Research summary

Performance test

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The TNO quality system is ISO 9001 certified.

Hilti battery actuated direct fastening tool BX 3

Commissioned by
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In recent years, TNO has focused intensively upon innovative improvements to tools, processes and workplace design in the industrial environment. The main purpose of these efforts is to create low-dust production processes and tools. As well as construction, our product and process development activities have targeted the metal, aircraft and quartz industries, working closely with industry organizations, trades unions, governments, employers, employees and manufacturers.

To describe innovative production processes and tools, and to assess their practical functionality, we have developed the TNO Performance Test. This checks that relevant statutory and in-house occupational exposure limits (OELs) for hazardous substances such as crystalline silica, (hard)wood dust and hexavalent chromium are not exceeded in areas where they may be inhaled by workers in the course of their everyday duties.

Inspectie SZW, the Dutch labour inspectorate, explicitly endorses the TNO Performance Test in its "Basic Inspection Module for Crystalline Silica" (Basisinspectiemodule Kwartsstof). That document states, "If you decide to conduct your working activities using the measures contained in a TNO Performance Test, as described on the TNO website (stofvrijwerken.tno.nl or dustfreeworking.tno.nl), I [the inspector] will regard exposure as being adequately managed".

This means that an employer using the test is able to communicate unambiguously with the inspectors and that no additional exposure measurements need to be agreed. Moreover, it provides both the employer and its personnel with an objective measuring tool for the accurate assessment of proposed investments. Innovative manufacturers and suppliers of production processes and tools can also highlight their quality by complying with the test criteria.

Assessment criteria

The TNO Performance Test assesses exposure to hazardous substances in the "employee inhalation zone" in the workplace. The applicable norms for each substance, both statutory and in-house, are those contained in the database of Occupational Exposure Limits (Grenswaarde Stoffen op de Werkplek, GSW) maintained by the Social and Economic Council of the Netherlands (see http://www.ser.nl/en/oel_database.aspx).

Project description

For this project, TNO studied emissions of respirable quartz dust when working in concrete with a Hilti actuated direct fastening tool. During the test, plywood boards are fastened to concrete curbs, using nails fired by a gas, powder, or battery actuated tool. This report contains the results reported for the Hilti battery actuated direct fastening tool BX 3.The BX 3 is equivalent to the Hilti DX 460, which has been tested by TNO.

System specifications

The system consists of a Hilti battery actuated direct fastening tool BX 3 (or equivalent*). Figure 1 shows the complete system.

* An "equivalent" tool system is one with dust production equal or less than those of the model tested. The impact energy is normative for this.

Hilti battery actuated direct fastening tool BX 3

Figure 1. The complete system.

Table 1 lists the key technical specifications of the system tested and its equivalents.

Table 1. Technical specifications of Hilti tool systems and equivalent.

Specifications	Impact energy [J]	Weight [kg]
BX 3	85	3,3
DX 460	325	3,6
DX 351	275	2,2
DX 462	325	3,9
DXA 40	300	3,2
DXA 41	300	3,2
GX 90	85	3,7
GX 100	90	3,9
GX 120	100	3,9

TNO Performance Test

Table 2 lists the key specific test conditions.

Table 2. "Worst case" test conditions.

Material: concrete curbs and plywood boards with dimensions 200x100x18 mm

Source strength: 1600 assemblies per day
TNO Productivity: permanent operation
Operator exposure period: eight-hour working day.

Direction of dust generation: random

Nail length: 37 mm

The distance between the nails to the edge of the material and the mutual measure distance between the nails must be at least 80 mm to avoid fracture of the material and additional quartz dust dissemination

Test results

Table 3 and Figure 2 summarize the test results.

Table 3. Summary of measured data.

Situation	Respirable quartz dust concentration (mg/m^3)
OEL, eight-hour time-weighted average (TWA)	0.075
Permanent operation	0.015
"Heavy" use	0.007
"Light" use	0.002
Outdoor use	-
Practical use	-

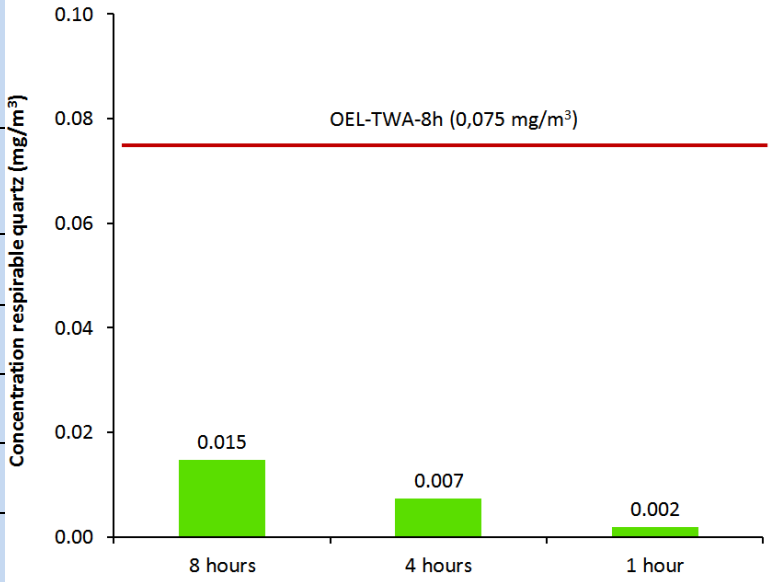


Figure 2. Exposure to respirable quartz dust at OEL.

Conclusion

TNO measured exposure to respirable quartz dust in the "employee inhalation zone" when fastening plywood boards to concrete curbs using a Hilti actuated direct fastening tool.

In permanent operation (an entire eight-hour working day), average exposure was 0.015 mg/m³. This is below the statutory occupational exposure limit (OEL) of 0.075 mg/m³ (eight-hour time-weighted average or TWA), meaning that the system tested does comply with the applicable standard for exposure to quartz dust in this situation.

As well as "permanent operation" TNO has also defined two more reference situations.

- Heavy use: four hours of operation per eight-hour working day.
- Light use: one hour of operation per eight-hour working day.

In both of these situations, too, the system complies with the norm.

The inaccuracy of the exposure measurements is about 15% (5% for the analysis, 5% sampling and 5% reproducibility of the test operator). Readers are referred to the TNO measurement protocol (see TNO website www.dustfreeworking.tno.nl).

The labels below present the system's performance in graphic form. The round label shows the total "responsible operating time" in hours per eight-hour working day. The rectangular label provides more detailed information for the situations tested, with the green bars indicating what proportion of each type of use during an eight-hour working day remains within the OEL.

Label for fastening in concrete

Reference: permanent operation.

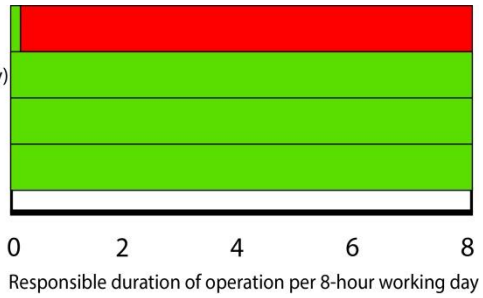
No measures

100% duration of operation (8 hrs per 8hr working day)

Heavy use (4 hrs per 8hr working day*)

Light use (1 hrs per 8hr working day*)

* Given proportional operation during an 8-hour working day



Label for fastening in sand-lime blocks

Reference: permanent operation.

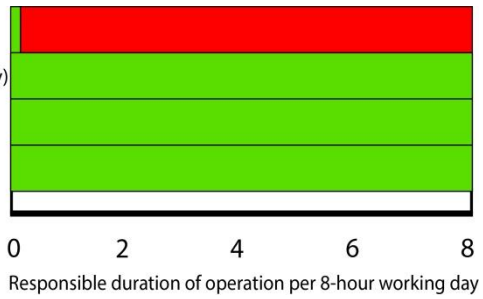
No measures

100% duration of operation (8 hrs per 8hr working day)

Heavy use (4 hrs per 8hr working day*)

Light use (1 hrs per 8hr working day*)

* Given proportional operation during an 8-hour working day



Initials: