Hexavalent Chromium Exposures During Hot Work Activities

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AIHce 2007, Podium 108
Project Need

• New OSHA standard requiring initial exposure determination
• Focus on hot work activities
• Historical data review found:
  – Most data analyzed for total chrome
  – Most data had insufficient task detail
  – Many had insufficient level of detection
• Focus on large projects to get full shift samples
• Needed “Objective data” that could be shared
Project Details

• ICU Environmental Health & Safety
• Five distinct projects (Oct 05’ to Jun 06’)
  – 3 Refinery turnarounds
  – 1 Petrochemical unit turnaround
  – 1 New construction (refinery unit)
• 271 total samples
  – 63 samples at or above OSHA Action Level (2.5 \( \text{ug/m}^3 \))
  – 51 samples at or above OSHA PEL (5 \( \text{ug/m}^3 \))
Sample Methodology

- Sampling and analysis according to NIOSH 7605 at AIHA accredited lab
  - (OSHA 215 Ver.2 not available)
- PVC filters at 1 liter/min
- Sample media placed outside PPE/Hood
- Most samples were full shift (8+ hours)
  - Samples calculated as TWA with no shift correction
Key Factors in Hot Work Exposure

- Base Metal
- Welding Process
  - Type
  - Parameters – voltage, amperage, carrier gas, etc.
- Task performed
- Electrode/Wire
- Type of work environment
- Ventilation (type and how much)
- Vessel Type (openings, internals, etc)
- Other activities in area
# API CrVI Characterization Project Data Sheet

## Sample Number: __________________________  Sample Date: __________________________

### Task Monitored:
- Welder/Cutter
- Helper
- Fitter
- Rigger
- Scaffold Builder
- Other tool-user
- Other non-tool-user

### Site:

### Worker Name:

### Worker ID:

### Worker Employer:

## Filler/Electrode:

### Media Placement
- [ ] Inside
- [ ] Outside

### Monitoring Period:

### Sample Type:
- [ ] Area
- [ ] Personal

### Respiratory Protection Used

### Comments: (Include weather conditions and other PPE used)

## Base Metal:
- Chrome Steel 7%
- Chrome Steel <2.5%
- Chrome Steel 12%
- Chrome Steel 6%
- Chrome Steel 6%
- Carbon Steel
- Galvanized Steel
- Inconel
- Monel
- Other Alloy Steel
- Stainless Steel
- SS 308-310L; 329; 422; 904L
- SS 400 to 420
- SS 200-304; 316-321; 330-347; 430-440
- Unknown

## Hotwork Process:
- GAC
- FCAW
- GMAW (MIG)
- Grinding
- GTAW (TIG)
- Not Specified
- OFC (Torch Cutting)
- PAC
- PAW
- SMAW (Stick)

## Environment

### Work Environment:
- Wide Open Area
- Open Area with Restricted Access
- In a Shop
- Temporary Fab Tent
- Spark Enclosure
- Inside Vessel
- Outside Vessel

### Vessel Type:
- Horizontal
- Vertical
- Spherical
- Furnace
- Storage Tank

### Ventilation Type:
- Local Exhaust
- Mechanical
- Natural

### Workspace Volume Estimate (ft³):

### Local Exhaust Estimate (cfm):

### Dilution Ventilation Estimate (cfm):

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Types of Hot Work Included

- Carbon Arc Cutting (CAC or arc gouging)
- Flux Cored Arc Welding (FCAW)
- Gas Metal Arc Welding (GMAW or MIG)
- Grinding
- Gas Tungsten Arc Welding (GTAW or TIG)
- Oxyfuel Gas Cutting (OFC or torch cutting)
- Shielded Metal Arc Welding (SMAW or stick)
Overview by Type of Hot Work
Base Metal

- Carbon Steel
- Chrome Steel
  - <2.5%, 5%, 9% and 12%
- Galvanized Steel
- Inconel (nickel-based alloy typically high in Cr content)
- Stainless Steel
  - 11-13%, 17-19%, >19% and Unspecified
Overview by Base Metal

- **Carbon Steel**: Total 66, Number > PEL 2, Number > Action Limit 3
- **Chrome Steel**: Total 54, Number > PEL 6, Number > Action Limit 9
- **Galvanized Steel**: Total 22, Number > PEL 0, Number > Action Limit 0
- **Inconel**: Total 49, Number > PEL 9, Number > Action Limit 12
- **Stainless Steel**: Total 80, Number > PEL 34, Number > Action Limit 39
Overview by Work Task

78% Welder/Cutter
Overview by Work Environment

- In a Shop
- Inside Vessel
- Open Area with Restricted Circ
- Outside Vessel
- Spark Enclosure
- Temporary Fab Tent
- Wide Open Area

46% Inside Vessel
Carbon Arc Cutting Results

• **Observations**
  – Small data set, but results indicate potential to exceed PEL for base metals with significant chrome

• **Statistical Conclusions**
  – None made
Carbon Arc Cutting Results

- <0.5 ug/m³ Exclusion Limit
- 0.5 to <2.5 ug/m³ Action Level
- 2.5 to <5 ug/m³ PEL
- 5 to <50 ug/m³ 10x PEL
- 50 to <125 ug/m³ 25x PEL
- 125 to <250 ug/m³ 50x PEL
- 250 to <500 ug/m³ 100x PEL
- 500 to <5000 ug/m³ 1000x PEL
- ≥5000 ug/m³ >1000x PEL
Flux Cored Arc Welding Results

• Observations
  – All samples on stainless steel
  – 1 of 9 above PEL, but this was only sample in a confined space

• Statistical Conclusions
  – Likely to exceed PEL \((UCL_{1.95\%} > 20\%)\)
    • FCAW on stainless steel outside

95% confident that 20% or more of the exposure results will be above the PEL
Flux Cored Arc Welding Results

 ug/m³

<0.5
0.5 to <2.5
2.5 to <5
5 to <50
50 to <125
125 to <250
250 to <500
500 to <5000
≥5000

Stainless Steel
Gas Metal Arc Welding (MIG) Results

- **Observations**
  - All samples on stainless steel and Inconel
  - Based on number of samples taken, MIG had highest percent exceeding PEL

- **Statistical Conclusions**
  - Likely to exceed PEL (UCL $1.95\% > 20\%$)
    - GMAW on stainless steel inside vessel
  - Likely to be below Action Limit (UCL $1.95\% < 20\%$)
    - GMAW on Inconel inside a vessel
Gas Metal Arc Welding (MIG) Results

- **Gas Metal Arc Welding (MIG) Results**

- **MIG weld overlay**
Grinding Results

• **Observations**
  – All samples above exclusion level (0.5 ug/m3) were on stainless steel
  – All samples above PEL were in confined space with concurrent welding

• **Statistical Conclusions**
  – *Likely to be below Action Limit (UCL 1.95% < 20%)*
    • Grinding on carbon steel outside
Grinding Results

<table>
<thead>
<tr>
<th>Particle Size (um)</th>
<th>Carbon Steel</th>
<th>Chrome Steel</th>
<th>Galvanized Steel</th>
<th>Inconel</th>
<th>Stainless Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;0.5</td>
<td>14</td>
<td>12</td>
<td>6</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>0.5 to &lt;2.5</td>
<td>10</td>
<td>8</td>
<td>5</td>
<td>3</td>
<td>3</td>
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<tr>
<td>2.5 to &lt;5</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>5 to &lt;12.5</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
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<tr>
<td>12.5 to &lt;25</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>25 to &lt;50</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>50 to &lt;500</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
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<tr>
<td>500 to &lt;5000</td>
<td>1</td>
<td>0</td>
<td>0</td>
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<td>0</td>
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<tr>
<td>≥5000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

 ug/m3
Gas Tungsten Arc Welding Results

- **Observations**
  - Only 1 of 18 on stainless steel above Action Level
  - 12 of 38 on Inconel above AL, all in confined space

- **Statistical Conclusions**
  - Likely to exceed PEL (UCL 1.95% > 20%)
    - GTAW on Inconel inside vessel
  - Likely to be below Action Limit (UCL 1.95% < 20%)
    - GTAW on chrome steels outside
    - GTAW on stainless steel inside vessel
Gas Tungsten Arc Welding Results
Shielded Metal Arc Welding Results

• **Observations**
  – Only 1 of 44 on carbon steel above PEL
  – All galvanized(22) below PEL
  – 10 of 16 on stainless steel above PEL

• **Statistical Conclusions**
  – **Likely to exceed PEL** \( (UCL_{1,95%} > 20\%) \)
    • SMAW on stainless steel inside vessel
  – **Likely to exceed Action Limit** \( (UCL_{1,95%} > 20\%) \)
    • SMAW on chrome steel outside
  – **Likely to be below Action Limit** \( (UCL_{1,95%} < 20\%) \)
    • SMAW on carbon steel regardless of environment
    • SMAW on galvanized steel outside
Shielded Metal Arc Welding Results

- Carbon Steel
- Chrome Steel
- Galvanized Steel
- Stainless Steel

 ug/m³
Overall Summary

• Some overall observations could be made –
  – 85% of the results > Action Level were inside a vessel
  – Except for SMAW inside a vessel, carbon steel tasks are likely to be < Action Limit
  – Work on galvanized metal appears likely to be < Action Limit (no confined space data was collected)
  – Grinding by itself does not appear to be a significant exposure issue
  – With the exception of GTAW, hot work on stainless steel appears likely to be > Action Limit

• Much more data is needed
Concerns with Data Results

• Delay in sample analysis may have resulted in lower results
• Difficult to classify the task
  – Mixed metal work (weld overlay)
  – Mixed welding processes (Root pass with TIG; cap with SMAW)
  – Multiple activities in work area affecting worker’s exposure
Amendment to Original Report

• Fifteen GMAW(MIG) samples characterized as work on carbon steel have been changed to stainless steel
• Work on a carbon steel vessel, but involved a weld overlay of 309 stainless using E309 welding rods
Questions?

Report and data file available from API:

**API Publication 4629 rev.2**

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