

Occupational hygiene measures to be applied when working on
paints and coatings containing hexavalent chromium

RWS, RVB and ProRail hexavalent chromium management regime

Version 1.1



Disclaimer

Rijkswaterstaat, Rijksvastgoedbedrijf and ProRail have drafted this management regime with the aim of preventing the health burden resulting from exposure to coatings containing hexavalent chromium. The prescribed management regime is based on the latest technological and scientific insights, as well as measurements of the emissions generated in each process involving a coating containing hexavalent chromium. When measurement data were incomplete or unavailable, the emissions generated by a process were determined by an expert panel using a standing procedure. In case of new insights, the list of processes and the management measures may be amended in subsequent versions of the management regime.

In the Netherlands, deviation from this management regime is allowed after consulting a qualified occupational hygienist. Any deviation must be recorded in writing, together with the relevant grounds. Compliance with this management regime supplements the management measures required to manage the other risks and safety aspects of the work to be done.

This management regime is in line with Dutch legislation. Note that the regulation for management and prevention of exposure to coatings containing hexavalent chromium may differ in your country. While this management regime may be used outside the scope of the Netherlands, be aware that this should be done only as a guideline. Rijkswaterstaat, Rijksvastgoedbedrijf and ProRail are in no way responsible for the (consequences of) the use of this management regime outside of the Netherlands.

Document information

Notes

Written by: PreventPartner expert group
Photo: Thea van den Heuvel | Waalbrug

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Hexavalent chromium management regime

The objective of the management regime

The objective of this management regime is to provide everyone with guidelines for the safe processing and removal of coatings containing hexavalent chromium.

It is assumed that the measures to prevent exposure to hexavalent chromium during work will also help to prevent exposure to other hazardous substances.

In the past, paint/coatings containing hexavalent chromium have been used to preserve metals, concrete and wooden building materials. Hexavalent chromium compounds can be released during the processing or removal of these coatings from objects such as bridges/engineering structures, stations and buildings.

Hexavalent chromium is harmful to health. It can cause diseases such as cancer. There is a risk only when people are exposed to hexavalent chromium, for example during work with coatings containing hexavalent chromium. The health risk increases with the intensity and duration of the exposure.

The Health Council of the Netherlands considers lung cancer to be the most critical effect. Limit values have been established for occupational exposure based on health risks accepted in the Netherlands. The statutory limit value for

hexavalent chromium in the Netherlands is $1 \mu\text{g}/\text{m}^3$.

This limit has been adopted as the prohibitive risk level that may not be exceeded. In addition, a target risk level of a factor of a hundred lower has been set¹.

This management regime prescribes measures to prevent exposure to hexavalent chromium during the processing or removal of coatings². The regime is meant to be a working document and it will be further developed and substantiated by observations in the coming period.

How will this protocol be updated and substantiated further?

Rijkswaterstaat (RWS), ProRail and Rijksvastgoedbedrijf (RVB) will use the time to come to collect measurement data from studies on the emission of hexavalent chromium during the processing or removal of coatings. This will involve comparing different techniques in different conditions. The research results may lead to changes in the measures in the management regime or to techniques being added as safe working practices.

For whom has this document been written?

This regime is public and it can be used by anyone whose work involves the processing or removal of coatings and paints containing hexavalent chromium.

1. In the Netherlands, the aim for occupational exposure is to limit any additional risk of cancer to one in a million workers per year of exposure. For an entire working life (40 years, 40 hours per week), this means that 1 in 25,000 exposed workers will develop cancer at this level of exposure. At the prohibitive risk level on which the statutory limit value is based, this is 1 in 250 workers.
2. These measures should, as far as possible, be based on research. Where emission or exposure studies are not possible or have not yet been carried out, the measures are based on the assessment of a panel of experts (occupational hygienists and toxicologists). See also annex 2 of this regime.

Background information about hexavalent chromium

There are several types of chromium. Hexavalent chromium is thought to be the one that is most harmful to health. Hexavalent chromium, like chromium-3, occurs in natural minerals but it is also produced industrially because of its useful properties. Hexavalent chromium is never found separately: it always binds to another substance. This means that it occurs only in the form of a 'hexavalent chromium compound'. There are several hexavalent chromium compounds with their own specific properties, including colour and solubility. Hexavalent chromium compounds are added as colouring agents to paints and, because they are good corrosion inhibitors, to primers as well.

How can hexavalent chromium enter the body?

It can be released as dust or vapour during work with coatings/paint that contain hexavalent chromium. The hexavalent chromium compounds can enter the body in three ways: through ingestion (the stomach), inhalation (the lungs) or through the skin. Given the nature of exposure during maintenance work (in other words, the release of dust or vapour), inhalation exposure is most relevant. Hexavalent chromium from coatings is not absorbed into the body through the skin, or only to a minimal extent. Skin exposure can cause only local effects on the skin in the form of allergic symptoms. This risk is mainly associated with wet processing. Because dust can stick to the hands, hexavalent chromium can also enter the stomach if there is hand-to-mouth contact. Exposure via hand-to-mouth contact should therefore be avoided as much as possible.

Hexavalent chromium is converted into the less harmful chromium-3 after absorption into the body. If this conversion takes place in a cell, it can cause cell damage and therefore health damage.

Preventing exposure

Low-emission techniques should preferably be used. Workers may be exposed to coatings containing hexavalent chromium during their work because dust or vapour are released (direct exposure). In addition, there is also indirect exposure when employees are in the vicinity of someone who is producing dust or vapour during their work. Dust from the work descends in the vicinity of the workplace. It can then be disturbed, with potential exposure as a result. Furthermore, employees can also expose

themselves, colleagues or third parties later if they have dust on their clothes and carry it around. This is known as 'secondary exposure'. Good housekeeping is important to prevent secondary exposure. Measures targeting the source are most effective in reducing exposure. Preventing the release of dust at the source means that other measures do not have to be as drastic.

Technical, organisational measures or the use of personal protective equipment such as respirators or gloves can prevent direct exposure. Indirect exposure can be prevented by zoning, positioning dust protection, effective cleaning procedures and strict hygiene and clothing procedures.

Deviation from the management regime

The regime provides a general framework for safe working practices. Deviation from this framework is only possible if a qualified occupational hygienist making a well-founded assessment is involved.

Measures in management regime

The inset below lists the general measures that apply at all times.

General measures

Personal hygiene

1. Do not eat, drink or smoke in the workplace where exposure to hexavalent chromium dust or vapour³ is possible.
2. Wash your hands: before eating, drinking, smoking or visits to the lavatory⁴.
3. Showering if there are observable traces of dust on hair after completion of the work.

Safeguards associated with the measures

1. Education and instruction about the specific measures relating to hexavalent chromium in the specific working situation.
2. Biological monitoring⁵ for anyone with a relevant exposure to hexavalent chromium. Biological monitoring should be supervised by a specialised occupational hygienist in collaboration with a company doctor.
3. Release of the working area: observe the measures matrix for cleaning. After cleaning, a visual check on the presence of dust.

3. Vapours when coatings or materials are heated. These are mixtures of gases and particles at a high temperature that can be inhaled (welding fumes, for example).

4. The face must be washed if there is visible contamination with dust containing hexavalent chromium (or suspicion thereof).

5. See annex 2

Clothing

When a clothing procedure is listed in the matrix of measures, the following matters are important:

1. Clothing procedure to prevent secondary exposure.
 - a. Over-garments that have been in contact with substances containing hexavalent chromium must be taken off before the persons in question leave the work area. These garments should be collected (respiratory protection equipment must be worn when taking them off) at the workplace (in a decontamination unit, for example) and clean clothes should be put on.
 - b. Collect dirty working garments in special washing bags⁶ and industrially clean them with the bags.
2. Process disposable over-garments as chemical waste.
3. If the exposure of head hair to dust is plausible and cannot be prevented, a hair cover is recommended.

Hygiene

If the measures matrix indicates that shower facilities must be available, this means that those facilities must be in the vicinity of the working area. This does not necessarily have to be at the workplace itself or immediately alongside the workplace. This is a personal hygiene measure designed to prevent relevant secondary exposure. Showering can prevent, for example, hexavalent chromium being taken into the canteen or private locations (such as in the car or at home).

Respiratory protection equipment

Where exposure through the inhalation of dust or vapour is possible, respiratory protection equipment is required. Annex 1 of this regime discusses this area in more detail.

Dust protection

Dust protection is used to prevent the spread of dust (which may contain hexavalent chromium) to the surroundings. Extraction systems for a protected work area in which dust is produced have two purposes:

1. Prevention of the spread of dust containing hexavalent chromium to the surroundings.
2. Filtering the air leaving the work area.

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6. Laundry bags that are washed with the laundry and that open or dissolve in the machine.

Measures matrix: processing of a structure

Supplementary management measures when working with paint/coatings containing hexavalent chromium. The standard applicable measures have not been included in this matrix.

	Pneumatic loosening of bolts	Drilling ¹⁰	Grinding/sawing	Manual cutting or manual loosening of bolts	Hydraulic cutting	Abrasive cutting (water)	Welding on coated surface	Thermal cutting	Torch cutting ¹¹	Loosening with heat	Removing glazing bars
<p> Mandatory.</p> <p> When more than one box is ticked for respiratory projection equipment, one of the three may be chosen (see also annex 1).</p> <p> When more than one option is ticked for clothing, one of the two may be selected depending on the scope of work and the circumstances.</p>											
Source extraction and/or on-tool extraction											
Room ventilation											
Dust protection with extraction ⁷											
Dust protection ⁸											
Demarcation of working area											
Self-contained respirator and blasting suit											
Airstream ⁹ helmet											
Half- or full-mask respirator + P3 filter											
Disposable respirator FFP3											
Disposable overalls											
Clothing procedure											
Showering											
Gloves											

7. Prevents spread of dust containing hexavalent chromium to the surroundings. The outflowing air is HEPA filtered

8. Prevents spread of dust containing hexavalent chromium to the surroundings.






























9. See also annex 1.

10. Based on the literature from drilling work in other sectors, exposure to dust seems limited and therefore respiratory projection equipment and the clothing procedure may not be necessary. However, in the absence of hard data on exposure to hexavalent chromium during drilling work, these measures are still being proposed for the time being.

11. Ultra-fine dust particles are released during cutting and welding and so respiratory projection equipment is needed given hexavalent chromium exposure but direct contamination of clothing will be limited. There are therefore no additional requirements for clothing or the clothing procedure.

Measures matrix: cleaning

Supplementary management measures when working with paint/coatings containing hexavalent chromium. The standard applicable measures have not been included in this matrix.

	Steam cleaning	Removal from treated surfaces with compressed air	Cleaning / sweeping	Cleaning / vacuuming ¹²	Replace filters
<p> Mandatory.</p> <p> When more than one box is ticked for respiratory projection equipment, one of the three may be chosen (see also annex 1).</p> <p> When more than one option is ticked for clothing, one of the two may be selected depending on the scope of work and the circumstances.</p>					
On-tool extraction / source extraction					
Room ventilation					
Dust protection with extraction⁷					
Dust protection⁸					
Demarcation of working area					
Self-contained respirator and blasting suit					
Airstream⁹ helmet					
Half- or full-mask respirator + P3 filter					
Disposable respirator FFP3					
Disposable overalls					
Clothing procedure					
Showering					
Gloves					

7. Prevents spread of dust containing hexavalent chromium to the surroundings. The outflowing air is HEPA filtered.

8. Prevents spread of dust containing hexavalent chromium to the surroundings.

9. See also annex 1.

10. Dust should not be swept in order to prevent the spread of the dust. An industrial vacuum cleaner should be used for cleaning.

Measures matrix: removal of coating with dry methods

Supplementary management measures when working with paint/coatings containing hexavalent chromium. The standard applicable measures have not been included in this matrix.

	Manual sanding	Machine sanding / grinding / deburring / poker vibrator (with on-tool extraction) ^{13, 14}	Machine sanding / grinding / deburring / poker vibrator (no on-tool extraction) ¹⁴	On-site abrasive blasting	Abrasive blasting in blasting shed	Vacuum blasting	Sponge blasting	Induction cleaning ⁵	Laser cleaning
On-tool extraction / source extraction		●						●	●
Room ventilation					●				
Dust protection with extraction⁷			●	●		●	●	●	
Dust protection⁸		●							●
Demarcation of working area	●								
Self-contained respirator and blasting suit				●	●	●	●		
Airstream⁹ helmet	■	■	●					■	■
Half- or full-mask respirator + P3 filter	■	■						■	■
Disposable respirator FFP3	■	■						■	■
Disposable overalls	▲	▲	●						
Clothing procedure	▲	▲		●	●	●	●		
Showering	●		●						
Gloves									

7. Prevents spread of dust containing hexavalent chromium to the surroundings. The outflowing air is HEPA filtered.

8. Prevents spread of dust containing hexavalent chromium to the surroundings.

9. See also annex 1.





















10. Wear fire-retardant clothing when working near open fires, planes, torches, welding or spark-producing machinery or working methods.

11. If the work involving the use of these techniques is limited, derogation is possible on condition that grounds are stated (see annex 2).

12. When using induction, potentially high electromagnetic fields (EMF) must be considered. The risks must be assessed by a trained expert (occupational hygienist or radiation expert).

Measures matrix: removal of coating with wet methods

Supplementary management measures when working with paint/coatings containing hexavalent chromium. The standard applicable measures have not been included in this matrix.

<p>  Mandatory.  When more than one box is ticked for respiratory protection equipment, one of the three may be chosen (see also annex 1).  When more than one option is ticked for clothing, one of the two may be selected depending on the scope of work and the circumstances. </p>	manual wet sanding	High-pressure water jetting	Wet blasting with water and grit	Wet blasting with water, grit and additive after surface treatment with gel ¹⁰	Scouring / soaking
On-tool extraction / source extraction					
Room ventilation					
Dust protection with extraction⁷					
Dust protection⁸					
Demarcation of working area					
Self-contained respirator and blasting suit					
Airstream⁹ helmet					
Half- or full-mask respirator + P3 filter					
Disposable respirator FFP3					
Disposable overalls					
Clothing procedure					
Showering					
Gloves					

7. Prevents spread of dust containing hexavalent chromium to the surroundings. The outflowing air is HEPA filtered.

8. Prevents spread of dust containing hexavalent chromium to the surroundings.

9. See also annex 1.

10. Blasting with additive results in specific risks associated with the additive used.

Annex 1

Notes on use of respiratory projection equipment

Notes on use of respiratory projection equipment

Respiratory projection equipment can be used to prevent the inhalation of hexavalent chromium. In the case of blasting work, that means supplying fresh air from outside the containment area. However, other forms of respiratory projection equipment must be used in some cases. Different options are possible and they are shown in the photographs in the table below.

The level of protection depends on the selected option. For example, a disposable P₃ respirator has an assigned protection factor of 20, which means that the respirator reduces exposure by a factor of 20 (if the level of hexavalent chromium exposure in the workplace is 20 µg/m³, exposure behind the respirator is approximately 1 µg/m³). The assigned protection factor for the airstream helmet with P₃ filter is 40.

In the case of disposable respirators and half- and full-mask respirators, it is important for the respirator to fit well to the face because there can otherwise be leakage along the edges so that hexavalent chromium can get into the respirator and be inhaled. Leakage can be prevented by with face-fitting

tests. Tests of this kind should be standard. They will identify any leaks. The table below shows the differences between the different types of respiratory projection equipment. The models may vary slightly depending on the supplier.

Protection factors

The following *Assigned Protection Factors* (APF) have been used to classify the respiratory protective equipment.

Description of respiratory protective equipment	APF used in this regime
Disposable half-mask respirator FFP ₃	20 ¹⁷
Half-mask respirator with P ₃ filter	20 ¹⁷
Full-mask respirator with P ₃ filter	40 ¹⁷
Powered full-mask supplied-air respirator TM ₃	40 ¹⁷
Airstream helmet TH ₃	40 ¹⁷
Self-contained respirator hoods/helmets	40 ¹⁷
Self-contained respirator with blasting hood for abrasive blasting	200 ¹⁸

17. Source: HSG53, 2013

18. Source: recent research by TNO (via ISZW)

Protective respirators



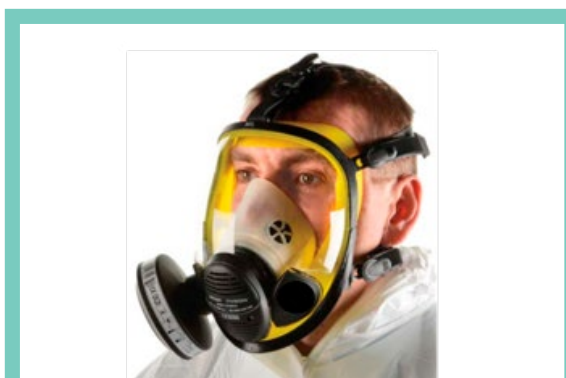
Disposable respirator P₃

Risk of leaks on the edges of the respirator. Face-fitting tests necessary.



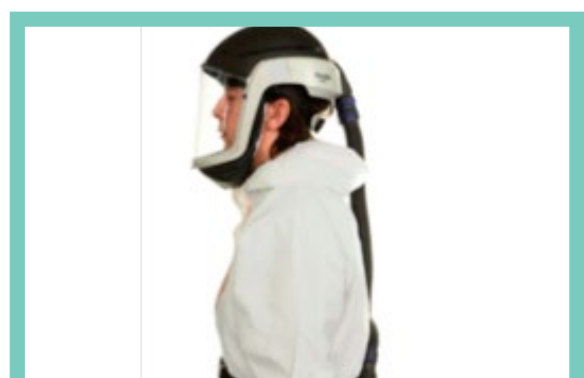
Half-mask respirator with P₃ filter

Risk of leaks on the edges of the respirator. Face-fitting tests necessary.



Full-face respirator with P₃ filter

Risk of leaks on the edges of the respirator. Face-fitting tests necessary.



Airstream helmet with motor powered P₃ filtered air

Often felt to be more comfortable to wear than the other options listed here. An additional advantage is that dust does not get into hair either.

Annex 2

Basic principles relating to the hexavalent chromium management regime

This annex explains the choices made in the prevention regime.

The underlying principles for the regime

- The measures in the regime are based on the assumption that hexavalent chromium compounds may be released when coatings are removed or processed.
- The report published in 2016 by the Health Council of the Netherlands on hexavalent chromium compounds states that the most critical effect of exposure to hexavalent chromium compounds is the possibility that they may cause cancer. No distinction was made between soluble and insoluble hexavalent chromium compounds. This management regime does not make that distinction either.
- Most descriptions of skin absorption in the literature relate to water-soluble chromium compounds. On the basis of the literature (SCOEL, Gestis), it is assumed that there is no relevant absorption through the skin.
- For the health effects described here, skin exposure, oral intake and/or secondary ingestion are also important routes of exposure, but it is not known to what extent (RIVM). However, since lung cancer is considered to be the critical effect by the Health Council of the Netherlands, the basic assumption is that these effects will not occur if exposure is already low enough to prevent lung cancer:
 - Stomach cancer (hand-mouth contact and secondary ingestion)

- Nasal/nasal sinus cancer, nasal perforation and allergic rhinitis (hand-nose contact)
- Allergic contact eczema (skin contact).
- The aim of hygiene measures is to prevent hand-mouth contamination as much as possible in the event of exposure to dust. For example, washing hands and the clothing regime to prevent dust from spreading unnecessarily outside the workplace. These measures also help to reduce the duration of skin contact with hexavalent chromium and therefore the risk of local effects on the skin (allergy).
- The basic assumptions for risk levels that apply to work and the environment range from $1 \cdot 10^{-8}$ to $1 \cdot 10^{-4}$.
- The limit value for hexavalent chromium has been set in the Netherlands on the basis of the prohibitive risk ($1 \cdot 10^{-4}$), not the target risk ($1 \cdot 10^{-6}$).

Classification of processes

Categories based on expected emissions (dust or vapour)

All processes have been classified on the basis of the expected emissions from a process. Three factors have been taken into account:

- Low-energy (such as manual sanding) or high-energy processes (for example with a sanding machine).
- The release of dust or vapour (with dust, secondary exposure can play a role because it may be stirred up again).
- The surface to be processed is large (in the case of sanding, for example) or small (during sawing work, for instance).

Measures to protect employees have been adopted for each category. Where dust is likely to be released, the measures needed to prevent the unnecessary spread of the dust have also been determined for the following reasons:

- Limitation of spread by introducing dust protection (with or without ventilation/under-pressure);
- Preventing dust from being stirred up again and resulting in repeat exposure;
- Preventing hand-mouth contamination as a result of direct contact.

The measures are primarily designed to prevent the inhalation of dust and vapour.

Substantiated by measurements

The measures described for each process are primarily based on *expert judgement*. However, practical measurements are already available about exposure to hexavalent chromium for some of the processes. The available reports on those measurements can be found in the list of sources. The measurement results for these processes have been taken into account during the formulation of the package of measures.

However, there are not enough measurements available at present to assert that we have validated good practices. Additional measurements for each process will therefore be required in the future. Nevertheless, measurements have been very useful for the description of the desirable management regime for each process.

Measurement results were a factor in the selection of the management regime for the following processes:

- Machine sanding / grinding / deburring / use of a poker vibrator;
- Blasting after the surface has been treated with gel;
- Drilling;
- Cutting;
- Torch cutting;
- Welding on a coated surface;
- Thermal cutting;
- Loosening with heat;
- Removing bolts;
- Manual wet sanding.

For the other processes, the categories for potential emissions described above have been followed, and the package of measures is based solely on expert judgement. The package of measures can be altered where necessary as soon as measurement data become available.

Duration not taken into account

At the express request of the principals, the duration of the work or processes has not been taken into account. When a process is brief in practice, less drastic measures may be needed. Downscaling for specific reasons will be permitted

only with a recommendation, stating the relevant grounds, from a qualified occupational hygienist.

Measures based on risk, not hazard

For the purposes of the description of the measures, zero exposure has not been assumed; the formulated measures are considered to be proportional to the risk. This means that the underlying assumption is that exposure in the case of inhalation must always be below the statutory limit value. Given the fact that no limit values have been adopted for exposure through skin and oral ingestion, the measures are intended to reduce these forms of exposure as much as possible. Biomonitoring can be used to evaluate all forms of exposure.

Occupational hygiene strategy

The application of the Occupational hygiene strategy has been taken into account as much as possible during the formulation of measures. In the case of existing methods and processes, the measures are based on knowledge about those processes and the available exposure measurements. New, innovative methods have also been proposed for the removal of coatings containing hexavalent chromium. Until it has been confirmed that the source-targeted approach in these new removal methods is adequate, personal protective equipment will be required. The effectiveness of alternative methods should be demonstrated by measurements.

Measures for the prevention of the unnecessary transportation of dust

In addition to primary, direct exposure by the inhalation or ingestion of dust or vapour during work, people may also be indirectly exposed when they are in the vicinity of a place where dust or vapour is produced.

Particular attention is paid to the unnecessary transportation of dust from the workplace to other places resulting in the possible exposure of third parties. For example on contaminated clothing, hair or skin.

Safeguards

Hexavalent chromium can be biologically monitored by measuring the concentration of chromium in urine. The urine samples should always be taken at the end of the working week and then at the end of the working day. Biological monitoring is particularly valuable when the work extends over a long period of time (in other words, several weeks) and is done repeatedly. Work relevant to possible exposure to hexavalent chromium should have been carried out on the days preceding biomonitoring. The results of the monitoring can be used to assess whether the total package of measures is effective *and* they can be added to the personal file.¹⁹

19. In the case of biological monitoring, the proposal is to test the results both in a comparison with background values found in the general population (less than 2 µmol of chromium/mol creatinine) and with the Biological Monitoring Guidance Value (BMVG) of 10 µmol chromium/mol creatinine at the end of the shift.

What is not covered in this management regime?

The regime focuses:

- only on those measures that need to be taken additionally as a result of the release of dust or vapour containing hexavalent chromium (standard measures such as goggles, hearing protection or safety shoes are not included),
- on the measures required for the processing and/or removal of coatings containing hexavalent chromium,
- does not focus on measures needed to prevent risks other than exposure to hexavalent chromium, such as working with caustic soda or welding uncoated surfaces. The reader is referred to other instruments, such as the welding fumes improvement check, for the measures relevant to those activities.

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ProRail



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+31 (0)800 - 8002

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