Employer's requirement to minimise exposure to chromium(VI) compounds at the workplace

Minimization requirement and substitution test obligation in the presence (inhalable fraction (E)) of chromium(VI) compounds in the energy-generating industry; here: gas engines
EU, United Kingdom and USA

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1. Introduction

Exposure to carcinogenic, mutagenic and reprotoxic substances (CMR substances) poses a significant health risk to workers. This study examines the legal requirements and measures that employers in the European Union (EU) must take to minimize exposure to chromium(VI) compounds, especially calcium chromate. Calcium chromate is formed by the thermochemical reaction of calcium-containing insulation products on chromium-containing hot parts of engines at temperatures from about 300°C.

2. Technical Background

Today's engines for energy generation, especially emergency power generators or combined heat and power plants, are usually equipped with calcium-containing high-temperature insulation by the manufacturer. It has been found that these insulation materials release calcium oxides through mechanical wear and aging. These calcium oxides react at higher temperatures (above approx. 300°C) in oxygen environments with chromium(III) compounds contained in stainless steel alloys, which leads to a high oxidation of the trivalent chromium compounds to hexavalent chromium compounds (chromate).

The chemical reaction can be described as follows:

$$2Cr_2O_3 + 4CaO + 3O_2 \longrightarrow 4CaCrO_4$$

The resulting chromium(VI) compound calcium chromate is a CMR substance and is classified as a Substance of Very High Concern (SVHC).

3. Legal framework

3.1 EU Directive 98/24/EC, merged into 2004/37/EC

Both Directives are aimed at protecting workers from the risks arising from chemical agents. It calls on employers to carry out risk assessments, carry out a substitution test, take technical and organisational measures, comply with exposure limits, carry out regular monitoring and health surveillance, and provide workers with comprehensive information and training.

3.2 EU Regulation (EU) 2016/425

Regulation (EU) 2016/425 on personal protective equipment (PPE) sets out requirements for the placing on the market and use of PPE to ensure the health and safety of users. The regulation divides PPE into three categories depending on the risk, defines essential health and safety requirements, and requires CE marking to ensure compliance.

4. Principles of health protection

4.1 Minimization requirement

Regardless of whether the occupational exposure limits (OEL) are met, employers must minimize exposure to CMR substances such as chromium(VI) compounds, especially calcium chromate, as much as technically possible. This means that safer alternatives and measures must always be sought to reduce the risk to workers.

4.2 STOP Principle

The STOP principle represents a hierarchical sequence of risk mitigation measures:

1. *Substitution*: Replacing hazardous substances with less hazardous ones.
2. *Technical measures*: use of closed systems, extraction, ventilation.
3. *Organisational measures*: limitation of the duration of exposure, access restrictions.
4. *Personal protective measures (PPE):* Use of protective equipment when other measures are not sufficient.

5. Practical implementation

5.1 Substitution test

The substitution test is a central element of the minimization requirement. Employers are obliged to continuously check whether chromium(VI) compounds, especially calcium chromate, can be replaced by less hazardous substances or processes. This check must be documented and regularly updated to reflect the latest state of the art and available alternatives. Calcium-free insulation is available, and field tests have shown that it can replace calcium-containing insulation in a technically viable way.

5.2 Risk assessment

Parallel to the substitution test, a comprehensive risk assessment must be carried out. This assesses the risks of exposure and identifies measures to mitigate the risk. Here, too, regular updating is necessary to take into account changes in the work process and new findings.

5.3 Technical and organizational measures

If substitution is not possible, technical and organisational measures must be taken to minimise exposure. These include closed systems, effective ventilation, extraction, and organizational measures such as rotating tasks and limiting exposure time.

5.4 Use of neutralizing fluids

Some manufacturers recommend using neutralizing fluids containing ascorbic acid to reduce chromium(VI) compounds to chromium(III) compounds. However, this down-oxidation is only an immediate measure and does not release from the obligation to carry out substitution testing and the implementation of further protective measures. Since chromium(VI) compounds can re-emerge if the calcium-containing material continues to be used, a long-term solution is needed.

5.5 Negative properties of chromium(III) compounds

Although chromium(III) compounds are considered less dangerous than chromium(VI) compounds, they are not completely harmless. Chromium(III) compounds can still cause skin and respiratory irritation and cause allergic reactions. In addition, if they are inadequately handled and protected, they can be converted into chromium(VI) compounds, creating the risk again. Work with chromium(III) compounds should be carried out drain-free to avoid contamination of the environment and to minimize the risk of conversion to chromium(VI).

5.6 Permanent use of PPE

Even if the OEL is complied with, the permanent use of PPE is required as long as there is a risk from chromium(VI) compounds, especially calcium chromate. PPE serves as the last protective barrier and must be used whenever other measures are not sufficient to reduce exposure to safe levels. This is particularly relevant for activities where complete elimination of exposure is not technically possible.

5.7 Training and information of employees

Workers must be fully informed and regularly trained about the dangers of chromium(VI) compounds, especially calcium chromate, and the necessary protective measures. This ensures that they understand the importance of the protective measures and apply them correctly.

5.8 Regular Monitoring and Documentation

Workers' exposure to chromium(VI) compounds, in particular calcium chromate, must be regularly monitored and documented to ensure the effectiveness of protective measures. This also includes recording health surveillance and evaluating exposure results.

5.9 Operator Responsibility

The engine operator is responsible for carrying out a workplace risk assessment to assess the risks posed by the operation of the engines and the possible release of CMR substances. He must take measures to minimise exposure, such as the implementation of technical and organisational measures and the use of PPE. In addition, the operator must ensure that all legal requirements are met, including regular monitoring and documentation of exposure, as well as training of employees.

6. Manufacturer's Obligation

Based on European regulations, in particular the REACH Regulation and the RoHS Directive, there is a strong basis to oblige the engine manufacturer to use safe, calcium-free insulation when it is clear that the calcium-containing insulation currently used will lead to the formation of CMR materials during commissioning. Here are the relevant points:

1. *Detection of the formation of CMR substances*:
    - If it is clearly proven that the calcium-containing insulations are the only source of calcium and lead to the formation of calcium chromate during commissioning.
2. *Existence of safe alternatives*:
    - Calcium-free insulation is available, and field tests have shown that it can replace calcium-containing insulation in a technically viable way.
3. *Responsibility for product safety*:
    - The REACH and RoHS regulations require manufacturers to ensure that their products do not pose unnecessary risks to health and the environment. If safe alternatives are available, they must be used to ensure safety.

As long as the engine manufacturer does not provide calcium-free insulation, the area of responsibility for compliance with the minimization requirement and the substitution test obligation lies with the operator for the time being.

7. Conclusion

Minimizing exposure to chromium(VI) compounds, especially calcium chromate, in the workplace is a legal obligation and a crucial aspect of health protection. Employers must take all possible measures to reduce the risks to their employees. This includes a thorough substitution check, the implementation of technical and organizational measures, and regular training and information for employees.

The use of neutralizing fluids to reduce chromium(VI) compounds is only a short-term solution and does not replace the need for long-term risk mitigation strategies. Employers must ensure that technical measures such as closed systems and effective ventilation are in place and PPE is used continuously to minimise exposure.

In addition, engine operators have the responsibility to prevent the release of CMR substances through careful risk assessment and compliance with legal requirements. You must ensure that all measures to minimise exposure are taken and continuously monitored.

Manufacturers of engines that use calcium-containing insulation must ensure that their products do not pose unnecessary risks. Based on the REACH Regulation and the RoHS Directive, they are obliged to use safe alternatives when they are available to prevent the formation of CMR substances. Calcium-free insulation is available, and field tests have shown that it can replace calcium-containing insulation in a technically viable way. As long as the engine manufacturer does not provide calcium-free insulation, the area of responsibility for compliance with the minimization requirement and the substitution test obligation lies with the operator for the time being.

By complying with these measures and regulations, both manufacturers and operators can help protect the health of workers and protect the environment. Continuous evaluation and adaptation of the materials and processes used is essential to ensure the highest safety standard.

8. Applicability in the United Kingdom

The UK legislation is similar to European regulations and requires measures to minimise exposure to hazardous substances in the workplace. Here are the relevant points:

1. *Control of Substances Hazardous to Health (COSHH) Regulations 2002*
    - This regulation requires employers to assess and control the risks posed by the use of hazardous substances. This includes carrying out risk assessments, implementing control measures and monitoring occupational exposure.
    - COSHH regulations require employers to replace hazardous substances with less hazardous alternatives whenever possible, which is in line with the EU's substitution principle.
2. *Restriction of Hazardous Substances (RoHS) Regulations*
    - This regulation restricts the use of certain hazardous substances in electrical and electronic equipment in order to ensure health and safety. Manufacturers must ensure that their products do not pose unnecessary risks and that safer alternatives are used when they are available.
3. *Responsibility of manufacturers*
    - Manufacturers are required to provide technical documentation demonstrating compliance. This includes a declaration of conformity and test reports. This documentation must be kept for a certain period of time and made available to the authorities upon request.

9. Regulations in the USA

The United States has regulations similar to those of the EU that require minimizing exposure to hazardous substances. Here are the most important regulations:

1. *Toxic Substances Control Act (TSCA)*
   - The TSCA gives the Environmental Protection Agency (EPA) the authority to require reporting requirements, record-keeping requirements, and testing requirements, as well as restrictions related to chemical substances. The TSCA covers the production, processing, distribution, use, and disposal of certain chemicals. Manufacturers must assess risks and ensure that their products do not pose unnecessary risks to human health and the environment.
2. *Occupational Safety and Health Administration (OSHA)*
   - OSHA regulations, especially the Hazard Communication Standard (HCS) (29 CFR 1910.1200), require chemical manufacturers and importers to prepare Material Safety Data Sheets (MSDS) for each hazardous chemical they produce or import. Employers must provide MSDS for every hazardous chemical used in the workplace. These regulations also require the substitution of hazardous substances with less hazardous substances whenever possible.

Summary

Regulatory requirements in the U.S., especially TSCA and OSHA regulations, are similar to European regulations and require employers and manufacturers to take steps to minimize exposure to hazardous substances.

Manufacturers must ensure that safe alternatives are used, and employers must implement and regularly review appropriate safeguards.
Therefore, the application of the measures described in the study is also relevant and valid in the USA.

By complying with these measures and regulations, both manufacturers and operators in the U.S. can help protect workers' health and protect the environment. Continuous evaluation and adaptation of the materials and processes used are essential to ensure the highest safety standards.

The legal requirements in the UK and the US are similar to European regulations and require employers and manufacturers to take measures to minimise exposure to hazardous substances.

Manufacturers must ensure that safe alternatives are used, and employers must implement and regularly review appropriate safeguards. Therefore, the application of the measures described in the study is also relevant and valid in the UK and the USA.

By complying with these measures and regulations, both manufacturers and operators in the UK and the US can help protect workers' health and protect the environment. Continuous evaluation and adaptation of the materials and processes used are essential to ensure the highest safety standards.

Literature references for the study

1. *REACH Regulation (EC 1907/2006)*
   - The REACH Regulation obliges manufacturers, importers and downstream users to ensure the safe use of chemicals. This includes the registration and assessment of risks as well as the substitution of hazardous substances with less hazardous alternatives. For more information, please visit the EU's official REACH page.

2. *RoHS Directive (2011/65/EU)*
    - The RoHS Directive restricts the use of certain hazardous substances in electrical and electronic equipment in order to protect human health and the environment. Manufacturers must ensure that their products meet the set standards. Details can be found on the official EU RoHS page.
3. *CLP Regulation (EC 1272/2008)*
    - This regulation on the classification, labelling and packaging of substances and mixtures ensures that the hazards posed by chemicals are clearly communicated. Information on the CLP Regulation can be found on the ECHA website.
4. *Control of Substances Hazardous to Health (COSHH) Regulations 2002*
    - This regulation requires employers in the UK to assess and control the risks associated with the use of hazardous substances. For more information, please visit the HSE website.
5. *Toxic Substances Control Act (TSCA)*
    - The TSCA gives the Environmental Protection Agency (EPA) the authority to require reporting requirements, record-keeping requirements, and testing requirements, as well as restrictions related to chemical substances. Details can be found on the EPO website.
6. *Occupational Safety and Health Administration (OSHA)*
    - OSHA's Hazard Communication Standard (HCS) requires chemical manufacturers and importers to create Material Safety Data Sheets (MSDS) and share this information with workers. For more information, visit the OSHA website.

These references provide a solid basis for the legal requirements and measures to minimise exposure to hazardous substances in the EU, UK and US.

Version history

Version	Date	Change
1.0	August 2024	First edition
1.1	November 2026	New layout in the design system of the Chromate Experts; spelling of chromium(VI) standardized.