OSHA’s Hexavalent Chromium Standards, etc.

Doug Dunbar, CSP, CIH
EHS Department
Sassaman LLC
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This presentation has been tailored to the applications in the welding industry and focuses on the application of industrial hygiene principles and may discuss OSHA’s intent and general requirements. It is not inclusive of all potential requirements based on specific applications.

Please refer to the applicable standard for a full discussion of the regulatory requirements.
Hexavalent Chromium
Performance Based Standards
OSHA Regulatory Standards

Examples of chemical specific performance based standards

- Lead - 29CFR 1910.1025
- Cadmium - 29CFR 1910.1027
- Hexavalent Chromium
  - General Industry - 29CFR 1910.1026
  - Construction - 29CFR 1926.1126
  - Shipyards - 29 CFR 1915.1026
Chromium and Its Valence States

- Chromium can exist as base metal (Cr 0), divalent chromium (Cr II), and trivalent chromium (Cr III), and hexavalent chromium (Cr VI)
- Trivalent chromium (Cr III) is the most stable state; naturally occurring
- Cr VI is less chemically stable; most compounds are man made
Chromium VI Compounds

- Man-made substances used in industrial applications

- Hexavalent chromium compounds have many varied uses in industry and are often used for their anti-corrosive properties in metal coatings, protective paints, dyes, and pigments.

- Hexavalent chromium can be formed when performing “hot work” such as welding on stainless steel, melting chromium metal, or heating refractory bricks in kilns, or performing hot work on steel structures with chromates in the coatings.
Chromium VI Compounds

- Portland cement contains trace levels of hexavalent chromium
- Formally exempt from the standard
- OSHA has used other general standards provision to enforce protection from overexposure
OSHA PEL

♦ Permissible Exposure Limit (PEL)

8-hour time-weighted average exposure limit (TWA)

Action Level (AL)
0.5 of PEL

5 µg/m³ TWA₈ in the air

2.5 µg/m³ TWA₈ in the air
Routes of Exposure

How Can Hexavalent Chromium Enter the Body?

♦ Inhalation of dusts, mists, or fumes created during processes involving the use of Cr VI compounds or hot processes that cause the formation of Cr VI

♦ Eye or skin contact with powder, dusts, or liquids containing Cr VI
OSHA’s Hexavalent Chromium Standards
Who does the New Standard apply to?

♦ **Scope**
  - General Industry 29 CFR 1910.1026
  - Shipyards 29 CFR 1915.1026
  - Construction 29 CFR 1926.1126

♦ **Are you affected?**
  - Review applications for use of chromium containing materials including surface coatings.
  - Analyze your MSDS sheets for chrome content
OSHA’s Hexavalent Chromium Standards
What you need to know!

♦ Does the New Standard apply to your operations?
♦ What is the Cr(VI) exposure of each potentially exposed worker?
♦ If engineering controls are not immediately available, then protect any worker over the PEL with a respirator!
♦ Plan, evaluate and implement permanent engineering and work practice controls!
♦ The burden of not permanently controlling exposures!
♦ The importance of communications and recordkeeping!
Significant Dates to Remember

- February 28, 2006 - OSHA published the new standard
- May 30, 2006 – Effective date
- Enforced 180 days from the effective date with exceptions
  - Nov 27, 2006 – 20 or more employees
  - May 31, 2007 – less than 20 employees
  - May 31, 2010 - engineering control requirements
OSHA’s Hexavalent Chromium Standards

Exposure Determination

It all starts with determining exposure!

♦ Each employer shall determine the 8-hour TWA exposure for each employee exposed to hexchrome.

♦ Two options for determining employee exposure:
  – Performance-oriented option
    • Objective data
      (Manufacturer physical data and Industry-wide exposure surveys)
    • Historic monitoring data
      (Company specific exposure data)
  – Scheduled monitoring option
OSHA’s Hexavalent Chromium Standards
Exposure Determination

Scheduled Monitoring Option

♦ Purpose:
  – Identify source(s) of exposure.
  – Determine extent and degree of exposure(s) at the worksite.
  – Prevent employee overexposure

♦ Perform initial monitoring of each employee, or establish similar exposure groupings and select “representative” worst case exposure.

♦ Utilize a Certified Industrial Hygienist.
**Monitoring**

*Scheduled Monitoring*

If initial Cr VI concentration is:

- **Below the Action Level**
  - Discontinue monitoring

- **At or Above the Action Level**
  - **Monitor every 6 months**
    - Can discontinue monitoring if exposures are below AL and confirmed

- **Above the PEL**
  - **Monitor every 3 months**
    - Can discontinue monitoring if exposures are below AL and confirmed
Exposure Monitoring

♦ Area Sampling
  - A screening technique to help prioritize monitoring

♦ Employee Sampling
  - Evaluate personal exposures
Methods Used to Maintain Exposures Below the PEL:

- *Engineering controls—such as local exhaust ventilation*
- *Warning signs to demark where an employee’s exposure to Cr VI is at or above the PEL*
- *Hygiene facilities and practices*
- *Protective work clothing and equipment*
- *Respiratory protection*
OSHA’s Hexavalent Chromium Standards
Methods of Control

♦ Substitution: reduce or eliminate fume by changing the welding process and/or procedures

♦ Isolation: enclose or barricade the source

♦ Ventilation: local exhaust ventilation (LEV)

♦ Safe Work Practices: operator technique

♦ Personal Protection Equipment: respirators
  – Until May 30th, 2010
OSHA’s Hexavalent Chromium Standards
Methods of Control

“OSHA has determined that the use of an alternate welding process that reduces fume generation, such as switching from shielded metal arc welding (SMAW) to gas metal arc welding (GMAW) could be effective in reducing a worker’s exposure to hexavalent chromium to a level at or below the PEL.”

OSHA’s Hexavalent Chromium Standards

Methods of Control

Substitution

Generate less welding fume constituent by substituting:

♦ Welding Process
♦ Consumable Type
♦ Gas Selection
♦ Welding Procedure
♦ Waveform Control Technology
OSHA’s Hexavalent Chromium Standards
Methods of Control

**Isolation**

*Place a barrier between employees and the source of exposure.*

♦ **Switch from manual welding to automation and ventilate enclosure.**
OSHA’s Hexavalent Chromium Standards

Methods of Control

OSHA has determined that … “local exhaust systems that capture airborne Cr(VI) near its source and remove it from the workplace . . . is generally preferred to dilution ventilation because it provides a cleaner and healthier work environment.”

Source: OSHA Small Entity Compliance Guide for the Hexavalent Chromium Standards, Page 9, OSHA 3320-10N 2006
OSHA’s Hexavalent Chromium Standards

Methods of Control

Ventilation

Local Extraction

Source Extraction

General Extraction & Ventilation
OSHA’s Hexavalent Chromium Standards
Methods of Control

**Safe Work Practices**

Complement Engineering Controls:

- *Proper operator welding techniques*
- *Proper usage of ventilation systems*
- *Periodic inspection and maintenance*
- *Rotation of employees (to reduce exposure) not allowed except for cross-training and ergonomics*
Welding Processes

♦ Percent fume produced by different welding processes (as % of pounds of consumable used)

- Submerged Arc (SAW) 0.02 – 0.1%
- MIG Wire (GMAW) 0.3 – 0.8%
- Cored Wire (FCAW-GS) 0.8 – 1.5%
- Stick (SMAW) 1.0 – 2.5%
- Cored Wire (FCAW-SS) 1.3 – 4.0%

♦ Estimates indicate SMAW and GMAW on mild steel, stainless steel, and aluminum are performed by 70% of welders
Respirators

Provide respiratory protection when:

- Employee exposure to Cr VI is at, or exceeds the PEL
- Engineering and work practice controls are not sufficient to reduce exposure levels to or below the PEL (Must be in place)
- An employee requests a respirator

Half-Mask P-100 Respirator
OSHA’s Hexavalent Chromium Standards
Personal Protective Equipment

OSHA has determined that “If feasible engineering and work practice controls are not sufficient to reduce employee exposure to or below the PEL, the employer must use them to reduce the exposure to the lowest level achievable. Respirators must then be used to reduce employee exposure to or below the PEL.”

OSHA’s Hexavalent Chromium Standards
Personal Protective Equipment

Respirators

*Exposure determination trigger: > PEL*

- Cannot be used (after May 31, 2010) without implementing engineering solutions.
- Engineering and work practice controls have reduce exposures to the lowest levels achievable but exposure is still above the PEL
- Employee exposure to Cr(VI) above the PEL are less than 30 days per year. (12 consecutive months)
OSHA’s Hexavalent Chromium Standards
Personal Protective Equipment

Hygiene & Clothing

*Exposure determination trigger: Judgment*

- Employer must provide appropriate protective clothing & equipment if needed.
- Employer must make sure they use the clothing & equipment properly.
- Ensure employees with skin contact wash their hands and faces (skin & eye contact)
- Ban eating, drinking & chewing in regulated areas (ingestion)
Hygiene Facilities and Practices

Where airborne exposure to Cr VI is at, or exceeds the PEL

- Change rooms
  - separate storage facilities for PPE and street clothes

- Washing facilities
  - Wash hands and face:
    - at the end of the work shift
    - prior to eating, drinking, smoking, chewing tobacco or gum, applying cosmetics, or using the toilet
  - Employees are required to shower after work and must not leave their work area wearing any protective clothing or equipment worn during their shift
OSHA’s Hexavalent Chromium Standards

Regulated Area

Establishment of a Regulated Area

Exposure determination trigger: > PEL

Regulated area means an “area, demarcated by the employer, where an employee’s exposure to airborne concentrations of Cr(VI) exceeds, or can reasonably be expected to exceed, the PEL.”
OSHA’s Hexavalent Chromium Standards

Housekeeping

Purpose:

*Exposure Determination trigger: Judgment*

– **Surfaces maintained as free as “practicable”**

– **Methods for cleaning surfaces and spills**
  - Do **USE** vacuum HEPA-filter
  - Do **USE** wet methods
  - Do **NOT** use compressed air
  - Do **NOT** use dry methods.

– **Proper disposal of contaminated materials to minimize contact**
Purpose:
Exposure determination trigger:  >AL

♦ The purpose is to:
  – Determine if exposure can occur without adverse health effects.
  – Identify adverse health effects when they occur.
  – Specify who, when, what and how medical surveillance is to be provided.
  – Determine fitness to use PPE such as a respirator.
OSHA’s Hexavalent Chromium Standards

Hazard Communication

Follow the requirements of the Hazard Communication standard; 29CFR 1910.1200

- **Trigger** = Scope of standard applies to you

- **The requirements include:**
  - Methods used to detect Cr(VI) in the workplace
  - Measures employees can take to protect themselves
  - The requirements of the standard
  - The medical surveillance program requirements

- **Training must be provided as often as is necessary**
OSHA’s Hexavalent Chromium Standards Recordkeeping

Purpose

- **Trigger = Scope of standard applies to you.**
- **Assist in identifying workplace-related illness.**
- **Demonstrate employer compliance:**
  - Employee exposure assessment
  - Air sampling data
  - Historical data
  - Objective data
  - Medical surveillance
  - Hazard Communications
OSHA’s Hexavalent Chromium Standards

Recap: **Compliance Dates**

- **Employers with 20 or more employees must comply by** **November 27, 2006.**

- **Employers with 19 or fewer employees must comply by** **May 30, 2007.**

- **Engineering and work practice controls must be in place by** **May 31, 2010.**
OSHA’s Hexavalent Chromium Standards

Action Steps

♦ **Perform the Exposure Determination**
  – Recommend a Professional Industrial Hygienist

♦ **Immediately protect any worker who exceeds regulatory triggers**
  – Provide Respirator, other PPE, Housekeeping, etc.

♦ **Determine the Practicable Control Solutions**
  – Substitute
  – Isolation
  – Ventilate
  – Safe Work Practices
  – Personal Protective Equipment

♦ **Maintain detailed records**
OSHA’s Hexavalent Chromium Standards

Resources:

♦ OSHA Small Entity Compliance Guide

♦ LECO “OSHA Hexavalent Chromium Standards” Brochure
Update: ACGIH NOIC for Manganese
Update: ACGIH NOIC for **Manganese**
Health Effects of Fumes

♦ Manganese - Mn

- Occurs naturally in environment and, at low levels, is essential for maintaining good health
- Prolonged overexposure alleged to cause neurological injury
- Very common component of earth’s crust
- Component in all mild steel products
  - Largest user is steel industry (adds strength and hardness and removes sulphur contamination)
- Ingredient of flux in many SMAW and FCAW electrodes
- Ingredient of GMAW consumables as well
- Current ACGIH TLV® is 0.2 mg/m³
ACGIH Threshold Limit Values – Chemical Substances and Physical Agents

<table>
<thead>
<tr>
<th>Substance (CAS No.) (Documentation date)</th>
<th>TWA</th>
<th>STEL</th>
<th>Notation</th>
<th>MV</th>
<th>TLV® Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,2-Dichloroethane (59-88-7) (1990)</td>
<td>0.002 ppm</td>
<td>—</td>
<td>A7</td>
<td>119.38</td>
<td>Lung cancer</td>
</tr>
<tr>
<td>1,1-Dichloroethylene (106-93-7) (1985)</td>
<td>5 ppm</td>
<td>—</td>
<td>A3</td>
<td>120.81</td>
<td>Chronic, skin, eye, respiratory system</td>
</tr>
<tr>
<td>Chloroform (75-09-2) (1978)</td>
<td>1000 ppm</td>
<td>—</td>
<td>—</td>
<td>154.47</td>
<td>Carcinogenic</td>
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<tr>
<td>Dichloromethane (75-09-2) (1990)</td>
<td>0.01 ppm</td>
<td>—</td>
<td>A4</td>
<td>164.30</td>
<td>Skin, pulmonary system</td>
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<tr>
<td>1-Chloro-2-propanol (122-99-3) and 2-Chloro-1-propanol (79-66-7) (2000)</td>
<td>1 ppm</td>
<td>—</td>
<td>—</td>
<td>64.54</td>
<td>Liver, skin</td>
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</tbody>
</table>

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<th>TLV® Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Chloro-4-methylbenzene (108-86-1) (1990)</td>
<td>10 ppm</td>
<td>—</td>
<td>A1</td>
<td>66.54</td>
<td>Heart &amp; blood</td>
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<tr>
<td>2-Chloroaniline (97-15-8) (1988)</td>
<td>0.1 ppm</td>
<td>—</td>
<td>—</td>
<td>58.53</td>
<td>Cutting fluid</td>
</tr>
<tr>
<td>3-Chloroaniline (97-15-8) (97-15-8)</td>
<td>10 ppm</td>
<td>—</td>
<td>—</td>
<td>138.60</td>
<td>CNS impact, peripheral neuropathy</td>
</tr>
<tr>
<td>4-Chloroaniline (97-15-8) (1987)</td>
<td>100 ppm</td>
<td>—</td>
<td>—</td>
<td>150.59</td>
<td>CNS impact, peripheral neuropathy</td>
</tr>
<tr>
<td>2,4-Dichlorophenol (95-31-7) (1975)</td>
<td>5 ppm</td>
<td>—</td>
<td>—</td>
<td>33.51</td>
<td>Cholinesterase inhibitory</td>
</tr>
<tr>
<td>Chromium (7440-87-0) (1981-90)</td>
<td>0.005 mg/m³</td>
<td>—</td>
<td>—</td>
<td>2.17</td>
<td>Lung cancer</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Element</th>
<th>ADOPTED VALUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chromium (7440-87-0) (1981-90)</td>
<td>0.005 mg/m³</td>
</tr>
<tr>
<td>Iron (6726-06-8) (1972-79)</td>
<td>0.005 mg/m³</td>
</tr>
<tr>
<td>Nickel (7440-02-0) (1982-88)</td>
<td>0.005 mg/m³</td>
</tr>
<tr>
<td>Cobalt (7440-33-0) (1992-93)</td>
<td>0.005 mg/m³</td>
</tr>
</tbody>
</table>

Lincoln Electric
Update: ACGIH NOIC for Manganese

BEI® Development

Proposed metabolic pathways of n-hexane in animals:
- a Isomeric form not specified in original report.
- ? Some investigators have questioned the validity of these pathways.
- b Possibly via 5-hydroxy-2-hexanone.
Threshold Limit Value (TLV®)

- ACGIH term used to express the maximum airborne concentration of a material which most workers can be exposed to daily throughout their working career without adverse health affects.
- Not to be considered as a fine line between safe and unsafe exposures.
- Not a relative index of toxicity
- Intended for use in the practice of industrial hygiene.
- Used as guidelines in the control of health hazards
MANGANESE, ELEMENTAL and INORGANIC COMPOUNDS

CAS number: 7439-96-5 (Manganese)

Empirical formula: Mn

TLV–TWA, 0.02 mg/m$^3$, as Mn, Respirable particulate matter
0.2 mg/m$^3$, as Mn, Inhalable particulate matter

A4 — Not Classifiable as a Human Carcinogen

TLV$^\circledR$ Recommendation

The respiratory tract is the most important portal of entry for manganese in the occupational setting. The inhalation toxicity of manganese is a function of particle dosimetry and subsequent pharmacokinetic events. Particles depositing in the upper respiratory tract and within intrathoracic airways (alveoli and main bronchi) conclude that an eight-hour TWA exposure of approximately 1.0 mg Mn/m$^3$ (total dust) could lead to pre-clinical effects in the nervous system, lungs, and blood of workers exposed for less than 20 ye (Roels et al., 1987b). A male fertility study in the same cohort (Lauwerys et al., 1985) suggested that exposure to 1.0 mg Mn/m$^3$ (total dust) may impair...
<table>
<thead>
<tr>
<th>Health Effects</th>
<th>Exposure Duration (yr)</th>
<th>NOAEL (mg/m³)</th>
<th>LOAEL (mg/m³)</th>
<th>Study Referenced Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory (pneumonia)</td>
<td>NS</td>
<td>3.6 (T)</td>
<td></td>
<td>Lloyd Davies (1946)</td>
</tr>
<tr>
<td>Respiratory (cough, decreased lung function)</td>
<td>1–19 years</td>
<td>0.97 (T)</td>
<td>0.97 (T)</td>
<td>Roels et al. (1987a, b)</td>
</tr>
<tr>
<td>Neurological (decreased reaction time, short-term memory, hand steadiness)</td>
<td></td>
<td>†0.15 (R)</td>
<td></td>
<td>Clewell et al. (2003)</td>
</tr>
<tr>
<td>Hematological</td>
<td>0.97 (T)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male reproduction (decreased fertility)</td>
<td>0.97 (T)</td>
<td></td>
<td></td>
<td>Lauwers et al. (1985)</td>
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<tr>
<td>Respiratory</td>
<td>5.3 years (mean)</td>
<td>0.18 (R)</td>
<td>0.036 (R)</td>
<td>Roels et al. (1992)</td>
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<tr>
<td>Neurological (impaired visual time, eye-hand coordination, hand steadiness)</td>
<td></td>
<td>*0.07 (R)</td>
<td></td>
<td>ATSDR (2000)</td>
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<tr>
<td>Endocrine</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Neurological (decreased reaction time, finger tapping)</td>
<td>1–35 years (2.6 median)</td>
<td>0.14 (T)</td>
<td>0.07 (R)</td>
<td>Iregren (1990)</td>
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<tr>
<td>Neurological (postural sway with eyes closed)</td>
<td>1.1–15.7 years</td>
<td>1.59 (T)</td>
<td></td>
<td>Chia et al. (1993)</td>
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<tr>
<td>Neurological (decreased motor function)</td>
<td>16.7 years (mean)</td>
<td>0.032 (R)</td>
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<td>Mergler et al. (1994)</td>
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<tr>
<td>Neurological (decreased finger tapping, symbol digit, digit span, additions)</td>
<td>1–28 years</td>
<td>NS</td>
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<td>Lucchini et al. (1995)</td>
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<tr>
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<td>12.7 years (mean)</td>
<td>0.051 (R)</td>
<td>0.09 (R)</td>
<td>Gibbs et al. (1999)</td>
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<tr>
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<td></td>
<td>NS</td>
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<tr>
<td>Neurological</td>
<td>11.5 years (mean)</td>
<td>0.097 (T)</td>
<td>0.038 (R)</td>
<td>Lucchini et al. (1999)</td>
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<td>Neurological</td>
<td></td>
<td></td>
<td></td>
<td>MnO₂, Mn₃O₄</td>
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<tr>
<td>Neurological</td>
<td>18.2 years</td>
<td>0.01–0.04</td>
<td></td>
<td>Young et al. (2005)</td>
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</table>
Bench Testing & Exposures Assessment Trials
AWS F1.2 Method – Fume Collection Apparatus
Update: ACGIH NOIC for **Manganese**

- **Summary**

- **ACGIH NOIC Mn TLV**
  - Respirable Mn – from 0.2 mg/m³ to 0.02 mg/m³
- **ACGIH, Scientific Body**
  - Makes TLVs as Guidelines
- **Basis For TLV Changes**
  - Pre-clinical effects (Still controversial)
- **Many welding processes**
  - would require additional controls to Meet the Proposed TLV
- **3rd Comment Period Ends**
  - 7/31/11