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Post-OSHA Final Silica Rule:

What We Have Learned…

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Silica: It's More Than Dust

Silica

Crystalline

Amorphous

Quartz

Cristobalite

SKC

Before the Silica Rule…

1920-1936
- U.S. field research on silicosis (mining, granite, and cement industries)
- WV, Hawks Nest tunnel disaster

1938
- *Stop Silicosis* document

1971
- OSHA issued the first silica standard

1974
- CDC proposing a new PEL

Before the Silica Rule…

- **29 CFR 1910.1000 Table Z-3**
  - OSHA PEL (for quartz)

$$\frac{10\ mg/m^3}{\%SiO_2 + 2}$$

  - OSHA PEL (cristobalite)
    - ½ the value calculated from the mass formula for quartz

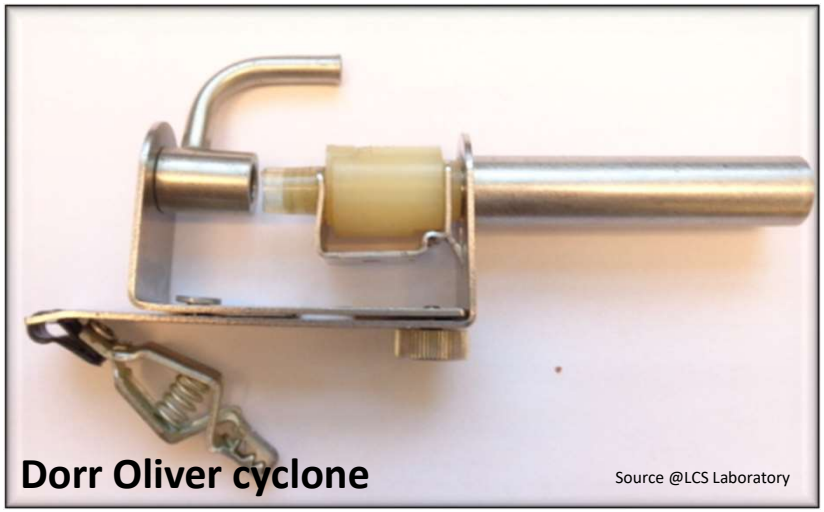
- **29 CFR 1926.1153** (Construction)
  - OSHA PEL

$$\frac{250\ mppcf}{\%SiO_2 + 5}$$

- **ACGIH-TLV®**
  - 0.025 mg/m^3
- **NIOSH-REL**
  - 0.05 mg/m^3

Before the Silica Rule…

- **Air Sampling**
  - Analytical Method
    - OSHA ID-142
    - NIOSH 7500
  - Air Sampling
    - 1.7 LPM


Dorr Oliver cyclone

Source @LCS Laboratory


37 mm 5.0 µm pre-weighed PVC filter cassette


Calibration Jar

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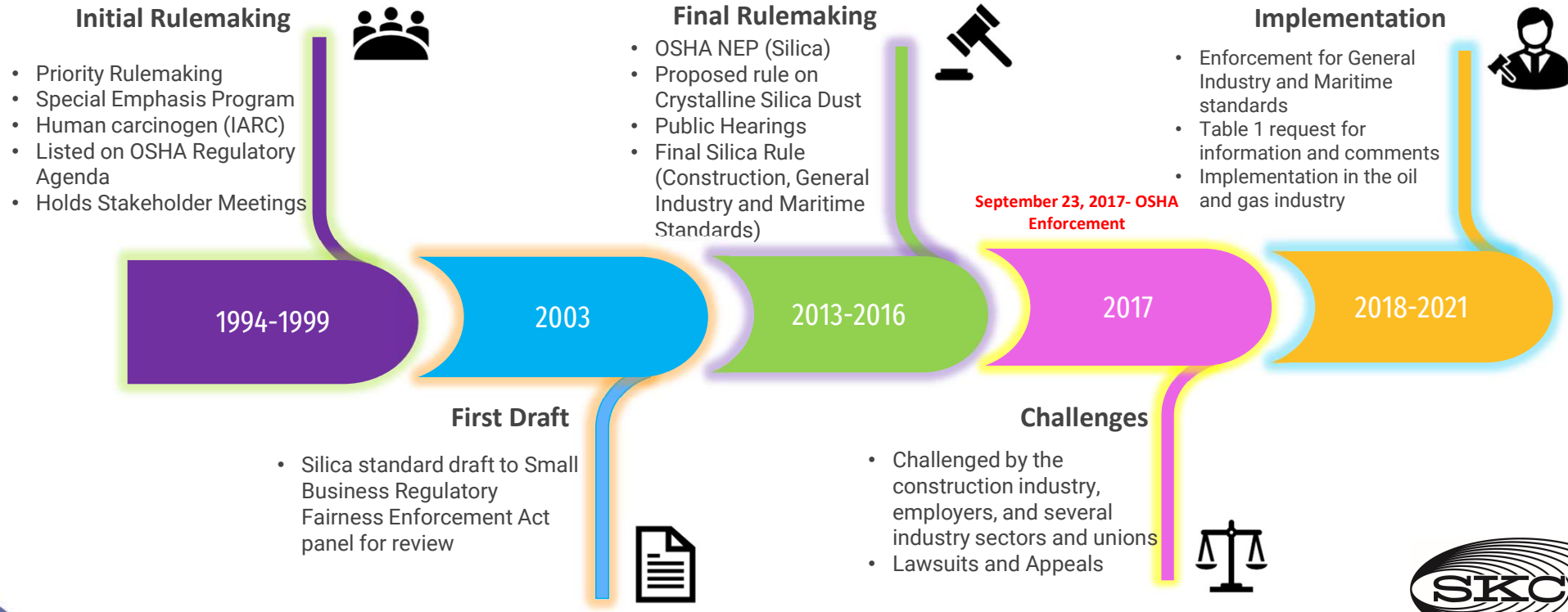
Silica Final Rule…A Long Process



The New Silica Rule's Pros and Cons

Provides more protection to employees.

"Too restrictive". Causes a burden on the construction industry.

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The New Standard

- PEL respirable crystalline silica 50 µg/m^3, 8-hr, TWA
- AL respirable crystalline silica 25 µg/m^3, 8-hr, TWA
- Exposure assessment
- Methods for controlling exposures
- Respiratory Protection
- Medical Surveillance
- Hazard Communication
- Recordkeeping

The New Standard

- **29 CFR 1910.1053**
  - Respirable Crystalline Silica, written for General and Maritime Industries
- **29 CFR 1926.1153**
  - Respirable Crystalline Silica, written for the Construction Industry

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The Table 1…

(29 CFR 1926.1153)

Equipment Task	Engineering & Work Practice Control Methods	Required Respiratory Protection & Minimum Assigned Protection Factor (APF)	
		≤ 4 hrs/shift	> 4 hrs/shift
Stationary Masonry Saws	Equipped with an integrated water system.	None	None
Handheld Power Saws	Equipped with an integrated water system.		
Handheld Power Saws (Any Blade Diameter)	Equipped with an integrated water system.		
	When used outdoors	None	APF 10
	When used indoors or in an enclosed area	APF 10	APF 10
	Tasks performed outdoors only: • Saw equipped with dust collection • Collector must provide adequate air flow and a filter with 99% or greater efficiency	None	None

https://www.osha.gov/sites/default/files/2018-12/fy16_sh-29650-sh6_ExposureTable.pdf

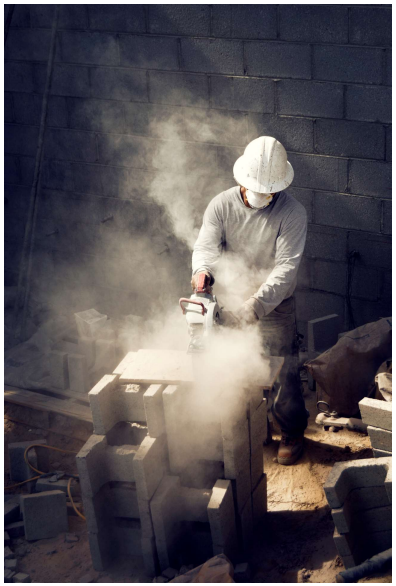

Table 1 for General Industry and Maritime?

- OSHA paragraph (a)(3) for general industry and maritime standards.
- General industry activities may be indistinguishable from the construction tasks listed.
- Tasks may be performed in varied environments and conditions.

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Appendix A

- Analytical methods used:
  - ~~– OSHA ID-142~~
  - – NIOSH 7500 by XRD
  - – NIOSH 7601 by VIS
  - – NIOSH 7602 by IR
  - – NIOSH 7603 (coal mine dust by IR)
- Lab Accreditations:
  - – AIHA LAP
  - – A2LA

SILICA, CRYSTALLINE, by XRD (filter redeposition) 7500

SiO_2 MW: 60.08 CAS: 14808-60-7 (quartz) RTECS: VV7330000 (quartz)
14464-46-1 (cristobalite) VV7325000 (cristobalite)
15468-32-3 (tridymite) VV7335000 (tridymite)

METHOD: 7500, Issue 4 **EVALUATION: FULL** **Issue 1: 15 August 1990**
Issue 4: 15 March 2003

OSHA : quartz (respirable) 10 mg/m³/(%SiO_2+2); cristobalite and tridymite (respirable) ½ the above
NIOSH: 0.05 mg/m³; carcinogen
ACGIH: quartz (respirable) 0.1 mg/m³
cristobalite (respirable) 0.05 mg/m³
tridymite (respirable) 0.05 mg/m³

PROPERTIES: solid; d 2.65 g/cm³ @ 0 °C; crystalline transformations: quartz to tridymite @ 867 °C; tridymite to cristobalite @ 1470 °C; α-quartz to ß-quartz @ 573 °C

SYNONYMS: free crystalline silica; silicon dioxide

SAMPLING		MEASUREMENT	
SAMPLER:	CYCLONE + FILTER (10-mm nylon cyclone, Higgins-Dewell (HD) cyclone, or aluminum cyclone + 5-µm PVC membrane) *see sampling section	**TECHNIQUE:**	X-RAY POWDER DIFFRACTION
FLOW RATE:	Nylon cyclone: 1.7 L/min; HD cyclone: 2.2 L/min; aluminum cyclone: 2.5 L/min	**ANALYTE:**	Crystalline SiO_2
VOL-MIN:	400 L	**ASH:**	Muffle furnace or RF plasma asher or dissolve in tetrahydrofuran
-MAX:	1000 L	**REDEPOSIT:**	On 0.45-µm Ag membrane filter
SHIPMENT:	Routine	**XRD:**	Cu target X-ray tube, graphite monochromator Optimize for intensity; 1° slit Slow step scan, 0.02°/10 sec Integrated intensity with background subtraction
SAMPLE STABILITY:	Stable	**CALIBRATION:**	NIST SRM 1878a quartz, NIST SRM 1879a cristobalite, USGS 210-75-0043 tridymite suspensions in 2-propanol.
BLANKS:	2 to 10 per set (see step 13.g.)	**RANGE:**	0.02 to 2 mg SiO_2 per sample [2]
BULK SAMPLE:	High-volume or settled dust; to identify interferences	**ESTIMATED LOD:**	0.005 mg SiO_2 per sample [2]
		PRECISION ($\hat{s}_r$):	0.08 @ 0.05 to 0.2 mg per sample [1]

ACCURACY

RANGE STUDIED:	25 to 2500 µg/m³ [1] (800-L sample)
BIAS:	None known
OVERALL PRECISION ($\hat{s}_{rT}$):	0.09 (50 to 200 µg) [1]
ACCURACY:	± 18%

APPLICABILITY: The working range is 0.025 to 2.5 mg/m³ for an 800-L air sample.

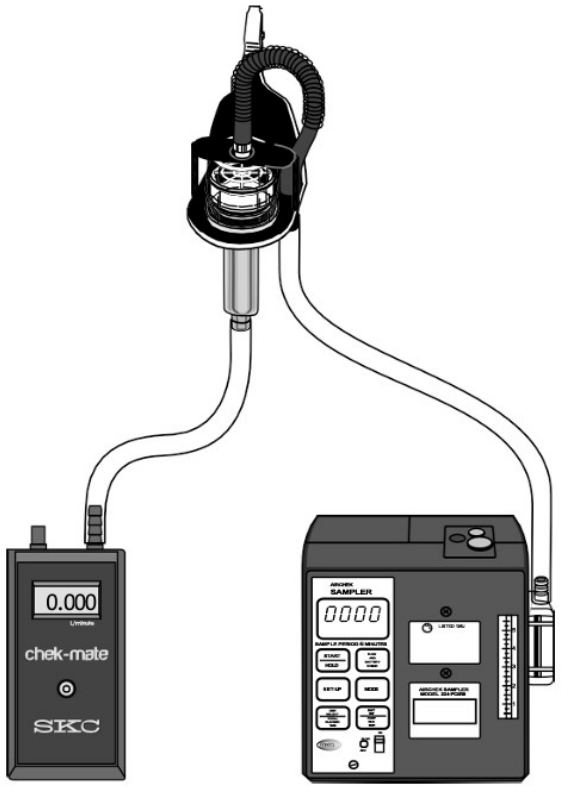
INTERFERENCES: Micas, potash, feldspars, zircon, graphite, and aluminosilicates. See APPENDIX.

OTHER METHODS: This is similar to the method in the Criteria Document [3] and P&CAM 259 [4] which has been collaboratively tested [1]. This method is similar, except for sample collection, to S315 [5,6]. Method P&CAM 109 [7,8,9], which incorporates an internal standard, has been dropped. XRD can distinguish the three silica polymorphs and silica interferences can be eliminated by phosphoric acid treatment. IR (methods 7602 and 7603) can also quantify quartz, cristobalite and tridymite if amorphorous silica and silicates are not present in large amounts. However sensitivity is reduced if multiple polymorphs are present and secondary peaks must be used. Crystalline silica can also be determined by visible absorption spectrophotometry (e.g., Method 7601), but polymorphs can not be distinguished. Visible absorption methods also have larger laboratory-to-laboratory variability than XRD and IR methods and therefore are recommended for research use only [10].

NIOSH Manual of Analytical Methods (NMAM), Fourth Edition

Active Sampling for Silica

- Normal Sampling Procedures
  - Pump, cyclone, media, calibrator
- Differences for Silica
  - Short tasks – concrete cutting, grinding, etc.
  - High Flows – necessary for valid analysis
- Availability of proper sampling devices
  - New Larger Cyclones for higher flow



For most workplace conditions, the change in the criteria for respirable dust in the final rule would theoretically increase the mass of respirable dust collected over that measured under the previous criteria by an amount that depends on the size distribution of airborne particles in the workplace. Soderholm (1991, Document ID 1661) examined these differences based on 31 aerosol size distributions measured in various industrial workplaces (*e.g.*, coal mine, lead smelter, brass foundry, bakery, shielded metal arc [SMA] welding, spray painting, pistol range) and determined the percentage increase in the mass of respirable dust that would be collected under the ISO/CEN convention over that which would be collected under the 1968 ACGIH criteria. Soderholm concluded that, for all but three of the 31 size distributions that were evaluated, the increased respirable dust mass that would be collected using the ISO/CEN convention for respirable dust instead of the 1968 ACGIH criteria would be less than 30 percent, with most size distributions (25 out of the 31 examined, or 80 percent) resulting in a difference of between 0

cyclone samplers on the market, such as the Dorr-Oliver, Higgins-Dewell (HD), GK2.69, SIMPEDS, and SKC aluminum. In the PEA, OSHA reviewed several studies demonstrating that these samplers collect respirable particles with efficiencies that closely match the ISO/CEN convention (Document ID 1720, pp. IV–21—IV–24). In addition to cyclone samplers, there are also personal impactors available for use at flow rates from 2 to 8 L/min that have been shown to conform closely with the ISO/CEN convention (Document ID 1834, Attachment 1). Cyclones and impactors both separate particles by size based on inertia. When an airstream containing particles changes direction, smaller particles remain suspended in the airstream and larger ones impact a surface and are removed from the airstream. Cyclones employ a vortex to separate particles centrifugally, while impactors use a laminar airflow around a flat surface such that particles in the desired size range impact onto the surface.

The current OSHA sampling method for crystalline silica, ID–142, is the method used by OSHA to enforce the

Method 7500 also allows for the use of an aluminum cyclone at 2.5 L/min. NIOSH is revising its respirable dust method to include any sampler designed to meet the ISO/CEN criteria (Document ID 3579, Tr. 318).

The devices discussed above, when used at the appropriate flow rates, are capable of collecting a quantity of respirable crystalline silica that exceeds the quantitative detection limit for quartz (the principle form of crystalline silica) of 10 µg for OSHA's XRD method (Document ID 0946). For several scenarios based on using various devices and sampling times (8-hour, 4-hour, and 1-hour samples), OSHA calculated the amount of respirable quartz that would be collected at quartz concentrations equal to the existing general industry PEL, the proposed (and now final) rule's PEL, and the proposed (and now final) rule's action level. As seen in Table IV.3–A, computations show that the 10-mm nylon Dorr-Oliver operated at an optimized flow rate of 1.7 L/min, the aluminum cyclone operated at 2.5 L/min, the HD cyclone operated at 2.2 L/min, and the GK2.69 operated at [illegible] will all collect enough

https://www.govinfo.gov/content/pkg/FR-2016-03-25/pdf/2016-04800.pdf

KG0

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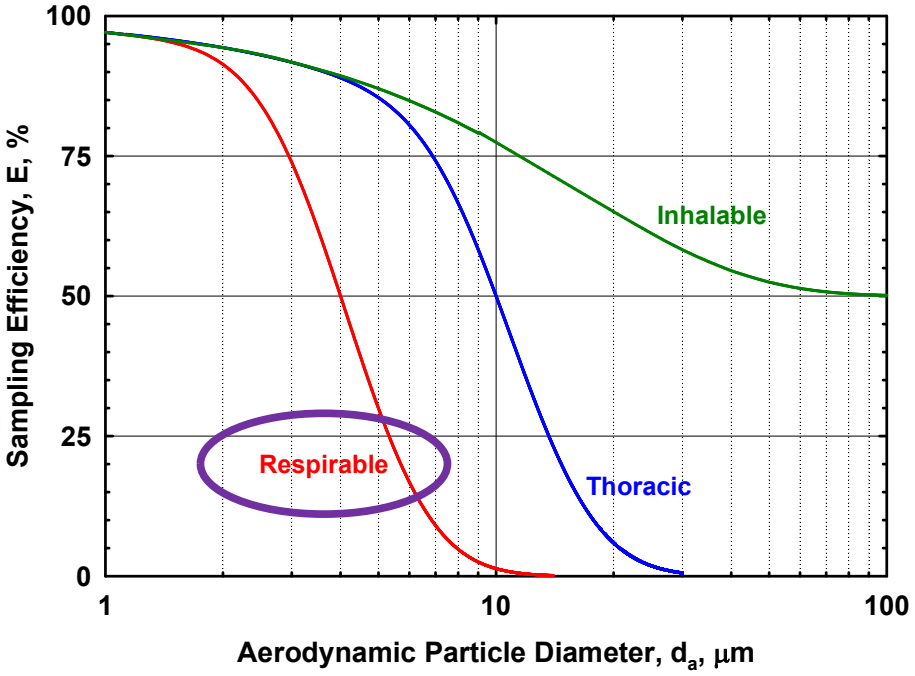
Active Sampling for Silica

- Particle-Size-selective Samplers
  - ISO/CEN Respirable Criteria

Cyclones

PPI®



Slide 15

KG0 [@Lucinette Alvarado] You may want to caption the page numbers in the OSHA Silica Rule on which our samplers are listed. I know the PPI are listed on page 16439. I don't recall the page for our cyclones.
Karin Galligan, 2023-08-06T14:46:02.980

LA0 0 [@Karin Galligan] Thanks for the reference. The SKC aluminum cyclone is mentioned on the same page. I will add a slide with the snapshot of the section
Lucinette Alvarado, 2023-08-07T17:08:10.233

KG0

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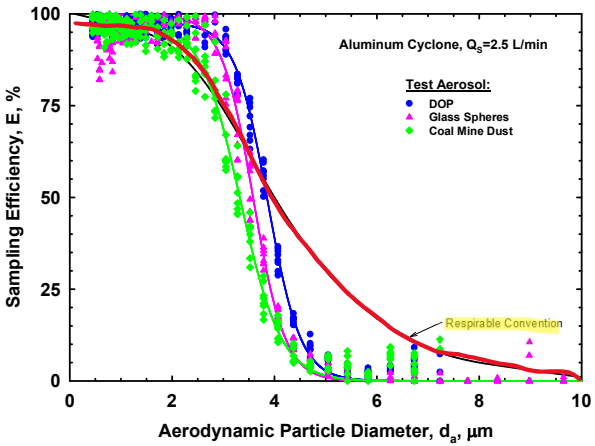
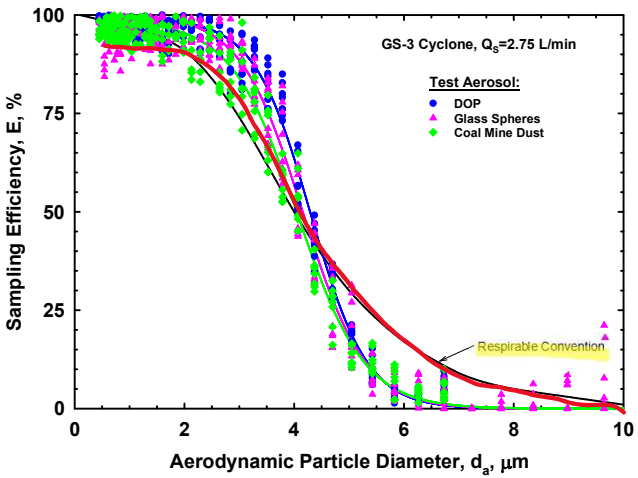
• Cyclones' Collection Efficiency

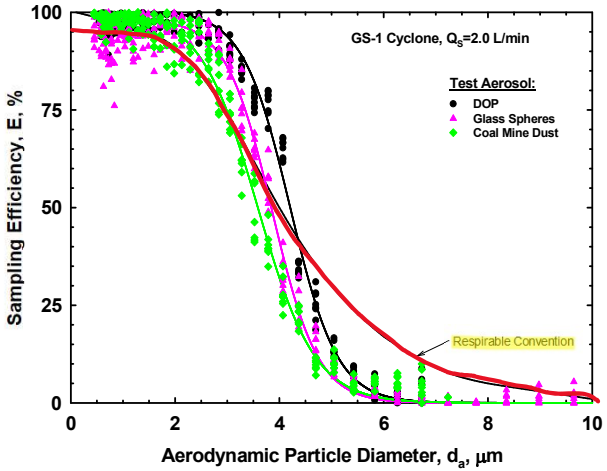


Aluminum

GS-3



GS-1



Respirable Convention
ISO 7708:1995

Slide 16

KG0 [@Lucinette Alvarado] Cite source of data?
Karin Galligan, 2023-08-06T14:47:35.607

KG0

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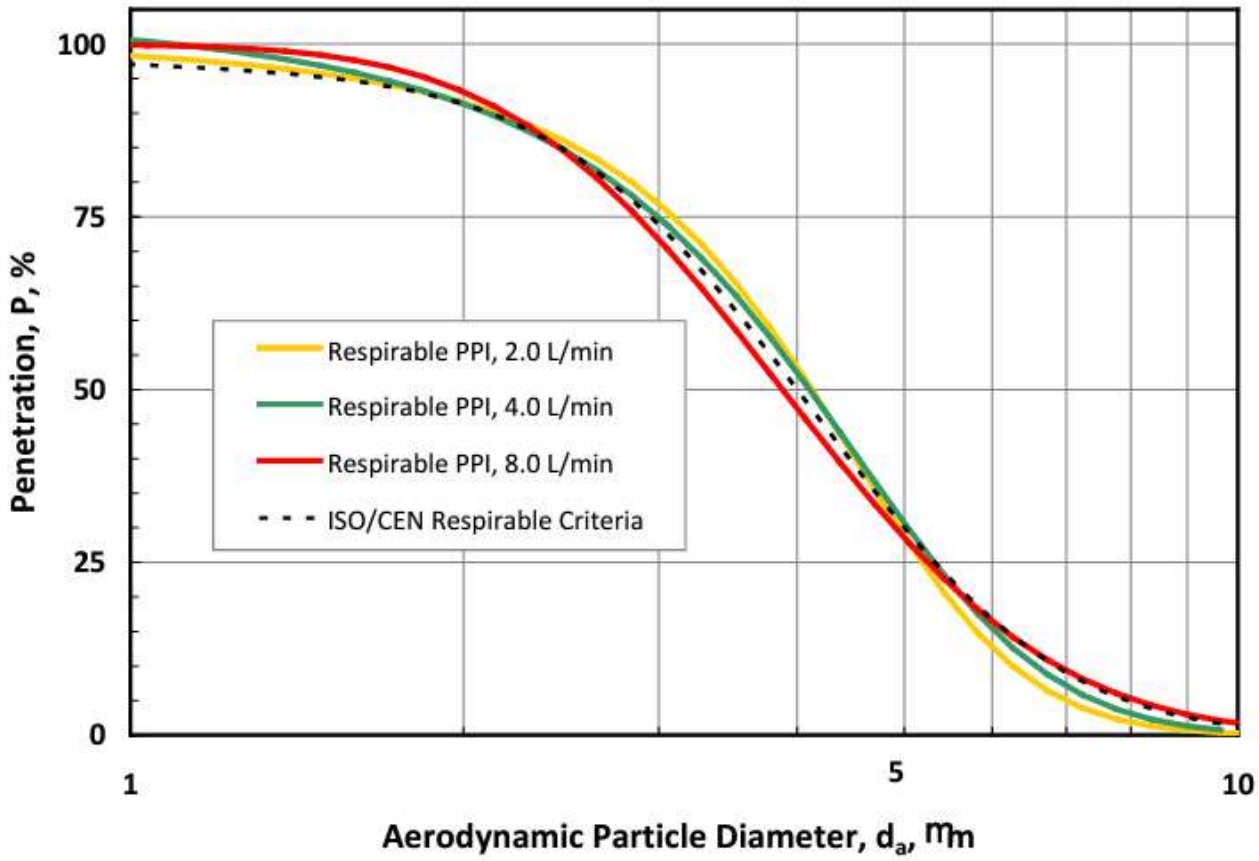
Parallel Particulate Impactor (PPI®)



Slide 17

KG0 [@Lucinette Alvarado] I wonder if Saulius could output a higher resolution of this graph for you. This looks a little fuzzy.
Karin Galligan, 2023-08-02T18:56:22.160

LA0 0 [@Karin Galligan] we found a better one!
Lucinette Alvarado, 2023-08-07T17:47:35.414

KG0 1 So much better! Great job!
Karin Galligan, 2023-08-07T17:51:01.264

KG0

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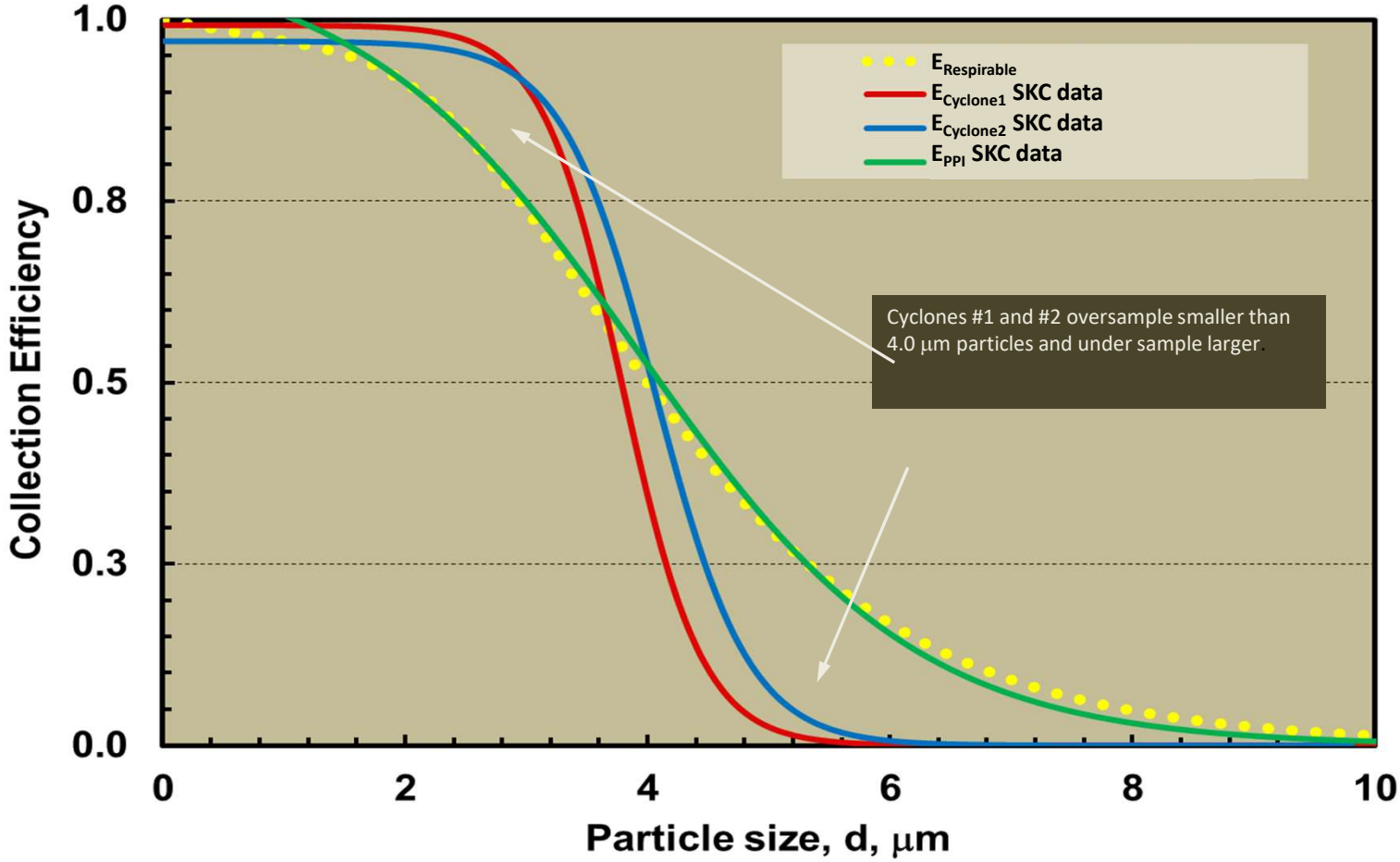
Cyclones vs PPI®



Slide 18

KG0 [@Lucinette Alvarado] Can you cite the source for the data shown on this slide (it's only shown as "SKC data" in the graph key?

Karin Galligan, 2023-08-06T14:30:55.286

KG0

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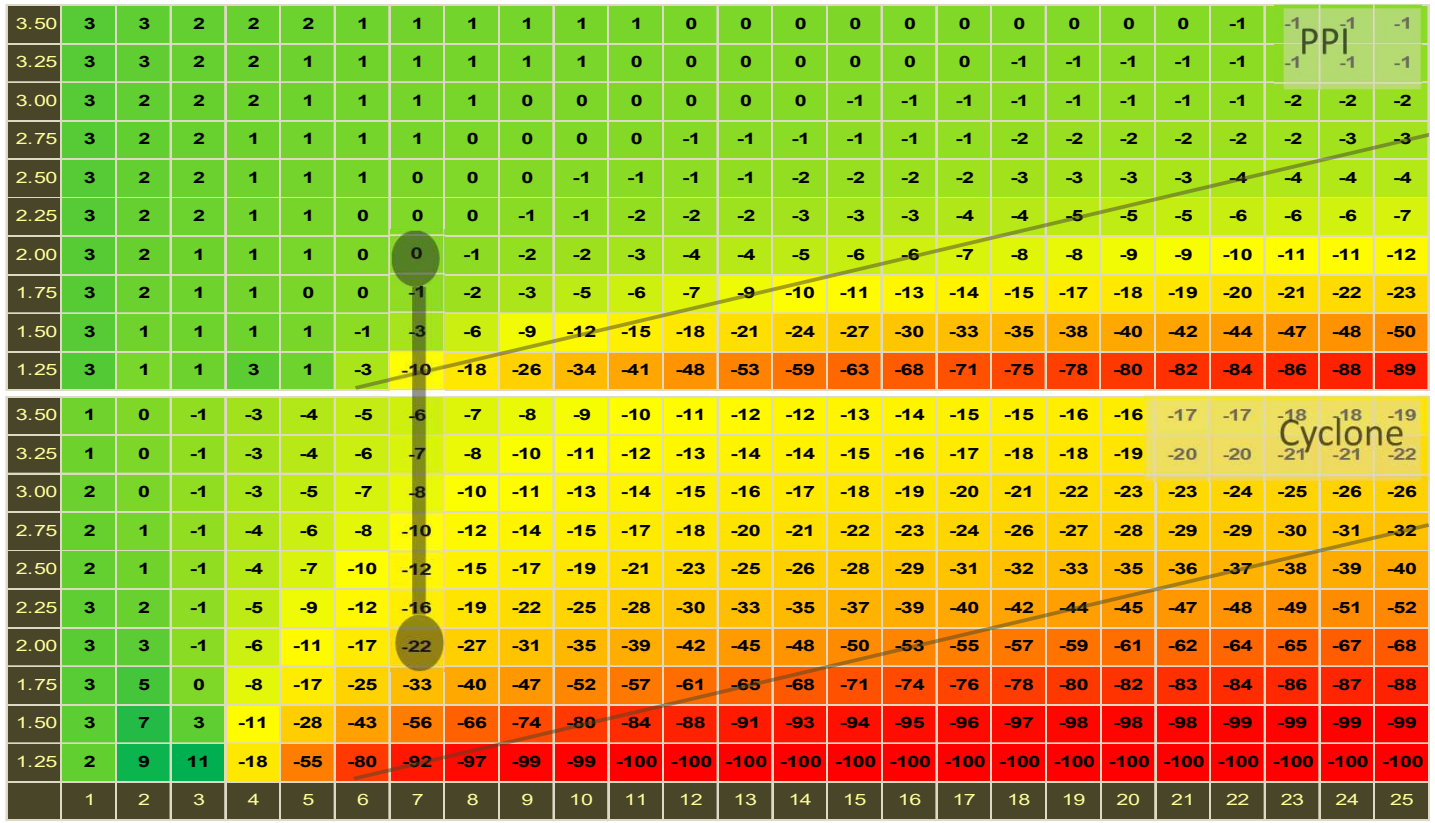
Cyclones vs PPI®

Bias Map



3.50	3	3	2	2	2	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	-1	-1	-1	-1
3.25	3	3	2	2	1	1	1	1	1	1	0	0	0	0	0	0	0	-1	-1	-1	-1	-1	-1	-1
3.00	3	2	2	2	1	1	1	1	0	0	0	0	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-2	-2	-2
2.75	3	2	2	1	1	1	1	0	0	0	0	-1	-1	-1	-1	-1	-1	-2	-2	-2	-2	-2	-2	-3	-3
2.50	3	2	2	1	1	1	0	0	0	-1	-1	-1	-1	-2	-2	-2	-2	-3	-3	-3	-3	-4	-4	-4	-4
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3.25	1	0	-1	-3	-4	-6	-7	-8	-10	-11	-12	-13	-14	-14	-15	-16	-17	-18	-18	-19	-20	-20	-21	-21	-22
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2.75	2	1	-1	-4	-6	-8	-10	-12	-14	-15	-17	-18	-20	-21	-22	-23	-24	-26	-27	-28	-29	-29	-30	-31	-32
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2.25	3	2	-1	-5	-9	-12	-16	-19	-22	-25	-28	-30	-33	-35	-37	-39	-40	-42	-44	-45	-47	-48	-49	-51	-52
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1.75	3	5	0	-8	-17	-25	-33	-40	-47	-52	-57	-61	-65	-68	-71	-74	-76	-78	-80	-82	-83	-84	-86	-87	-88
1.50	3	7	3	-11	-28	-43	-56	-66	-74	-80	-84	-88	-91	-93	-94	-95	-96	-97	-98	-98	-98	-99	-99	-99	-99
1.25	2	9	11	-18	-55	-80	-92	-97	-99	-99	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25

Slide 19

KG0 [@Lucinette Alvarado] Cite data source?
Karin Galligan, 2023-08-06T14:31:44.975

The New Rules

- Restrict Housekeeping Practices
- Medical Exams
- Employee Training
- Recordkeeping
  - Exposure measurements
  - Objective data

Appendix B

- **Medical Surveillance**
  - Physical Examination
  - Baseline Testing for TB
  - Pulmonary Function Testing
  - Chest X-ray
  - Recordkeeping

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Penalties

Lessons Learned…

- New Action Level
- Table 1 in 1926.1153(c)(1)
- Review of Analytical Methods
- Size-Selective Samplers Added
- To Be Patient…
- Comply With The Regulations

KG0

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The Future of Silica Safety

Exposure Monitoring	• Additional Airborne Samplers • Analytical Methods
Engineering Controls	• Wet Cutting • HEPA Filters LEV
Administrative Controls	• Regular Inspections • Good Working Practices • Personal Hygiene Practices
Personal Protective Equipment	• Respiratory Protection • Disposable or washable work clothes • Shower and change into clean clothes

SKC

Slide 24

KG0 [@Lucinette Alvarado] Does exposure monitoring play any role in the future of silica safety?
Karin Galligan, 2023-08-06T14:34:17.228

Thank you for your attention!

www.skcinc.com

www.skctech@skcinc.com