Review of Hilti's facilities and equipment for compliance with EN 50632-1

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1 INTRODUCTION

Extraction integrated into a power tool, often referred to as 'on-tool extraction', has an important role to play in reducing workers exposure to hazardous substances, particularly dust. A review[1] of the many studies has demonstrated that significant reductions in exposure to workers can be achieved with on-tool extraction. Since this review was published on-tool designs have continued to improve.

Recently, parts of a new EN standard have been published, EN 50632[2] part 1 of which specifies a procedure to measure dust concentrations (inhalable and/or respirable) produced during the use of mains or battery powered tools under standardised conditions. Whilst the airborne dust concentration during actual use of the tool will differ, the test procedure does allow comparison of dust concentrations produced by tools of the same type. In addition, the test can be carried out on tools with and without dust extraction so the effectiveness of control measures can be evaluated and optimised.

Hilti GB Ltd commissioned the Health and Safety Laboratory (HSL) to carry out a review of their facilities and equipment at Kaufering, Germany, used to access airborne dust concentrations generated when operating electric power tools according to the EN standard series EN 50632.

This report describes the review of the facilities and equipment used to measure airborne dust concentrations and assesses their compliance with the EN standard series EN 50632. This report also includes comments on Hilti's approach to on-tool dust extraction control.

The author visited Hilti Entwicklungsgesellschaft mbH, at Hiltistraße 6, 86916 Kaufering, Germany on the 22nd June 2016.

2 REVIEW OF HILTI'S EQUIPMENT AND FACILITIES FOR TESTING TO EN 50632

2.1 SUMMARY OF EUROPEAN STANDARD EN 50632

The European standard EN 50632 (Electric motor-operated tools — Dust measurement procedure) is divided up into three parts:

- Part 1 – General requirements
- Part 2 and 3 – Requirements for the dust measurement for particular types of tools, which will supplement the requirements given in Part 1 to account for specific tool characteristics.

At the time of this report three sub-parts of Part 2 had been published. These were:

- Part 2-1 – Particular requirements for diamond core drills
- Part 2-6 – Particular requirements for hammers
- Part 2-22 – Particular requirements for cut-off machines and wall chasers

The intention of part 1 of the standard is to specify the procedure to measure dust concentrations (inhalable and/or respirable) produced during the use of mains or battery powered tools under standardised conditions. Whilst the airborne dust concentration during actual use will differ, the test does allow comparison of dust concentrations produced by tools of the same type. In addition, the test can be carried out on tools with and without dust extraction so the effectiveness of control measures can be evaluated and optimised.

This report reviews Hilti's equipment and facilities against Part 1 of EN 50632 (General requirements).

2.2 REVIEW OF HILTI'S EQUIPMENT AND FACILITIES FOR TESTING TO EN 50632

2.2.1 Test room

The standard states that tools have to be tested in an enclosed test room. The standard specifies the test room volume and the restrictions on the room dimensions, plus other requirements. These include:

- no other sources of fixed air-polluting material in the room;
- no room ventilation during the dust measurement;
- size of the room 200 m^3 ± 10% with a height between 3 m and 4.5 m;
- large enough to ensure a distance between the tool and the walls of at least 2.0 m.

Hilti's test room occupies a corner of a much larger room with which it shares two of its walls. The test room has dimensions of 7.8 m by 7.8 m by 3.3 m high (200.8 m^3), which is within 1% of 200 m^3. The shape is such that it is possible to ensure the distance between the tool and the walls are at least 2 m. The room is accessed via a double door, which is fitted with door seals to minimise ventilation. In addition, there are windows fitted to one of the internal walls, allowing staff outside of the room to observe tests. The room has no other sources of air pollution within. Therefore the test room meets the requirements of EN 50632.

2.2.2 Sampling equipment

EN 50632 states that performance of the dust sampler used shall comply with EN 481[3] and therefore be suitable for determining inhalable or respirable dust. Currently Hilti are testing tools intended to be used with construction materials containing quartz. As this material contains respirable crystalline silica, the respirable fraction would need to be measured and analysed as specified by the different countries in the EU and world.

Hilti have selected an FSP 10 cyclone dust sampler (manufactured by GSA, Germany) to sample the respirable size fraction. This is designed to operate at 10 l min^{-1}, and is classed as a high flow rate respirable sampler. A SG10-2 sampling pump (GSA, Germany) is used to provide the manufacturers specified sample flow rate. The SG10-2 sampling pump is calibrated by an external company once per year and checked by Hilti every quarter using a calibrated TSI Primary Calibrator, model 4146.

The FSP 10 sampler complies with EN 481 as required by EN 50632.

The advantage of selecting a high flow rate sampler is an increased volume of air sampled per test. This translates to a greater weight of dust sampled onto the filter and therefore gives a lower limit of detection for calculated respirable dust concentrations.

EN 50632 specifies that two samplers should be placed on either side of the tool operator's upper chest. The Hilti operator uses a harness which facilitates this. The wearing of the harness was demonstrated and met the requirements of EN 50632.

2.2.3 Test operating conditions

Rather than carry out a full one hour test, the Hilti tool operator performed short tests with a Hilti diamond cutter model DCH 300 connected to a VC 40-UM extractor to demonstrate the test procedure. Short tests were carried out with the extractor on and off. Viewed from outside of the room, a considerable difference could be seen with and without the extractor operating. After just a couple of minutes with the extractor switched off it was difficult to see across the test room. With the extraction unit on, the room appeared to remain clear for the duration of the test.

As required by EN 50632, the work piece was positioned so that the distance between the tool and the walls/ceiling was at least 2 m. Also, the extraction unit remained in the test room during the test as specified in EN 50632.

EN 50632 specifies that the amount of dust collected by the dust extraction unit shall be determined by weighing the unit before the start of a test, before each emptying of the unit, and after a test. It is not clear from the standard why this task should be carried out as the data gathered is not required for the test report. Nevertheless, Hilti had a suitable large floor balance available to carry out this task. This was able to weigh up to 300 kg with a resolution of 10 g.

2.2.4 Method for sampling and gravimetric analysis

Equipment used

The filters used with the FSP 10 sampler were conditioned, handled, and weighed in a room adjacent to the test room. The manufacturer of the FSP 10 recommend glass fibre or membrane filters with a pore size of 8 µm. Hilti are currently using membrane (cellulose nitrate) filters, which have a pore size of 8.0 µm and therefore they are complying with the manufacturers recommendations.

Filters were conditioned in a small Perspex enclosure containing silica gel to control the humidity. Both humidity and temperature within the enclosure were displayed and monitored.

Filters were weighed on a KERN 5-figure balance (model ABT 100-5M), which had the required resolution and accuracy for weighing the sample filters.

Analysis method

EN 50632 does not give or reference guidance for sampling the inhalable or the respirable fraction. It is the opinion of the author that this is an important omission from the standard. Ideally PD CEN/TR 15230:2005[4] should be referenced and followed. An alternative document is the HSE publication MDHS 14/4[5] which details a similar methodology.

At present Hilti follows some, but not all, of the sampling procedures detailed in PD CEN/TR 15230. The main discrepancies are:

1. **Use of field blank (control) filters** – Field blanks (or control filters) should be weighed at the same time as the filters that are to be used with the samplers. The controls are then used to correct for any weight changes caused by atmospheric conditions. PD CEN/TR 15230 recommends retaining one blank for each batch of ten prepared, although a minimum of three blanks should always be kept.

2. **Measurement of the sampler flow rate via the sampler inlet before and after each test** – it is imperative that the pump flow rate is measured with the FSP 10 (loaded with the test filter) connected. This requires the TSI primary flow calibrator to be connected to the rectangular inlet of the FSP 10. GSA offer a push fit silicone adaptor (SG10) that makes this process easier. This is because the pump flow rate may differ with the sampler attached due to the added resistance that this creates.

3. **Measurement of the sampler flow rate both before and after each test** – The SG10-2 sampling pump has automatic flow control and regulation that is designed to keep the flow rate within ±5% of the initial set point during the sampling time (as required by PD CEN/TR 15230 and the manufacturer of the FSP10). However, as noted in PD CEN/TR 15230, the flow rate should be checked before and after sampling. This is because the back pressure experienced by the pump increases as the filter becomes loaded with dust. It is common for the flow rate to be quite different when filters are heavily loaded, for example as might be the case when tests are carried out to EN 50632 with no on-tool extraction. Furthermore, as the FSP10 uses a cyclone to sample the respirable fraction, the flow rate dictates the particle size fraction sampled, therefore, the before and after flow rate should not differ by more than ±5%.

The above issues are easily resolved by modifying the test procedure to comply with PD CEN/TR 15230 with little or no new equipment required.

3 COMMENTS ON HILTI'S APPROACH TO ON-TOOL EXTRACTION

During the visit to Hilti's Kaufering site, the author had the opportunity to discuss Hilti's approach to on-tool extraction and to visit Hilti's tool testing laboratory.

It was reassuring to observe the holistic approach Hilti have taken to dust control. It is clear that the design of extraction has not been added to the tool as 'an afterthought', rather it has been embedded into the tool design at an early stage. This is important as the insert used in the demonstration described in Section 2.2.3 was manufactured with industrial grade diamonds equally spaced in the cutting segments (model EQD SPX 305/22). See Figure 1. This design increases the life of the insert but also increases the cutting performance and therefore the extraction needs to be designed to cope with this increase in performance.

Figure 1. Blade insert showing the equidistant diamond formation embedded within each segment

This holistic approach was illustrated by the use of computational fluid dynamics (CFD) to predict flow profiles within the housing of the Hilti cutting tool, which are then prototyped and tested (see Figure 2 for an illustration of the use of CFD). This cycle of CFD coupled with prototyping has allowed the extraction design to be optimised.

Hilti understands that whilst the correct volume air flow rate coupled with M-class extraction units is important, the design of the extraction on the tool is critical to ensure effective control of generated dust. This concept is noted in HSE guidance[6]. Simply put, if the hood is not able to capture and retain the dust created, the filtration of the vacuum unit is irrelevant. It is clear that Hilti recognise the importance of design.

Attention to detail was also evidenced during a visit to the tool testing laboratory, where extensive testing was being carried out to determine the lifetime of components as well as studying the effects on vibration. This information is used to improve tool design and inform the service intervals programmed into the tools electronics timers.

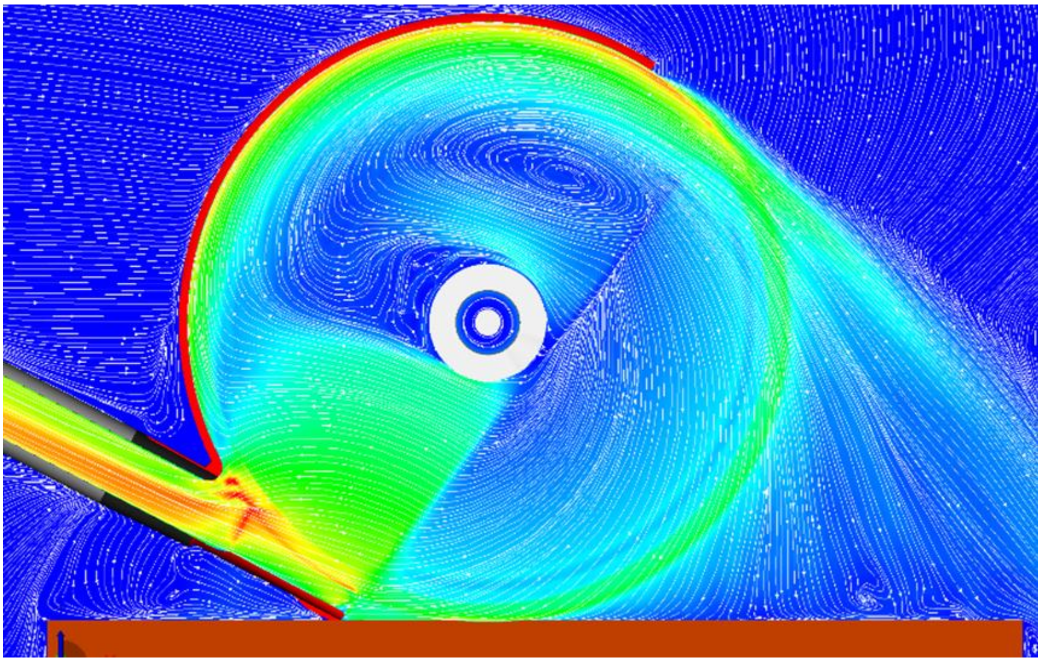
Figure 1. An illustration of how CFD is used to predict flow profiles in and around the housing of the Hilti cutter

4 CONCLUSIONS

Hilti have designed and built a test room that complies with the requirements of EN 50632-1. They also have the appropriate scientific equipment to carry out the personal sampling requirements detailed in the standard, including a system in place to ensure equipment is calibrated on an annual basis.

Hilti need to alter the personal sampling methodology to comply with PD CEN/TR 15230, which details guidance for sampling of inhalable, thoracic and respirable aerosol fractions, although it is noted that reference to PD CEN/TR 15230 is not included as a Normative References within EN 50632-1.

It is clear that Hilti have a philosophy where engineering controls are integrated into their tools as part of their tool design process. It is the author’s opinion that this approach is the key to achieving effective, reliable dust control, whilst ensuring that a power tool is comfortable and easy to use.

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