Session 2: Silica Sampling

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Requirements

- Must assess the 8 hour TWA exposure of each employee who is or may be reasonably expected to be exposed to RCS above the AL
  - Each shift
  - Each job classification
  - Each work area
- Representative sampling is allowed
- Assessments are not one time events
- Specific methods must be followed
- Employees must be notified of the results
- Employees or their representatives are allowed to observe
- Results are used to determine what other aspects of the Standard apply
- Frequency of sampling after the initial assessment
  - If a job’s exposure exceeds the PEL, sampling must be repeated for these jobs every quarter
  - If a job’s exposure is below the PEL but above the Action Level, sampling must be repeated for those jobs every 6 months
You have to live with the data you get. Plan carefully and execute correctly!
Who Must Be Assessed?

• Each employee who is or may reasonably be expected to be exposed to respirable crystalline silica at or above the AL in accordance with either the performance option or the scheduled monitoring
  • This is regardless of whether or not a respirator is used

• “Employers should not be required to conduct assessments when employee exposures are only likely to exceed the AL during a foreseeable, but unexpected event”
  • Note-this does not include equipment malfunctions or other unexpected events when it is not reasonable to expect that exposures could remain below the AL

• What about short duration, intermittent tasks?
  • Not exempt from an assessment

• For anyone required to wear a respirator
  • 1910.134 requires an exposure assessment before employees are required to wear a respirator
Performance Option

• Use any combination of air sampling data and objective data

• Examples
  ▪ Different shifts
    o If there are no differences in exposures for a job task/classification, then 2\textsuperscript{nd} employee can be classified the same as the 1\textsuperscript{st} employee who was sampled
  ▪ Use of exposure ranges
    o Determine who should be in a medical surveillance program
    o Properly select respirators for those in a exposure group
  ▪ Data from direct reading instruments
Representative Sampling

“Representative exposure sampling is permitted when several employees perform essentially the same job on the same shift and under the same conditions”

If employees are engaged in similar work and have exposure to RCS that is of similar duration and magnitude, then data from the employee(s) reasonably expected to have the highest exposure can represent all of these employees.

This means you have to carefully choose employees you think might have the highest exposures.
Potential Pitfalls with Representative Sampling

• Employee variations
  ▪ Employees move around to do different tasks with different exposures during shift
  ▪ Movement may not be the same every day or be the same between employees

• Part variations
  ▪ Size & configuration of castings
  ▪ Tools/equipment used
  ▪ Special handling requirements

• Task variations
  ▪ Cleaning/housekeeping work
  ▪ Maintenance activities
  ▪ Repair work

• Equipment variations
  ▪ Leaks
  ▪ Ventilation
Without observations and good data gathering at the time of the sampling, you can’t make accurate judgements about what a sample represents.
Planning

• Make sure jobs/tasks most likely to create exposures over the AL are assessed
  • If you don’t have air sampling data can you confidently say you know the exposures are less than the AL?
  • Review past data

• Sampling options
  ▪ Sample every job OR
  ▪ Do representative sampling accounting for variations in a job classification
    o If you know a job classification is likely to have a lot of variation, plan to collect more samples

• Determine who is going to conduct the sampling
Past Data-Can You Use It?

• There must be context to the numbers
• The sampling must have been done correctly
  • Respirable sampling
  • Personal breathing zone
  • TWA assessments
  • Correct lab method
• Need to be able to extract/convert data under the old PEL formula into respirable silica
• Data must represent current workplace conditions
• If it is quality data, it can be used to categorize jobs/tasks and identify data gaps
• If it is not quality data or if there are gaps or the past data does not represent the present exposures, you need to do new assessments
Common Problems with Old Data

• The data doesn’t include respirable silica concentrations (this will be discussed tomorrow)

• If the formula to calculate the PEL was used, was it compared to the proper analyte (e.g. respirable dust)?

• There is no description of the sampling method used so it may not be clear …..
  - If a size selective device was used at all or
  - What type of device and flow rate was used

• Samples did not assess the full shift exposures or TWAs were not correctly calculated and/or interpreted

• Important contextual info is missing
  - Employee name
  - Specific job performed during the sampling period
  - Information about ventilation, products processed, unusual conditions etc.
Where Do You Start?

• Identify tasks within your foundry that are likely to have the highest potential for RCS exposures (see following slides)
  • In general, the more manual the task, the greater the potential for dust exposure

• Identify products that may result in greater RCS exposure and try to sample when these are run
  ▪ Large castings
  ▪ Castings with cavities
  ▪ Casting requiring a lot of manual, internal cleaning work
  ▪ Castings with a lot of sand burn-in
  ▪ Castings requiring a lot of manual handling

• Identify if there are jobs/tasks that might be done off-shift or on weekends that could have significant exposure to RCS
Jobs/Tasks Likely to Be Over the AL

- Ladle/furnace knockout & reline or furnace gunning
- Post pour, pre-blast tasks
  - Manual shakeout handling
  - Casting sorting
  - Despruing/degating
- Blasting
- Manual casting cleaning
- Sand system
  - Cleaning
  - Manual additions
- Core room
  - Finishing
  - Coremaking with leaks/spills
  - Clean-up
- Molders
- Maintenance tasks (highly dependent on what work is done)
- Non-sand foundries
  - Knock-out operations
  - Die prep if silica containing coating/washes are used
Jobs/Tasks Less Likely to Be Over the AL

- Scrap handling
- Furnace related tasks (unless employees also do refractory related work)
- Pattern related work
- Material handling (dependent on tasks performed)
- Non-sand foundries (investment casting, permanent mold and centrifugal casting)
  - Most all tasks except for ones on previous slide
Keep in Mind….

• Jobs with typically lower exposure can be effected by fugitive dust
  ▪ Look at potential sources of fugitive dust emissions, the direction air generally travels and determine if there are employees who could be exposed by being in the path of the dust
  ▪ Sources of fugitive dust include
    o Sand transfer conveying systems
    o Sand or mold dumps
    o Sand mixing systems
    o Leaky dust collectors or blasters
    o Poorly controlled point dust sources

• Intermittent tasks with high dust emissions can create bystander exposure
  ▪ Refractory work
  ▪ Housekeeping tasks
Requirement to Assess Each Job Classification

• OSHA requires that each job classification be assessed
• Job title alone may not be the best way to look at this—you could miss significant exposures
• Go through your foundry and break up the job titles or departments into meaningful classifications based on job duties and tasks performed
Exposure Variability

• Be careful about making decisions based upon a small number of samples

• Industrial hygiene data is inherently quite variable

• Rules of thumb
  - If you are over a limit, you are over the limit
  - If you are 50% of a limit, there is a very good chance on other days, you will exceed the limit
  - If you are between 10-50% of a limit, the odds of being over the limit decreases BUT you can’t be assured that it will be under the limit during every sampling episode
  - If you are less than 10% of the limit, the odds of being over the limit are low, HOWEVER, even this is dependent on knowing how representative that data point is
Exposure Variability-OSHA’s Worldview

• “In general industry, most operations are at a fixed location and involve manufacturing processes that remain relatively constant over a work shift”.

• One impact of variability
  • OSHA “recognizes” that it may measure silica exposures on a day when the PEL is exceeded due to “unforeseeable, random exposure variations”.
    ▪ If the employer has a long-term, body of data, it will be reviewed but they will ask is it representative?
    ▪ If it can be shown that OSHA’s measurement may be unrepresentatively high”, OSHA will likely reinspect
    ▪ Citations may not be issued but the “employer must demonstrate that the inspector’s one-day sample is unrepresentative of normal exposure levels. In most cases, this demonstration would consist of a series of full shift measurements representative of the exposure of the employee under consideration. These measurements should consist of all valid measurements related to the employee under consideration taken within the last year and should show that only on rare occasions could random fluctuations result in TWA concentrations above the PEL”.
      ▪ It is to your benefit to have high quality data to deal with this
Who Does the Sampling?

• Use a “free” service
  ▪ OSHA Consultation programs
  ▪ Insurance companies
  ▪ The quality of work performed is highly variable

• Use an IH Consultant
  ▪ CIHs (ABIH Certified Industrial Hygienist), IHs, IH Tech
  ▪ The quality of work performed is highly variable

• In-house capabilities
  ▪ Need to devote the time to collect quality data
  ▪ Need to develop the necessary skills
  ▪ Need to obtain necessary sampling and calibration media and select a laboratory
Ask Questions of Those You Hire!

- What experience does the person have sampling silica and working in foundries?
- Who will actually perform the work and what experience does he/she have?
- What silica sampling methods are used? (type of size selective device used, media, calibration, AIHA Accredited laboratory used)
- How does he/she identify who to sample?
- Ask for a description of how they spend their time during a survey
- What information is included in the IH report?
Respirable Dust Sampling

• Collection methods separate particles by size so that “only” particles considered to be respirable end up on the media sent to a lab for analysis however this is flowrate dependent

• Respirable dust commonly refers to particles less than 10 microns in size

• Size collection criteria are also defined by their 50% cut point which is the particle diameters at which 50% of the mass is collected
  ▪ A sampler’s flow rate is optimized to achieve this criteria
  ▪ In the Standard, OSHA adopted the ISO/CEN convention where the 50% cut point is 4 microns; the “old” cut point was 3.5
  ▪ Most samplers tend to over-sample small particles and under-sample large ones at the optimized flow rates
  ▪ Any sampler that meets the ISO/CEN criteria can be used
  ▪ ISO/CEN samplers will capture “somewhat” more particles-OSHA estimates this amount to a 25% or less difference in results which is does not consider to be a big deal
Sampling

- You need something to suck air (a pump)
- You need something to collect the dust (a filter)
- You need to measure how much air went through the collection device
- You need a way to analyze the sample
Sampling Equipment

• Something to suck the air through the collection device
  - Personal air sampling pump
  - For RCS sampling, “high” flow pumps (capable of sampling at the correct flow rates) are used
  - Tubing to connect the sample collection device to the air sampling pump
  - Chargers for the batteries

• Something to collect the samples
  - Must be size selective
  - Must use the correct flow rate

• A calibrator to measure the air flow rate
  - Used to set the flow rate through each sampling device and check it when sampling is complete
  - You need to know how fast the air is flowing through the collection device
  - This, along with the number of minutes the sample lasted, will provide the volume of air, in liters, that went through the collection device
  - It must cover the flow range you are sampling at
Personal Air Sampling Pumps
Calibration

• While many modern pumps have flow rates on the display, internal sensors an drift over time. Verifying the flow rate is an essential step.

• Labs may calibrate pumps before shipment & check flow rate when they are returned.
  ▪ Not ideal; need to make sure the lab is calibrating the pump using the same size selective device you are using

• Field calibration is the best practice
  ▪ Filters have a pressure drop and this must be accounted for
  ▪ Precision calibrated flow meters
  ▪ Electronic calibrators

• All calibrators must be traceable to a primary calibration unit and should be recertified on an annual basis

• Adaptors may be necessary to connect the calibration device to the sampling device (SKC PPI & Aluminum cyclone).
Size Selective Devices

SKC Aluminum Cyclone
Respirable Flow Rate= 2.5 lpm
Uses a 3 piece pre-weighed PVC filter cassette

Dorr Oliver Cyclone
Respirable Flow Rate=1.7 lpm
Uses a 2-piece pre-weighed PVC cassette

SKC PPI Sampler
Respirable Flow Rate=2 lpm
Loaded with a pre-weighed PVC filter

SKC GS3 Cyclone
Respirable Flow Rate=2.75 lpm
Uses a 3 piece cassette
Breathing Zone Sampling

• Near the point where the employee breathes

• Sample *collection* devices should be placed in the BZ
  ▪ Reality-sometimes this can be a real challenge

• If the employee is wearing a respirator, the sampling device goes outside of it
  ▪ Reality-it can be a challenge to keep the sampling device outside of a hood/shroud AND keep the device in the BZ
Where Do You Get These Things?

• Pumps, cyclones & calibrators
  ▪ IH equipment rental companies
  ▪ Many analytical labs have free loaner pumps, cyclones and flow meters
  ▪ Purchase your own

• Sample media
  ▪ Obtain these from the lab you are using
  ▪ If you return the filters to the lab there is generally no charge except for certain types of samplers (SKC PPIs)
Sample Analysis

• The OSHA method (OSHA ID 142) is a 2 step process
  ▪ First the sample is weighed (gravimetric step)
  ▪ It is then further analyzed via X-ray diffraction to measure the silica content; this method is very specific for crystalline silica and can distinguish between quartz & cristobalite

• There have been concerns expressed about interferences for other materials, however, good labs are able to deal with this

• Limits
  ▪ The Limit of Quantification (LOQ) is the lowest amount of analyte that can be reliably quantified in a sample
    o The LOQ for quartz using OSHA ID 142 is 10 µg
  ▪ The Limit of Detection (LOD) is the smallest amount of an analyte that can be detected with acceptable confidence that the instrument response is due to the presence of the analyte
  ▪ These limits can vary from lab to lab
Sampling Errors

• Sampling method errors occur at the collection and analytical stages
  - Pump flow rate consistency (typically expected to be about 5%)
  - Analytical errors (estimated to be about 6%)
  - This does **not** include errors associated with doing the sampling incorrectly

• SAE (Sampling & Analytical Error)
  - Used to determine whether a sample may be over an exposure limit
  - For OSHA collected samples, the SAE is 0.17
    - The PEL X the SAE is added to the PEL; this value is compared to the sample result to determine compliance
    - Using this approach, a sample would have to exceed 58.5 µg/m³ to have definitively exceeded the PEL
  - The SAE will vary by lab
TWA Calculations

• TWAs in OSHA’s world apply to a 480 minute (8 hour) time period
• Getting a 480 minute sample is not as easy as it sounds!
  ▪ Time lost at beginning and ends of shifts setting up samples or if equipment is removed at breaks
  ▪ Equipment problems
  ▪ Employee movement

• TWAs can be calculated to cover 2 scenarios
  ▪ Multiple samples collected for a job during a hour shift (segmental samples)
  ▪ Sample times are less than 480 minutes

▪ Calculating a TWA using the OSHA formula is not easy
Example #1-480 minute time period covered
RCS Exposure for 210 minute sample = 60 µg/m³
RCS Exposure for 270 minute sample = 26 µg/m³

TWA = (210 minutes)(60 µg/m³) + (270 minutes)(26 µg/m³)/480 minutes = 12000 + 7020/480 = 19020/480 = 39.6 µg/m³
This number is compared to the new OSHA PEL
What About A Sample Less Than 8 Hours?

- **OSHA Method**
  - Assumes zero exposure for the non-sampled portion of the shift
  - Is it reasonable to assume that the exposure is really zero?
    - What was the employee actually doing during the non-sampled portion of the shift?
    - *You could underestimate exposure by assuming zero if it is not true*

- If you are confident that the exposure really was zero then a TWA can be calculated

**Example #2**
A 430 minute sample is collected—the exposure was 44 µg/m³. The employee worked a 480 minute shift. During the non-sampled portion of the shift the employee had a paid 30 minute lunch & was not in the plant.

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\text{TWA} = \frac{(430 \text{ minutes})(44 \text{ µg/m}^3)}{480 \text{ minutes}} = 39.4 \text{ µg/m}^3
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Questions?

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