Airborne Exposure to Hexavalent Chromium Associated With Welding in the Electric Utility Industry

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OSHA Standards

- OSHA comprehensive standard on hexavalent chromium established in 2006
- CFR 1910.1026 – General Industry and Shipyards
- CFR 1926.1126 - Construction
- Establishes new PEL and action levels
  - PEL = 5 µg/m^3
  - Action level = 2.5 µg/m^3
- Requires exposure determinations
- Exposure controls are required – feasible engineering controls must be implemented by 2010
- Welding and torch cutting on chromium containing metals can result in formation of hexavalent chromium

Exposure Determination

- Measure airborne exposures by traditional methods:
  - OSHA method ID-215
  - Welding fume air sampling conducted inside welding helmet
- OSHA standard allows for the use of "objective data" to evaluate exposures
  - Data that represents what workers will encounter that resemble similar conditions

Objective Data - Defined

Objective data means information such as air monitoring data from industry-wide surveys. The data must reflect workplace conditions closely resembling the processes, types of material, control methods, work practices, and environmental conditions in the employer's current operations.

OSHA – Interpretation of "Objective Data"

- Where objective data are used to satisfy the exposure determination requirement, the employer must establish and maintain an accurate record of all the information it relied on. This record must include: the **specific chromium-containing material in question; the source of the objective data; the testing protocol and results of testing or analysis of the material that releases chromium (VI); a description of the process, operation, or activity involved and how the data support the determination; and any other data relevant to the process, operation, activity, material, or employee exposures** (71 *FR* 10370).

OSHA – Interpretation of "Objective Data"

- Since objective data may be used to exempt the employer from provisions of the standard or provide a basis for selection of respirators, it is critical that this determination be **carefully documented**. Reliance on objective data is intended to provide the same degree of assurance that employee exposures have been correctly characterized as air monitoring would have. Records must demonstrate a reasonable basis for the underlying exposure determination (71 *FR* 10370).

OSHA – Interpretation of "Objective Data"

- OSHA's term **"closely resemble"** that appears in this standard's definition for both **"objective data"** and "historical monitoring data" (note that historical data may be used as objective data) in the standard's paragraph (b) has been defined in other standards as circumstances where the major workplace conditions which have contributed to the levels of historic exposure are no more protective than in the current workplace. OSHA's intent is to allow data reflecting past exposures to be used to predict current exposures only when the conditions of the earlier job were not more protective, i.e., employees were not better trained, work practices were not used more consistently, and no more supervision was present (reference 59 *FR* 40977, 29 CFR Parts 1910, et al., *Occupational Exposure to Asbestos; Final Rule*, August 10, 1994).

OSHA – Interpretation of "Objective Data"

- The burden is ultimately on the employer to show that the objective data comply with the requirements of the standard. OSHA's intent is to allow employers the greatest possible flexibility in selecting methods used to determine employee exposures to chromium (VI), so long as the methods used are accurate in characterizing employee exposures (71 *FR* 10342).

Gathering Data

- We are gathering welding fume hexavalent chromium exposure data from electric utilities (and other industries) to build a robust data base
- Task specific data
- Inputting into data base to allow for organizing, grouping, combining and analyzing
- Can be used to predict exposures and dictate exposure controls
- Can be used to serve as objective data, limiting (or completely eliminating) the need for future air sampling and analysis
- Will serve to help identify need for and feasibility of engineering controls

Welding – Hexavalent Chromium Data

- Steps in the process
  - Gathering data
  - Verification and quality assurance
  - Entry into data base
  - Statistical analysis
  - Identifying data gaps

Welding – Factors Affecting Hexavalent Chromium

- Welding or cutting process
- Chromium content in base metal
- Chromium content in welding consumable
- Worker orientation to welding activity
- Job Description
- Ventilation
- Arc time
- Voltage

Types of Welding/Cutting Processes

- Shielded Metal Arc Welding (SMAW or Stick Arc)
- Gas Metal Arc Welding (GMAW or MIG)
- Gas Tungsten Arc Welding (GTAW or TIG)
- Flux Cored Arc Welding (FCAW)
- Submerged Arc Welding (SAW)
- Plasma torch cutting
- Torch Cutting
- Arc Gouging
- Others (e.g. Plasma Arc, Electrogas, etc.)

Chromium Content in Base Metals

- Categorized into 5 groups
  - Very High = >30%
  - High = 20 to 30% (e.g. 314 and 329)
  - Medium = 5 to 19.9% (e.g. 304 and 316 SS)
  - Low = <5%
  - None

Chromium Content in Consumables

- Typical consumables include welding rods, welding wires, and flux materials
- Categorized into 5 groups
  - Very High = >30%
  - High = 20 to 30%
  - Medium = 5 to 19.9%
  - Low = <5%
  - None

Environmental (Ventilation) Conditions

- High = Outdoor or with some active ventilation (local exhaust, directed dilution ventilation), no observed lingering plume
- Moderate = good ventilation (some lingering plume present), e.g. indoors with only natural ventilation
- Low = Confining work area with visible accumulated fume present)
- LAV = Local exhaust ventilation used (if available describe equipment or set-up)
- Unknown
- Variable = Variable ventilation

Orientation to Fume

- Welding process is above the waist
- Welding process is below the waist

Job Description

- Welder
- Helper/observer

A Lot of Data is Needed

- Approximately 1750+ permutations per job description
- Some welding types and conditions are common:
  - SMAW, GMAW and GTAW
  - Low and medium chromium content in base metal and consumables (304 and 316)
  - High and Moderate ventilation (open work areas indoors is most common)

Data Gathering

- We have received data from 5 utilities.
  - This represents approximately 1650 air sampling results
  - About 500 data points (about 1/3 of what we have been provided) will be useful for our data base
  - Typical problems with this data that excludes it from our use:
    - Insufficient information (e.g. no welding type identified, no information about welding consumables, no information about where the sampler was located [breathing zone under hood or elsewhere], no information about the environment [inside, outdoors, confined area, etc.])
    - Air samples collected during multiple activities (e.g. GTAW and SMAW done sequentially)

Data Gathering

- Most data we are using has information about welding type and chromium content in consumable, as well as general ventilation conditions
- Breakdown of data entered based on welding type:
  - SMAW: 76%
  - GTAW: 11
  - GMAW: 9
  - FCAW: 4
  - Plasma cut: 1
  - Air gouge: 5

Hexavalent Chromium Airborne Concentration Determinants

- There are numerous factors that affect airborne hexavalent chromium concentrations from welding fume
  - The chromium content in the consumable material (rod, wire)
  - The degree of ventilation
    - Local exhaust and dilution ventilation can drastically lower welding fume concentrations

Preliminary Results – SMAW, Low & Medium Chromium Content in Consumable (Welding Rod)

Concentrations in µg/m³

Chromium Content in Consumable	Ventilation	n	Range	Mean	Geometric Mean	% Above PEL
Low	All conditions	71	<0.03 – 22	2.3	0.64	12.6
Low	Low	8	0.06 – 0.85	0.39	0.15	0
Low	Medium	39	<0.06 – 22	2.52	0.71	18
Low	High	8	<0.03 – 17	2.54	0.77	8
Medium	All	10	<0.1 – 28	11.3	4.1	30

Preliminary Results – SMAW, Low & Medium Chromium Content in Consumable (Welding Rod)

Chromium Content in Consumable	Ventilation	n	Concentrations in µg/m³ Range	Mean	Geometric Mean	% Above PEL
High	All conditions	44	0.06 – 330	35.6	3.93	45
High	Low	9	<0.7 – 261	67.1	25.3	78
High	Medium	13	0.06 – 174	22.3	1.26	23
High	High	22	0.12 – 330	31.9	3.91	45

Preliminary Results – Other Welding Types

Concentrations in µg/m^3

Welding Type	Chromium Content in Consumable	n	Range	Mean	Geometric Mean	% Above PEL
GMAW	High & Medium	19	0.39 – 52	7.7	3.4	50
GTAW	High, Medium & Low	31	<0.2 – 1.8	0.94	0.81	0
Arc Gouging	High & Medium	18	4.6 – 105	57	50	96
FCAW	High & Low	9	0.72 – 660	262	23	55

Using this Data

- As the data base grows, the compiled information can be used to predict possible exposures
  - Can be used to replace air monitoring
  - Can help predict the need for exposure controls
  - Should be useful in evaluating the use of engineering controls

Conclusions

- **WE WANT YOUR DATA** – see me or email jhicks@exponent.com
- The more data we have, the more robust is the data base and the analyses that can be conducted