Objective Data Testing for Concrete Drilling
OSHA 29 CFR §1926.1153 Respirable Silica Dust Exposure
Makita Rotary Hammers with Dust Extractors DX01 & XCV05Z

Makita performed testing to determine the operator's exposure level to respirable crystalline silica dust[1]. The purpose of the test was to produce "objective data" required for compliance under the exposure assessment performance option of OSHA respirable crystalline silica standard, 29 CFR §1926.1153(d)(2)(ii) when the task is performed under the same conditions tested by Makita.

Testing conditions:

- Test duration: 1 hour
- Room size: 8.4m x 5.1m x 4.9m ($210m^3$)
- Room ventilation: Closed with no ventilation openings
- Base material: Concrete
- Drilling orientation: Overhead
- Drilled hole dimensions: 5/8" x 2"
- Total holes drilled: 75
- Dust container on dust extractor emptied every 8 holes drilled with DX01 and every 25 holes drilled with XCV05Z
- Sampler: 10 L/min GSP pump, FSP sampler. ISO 7708-compliant. 5 µm filter
- Air sample volume collected by sampler during test: 600 liters

Results:

Dust Extractor	DX01	XCV05Z	XCV05Z
Tool Used	XRH01Z	XRH05Z	HR2641
Dust Attachment	DX01	193472-7	193472-7
Connection Adapter	N/A	417765-1	417765-1
Hose	N/A	143787-2	143787-2
Time-Weighted Average Respirable Silica Dust Exposure[2,3]	22 µg/m3	203 µg/m3	270 µg/m3

The 1 hour TWA for XRH05Z is 203 μg/m^3 and for HR2641 is 270 μg/m^3. Assuming no additional silica exposure occurs throughout an 8-hour work shift, the TWA for the 8-hour work shift would be 26 μg/m^3 and 34 μg/m^3 respectively. See reverse side for details on calculating TWA.

[1] Testing performed in accordance with EN 50632 1 and EN 50632 2 6. Exception: EN 50632 2 6 specifies drilling one hundred twenty ø16mm x 50mm holes at a 15° downward-from-horizontal position; and the monitor be equipped with an 8-micron filter.

[2] The silica content of base materials varies. As a result, the silica content in respirable dust samples also varies. The above-published exposure value is based on a 20% silica content applied to the total respirable dust measurement.

[3] Exposure value is a representation of the time-weighted average (TWA) over the 1-hour test period. Due to the test being conducted in a closed room with no ventilation, this TWA silica exposure value would increase if the test duration was extended under the same conditions.

29 CFR §1926.1153(d)(2)(ii)
Performance Option
General Interpretation of "Time-Weighted Average"

Permissible Exposure Limit (PEL) is a legal limit for permissible exposure of an employee to respirable silica. The new OSHA statute requires the employer ensure that no employee is exposed to an airborne concentration of respirable crystalline silica in excess of 50 μg/m^3, calculated as an 8-hour TWA. (29 CFR § 1926.1153(d)(1)). A TWA (time-weighted average) is the *average* exposure workers have to respirable silica over an eight-hour standardized work period. This means the exposure level as an 8-hour TWA is ≤50 μg/m3; a 4-hour TWA is ≤100 μg/m3 (assuming no exposure for the remainder of the shift); a 2-hour TWA is ≤200 μg/m3 (assuming no exposure for the remainder of the shift) and a 1-hour TWA is ≤400 μg/m3 (assuming no exposure for the remainder of the shift).

Calculating the TWA: A TWA is equal to the sum of the time period each task is performed multiplied by the level of silica dust exposure while performing the task, divided by the hours in the workday.

The following formula can be used to determine TWA:
$$TWA = [t_1 c_1 + t_2 c_2 + \ldots t_n c_{n]} / [t_1 + t_2 + \ldots t_n]$$

- "t" represents the time for each task, "c" indicates the concentration of silica exposure during the task and μg/m3 indicates micrograms per cubic meter.
- The denominator (bottom number) for determining TWA for a workday would equal 8 hours. If exposure is different than 8 hours, the denominator would change to reflect the time period worked.
- **Example:** An employee is exposed to silica on 3 separate occasions in 3 discrete locations during an 8-hour work day. Task 1 was performed for 1 hour with an exposure of 200 μg/m^3. Task 2 was performed for 2 hours with an exposure of 60 μg/m^3 . Task 3 was performed for 1.5 hours with an exposure of 40ug/m^3. The employee had no further silica exposure for the remaining 3.5 hours of his shift.

> 8-hour TWA = [(1 hour)(200 μg/m^3) + (2 hours)(60 μg/m^3) + (1.5 hours)(40 μg/m^3) +
>   (3.5 hours)(0 μg/m^3)] / [1 hours + 2 hours + 1.5 hours + 3.5 hours]
> 8-hour TWA = [200 μg/m^3 + 120 μg/m^3 + 60 μg/m^3 + 0 μg/m^3]/ [8 hours]
> 8-hour TWA = [380 μg/m^3] / [8 hours]
> 8 hour TWA = 47.5 μg/m^3

In this example, the employee's TWA (47.5 μg/m^3) is below the PEL of 50 μg/m^3.