**Case Study:**

# Misleading Safety Measures and Deficiencies in the Assessment of Chromate Formation by Calcium-Containing Insulation Systems in Combined Heat and Power Plants and Other Energy-Generating Units

## 1. Introduction

In industrial applications such as combined heat and power plants (CHPs), gas and steam turbines, but also components of exhaust gas aftertreatment in (commercial) vehicles, it can be assumed that the use of **calcium-containing insulation materials** in particular produces dangerous **chromium (VI) compounds such as calcium chromate**.

In these applications, the development principle is based on a **thermochemical reaction** between **calcium oxides** from the insulation materials and **chromium(III) compounds** originating from the passive layers of the **stainless steel hot parts** of the energy generators.

The effect of e.g. **humidity** and other external conditions, **calcium hydroxide can also** form, which additionally attacks the **passive layer of the stainless steel** and **strengthens and accelerates the** release of chromium (III) compounds.

These chromium (III) compounds then react with the calcium compounds at high temperatures to form dangerous **calcium chromate**, a highly carcinogenic and chronically environmentally harmful chromium (VI) compound.

This case study examines how negligent and misleading manufacturers, operators and authorities deal with the risks of chromium (VI) formation and what grievances exist in terms of responsibility and safety.

## 2. Problem

**Engine manufacturers**, but also manufacturers of turbines, explicitly point out the risk posed by the formation of calcium chromate due to the calcium-containing insulation materials used. He suggests fixing the problem by using **neutralization solutions** during maintenance. This suggests that the risks are controllable and controllable. In reality, however, it turns out that this conveys a **misleading security** and does not eliminate the root causes. The **operators** of the systems, who rely on the information provided by the manufacturer, believe that they are in a false sense of security by using these neutralization solutions. At the same time, the **authorities** have been reluctant to react to the state of affairs for years, which may be due to **technical overload** and adherence to occupational exposure limits that may not be sufficient for chromium(VI) compounds.
In addition, **the manufacturers of the insulation materials** are trying to take their products out of focus by arguing that **gaseous chromium compounds**, which could possibly also be hexavalent, are released.

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This is intended to suggest that their **calcium-containing products** have nothing to do with the formation of calcium chromate, although these have been shown to play a key role in the formation of these carcinogenic substances.

## 3. Stakeholder perspectives

### 3.1 Manufacturer Perspective

#### Engine and turbine manufacturers

The **engine and turbine manufacturer** point out in documents that are not very worrying that the thermal insulation used can lead to the formation of calcium chromate.

It is recommended to use neutralization solutions for visible chromates and during maintenance work to convert the dangerous chromium (VI) into the less dangerous chromium(III).

#### Insulation material manufacturer

The **manufacturers of calcium-containing insulation materials** are trying to take their products out of the focus of criticism by arguing that **gaseous chromium compounds** could be released at high temperatures, which may also contain chromium(VI).

This should make it clear that calcium **chromate formation** is not caused by their insulation materials, but by other processes.

**Problem:**

- **Misleading communication (engine and turbine manufacturers):**

  the so-called neutralization solution is presented as a sufficient safety measure, although these are only a **reactive measure** and do not prevent the basic problem, the formation of chromium(VI) compounds.

- **Avoidance of responsibility (insulation material manufacturers)**:

  The argumentation of the manufacturers of insulation materials that gaseous chromium compounds are already the cause of the hazard is a **distraction from the actual problem**.

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The formation of **calcium chromate** is caused by the **thermochemical reaction** of the **calcium oxides in their products with** chromium (III) **compounds of engine and turbine components containing stainless steel** released from the passive layer.

### 3.2 Operator perspective

The operators of the plants that rely on the manufacturer's engines or turbines follow the above recommendations – if at all – and apply the neutralization solutions during maintenance work.

They assume and also claim that this measure sufficiently solves the problem and completely eliminates the chromium (VI) danger; a train of thought that is quite pleasing to them as the most minimal, albeit misinterpreted, form of a feigned form of occupational health and safety.

**Problem:**

- **False security**:

  The operators lull themselves and affected personnel into a false sense of security due to the neutralization solutions.

  They overlook the fact that chromium (VI) compounds can be present in the air or on surfaces even before maintenance or before visible deposits and represent a chronic burden for employees.

- **Long-term exposure**:

  **Continuous exposure** of workers to chromium (VI) through invisible dusts or aerosols is not sufficiently taken into account.

  This increases the risk of **long-term consequences** such as cancer.

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- **Multiple routes of exposure**:

  In addition to **inhalation exposure** to dusts and vapours, there are also considerable hazards from **skin contact**.

  Chromium (VI) compounds can also be absorbed through the skin.

  There is a risk that **dangerous chromium compounds will attach to clothing**, which in turn will be introduced into other areas.

  Since **carcinogenic, mutagenic and reprotoxic (CMR) substances** are now also generally considered **to be skin resorptive**, this is an important aspect that must be taken into account in protective measures.

### 3.3 Perspective of the authorities

The authorities have been aware of the grievance for several years, but have not yet given any clear measures or recommendations.

In some cases, they argue with the applicable **occupational exposure limits**, which are often not exceeded, and thus also create a misleading and thus false sense of safety among the operators of technical systems and the employees directly affected, which tempts them to consider the much-cited air pollution below 0.001 mg/m³ as below a threshold value that does not exist:

However, there are no safe threshold values for carcinogenic chromium (VI) compounds in particular, because the occupational health and safety risk assessment is defined by an acceptance limit (0.0001 mg/m³) [AW] and tolerance limit (0.001 mg/m³) [TW] in the **Technical Rules for Hazardous Substances (TRGS 910).**

If there are chromium (VI) compounds in the air (>0.0001 <0.001 mg/m³), the so-called "medium risk" (traffic light model: yellow) already applies to the workplace and measures are already required, which must be specified in the risk assessment.

The closer the air pollution moves towards TW, the higher the safety measures are to be set.

If the TW is exceeded, the risk is to be assessed as "high" (traffic light model: red), normal work is now de facto no longer allowed.

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**Problem:**

- **Overwhelm and lack of measures**:

  There is the impression that the authorities are overwhelmed by the complexity of the issue . Technical and factual deficits mean that no clear recommendations are made for the substitution of hazardous materials or for preventive measures.

- **Failure to take into account the exposure-risk relationship**:

  The authorities rely on occupational exposure limits, which are not applicable to chromium (VI) compounds because there is no absolutely safe exposure limit.

  The **exposure-risk relationship** of TRGS 910 shows that there is an increased risk of cancer even at very low concentrations. A **minimization requirement** is mandatory in such cases, but is not sufficiently implemented and is even wrongly pronounced as not recommended, because the authorities assume that only "insulators" have contact with high-temperature insulation materials and "therefore already wear sufficient protective clothing in accordance with their profession and due to contact with mineral fibers and other insulation materials.

  This argumentation does not take into account the fact that "non-insulators" also have direct contact with chromate-contaminated insulation materials in the context of other activities (e.g. service personnel for the maintenance of energy-generating systems such as combined heat and power plants, emergency power generators, etc.) and do not wear protective clothing customary for insulators.

## 4. Legal duties and responsibilities

### 4.1 Substitution test obligation according to the Hazardous Substances Ordinance

According to the Hazardous Substances Ordinance (§ 7), there is a clear obligation to check whether hazardous substances can be replaced by less hazardous alternatives, if this is technically possible.

Since calcium-free insulation systems are available and have been shown to prevent the formation of calcium chromate (no calcium – no calcium chromate), they would have to be used instead of the calcium-containing systems.

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The manufacturer violates this **substitution obligation** by continuing to use the more hazardous materials and not offering effective preventive measures, also because it follows "recommendations" of the authorities that do not mention substitution possibilities, because the authorities follow the argumentation of the engine/turbine or insulation manufacturers without checking that no alternatives are available.

### 4.2 Occupational exposure limit values and exposure-risk relationship

For carcinogenic substances such as chromium (VI) compounds, there are no safe limit and/or threshold values in Germany.

TRGS 910 clarifies that there is no exposure level for these substances that can be considered completely harmless.

The authorities wrongly argue with occupational exposure limits, even though chromium (VI) requires strict minimization of any exposure.

Analyses of the information published so far by employers' liability insurance associations and occupational health and safety authorities clearly show that the principle of formation of chromates has not been understood, or only partially understood.

### 4.3 Responsibility of the actors

- **Manufacturers of energy generators and insulation materials**:

  Both have a significant responsibility. The engine/turbine manufacturer is sticking to hazardous materials and is relying on neutralization solutions to combat symptoms.

  The manufacturers of insulation materials try to exonerate themselves from responsibility by false arguments, even though their products play an essential role in the formation of calcium chromate.

- **Operator**:

  The operator is also obliged to take appropriate measures to minimise exposure. However, it relies too much on the manufacturer's recommendations and ignores long-term risks, such as the **multiple hazards of inhalation and skin absorption**.

- **Authorities**: The authorities also share responsibility for failing to adopt clear and binding measures or recommendations to remedy the situation.

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## 5. Conclusions and recommendations

The continued use of calcium-containing insulation systems, which lead to the formation of carcinogenic calcium chromate, poses a significant risk to workers and the environment.

Neither the manufacturer's proposed solution nor the reactions of operators and authorities are sufficient to adequately minimise the risks.

**Recommendations:**

- **Substitution of insulation materials**:

  Calcium-free insulation systems should be used to prevent the formation of chromium(VI) compounds (chromates) from the outset.

- **Increased controls and stricter regulations**:

  Authorities should strengthen their technical capacities and adopt stricter regulations on the handling and substitution of hazardous materials.

- **Education and training**:

  Operators and employees must be comprehensively informed about the actual risks and trained in the handling of hazardous substances. In particular, training should be provided on the **dangers of skin contact and contaminated clothing**.

- **Long-term risk minimisation**:

  In addition to reactive measures (such as neutralisation), the focus must be on proactive measures to reduce exposure and avoid sources of danger.

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## 6. Conclusion

The current situation points to systematic failures and misleading measures in the handling of chromium (VI) compounds (chromates) in CHP plants and other energy-generating units.

Only through comprehensive substitution of the problematic materials, increased training of workers with regard to **inhalation and dermal risks** and better cooperation between manufacturers, operators and authorities can a long-term solution be found that guarantees the health of workers and environmental protection, so that the previous negligence or ignorance of all those involved ends and occupational health and safety and environmental protection is finally achieved in the future. even if the measures to be introduced mean a certain amount of cost.

Some fragments of the facts and behavioural patterns described are reminiscent of the asbestos problem many decades ago; the mistakes made at that time should not and must not be repeated.

All three named groups can only maintain or regain their credibility and reputation if they show the courage to deal with the findings and the state of the art.

## Document matrix for other countries

The regulations for the handling of hazardous substances and carcinogenic substances such as chromium (VI) compounds differ from country to country.

Comparison of relevant regulations in Germany, the Netherlands, France and the United Kingdom (UK):

**Germany:**

**TRGS 910** (Technical Rules for Hazardous Substances) defines the exposure-risk relationships for carcinogenic substances such as chromium (VI).

**GefStoffV** (Hazardous Substances Ordinance) regulates protection against hazardous substances.

**Netherlands:**

**Arbeidsomstandighedenbesluit** (Arbobesluit) regulates the protection of workers when handling hazardous substances. It is the Dutch equivalent of the GefStoffV.

**Publicatiereeks Gevaarlijke Stoffen** (PGS) is comparable to the TRGS in Germany and contains technical rules and guidelines for the safe handling of hazardous substances.

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**France:**

**Code du Travail** (Labour Code) contains detailed provisions on protection against hazardous substances and carcinogenic substances.

**INRS** (Institut National de Recherche et de Sécurité) publishes technical guidelines and recommendations for the handling of hazardous substances. These are comparable to the German TRGS.

**United Kingdom (UK):**

**COSHH** (Control of Substances Hazardous to Health Regulations) is the corresponding regulation to the Hazardous Substances Ordinance in Germany. It prescribes measures to protect against hazardous substances in the workplace.

**HSE** (Health and Safety Executive) publishes technical guidelines and recommendations for the handling of hazardous substances, comparable to the TRGS.

**EU-wide regulation:**

**2004/37/EC** (Directive of the European Parliament and of the Council on the protection of workers from the risks related to exposure to carcinogens or mutagens at work) is a **binding regulation** in all EU member states and ensures that dangerous substances such as chromium (VI) are covered by uniform protective measures throughout the European Union.

National rules must therefore be implemented in accordance with Directive 2004/37/EC in order to ensure the protection of workers (and the environment).

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