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Chromium(VI) Compounds Formed During Operation of Thermally Loaded Installations

In-situ formation on chromium-alloyed hot components: formation, evidence, legal framework and implementation

Chromium(VI) compounds are known as chemicals that are deliberately manufactured and used under high occupational and environmental protection requirements. Their use is strictly regulated and partly subject to authorisation.

Little attention has been paid to a second formation route: the thermochemical in-situ formation of chromates. It occurs when chromium-containing alloys at operating temperature come into contact with alkaline oxides and atmospheric oxygen, for example on insulated exhaust components of engines and turbines or on grate components of combustion plants. Since 4 May 2026, the German Technical Rule for Hazardous Substances TRGS 561 describes this situation in sections 3.3.4 and 5.9.3.

The chromates formed in this way are not brought into the installation; they develop during normal operation. They become relevant for exposure during maintenance, dismantling, cleaning, storage, reconditioning and disposal. This paper summarises formation, evidence and legal framework and shows the tasks that arise from them for those involved.

1. Formation during operation

TRGS 561 section 5.9.3 names as influencing factors the steel temperature, the chromium content of the alloy, the reaction time, alkali and alkaline earth metal oxides from insulation materials or assembly pastes, and atmospheric oxygen and humidity. Accordingly, insulation containing calcium oxide can form calcium chromate, and mineral wool containing sodium oxide can form sodium chromate.

These conditions are permanently met in many installations during normal operation. The reaction takes place at the interface between the chromium-alloyed hot component and the alkaline contact material, for sodium chromate from approx. 200 °C, for calcium chromate from approx. 300 to 350 °C. It requires neither a defect nor an operating error.

Chromium-alloyed steel 1	Alkaline oxides 2	Oxygen 3	Temperature 4
Manifolds, turbochargers, turbine casings, grate and furnace components	Calcium, sodium from insulation, gaskets, assembly pastes or combustion residues	from ambient air, plus humidity	from approx. 200 °C (sodium), from approx. 300 to 350 °C (calcium)

Result: Chromium(VI) compounds (calcium chromate, sodium chromate) on the component, in the insulation and in combustion residues.

Formation conditions according to TRGS 561 section 5.9.3, schematic.

Once formed, the chromates remain as loose deposits that are easily stirred up and as chromate-containing dust on the component, in the insulation and in its surroundings. If the alkaline contact material remains in the system, they form again in the next operating cycle.

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2. Affected installations and components

The applications worked out so far differ in technology and industry, but follow the same constellation.

Application	Chromium-alloyed component	Alkaline reaction partner	Activity relevant for exposure
CHP and cogeneration engines, including sewage gas CHP	Exhaust manifolds, turbochargers, exhaust lines, expansion joints	High-temperature insulation containing calcium and sodium oxide	Overhaul, dismantling, maintenance, removal of insulation
Power plants and combined cycle plants, power supply of data centres	Turbine casings, pipework, flanges, valves	Mineral wool, glass fabric, AES wools, calcium-containing silicate products, also microporous insulation	Overhaul, removal of insulation, cleaning
Waste incineration	Grate and furnace components, load-bearing surfaces below the grate	Calcium, sodium and potassium in the ash, sorbent from flue gas cleaning	Door opening, overhaul, removal of crusts, cleaning, area in front of the doors
Vehicle and industrial engines	Turbochargers, manifolds, EGR, catalytic converter, DPF, SCR, exhaust pipes	Heat shields and insulation mats, gaskets, assembly pastes	Workshop, used parts storage, reconditioning, recycling

The manufacturers' service information covers not only passenger cars and vans but also commercial vehicles, construction machinery, industrial and marine engines; the same constellation exists in diesel locomotives. The applications listed are examples, not an exhaustive list.

3. Evidence

The situation is described in the regulations, taken up by statutory accident insurance institutions, reported by manufacturers and confirmed by measurements. Quotations from German sources are our translations.

- **TRGS 561, version of 4 May 2026, section 5.9.3 paragraph 4:** "Particularly during plant overhauls (maintenance work), dismantling and troubleshooting, exposure of employees to chromium(VI) compounds cannot be ruled out."
- **BG ETEM (German statutory accident insurance for energy, textiles, electrical and media products), technical publication "Possible chromium(VI) exposure", as of 3 August 2026:** "According to current knowledge, all industries in which the above-mentioned influencing factors apply may be affected by the problem."
- **BG BAU (German statutory accident insurance for the construction industry), WINGIS operating instruction "Removal of chromate-contaminated insulation":** Removal is classified as a carcinogenic activity (signal word danger). Removed mineral wool products must not be reused.
- **Manufacturers' service information, since December 2023:** Manufacturers of engines, vehicles, exhaust aftertreatment, gaskets and insulation report the formation of calcium chromate on exhaust-carrying components and require protective measures during maintenance, dismantling and recycling. One insulation manufacturer confirms calcium oxide in its own textile insulation materials.
- **INRS, Références en Santé au Travail No. 183, September 2025:** The occupational health service of Alpes-Maritimes detected chromium(VI) on the exhaust manifold, turbocharger and screw connections in a company servicing diesel engines, and after dismantling also on the mechanics' hands, although they wore gloves. The in-house colour test on the turbocharger remained negative despite 869 ng chromium(VI).

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4. Recognisability

Appearance is a possible indication, but not an exclusion criterion. Fully developed chromates appear as yellowish to greenish-yellow deposits, which in practice are often mistaken for sulphur. Visually, the two cannot be distinguished. Chromate-containing dust can also be whitish and look like ordinary dirt.

An on-site rapid test does not provide certainty either, as the French study shows, in which a colour test remained negative despite analytically proven contamination.

The decisive factor is therefore the risk assessment: if chromium(VI) contamination is present or cannot be ruled out, the protective measures of TRGS 561 sections 4.1 and 4.2 apply.

5. Path of contamination over the life cycle

The contamination does not stay where it forms. With every removed component, every removed insulation and every bag of overhaul waste, it leaves the original workplace, often without being mentioned in the accompanying documents.

This successively affects on-site maintenance, used and spare parts storage, reconditioners and regenerators, recyclers, transporters and waste disposal companies. In waste incineration, the area in front of the furnace doors is added, from which dust is carried on footwear into workshops, break rooms and control rooms.

The chromium(VI) compounds named here are water-soluble and additionally classified as chronically hazardous to the aquatic environment with long-lasting effects (H410). Outdoor storage, washing water and blasting media carry them into soil and sewers. For waste classification, HP14 (ecotoxic) must be examined in addition to HP7 (carcinogenic).

If contaminated components are reinstalled, formation starts again in the next operating cycle as long as the alkaline contact material remains in the system.

6. Legal framework

The occupational safety regulations are in place. In Germany, the following apply:

- TRGS 561 section 5.9.3 in conjunction with sections 4.1 and 4.2, and the minimisation requirement under § 7 GefStoffV (German Hazardous Substances Ordinance)
- Risk assessment and substitution check under § 6 GefStoffV and TRGS 600, here: contact materials free of calcium and sodium oxide
- Exposure register under § 10a GefStoffV for employees for whom exposure to category 1A or 1B carcinogens cannot be ruled out
- Information of contractors under § 15 GefStoffV
- Occupational medical care under ArbMedVV (Ordinance on Occupational Health Care) if repeated chromium(VI) exposure cannot be ruled out

Chemicals legislation also applies. Sodium chromate is listed in Annex XIV of the REACH Regulation (entry 22, sunset date 21 September 2017). In the assessment of The Chromate Experts, the reuse of chromate-contaminated insulation or components may therefore constitute a use subject to authorisation.

In parallel, the procedure to transfer the chromium(VI) substances from Annex XIV into a restriction under Annex XVII is under way. A ban on use above 0.01 per cent by weight with an exhaustive list of exemptions has been proposed. The final SEAC opinion is scheduled for December 2026.

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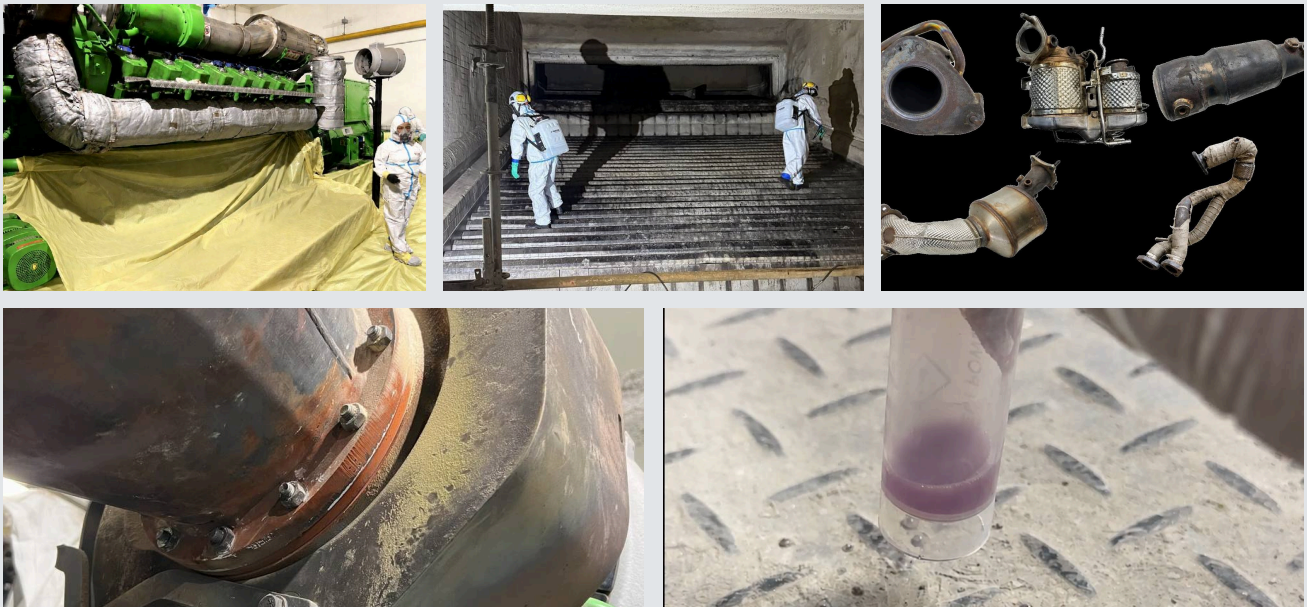
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7. From regulation to implementation

With the regulations, the manufacturers' warnings and the practical evidence, implementation in companies begins. It follows a chain of tasks involving different professional fields.

Step	Task	Professional fields involved
Detect	Identify affected installations, components and activities	Operators, maintenance, occupational safety specialists
Assess	Sampling, speciation, exposure assessment, risk assessment	Experts, occupational medicine
Protect	Zoning, low-dust working, protective equipment, contractor coordination	Maintenance, insulators, workshops, occupational safety service providers
Decontaminate	Treat contaminated components and surfaces, prove effectiveness by wipe samples	Hazardous substance remediation, special cleaning
Dispose	Separate collection, classification, transport, treatment	Waste disposal companies, recyclers
Substitute	Insulation, gaskets and assembly pastes free of calcium and sodium oxide	Manufacturers of insulation, gaskets and pastes, plant engineering
Monitor	Exposure register, occupational medical care, effectiveness control	Company doctors, authorities, accident insurance institutions

This chain gives rise to tasks, services and technical solutions. Decontamination only secures the respective work step; only substitution of the alkaline contact material prevents new formation.



Top: CHP overhaul with delimited work area and protective equipment; overhaul on the grate of a waste incineration plant; typical used parts from the exhaust line of vehicle engines. Bottom: Turbocharger of a CHP engine contaminated with chromates; chromate-containing floor dust in a waste incineration plant.

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8. Further information

The application-specific technical notes of The Chromate Experts (in German) are available on request:

- Possible release of chromium(VI) compounds during maintenance of CHP and cogeneration engines
- Possible release of chromium(VI) compounds during maintenance of CHP engines in sewage treatment plants
- Possible release of chromium(VI) compounds during door openings and overhauls of waste incineration plants
- Chromate in the engine compartment: chromium(VI) compounds on exhaust-carrying components of vehicle engines

The service information of engine, vehicle, gasket and insulation manufacturers is available at www.chromatexperten.de.

References:

TRGS 561, version 4 May 2026, sections 3.3.4 and 5.9.3 [4.1 and 4.2]

TRGS 400, 401, 402, 500, 600, 910; GefStoffV §§ 6, 7, 10a, 15; ArbMedVV; REACH (EC) 1907/2006

BG ETEM, technical publication "Mögliche Chrom(VI)-Exposition", as of 3 August 2026

BG BAU, WINGIS operating instruction "Ausbau chromatbelasteter Dämmstoffe"

INRS, Références en Santé au Travail No. 183 (2025)

About The Chromate Experts

The Chromate Experts is a network with partners in Germany, Switzerland and the United Kingdom. It deals with the formation of chromium(VI) compounds on thermally loaded chromium-alloyed components in industry, power plants, energy generation, waste incineration, shipping and vehicle technology. Its initiator is Markus Sommer, who has worked in high-temperature insulation since 1988.

Contact

Markus Sommer - The Chromate Expert

markus.sommer@chromatexperten.de · www.chromatexperten.de · +49 1525 429 9530