nichrome or nickel aluminide for thermal spray coating (for metal coating)	not asked	25%	not asked	not asked	75%
Grinding or polishing nickel, stainless steel before plating or coating	not asked	not asked	not asked	53%	47%

[1] When using sanding, blasting or grinding methods to strip old paint, 34% of workers exposed to nickel reported doing wet sanding, blasting or grinding.

[2] When working with nickel or nickel compounds in chemical or pharmaceutical products manufacturing, 19% of workers exposed to nickel reported working in a partially enclosed system.

Source: WES 2023, EU-OSHA; reference population: workers exposed to nickel in Germany, Ireland, Spain, France, Hungary and Finland and working in one or more of the circumstances listed.

4 Occupational exposure to cancer risk factors by demographics and job-related characteristics

In this section, we present some findings for some job-related characteristics (economic activity and type of employment and contract) and demographics (gender and age). WES results by workplace size and weekly number of working hours were presented in a previous publication (EU-OSHA, 2023b).

4.1 Occupational exposure by job-related characteristics

4.1.1 Occupational exposure by economic activity

In section 2, the most common exposures at work are mentioned, but there are notable differences by sector of economic activity, in particular when looking at the sectors where the average number of cancer risk factors workers are exposed to is higher than two (Table 50). The sectors of economic activity follow the NACE Rev. 2 sections and divisions (Statistical Classification of Economic Activities[12]).

Among workers in **forestry and logging**, the biggest differences with the whole working population are for exposure to wood dust (52.7% vs 3.2%), mineral oils (23.4% vs 2.0%), arsenic (3.5% vs 0.5%) and 1,3-butadiene (8.1% vs 1.3%).

Among workers in **mining of metal ores** or **other mining or quarrying**, the largest differences with all workers are for exposure to RCS (97.1% vs 8.4%), arsenic (13.1% vs 0.5%), asbestos (8.6% vs 1.7%) and DEE (97.5% vs 19.9%). These workers are not exposed at all to industrial chemicals.

Among workers in **waste collection, treatment and disposal activities, and material recovery**, the differences with all workers were more important for exposure to metals, and in particular cobalt (13.7% vs 1.0%), cadmium (13.6% vs 1.6%) and nickel (14.0% vs 2.3%), and for exposure to asbestos (10.2% vs 1.7%).

Among workers in **construction**, the differences with the whole population were more important for exposure to RCS (57.5% vs 8.4%), exposure to lead and inorganic compounds in specialised construction activities (19.1% vs 3.8%), and exposure to asbestos in civil engineering (6.7% vs 1.7%). Concerning the exposure to hexavalent chromium (21.4% vs 4.7%) and wood dust (11.5% vs 3.2%), the differences were even more important in the construction of buildings and in specialised construction activities than for workers in civil engineering.

Table 50: Probable exposure to cancer risk factors by sector of economic activity

Economic activity	Base (n)	Exposure to at least one cancer risk factor (%)	Average number of cancer risk factors a worker is exposed to
All workers	**24,402**	**47.3%**	**1.0**
Agriculture, forestry and fishing			
Crop and animal production, hunting and related service activities	976	84.4%	1.9
Forestry and logging	158	93.5%	2.5

[12] For more details on the classification, see Eurostat website: https://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/ks-ra-07-015

Economic activity	Base (n)	Exposure to at least one cancer risk factor (%)	Average number of cancer risk factors a worker is exposed to
Fishing and aquaculture	173	81.9%	1.8
Mining and quarrying			
Mining of coal and lignite	*	-	-
Extraction of crude petroleum and natural gas	146	51.0%	0.9
Mining of metal ores	39	100.0%	3.3
Other mining and quarrying	119	100.0%	2.9
Mining support service activities	*	-	-
Manufacturing			
Manufacture of food products	377	35.1%	0.8
Manufacture of beverages	60	44.5%	1.1
Manufacture of tobacco products	*	-	-
Manufacture of textiles	216	35.2%	0.7
Manufacture of wearing apparel	191	10.0%	0.1
Manufacture of leather and related products	338	81.2%	1.4
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	160	79.3%	1.9
Manufacture of paper and paper products	68	60.1%	1.0
Printing and reproduction of recorded media	242	54.9%	0.9
Manufacture of coke and refined petroleum products	122	59.3%	1.0
Manufacture of chemicals and chemical products	193	64.6%	1.9
Manufacture of basic pharmaceutical products and pharmaceutical preparations	271	50.7%	1.5
Manufacture of rubber and plastic products	399	78.5%	2.0
Manufacture of other non-metallic mineral products	245	78.7%	1.9
Manufacture of basic metals	498	58.3%	1.5
Manufacture of fabricated metal products, except machinery and equipment	408	64.1%	1.8

Economic activity	Base (n)	Exposure to at least one cancer risk factor (%)	Average number of cancer risk factors a worker is exposed to
Manufacture of computer, electronic and optical products	97	30.7%	0.6
Manufacture of electrical equipment	116	59.8%	1.5
Manufacture of machinery and equipment not elsewhere classified	338	54.8%	1.7
Manufacture of motor vehicles, trailers and semi-trailers	235	57.8%	1.4
Manufacture of other transport equipment	71	65.4%	1.3
Manufacture of furniture	245	87.0%	1.9
Other manufacturing	110	37.4%	0.9
Repair and installation of machinery and equipment	337	61.8%	1.9
Electricity, gas, steam and air conditioning supply	246	52.6%	1.4
Water supply; sewerage, waste management and remediation activities			
Water collection, treatment and supply	103	61.9%	1.2
Sewerage	128	48.3%	0.9
Waste collection, treatment and disposal activities; materials recovery	808	73.8%	2.2
Remediation activities and other waste management services	*	-	-
Construction			
Construction of buildings	639	81.4%	2.3
Civil engineering	458	87.4%	2.6
Specialised construction activities	1242	79.6%	2.1
Wholesale and retail trade; repair of motor vehicles and motorcycles			
Wholesale and retail trade and repair of motor vehicles and motorcycles	470	69.7%	1.6
Wholesale trade, except of motor vehicles and motorcycles	178	56.3%	1.1
Retail trade, except of motor vehicles and motorcycles	1346	42.9%	0.8
Transportation and storage			

Economic activity	Base (n)	Exposure to at least one cancer risk factor (%)	Average number of cancer risk factors a worker is exposed to
Land transport and transport via pipelines	360	77.6%	1.4
Water transport	146	84.8%	1.9
Air transport	225	43.2%	0.6
Warehousing and support activities for transportation	157	51.9%	1.0
Postal and courier activities	*	-	-
Accommodation and food service activities			
Accommodation	227	20.3%	0.2
Food and beverage service activities	1320	13.0%	0.2
Information and communication			
Publishing activities	30	31.7%	0.4
Motion picture, video and television programme production, sound recording and music publishing activities	138	23.2%	0.3
Programming and broadcasting activities	15	-	-
Telecommunications	34	34.6%	0.7
Computer programming, consultancy and related activities	95	18.1%	0.2
Information service activities	*	-	-
Financial and insurances activities			
Financial service activities, except insurance and pension funding	34	36.8%	0.4
Insurance, reinsurance and pension funding, except compulsory social security	*	-	-
Activities auxiliary to financial services and insurance activities	*	-	-
Real estate activities	44	46.2%	0.7
Professional, scientific and technical activities			
Legal and accounting activities	45	38.3%	0.4
Activities of head offices; management consultancy activities	38	28.4%	0.4

Economic activity	Base (n)	Exposure to at least one cancer risk factor (%)	Average number of cancer risk factors a worker is exposed to
Architectural and engineering activities; technical testing and analysis	170	45.6%	0.9
Scientific research and development	196	52.4%	1.8
Advertising and market research	75	52.1%	0.8
Other professional, scientific and technical activities	116	40.3%	0.5
Veterinary activities	142	36.9%	0.5
Administrative and support service activities			
Rental and leasing activities	*	-	-
Employment activities	*	-	-
Travel agency, tour operator and other reservation service and related activities	*	-	-
Security and investigation activities	104	49.2%	1.0
Services to buildings and landscape activities	771	48.1%	0.8
Office administrative, office support and other business support activities	60	37.5%	0.7
Public administration and defence; compulsory social security	1094	53.1%	1.5
Education	605	33.0%	0.5
Human health and social work activities			
Human health activities	2478	28.1%	0.4
Residential care activities	329	24.4%	0.3
Social work activities without accommodation	234	54.1%	0.7
Arts, entertainment and recreation			
Creative, arts and entertainment activities	315	29.6%	0.4
Libraries, archives, museums and other cultural activities	116	50.4%	0.9
Gambling and betting activities	*	-	-
Sports activities and amusement and recreation activities	135	48.0%	0.7

Economic activity	Base (n)	Exposure to at least one cancer risk factor (%)	Average number of cancer risk factors a worker is exposed to
Other service activities			
Activities of membership organisations	47	50.6%	0.7
Repair of computers and personal and household goods	102	88.3%	1.8
Other personal service activities	1633	45.7%	0.7

* The number of respondents in this sector is less than 30.
Source: WES 2023, EU-OSHA; reference population: workers in Germany, Ireland, Spain, France, Hungary and Finland.

4.1.2 Occupational exposure by professional status and type of contract

Most of the workers were **employed with a contract of unlimited duration** (n=17,018; 74.7%). Consequently, their assessed exposure is equal or very close to the assessed exposure of all the workers.

If we consider the most significant differences with all workers, the survey results show that:

- **Self-employed workers** are more often exposed than all workers to leather dust (1.7% vs 0.7%), ethylene oxide (3.1% vs 1.8%), wood dust (5.3% vs 3.2%) and formaldehyde (9.3% vs 6.4%), and less often exposed to the other industrial chemicals, trichloroethylene, metals and mineral oils.
- Exposure to asbestos was more often assessed among the **workers having a contract of limited duration** than among all workers (3.3% vs 1.7%).
- The **workers with a temporary employment agency contract** were also more often exposed to asbestos (2.6% vs 1.7%) and solar UV radiation (30.3% vs 20.8%).
- Although they were not many among the respondents (n=95; 0.2%), **workers who reported not having a contract in place in their job** were more often exposed to wood dust (12.7% vs 3.2%), ionising radiation (5.1% vs 2.5%), benzene (20.5% vs 12.8%), asbestos (2.6% vs 1.7%) and RCS (12.7% vs 8.4%).

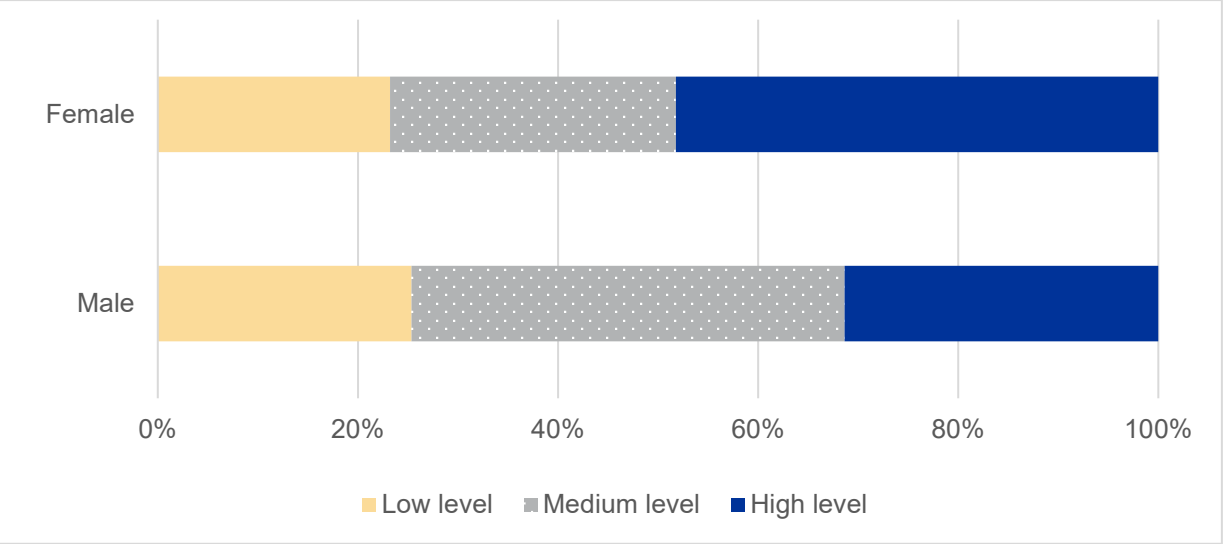
4.2 Occupational exposure by demographics

4.2.1 Occupational exposure by gender

Almost 62% of the respondents were male workers (n=15,068), and 38% were female (n=9,268). A small proportion of participants described their gender in another way (n=26; 0.1%) (EU-OSHA, 2023b). Male workers have a higher percentage of probable exposure to cancer risk factors than female workers, whether it is to at least one cancer risk factor at any level (56.5% vs 36.3%), to five or more cancer risk factors at any level (4.8% vs 1.4%), or to at least one cancer risk factor at a medium or a high level (38.9% vs 19.7%). However, there are exceptions when looking at the exposure to single risk factors that include ionising radiation, ethylene oxide, trichloroethylene, leather dust, acrylamide and epichlorohydrin, which are either similar for both genders or slightly higher for female workers, but concerning fewer workers (EU-OSHA, 2025).

When looking at specific sectors or occupations, there are also some exceptions. For example, 48% of the female workers exposed to formaldehyde in the healthcare sector are exposed at a high level, compared to 31% of the male workers (EU-OSHA, 2025) (Figure 2).

Figure 2: Healthcare workers probably exposed to formaldehyde, by exposure level and gender



Source: WES 2023, EU-OSHA; reference population: healthcare workers exposed to formaldehyde in Germany, Ireland, Spain, France, Hungary and Finland.

4.2.2 Occupational exposure by age

Most of the **workers were aged 25 to 54 years old** (n=19,497; 72.0%). Their assessed exposure is equal or very close to the assessed exposure of all the workers. The only exceptions were:

- **Workers aged 25 to 34 years old** (n=5,340; 21.1%) were more often exposed to ethylene oxide than all the workers (2.7% vs 1.8%).
- **Workers aged 45 to 54 years old** (n=6,942; 25.9%) were more often exposed to lead and inorganic compounds than all the workers (4.8% vs 3.8%).

Although they were not many among the respondents (n=246; 0.8%), **workers aged 65 to 74 years old** were more often exposed to at least one cancer risk factor than the average (53.8% vs 47.3%), but when looking at the level of exposure, they were more often exposed to at least one cancer risk factor at a low level (40.2% vs 33.3%). For this age group, the biggest differences with all age categories are in exposure to wood dust (5.6% vs 3.2%) and DEE emissions (31.1% vs 19.9%), and most exposures were less common than for the average, in particular, to most of the industrial chemicals, inorganic dusts, ionising radiation, leather dust and trichloroethylene.

5 Conclusion

WES provides a comprehensive overview of occupational exposure to cancer risk factors across six EU Member States. The survey reveals that nearly half (47.3%) of workers are probably exposed to at least one of the 24 cancer risk factors assessed, with approximately 11% exposed to at least one at a high level. The most common exposures are to solar UV radiation, DEE, benzene, RCS and formaldehyde. Exposures at a high level are more frequent for RCS, DEE, wood dust, benzene and formaldehyde.

Multiple exposures are common, concerning 26.1% of the workers. The survey highlights that the probability of co-exposure between two specific cancer risk factors is generally low, but moderate correlations exist between metals, especially cadmium, cobalt, nickel and hexavalent chromium, indicating sector-specific risks (e.g. metalworking industries).

Section 3 details the main circumstances and control measures for each risk factor. For example, exposure to solar UV radiation is most prevalent among outdoor workers, while exposure to DEE is common among those driving or maintaining diesel-powered vehicles. The use of control measures varies widely: while workers in some sectors report high adoption of protective measures (e.g. in scientific laboratories and in chemical and pharmaceutical products manufacturing), workers in other sectors report

using none. The latter especially happens for exposures to benzene and DEE (e.g. when working in an area with running vehicles or generators, or when performing maintenance work on vehicles), to RCS in construction trades, and to asbestos in repair or maintenance tasks. On the one hand, this shows the use of control measures has been formalised and is consistently applied in some sectors, in particular in exposure circumstances involving trichloroethylene and industrial chemicals, or ionising radiation. On the other hand, it emphasises the need for improved implementation of technical, organisational and personal protective measures in general, following the hierarchy of controls.

Section 4 explores exposure by demographics and job-related characteristics. Notably, self-employed and temporary workers face higher exposure rates to certain risk factors. There are also significant differences by sector: for instance, forestry and logging workers have much higher exposure to wood dust and mineral oils, while mining and quarrying workers are more exposed to RCS, arsenic, asbestos and DEE. Gender and age also play a role, with male workers generally more exposed than female workers and to higher levels, though exceptions exist for certain substances and sectors (e.g. higher formaldehyde exposure at a high level among female healthcare workers). Older workers tend to have higher exposure to multiple risk factors, but at lower levels compared to other workers.

These findings highlight the importance of targeted interventions and policies tailored to specific sectors, job types and demographic groups. Effective prevention strategies must account for the varying types and levels of exposure experienced by different groups and should prioritise eliminating or substituting cancer risk factors where possible or ensuring the consistent use of adequate control measures. WES data provide valuable evidence to inform policy development, workplace prevention strategies, and possible future amendments to EU directives on carcinogens, mutagens or reprotoxic substances at work.

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