Hex Chrome Exposures from Metal Cladding Work in a Boiler

October 2012
Luminant Corporate Safety
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Background Information

• Situation occurred at a lignite plant in Central Texas.
• The plant has two units and the work was done in a 3 year-old boiler which is part of a 580 MW unit.
• The unit has a circulating fluidized bed boiler and the circulating fuel and ash create a lot of wear and tear on the boiler walls.
• The boiler walls were not originally coated when the unit was constructed in 2009.
• Inspections of the boiler had revealed that a significant amount of erosion had occurred since 2009
• A decision was made to have the boiler walls coated with a high-chrome metal cladding during the Spring 2012 outage.
Circulating Fluidized Bed Boiler
Arrowhead Nozzles at Bottom of Boiler
Cladding Process

• The vendor applied the cladding with a high velocity continuous combustion (HVCC) metal spray process.

• The HVCC process involves melting a high-chrome wire inside a hand-held gun and spraying the atomized metal onto the surface.

• Before the tubes are coated they are blasted with a non-silica containing material.

• In order to access the tubing for the blasting and coating multi-level scaffolds are set up throughout the interior of the boiler.
Scaffolding Set Up in Boiler
Blasting of Boiler Tubes in Preparation for Coating
Cladding Application
Close Up of Application Process
Finished Product with Paint
Chromium

A commonly occurring metal

Present in different valence (oxidation) states

- Elemental (does not exist in nature)
- Cr\(^{+2}\) (Divalent)
- Cr\(^{+3}\) (Trivalent)
- Cr\(^{+6}\) (Hexavalent)
  - Water soluble
  - Water insoluble

Valence state and solubility greatly affects toxicity

Can oxidize or reduce depending on conditions

Hex Chrome will reduce from Cr\(^{+6}\) to less toxic Cr\(^{+3}\)
**Hex Chrome Health Effects**

### Routes of exposure
- Skin contact
- Inhalation
- Ingestion

### Trivalent form
- Irritant
- Less toxic than Hex Chrome

### Cancer
- Evidence is primarily from chromate production, chromate pigment & chrome plating; less compelling for welding

### Soluble forms
- Perforation of nasal septum
- Nasal irritation
- Nasal ulcerations
- Asthma
- Bronchitis
- Allergic skin reactions
- Skin ulcers
- Irritant contact dermatitis
Overview of the OSHA Standard

1910.1026 – General Industry
1926.1126 – Construction
1915.1026 – Shipbuilding

A performance oriented standard

 Applies only to the hexavalent form of chromium (Cr⁶⁺)

Exemptions

- Pesticides that contain Cr⁶⁺
- Portland cement
- Where the employer has objective data that a material, operations or process cannot release Cr⁶⁺ at levels that would exceed 0.5 ug/m³ under any expected conditions of use
Exposure Limits and Some Other Requirements

• PEL = 0.005 mg/m$^3$ or 5 µg/m$^3$ as an 8 hour TWA

• Action level (AL) = 0.0025 mg/m$^3$ or 2.5 µg/m$^3$ as an 8 hour TWA

• If results are > PEL, monitoring must be done at least every 3 months

• If results are < PEL and > AL, monitoring must be done at least every 6 months

• If > AL for 30 + days per year, med surveillance is required

• PPE – Skin and Eye Protection if hazard is present

• Change areas & Washing facilities also required

• Training about standard, hazards and protective measures

• Note: These are not all the requirements, consult the standard for more detailed information
Spring 2012 Outage Activities

• Contractor A coated the boiler with a metallic spray that contained a high percentage (20 to 30%) of chrome. The coating process involved melting the wire so it could be sprayed as a liquid.

• The heating process oxidized the chrome metal into hex chrome and the spraying created very high airborne hex chrome levels.

• Contractor A also blasted the boiler before the coating application was done.

• A large containment was placed in the boiler around the spraying and a mechanical exhaust ventilation system was used.
Spring 2012 Outage Activities Continued

- Contractor A support employees wore full-face respirators when in the boiler. Employees wore supplied air blast hoods (Bullard 88 VX) when blasting and supplied air hoods (Bullard CC20) and full-face respirators when spraying / cladding.

- Area air samples in the containment during the spraying had results ranging from about 200 to 5000 µg/m$^3$.

- Personal air samples, collected under the spray hoods had results ranging from 1.2 to 5.5 µg/m$^3$.

- The Protection Factor for the blast hood and spray hood is 1000 so they will protect up to 5000 µg/m$^3$ (1000 x PEL)
Spring 2012 Outage Activities Continued

• Contractor A employees were working on scaffolding which needed to periodically be moved and repositioned.

• The scaffold moving was done by Contractor B and a question was brought up about how much hex chrome exposure Contractor B employees would have when doing this.

• There was no air monitoring data on the exposures so it was not clear as to what type of PPE and training would be needed for Contractor B employees.

• A hex chrome video was shown to Contractor B employees which apparently caused a lot of concern and a number of Contractor B employees walked off the job.
Spring 2012 Outage Activities Continued

• Contractor B hired an Industrial Hygiene consultant to conduct air sampling when the scaffolding was being moved and while it was being cleaned (blown down) prior to its dismantling.

• A crew of Contractor B employees was trained and provided with coveralls and full-face respirators to wear during the scaffolding cleaning and moving.

• The air samples showed hex chrome levels during the blow down ranged from about 0.2 to 16 µg/m³.

• Hex chrome levels during the scaffold moving ranged from about 0.4 to 20 µg/m³.
2012 Outage – Scrubber

• In addition to the boiler coating work, a large portion of the bottom of a scrubber was cut out for repairs.

• The scrubber was made of stainless steel and the cutting was done by an arc gouger.

• A wooden deck “dance floor” was installed above the cutting area so contractors could work on the spray nozzles. The dance floor was not air tight.

• Mechanical ventilation- air horns were placed on the level of the scrubber to force air in and pull it out.

• Area hex chrome air samples were collected on the dance floor and next to the air horns. No samples were collected on the contractors running the arc gougers.
2012 Outage – Scrubber

• The hex chrome results collected during the scrubber arc gouging work ranged from below detectable limits (less than 0.27 µg/m$^3$) to about 0.3 µg/m$^3$. 
Conclusions

• Contractor A’s employees had proper respiratory protection during cladding (coating) process.

• Exposures during scaffold cleaning and moving ranged from less than the AL of 2.5 µg/m³ to as much as 4 times the PEL of 5 µg/m³.

• Based on these results employees need to wear P100 filtering face piece respirators (dust masks) or half-mask respirators with P100 filters when cleaning and moving the scaffolding.

• Employees also need coveralls and access to showers and change rooms.
Conclusions Cont.

• Metallic spray coating produces much more hex chrome than arc gouging does.

• Air sampling data is very important to select respirators, PPE and for regulatory purposes.

• When planning jobs that involve spray coating, arc gouging, welding or oxy acetylene cutting with high–chrome materials its important to consider the hex chrome exposures to all persons in the work area.

• Only necessary personnel should be in the work area when hex chrome is being generated. When possible work should be scheduled to limit the number of personnel.

• Ventilation should be used as much as possible to reduce exposures.
Conclusions Cont.

• Employers need to decide if employees need medical surveillance- will employees be exposed > AL for more than 30 days per year?

• Employees need to be trained about hazards of hex chrome and the proper control methods.

• The training should be appropriate for their tasks. The video shown to Contractor B Employee’s pertained to welding and not incidental exposures such as cleaning and moving scaffolding.

• Environmental compliance specialists should be consulted during the planning since the waste material may contain hex chrome that can effect the disposal methods.
Any Questions?
Thank You