

GreenMetalWaste

– Exposure to dust and metals among recycling workers

Recycling metals is essential for sustainable development, but workers in metal recycling facilities can be exposed to high levels of dust, metals, and other potentially toxic substances that may affect their health. Currently, there is a lack of knowledge about exposure at Swedish recycling workplaces. To address this gap, the GreenMetalWaste¹ project (2022–2024) was carried out by four occupational and environmental medicine clinics and researchers in Sweden. GreenMetalWaste investigated exposure to metals and other exposures at Swedish metal recycling companies, health effects and risk measures. Here, we present the survey results on dust and metal exposure.



Metal recycling

Metal recycling processes range from open manual processes to highly automated closed systems, and include tasks such as dismantling, crushing, grinding, sorting and casting. At every stage, workers may be exposed to hazardous chemicals that can affect their health.

Exposure measurements and exposure assessments

GreenMetalWaste completed measurements at 13 different workplaces across Sweden. Air sampling of inhalable dust and metals was conducted for 139 workers who worked with the recycling of metals, electronic waste (e-waste), or other types of waste. Metal concentrations were also analyzed in blood and urine samples from participants. Air levels were compared to Swedish occupational exposure limit values, and blood and urine concentrations were compared with a control group of 90 individuals not exposed to metals at work. The study also evaluated workplace hygiene, ventilation systems, and the use of personal protective equipment.

Workers are at risk of exceeding the occupational exposure limit value

Nineteen participants (14%) were exposed to inhalable dust levels exceeding the Swedish occupational exposure limit of 5 mg/m³ (Figure 1). Median values in dust were highest among workers who extracted waste (2.1 mg/m³), such as grinding or casting, followed by those who sorted waste (1.5 mg/m³) and those performing maintenance tasks (1.4 mg/m³) (Figure 2). Workers in transport or office/control room roles had significantly lower median exposures. For ten participants (9%), the occupational exposure limit value for lead in the air was exceeded, and a few workers, exceeded limit values for arsenic, copper, cadmium and antimony.

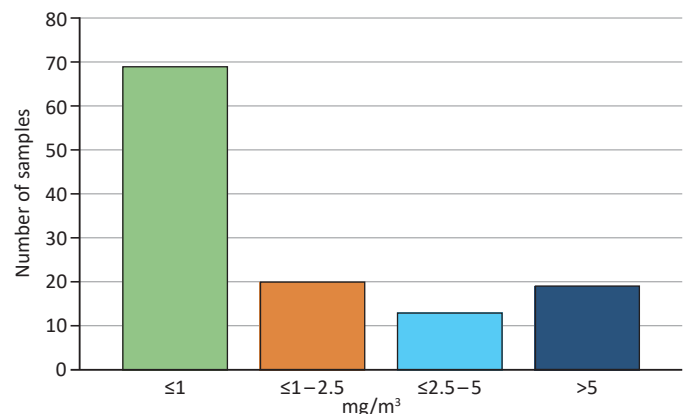


Figure 1. Inhalable dust in air

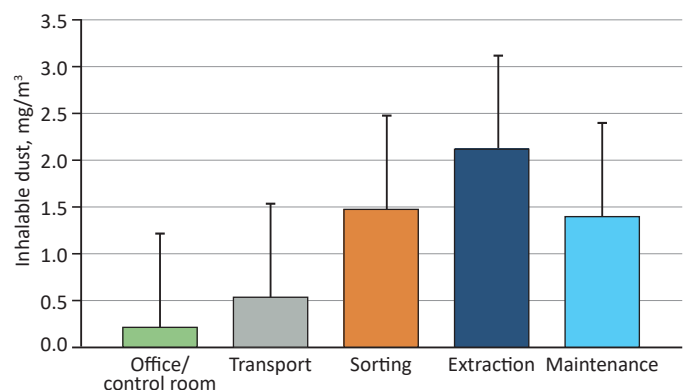


Figure 2. Work tasks in the metal recycling industry and inhalable dust

¹ GreenMetalWaste is funded by the Swedish Science Councils FORTE and FORMAS (2021-01757) and the EU projects INTERCAMBIO (101137149) and PARC (101095186).

LIMIT VALUES IN AIR

To protect the health of employees, occupational exposure limit values are set to limit air pollution in the workplace (see the Swedish Work Environment Authority's regulations and general advice (AFS 2023:14 on limit values for respiratory exposure in the work environment). Limit values are based on health risks and what is technically and economically feasible. In GreenMetalWaste, measured air concentrations have been compared with occupational exposure limit values for dust and a number of metals. In the recycling facilities many limits may apply, so it is important to promote a work environment to keep exposures as low as possible. For lead and cadmium, there are also statutory requirements to carry out air measurements if exposure occurs at the workplace (see the Swedish Work Environment Authority's regulations and general advice (AFS 2023:10) on risks in the work environment).

Compared to the control group, participants from the recycling companies had higher levels of metals in blood and/or urine. For example, toxic metals such as lead, mercury, aluminium, and antimony were elevated. In addition, many workers were exposed to multiple metals simultaneously (Figure 3). Nineteen percent of the participants showed higher levels of more than 10 metals in their blood compared to the highest level in the control group. Inhalation was likely the primary route of exposure for many metals.

The results show the importance of working according to the hierarchy of control

Our analysis of inhalable dust in air and metals in blood and urine, combined with an assessment of workplace protective measures, led to the following conclusions and recommended actions from the GreenMetalWaste project:

Limit the risk

The simplest and most cost-effective way to reduce exposure is by changing work methods and routines. For example, cleaning more often - by vacuuming and wet cleaning instead of dry sweeping and compressed air - as well as through improved hygiene routines and introducing work rotation.

Improvement of local exhaust ventilation and general ventilation

Participants with acceptable local exhaust ventilation had lower levels of inhalable dust in air (Figure 4a) and lower levels of lead in blood (Figure 4b). In many companies, local exhaust ventilation and general ventilation were often insufficient. The exception was participants working in transport, where ventilated cabins resulted in reduced exposure to dust and metals.

Use of respiratory protection

Sixty-six percent of participants did not use respiratory protection during work. Thirty-three percent did use respiratory protection, and 9% used it correctly. This highlights the importance for workers to get trained on how to use, maintain, and store respiratory protection. Tight-fitting respirators require fit testing, and facial hair such as beards or stubble can prevent a proper seal, reducing protection. In such cases, powered or fan-assisted respirators should be used.

Results for GreenMetalWaste in brief

Many workers in the metal recycling industry exceeded the Swedish occupational exposure limit value for dust, and some exceeded limits for specific metals, such as lead in air. Similarly, metal levels were elevated in blood and urine, and there was often co-exposure to multiple metals. The results from GreenMetalWaste stress the relevance of working according to the hierarchy of control (see fact box below). In the metal recycling industry, it is important to first try to minimize exposure through encapsulation. Improved cleaning and hygiene routines, along with enhanced general and process ventilation, can further reduce metal levels in the work environment. Personal protective equipment should be used as a last resort, and employees must be trained in its correct use and storage. The results are published in a scientific article.¹

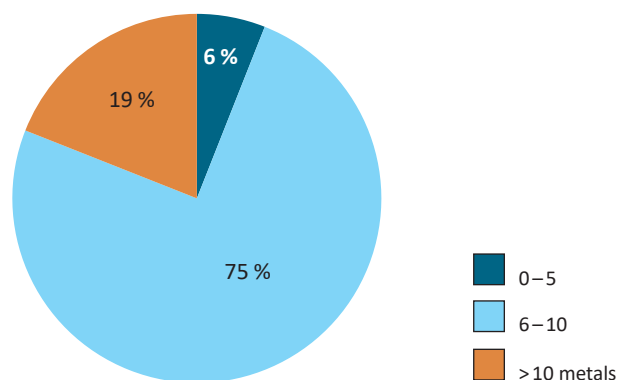


Figure 3. The proportion of metal recycling workers (in percent) with elevated concentrations of metals in blood compared to controls

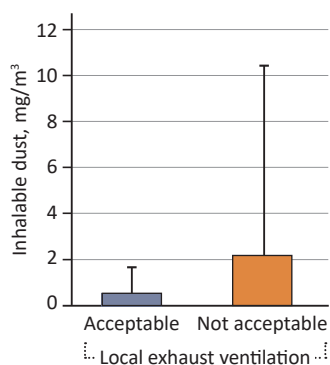


Figure 4a. Exposure to inhalable dust in relation to the use of local exhaust ventilation

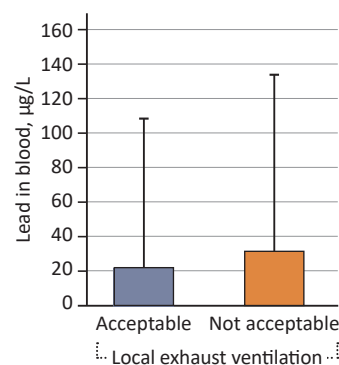


Figure 4b. Exposure to lead in blood in relation to use of local exhaust ventilation

¹ Stajniko et al. 2025 Metal and dust exposure in workers from the metal recycling industry in Sweden: cross-sectional GreenMetalWaste study

THE HIERARCHY OF CONTROL

According to the Swedish Work Environment Authority regulations, measures to reduce exposures that are hazardous to health must be taken in a certain order of priority, the so-called hierarchy of control. The employer is obliged to choose chemical products and work methods so that the risks are as small as possible. If it is assessed that further measures are needed, it must first be determined whether it is possible to minimize and limit the risk from the hazardous substance through, for example, encapsulation, selection of work methods, processes or technical devices that provide as low exposure as possible. Subsequently, in descending order of priority, attempts should be made to reduce exposure through local exhaust ventilation or by relocating work to a specific time or place. Personal protective equipment should be used as a last resort when other measures are insufficient or cannot be implemented.

