

The effectiveness of British Standard BS EN ISO 28927-10:2011 concerning the vibration emission of percussive drills, hammers and breakers

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Hand-Arm Vibration Syndrome (HAVS) is a painful and disabling disorder of the blood vessels, nerves and joints, caused by exposure to hand transmitted vibration, often from use of power tools. HAVS is preventable, but once damage is done, it is irreversible.

The Supply of Machinery (Safety) Regulations 2008 require manufacturers to minimise machinery vibration risk and declare vibration emission. British standard test codes can be used for this declaration.

This report will be of interest to standards makers and technical specialists dealing with hand arm vibration emission standards. It describes work carried out up until 2013 to investigate BS EN ISO 28927-10:2011, a British Standard that defines a vibration emission test code for percussive drills, hammers and breakers.

For the majority of tool types covered, the test code does not produce vibration magnitudes that represent the in-use vibration; the only exception being some rock drills. Any risk assessment based on emission values generated by this test code would be likely to result in a serious underestimate of the in-use vibration risk.

Use of the dynamic loading device (known as the dynaload) for testing vibration emissions is not suitable for generating values that reflect the upper quartile of in-use vibration magnitudes.

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The effectiveness of British Standard BS EN ISO 28927-10:2011 concerning the vibration emission of percussive drills, hammers and breakers

Sue Hewitt, Graeme Hunwin and Mick Mole
Health and Safety Executive
Harpur Hill
Buxton
Derbyshire SK17 9JN

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KEY MESSAGES

Prolonged exposure to vibration transmitted to the hand can cause painful and disabling disorders of the blood vessels, nerves and joints. These health effects are referred to as Hand Arm Vibration Syndrome (HAVS). HAVS is preventable, but once the damage is done, it is permanent.

This report describes work done on percussive tools up until 2013. It will be of interest to standards makers and technical specialists dealing with hand arm vibration emission standards. It describes an investigation of BS EN ISO 28927-10:2011, the British standard that defines a vibration emission test code for percussive drills, hammers and breakers to establish vibration emission information for the management of risk.

For the majority of tool types the vibration emission test code in BS EN ISO 28927-10:2011 does not produce vibration magnitudes that represent the in-use vibration; the only exception being some rock drills. Any risk assessment made based on emission values generated by this test code would be likely to result in a serious under-estimate of the in-use vibration risk.

Use of the dynamic loading device known as the dynaload is not a suitable technique for generating emission values for percussive tools that reflect the upper quartile of in-use vibration magnitudes, as required by BS EN ISO 20643:2008+A1:2012.

EXECUTIVE SUMMARY

Background

Prolonged exposure to vibration transmitted to the hand can cause painful and disabling disorders of the blood vessels, nerves and joints. These health effects are referred to as Hand Arm Vibration Syndrome (HAVS). HAVS is preventable, but once the damage is done, it is permanent.

The Supply of Machinery (Safety) Regulations 2008 requires manufacturers to minimise vibration risk from their machinery and to declare the vibration emission. The measurement method and operating conditions to determine vibration emission must be specified; this may be by reference to a British standard, which must include the appropriate part number and date.

Following publication of the British standard test codes, and in anticipation of declared vibration emission data being used to assess and manage workplace risk, the Health and Safety Executive (HSE) began to investigate the relationship between vibration emission measured according to British standards and the vibration measured in use. This report describes the findings from tests, conducted for percussive drills, hammers and breakers up until 2013, to establish vibration emission information for the management of risk.

Objectives

At the time of testing, the current version of the test code for measurement of vibration emission of the pneumatic tools investigated for this project was BS EN ISO 28927-10:2011. As part of the project, HSE investigated the differences between this test code and the test code for electric tools of similar application, BS EN ISO 60745-2-6:2007. The objectives of the work described in this report were:

1. To assess the standard test defined in BS EN ISO 28927-10:2011 for usability, repeatability and reproducibility.
2. To evaluate the influence of differences in the standardised specification for the dynamic loading device for pneumatic and electric tools and also evaluate differences in the interpretations of those specifications.
3. To compare measured vibration emission values according to BS EN ISO 28927-10:2011 with vibration magnitudes measured under real operating conditions and to consider the factors that might influence the relationship between the two.
4. To produce information regarding (3) above, so that HSE can better inform users and suppliers of machines of the worth of vibration emission data measured in accordance with BS EN ISO 28927-10:2011, in terms of estimating likely vibration exposures.

Main Findings

Nine tools were selected for testing in accordance with BS EN ISO 28927-10:2011. The test was found to be repeatable.

Most of the tools tested had a declaration in accordance with a previous version of the test code which was in the BS EN 28662 series. This meant that assessment of the reproducibility was confined to the 2 tools for which the manufacturer had declared in accordance with BS EN ISO

28927-10:2011. The 2 tools were from the same manufacturer. Both of the declarations were verified.

BS EN ISO 28927-10 and BS EN ISO 60745-2-6 have slightly different specifications for the dynamic loading device (dynaload). Investigation of the effects of these differences showed that the height of the device had little influence on the HSE measured emission for 5 of the 7 tools for which a comparison was made. However, the internal diameter of the collar retaining the test bit had a significant influence on the HSE measured emission, for 4 of the 5 tools for which the comparison was made. The differences in specification between pneumatic and electric powered tools mean that emission values derived for pneumatic tools can be systematically lower than their electric counterparts.

Comparison of the HSE measured emission values, a , with the in-use vibration measured on the same machines showed that the BS EN ISO 28927-10:2011 emission values reflect the upper quartile of in-use vibration magnitudes in only 1 of the 9 cases (11%). This one instance was for a rock drill which was tested drilling into concrete in accordance with the BS EN ISO 28927-10:2011 test for tools of this type. None of the a emission values of the 8 tools measured with a dynaload reflected the upper quartile in-use vibration.

For 3 of the tools the HSE measured a emission value was only one fifth of the upper quartile in-use value and for a further 3 tools the HSE measured a emission value was only one half on the upper quartile in-use value. Considering the $a+K$ value, only 2 out of 9 of the declarations (22%) could be considered to reflect in-use vibration magnitudes. Any risk assessment made based on emission values generated by this test code would result in a serious under-estimate of the likely risk in most cases.

Use of the dynamic loading device, known as the dynaload, is not a suitable technique for generating emission values which reflect the upper quartile of in-use vibration magnitudes for percussive drills, hammers and breakers.

Recommendations

Consideration should be given to replacement of the dynaload in vibration emission test codes for percussive drills, hammers and breakers, because it has been shown to be unsuitable for generating emission values which reflect the upper quartile of in-use vibration magnitudes, as required by BS EN ISO 20643:2008+A1:2012.

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1. INTRODUCTION

The Health and Safety Executive (HSE) has an ongoing programme of research, carried out by staff at its research laboratory at Buxton. HSE has been investigating the relationship between manufacturers' declared vibration emission, HSE measured emission and vibration magnitudes measured during simulated real or real use, for different categories of tool.

Through its work, of which this research is a part, the HSE has succeeded in raising awareness of the issues associated with hand-arm vibration amongst power tool manufacturers and end users. With the help of colleagues in the wider scientific community in Europe, HSE has pushed for and secured changes to the way that standard test codes are developed and applied. As a result, the information required by law and supplied with machinery will now be more likely to closely represent the risk from use of a machine. By securing and supporting the development and implementation of test codes, which generate vibration information that is at least intended to be a reasonable reflection of the actual vibration risk, the workforce are far less likely to be unwittingly exposed to excessive levels of hand transmitted vibration.

The current programme of research aims to investigate the newly revised emission test codes for pneumatic tools defined in the BS EN ISO 28927 series of standards. These test codes have been produced in line with the requirements of BS EN ISO 20643:2008+A1:2012, which specifies, amongst other things, that the emission values from test codes should reflect the upper quartile of in-use vibration. This report describes an investigation of the effectiveness of BS EN ISO 28927-10:2011 concerning the vibration of hand-held, power-driven percussive drills, hammers and breakers. In particular, the work addresses the question of whether the revised test code is capable of producing data that reflect the vibration risks associated with use of machines that fall within its scope. The BS EN ISO 28927 series of test codes is a revision of the older BS EN 28662 series, which previous research by HSE showed to be unsuitable for the purposes of risk assessment.

1.1 DECLARATION OF VIBRATION EMISSION

The Supply of Machinery (Safety) Regulations 2008 require that, among other information, suppliers of machinery must declare the vibration emission of their tools and machines. The purpose of declaring such information is to allow purchasers and users of tools and machinery to make informed choices regarding the safety of a potential purchase. A method of declaring vibration emission and gaining a presumption of conformity is to apply a harmonised standard test to a machine or tool. The purpose of a standard test is to provide a repeatable and reproducible method of producing a vibration emission value for declaration purposes. In respect of emission testing, repeatability and reproducibility are defined as:

- Repeatability - the ability of the test to replicate the result for a specific product upon repeat of the series of tests for the tool, the same group of operators and the same test and measurement system.
- Reproducibility - the ability of the test to replicate the result for a specific product upon conducting the series of tests for the same tool, with each test house using their own group of operators and their own test and measurement system.

In practice it has been difficult to design a standard test that is both based on a realistic operation and provides the repeatability and reproducibility sought by manufacturers; therefore the standard tests are often based on artificial operations.

The previous series of test codes for pneumatic tools, the BS EN 28662 series, was produced in the 1990s. At that time, it was accepted practice to measure a single, highest axis of vibration as a means of establishing the likely vibration risk from use of a machine. In 2001, the standard for field measurement, BS EN ISO 5349 parts 1 and 2, was revised to require triaxial measurements of vibration from power tools for risk assessment purposes. In 2005 the Control of Vibration at Work Regulations also required triaxial measurements. BS EN ISO 20643:2005 was also produced. This standard gives guidance on production of vibration test codes and also recommends triaxial measurements.

The BS EN ISO 28927 series is a revision of the BS EN 28662 series of test codes, which brings the test codes for pneumatic tools in line with the requirement for triaxial measurements of vibration. The BS EN ISO 28927 series specify measurements at both hand locations, rather than just one, with declaration of the vibration emission at the higher hand. The procedures for some machines are also modified to make the test conditions more representative of real work and thereby produce vibration emission values that better represent the likely vibration risk from use of the machine. BS EN ISO 20643 (including the most recent version; BS EN ISO 20643:2008+A1:2012) specifies that the target for the declared emission value is to reflect the upper quartile of in-use vibration.

1.1.1 Emission declaration

The declaration of vibration emission values is standardised under BS EN 12096:1997. This standard gives the following vibration related definitions:

1. **Measured vibration emission value, a , in m/s^2** — a value that represents the measured vibration emission value of a single machine or the mean value of a reasonably large sample from a batch of machines.
2. **Uncertainty, K , in m/s^2** — a value representing the measurement uncertainty of the measured vibration emission value a , and also, in the case of batches, production variations of machinery.
3. **Declared vibration emission value, $a+K$** — the sum of the measured vibration emission value, a , and its associated uncertainty, K . The sum of a and K indicates the limit below which the vibration value of an individual machine, and/or a specified large proportion of the vibration values of a batch of machines, is stated to lie when the machines are new.

1.2 OUTLINE OF WORK

The latest standard test code for measurement of vibration emission of pick hammers and chipping hammers is BS EN ISO 28927-10:2011 “Hand-held portable power tools – Test methods for evaluation of vibration emission. Part 10: Percussive drills, hammers and breakers (ISO 28927-10:2011)”. As part of the project, differences between this test code and the current test code for electric tools of similar application, BS EN ISO 60745-2-6, were investigated. The objectives of the work described in this report were:

1. To assess the standard test defined in BS EN ISO 28927-10:2011 for usability, repeatability and reproducibility.
2. To evaluate the influence of differences in the standardised specification for the dynamic loading device for pneumatic and electric tools and also evaluate differences in the interpretations of those specifications.

3. To compare measured vibration emission values with vibration magnitudes measured under real operating conditions and to consider the factors that might influence the relationship between the two.
4. To provide HSE with information regarding (3) above, so that it can better inform users and suppliers of machines of the worth of vibration emission data measured in accordance with the current standard, in terms of vibration exposure.

To achieve these aims, the vibration emission of a selection of small pneumatic hammers, chipping hammers, demolition hammers, riveting hammers and rock drills was measured according to the provisions in BS EN ISO 28927-10:2011.

After completion of laboratory measurements of the vibration emission, field measurements using all of the same transducer mounting locations were made in order to compare emission and field data. The current standard technique for workplace exposure measurements is defined in BS EN ISO 5349 parts 1 and 2:2001. In BS EN ISO 5349-2:2001 the transducer mounting locations are defined in the centre of the gripping zone. This is different from the location defined in BS EN ISO 28927-10:2011. To ensure that selection of mounting location did not cause a systematic error in the results for comparison, the BS EN ISO 28927-10:2011 mounting locations were used for both emission and field measurements.

2. TOOLS TESTED

The test code BS EN ISO 28927-10:2011 relates to hand-held, pneumatic power-driven percussive machines, with and without rotary action. From this standard, the definitions of machines that fall into this category include:

- Rotary hammer - rotary percussive drill with spiral drill bit and without air flushing
- Breaker - percussive machine for breaking up concrete, rock, brick work and asphalt
- Plug hole drill - rotating percussive machine with spiral or straight drill mainly intended for drilling in concrete, rock, bricks, etc.
- Chipping or chiselling hammer - percussive machine for chipping, caulking, trimming or fettling castings, welds, etc., normally using chisels or inserted cutting/shaped tools
- Riveting hammer - percussive machine for forming rivet heads
- Pick hammer - percussive machine for light demolition or mine work
- Rock drill - percussive power rotating machine with flushing for drilling holes in rock, concrete, etc.

In order to maximise the relevance of the HSE research, the tools selected for testing were chosen to represent as broad a spectrum of machines covered by the test code as possible. Machines were chosen mostly from the major manufacturers, with one or two additional machines also chosen to represent the types of machines more often used in small and medium sized enterprises (SMEs).

Hammers are supplied with a number of different chisels for a variety of applications on different materials. Depending on the attachments, hammers can be tested under BS EN ISO 28927 part 9 as a scaling hammer and part 10 as a chipping/chiselling hammer.

All of the tools came with a vibration emission value, a , declared by the manufacturer. In most cases the declaration also included a K value, which is an indication of the uncertainty in the emission value. Where no K value has been supplied, a value has been calculated according to the provisions of BS EN 12096:1997, where a single machine has been tested.

3. LABORATORY TESTING OF VIBRATION EMISSION

3.1 BS EN ISO 28927-10:2011 EMISSION TEST CODE

Two possible test conditions are specified for percussive drills, hammers and breakers depending on the type of machine. The test can be made either using a Steel Ball Energy Absorber (SBEA), also known as a ‘dynaload’, or drilling into concrete. Some tools covered by the test code should be tested under both conditions. For example, a percussive machine which can be used either with or without rotation should be tested as a chiselling hammer, in a dynaload and as a rotary drill, drilling into concrete.

Table 1 shows details of the tools selected for testing and the test applied.

Table 1. Tools selected for testing

Tool	Section ID	Tool mass (kg)	Description	Dynaload test (Y/N and size)	Drilling test (Y/N)	Speed (Impacts/min)
A	NV/11/41	1.54	Pneumatic Hammer	Y(40 mm)	N	3500
B	NV/11/21	1.6	Pneumatic Hammer	Y(40 mm)	N	4000
C	NV/11/42	Not supplied	Chipping Hammer	Y(40 mm)	N	Not supplied
D	NV/11/32	6.4	Chipping Hammer	Y(40 mm)	N	2200
E	NV/12/05	6.3	Demolition Hammer	Y(40 mm)	N	2640
F	NV/12/07	10.5	Demolition Hammer	Y(40 mm)	N	1800
G	NV/12/O/1	1.3	Riveting Hammer	Y(40 mm)	N	2160
H	NV/12/06	15.6	Rock Drill	Y(40 mm)*	Y*	2520
I	NV/12/08	6.9	Rotary Hammer Drill	N	Y	3420

* Tool H was tested both in a dynaload with rotating test bit and drilling concrete for comparison.

3.2 TESTS IN DYNALOADS

According to the requirements of BS EN ISO 28927-10:2011, hammers with percussive action only, such as heavy rock drills and breakers, picks, chiselling and riveting hammers and rotary hammers for which the rotation can be switched off, are tested under load in a dynaload. The dynaload is a dynamic loading device, which attempts to simulate the operating conditions in a test environment.

The dynaload consists of a column of hardened steel ball bearings, contained within a hardened steel tube that is firmly mounted on a rigid base-plate. The machine to be tested is fitted with a purpose-made test tool, which is positioned in the dynaload, resting on top of the column of steel ball bearings. The operator maintains the tool in a vertical position and applies a specified downward push force.

The principle of the dynaload is that the device absorbs some of the blow energy from the power tool. Much of the shock wave is absorbed by the steel balls. However, the design is such that it is intended to reflect 15% to 20% of the energy back to the power tool, as would be the case in a normal working situation. Research carried out by Ward (1998) showed that the reflected energy

from the HSE dynaload was on average 20% of the total energy, although the range for individual impacts could be between 5% and 57%.

3.2.1 Specification and design of dynaloads used in testing

For testing according to BS EN ISO 28927-10:2011, a type 1 dynaload was constructed according to the specifications of the standard and the supplementary document '*DYNALOAD - design, construction, use and maintenance*' (PNEUROP, 2005), which is referenced in the normative Annex C of the standard. Type 1 refers to the style of test bit used, which in this case is a single, solid formed tool piece and anvil.

The dynaload can be one of two sizes, depending on the diameter of the test bit of the machine that is to be tested. The two sizes, 40 mm and 60 mm refer to the diameter of the steel ball column (see Figure 1a). The shank diameter of each of the tools tested in a dynaload was less than 23 mm, therefore all tools were tested in a 40 mm diameter dynaload.

HSE investigations according to earlier vibration test codes for different tool types have been made using a 40 mm dynaload, which met the specifications in the individual standards. The standards concerned were:

- BS EN 28662-5:1995 (Ward 1998)
- BS EN 28662-2:1995 (Hewitt et al, 1999)
- BS EN 28662-5:1995 (Hewitt et al 2006) and
- BS EN 60745-2-6:2003+A2:2009 (Hewitt et al 2010).

Each of these standards provides only limited specifications for the design of the dynaload. The PNEUROP document includes a more detailed specification of the device and includes some differences from the HSE dynaload used for previous tests. The main differences include specification of the length of the cylinder and the height of the test bit above the top of the dynaload and a tighter clearance between the collar and the test bit in the neck of the dynaload. Because these differences were considered to have the potential to affect results, HSE constructed a new dynaload to ensure that tests were strictly in accordance with the specification of BS EN ISO 28927-10:2011 and met all the requirements of the PNEUROP document.

To investigate the effect on measured vibration emission values of the differences in the specification of the dimensions of the dynaload constructed according to the requirements of BS EN ISO 28927-10:2011, Tools A to G were tested in both of HSE's dynaloads. The older dynaload was constructed for previous research, according to the requirements of the previous BS EN 28662 and BS EN ISO 60745 series of test codes, and the new dynaload according to BS EN ISO 28927-10:2011.

Figure 1a shows a drawing of a dynaload, with the main components identified. Figure 1b is a photograph of the HSE type 1 40 mm dynaload constructed according to the specifications of BS EN ISO 28927-10:2011 and PNEUROP, 2005. This dynaload is referred to as the new dynaload throughout this report. Figure 1c shows the new dynaload (on the left) and the dynaload used for previous HSE tests (subsequently referred to as the old dynaload), mounted side-by-side, ready for the comparative tests.

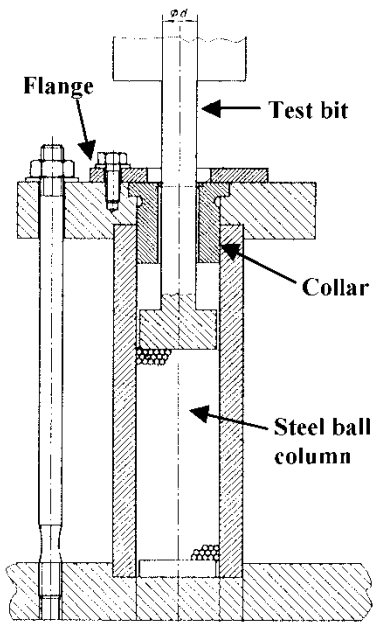


Figure 1a. Illustration of the main components of a type 1 dynaload



Figure 1b. HSE type 1 40 mm dynaload to BS EN ISO 28927-10:2011



Figure 1c. New (on left) (BS EN ISO 28927-10:2011) and old dynaloads

3.2.1.1 Differences in collar

The specifications for the collar of the new dynaload require that “a clearance of 1 mm on the diameter of the hole should be maintained between the bush and the inserted tool piece.” In previous test codes, a clearance of 3 mm between the tool piece and the collar was indicated. As the collar diameter and the consequences of the test bit contacting the collar, are known to have an effect on the measurement of vibration magnitudes, this difference alone could be sufficient to

generate differences in results between the two dynaloads. To attempt to control for this, a new collar was made for the old dynaload, with a 1 mm clearance rather than a 3 mm clearance. The depth of this collar could not however be made in accordance with the specification of the PNEUROP document, because of the smaller cylinder height in the old dynaload.

Figure 2a shows the collar for the new dynaload. Figure 2b shows the collars for the old dynaload. On the left of Figure 2b is the collar manufactured with a 1 mm clearance for use with the old dynaload and on the right is that with a 3 mm clearance from previous tests for the old dynaload. Figures 2a and 2b also show the differences in height of the collars.



Figure 2a. Collar for new dynaload to BS EN ISO 28927-10:2011



Figure 2b. Collars for old dynaload; 1 mm clearance (left) and 3 mm clearance (right)

Figure 2a shows the grooves both inside and outside the collar that are specified in the PNEUROP document. The grooves on the collar are there to accommodate o-rings (not shown) to seal the bush in the top of the dynaload. In Figure 2b, an o-ring is shown in place on the outside of the left hand collar. The o-rings on the outside of the collar hold the collar centrally in the dynaload. The collar on the right of Figure 2b with 3mm clearance for the old dynaload does not have o-rings.

Figure 3 shows examples of the test bits manufactured for both the new dynaload (left), and the old dynaload (right).

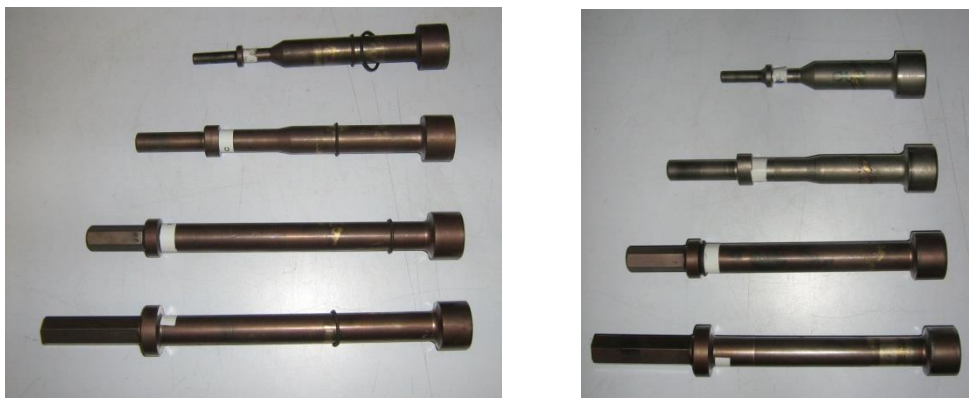


Figure 3. Examples of test bits for the new dynaload (left) and those for the old dynaload (right)

The test bits for the new dynaload are approximately 50 mm longer in the main part of the shaft than those for the old dynaload. This is to ensure that the top section of the test bit protrudes to

the correct height above the top plate of the dynaload, as specified in the normative Annex of BS EN ISO 28927-10:2011. The test bits for the new dynaload are also fitted with o-rings, which are moved to the correct location inside the groove on the inner wall of the collar when fitted in the new dynaload. These o-rings also ensure that the test bit is held centrally and vertically in the dynaload. The test bits for the old dynaload do not have o-rings fitted.



Figure 4. Test set-up for tools operated in the dynaloads

Figure 4 shows an example of the test set-up for a hammer in the dynaload. The operator is standing on a force platform. A monitor displays the feed force to the operator so that he can control and maintain a steady feed force during operation of the tool. The feed force specified in the standard and applied to each tool for each emission test is shown in Table 2 below.

Table 2. Feed forces applied to each tool during the emission tests

Tool ID	Feed force (N)
A	60
B	60
C	60
D	60
E	100
F	150
G	60
H	240

3.2.2 Drilling Tests

For rotary hammers, plug hole drills and light rock drills (defined as equal to or less than 15 kg in BS EN ISO 28927-10:2011), the emission test method involves drilling vertically downwards into non-reinforced concrete (see Figure 5). The concrete has a compressive strength and

formulation as specified within the standard. The concrete block was positioned on a wooden pallet, in order to compensate for any unevenness of the floor surface.

Two machines were included in the drilling tests. Tool I is described by the manufacturer as a 'rotary hammer drill'.

Tool H is described by the manufacturer as a 'light rock drill' and for this reason was tested drilling into concrete. However, BS EN ISO 28927-10:2011 defines a 'light' rock drill as having a mass of less than or equal to 15 kg without the inserted tool. Tool H actually has a mass of 15.6 kg, so according to the definition in BS EN ISO 28927-10:2011, it is actually a 'heavy' rock drill. Heavy rock drills require an emission test to be carried out in a dynaload. Tool H was therefore tested under both emission test conditions to investigate the effect on the measured vibration emission. In the dynaload test, the test bit for Tool H was allowed to rotate, as the rotation could not be switched off. This is in accordance with the guidance in the test code.



Figure 5. Emission test set-up for drilling vertically into concrete

3.3 EMISSION TEST PROCEDURE

Whether a machine is tested in the dynaload or drilling concrete, the vibration measurement method is the same. For each of the test conditions, three operators are required to carry out a series of five test runs, after which the coefficient of variation, C_v , is calculated. The C_v is equal to the standard deviation of the five measurements divided by the mean vibration magnitude of the five measurements.

The test code requires that the value of C_v for five consecutive measurements for one operator should be less than 0.15 for the data to be valid. If the C_v is greater than 0.15, then the standard

requires that ‘*the measurements shall be checked for error before the data are accepted*’. If there is concern about the magnitude of the variability, then testing continues until five consecutive measurements give an acceptable value of C_v , which will normally be less than 0.15.

For each tool, the overall arithmetic mean vibration emission value, a , is obtained from the mean values for three operators. A value for the individual tool uncertainty, K , is calculated from the results of all the three operators. For emission declarations according to BS EN ISO 28927-10:2011 both a and K values should be given.

The vibration emission declarations are given in terms of the vibration total values at each measurement location. The vibration total value is the root-sum-of-squares of the vibration magnitudes in three orthogonal axes of vibration.

3.3.1 Equipment

A list of the equipment used for the vibration emission measurements is given in Annex A.

3.3.2 Transducer mounting locations

The transducer mounting locations are specified in BS EN ISO 28927-10:2011 for the different types of machine. The general principle is that the transducers are located as close as possible to the hand between the thumb and the index finger, where an operator normally holds the machine. Annex B contains figures showing the transducer mounting locations for different types of machine.

3.4 DATA ACQUISITION AND ANALYSIS

The transducers used for all the measurements were Brüel & Kjær (B&K) type 4393 piezoelectric accelerometers. For each measurement location, the accelerometers were bolted on to an aluminium mounting block, which was fixed using a plastic cable tie fitted using a tensioning gun. The total mass of this mounting assembly was ~18 grams.

The signals from the transducers were amplified using B&K type 2635 charge amplifiers and analysed using a B&K Pulse multi-channel real time frequency analyser. Vibration was measured in unweighted one-third octave bands for each of the three accelerometers at each hand position. The one-third octave band data were frequency-weighted in accordance with BS EN ISO 8041:2005 and then the vibration total values were calculated.

After five consecutive measurements, the coefficient of variation C_v , was calculated. If the C_v was greater than 0.15, then testing continued until five consecutive measurements gave an acceptable value of C_v .

4. FIELD MEASUREMENTS

4.1 IN-USE TESTS

All field measurements were carried out at the HSE's laboratory in Buxton. Measurements were made whilst carrying out a number of different activities, as appropriate to the different accessories supplied with each tool, under conditions of typical use.

4.1.1 Pneumatic Hammers - Tools A and B

The pneumatic hammers were tested whilst carrying out a number of appropriate activities, using tools supplied with the kits. The possible tests were:

- Rivet busting tool - removing 0.5 inch countersunk, aluminium rivets (as used in the riveting hammer tests described below), from two steel plates, which were mounted horizontally (illustrated in Figure 4a) and vertically
- Punching tool - punching out 0.5 inch countersunk, aluminium rivets from steel plates riveted together, after the rivet heads had been removed
- Punching tool - punching holes into a car bonnet
- Panel ripping tool - ripping a car bonnet over a distance of approximately 20 to 30 cm in length (illustrated in Figure 4b)



Figure 4. (a) Rivet busting (left) and (b) panel ripping (right)

For each test activity listed above, each vibration measurement was made over a 30 second period of operation, and each operator repeated each test three times. Whilst punching holes in the car bonnet, each operator punched a series of holes and a single vibration measurement of 30 seconds duration was made.

4.1.2 Chipping Hammers – Tools C and D

The following activities were carried out using either or both of the chipping hammers:

- Chipping rust from a steel plate with the tool at approximately 45° angle to surface
- Chipping weld from a steel bar
- Chipping rust and paint from a piece of angle iron
- Breaking a concrete block with a moil point tool.

Each test was measured over 16 seconds, and each test was repeated three times by each of the operators.

4.1.3 Demolition Hammers – Tools E and F

The in-use activities using either or both of the demolition hammers included:

- Breaking a 40 Newton concrete block with amoil point and/or chisel (Figure 5a)
- Breaking a concrete pad with amoil point or a chisel. Tests with tool F were carried out for the following conditions:
 - Continuous throttle – the tool was run continuously and included natural periods of no load exposure
 - Intermittent throttle – the tool was used in accordance with the manufacturer’s guidance and therefore included periods whilst the throttle was released, ie in between removing and reapplying the tool to the surface
- Demolishing a brick wall (Figure 5b).



Figure 5. (a) Breaking the concrete pad (left) and (b) demolishing a brick wall

Each operator repeated each activity 3 times. The measurement duration for each test was 30 seconds.

4.1.4 Riveting Hammer – Tool G

Measurements of the in-use vibration of the riveting hammer (Figure 6a) and “bucking bar” (Figure 6b) were made whilst riveting two steel plates together, with rivets of 0.25 inches in diameter by 0.5 inches in length. Tests were carried out with both aluminium and mild steel rivets. Each operator carried out a single test, which consisted of fitting up to 6 rivets. The test was measured over the duration of the task.

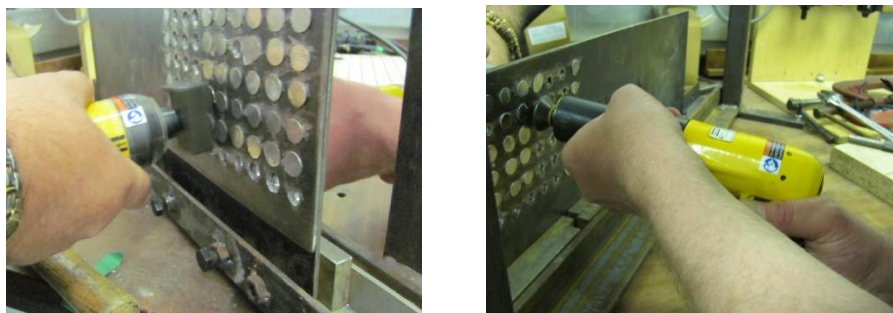


Figure 6. (a) Backing the rivets with the bucking bar (left) and (b) fitting rivets with a hammer

The rivets were supported or closed using a bucking bar supplied with the tool. A bucking bar is a device used to provide a reaction surface for the rivet to close on to. A second operator is needed to hold the bucking bar on the other side of the workpiece. Measurements were also made on the bucking bar during the testing. The bucking bar had a vibration isolation system, and this could be overridden if heavy forces were applied during its use. To investigate if the bucking bar had an influence on the results for the riveting hammer, measurements were made at both normal and high levels of force.

4.1.5 Rock Drill and Rotary Hammer Drill - Tools H and I

The rock drill and the rotary hammer drill were tested under the following conditions:

- Drilling vertically into a 40 N concrete block (Figure 7a)
- Drilling vertically into a reinforced concrete pad (Figure 7b)



Figure 7. (a) Drilling vertically into concrete block, and (b) drilling into reinforced concrete pad

Each measurement was made over the time to complete a single hole. Each operator drilled a minimum of 3 holes to the full depth of the drill bit.

4.2 MEASUREMENT TECHNIQUE

The equipment listed in Annex A was also used in the field tests. The data acquisition technique for the field measurements was the same as for the laboratory tests. For each operator, sample measurements of vibration magnitudes were made during use of the tool. Transducers were mounted in the same locations and using the same techniques as in the emission tests. Data were analysed using a B&K Pulse multi-channel, real time frequency analyser. One-third octave band analyses of the data were carried out. The data were also frequency-weighted in accordance with BS EN ISO 8041:2005.

All of the measurements obtained for each tool were used to derive a mean frequency-weighted vibration magnitude and standard deviation, and an upper quartile value from the range of magnitudes for that tool.

5. RESULTS

5.1 EMISSION TEST RESULTS

Annex C contains the full data from the HSE emission tests for all the tools tested.

5.1.1 Emission test comparisons

Table 3 contains a summary of the HSE emission test results according to the requirements of BS EN ISO 28927-10:2011, for all of the tools tested. The figures in bold indicate the handle position for which the magnitude of the measured vibration was higher.

Table 3. HSE measured emission test results

Tool ID	HSE measured emission (m/s ²)							
	Test Condition	Throttle handle		Support handle		Highest hand		
		<i>a</i>	<i>k</i>	<i>a</i>	<i>k</i>	<i>a</i>	<i>k</i>	<i>a+k</i>
A	Dynaload	2.8	1.0	3.4	1.0	3.4	1.0	4.4
B	Dynaload	2.5	0.8	2.8	0.8	2.8	0.8	3.6
C	Dynaload	9.6	1.5	9.5	1.7	9.6	1.5	11.1
D	Dynaload	11.6	1.7	11.3	1.6	11.6	1.7	13.3
E	Dynaload	1.2	1.2	2.4	1.9	2.4	1.9	4.3
F	Dynaload	8.1	1.6	9.0	1.4	9.0	1.4	10.4
G	Dynaload	3.2	2.1	3.1	2.2	3.2	2.1	5.3
H*	Drilling concrete	10.7	2.0	9.6	3.3	10.7	2.0	12.7
H*	Dynaload (rotating)	6.4	1.2	6.6	1.2	6.6	1.2	7.8
I	Drilling concrete	7.2	1.8	8.7	1.4	8.7	1.4	10.1

* Tool H has options for both 19 and 22 mm chuck dimension. The HSE measured emission data relates to the 19 mm dimension tool, tested in concrete and also in a 40 mm dynaload with rotating test bit.

Note that for each pair of comparable tools; A and B, C and D, E and F, the same hand position is the higher of the two. Tools H and I were tested as the same type of tool, but have different handle configurations, so they are not comparable.

5.2 FIELD MEASUREMENTS

Table 4 summarises the field measurement results on the 7 different types of pneumatic hammer for each of the different test conditions. Results are given in terms of the mean, standard deviation and upper quartile of the frequency-weighted highest hand total values for each of the different operating conditions. Annex D contains the data from the HSE field tests for all the tools.

Annex E contains additional data for the use of the riveting hammer, Tool G, which is used in conjunction with a bucking bar.

Table 4. Field measurement results for the 7 different pneumatic hammers tested

Tool ID	Application	Field total values (m/s ²)		
		Mean	Std dev	Upper quartile
A	Rivet busting aluminium rivet heads	11.2	2.2	12.6
A	Rivet busting aluminium rivet shank	11.9	1.8	13.1
A	Punching out aluminium rivets	10.3	1.9	11.7
A	Punching holes into car bonnet	12.1	2.9	13.8
A	Panel ripping	22.8	3.8	26.0
B	Panel ripping	23.9	9.9	26.6
B	Rivet busting aluminium heads, mounted vertically	22.5	4.6	25.2
B	Rivet busting aluminium heads, mounted horizontally	17.8	3.1	19.3
B	Punching out aluminium rivets, mounted vertically	9.6	1.9	11.1
C	Chipping rust from steel plate at approx. 45 degrees	21.9	2.0	23.2
C	Chipping weld from angle iron	20.7	1.9	21.9
C	Chipping weld and rust from painted angle iron	24.2	0.8	24.7
C	Chipping weld from base of steel bar	19.6	2.0	21.1
D	Chipping lengths of weld from steel bar	31.7	3.6	33.3
D	Chipping weld and rust from painted angle iron - low force	32.4	1.8	33.1
D	Breaking concrete block withmoil point	13.6	3.8	14.5
D	Chipping weld and rust from painted angle iron - high force	23.0	5.1	28.9
D	Chipping lengths of weld from steel bar - high force	29.6	2.0	31.2
E	Breaking 40 N concrete withmoil point	14.3	2.7	16.6
E	Breaking 40 N concrete with chisel	13.4	1.7	14.4
E	Breaking concrete pad with chisel	14.6	1.3	14.8
E	Demolishing brick wall	15.5	4.9	19.1
F	Breaking concrete pad withmoil point - continuous throttle	22.9	3.3	25.1
F	Breaking concrete pad withmoil point - intermittent throttle	12.6	2.5	14.3
F	Breaking 40 N concrete withmoil point	16.7	5.6	22.6
G	Riveting steel plate - mild steel rivets - high force on bar	4.6	0.7	5.0
G	Riveting steel plate - mild steel rivets - low force on bar	5.5	1.8	6.0
G	Riveting steel plate - aluminium rivets - low force on bar	4.3	0.9	4.7
G	Riveting steel plate - aluminium rivets - high force on bar	4.2	0.5	4.3

Table 5 shows the field total values for the mean and standard deviation, along with the upper quartile, for the rock drill and rotary hammer drill for each of the different test conditions.

Table 5. Field measurement results for the rock drill and rotary hammer drill

Tool ID	Application	Field total values (m/s ²)		
		Mean	Std dev	Upper quartile
H	Drilling 40 N concrete block	10.5	0.8	11.0
H	Drilling concrete pad with rebar	10.6	0.8	11.1
I	Drilling 40 N concrete block	8.7	0.7	9.3
I	Drilling concrete pad with rebar	8.8	0.4	9.1

The data in Tables 4 and 5 are illustrated in Figures 8 and 9.

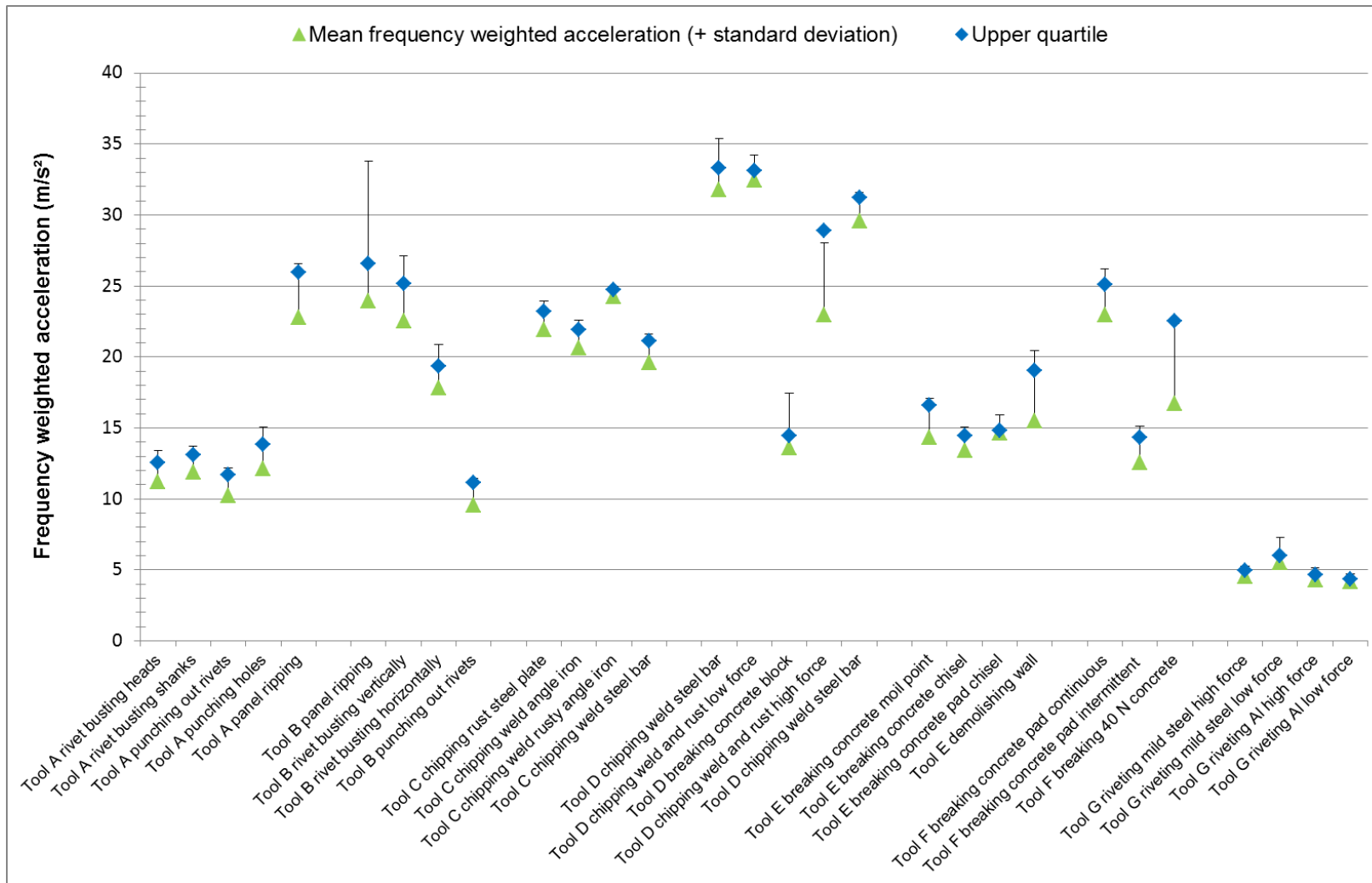


Figure 8. Mean, standard deviation and upper quartile of the frequency-weighted acceleration for Tools A to G - field test data

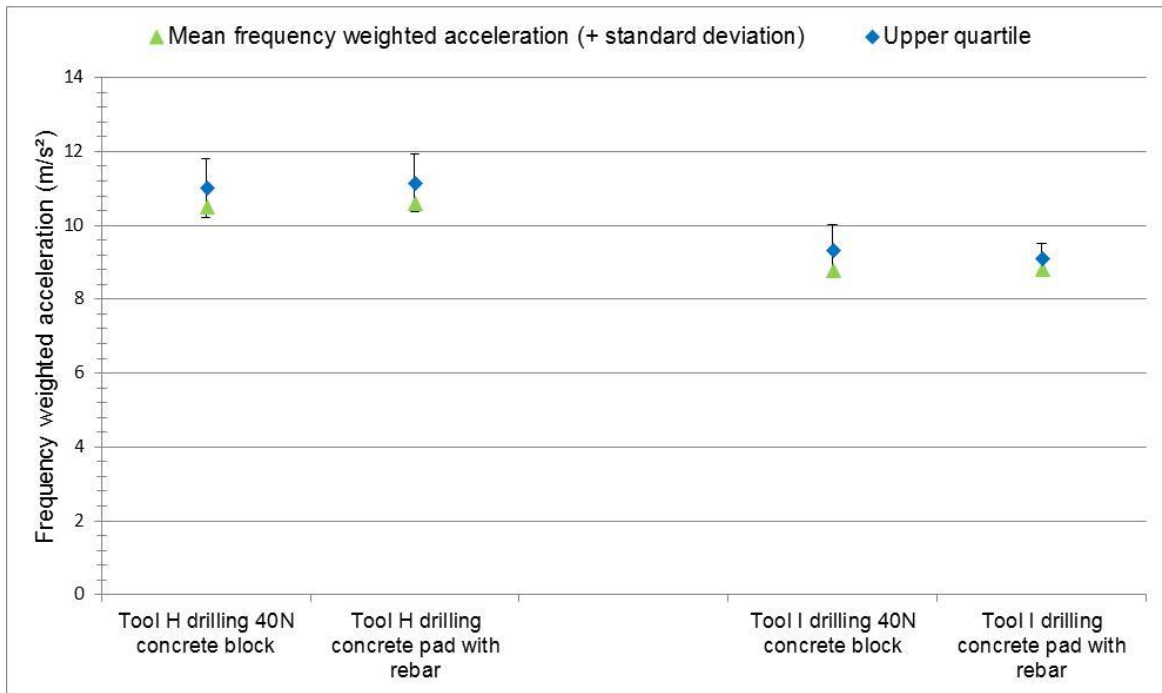


Figure 9. Mean, standard deviation and upper quartile of the frequency-weighted acceleration for drills H and I - field test data

6. DISCUSSION

6.1 COMPARISON OF DECLARED EMISSION WITH HSE MEASURED EMISSION

BS EN 12096:1997 defines the technique for verification of manufacturer's declared vibration emission value where one machine has been tested. The manufacturer's data are verified if the HSE measured a value is less than or equal to the manufacturer's declared $a+K$ value. Table 6 shows the results of this comparison. Where the manufacturer has not declared a K value, to facilitate this comparison, the value of K has been estimated according to the provisions of BS EN 12096:1997. Manufacturers' declared K values are shown in the K_{dec} column, and estimated K values are shown in the K_{calc} column.

At the time the tools for this current study were acquired, BS EN ISO 28927-10:2011 had only relatively recently been introduced. Consequently only two machines, G and H, both from the same manufacturer, had been tested and declared according to this standard. The results in Table 6 show that the HSE measured a emission values verify the manufacturer's declared emission values, according to the criteria described in BS EN 12096:1997 in both cases where the comparison is valid. With only 2 machines tested according to BS EN ISO 28927-10:2011, it is not possible to draw any conclusions about the reproducibility of this test code.

Tool H can be supplied with either a 19 mm or a 22 mm chuck dimension. The manufacturer's declared emission value refers to the 22 mm dimension tool, which is tested in a 60 mm diameter dynaload. The HSE measured emission data relates to the 19 mm dimension tool, tested in a 40 mm dynaload. When tested in a dynaload, despite the size of the dynaload being different to that used by the manufacturer, the HSE measured emission value $a = 6.6 \text{ m/s}^2$ verified the manufacturer's declared emission value $a = 7.0 \text{ m/s}^2$, $K = 1.2 \text{ m/s}^2$.

HSE also carried out emission tests for Tool H, with the tool drilling into concrete. The results of the drilling emission test resulted in an HSE measured emission value of $a = 10.7 \text{ m/s}^2$, $K = 2.0 \text{ m/s}^2$. These data are much higher than the HSE emission values measured in the dynaload test. They are also much closer to the in-use upper quartile values of 11.0 m/s^2 to 11.1 m/s^2 measured during HSE's in-use tests. This is hardly surprising, since the process in the drilling emission test is a realistic operation, very much the same as the in-use test. However, because Tool H has a mass in excess of 15 kg (15.6 kg), it is classed as a heavy rock drill for the purposes of BS EN ISO 28927-10:2011 and should therefore be tested in a dynaload with rotating test bit according to the standard.

6.2 ANOVA ON HSE EMISSION TESTS

The raw data from each of the HSE emission tests were analysed to investigate the significance of any apparent differences in measured emission values. Analysis of variance (ANOVA) was carried out on the HSE emission data to identify any significant differences. The full results of the ANOVA comparisons are given in Annex F. Results of the HSE emission test comparisons are shown graphically in Figure 10 where the mean emission value, a , has been plotted against the standard deviation of the fifteen individual measurements for each tool (ie 3 operators with 5 tests per operator). The error bars on the horizontal axis indicate the K value associated with each HSE emission value.

Table 6. Comparison of manufacturers' declared and HSE measured vibration emission value

Tool ID	Manufacturer's vibration declaration (m/s ²)					HSE Measured vibration emission (m/s ²)								HSE verifies according to EN12096
	Standard	<i>a</i>	<i>K</i> _{dec}	<i>K</i> _{calc}	<i>a+K</i>	Test Condition	Throttle		Support		Highest Hand			
							<i>a</i>	<i>K</i>	<i>a</i>	<i>k</i>	<i>a</i>	<i>k</i>	<i>a+k</i>	
A	ISO 8662-2	30	–	12	42	Dynaload	2.8	1.0	3.4	1.0	3.4	1.0	4.4	n/a
B	–	n/a	n/a	-		Dynaload	2.5	0.8	2.8	0.8	2.8	0.8	3.6	n/a
C	ISO 8662-2	4.3	–	2.2	6.5	Dynaload	9.6	1.5	9.5	1.7	9.6	1.5	11.1	n/a
D	EN-ISO 5349	8	–	3.2	11.2	Dynaload	11.6	1.7	11.3	1.6	11.6	1.7	13.3	n/a
E	ISO 20643	2.4	0.7		3.1	Dynaload	1.2	1.2	2.4	1.9	2.4	1.9	4.3	n/a
F	ISO 20643	4.2	0.9		5.1	Dynaload	8.1	1.6	9.0	1.4	9.0	1.4	10.4	n/a
G	ISO 28927-10	3.9	1.4		5.3	Dynaload	3.2	2.1	3.1	2.2	3.2	2.1	5.3	Y
H*	ISO 28927-10	7	1.2		8.2	Drilling Concrete	10.7	2.0	9.6	3.3	10.7	2.0	12.7	N
H*	ISO 28927-10	7	1.2		8.2	Dynaload (rotating)	6.4	1.2	6.6	1.2	6.6	1.2	7.8	Y
I**	-	n/a	n/a			Drilling Concrete	7.2	1.8	8.7	1.4	8.7	1.4	10.1	n/a

* Tool H has option for both 19 and 22 mm chuck dimension. The manufacturer's declared emission value refers to the 22 mm dimension tool, which is tested in a 60 mm diameter dynaload. The HSE measured emission data relates to the 19 mm dimension tool, tested in concrete and also in a 40 mm dynaload with rotating test bit.

** Manufacturer has provided in-use vibration information (to ISO 5349) on request, but emission test data were not available.

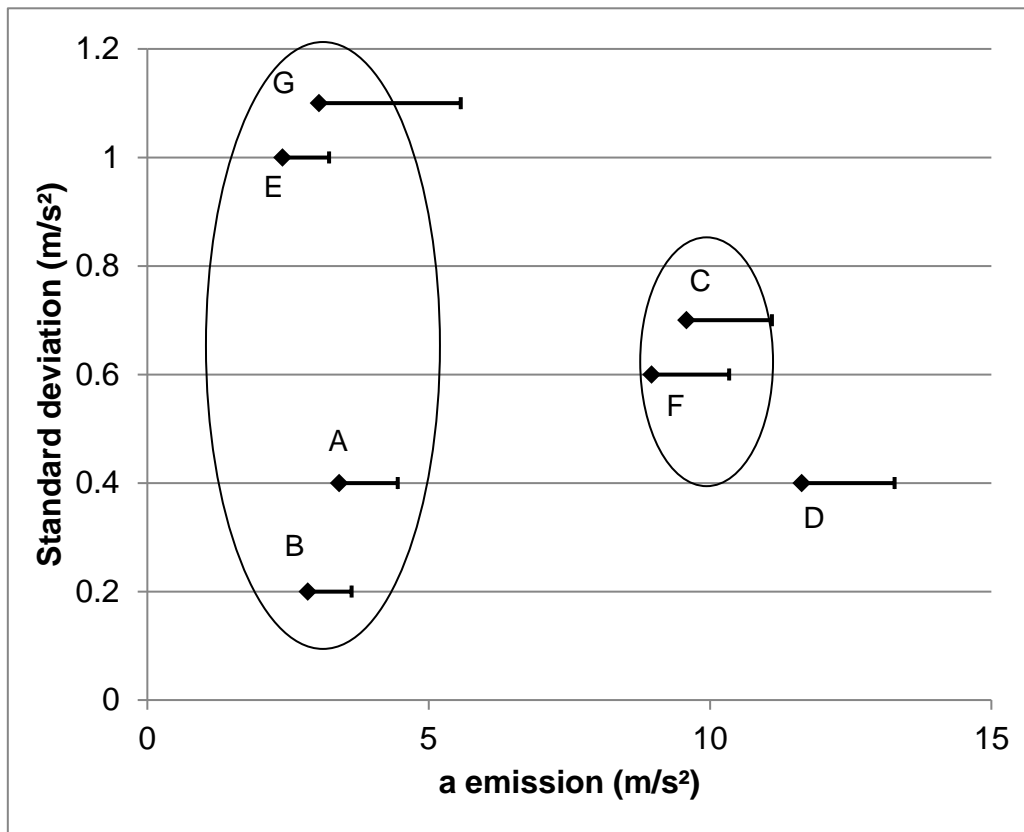


Figure 10. Standard deviation vs a emission for tools tested to BS EN ISO 28927-10:2011 in dynaload without rotation

Tools for which emission values were not significantly different are indicated by circling. The ANOVA indicates one group of four tools, A, B, E and G for which the emission values are not significantly different. C and F are not significantly different from each other and D is the highest emission value, significantly different from all the others.

Analysis of variance showed that the emission values for many of the tools were not distinguishable from each other. Therefore comparison of the emission values by rank and the calculation of a rank correlation coefficient would not be informative. The tests have shown, however, that Tool D is clearly identifiable as the highest vibration tool from the tests in the dynaload.

6.3 COMPARISON OF EMISSION TEST RESULTS FOR NEW AND OLD DYNALOADS

Analysis of variance was used to investigate whether changes to the specification of the dynaload resulted in significant differences in the measured vibration emission value, *a*. The outcome of this ANOVA is also included in Annex F.

Figure 11 illustrates a comparison of HSE measured vibration emission, *a*, values for tools tested in the new dynaload constructed according to BS EN ISO 28927-10:2011 and the old dynaload constructed for investigation of earlier test codes. The left hand bar for each tool (diagonal lined pattern) represents the *a* value measured according to the current test code BS EN ISO 28927-10:2011. The middle (or grey shaded) bar represents the *a* value measured in the

old dynaload constructed for earlier tests, with 1 mm clearance between the collar and the test piece (tight collar). The right-hand bar (white) indicates the a value also measured in the old dynaload, with 3 mm clearance between the collar and the test piece (loose collar). The error bars indicate the K value. The data are also shown numerically in Table 7 with the highest measured emission values shown in bold.

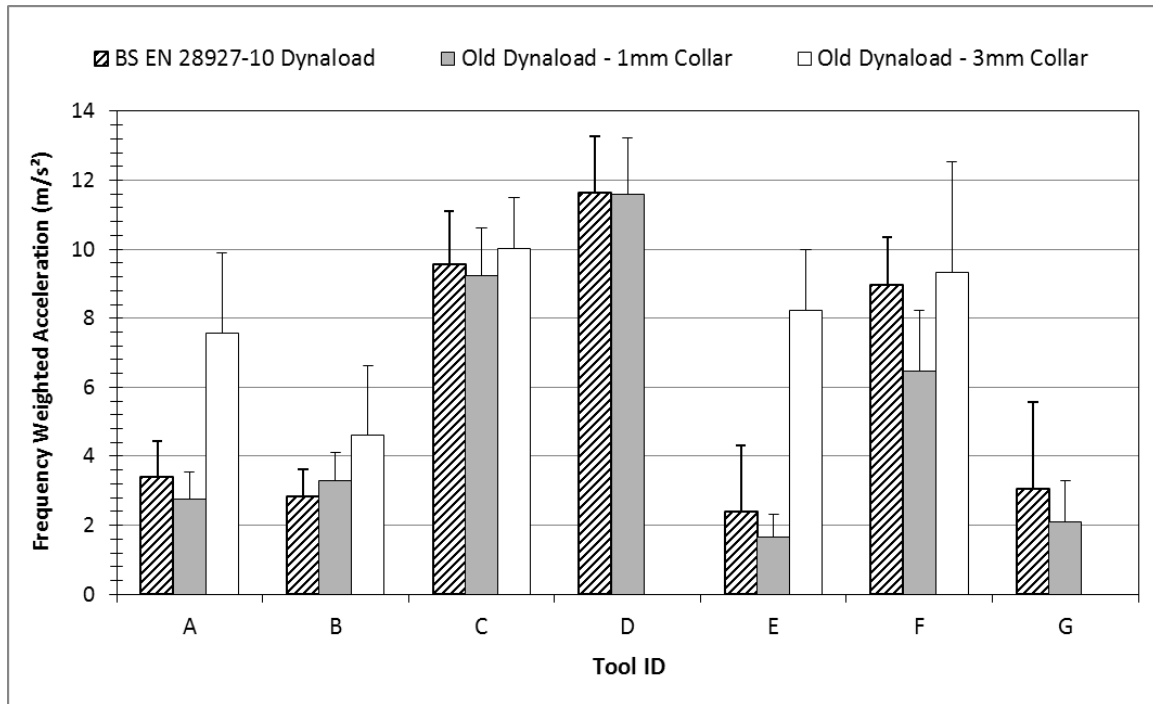


Figure 11. Comparison of the HSE measured vibration emission value, a (+ K) for each tool, measured in three possible configurations of dynaload

6.3.1 Comparison of emission test results for new and old dynaloads with collars of 1 mm clearance

Analysis of variance showed that for 5 of the 7 tools (71%) there was no significant difference between the emission values determined using the new and old dynaload. Both devices are constructed with a tight collar, ie 1 mm clearance between the collar and the test piece. The results mean that the bars with diagonal lines and those with grey shading in Figure 11 are statistically similar for Tools A, B, C, D and E.

There was a significant difference between emission values for Tool F, which were obtained using the two dynaloads with a tight collar. The vibration emission a in the new dynaload is 9.0 m/s² compared with 6.5 m/s² in the old dynaload. The vibration emission measured in the new dynaload is significantly higher at both hand positions. It is thought that the increased height of the tool in the new dynaload and consequently the increased distance of the measurement location from the point of impact, might cause higher vibration magnitudes; particularly in the lateral axes in the new dynaload compared with the old dynaload. The data for Tool F for the individual axes, which can be found in Annex D, show that the vibration is consistently higher in all axes not just the lateral axes.

ANOVA also showed a significant difference between the emission values for Tool G when tested in the two dynaloads. The mean vibration emission value, a , for the old dynaload is 2.1

m/s² with an uncertainty, K , of 1.2 m/s², and in the new dynaload, a is 3.1 m/s² with an uncertainty, K , of 2.1 m/s². The magnitude of the measured vibration emission, a , is low in both dynaloads and the magnitude of the uncertainty in the results is a very large proportion of the mean value (approximately 60 or 70% of the measured vibration emission). There was a great deal of variability in results when measuring the vibration emission for Tool G in both dynaloads. It was often necessary to carry out several repeat test runs in order to achieve an acceptable coefficient of variation during the testing. The wide variability in measurements is masked to a certain extent by the procedure for obtaining an acceptable coefficient of variation and the consequent discarding of data. The data for Tool G were therefore not considered to be of value in attempting to identify differences between the two sizes of dynaload, due to the variability in measured vibration emission values.

Although the data for Tools F and G obtained using the old and new dynaloads were significantly different, the results for the other five tools (71%) showed that there was no significant difference between the two sizes of device. It is therefore reasonable to conclude that the height difference between the two dynaloads was not a major influencing factor for the outcome of the vibration emission tests.

Table 7. Manufacturers' declared and HSE measured vibration emission test values for the three possible dynaload configurations

Tool ID	Manufacturers' declared emission (m/s ²)			HSE measured emission (m/s ²)					
				New dynaload 1 mm collar		Old dynaload 1 mm collar		Old dynaload 3 mm collar	
	a	K_{dec}	K_{calc}	a	K	a	K	a	K
A	30	–	12	3.4	1.0	2.8	0.8	7.6	2.3
B	-	-	-	2.9	0.8	3.3	0.8	4.6	2.0
C	4.3	–	2.15	9.6	1.5	9.2	1.4	10.0	1.5
D	8	–	3.2	11.6	1.7	11.6	1.6		
E	2.4	0.7		2.4	1.9	1.7	0.7	8.2	1.8
F	4.2	0.9		9.0	1.4	6.5	1.7	9.3	3.2
G	3.9	1.4		3.1	2.5	2.1	1.2		

6.3.2 Comparison of emission test results for the old dynaload with two different collars: 1 mm clearance and 3 mm clearance

Tools A, B, C, E and F were tested with both a 1 mm clearance collar and a 3 mm clearance collar in the old dynaload, to investigate the effect of the collar dimensions on the resultant emission values. Tools D and G were not tested with the loose collar due to the wide variation in earlier results.

The vibration emission values, a , for Tools A, B, C, E and F were higher when measured using old dynaload with 3 mm clearance collar, shown in bold on the right hand side of Table 7, compared with the 1 mm clearance collar. Analysis of variance showed the differences were statistically significant for Tools A, B, E and F, ie for 80% of the cases. Only Tool C did not show a significant difference, but for all five tools for which the comparison was made, the

vibration magnitude was higher using the loose collar. These data indicate that the dimensions of the collar are an important factor in determining the vibration emission value measured in a dynaload. BS ISO 28927-10:2011 specifies the use of a dynaload for the testing of heavy rock drills and breakers without rotation, and chiselling, chipping and riveting hammers. It specifically states that the machines are operated vertically downwards on the loading device, and the machine or test piece shall not come into contact with the bushing as this can influence the test result. Despite this statement, the dynaload design drawings include o-rings on both the outside and inside of the collar. These o-rings clamp the test piece in the neck of the dynaload to keep the collar, test piece and the tool centrally located and vertical. The extent to which the o-rings also minimise any lateral vibration is unclear as this will be very much frequency dependent. However when a 3 mm collar without o-rings was used, there was more scope for lateral vibration and the measured emission increased for all five tools for which a comparison was made.

HSE tests did not investigate the effect of the o-rings with the 1mm collar as this was beyond the scope of the investigation. However, it would be useful to investigate the transmissibility through the o-ring material to ascertain how much damping influence the o-rings might have on the vibration of the tool itself.

Using a tighter collar and including o-rings might be measures intended to improve repeatability and reproducibility of the emission test. The results for three of the 5 tools (A, B and F) support this as the K values were considerably higher when measured using the 3 mm collar. However, in terms of achieving an emission test result that better reflects the in-use vibration magnitude, use of a tighter collar is clearly a retrograde step. Data from emission tests carried out according to BS EN ISO 28927-10:2011 are compared with in-use vibration magnitudes in the next section.

6.4 COMPARISON OF BS EN ISO 28927-10:2011 AND BS EN 60745-2-6:2007

BS EN 60745-2-6:2007 contains the test code for the electrical tools, which are similar to the pneumatic tools covered by BS EN ISO 28927-10:2011. This electrical tools test code was the subject of a previous HSE investigation (Hewitt et al 2010). The two test codes are very similar with one notable difference; both tests include a test with a specified downward feed force whereas BS EN 60475-2-6:2007 also includes a 'no load' test. The 'no load' test is carried out with the operator supporting the weight of the tool and running it with no feed force applied. A mean of fifteen measurements a is obtained in the same way as for the load test. The two a values are combined in a ratio of 80% load to 20% no load, to produce the overall declared emission value, the $a_{h,CHeq}$ for the tool. The $a_{h,CH}$ value is the mean emission value for the chiselling process, as tested in the dynaload. The $_{eq}$ subscript indicates that the process is 'equalised' to represent the a typical work pattern for use of such tools, where 20% of the time the tool is free running with no material being worked.

Hewitt et al (2010) showed that the $a_{h,CHeq}$ values (20% with no load and 80% with full load) were typically lower than the $a_{h,CH}$ values (100% full load) for the electrical tools tested in the dynaload. Of 20 tools tested, only one tool gave higher vibration magnitudes in the no load test, which therefore resulted in the $a_{h,CHeq}$ value being higher than the $a_{h,CH}$ value. For most tools, the $a_{h,CHeq}$ value was within the range of $a_{h,CH} \pm K$. ie within the range of uncertainty of the measurement in the dynaload. This indicates that, in most instances for electrical machines, the K value alone is probably sufficient to take account of the differences caused by operating the machine under no load conditions.

During the field tests for electrical tools in the previous research, there were no obvious step changes in vibration magnitudes due to periods of load and no load. Consequently no comparison of the effect of no load data on in-use magnitudes was made.

The results from the HSE field tests for Tool F showed that there was a marked effect of running the tool with the inclusion of natural periods of ‘no load’ exposure (referred to as ‘continuous throttle’ in this report) compared with the manufacturer’s recommended technique of releasing the throttle, when the bit is not engaged in the material being worked (referred to here as intermittent throttle). The mean in-use magnitude for continuous throttle was 22.9 m/s² compared with mean in-use magnitude for intermittent throttle of 12.6 m/s². Neither of these values compare favourably with the manufacturer’s quoted in-use values for vertical use on concrete which is a range of 3.6 m/s² to 4.2 m/s² with a mean of 3.8 m/s². It is not clear why such large differences in magnitudes occur across these different tests.

6.5 COMPARISON OF EMISSION VALUES WITH IN-USE DATA

Figure 12 shows how the HSE measured emission data and the manufacturer’s declared emission data compared with in-use vibration magnitudes for each of the tools tested. The data for Tools E and F shown in Figure 12 also includes the mean and range of in-use values for vertical operation in concrete.

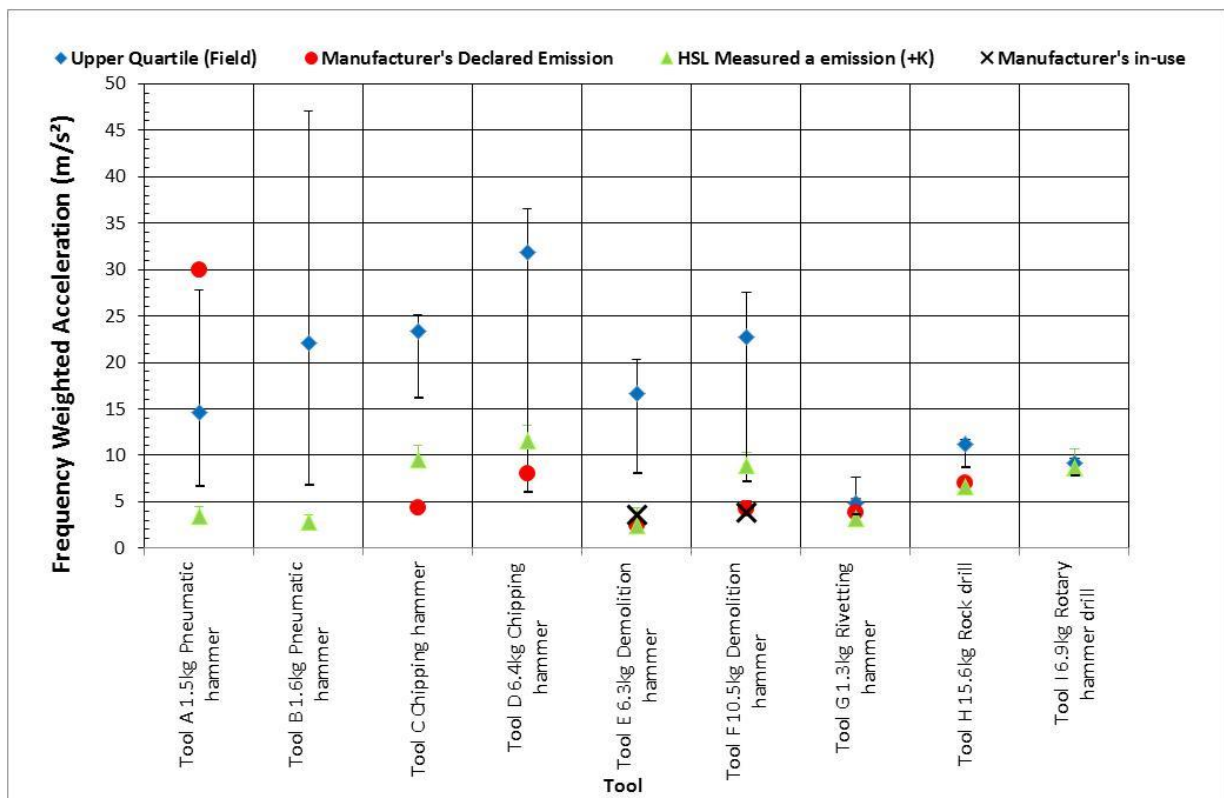


Figure 12. Comparison of the manufacturer’s declared emission value with the HSE measured a emission value and the upper quartile in-use value for each tool

Figure 12 shows manufacturer's emission data are generally lower than the HSE measured in-use data. Exceptions include Tool A, which has an extremely high declaration value, and Tools B and I for which no manufacturer's declaration was available. The HSE emission value is below the range of HSE in-use vibration values for 6 of the 9 tools tested; the range of measured in-use vibration data is very wide for most of the tools, as indicated by the positive and negative error bars. For Tools G, H and I the range of vibration data is much narrower.

6.6 EMISSION DATA AS A PREDICTOR OF RISK

The consequences of using emission values as an indicator of risk can be shown effectively by plotting the ratio of the a emission value to the upper quartile of the in-use value as shown in Figure 13. A ratio of less than 1 indicates that the emission value under-estimates the vibration in-use. A ratio of greater than 1 indicates that the emission value over-estimates the vibration when in-use. BS EN ISO 20643:2008+A1:2012 specifies that new test codes should be developed to produce vibration emission values which reflect the upper quartile of in-use values. Therefore the upper quartile of in-use vibration can be seen as the target value for the measured a emission to achieve.

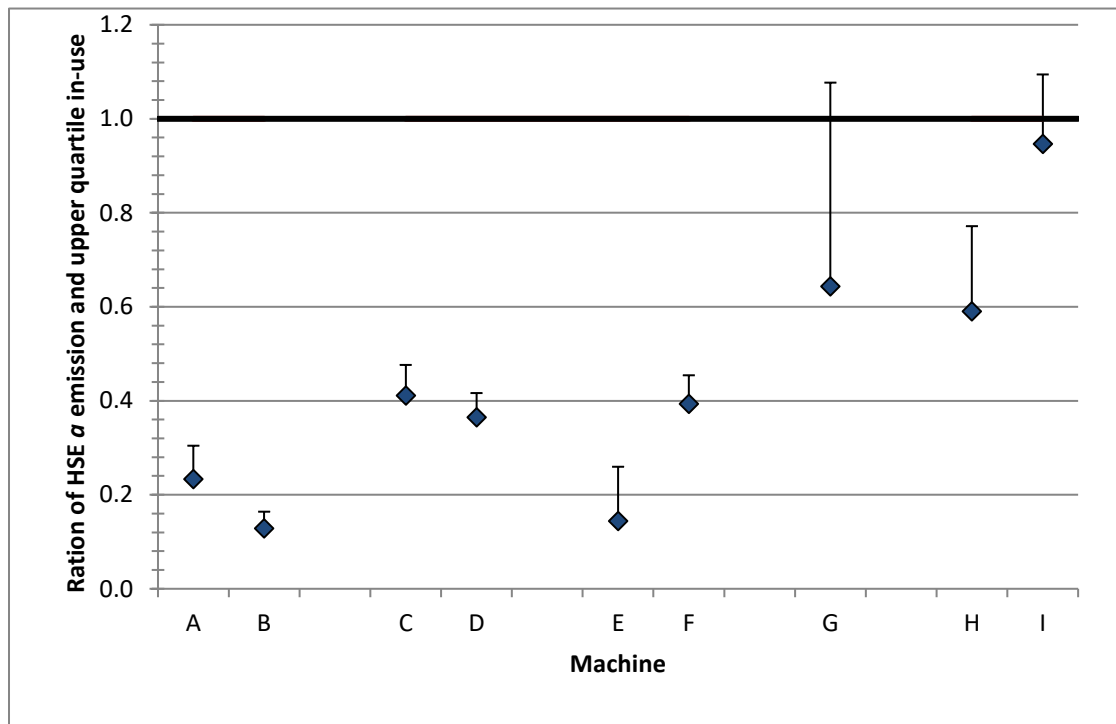


Figure 13. Ratio of HSE measured a emission to upper quartile in-use data (error bars indicate $a+K$)

For most of the tools tested during this study, the HSE a emission value did not reach the upper quartile of in-use vibration measured by HSE. Only one of the tools tested had an a value which was close to the upper quartile of in-use data. This was Tool I, which was a light rock drill and was tested drilling into concrete. HSE measured a emission values did not reflect the upper quartile of in-use vibration for any of the tools tested using the dynaload.

The comparison of HSE emission and field data also includes a consideration of the $a+K$ value as indicated by the error bars in Figure 13. The figure shows that the HSE measured a emission

values for Tools A, B and E are only roughly one fifth of the upper quartile in-use vibration. If the uncertainty K is also taken into account, the HSE $a + K$ emission value is still only around 30% of the upper quartile in-use value or less for these three tools.

The results for Tool C, D and F indicate that the HSE measured a emission data is around 40% of the upper quartile in-use value for these tools. When the ratio of the $a+K$ value is taken into account, the emission test value is still only approximately 50% of the upper quartile in-use value.

Annex G contains a more detailed analysis of the different in-use activities for each tool because some of the tasks gave in-use vibration values which were very different from each other.

7. CONCLUSIONS

The majority of emission tests carried out for this research (71%) indicated that there is no significant difference in emission values for pneumatic tools produced by the two sizes of dynaload device used. It is therefore reasonable to conclude that the height difference between the two dynaloads was not a major influencing factor for the outcome of the vibration emission tests.

For all the pneumatic tools, lower emission values were obtained using the collar with 1 mm clearance, as specified in BS EN ISO 28927-10:2011, compared with a collar with 3 mm clearance, as specified in earlier test codes. This effect was significant for 4 out of the 5 tools which is 80% of the cases. This has implications for differences between emission test values for pneumatic tools when compared with their electrically powered equivalents in that electrically powered tools may be tested under conditions which generate vibration emission values which are systematically higher than their pneumatic counterparts. The more recently published emission test, BS EN ISO 28927-10:2011, now incorporates a tighter collar. Consequently the latest change makes emission test data using the dynaload even less likely to reflect risk than was previously the case.

Comparison of the HSE measured a emission values with the in-use vibration measured on the same machines showed that none of the BS EN ISO 28927-10:2011 emission values measured using the dynaload reflect the upper quartile of in-use vibration magnitudes. Only 1 of the 9 tools (11%) tested according to BS EN ISO 28927-10:2011 produced an emission value that reflected the upper quartile of in-use data. This tool was a light rock drill which was tested drilling into concrete rather than using a dynaload.

Taking the $a+K$ value, only 2 out of 9 of the measured emission values (22%) could be considered to reflect in-use vibration magnitudes. For 3 of the tools, the HSE measured a emission value was only one fifth of the upper quartile in-use value. For a further three tools, the HSE measured a emission value was only one half on the upper quartile in-use value. Any risk assessment made based on emission values generated by this test code would result in a serious under-estimate of the likely risk in most cases.

Using the dynaload for vibration emission testing does not produce emission values that adequately reflect the upper quartile of in-use vibration. Therefore these emission values do not adequately reflect the vibration risk from use of these tools. Consideration should be given to the development of alternative test methods that are more realistic and therefore more likely to generate emission data that reflect typical in-use magnitudes for pneumatic percussive drills, hammers and breakers.

8. REFERENCES

British Standards Institution (1995) Hand-held portable power tools – Measurement of vibrations at the handle – Part 2: Chipping hammers and riveting hammers. BS EN 28662-2:1995.

British Standards Institution (1997) Mechanical vibration – Declaration and verification of vibration emission values. BS EN 12096:1997.

British Standards Institution (2001) Mechanical vibration – Measurement and evaluation of human exposure to hand-transmitted vibration. General requirements. BS EN ISO 5349-1:2001.

British Standards Institution (2002) Mechanical vibration. Measurement and assessment of human exposure to hand-transmitted vibration. Practical guidance for measurement at the workplace. BS EN ISO 5349-2:2002.

British Standards Institution (2001) Hand-held portable power tools – Measurement of vibrations at the handle – Part 5: Pavement breakers and pick hammers, BS EN 28662-5:1995, A1/1995 +A2/2001.

British Standards Institution (2005) Human response to vibration. Measuring Instrumentation. BS EN ISO 8041:2005.

British Standards Institution (2005) Mechanical vibration. Hand-held and hand-guided machinery. Principles for evaluation of vibration emission. BS EN ISO 20643:2005.

British Standards Institution (2009) Hand-held motor-operated electric tools – Safety – Part 2-6: Particular requirements for hammers. BS EN 60745-2-6:2003 + A2:2009.

British Standards Institution (2009) Hand-held portable power tools – Test methods for evaluation of vibration emission – Part 9: Scaling hammers and needle scalers. BS EN ISO 28927-9:2009.

British Standards Institution (2011) Hand-held portable power tools – Test methods for evaluation of vibration emission – Part 10: Percussive drills, hammers and breakers, BS EN ISO 28927-10:2011.

British Standards Institution (2012) Mechanical vibration. Hand-held and hand-guided machinery. Principles for evaluation of vibration emission. BS EN ISO 20643:2008+A1:2012.

Health & Safety Executive (2005) Control of Vibration at Work Regulations.

Hewitt S M, Critchlow S G, and Ward T (1999) Comparison of EN ISO 8662 emission data with vibration in use: Chipping hammers and stoneworking tools. HSL Report NV/99/04.

Hewitt S M, Heaton R, Shanks E and Mole M (2006) Vibration emission and simulated real use measurements on six road breakers. HSL Report NV/06/17.

Hewitt S M, Shanks E, Heaton R and Mole M (2010). Evaluation of EN 60745 test codes: BS EN 60745-2-6:2003+A2:2009 concerning the vibration of hand-held electric hammers. HSL Report NV/10/07.

PNEUROP DYNALOAD - design, construction, use and maintenance, version 1.2, October 2005. http://www.pneurop.eu/uploads/documents/pdf/DYNALOAD_2005.pdf. Last accessed 27/07/2020.

Supply of Machinery (Safety) Regulations 2008. The Stationery Office, S.I. 2008/1597. ISBN 9780110818924.

Ward T (1998). Vibration emission of pavement breakers and pick hammers - Comparison of ISO 8662-5 emission data with real use vibration. HSL Report NV/98/03.

ANNEX A - EQUIPMENT FOR TESTING

Table A.1. Details of accelerometers (23/5/2012)

Channel	B&K type	Serial #	Sensitivity (pC/ms ⁻²)	Date of last calibration
1	4393	10701	0.323	Aug 2011
2	4393	11877	0.324	Aug 2011
3	4393	32163	0.307	Aug 2011
4	4393	32759	0.298	Aug 2011
5	4393	1873331	0.320	Aug 2011
6	4393	32760	0.297	Aug 2011

From 23/5/2012

- B&K Pulse frequency analyser sno. 2423351 last calibrated Jan12 (Calibration period: 2 years)

Table A.2. Details of accelerometers for in-use measurements (25/9/2012)

Channel	B&K type	Serial #	Sensitivity (pC/ms ⁻²)	Date of last calibration
1	4393	2279751	0.317	Aug 2012
2	4393	10693	0.320	Aug 2012
3	4393	10701	0.323	Aug 2012
4	4393	32163	0.307	Aug 2012
5	4393	32760	0.297	Aug 2012
6	4393	1665258	0.313	Aug 2012
7	4393	32162	0.293	Aug 2012
8	4393	31675	0.309	Aug 2012
9	4393	1873331	0.320	Aug 2012

From 25/9/2012

- B&K Pulse frequency analyser sno. 2325758 last calibrated Jan12 (Calibration period: 2 years) – Channel 1 – 6
- B&K Pulse frequency analyser sno. 2423351 last calibrated Jan12 (Calibration period: 2 years) – Channel 7 – 9

Table A.3. Details of Charge amplifiers for 9 channels simultaneous measurements (25/9/2012)

Channel	B&K type	Serial #	Date of last calibration
1	2635	1473734	20/12/2011
2	2635	1473733	6/6/2011
3	2635	1709921	6/6/2011
4	2635	2448012	23/8/2011
5	2635	2448013	24/8/2011
6	2635	2448014	24/8/2011
7	Nexus Ch 1	2056119	12/9/2011
8	Nexus Ch 2	2056119	12/9/2011
9	Nexus Ch 3	2056119	12/9/2011

ANNEX B - MOUNTING LOCATIONS

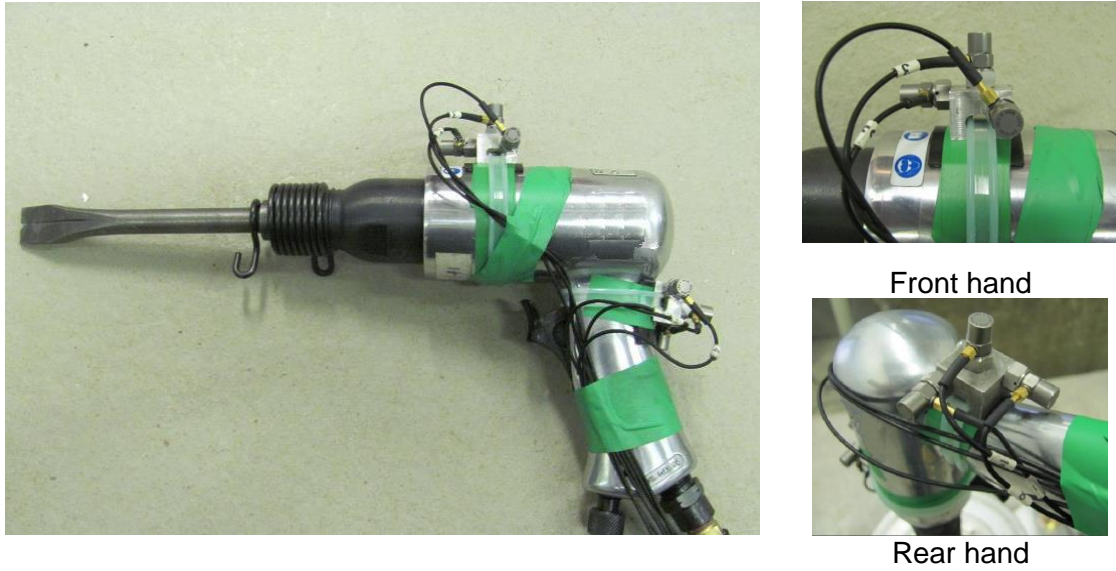


Figure B.1. Pistol grip pneumatic hammer with front and rear hand positions

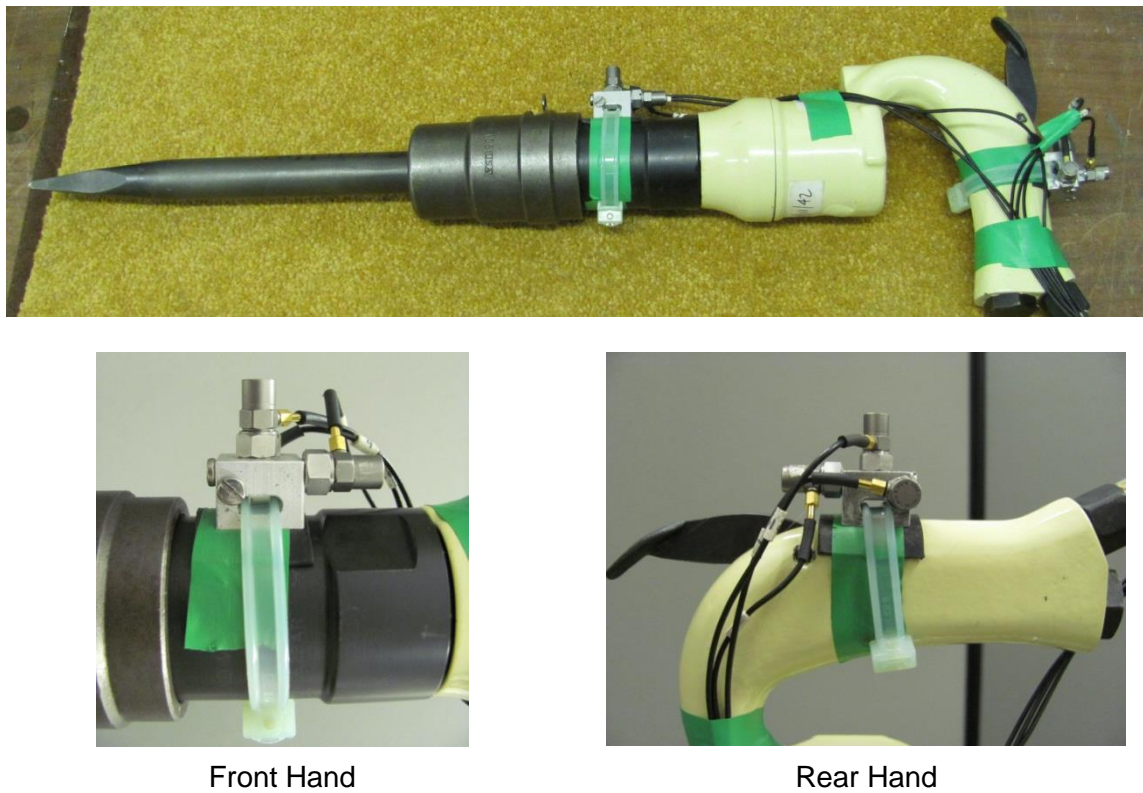


Figure B.2. Chipping hammer with front and rear hand positions



Front hand position



Rear hand position

Figure B.3. Breaker illustrating the support and throttle hand positions

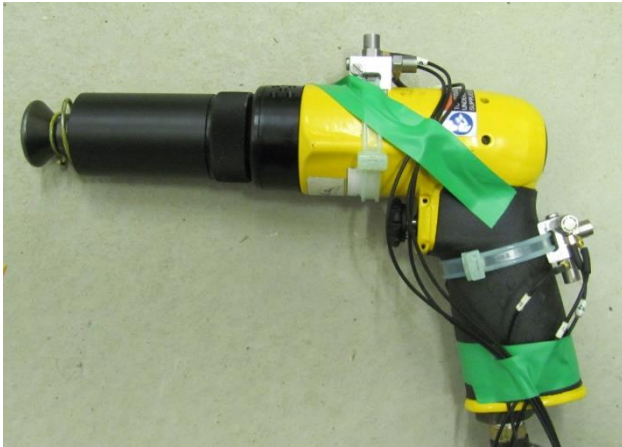
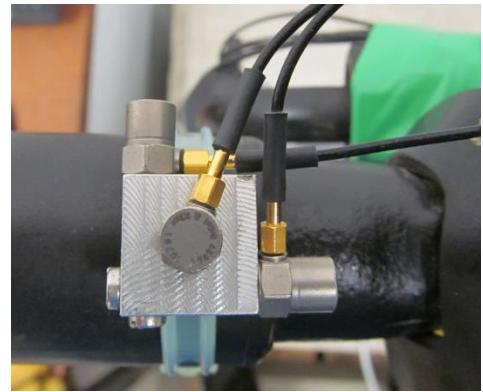
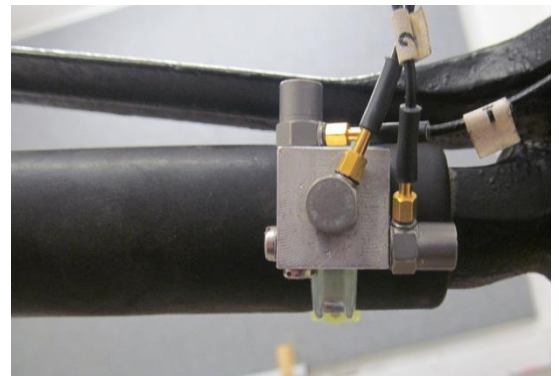


Figure B.4. Riveting hammer showing the front and rear hand positions, with the bucking bar (right)



Support hand position



Throttle hand position

Figure B.5. Heavy rock drill with the support position (left handle) and throttle position (right handle)

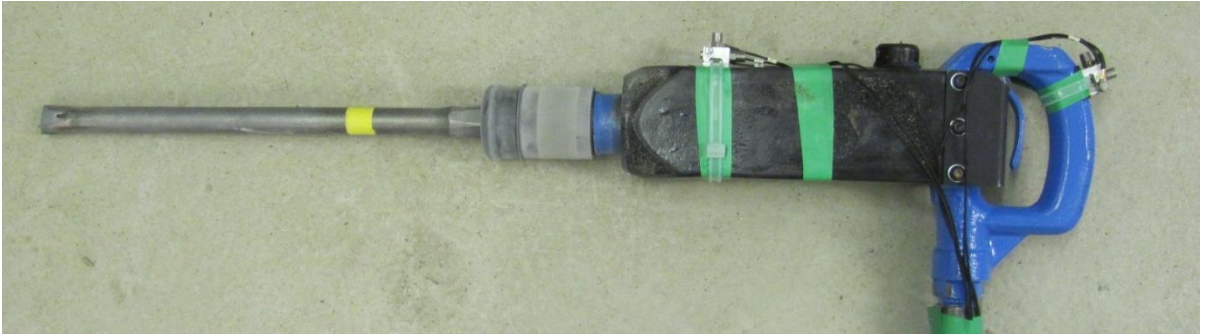


Figure B.6. Pick hammer with the front and rear hand positions

ANNEX C - EMISSION TEST RESULTS

Note: In the following tables, figures in red indicate the standard deviation or coefficient of variation of the data set may be outside tolerances suggested in the emission test code. In some cases there has been difficulty in achieving a coefficient of variation of <0.15 because of the variable nature of the vibration. All emission data have been considered on a case by case basis before being accepted.

Tool A

Vibration Emission Test report

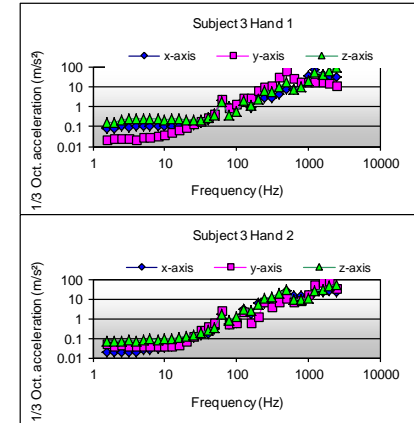
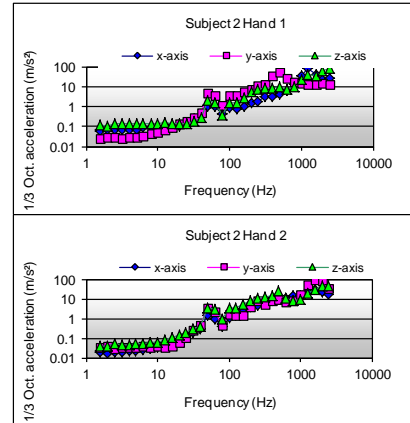
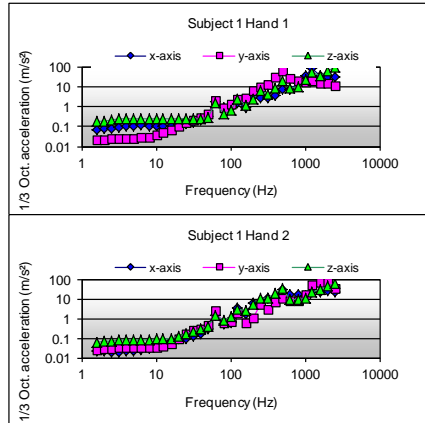
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Spreadsheet: Version 4.0 19/1/12

Standard: BS EN ISO 28927-10:2011

N&V reference ID: NV/11/41

Measurement file name: Tool A New Dynaload, 60N Repeat

TestNo.	Operator	Meas. Name	Meas. Date	Meas Time	Hand Position 1 - Front handle				Hand position 2 - Rear handle										
					a_{whx}	a_{why}	a_{whz}	a_{hv}	Operator Statistics			a_{whx}	a_{why}	a_{whz}	a_{hv}	Operator Statistics			
									Mean a_{hv}	S_{n-1}	C_v					Mean a_{hv}	S_{n-1}	C_v	
1	1				1.22	2.67	1.35	3.23					1.57	1.21	1.78	2.67			
2	1				1.24	2.77	1.33	3.31					1.60	1.17	1.83	2.70			
3	1				1.20	2.75	1.29	3.27	3.16	0.149	0.047	1.59	1.13	1.79	2.65	2.62	0.080	0.030	
4	1				1.12	2.54	1.25	3.04				1.55	1.08	1.72	2.56				
5	1				1.07	2.49	1.21	2.97				1.49	1.08	1.70	2.51				
6	2				1.07	3.50	1.53	3.97				1.07	2.18	2.44	3.44				
7	2				1.19	3.30	1.44	3.79				1.17	1.58	2.27	3.00				
8	2				1.09	3.11	1.40	3.58	3.81	0.272	0.071	1.05	1.43	2.20	2.83	3.16	0.399	0.126	
9	2				1.13	3.07	1.31	3.53				1.08	1.40	2.19	2.81				
10	2				1.19	3.68	1.58	4.18				1.32	1.95	2.86	3.70				
11	3				1.13	2.57	1.26	3.08				1.56	1.21	1.76	2.65				
12	3				1.16	2.69	1.24	3.18				1.48	1.18	1.83	2.63				
13	3				1.20	2.64	1.22	3.14	3.27	0.196	0.060	1.23	1.21	1.71	2.43	2.59	0.091	0.035	
14	3				1.23	2.86	1.27	3.36				1.54	1.19	1.76	2.62				
15	3				1.23	3.08	1.29	3.56				1.42	1.17	1.86	2.62				
					1.17	2.91	1.33	3.41					1.38	1.35	1.98	2.79			
					a_h (overall mean a_{hv}): 3.41 m/s ²				a_h (overall mean a_{hv}): 2.79 m/s ²										
					ρR (single m/c.): 0.63 m/s ² or 0.50				ρR (single m/c.): 0.61 m/s ² or 0.47										
					K (single m/c.) value: 1.04 m/s ²				K (single m/c.) value: 1.01 m/s ²										
Single machine emission a_{hd} (= greatest a_h value):					3.41 m/s²				K(single m/c.) value: 1.04 m/s²										

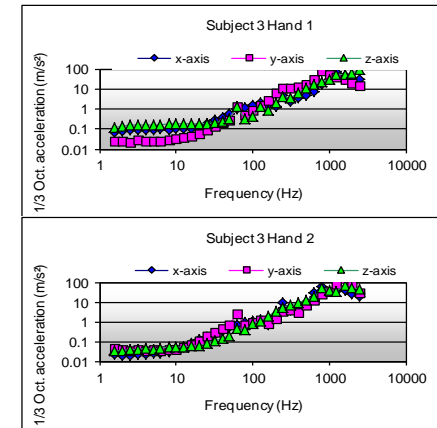
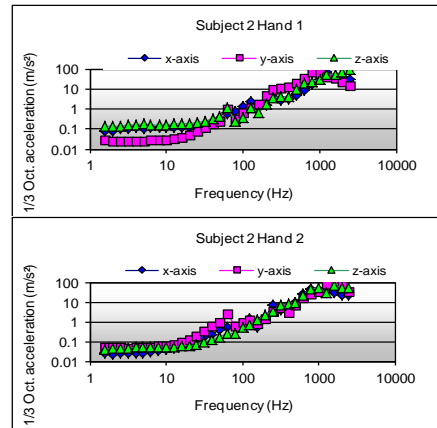
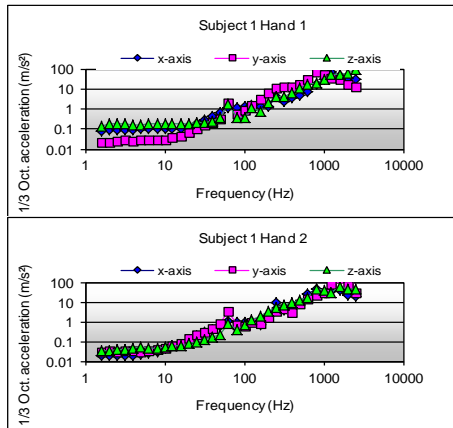


Vibration Emission Test report

Pulse file version: HAV Emission V2.1.2 2008-07-25.pls
Spreadsheet: Version 4.0 19/1/12

Standard: BS EN ISO 28927-10:2011
N&V reference ID: NV/11/41
Measurement file name: Tool A Old Dynaload

TestNo.	Operator	Meas. Name	Meas. Date	Meas Time	Hand Position 1 - Front handle				Operator Statistics			Hand position 2 - Rear handle				Operator Statistics			
					a_{whx}	a_{why}	a_{whz}	a_{hv}	Mean a_{hv}	S_{n-1}	C_v	a_{whx}	a_{why}	a_{whz}	a_{hv}	Mean a_{hv}	S_{n-1}	C_v	
1	1				1.15	2.16	1.23	2.74	2.79	0.043	0.015	1.66	1.47	1.35	2.60	2.54	0.042	0.017	
2	1				1.09	2.22	1.21	2.75				1.44	1.50	1.37	2.49				
3	1				1.12	2.26	1.24	2.81				1.48	1.52	1.39	2.54				
4	1				1.10	2.30	1.24	2.84				1.49	1.52	1.40	2.54				
5	1				1.12	2.31	1.18	2.83				1.54	1.38	1.42	2.51				
6	2				1.05	2.08	1.18	2.61	2.75	0.094	0.034	1.45	1.39	1.37	2.44	2.43	0.013	0.005	
7	2				1.05	2.16	1.18	2.68				1.43	1.39	1.35	2.41				
8	2				1.05	2.30	1.18	2.79				1.41	1.42	1.40	2.44				
9	2				1.06	2.32	1.19	2.81				1.41	1.43	1.39	2.44				
10	2				1.06	2.32	1.22	2.83				1.34	1.45	1.41	2.42				
11	3				1.10	2.28	1.16	2.78	2.83	0.033	0.012	1.64	1.30	1.47	2.56	2.60	0.039	0.015	
12	3				1.11	2.29	1.16	2.80				1.66	1.30	1.46	2.56				
13	3				1.14	2.33	1.19	2.85				1.73	1.37	1.48	2.65				
14	3				1.11	2.36	1.16	2.86				1.65	1.37	1.47	2.60				
15	3				1.11	2.35	1.15	2.84				1.72	1.29	1.48	2.61				
					1.09	2.27	1.19	2.79					1.54	1.41	1.41	2.52			
					a_h (overall mean a_{hv}): 2.79 m/s ²				a_h (overall mean a_{hv}): 2.52 m/s ²										
					ρR (single m/c.): 0.21 m/s ² or 0.47				ρR (single m/c.): 0.29 m/s ² or 0.45										
					K (single m/c.) value: 0.77 m/s ²				K (single m/c.) value: 0.74 m/s ²										
					Single machine emission a_{hd} (= greatest a_h value): 2.79 m/s²				K (single m/c.) value: 0.77 m/s²										

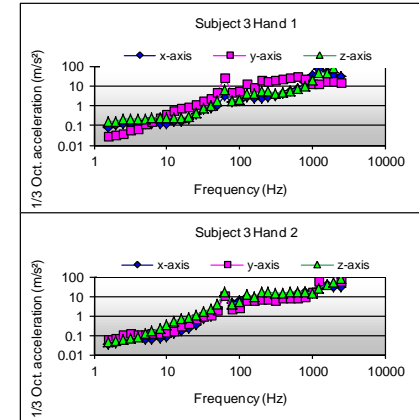
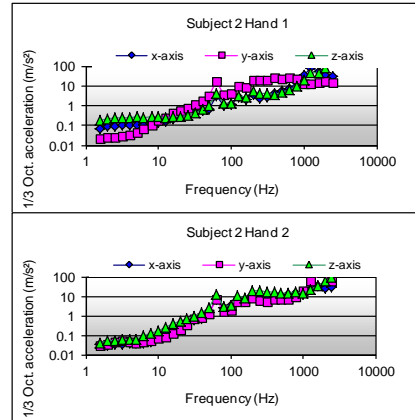
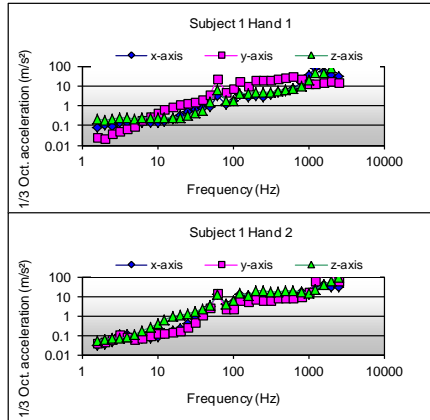


Vibration Emission Test report

Pulse file version: HAV Emission V2.1.2 2008-07-25.pls
Spreadsheet: Version 4.0 19/1/12

Standard: BS EN ISO 28927-10:2011
N&V reference ID: NV/11/41
Measurement file name: Tool A Old Dynaload, 60N, 3mm Collar

TestNo.	Operator	Meas. Name	Meas. Date	Meas Time	Hand Position 1 - Front handle				Operator Statistics			Hand position 2 - Rear handle				Operator Statistics						
					a_{whx}	a_{why}	a_{whz}	a_{hv}	Mean a_{hv}	S_{n-1}	C_v	a_{whx}	a_{why}	a_{whz}	a_{hv}	Mean a_{hv}	S_{n-1}	C_v				
1	1				1.70	7.28	1.93	7.73	8.09	1.129	0.140	3.51	3.85	5.45	7.54	8.18	0.778	0.095				
2	1				1.79	9.24	2.93	9.86				5.25	5.11	5.72	9.29							
3	1				1.76	8.03	2.10	8.48				4.74	4.67	5.56	8.67							
4	1				1.37	6.66	1.63	6.99				3.82	3.82	5.19	7.49							
5	1				1.47	6.98	1.95	7.40	4.50	4.14	5.02	7.91	6.31	0.359	0.057	2.99	2.75	4.98	6.43	5.86	0.399	0.068
6	2				1.46	6.28	1.79	6.70	2.86	2.45	4.74	6.06										
7	2				1.65	5.98	1.60	6.41	2.30	2.29	4.35	5.43										
8	2				1.74	5.46	1.49	5.92	2.47	2.31	4.77	5.84										
9	2				1.63	6.14	1.70	6.58	2.21	2.16	4.63	5.56	8.29	0.792	0.096	4.13	3.71	5.27	7.66	7.83	0.672	0.086
10	2				1.25	5.64	1.45	5.95	4.83	4.26	6.19	8.93										
11	3				1.60	7.82	2.44	8.35	3.56	3.17	5.30	7.13										
12	3				1.61	9.03	2.62	9.54	3.20	3.15	6.09	7.57										
13	3				1.53	7.00	1.91	7.42	3.59	3.11	6.27	7.87	1.57	7.12	1.99	7.56	3.60	3.40	5.30	7.29	a _h (overall mean a_{hv}): 7.56 m/s ²	a _h (overall mean a_{hv}): 7.29 m/s ²
14	3				1.49	7.81	2.26	8.26	ρR (single m/c.): 1.42 m/s ²								ρR (single m/c.): 1.36 m/s ²					
15	3				1.52	7.45	2.01	7.87	K (single m/c.) value: 2.34 m/s ²								K (single m/c.) value: 2.24 m/s ²					
					Single machine emission a_{hd} (= greatest a_h value): 7.56 m/s²				K (single m/c.) value: 2.34 m/s²													



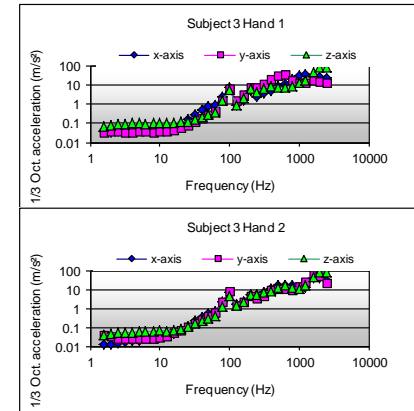
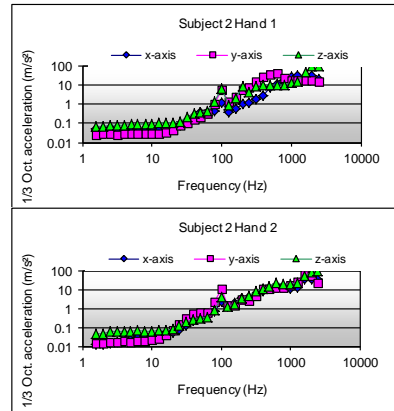
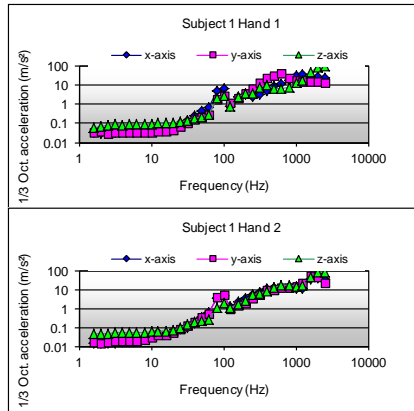
Tool B

Vibration Emission Test report

Pulse file version: HAV Emission V2.1.2 2008-07-25.pls
 Spreadsheet: Version 4.0 19/1/12

Standard: BS EN ISO 28927-10:2011
 N&V reference ID: NV/11/21
 Measurement file name: Tool B New Dynaload, 60N

TestNo.	Operator	Meas. Name	Meas. Date	Meas. Time	Hand Position 1 - Front handle				Operator Statistics			Hand position 2 - Rear handle				Operator Statistics			
					a_{whx}	a_{why}	a_{whz}	a_{hw}	Mean a_{hv}	S_{n-1}	C_v	a_{whx}	a_{why}	a_{whz}	a_{hw}	Mean a_{hv}	S_{n-1}	C_v	
1	1				1.38	1.99	1.16	2.68	2.70	0.082	0.030	1.36	1.48	1.15	2.32	2.26	0.083	0.037	
2	1				1.83	1.94	0.95	2.82				1.65	1.32	1.05	2.36				
3	1				1.71	1.89	0.98	2.73				1.54	1.33	0.99	2.26				
4	1				1.57	1.88	1.05	2.66				1.40	1.40	0.99	2.21				
5	1				1.52	1.86	1.01	2.61				1.34	1.38	0.97	2.15				
6	2				0.77	2.49	1.60	3.06	2.85	0.121	0.042	0.81	1.86	1.53	2.55	2.54	0.090	0.036	
7	2				0.84	2.24	1.54	2.84				1.17	1.98	1.38	2.68				
8	2				0.74	2.23	1.44	2.76				0.91	1.89	1.22	2.43				
9	2				0.76	2.22	1.55	2.81				0.97	1.96	1.28	2.53				
10	2				0.72	2.19	1.57	2.79				0.87	1.98	1.30	2.52				
11	3				1.64	2.36	1.40	3.19	3.01	0.360	0.120	1.72	1.67	1.48	2.82	2.70	0.295	0.109	
12	3				1.89	2.49	1.39	3.42				1.99	1.69	1.68	3.10				
13	3				2.07	2.10	1.11	3.16				1.95	1.46	1.31	2.76				
14	3				1.20	1.87	1.33	2.59				1.33	1.71	1.01	2.39				
15	3				1.54	1.83	1.18	2.67				1.54	1.58	1.04	2.43				
					1.34	2.10	1.28	2.85					1.37	1.65	1.22	2.50			
					a_h (overall mean a_{hw}): 2.85 m/s ²								a_h (overall mean a_{hw}): 2.50 m/s ²						
					ρR (single m/c.): 0.44 m/s ² or 0.47								ρR (single m/c.): 0.50 m/s ² or 0.45						
					$K_{(single\ m/c.)}$ value: 0.78 m/s ²								$K_{(single\ m/c.)}$ value: 0.83 m/s ²						
					Single machine emission a_{hd} (= greatest a_h value): 2.85 m/s²								$K_{(single\ m/c.)}$ value: 0.78 m/s²						

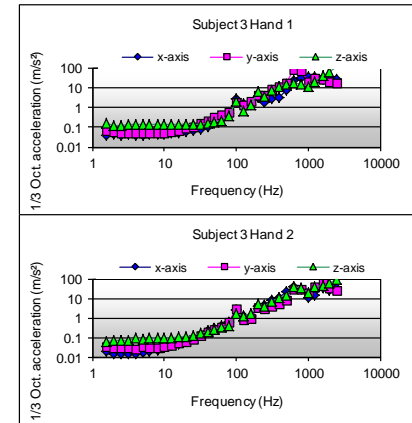
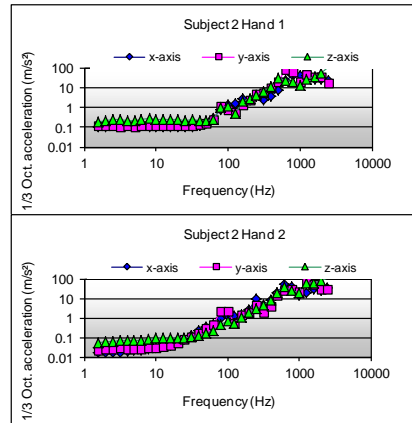
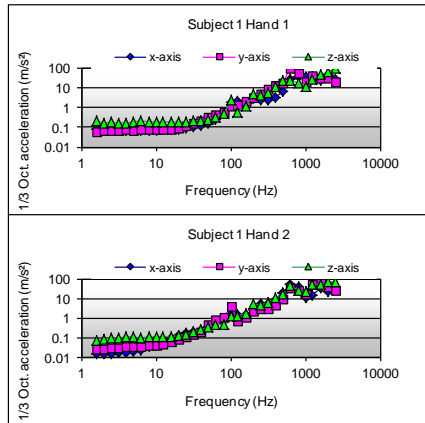


Vibration Emission Test report

Pulse file version: HAV Emission V2.1.2 2008-07-25.pls
Spreadsheet: Version 4.0 19/1/12

Standard: BS EN ISO 28927-10:2011
N&V reference ID: NV/11/21
Measurement file name: Tool B Old Dynaload, 60N

TestNo.	Operator	Meas. Name	Meas. Date	Meas Time	Hand Position 1 - Front handle				Operator Statistics			Hand position 2 - Rear handle				Operator Statistics		
					a_{whx}	a_{why}	a_{whz}	a_{hV}	Mean a_{hV}	S_{n-1}	C_V	a_{whx}	a_{why}	a_{whz}	a_{hV}	Mean a_{hV}	S_{n-1}	C_V
1	1				1.14	2.84	1.22	3.29	3.36	0.049	0.014	1.56	1.27	1.64	2.60	2.77	0.101	0.037
2	1				1.22	2.93	1.28	3.42				1.86	1.42	1.66	2.87			
3	1				1.20	2.85	1.32	3.36				1.79	1.36	1.65	2.79			
4	1				1.21	2.88	1.35	3.40				1.75	1.36	1.66	2.77			
5	1				1.25	2.76	1.42	3.35				1.83	1.39	1.62	2.81			
6	2				1.26	2.87	1.08	3.31	3.29	0.145	0.044	1.99	1.40	1.66	2.95	2.80	0.164	0.059
7	2				1.27	2.48	1.26	3.06				1.80	1.31	1.58	2.73			
8	2				1.31	2.51	1.73	3.32				1.60	1.52	1.48	2.66			
9	2				1.39	2.46	1.99	3.46				1.99	1.65	1.51	2.99			
10	2				1.25	2.46	1.83	3.31				1.73	1.46	1.38	2.65			
11	3				1.23	2.78	1.39	3.35	3.19	0.247	0.077	1.62	1.36	1.62	2.66	2.57	0.151	0.059
12	3				1.26	2.37	1.02	2.87				1.65	1.05	1.39	2.40			
13	3				1.15	2.56	1.03	2.99				1.54	1.09	1.50	2.41			
14	3				1.19	2.98	1.23	3.43				1.64	1.34	1.67	2.70			
15	3				1.23	2.72	1.45	3.32				1.58	1.41	1.64	2.68			
					1.24	2.70	1.37	3.28				1.73	1.36	1.58	2.71			
					a_h (overall mean a_{hV}): 3.28 m/s ²				a_h (overall mean a_{hV}): 2.71 m/s ²									
					ρR (single m/c.): 0.34 m/s ² or 0.50				ρR (single m/c.): 0.38 m/s ² or 0.46									
					K (single m/c.) value: 0.82 m/s ²				K (single m/c.) value: 0.76 m/s ²									
					Single machine emission a_{hd} (= greatest a_h value): 3.28 m/s²				K (single m/c.) value: 0.82 m/s²									

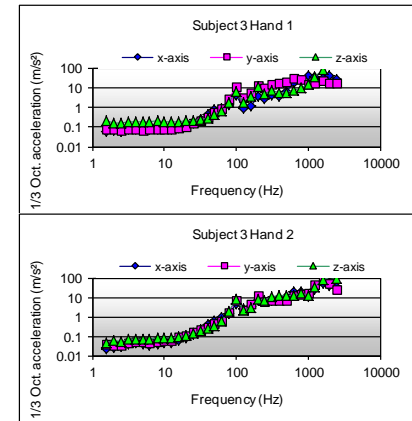
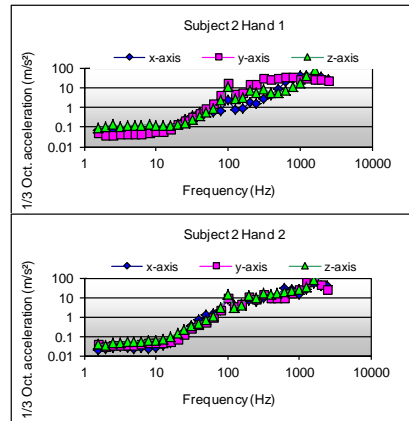
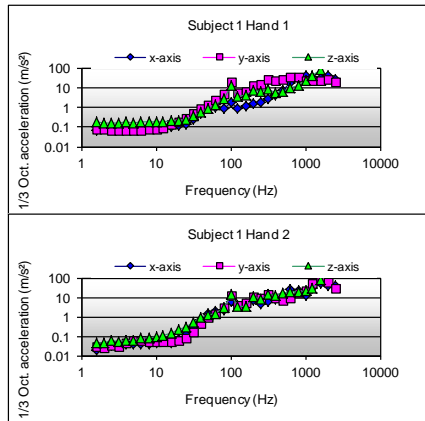


Vibration Emission Test report

Pulse file version: HAV Emission V2.1.2 2008-07-25.pls
Spreadsheet: Version 4.0 19/1/12

Standard: BS EN ISO 28927-10:2011
N&V reference ID: NV/11/21
Measurement file name: Tool B Old Dynaload, 60N, 3mm Collar

TestNo.	Operator	Meas. Name	Meas. Date	Meas Time	Hand Position 1 - Front handle				Operator Statistics			Hand position 2 - Rear handle				Operator Statistics		
					a_{whx}	a_{why}	a_{whz}	a_{hv}	Mean a_{hv}	S_{n-1}	C_v	a_{whx}	a_{why}	a_{whz}	a_{hv}	Mean a_{hv}	S_{n-1}	C_v
1	1				1.23	4.49	2.54	5.31	5.22	0.655	0.126	2.21	2.74	3.08	4.68	4.48	0.449	0.100
2	1				1.20	5.46	2.88	6.29				2.13	3.41	3.22	5.16			
3	1				1.15	4.35	2.37	5.09				1.82	2.70	2.90	4.36			
4	1				1.11	4.05	2.19	4.73				1.60	2.47	2.84	4.09			
5	1				1.11	3.86	2.39	4.67	5.00	0.527	0.105	1.65	2.33	2.94	4.10	4.46	0.410	0.092
6	2				1.37	4.23	2.00	4.87				3.05	1.93	3.18	4.81			
7	2				1.15	4.33	2.04	4.92				2.12	2.18	3.25	4.45			
8	2				1.07	3.65	2.20	4.40				1.64	2.25	2.64	3.83			
9	2				1.16	5.06	2.70	5.85	3.61	0.437	0.121	2.03	2.83	3.37	4.85	3.10	0.307	0.099
10	2				1.16	4.36	2.06	4.96				2.12	2.33	3.04	4.38			
11	3				1.28	3.29	1.91	4.01				1.44	2.14	2.10	3.32			
12	3				1.09	3.01	1.78	3.66				1.28	1.85	2.11	3.08			
13	3				1.35	3.33	1.88	4.06	3.61	0.437	0.121	1.73	2.04	2.25	3.50	3.10	0.307	0.099
14	3				1.60	2.28	1.47	3.14				1.73	1.62	1.50	2.81			
15	3				1.26	2.50	1.52	3.18				1.36	1.65	1.82	2.81			
					1.22	3.88	2.13	4.61				1.86	2.30	2.68	4.02			
					a_h (overall mean a_{hv}): 4.61 m/s ²				a_h (overall mean a_{hv}): 4.02 m/s ²									
					ρR (single m/c.): 1.22 m/s ² or 0.58				ρR (single m/c.): 1.08 m/s ² or 0.54									
					K (single m/c.) value: 2.02 m/s ²				K (single m/c.) value: 1.78 m/s ²									
					Single machine emission a_{hd} (= greatest a_h value): 4.61 m/s²				K(single m/c.) value: 2.02 m/s²									



Tool C

Vibration Emission Test report

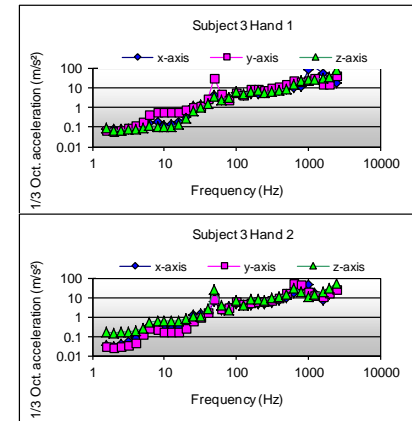
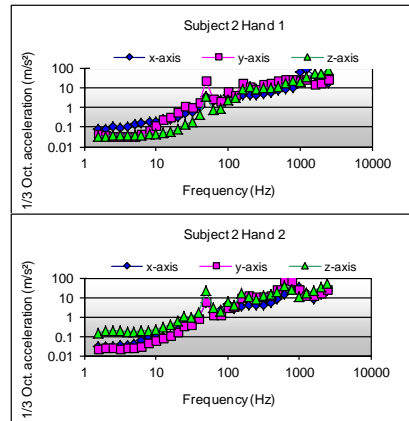
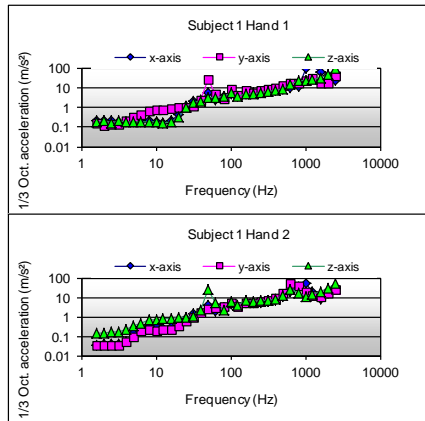
Pulse file version: HAV Emission V2.1.2 2008-07-25.pls
Spreadsheet: Version 4.0 19/1/12

Standard: BS EN ISO 28927-10:2011

N&V reference ID: NV/11/42

Measurement file name: Tool C New Dynaload, 60N FF

TestNo.	Operator	Meas. Name	Meas. Date	Meas Time	Hand Position 1 - Front handle				Operator Statistics			Hand position 2 - Rear handle				Operator Statistics		
					a_{whx}	a_{why}	a_{whz}	a_{hv}	Mean a_{hv}	S_{n-1}	C_v	a_{whx}	a_{why}	a_{whz}	a_{hv}	Mean a_{hv}	S_{n-1}	C_v
1	1				3.10	8.73	2.48	9.60	9.69	0.247	0.025	2.43	2.77	8.85	9.59	9.59	0.264	0.028
2	1				3.19	8.75	2.81	9.73				2.49	3.15	8.98	9.84			
3	1				3.13	8.58	2.28	9.41				2.42	2.27	8.62	9.24			
4	1				3.39	8.71	2.37	9.64				2.64	2.34	8.74	9.43			
5	1				3.97	8.87	2.68	10.08	8.45	0.361	0.043	3.11	2.61	8.98	9.85	8.79	0.274	0.031
6	2				1.82	7.92	2.06	8.38				2.05	3.90	7.67	8.84			
7	2				2.69	7.70	2.15	8.43				2.59	3.73	7.47	8.74			
8	2				2.47	8.35	2.52	9.07				2.53	3.41	8.21	9.24			
9	2				2.07	7.60	2.15	8.16	10.35	0.348	0.034	2.02	3.87	7.38	8.58	10.36	0.303	0.029
10	2				2.30	7.58	2.21	8.22				2.01	3.97	7.32	8.57			
11	3				3.48	9.59	2.61	10.53				3.48	4.34	8.93	10.52			
12	3				2.84	9.77	2.85	10.56				3.36	3.98	9.12	10.50			
13	3				3.06	9.85	2.69	10.66	10.35	0.348	0.034	3.09	4.14	9.33	10.66	10.36	0.303	0.029
14	3				2.61	9.57	2.34	10.20				2.65	3.42	9.23	10.19			
15	3				2.57	9.23	2.15	9.82				3.03	2.77	9.02	9.91			
					2.84	8.72	2.42	9.50				2.66	3.38	8.52	9.58			
					a_h (overall mean a_{hv}): 9.50 m/s ²				a_h (overall mean a_{hv}): 9.58 m/s ²									
					ρR (single m/c.): 1.02 m/s ² or 0.87				ρR (single m/c.): 0.92 m/s ² or 0.87									
					K (single m/c.) value: 1.69 m/s ²				K (single m/c.) value: 1.52 m/s ²									
					Single machine emission a_{hd} (= greatest a_h value): 9.58 m/s²				K(single m/c.) value: 1.52 m/s²									

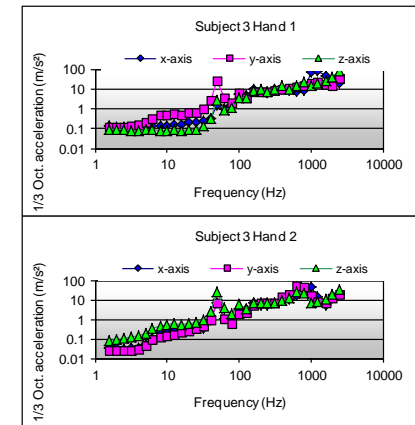
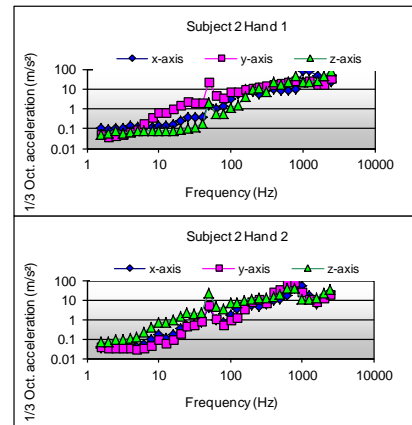
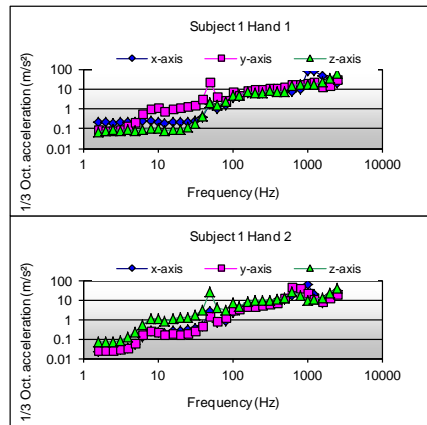


Vibration Emission Test report

Pulse file version: HAV Emission V2.1.2 2008-07-25.pls
Spreadsheet: Version 4.0 19/1/12

Standard: BS EN ISO 28927-10:2011
N&V reference ID: NV/11/42
Measurement file name: Tool C Old Dynaload, 60N

TestNo.	Operator	Meas. Name	Meas. Date	Meas. Time	Hand Position 1 - Front handle				Operator Statistics			Hand position 2 - Rear handle				Operator Statistics		
					a_{whx}	a_{why}	a_{whz}	a_{hV}	Mean a_{hV}	S_{n-1}	C_v	a_{whx}	a_{why}	a_{whz}	a_{hV}	Mean a_{hV}	S_{n-1}	C_v
1	1				2.08	8.90	1.79	9.32	9.09	0.223	0.025	1.85	2.12	8.95	9.38	9.13	0.208	0.023
2	1				2.25	8.77	1.90	9.25				1.91	1.88	8.85	9.24			
3	1				2.15	8.61	1.88	9.07				1.93	1.92	8.66	9.08			
4	1				2.16	8.60	1.97	9.08				2.01	2.02	8.66	9.12			
5	1				2.22	8.27	1.77	8.74	2.00	1.75	8.41	8.82	8.98	0.399	0.044			
6	2				2.37	8.74	2.03	9.28	1.99	3.42	8.59	9.46						
7	2				2.05	7.38	1.99	7.91	2.04	3.39	7.38	8.37						
8	2				2.13	7.99	2.02	8.51	2.02	3.45	7.94	8.89						
9	2				2.21	8.22	1.98	8.74	2.38	3.28	8.11	9.06	9.54	0.242	0.025			
10	2				2.17	8.06	2.09	8.60	2.27	3.94	7.91	9.12						
11	3				2.16	8.62	1.95	9.10	2.61	2.79	8.41	9.24						
12	3				2.36	8.99	1.99	9.51	2.76	3.75	8.62	9.80						
13	3				2.27	8.82	2.13	9.35	3.01	2.95	8.60	9.58	9.31	0.151	0.016			
14	3				2.28	8.84	1.98	9.34	3.12	3.17	8.67	9.74						
15	3				2.37	8.67	2.09	9.23	2.41	3.19	8.46	9.36						
					2.22	8.50	1.97	9.00				2.29	2.87	8.41	9.22			
					a_h (overall mean a_{hV}): 9.00 m/s ²				a_h (overall mean a_{hV}): 9.22 m/s ²									
					ρR (single m/c.): 0.68 m/s ² or 0.84				ρR (single m/c.): 0.62 m/s ² or 0.85									
					$K_{(single\ m/c.)}$ value: 1.39 m/s ²				$K_{(single\ m/c.)}$ value: 1.41 m/s ²									
					Single machine emission a_{hd} (= greatest a_h value): 9.22 m/s²				$K_{(single\ m/c.)}$ value: 1.41 m/s²									

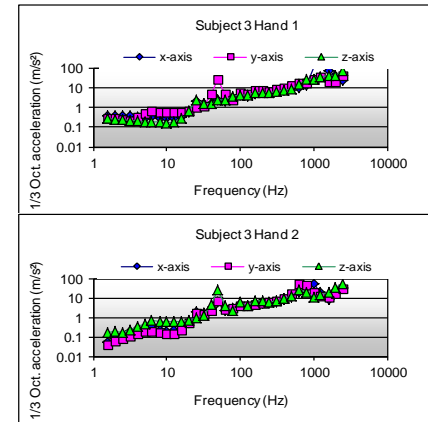
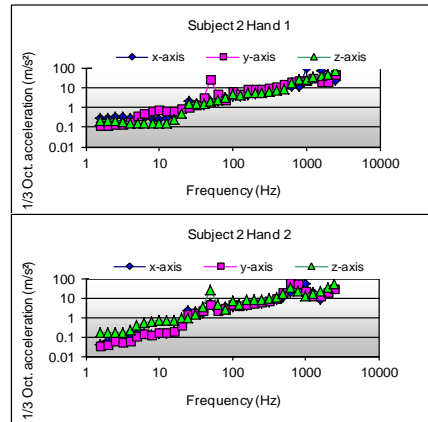
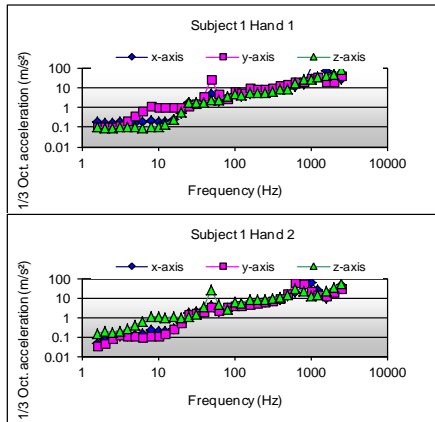


Vibration Emission Test report

Pulse file version: HAV Emission V2.1.2 2008-07-25.pls
Spreadsheet: Version 4.0 19/1/12

Standard: BS EN ISO 28927-10: 2011
N&V reference ID: NV/11/42
Measurement file name: Tool C Old Dynaload, 60N, 3mm Collar

TestNo.	Operator	Meas. Name	Meas. Date	Meas Time	Hand Position 1 - Front handle				Operator Statistics			Hand position 2 - Rear handle				Operator Statistics			
					a_{whx}	a_{why}	a_{whz}	a_{hw}	Mean a_{hv}	S_{n-1}	C_v	a_{whx}	a_{why}	a_{whz}	a_{hw}	Mean a_{hv}	S_{n-1}	C_v	
					3.11	9.06	2.51	9.90				2.87	2.97	8.76	9.68				
2	1				3.47	9.17	2.63	10.15	9.91	0.262	0.026	3.02	3.14	8.93	9.94	9.75	0.227	0.023	
3	1				3.31	8.96	2.65	9.91				3.01	3.25	8.74	9.80				
4	1				3.31	8.54	2.48	9.49				2.97	2.93	8.42	9.40				
5	1				3.67	9.00	2.75	10.11				3.28	3.18	8.84	9.95				
6	2				3.02	9.12	2.33	9.89	9.83	0.120	0.012	3.19	3.31	8.85	9.97	9.89	0.130	0.013	
7	2				2.93	9.08	2.46	9.86				3.14	3.25	8.79	9.88				
8	2				2.95	9.06	2.41	9.83				2.96	3.10	8.89	9.87				
9	2				2.82	9.23	2.42	9.95				2.84	3.21	9.08	10.04				
10	2				2.98	8.79	2.58	9.63	10.29	0.289	0.028	3.17	3.79	8.34	9.69	10.23	0.281	0.027	
11	3				2.82	9.12	2.74	9.93				3.26	3.48	8.63	9.85				
12	3				3.00	9.47	2.79	10.32				3.66	4.03	8.86	10.40				
13	3				2.96	9.22	2.74	10.07				3.19	3.86	8.68	10.02				
14	3				3.09	9.74	2.65	10.56	3.10	3.27	9.35	10.38	3.12	3.23	9.51	10.51			
15	3				3.39	9.63	2.75	10.58											
					3.12	9.15	2.59	10.01					3.12	3.33	8.84	9.96			
					a_h (overall mean a_{hv}): 10.01 m/s ²				a_h (overall mean a_{hv}): 9.96 m/s ²										
					ρR (single m/c.): 0.57 m/s ² or 0.90				ρR (single m/c.): 0.57 m/s ² or 0.90										
					K (single m/c.) value: 1.49 m/s ²				K (single m/c.) value: 1.48 m/s ²										
					Single machine emission a_{hd} (= greatest a_h value): 10.01 m/s²				K (single m/c.) value: 1.49 m/s²										



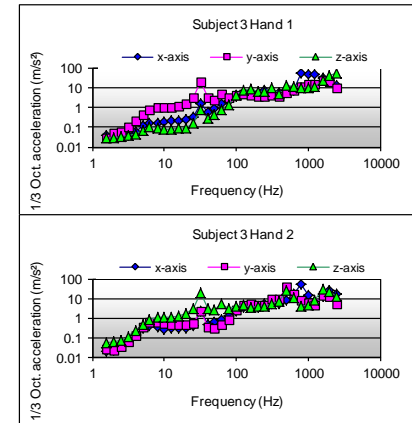
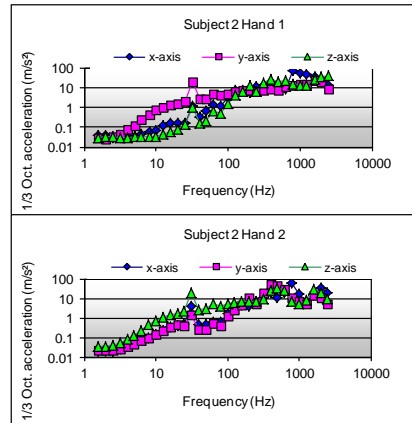
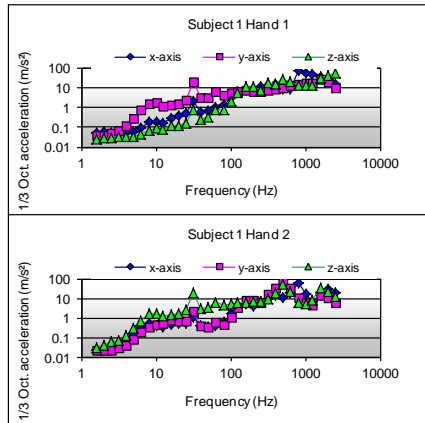
Tool D

Vibration Emission Test report

Pulse file version: HAV Emission V2.1.2 2008-07-25.pls
Spreadsheet: Version 4.0 19/1/12

Standard: BS EN ISO 28927-10: 2011
N&V reference ID: NV/11/32
Measurement file name: Tool D New Dynaload, 60N

TestNo.	Operator	Meas. Name	Meas. Date	Meas Time	Hand Position 1 - Front handle				Operator Statistics			Hand position 2 - Rear handle				Operator Statistics		
					a_{whx}	a_{why}	a_{whz}	a_{hV}	Mean a_{hV}	S_{n-1}	C_V	a_{whx}	a_{why}	a_{whz}	a_{hV}	Mean a_{hV}	S_{n-1}	C_V
1	1				2.59	10.93	2.38	11.49	11.47	0.188	0.016	1.93	3.46	11.10	11.79	11.84	0.240	0.020
2	1				2.65	10.68	2.18	11.22				1.92	3.22	10.86	11.49			
3	1				2.63	10.94	2.36	11.49				2.05	3.54	11.16	11.88			
4	1				2.67	11.20	2.33	11.75				2.33	3.60	11.38	12.16			
5	1				2.80	10.83	2.24	11.41				2.44	3.62	11.04	11.87			
6	2				2.83	11.10	2.25	11.67	11.28	0.599	0.053	2.90	3.38	11.15	12.01	11.70	0.566	0.048
7	2				2.75	11.25	2.51	11.85				2.68	3.47	11.44	12.25			
8	2				2.55	11.05	2.47	11.61				2.62	3.40	11.24	12.04			
9	2				2.30	10.29	2.24	10.77				2.73	3.02	10.46	11.22			
10	2				2.17	10.08	2.02	10.51				3.04	2.92	10.13	10.97			
11	3				2.16	11.21	1.89	11.57	11.20	0.493	0.044	1.88	2.43	11.24	11.65	11.34	0.396	0.035
12	3				2.29	11.25	1.99	11.65				1.90	2.35	11.29	11.69			
13	3				2.07	11.03	1.87	11.38				1.90	2.20	11.11	11.48			
14	3				2.00	10.14	1.69	10.47				2.07	2.68	10.20	10.75			
15	3				2.16	10.58	1.73	10.93				2.06	2.45	10.67	11.14			
					2.44	10.84	2.14	11.32				2.30	3.05	10.96	11.63			
					a_h (overall mean a_{hV}): 11.32 m/s ²				a_h (overall mean a_{hV}): 11.63 m/s ²									
					ρR (single m/c.): 0.61 m/s ² or 0.98				ρR (single m/c.): 0.69 m/s ² or 1.00									
					K (single m/c.) value: 1.62 m/s ²				K (single m/c.) value: 1.65 m/s ²									
					Single machine emission a_{hd} (= greatest a_h value): 11.63 m/s²				K (single m/c.) value: 1.65 m/s²									

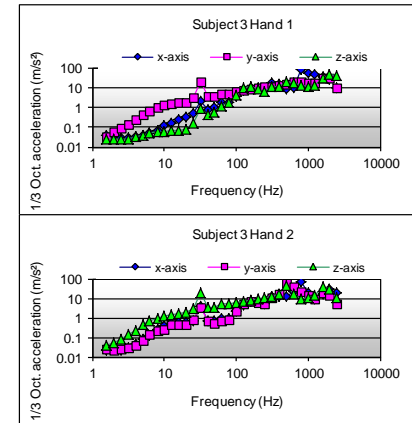
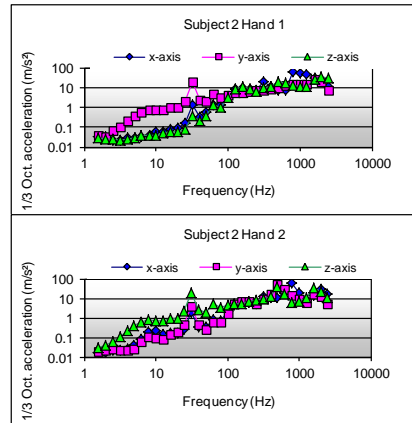
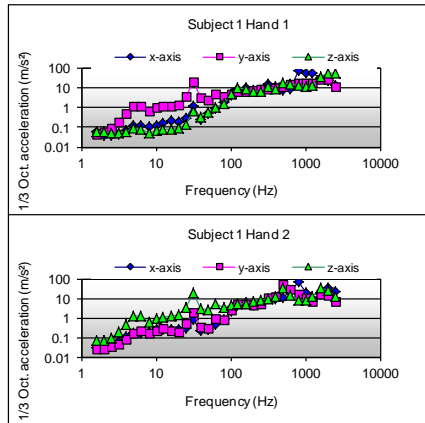


Vibration Emission Test report

Pulse file version: HAV Emission V2.1.2 2008-07-25.pls
Spreadsheet: Version 4.0 19/1/12

Standard: BS EN ISO 28927-10: 2011
N&V reference ID: NV/11/32
Measurement file name: Tool D Old Dynaload, 60N

TestNo.	Operator	Meas. Name	Meas. Date	Meas Time	Hand Position 1 - Front handle				Operator Statistics			Hand position 2 - Rear handle				Operator Statistics		
					a_{whx}	a_{why}	a_{whz}	a_{hvx}	Mean a_{hv}	S_{n-1}	C_v	a_{whx}	a_{why}	a_{whz}	a_{hvx}	Mean a_{hv}	S_{n-1}	C_v
1	1				2.65	11.33	2.27	11.85	11.63	0.176	0.015	1.87	2.48	11.41	11.83	11.68	0.137	0.012
2	1				2.58	11.28	2.19	11.78				1.91	2.60	11.32	11.77			
3	1				2.65	10.95	2.09	11.46				2.03	2.39	11.07	11.51			
4	1				2.71	10.96	2.08	11.48				2.15	2.39	11.12	11.57			
5	1				2.59	11.08	2.07	11.56				2.08	2.79	11.22	11.75			
6	2				2.63	10.00	1.95	10.52	10.63	0.338	0.032	1.84	2.63	10.34	10.83	11.07	0.403	0.036
7	2				2.49	9.62	2.14	10.17				2.00	3.17	9.94	10.63			
8	2				2.87	10.15	2.15	10.76				2.16	2.89	10.50	11.11			
9	2				2.60	10.06	2.24	10.63				2.22	3.14	10.42	11.11			
10	2				2.75	10.50	2.28	11.09				2.53	3.40	10.90	11.69			
11	3				2.95	11.01	2.30	11.63	11.60	0.126	0.011	2.74	3.13	11.07	11.83	12.01	0.291	0.024
12	3				2.94	11.13	2.20	11.72				2.72	2.77	11.24	11.89			
13	3				3.14	10.88	2.14	11.52				2.70	2.91	11.08	11.77			
14	3				3.08	10.71	2.51	11.43				3.79	3.65	10.89	12.10			
15	3				3.12	10.96	2.66	11.71				4.04	3.93	11.14	12.48			
					2.78	10.71	2.22	11.29				2.45	2.95	10.91	11.59			
					a_h (overall mean a_{hv}): 11.29 m/s ²				a_h (overall mean a_{hv}): 11.59 m/s ²									
					ρR (single m/c.): 0.79 m/s ² or 0.98				ρR (single m/c.): 0.78 m/s ² or 1.00									
					K (single m/c.) value: 1.61 m/s ²				K (single m/c.) value: 1.64 m/s ²									
					Single machine emission a_{hd} (= greatest a_h value): 11.59 m/s²				K (single m/c.) value: 1.64 m/s²									



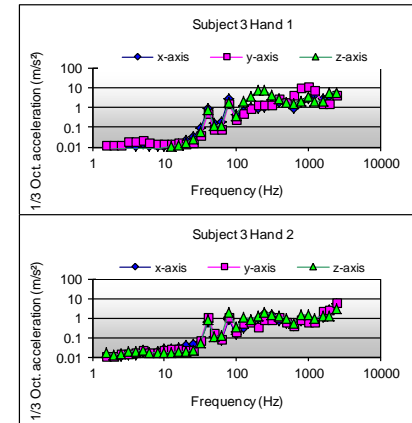
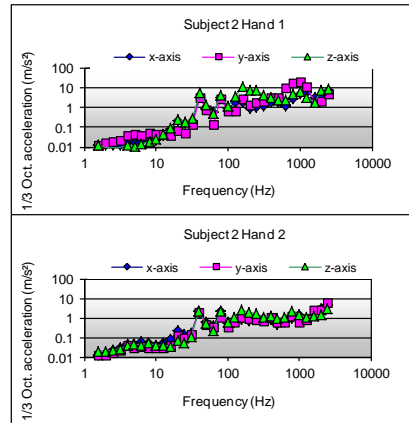
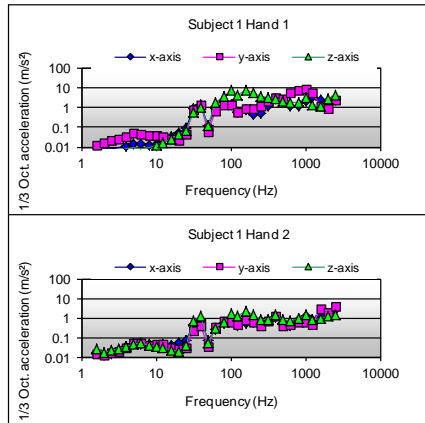
Tool E

Vibration Emission Test report

Pulse file version: HAV Emission V2.1.2 2008-07-25.pls
Spreadsheet: Version 4.0 19/1/12

Standard: BS EN ISO 28927-10:2011
N&V reference ID: NV/10/05
Measurement file name: Tool E New Dynaload, 100N

TestNo.	Operator	Meas. Name	Meas. Date	Meas Time	Hand Position 1 - Front handle				Operator Statistics			Hand position 2 - Rear handle				Operator Statistics		
					a_{whx}	a_{why}	a_{whz}	a_{hvx}	Mean a_{hv}	S_{n-1}	C_v	a_{whx}	a_{why}	a_{whz}	a_{hvx}	Mean a_{hv}	S_{n-1}	C_v
1	1				0.62	1.01	2.01	2.33	2.21	0.241	0.109	0.31	0.33	0.85	0.96	0.95	0.027	0.029
2	1				0.82	0.92	2.09	2.42				0.45	0.31	0.81	0.98			
3	1				1.08	0.78	1.85	2.28				0.49	0.33	0.72	0.93			
4	1				0.95	0.74	1.83	2.19				0.58	0.30	0.69	0.95			
5	1				0.95	0.71	1.36	1.80				0.55	0.33	0.64	0.91			
6	2				1.42	1.52	2.47	3.23	3.64	0.446	0.122	0.86	1.03	1.20	1.80	1.77	0.191	0.108
7	2				1.39	1.50	2.62	3.32				1.15	0.60	1.00	1.64			
8	2				1.26	1.67	2.75	3.45				1.16	0.99	1.12	1.89			
9	2				1.20	1.55	3.39	3.91				1.03	0.63	0.94	1.53			
10	2				2.39	1.72	3.12	4.29				1.29	0.98	1.18	2.00			
11	3				1.09	0.53	1.18	1.70	1.35	0.194	0.144	0.45	0.68	0.56	0.98	0.87	0.077	0.089
12	3				0.68	0.53	0.96	1.29				0.31	0.44	0.62	0.82			
13	3				0.75	0.50	0.89	1.27				0.42	0.51	0.63	0.91			
14	3				0.59	0.49	1.01	1.27				0.31	0.50	0.54	0.80			
15	3				0.52	0.49	1.00	1.23				0.26	0.52	0.59	0.83			
					1.05	0.98	1.90	2.40				0.64	0.56	0.81	1.20			
					a_h (overall mean a_{hv}): 2.40 m/s ²				a_h (overall mean a_{hv}): 1.20 m/s ²									
					ρR (single m/c.): 1.16 m/s ² or 0.44				ρR (single m/c.): 0.72 m/s ² or 0.37									
					K (single m/c.) value: 1.91 m/s ²				K (single m/c.) value: 1.18 m/s ²									
					Single machine emission a_{hd} (= greatest a_h value): 2.40 m/s²				K (single m/c.) value: 1.91 m/s²									

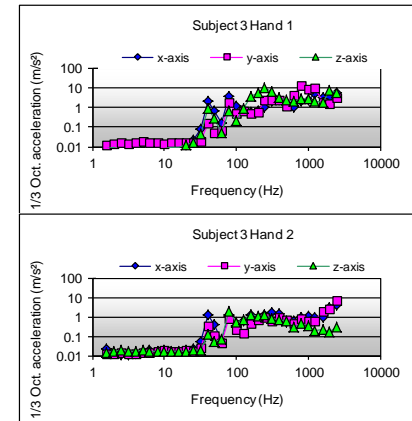
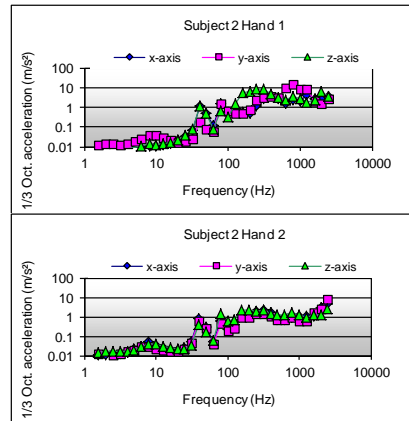
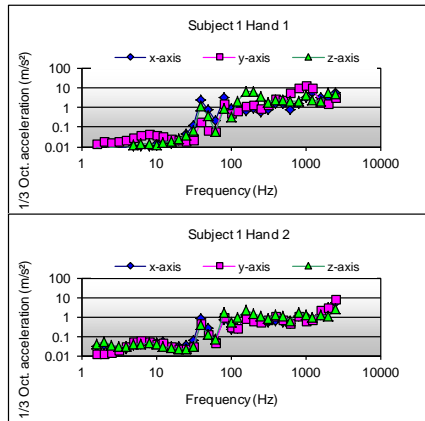


Vibration Emission Test report

Pulse file version: HAV Emission V2.1.2 2008-07-25.pls
Spreadsheet: Version 4.0 19/1/12

Standard: BS EN ISO 28927-10:2011
N&V reference ID: NV/12/05
Measurement file name: Tool E Old Dynaload, 100N.

TestNo.	Operator	Meas. Name	Meas. Date	Meas Time	Hand Position 1 - Front handle				Operator Statistics			Hand position 2 - Rear handle				Operator Statistics			
					a_{whx}	a_{why}	a_{whz}	a_{hv}	Mean a_{hv}	S_{n-1}	C_v	a_{whx}	a_{why}	a_{whz}	a_{hv}	Mean a_{hv}	S_{n-1}	C_v	
1	1				1.16	0.53	1.31	1.83	1.74	0.121	0.070	0.44	0.32	0.51	0.74	0.73	0.032	0.044	
2	1				1.17	0.55	1.10	1.70				0.40	0.33	0.53	0.74				
3	1				1.16	0.50	0.87	1.54				0.37	0.29	0.49	0.68				
4	1				1.39	0.49	1.04	1.81				0.47	0.33	0.51	0.77				
5	1				1.36	0.52	1.07	1.81	1.58	0.220	0.139	0.45	0.29	0.49	0.73	0.79	0.031	0.039	
6	2				0.51	0.68	1.29	1.55				0.43	0.39	0.57	0.81				
7	2				0.63	0.81	1.67	1.96				0.41	0.29	0.59	0.77				
8	2				0.63	0.55	1.15	1.42				0.46	0.32	0.51	0.76				
9	2				0.71	0.52	1.18	1.48	1.64	0.096	0.059	0.47	0.38	0.49	0.78	0.81	0.039	0.048	
10	2				1.00	0.48	0.98	1.48				0.51	0.45	0.47	0.83				
11	3				0.99	0.52	0.98	1.49				0.46	0.35	0.49	0.76				
12	3				1.28	0.53	1.01	1.72				0.65	0.27	0.46	0.84				
13	3				1.32	0.53	0.98	1.73	1.64	0.096	0.059	0.70	0.23	0.42	0.85	0.81	0.039	0.048	
14	3				1.21	0.53	0.96	1.63				0.67	0.20	0.40	0.80				
15	3				1.19	0.54	1.01	1.65				0.68	0.19	0.41	0.82				
					1.05	0.55	1.11	1.65					0.51	0.31	0.49	0.78			
					a_h (overall mean a_{hv}): 1.65 m/s ²								a_h (overall mean a_{hv}): 0.78 m/s ²						
					ρR (single m.c.): 0.32 m/s ² or 0.40								ρR (single m.c.): 0.21 m/s ² or 0.35						
					K (single m.c.) value: 0.66 m/s ²								K (single m.c.) value: 0.57 m/s ²						
					Single machine emission a_{hd} (= greatest a_h value): 1.65 m/s²								K(single m.c.) value: 0.66 m/s²						

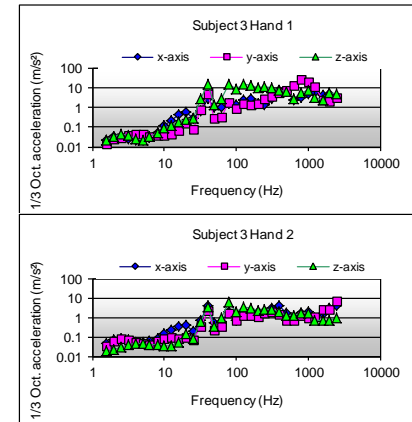
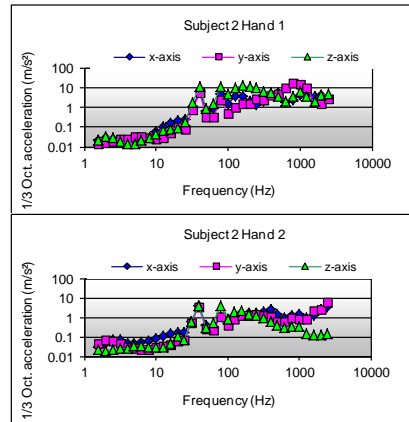
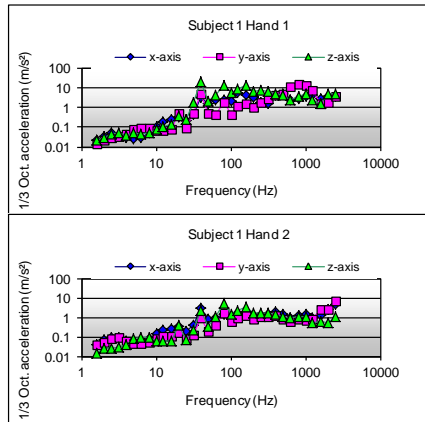


Vibration Emission Test report

Pulse file version: HAV Emission V2.1.2 2008-07-25.pls
Spreadsheet: Version 4.0 19/1/12

Standard: BS EN ISO 28927-10:2011
N&V reference ID: NV/12/05
Measurement file name: Tool E Old Dynaload, 3mm Collar, 100N, Repeat

TestNo.	Operator	Meas. Name	Meas. Date	Meas Time	Hand Position 1 - Front handle				Operator Statistics			Hand position 2 - Rear handle				Operator Statistics																		
					a_{whx}	a_{why}	a_{whz}	a_{hw}	Mean a_{hv}	S_{n-1}	C_v	a_{whx}	a_{why}	a_{whz}	a_{hw}	Mean a_{hv}	S_{n-1}	C_v																
1	1				1.99	2.29	8.81	9.32	9.08	0.283	0.031	1.57	0.66	1.68	2.39	2.25	0.128	0.057																
2	1				1.81	2.33	8.81	9.29				1.57	0.68	1.58	2.33																			
3	1				1.67	2.27	8.52	8.98				1.55	0.68	1.55	2.30																			
4	1				2.18	2.32	8.61	9.18				1.40	0.61	1.53	2.16																			
5	1				1.63	2.13	8.21	8.63	1.28	0.54	1.54	2.08	7.21	0.440	0.061	2.61	1.70	1.87	3.64	3.03	0.343	0.113												
6	2				5.24	2.44	5.28	7.83	1.83	1.31	1.80	2.88																						
7	2				4.09	2.24	5.45	7.17	1.45	1.44	1.97	2.83																						
8	2				2.86	2.20	5.52	6.59	1.48	1.63	2.01	2.98																						
9	2				1.47	2.35	6.76	7.30	1.50	1.47	1.89	2.82	8.39	0.543	0.065	1.82	0.80	1.80	2.68	2.97	0.225	0.076												
10	2				1.19	2.31	6.67	7.16	1.88	1.02	1.96	2.91																						
11	3				1.66	1.95	7.06	7.50	1.84	1.05	2.01	2.92																						
12	3				2.04	2.26	8.44	8.97	2.00	1.00	2.08	3.05																						
13	3				1.65	2.20	8.11	8.56	1.86	1.22	2.43	3.29	2.14	2.25	7.49	8.23	a_h (overall mean a_{hv}): 8.23 m/s ²	ρR (single m/c.): 1.07 m/s ² or 0.79	K (single m/c.) value: 1.77 m/s ²	1.71	1.05	1.85	2.75	a_h (overall mean a_{hv}): 2.75 m/s ²	ρR (single m/c.): 0.76 m/s ² or 0.47	K (single m/c.) value: 1.25 m/s ²								
14	3				1.23	2.19	7.96	8.35	Single machine emission a_{hd} (= greatest a_h value): 8.23 m/s² K (single m/c.) value: 1.77 m/s²																									
15	3				1.46	2.30	8.11	8.55	Single machine emission a_{hd} (= greatest a_h value): 8.23 m/s² K (single m/c.) value: 1.77 m/s²																									



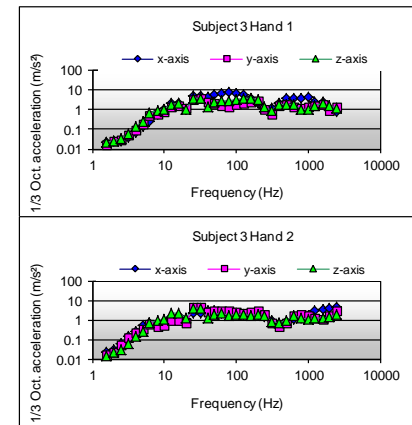
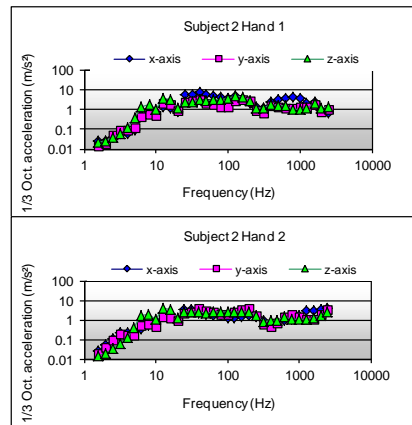
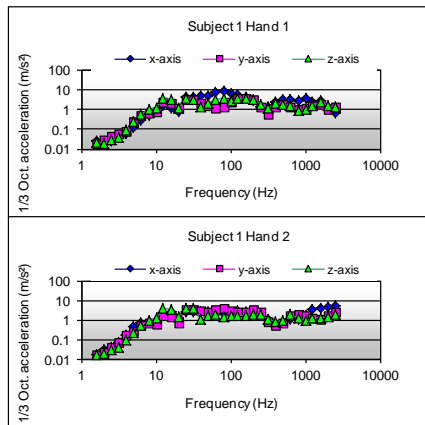
Tool F

Vibration Emission Test report

Pulse file version: HAV Emission V2.1.2 2008-07-25.pls
Spreadsheet: Version 4.0 19/1/12

Standard: BS EN ISO 28927-10:2011
N&V reference ID: NV/12/07
Measurement file name: Tool F New Dynaload, 150N

TestNo.	Operator	Meas. Name	Meas. Date	Meas Time	Hand Position 1 - Front handle				Operator Statistics			Hand position 2 - Rear handle				Operator Statistics		
					a_{whx}	a_{why}	a_{whz}	a_{hvx}	Mean a_{hv}	S_{n-1}	C_v	a_{whx}	a_{why}	a_{whz}	a_{hvx}	Mean a_{hv}	S_{n-1}	C_v
1	1				5.45	4.16	5.77	8.95	9.05	0.446	0.049	4.48	4.34	6.15	8.76	8.66	0.480	0.055
2	1				5.26	4.11	5.16	8.44				4.18	3.88	5.49	7.91			
3	1				5.61	4.16	5.55	8.92				4.49	4.13	5.92	8.50			
4	1				5.58	4.35	6.10	9.35				4.77	4.29	6.53	9.15			
5	1				5.81	4.62	6.09	9.61				4.44	4.02	6.66	8.96			
6	2				6.48	3.23	4.74	8.65	9.40	0.440	0.047	4.11	3.54	4.96	7.35	8.20	0.622	0.076
7	2				6.29	3.83	6.23	9.65				4.11	3.54	6.57	8.52			
8	2				6.39	3.85	5.69	9.38				3.94	3.23	5.89	7.79			
9	2				6.36	3.90	5.99	9.57				4.09	3.64	6.40	8.42			
10	2				6.31	4.19	6.15	9.75				4.70	3.71	6.59	8.90			
11	3				6.83	3.10	4.06	8.53	8.44	0.423	0.050	3.22	4.51	4.07	6.88	7.37	0.343	0.047
12	3				5.86	3.90	4.48	8.34				3.62	4.41	4.78	7.44			
13	3				5.67	3.70	3.96	7.84				3.46	4.63	4.24	7.17			
14	3				5.72	4.10	4.69	8.46				3.86	4.42	5.06	7.74			
15	3				6.33	4.20	4.88	9.03				3.69	4.10	5.21	7.59			
					6.00	3.96	5.30	8.96				4.08	4.03	5.63	8.07			
					a_h (overall mean a_{hv}): 8.96 m/s ²				a_h (overall mean a_{hv}): 8.07 m/s ²									
					ρR (single m/c.): 0.81 m/s ² or 0.84				ρR (single m/c.): 1.00 m/s ² or 0.78									
					K (single m/c.) value: 1.38 m/s ²				K (single m/c.) value: 1.64 m/s ²									
					Single machine emission a_{hd} (= greatest a_h value): 8.96 m/s²				K(single m/c.) value: 1.38 m/s²									

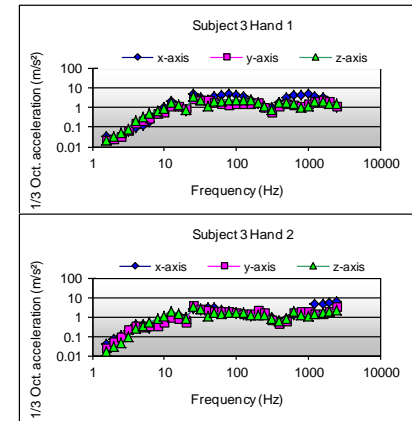
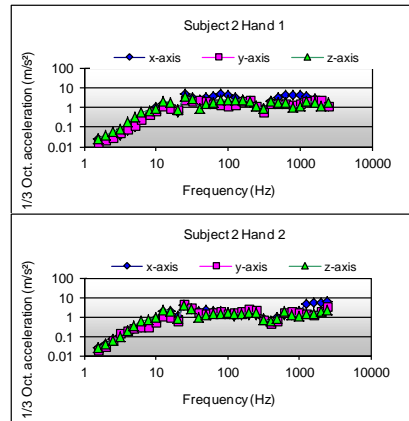
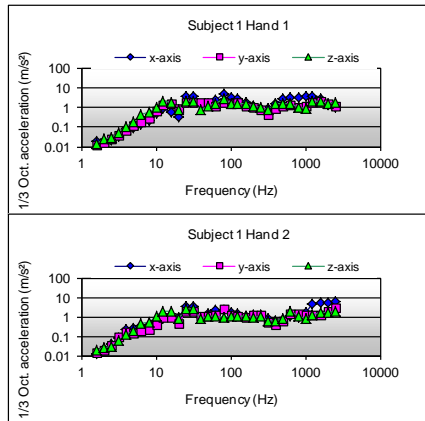


Vibration Emission Test report

Pulse file version: HAV Emission V2.1.2 2008-07-25.pls
Spreadsheet: Version 4.0 19/1/12

Standard: BS EN ISO 28927-10:2011
N&V reference ID: NV/12/07
Measurement file name: Tool F Old Dynaload, 150N

TestNo.	Operator	Meas. Name	Meas. Date	Meas Time	Hand Position 1 - Front handle				Operator Statistics			Hand position 2 - Rear handle				Operator Statistics			
					a_{whx}	a_{why}	a_{whz}	a_{hv}	Mean a_{hv}	S_{n-1}	C_v	a_{whx}	a_{why}	a_{whz}	a_{hv}	Mean a_{hv}	S_{n-1}	C_v	
					1	1				3.75	2.55	3.24	5.57	5.63	0.739	0.131	3.72	2.55	3.58
2	1				3.87	3.70	4.06	6.72	3.44	2.41	4.39	6.08							
3	1				3.57	2.95	3.74	5.95	3.39	2.39	4.02	5.78							
4	1				3.20	2.49	2.93	5.00	3.17	1.96	3.07	4.83							
5	1				3.38	2.33	2.72	4.93	3.14	1.96	2.87	4.68							
6	2				3.97	2.53	4.04	6.21	6.80	0.622	0.091	4.32	3.87	4.24	7.18	7.14	0.479	0.067	
7	2				4.53	2.83	3.65	6.47				4.30	3.58	3.85	6.80				
8	2				4.73	2.77	4.62	7.17				4.77	3.96	4.90	7.90				
9	2				4.69	2.32	3.76	6.45				4.26	3.38	3.87	6.67				
10	2				5.16	3.61	4.44	7.71				3.93	3.93	4.50	7.15				
11	3				5.29	3.11	4.02	7.34	7.02	0.398	0.057	3.62	3.59	4.27	6.65	6.39	0.394	0.062	
12	3				4.99	3.31	3.82	7.11				3.61	2.92	4.16	6.23				
13	3				5.17	3.07	3.98	7.21				3.63	3.21	4.20	6.41				
14	3				5.05	3.14	3.89	7.10				3.61	4.01	4.21	6.85				
15	3				4.53	3.41	2.80	6.33				3.13	3.85	3.06	5.82				
					4.39	2.94	3.71	6.48					3.74	3.17	3.94	6.32			
					a_h (overall mean a_{hv}): 6.48 m/s ²								a_h (overall mean a_{hv}): 6.32 m/s ²						
					ρR (single m/c.): 1.05 m/s ² or 0.69								ρR (single m/c.): 1.05 m/s ² or 0.68						
					K (single m/c.) value: 1.74 m/s ²								K (single m/c.) value: 1.73 m/s ²						
					Single machine emission a_{hd} (= greatest a_h value): 6.48 m/s²								K(single m/c.) value: 1.74 m/s²						

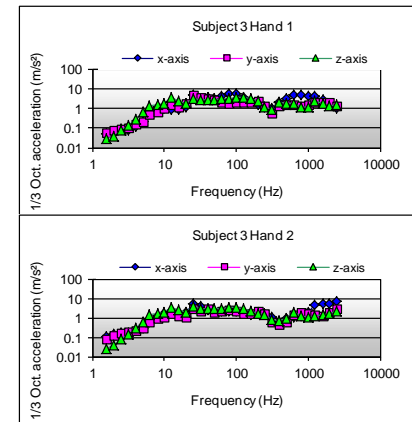
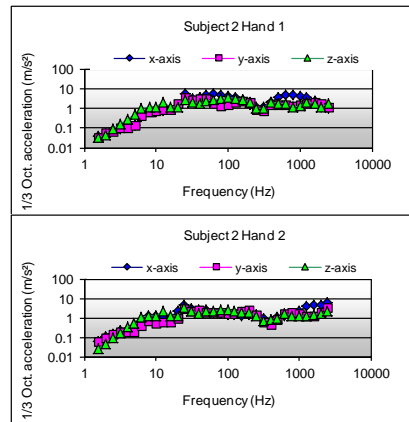
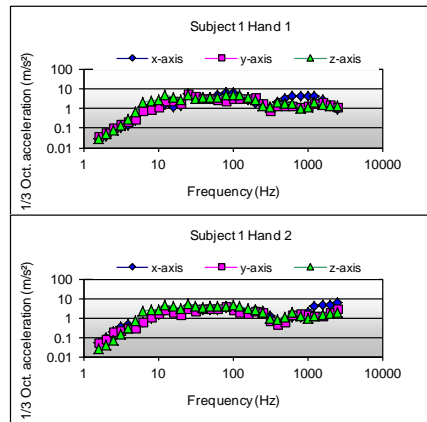


Vibration Emission Test report

Pulse file version: HAV Emission V2.1.2 2008-07-25.pls
Spreadsheet: Version 4.0 19/1/12

Standard: BS EN ISO 28927-10:2011
N&V reference ID: NV/12/07
Measurement file name: Tool F Old Dynaload, 3mm Collar 150N

TestNo.	Operator	Meas. Name	Meas. Date	Meas Time	Hand Position 1 - Front handle				Hand position 2 - Rear handle							
					a_{whx}	a_{why}	a_{whz}	a_{hv}	a_{whx}	a_{why}	a_{whz}	a_{hv}				
					Operator Statistics			Mean a_{hv}	S_{n-1}	C_v	Operator Statistics					
Mean a_{hv}	S_{n-1}	C_v	Mean a_{hv}	S_{n-1}	C_v											
1	1	SH01	6/28/12	13:50:34:874	5.67	5.43	7.53	10.88	5.48	4.69	8.01	10.78	11.18	1.298	0.116	
2	1	SH02	6/28/12	13:51:11:124	6.94	7.02	10.27	14.24	5.26	5.87	10.67	13.26				
3	1	SH03	6/28/12	13:51:42:373	4.76	5.53	6.76	9.94	5.18	4.05	7.24	9.78				
4	1	SH04	6/28/12	13:52:14:499	6.21	5.98	8.32	11.98	5.24	4.75	8.93	11.39				
5	1	SH05	6/28/12	13:52:44:874	5.60	5.17	7.86	10.95	4.85	4.52	8.37	10.68				
6	2	MM01	6/28/12	13:24:50:124	4.64	3.57	3.02	6.59	4.42	2.39	3.35	6.04	7.05	0.925	0.131	
7	2	MM02	6/28/12	13:25:23:624	4.83	3.56	3.20	6.80	4.62	2.52	3.37	6.24				
8	2	MM03	6/28/12	13:26:32:998	4.66	3.90	3.86	7.20	4.67	3.26	4.19	7.07				
9	2	MM04	6/28/12	13:27:05:249	5.46	4.30	4.35	8.20	4.96	3.48	4.72	7.68				
10	2	MM05	6/28/12	13:27:36:124	5.24	4.36	5.00	8.45	5.21	3.24	5.45	8.21				
11	3	GH01	6/28/12	13:32:33:874	5.16	4.50	5.64	8.87	5.26	3.79	6.18	8.96	9.07	0.592	0.065	
12	3	GH02	6/28/12	13:33:04:373	4.67	4.03	6.03	8.62	5.13	3.67	6.38	8.98				
13	3	GH03	6/28/12	13:33:34:623	5.01	4.94	6.34	9.47	5.91	3.78	6.86	9.81				
14	3	GH04	6/28/12	13:34:14:998	4.79	5.03	4.98	8.55	5.19	3.40	5.39	8.22				
15	3	GH05	6/28/12	13:34:56:248	4.90	5.21	5.72	9.16	5.89	3.72	6.29	9.39				
					5.24	4.83	5.92	9.33					5.15	3.81	6.36	9.10
					a_h (overall mean a_{hv}): 9.33 m/s ²				a_h (overall mean a_{hv}): 9.10 m/s ²							
					ρR (single m/c.): 1.94 m/s ² or 0.86				ρR (single m/c.): 1.81 m/s ² or 0.85							
					K (single m/c.) value: 3.21 m/s ²				K (single m/c.) value: 2.99 m/s ²							
					Single machine emission a_{hd} (= greatest a_h value): 9.33 m/s²				K(single m/c.) value: 3.21 m/s²							



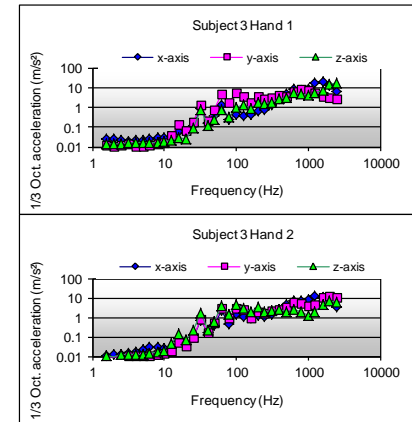
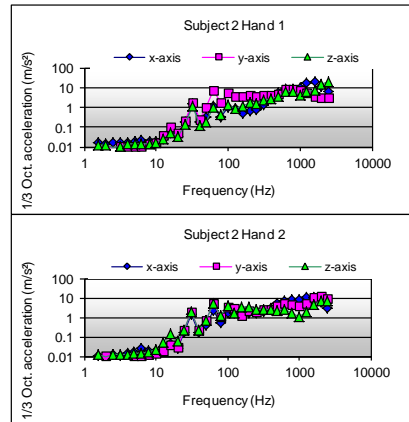
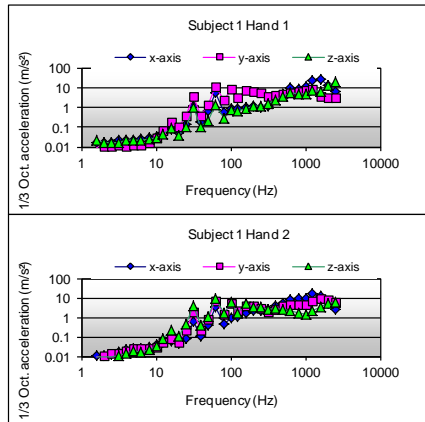
Tool G

Vibration Emission Test report

Pulse file version: HAV Emission V2.1.2 2008-07-25.pls
Spreadsheet: Version 4.0 19/1/12

Standard: BS EN ISO 28927-10: 2011
N&V reference ID: NV/12/o/a
Measurement file name: Tool G New Dynaload, 60N, Tool A Bit, Repeat

TestNo.	Operator	Meas. Name	Meas. Date	Meas Time	Hand Position 1 - Front handle				Operator Statistics			Hand position 2 - Rear handle				Operator Statistics		
					a_{whx}	a_{why}	a_{whz}	a_{hv}	Mean a_{hv}	S_{n-1}	C_v	a_{whx}	a_{why}	a_{whz}	a_{hv}	Mean a_{hv}	S_{n-1}	C_v
1	1				1.74	4.52	0.69	4.90	4.46	0.337	0.076	1.34	2.75	3.29	4.49	4.37	0.224	0.051
2	1				1.62	4.20	0.70	4.56				1.20	2.36	3.66	4.52			
3	1				1.51	4.14	0.78	4.48				1.07	2.41	3.67	4.52			
4	1				1.54	4.04	0.69	4.38				0.96	2.20	3.62	4.34			
5	1				1.62	3.55	0.70	3.96	2.88	0.360	0.125	0.98	2.01	3.31	4.00	2.91	0.368	0.126
6	2				0.86	2.34	0.67	2.58				0.94	1.49	1.95	2.62			
7	2				1.16	3.15	0.98	3.50				1.43	2.36	2.24	3.56			
8	2				1.02	2.40	0.80	2.73				1.16	1.75	1.88	2.82			
9	2				1.09	2.41	0.83	2.78	2.07	0.176	0.085	1.11	1.76	1.88	2.81	2.18	0.166	0.076
10	2				0.93	2.52	0.78	2.80				0.99	1.86	1.78	2.76			
11	3				0.80	1.77	0.55	2.02				0.82	0.94	1.71	2.11			
12	3				0.62	1.66	0.60	1.87				0.76	1.02	1.59	2.03			
13	3				0.71	2.03	0.64	2.24	2.07	0.176	0.085	0.90	1.24	1.79	2.36	2.18	0.166	0.076
14	3				0.72	2.06	0.61	2.27				0.92	1.21	1.80	2.35			
15	3				0.65	1.75	0.59	1.96				0.79	1.11	1.51	2.03			
					1.11	2.84	0.71	3.13				1.03	1.76	2.38	3.15			
					a_h (overall mean a_{hv}): 3.13 m/s ²				a_h (overall mean a_{hv}): 3.15 m/s ²									
					ρR (single m/c.): 1.35 m/s ² or 0.49				ρR (single m/c.): 1.28 m/s ² or 0.49									
					K (single m/c.) value: 2.23 m/s ²				K (single m/c.) value: 2.12 m/s ²									
					Single machine emission a_{hd} (= greatest a_h value): 3.15 m/s²				K(single m/c.) value: 2.12 m/s²									

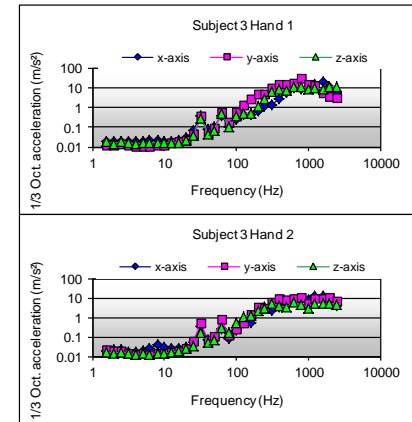
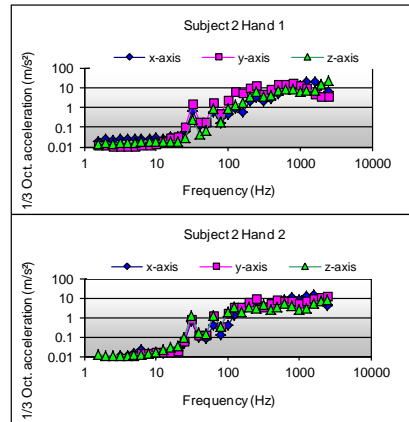
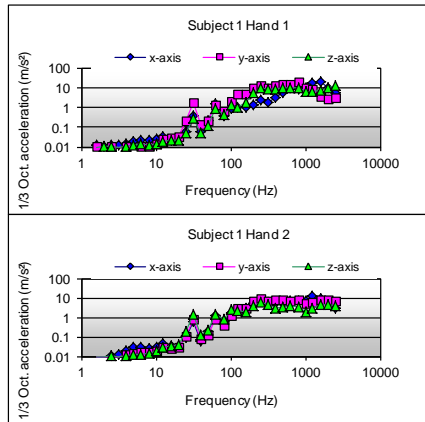


Vibration Emission Test report

Pulse file version: HAV Emission V2.1.2 2008-07-25.pls
Spreadsheet: Version 4.0 19/1/12

Standard: BS EN ISO 28927-10:2011
N&V reference ID: NV/12/o/a
Measurement file name: Tool G Old Dynaload, 60N, Tool G Bit, Repeat

TestNo.	Operator	Meas. Name	Meas. Date	Meas Time	Hand Position 1 - Front handle				Operator Statistics			Hand position 2 - Rear handle				Operator Statistics		
					a_{whx}	a_{why}	a_{whz}	a_{hv}	Mean a_{hv}	S_{n-1}	C_v	a_{whx}	a_{why}	a_{whz}	a_{hv}	Mean a_{hv}	S_{n-1}	C_v
1	1				0.56	1.68	1.02	2.04	2.41	0.232	0.097	0.86	1.12	0.72	1.58	2.04	0.295	0.145
2	1				0.73	2.23	1.24	2.65				1.16	1.43	1.22	2.21			
3	1				0.55	1.98	1.14	2.36				0.97	1.25	1.09	1.92			
4	1				0.88	2.13	1.09	2.55				1.27	1.23	1.53	2.34			
5	1				0.79	2.01	1.11	2.43	1.17	1.18	1.35	2.14	1.84	0.285	0.154			
6	2				0.66	2.29	0.90	2.55	1.02	1.44	1.27	2.18						
7	2				0.64	1.99	0.87	2.27	0.98	1.19	1.16	1.93						
8	2				0.77	2.03	0.75	2.29	0.93	1.28	1.11	1.94						
9	2				0.66	1.96	0.78	2.21	0.79	1.23	0.98	1.76	1.10	0.066	0.060			
10	2				0.58	1.60	0.66	1.83	0.65	1.00	0.76	1.41						
11	3				0.55	1.16	0.65	1.44	0.51	0.69	0.63	1.06						
12	3				0.49	1.20	0.65	1.45	0.51	0.73	0.52	1.03						
13	3				0.49	1.45	0.75	1.70	0.54	0.90	0.49	1.16	1.59	0.162	0.102			
14	3				0.48	1.55	0.80	1.81	0.51	0.97	0.44	1.18						
15	3				0.43	1.33	0.66	1.55	0.47	0.82	0.47	1.05						
					0.62	1.77	0.87	2.07				0.82	1.10	0.92	1.66			
					a_h (overall mean a_{hv}): 2.07 m/s ²				a_h (overall mean a_{hv}): 1.66 m/s ²									
					ρR (single m/c.): 0.73 m/s ² or 0.42				ρR (single m/c.): 0.80 m/s ² or 0.40									
					K (single m/c.) value: 1.21 m/s ²				K (single m/c.) value: 1.32 m/s ²									
					Single machine emission a_{hd} (= greatest a_h value): 2.07 m/s²				K(single m/c.) value: 1.21 m/s²									



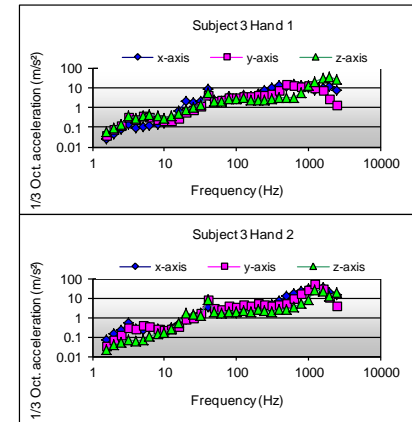
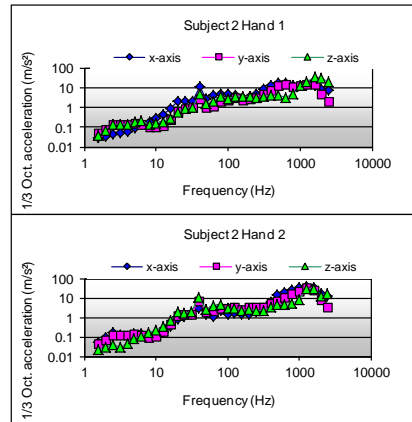
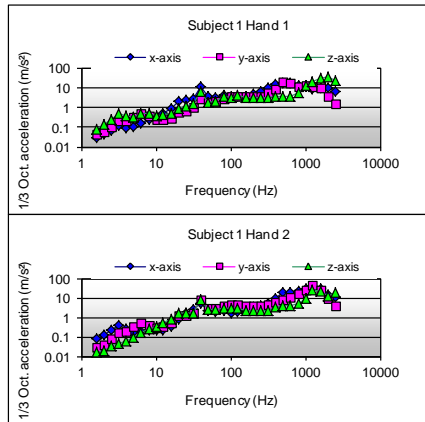
Tool H

Vibration Emission Test report

Pulse file version: HAV Emission V2.1.2 2008-07-25.pls
Spreadsheet: Version 4.0 19/1/12

Standard: BS EN ISO 28927-10:2011
N&V reference ID: Tool H
Measurement file name: Tool H, 40mm dynaload, 240 Newtons.

TestNo.	Operator	Meas. Name	Meas. Date	Meas Time	Throttle				Operator Statistics			Support				Operator Statistics		
					a_{whx}	a_{why}	a_{whz}	a_{hV}	Mean a_{hV}	S_{n-1}	C_v	a_{whx}	a_{why}	a_{whz}	a_{hV}	Mean a_{hV}	S_{n-1}	C_v
1	1				5.51	2.07	3.39	6.79	6.78	0.197	0.029	3.85	4.26	4.54	7.32	6.68	0.380	0.057
2	1				5.30	2.27	3.49	6.74				3.14	4.19	3.90	6.53			
3	1				5.56	2.27	3.40	6.91				3.23	4.19	4.14	6.71			
4	1				5.20	2.13	3.24	6.48				3.36	3.81	4.06	6.50			
5	1				5.96	2.16	2.96	7.00	6.36	0.169	0.027	2.71	4.06	4.05	6.34	6.74	0.104	0.015
6	2				5.38	1.99	2.64	6.31				2.11	3.69	5.35	6.84			
7	2				5.87	1.89	2.25	6.57				2.09	3.77	5.07	6.66			
8	2				5.69	2.11	2.34	6.50				2.26	3.74	4.94	6.60			
9	2				5.42	1.63	2.51	6.19	6.10	0.382	0.063	2.45	3.74	5.14	6.82	6.29	0.423	0.067
10	2				5.30	1.72	2.77	6.22				2.23	3.59	5.31	6.78			
11	3				5.53	2.27	3.10	6.73				2.13	3.94	5.09	6.78			
12	3				4.43	2.52	3.02	5.93				2.21	3.95	3.70	5.85			
13	3				4.30	2.67	2.94	5.85	6.10	0.382	0.063	2.51	4.20	4.04	6.34	6.29	0.423	0.067
14	3				4.63	2.79	3.01	6.19				2.81	4.25	4.19	6.60			
15	3				4.19	2.75	2.94	5.81				2.65	3.82	3.56	5.86			
					5.22	2.22	2.93	6.42				2.65	3.95	4.47	6.57			
					a_h (overall mean a_{hV}): 6.42 m/s ²				a_h (overall mean a_{hV}): 6.57 m/s ²									
					ρR (single m/c.): 0.70 m/s ² or 0.68				ρR (single m/c.): 0.63 m/s ² or 0.69									
					K (single m/c.) value: 1.15 m/s ²				K (single m/c.) value: 1.15 m/s ²									
					Single machine emission a_{hd} (= greatest a_h value): 6.57 m/s²				K(single m/c.) value: 1.15 m/s²									



Vibration Emission Test report

Pulse file version: HAV Emission V2.1.2 2008-07-25.pls

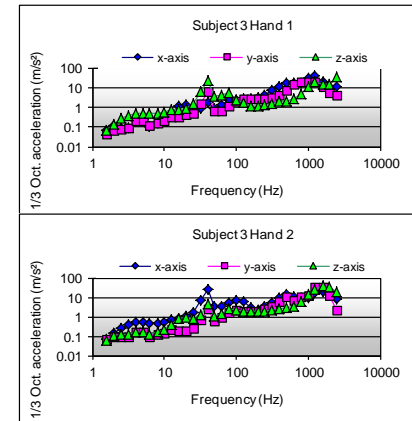
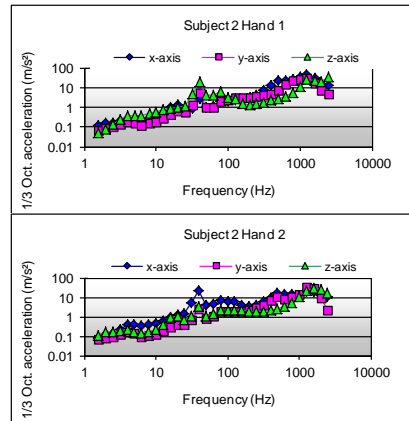
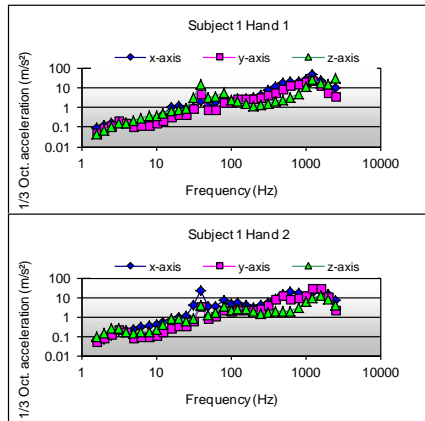
Spreadsheet: Version 4.0 19/1/12

Standard: BS EN ISO 28927-10:2011 Hand-held portable power tools - Test methods for evaluation of vibration emission. Part 10: Percussive drills, hammers and breakers

N&V reference ID: NV/12/06

Measurement file name: Tool H Emission Test File - Drilling Concrete

TestNo.	Operator	Meas. Name	Meas. Date	Meas Time	Hand Position 1 - Front handle				Operator Statistics			Hand position 2 - Rear handle				Operator Statistics				
					a_{whx}	a_{why}	a_{whz}	a_{hv}	Mean a_{hv}	S_{n-1}	C_v	a_{whx}	a_{why}	a_{whz}	a_{hv}	Mean a_{hv}	S_{n-1}	C_v		
1	1				2.34	2.28	7.73	8.39	7.63	0.951	0.125	9.82	1.66	2.17	10.20	9.93	0.183	0.018		
2	1				2.15	2.45	5.84	6.69				9.62	1.77	2.16	10.02					
3	1				2.27	2.11	7.36	7.98				9.42	1.74	2.30	9.85					
4	1				2.35	2.15	5.71	6.54				9.24	1.85	2.36	9.72					
5	1				3.03	2.15	7.69	8.54	9.76	1.134	0.116	9.35	1.86	2.67	9.89	10.41	0.635	0.061		
6	2				3.45	3.44	9.46	10.64				10.45	1.88	3.06	11.05					
7	2				2.34	2.50	9.62	10.21				10.31	1.45	2.25	10.65					
8	2				2.36	2.51	9.78	10.37				10.51	1.41	2.06	10.80					
9	2				2.44	2.92	6.82	7.81	11.38	0.235	0.021	9.11	1.71	1.88	9.46	11.84	0.129	0.011		
10	2				2.30	2.45	9.19	9.79				9.76	1.48	2.21	10.12					
11	3				2.52	3.11	10.27	11.02				11.55	1.34	2.14	11.82					
12	3				2.16	2.92	10.75	11.34				11.53	1.40	2.44	11.87					
13	3				2.18	2.77	11.07	11.62	11.62	11.26	1.47	2.70	11.67	11.84	0.129	0.011				
14	3				2.32	2.66	10.77	11.34									11.44	1.47	2.46	11.79
15	3				2.59	2.79	10.92	11.56									11.62	1.69	2.58	12.02
					2.45	2.61	8.86	9.59					10.33	1.61	2.36	10.73				
					a_h (overall mean a_{hv}): 9.59 m/s ²								a_h (overall mean a_{hv}): 10.73 m/s ²							
					ρR (single m/c.): 1.98 m/s ² or 0.88								ρR (single m/c.): 1.23 m/s ² or 0.94							
					K (single m/c.) value: 3.26 m/s ²								K (single m/c.) value: 2.02 m/s ²							
					Single machine emission a_{hd} (= greatest a_h value): 10.73 m/s²								K(single m/c.) value: 2.02 m/s²							



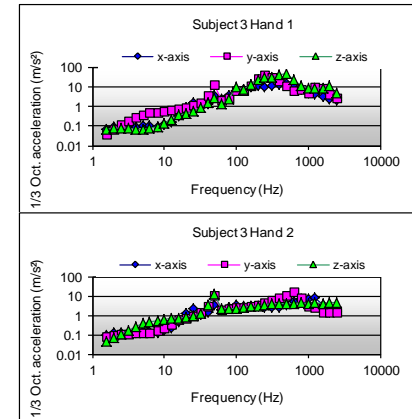
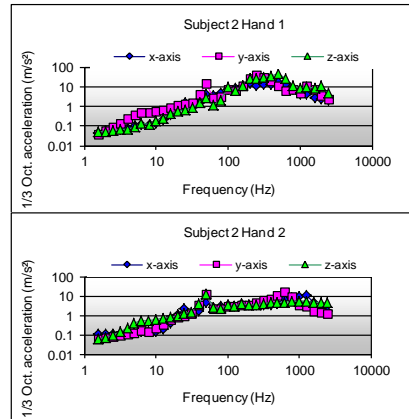
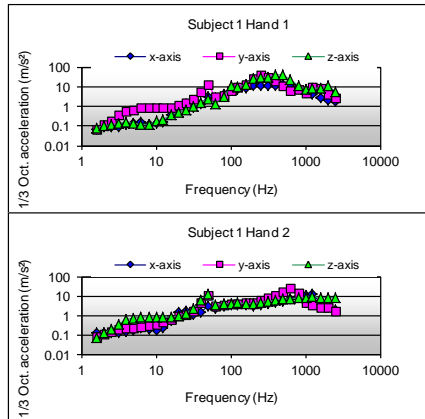
Tool I

Vibration Emission Test report

Pulse file version: HAV Emission V2.1.2 2008-07-25.pls
Spreadsheet: Version 4.0 19/1/12

Standard: BS EN ISO 28927-10:2011
N&V reference ID: NV/12/06
Measurement file name: Tool I

TestNo.	Operator	Meas. Name	Meas. Date	Meas Time	Hand Position 1 - Front handle				Operator Statistics			Hand position 2 - Rear handle				Operator Statistics		
					a_{whx}	a_{why}	a_{whz}	a_{hv}	Mean a_{hv}	S_{n-1}	C_v	a_{whx}	a_{why}	a_{whz}	a_{hv}	Mean a_{hv}	S_{n-1}	C_v
					1	1				3.18	6.41	4.99	8.73				2.31	3.74
2	1				2.85	6.76	3.98	8.35				2.39	4.31	5.74	7.56			
3	1				2.79	6.40	5.04	8.61	8.89	0.567	0.064	2.09	4.33	5.35	7.20	7.67	1.002	0.131
4	1				2.89	6.84	4.98	8.94				2.58	4.81	5.79	7.95			
5	1				3.55	7.73	4.92	9.83				3.10	5.53	6.63	9.18			
6	2				3.34	6.45	4.64	8.62				2.53	4.35	4.94	7.05			
7	2				3.55	6.29	4.64	8.58				2.75	4.26	4.90	7.05			
8	2				4.35	7.77	4.47	9.96	8.79	0.661	0.075	3.93	5.52	6.09	9.11	7.30	1.036	0.142
9	2				3.25	6.48	4.19	8.38				2.53	4.03	4.43	6.50			
10	2				3.20	6.60	4.13	8.41				2.39	4.23	4.75	6.79			
11	3				3.19	6.15	4.89	8.49				2.57	4.17	4.59	6.71			
12	3				3.22	6.16	4.80	8.45				2.76	3.95	4.23	6.41			
13	3				2.99	5.90	4.57	8.04	8.34	0.273	0.033	2.38	4.00	4.44	6.43	6.65	0.280	0.042
14	3				2.87	6.14	4.35	8.05				2.18	4.10	4.71	6.62			
15	3				3.06	6.80	4.38	8.65				2.38	4.39	5.05	7.10			
					3.22	6.59	4.60	8.67				2.59	4.38	5.09	7.21			
					a_h (overall mean a_{hv}): 8.67 m/s ²				a_h (overall mean a_{hv}): 7.21 m/s ²									
					ρR (single m/c.): 0.76 m/s ² or 0.82				ρR (single m/c.): 1.12 m/s ² or 0.73									
					K (single m/c.) value: 1.35 m/s ²				K (single m/c.) value: 1.84 m/s ²									
					Single machine emission a_{hd} (= greatest a_h value): 8.67 m/s²				K (single m/c.) value: 1.35 m/s²									



ANNEX D - FIELD / IN-USE TEST DATA

Tool A

		Dateofentrytodatabase: PrintDate	30-Oct-13
MainID:	1598		
DateOfVisit:	28/09/12		
LocationName:			
Occupation:	Scientist		
Process:	Removal of rivet heads		
ProcessNotes:	Removal of countersunk 0.5 inch, aluminium rivet heads from 2 steel plates.		
MachineModel:			InsertedToolType:
MachineModifications:			InsertedToolPhotoDirectoryName
MachineSize:			DataSource:
MachineWeight(kg):	1.54	HSLReportNumber:	
MachineOperatingPressure:	6.2 Bar	HSLReportDirectoryName:	
MachineSpeed(impacts/min):	3500	ShotsPerDay:	
MachineSpeed(revs/min):		DailyExposureTime:	
MachinePower:		Checked2012Initials:	
MachinePowerSource:	Pneumatic		
MachinePhotoDirName:	Photos\Chipping hammer photos		
InsertedToolCategoryID:	62		

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1598	11102	3.13	7.36	1.84	8.21	3.03	3.71	5.95	7.64	30.75			
	11103	3.25	7.74	1.59	8.55	4.00	3.74	6.09	8.19	30.50			
	11104	3.99	8.46	2.46	9.67	3.84	3.61	6.41	8.30	30.75			
	11105	3.23	10.11	1.99	10.80	4.29	3.88	8.28	10.10	30.50			
	11106	3.02	12.03	2.01	12.56	5.13	3.76	9.88	11.75	30.25			
	11107	3.04	10.63	2.10	11.26	4.14	3.50	8.87	10.40	31.00			
	11108	4.23	10.81	1.83	11.75	5.98	4.38	8.69	11.42	30.00			
	11109	4.48	12.89	2.13	13.81	6.44	4.82	10.47	13.20	30.00			
	11110	4.71	13.50	2.02	14.44	6.61	4.80	10.90	13.62	30.00			
Count:	9									Total:	273.75	seconds	

Mean:	3.68	10.39	2.00	11.23	4.83	4.02	8.39	10.51	Highest hand a_{hw} 11.2 ± 2.2 m/s²			
Stdev:	0.67	2.20	0.24	2.18	1.27	0.51	1.88	2.18				
Time to EAV:												0:23
Time to ELV:												1:35

25%ile	3.13	8.46	1.84	9.67	4.00	3.71	6.41	8.30	Highest hand 75%ile 12.6m/s²			
Median:	3.25	10.63	2.01	11.26	4.29	3.76	8.69	10.40				
75%ile	4.23	12.03	2.10	12.56	5.98	4.38	9.88	11.75				
IQ range	1.10	3.57	0.26	2.89	1.98	0.67	3.47	3.46				
Time to EAV:												0:27
Time to ELV:												1:50

Time-weighted mean:	3.67	10.38	2.00	11.21	4.82	4.02	8.38	10.50
Stdev:	1.38	4.03	0.70	4.26	2.00	1.42	3.31	4.06

V2.2 April 2012

Dateofentrytodatabase: PrintDate		30-Oct-13
MainID:	1599	
DateOfVisit:	28/09/12	
LocationName:		
Occupation:	Scientist	
Process:	Removal of rivet heads	
ProcessNotes:	Removal of flattened shank of 0.5 inch, aluminium rivets from 2 steel plates.	
MachineModel:		InsertedToolType:
MachineModifications:		InsertedToolPhotoDirectoryName:
MachineSize:		DataSource:
MachineWeight(kg):	1.54	HSLReportNumber:
MachineOperatingPressure:	6.2 Bar	HSLReportDirectoryName:
MachineSpeed(impacts/min):	3500	ShotsPerDay:
MachineSpeed(revs/min):		DailyExposureTime:
MachinePower:		Checked2012Initials:
MachinePowerSource:	Pneumatic	
MachinePhotoDirName:	Photos\Chipping hammer photos	
InsertedToolCategoryID:	62	

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1599	11112	6.57	13.15	1.67	14.79	6.60	4.72	10.60	13.35	30.00			
	11113	5.27	11.87	1.96	13.13	5.41	3.97	9.72	11.81	30.00			
	11114	3.46	9.41	1.80	10.18	3.25	3.47	7.64	9.00	30.00			
	11115	3.94	11.68	2.10	12.51	5.93	4.68	9.39	12.05	30.00			
	11116	3.65	13.31	2.57	14.04	5.59	4.78	11.00	13.23	30.00			
	11117	2.50	9.33	1.90	9.85	4.00	3.54	7.98	9.60	30.00			
	11118	2.49	10.78	1.62	11.18	4.53	4.26	8.97	10.92	30.00			
	11120	2.38	9.44	1.51	9.85	4.25	3.64	7.98	9.75	30.00			
	11121	2.80	10.71	1.60	11.18	4.52	3.96	9.04	10.85	30.00			
Count:	9									Total:	270.00	seconds	

Mean:	3.67	11.08	1.86	11.86	4.90	4.11	9.15	11.17	Highest hand a_{hw} 11.9 ± 1.8 m/s²		
Stdev:	1.43	1.54	0.33	1.84	1.06	0.52	1.17	1.56			
Time to EAV:					0:21						
Time to ELV:					1:25						
A(8):					1:36						

25%ile:	2.50	9.44	1.62	10.18	4.25	3.64	7.98	9.75	Highest hand 75%ile 13.1m/s²		
Median:	3.46	10.78	1.80	11.18	4.53	3.97	9.04	10.92			
75%ile:	3.94	11.87	1.96	13.13	5.59	4.68	9.72	12.05			
IQ range:	1.44	2.43	0.34	2.95	1.34	1.03	1.73	2.30			
Time to EAV:					0:24						
Time to ELV:					1:35						
A(8):					1:40						

Time-weighted mean:	3.67	11.08	1.86	11.86	4.90	4.11	9.15	11.17
Stdev:	1.82	3.97	0.69	4.32	1.91	1.46	3.24	4.01

V2.2 April 2012

Dateofentrytodatabase:		30-Oct-13	
PrintDate		30-Oct-13	
MainID:	1600		
DateOfVisit:	28/09/12		
LocationName:			
Occupation:	Scientist		
Process:	Punching out rivets		
ProcessNotes:	Punching out 0.5inch countersunk aluminium rivets from steel plate.		
MachineModel:		InsertedToolType:	
MachineModifications:		InsertedToolPhotoDirectoryName:	
MachineSize:		DataSource:	
MachineWeight(kg):	1.54	HSLReportNumber:	
MachineOperatingPressure:	6.2 Bar	HSLReportDirectoryName:	
MachineSpeed(impacts/min):	3500	ShotsPerDay:	
MachineSpeed(revs/min):		DailyExposureTime:	
MachinePower:		Checked2012Initials:	
MachinePowerSource:	Pneumatic		
MachinePhotoDirName:	Photos\Chipping hammer photos		
InsertedToolCategoryID:	61		

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1600	11123	1.92	6.23	1.08	6.61	3.17	1.31	5.24	6.26	30.00			
	11124	2.50	8.08	1.25	8.55	3.64	2.03	6.87	8.03	30.00			
	11125	2.38	8.40	1.22	8.81	3.41	2.02	6.81	7.88	30.00			
	11126	1.52	10.73	2.18	11.06	3.08	2.99	8.25	9.30	30.00			
	11127	1.52	9.73	1.97	10.04	2.34	2.71	7.72	8.51	30.00			
	11128	1.59	10.91	2.46	11.30	2.65	2.92	8.96	9.79	30.00			
	11129	2.96	11.95	1.88	12.46	5.45	2.27	9.26	10.98	30.00			
	11130	1.90	11.38	2.04	11.71	3.58	2.66	8.10	9.25	30.00			
	11131	1.77	11.36	2.51	11.77	3.56	3.05	7.82	9.12	30.00			
Count:	9									Total:	270.00	seconds	

Mean:	2.01	9.86	1.84	10.25	3.43	2.44	7.67	8.79	Highest hand a_{hw} 10.3 ± 1.9 m/s²			
Stdev:	0.50	1.91	0.54	1.92	0.88	0.58	1.23	1.34				
Time to EAV:												0:38
Time to ELV:												2:35
A(8):												

25%ile	1.59	8.40	1.25	8.81	3.08	2.03	6.87	8.03	Highest hand 75%ile 11.7m/s²			
Median:	1.90	10.73	1.97	11.06	3.41	2.66	7.82	9.12				
75%ile	2.38	11.36	2.18	11.71	3.58	2.92	8.25	9.30				
IQ range	0.79	2.96	0.93	2.90	0.50	0.89	1.38	1.26				
Time to EAV:												0:36
Time to ELV:												2:24
A(8):												

Time-weighted mean:	2.01	9.86	1.84	10.25	3.43	2.44	7.67	8.79
Stdev:	0.82	3.75	0.80	3.87	1.41	0.98	2.81	3.19

V2.2 April 2012

Dateofentrytodatabase:		30-Jul-13	
PrintDate		30-Jul-13	
MainID:	1602		
DateOfVisit:	11/10/12		
LocationName:			
Occupation:	Scientist		
Process:	Ripping panel		
ProcessNotes:	Ripping car bonnet panel open over approx. 20-30cm.		
MachineModel:		InsertedToolType:	
MachineModifications:		InsertedToolPhotoDirectoryName:	
MachineSize:		DataSource:	
MachineWeight(kg):	1.54	HSLReportNumber:	
MachineOperatingPressure:	6.2 Bar	HSLReportDirectoryName:	
MachineSpeed(impacts/min):	3500	ShotsPerDay:	
MachineSpeed(revs/min):		DailyExposureTime:	
MachinePower:		Checked2012Initials:	
MachinePowerSource:	Pneumatic		
MachinePhotoDirName:	Photos\Chipping hammer photos		
InsertedToolCategoryID:	60		

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1602	11141	3.95	22.13	3.37	22.73	8.61	9.74	14.89	19.76	9.50			
	11142	2.61	25.86	5.55	26.57	8.76	10.86	16.81	21.85	12.25			
	11143	2.97	27.10	5.18	27.75	9.81	11.74	17.18	23.00	9.50			
	11144	2.88	20.10	7.20	21.54	5.93	7.22	11.23	14.61	11.50			
	11145	2.37	18.93	6.73	20.23	4.84	5.24	11.18	13.26	13.75			
	11146	2.96	15.96	5.18	17.04	4.93	5.48	9.69	12.18	13.25			
	11147	2.81	17.53	3.51	18.09	3.93	6.31	11.77	13.92	11.25			
	11148	6.14	24.55	5.93	25.99	7.58	9.87	13.94	18.69	18.00			
	11149	3.24	23.91	5.98	24.86	6.59	10.44	12.93	17.88	12.00			
Count:	9									Total:	111.00	seconds	

Mean:	3.32	21.78	5.40	22.76	6.77	8.55	13.29	17.24	Highest hand a_{hw} 22.8 ± 3.8 m/s²			
Stdev:	1.14	3.88	1.30	3.82	2.03	2.49	2.61	3.92				
Time to EAV:												0:10
Time to ELV:												0:40
A(8):												

25%ile	2.81	18.93	5.18	20.23	4.93	6.31	11.23	13.92	Highest hand 75%ile 26.0m/s²			
Median:	2.96	22.13	5.55	22.73	6.59	9.74	12.93	17.88				
75%ile	3.24	24.55	5.98	25.99	8.61	10.44	14.89	19.76				
IQ range	0.43	5.61	0.80	5.76	3.68	4.13	3.66	5.84				
Time to EAV:												0:09
Time to ELV:												0:37
A(8):												

Time-weighted mean:	3.45	21.74	5.51	22.76	6.68	8.46	13.16	17.06			
Stdev:	1.58	8.12	2.21	8.40	2.94	3.67	5.03	6.78			

V2.2 April 2012

Date of entry to database:		30-Jul-13	
Print Date		30-Jul-13	
MainID:	1601		
Date Of Visit:	11/10/12		
Location Name:			
Occupation:	Scientist		
Process:	Punching holes		
Process Notes:	Punching out holes into car bonnet panel.		
Machine Model:		Inserted Tool Type:	
Machine Modifications:		Inserted Tool Photo Directory Name:	
Machine Size:		Data Source:	
Machine Weight (kg):	1.54	HSL Report Number:	
Machine Operating Pressure:	6.2 Bar	HSL Report Directory Name:	
Machine Speed (impacts/min):	3500	Shots Per Day:	
Machine Speed (revs/min):		Daily Exposure Time:	
Machine Power:		Checked 2012 Initials:	
Machine Power Source:	Pneumatic		
Machine Photo Dir Name:	Photos\Chipping hammer photos		
Inserted Tool Category ID:	61		

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1601	11133	1.67	8.48	1.60	8.79	2.36	4.00	6.20	7.74	30.00			
	11134	2.57	13.06	2.15	13.48	5.72	4.33	10.23	12.49	30.00			
	11135	3.91	13.41	2.41	14.18	3.93	3.61	12.51	13.60	30.00			
Count:	3									Total:	90.00	seconds	

Mean:	2.72	11.65	2.06	12.15	4.00	3.98	9.65	11.28	Highest hand a_{hw}		
Stdev:	1.13	2.75	0.41	2.93	1.68	0.36	3.20	3.11			
Time to EAV:									0:23		
Time to ELV:									1:34		
A(8):									12.1 ± 2.9 m/s²		

25%ile	2.12	10.77	1.88	11.14	3.14	3.80	8.22	10.12	Highest hand 75%ile		
Median:	2.57	13.06	2.15	13.48	3.93	4.00	10.23	12.49			
75%ile	3.24	13.23	2.28	13.83	4.82	4.16	11.37	13.05	13.8m/s²		
IQ range	1.12	2.47	0.40	2.69	1.68	0.36	3.16	2.93			
Time to EAV:									0:19		
Time to ELV:									1:16		
A(8):											

Time-weighted mean:	2.72	11.65	2.06	12.15	4.00	3.98	9.65	11.28
Stdev:	1.82	7.09	1.23	7.41	2.69	2.31	6.15	6.99

V2.2 April 2012

Tool B

Dateofentrytodatabase:		PrintDate		27-Nov-13	
MainID:	1603				
DateOfVisit:	12/10/12				
LocationName:					
Occupation:	Scientist				
Process:	Panel Ripping				
ProcessNotes:					
MachineModel:			InsertedToolType:		
MachineModifications:			InsertedToolPhotoDirectoryName:		
MachineSize:			DataSource:		
MachineWeight(kg):	1.6		HSLReportNumber:		
MachineOperatingPressure:	6Bar		HSLReportDirectoryName:		
MachineSpeed(impacts/min):			ShotsPerDay:		
MachineSpeed(revs/min):	4000		DailyExposureTime:		
MachinePower:			Checked2012Initials:		
MachinePowerSource:	Pneumatic				
MachinePhotoDirName:	Photos\Chipping hammer photos				
InsertedToolCategoryID:	60				

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measure-ment time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1603	11152	4.83	15.87	6.34	17.76	5.18	8.50	8.74	13.25	41.00			
	11153	4.93	24.08	10.09	26.57	5.29	11.94	12.91	18.37	37.00			
	11155	2.70	17.51	6.49	18.87	4.55	8.99	8.76	13.35	30.25			
	11156	2.88	17.27	6.40	18.64	8.93	9.17	8.21	15.20	24.50			
	11158	2.82	15.97	4.85	16.93	4.92	8.56	8.97	13.34	30.25			
	11160	4.13	44.48	14.85	47.07	6.84	22.73	22.23	32.52	36.00			
	11161	4.01	27.87	6.96	29.01	9.77	15.20	15.13	23.56	30.75			
	11162	3.32	23.37	8.49	25.08	7.31	10.98	13.95	19.20	30.50			
	11193	2.97	13.82	5.91	15.33	7.21	7.22	6.90	12.32	46.00			
Count:	9									Total:	306.25	seconds	

Mean:	3.62	22.25	7.82	23.92	6.67	11.48	11.76	17.90	Highest hand a_{hw} 23.9 ± 9.9 m/s²
Stdev:	0.88	9.54	3.04	9.90	1.84	4.85	4.86	6.61	
Time to EAV:					0:05				
Time to ELV:					0:37				
A(8):									

25%ile	2.88	15.97	6.34	17.76	5.18	8.56	8.74	13.34	Highest hand 75%ile 26.6m/s²
Median:	3.32	17.51	6.49	18.87	6.84	9.17	8.97	15.20	
75%ile	4.13	24.08	8.49	26.57	7.31	11.94	13.95	19.20	
IQ range	1.25	8.11	2.16	8.81	2.13	3.38	5.21	5.85	
Time to EAV:					0:08				
Time to ELV:					0:51				
A(8):									

Time-weighted mean:	3.68	22.15	7.88	23.86	6.58	11.42	11.70	17.80
Stdev:	1.48	11.64	3.89	12.27	2.80	5.95	6.02	8.60

V2.2 April 2012

Dateofentrytodatabase:		30-Jul-13	
PrintDate		30-Jul-13	
MainID:	1606		
DateOfVisit:	12/10/12		
LocationName:			
Occupation:	Scientist		
Process:	Punching out rivets		
ProcessNotes:	Punching out 0.5inch countersunk aluminium rivets from steel plate mounted vertically.		
MachineModel:		InsertedToolType:	
MachineModifications:		InsertedToolPhotoDirectoryName:	
MachineSize:		DataSource:	
MachineWeight(kg):	1.6	HSLReportNumber:	
MachineOperatingPressure:	6.0 Bar	HSLReportDirectoryName:	
MachineSpeed(impacts/min):		ShotsPerDay:	
MachineSpeed(revs/min):	4000	DailyExposureTime:	
MachinePower:		Checked2012Initials:	
MachinePowerSource:	Pneumatic		
MachinePhotoDirName:	Photos\Chipping hammer photos		
InsertedToolCategoryID:	61		

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1606	11181	1.97	10.67	2.48	11.13	4.26	5.17	6.44	9.29	31.00			
	11182	1.71	8.00	1.73	8.36	3.24	4.00	4.77	7.02	30.75			
	11183	2.72	11.57	2.58	12.17	4.54	5.47	7.11	10.05	30.50			
	11184	1.72	9.68	1.55	9.95	2.91	4.54	6.25	8.26	31.00			
	11185	1.46	6.32	1.68	6.70	2.90	2.92	4.23	5.90	31.25			
	11186	1.71	6.70	1.70	7.12	2.85	3.12	4.41	6.11	30.50			
	11187	1.65	10.88	1.83	11.16	3.15	5.46	6.81	9.28	30.50			
	11188	1.36	9.43	1.58	9.66	2.78	4.50	6.01	8.00	31.25			
	11189	1.72	9.68	1.55	9.95	2.91	4.54	6.25	8.26	31.00			
Count:	9									Total:	277.75	seconds	

Mean:	1.78	9.21	1.85	9.58	3.28	4.41	5.81	8.02	Highest hand a_{hw} 9.6 ± 1.9 m/s²		
Stdev:	0.39	1.84	0.40	1.86	0.65	0.93	1.07	1.44			
Time to EAV:					0:32						
Time to ELV:					2:10						
A(8):											

25%ile	1.65	8.00	1.58	8.36	2.90	4.00	4.77	7.02	Highest hand 75%ile 11.1m/s²		
Median:	1.71	9.68	1.70	9.95	2.91	4.54	6.25	8.26			
75%ile	1.72	10.67	1.83	11.13	3.24	5.17	6.44	9.28			
IQ range	0.07	2.67	0.25	2.77	0.34	1.17	1.67	2.27			
Time to EAV:					0:30						
Time to ELV:					2:01						
A(8):											

Time-weighted mean:	1.78	9.21	1.85	9.57	3.28	4.41	5.81	8.02
Stdev:	0.70	3.53	0.72	3.64	1.25	1.71	2.18	3.00

V2.2 April 2012

Dateofentrytodatabase:		30-Jul-13	
PrintDate		30-Jul-13	
MainID:	1605		
DateOfVisit:	16/10/12		
LocationName:			
Occupation:	Scientist		
Process:	Removal of rivet heads		
ProcessNotes:	Removal of 0.5inch aluminium rivet heads from steel plate. Plates mounted in horizontal position.		
MachineModel:		InsertedToolType:	
MachineModifications:		InsertedToolPhotoDirectoryName:	
MachineSize:		DataSource:	
MachineWeight(kg):	1.6	HSLReportNumber:	
MachineOperatingPressure:	6.0 Bar	HSLReportDirectoryName:	
MachineSpeed(impacts/min):		ShotsPerDay:	
MachineSpeed(revs/min):	4000	DailyExposureTime:	
MachinePower:		Checked2012Initials:	
MachinePowerSource:	Pneumatic		
MachinePhotoDirName:	Photos\Chipping hammer photos		
InsertedToolCategoryID:	62		

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1605	11171	3.16	16.04	2.33	16.52	5.06	5.58	11.60	13.83	31.00			
	11172	5.07	10.25	1.58	11.55	3.93	3.24	8.04	9.51	30.75			
	11173	4.47	17.85	3.04	18.65	4.12	7.32	12.69	15.21	31.00			
	11174	3.93	18.49	4.02	19.32	7.26	9.29	10.49	15.79	31.00			
	11175	2.77	20.42	3.77	20.95	7.29	10.00	12.08	17.29	30.50			
	11176	2.97	15.92	3.25	16.52	6.67	7.68	9.75	14.09	30.50			
	11177	3.50	16.22	2.34	16.76	5.61	7.72	11.33	14.81	31.00			
	11178	3.91	21.55	3.63	22.20	5.80	10.41	13.58	18.06	30.25			
	11179	4.91	16.97	2.99	17.91	4.10	7.49	12.09	14.80	30.50			
Count:	9									Total:	276.50	seconds	

Mean:	3.86	17.08	2.99	17.82	5.54	7.64	11.29	14.82	Highest hand a_{hw} 17.8 ± 3.1 m/s²			
Stdev:	0.83	3.23	0.79	3.08	1.34	2.23	1.66	2.43				
Time to EAV:												0:09
Time to ELV:												0:54
A(8):												

25%ile	3.16	16.04	2.34	16.52	4.12	7.32	10.49	14.09	Highest hand 75%ile 19.3m/s²			
Median:	3.91	16.97	3.04	17.91	5.61	7.68	11.60	14.81				
75%ile	4.47	18.49	3.63	19.32	6.67	9.29	12.09	15.79				
IQ range	1.32	2.44	1.29	2.81	2.55	1.97	1.60	1.69				
Time to EAV:												0:13
Time to ELV:												0:54
A(8):												

Time-weighted mean:	3.86	17.07	2.99	17.81	5.54	7.63	11.29	14.82
Stdev:	1.51	6.45	1.24	6.61	2.24	3.30	4.08	5.45

V2.2 April 2012

Dateofentrytodatabase:		30-Jul-13	
PrintDate		30-Jul-13	
MainID:	1604		
DateOfVisit:	12/10/12		
LocationName:			
Occupation:	Scientist		
Process:	Removal of rivet heads		
ProcessNotes:	Removal of 0.5inch aluminium rivet heads from steel plate. Plates mounted in vertical position.		
MachineModel:		InsertedToolType:	
MachineModifications:		InsertedToolPhotoDirectoryName:	
MachineSize:		DataSource:	
MachineWeight(kg):	1.6	HSLReportNumber:	
MachineOperatingPressure:	6.0 Bar	HSLReportDirectoryName:	
MachineSpeed(impacts/min):		ShotsPerDay:	
MachineSpeed(revs/min):	4000	DailyExposureTime:	
MachinePower:		Checked2012Initials:	
MachinePowerSource:	Pneumatic		
MachinePhotoDirName:	Photos\Chipping hammer photos		
InsertedToolCategoryID:	62		

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1604	11164	3.41	24.28	5.76	25.19	6.39	12.44	14.59	20.21	30.25			
	11165	3.36	17.98	3.08	18.55	7.91	9.41	10.37	16.08	31.75			
	11166	2.37	16.94	4.68	17.73	4.67	8.25	12.08	15.36	31.00			
	11167	2.31	15.65	3.97	16.31	5.08	7.63	10.83	14.19	30.25			
	11168	3.27	20.61	5.35	21.54	6.49	9.96	14.10	18.44	30.50			
	11169	3.32	21.25	5.09	22.10	4.85	10.46	13.92	18.08	30.50			
	11190	3.88	27.56	4.77	28.24	4.25	14.82	17.58	23.38	30.25			
	11191	3.67	28.73	6.09	29.60	5.93	15.33	18.20	24.52	30.50			
	11192	3.97	22.96	3.66	23.59	3.88	11.07	15.43	19.38	30.50			
Count:	9									Total:	275.50	seconds	

Mean:	3.28	21.77	4.72	22.54	5.50	11.04	14.12	18.85	Highest hand a _{hw} 22.5 ± 4.6 m/s ²				
Stdev:	0.59	4.56	0.99	4.60	1.28	2.70	2.73	3.49					
Time to EAV:												0:05	0:08
Time to ELV:												0:23	0:33
A(8):													

25%ile	3.27	17.98	3.97	18.55	4.67	9.41	12.08	16.08	Highest hand 75%ile 25.2m/s ²				
Median:	3.36	21.25	4.77	22.10	5.08	10.46	14.10	18.44					
75%ile	3.67	24.28	5.35	25.19	6.39	12.44	15.43	20.21					
IQ range	0.40	6.31	1.38	6.64	1.71	3.02	3.34	4.12					
Time to EAV:												0:06	0:08
Time to ELV:												0:24	0:35
A(8):													

Time-weighted mean:	3.28	21.75	4.71	22.51	5.51	11.03	14.10	18.83			
Stdev:	1.23	8.43	1.83	8.67	2.20	4.47	5.36	7.08			

V2.2 April 2012

Tool C

Dateofentrytodatabase: PrintDate		30-Jul-13
MainID:	1607	
DateOfVisit:	22/10/12	
LocationName:		
Occupation:	Scientist	
Process:	Scaling rusty steel plate (appr 45deg)	
ProcessNotes:		
MachineModel:		InsertedToolType:
MachineModifications:		InsertedToolPhotoDirectoryName:
MachineSize:		DataSource:
MachineWeight(kg):		HSLReportNumber:
MachineOperatingPressure:	6.2 Bar	HSLReportDirectoryName:
MachineSpeed(impacts/min):		ShotsPerDay:
MachineSpeed(revs/min):		DailyExposureTime:
MachinePower:		Checked2012Initials:
MachinePowerSource:	Pneumatic	
MachinePhotoDirName:	Photos\Chipping hammer photos	
InsertedToolCategoryID:	1	

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1607	11195	2.36	16.34	4.68	17.16	4.76	6.56	17.39	19.19	16.75			
	11196	2.90	16.15	4.20	16.94	7.12	6.89	16.96	19.64	18.50			
	11197	2.26	15.35	4.77	16.23	4.99	7.99	16.59	19.07	17.75			
	11198	3.29	20.09	4.48	20.84	5.02	9.39	20.42	23.04	16.00			
	11199	3.88	19.23	4.66	20.16	4.24	9.30	20.08	22.53	16.00			
	11200	3.78	19.66	4.70	20.57	4.19	9.26	20.55	22.92	16.00			
	11201	4.08	20.06	3.84	20.83	6.12	8.63	20.67	23.22	16.00			
	11202	3.54	19.24	4.44	20.06	5.97	10.33	20.05	23.33	16.00			
	11203	3.96	22.04	4.28	22.79	5.04	9.45	21.83	24.32	16.00			
Count:	9									Total:	149.00	seconds	

Mean:	3.34	18.68	4.45	19.51	5.27	8.64	19.39	21.92	Highest hand a_{hw} 21.9 ± 2.0 m/s²		
Stdev:	0.68	2.23	0.30	2.21	0.96	1.26	1.89	2.02			
Time to EAV:					0:07						
Time to ELV:					0:31						
A(8):					0:24						

25%ile	2.90	16.34	4.28	17.16	4.76	7.99	17.39	19.64	Highest hand 75%ile 23.2m/s²		
Median:	3.54	19.24	4.48	20.16	5.02	9.26	20.08	22.92			
75%ile	3.88	20.06	4.68	20.83	5.97	9.39	20.55	23.22			
IQ range	0.97	3.72	0.40	3.67	1.21	1.41	3.15	3.57			
Time to EAV:					0:07						
Time to ELV:					0:29						
A(8):					0:22						

Time-weighted mean:	3.31	18.59	4.45	19.42	5.30	8.60	19.31	21.83
Stdev:	1.28	6.54	1.51	6.80	1.98	3.10	6.68	7.52

V2.2 April 2012

Dateofentrytodatabase:		30-Jul-13	
PrintDate		30-Jul-13	
MainID:	1609		
DateOfVisit:	22/10/12		
LocationName:			
Occupation:	Scientist		
Process:	Chipping weld and removing paint / rust		
ProcessNotes:			
MachineModel:		InsertedToolType:	
MachineModifications:		InsertedToolPhotoDirectoryName:	
MachineSize:		DataSource:	
MachineWeight(kg):		HSLReportNumber:	
MachineOperatingPressure:	6.2 Bar	HSLReportDirectoryName:	
MachineSpeed(impacts/min):		ShotsPerDay:	
MachineSpeed(revs/min):		DailyExposureTime:	
MachinePower:		Checked2012Initials:	
MachinePowerSource:	Pneumatic		
MachinePhotoDirName:	Photos\Chipping hammer photos		
InsertedToolCategoryID:	1		

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1609	11215	3.82	22.30	4.26	23.02	6.47	8.22	21.98	24.34	16.00			
	11216	3.82	21.12	4.18	21.87	5.36	8.06	20.53	22.69	16.00			
	11217	3.43	21.59	3.38	22.12	6.00	7.69	21.15	23.29	16.00			
	11218	4.16	22.90	4.59	23.72	5.04	10.91	21.63	24.75	16.00			
	11219	5.10	21.57	5.15	22.76	5.97	12.70	20.27	24.66	16.00			
	11220	4.86	21.15	3.93	22.05	6.71	11.16	19.87	23.76	16.00			
	11221	2.59	22.91	3.65	23.34	6.67	8.82	22.10	24.71	16.00			
	11222	3.28	23.81	3.56	24.30	5.43	9.12	22.73	25.09	16.00			
	11223	3.08	22.62	3.97	23.17	5.61	9.97	21.80	24.62	16.00			
Count:	9									Total:	144.00	seconds	

Mean:	3.79	22.22	4.07	22.93	5.92	9.63	21.34	24.21	Highest hand a _{hw} 24.2 ± 0.8 m/s ²			
Stdev:	0.82	0.92	0.55	0.82	0.61	1.68	0.95	0.79				
Time to EAV:												0:05
Time to ELV:												0:20
A(8):												

25%ile	3.28	21.57	3.65	22.12	5.43	8.22	20.53	23.76	Highest hand 75%ile 24.7m/s ²			
Median:	3.82	22.30	3.97	23.02	5.97	9.12	21.63	24.62				
75%ile	4.16	22.90	4.26	23.34	6.47	10.91	21.98	24.71				
IQ range	0.87	1.33	0.61	1.22	1.04	2.69	1.45	0.96				
Time to EAV:												0:05
Time to ELV:												0:19
A(8):												

Time-weighted mean:	3.79	22.22	4.07	22.93	5.92	9.63	21.34	24.21
Stdev:	1.48	7.46	1.45	7.68	2.05	3.58	7.17	8.11

V2.2 April 2012

Dateofentrytodatabase:		30-Jul-13	
PrintDate		30-Jul-13	
MainID:	1608		
DateOfVisit:	22/10/12		
LocationName:			
Occupation:	Scientist		
Process:	Chipping Weld		
ProcessNotes:			
MachineModel:			InsertedToolType:
MachineModifications:			InsertedToolPhotoDirectoryName:
MachineSize:			DataSource:
MachineWeight(kg):			HSLReportNumber:
MachineOperatingPressure:	6.2 Bar		HSLReportDirectoryName:
MachineSpeed(impacts/min):			ShotsPerDay:
MachineSpeed(revs/min):			DailyExposureTime:
MachinePower:			Checked2012Initials:
MachinePowerSource:	Pneumatic		
MachinePhotoDirName:	Photos\Chipping hammer photos		
InsertedToolCategoryID:	1		

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1608	11205	3.76	18.63	5.19	19.70	5.08	8.91	19.38	21.93	16.00			
	11206	5.31	18.14	4.80	19.51	6.38	7.69	18.70	21.20	16.00			
	11207	4.07	19.21	4.45	20.14	6.04	8.25	19.94	22.41	16.00			
	11208	4.41	14.72	7.65	17.16	7.56	13.91	16.99	23.23	16.00			
	11209	3.57	10.56	5.96	12.65	4.00	11.48	13.61	18.25	16.00			
	11210	3.88	9.22	6.03	11.67	5.43	10.85	13.08	17.84	16.00			
	11211	8.10	11.93	5.53	15.44	8.81	8.82	13.83	18.62	16.00			
	11212	6.21	16.30	5.75	18.36	7.26	9.74	17.55	21.34	16.00			
	11213	6.70	16.47	5.06	18.48	8.46	8.63	17.34	21.13	16.00			
Count:	9									Total:	144.00	seconds	

Mean:	5.11	15.02	5.60	17.01	6.56	9.81	16.71	20.66	Highest hand a_{hw} 20.7 ± 1.9 m/s²			
Stdev:	1.58	3.66	0.93	3.11	1.60	1.96	2.59	1.94				
Time to EAV:												0:10
Time to ELV:												0:28
A(8):												

25%ile	3.88	11.93	5.06	15.44	5.43	8.63	13.83	18.62	Highest hand 75%ile 21.9m/s²			
Median:	4.41	16.30	5.53	18.36	6.38	8.91	17.34	21.20				
75%ile	6.21	18.14	5.96	19.51	7.56	10.85	18.70	21.93				
IQ range	2.34	6.22	0.90	4.06	2.13	2.22	4.86	3.31				
Time to EAV:												0:08
Time to ELV:												0:26
A(8):												

Time-weighted mean:	5.11	15.02	5.60	17.01	6.56	9.81	16.71	20.66
Stdev:	2.26	6.08	2.06	6.38	2.66	3.76	6.08	7.13

V2.2 April 2012

Dateofentrytodatabase:		30-Jul-13	
PrintDate		30-Jul-13	
MainID:	1610		
DateOfVisit:	23/10/12		
LocationName:			
Occupation:	Scientist		
Process:	Chipping Weld		
ProcessNotes:			
MachineModel:		InsertedToolType:	
MachineModifications:		InsertedToolPhotoDirectoryName:	
MachineSize:		DataSource:	
MachineWeight(kg):		HSLReportNumber:	
MachineOperatingPressure:	6.2 Bar	HSLReportDirectoryName:	
MachineSpeed(impacts/min):		ShotsPerDay:	
MachineSpeed(revs/min):		DailyExposureTime:	
MachinePower:		Checked2012Initials:	
MachinePowerSource:	Pneumatic		
MachinePhotoDirName:	Photos\Chipping hammer photos		
InsertedToolCategoryID:	1		

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1610	11225	3.37	15.39	6.15	16.92	4.76	11.98	16.32	20.80	16.00			
	11226	3.35	15.30	6.65	17.02	5.43	12.87	16.23	21.41	16.00			
	11227	3.09	17.11	5.96	18.38	4.08	12.20	17.99	22.11	16.00			
	11228	3.68	16.35	5.43	17.62	9.38	8.96	16.70	21.14	16.00			
	11229	3.25	15.29	5.97	16.74	6.58	11.14	15.44	20.14	16.00			
	11230	4.07	13.43	5.46	15.06	7.87	11.66	13.15	19.26	16.00			
	11231	3.31	14.85	4.49	15.87	4.78	9.28	14.66	17.99	16.00			
	11232	3.24	12.71	4.41	13.84	3.81	8.94	12.82	16.09	16.00			
	11233	3.23	12.71	5.15	14.09	5.09	10.60	13.02	17.54	16.00			
Count:	9									Total:	144.00	seconds	

Mean:	3.40	14.79	5.52	16.17	5.75	10.85	15.15	19.61	Highest hand a_{hw} 19.6 ± 2.0 m/s²			
Stdev:	0.30	1.55	0.75	1.57	1.85	1.49	1.85	2.03				
Time to EAV:												0:07
Time to ELV:												0:31
A(8):												

25%ile	3.24	13.43	5.15	15.06	4.76	9.28	13.15	17.99	Highest hand 75%ile 21.1m/s²			
Median:	3.31	15.29	5.46	16.74	5.09	11.14	15.44	20.14				
75%ile	3.37	15.39	5.97	17.02	6.58	11.98	16.32	21.14				
IQ range	0.13	1.97	0.82	1.96	1.82	2.70	3.17	3.15				
Time to EAV:												0:07
Time to ELV:												0:29
A(8):												

Time-weighted mean:	3.40	14.79	5.52	16.17	5.75	10.85	15.15	19.61
Stdev:	1.17	5.14	1.97	5.59	2.59	3.88	5.34	6.81

V2.2 April 2012

Tool D

Dateofentrytodatabase: PrintDate		30-Jul-13
MainID:	1613	
DateOfVisit:	24/10/12	
LocationName:		
Occupation:	Scientist	
Process:	Breaking Concrete	
ProcessNotes:		
MachineModel:		InsertedToolType:
MachineModifications:		InsertedToolPhotoDirectoryName:
MachineSize:		DataSource:
MachineWeight(kg):	6.4	HSLReportNumber:
MachineOperatingPressure:	6.3 Bar	HSLReportDirectoryName:
MachineSpeed(impacts/min):	2200	
MachineSpeed(revs/min):		ShotsPerDay:
MachinePower:		DailyExposureTime:
MachinePowerSource:	Pneumatic	Checked2012Initials:
MachinePhotoDirName:	Photos\Chipping hammer photos	
InsertedToolCategoryID:	4	

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1613	11255	5.54	14.84	7.19	17.40	6.13	8.24	16.48	19.42	16.00			
	11256	5.29	12.28	7.17	15.17	5.45	7.66	13.66	16.59	16.00			
	11257	3.87	12.18	2.48	13.02	4.08	3.85	12.73	13.91	16.00			
	11258	3.16	4.91	0.98	5.92	2.22	2.02	5.25	6.05	16.00			
	11259	3.40	11.17	3.93	12.32	4.12	5.23	11.71	13.47	16.00			
	11260	3.26	7.53	3.03	8.75	3.25	4.19	8.15	9.72	16.00			
	11261	4.70	11.65	4.34	13.29	4.29	4.98	12.87	14.45	16.00			
	11262	4.39	11.96	4.15	13.40	3.97	4.33	13.23	14.47	16.00			
	11263	4.77	11.63	3.54	13.06	4.49	4.50	12.82	14.31	16.00			
Count:	9									Total:	144.00	seconds	

Mean:	4.27	10.91	4.09	12.48	4.22	5.00	11.88	13.60	Highest hand a_{hw} 13.6 ± 3.8 m/s²			
Stdev:	0.89	2.93	2.03	3.36	1.13	1.91	3.29	3.82				
Time to EAV:												0:19
Time to ELV:												1:04
A(8):												

25%ile	3.40	11.17	3.03	12.32	3.97	4.19	11.71	13.47	Highest hand 75%ile 14.5m/s²			
Median:	4.39	11.65	3.93	13.06	4.12	4.50	12.82	14.31				
75%ile	4.77	12.18	4.34	13.40	4.49	5.23	13.23	14.47				
IQ range	1.37	1.01	1.31	1.08	0.52	1.04	1.52	1.01				
Time to EAV:												0:17
Time to ELV:												1:10
A(8):												

Time-weighted mean:	4.27	10.91	4.09	12.48	4.22	5.00	11.88	13.60
Stdev:	1.65	4.56	2.35	5.23	1.77	2.45	5.03	5.79

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Dateofentrytodatabase:		30-Jul-13	
PrintDate		30-Jul-13	
MainID:	1611		
DateOfVisit:	23/11/12		
LocationName:			
Occupation:	Scientist		
Process:	Chipping Weld		
ProcessNotes:			
MachineModel:		InsertedToolType:	
MachineModifications:		InsertedToolPhotoDirectoryName:	
MachineSize:		DataSource:	
MachineWeight(kg):	6.4	HSLReportNumber:	
MachineOperatingPressure:	6.3 Bar	HSLReportDirectoryName:	
MachineSpeed(impacts/min):	2200	ShotsPerDay:	
MachineSpeed(revs/min):		DailyExposureTime:	
MachinePower:		Checked2012Initials:	
MachinePowerSource:	Pneumatic		
MachinePhotoDirName:	Photos\Chipping hammer photos		
InsertedToolCategoryID:	1		

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1611	11235	5.84	18.19	8.79	21.03	5.04	9.18	20.86	23.34	16.00			
	11236	4.91	20.53	11.78	24.18	4.97	15.94	25.10	30.15	16.00			
	11237	6.87	24.31	10.31	27.29	8.52	16.19	26.35	32.08	16.00			
	11238	5.57	23.74	11.28	26.87	5.77	17.32	25.75	31.56	16.00			
	11239	6.90	24.58	13.48	28.87	7.39	18.33	26.81	33.31	16.00			
	11240	8.74	31.29	7.73	33.40	7.96	15.51	32.16	36.58	16.00			
	11241	4.79	22.06	10.73	24.99	5.74	17.99	25.62	31.83	16.00			
	11242	4.07	25.21	9.37	27.20	4.33	16.65	29.62	34.26	16.00			
	11243	4.06	23.30	9.51	25.49	4.73	17.59	27.08	32.63	16.00			
Count:	9									Total:	144.00	seconds	

Mean:	5.75	23.69	10.33	26.59	6.05	16.08	26.59	31.75	Highest hand a_{hw} 31.7 ± 3.6 m/s²			
Stdev:	1.54	3.61	1.72	3.41	1.52	2.76	3.11	3.64				
Time to EAV:												0:04
Time to ELV:												0:16
A(8):												

25%ile	4.79	22.06	9.37	24.99	4.97	15.94	25.62	31.56	Highest hand 75%ile 33.3m/s²			
Median:	5.57	23.74	10.31	26.87	5.74	16.65	26.35	32.08				
75%ile	6.87	24.58	11.28	27.29	7.39	17.59	27.08	33.31				
IQ range	2.08	2.53	1.91	2.30	2.42	1.64	1.46	1.75				
Time to EAV:												0:04
Time to ELV:												0:11
A(8):												

Time-weighted mean:	5.75	23.69	10.33	26.59	6.05	16.08	26.59	31.75
Stdev:	2.40	8.60	3.81	9.43	2.48	5.96	9.34	11.13

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Dateofentrytodatabase:		29-Nov-16	
PrintDate		29-Nov-16	
MainID:	1615		
DateOfVisit:	26/10/12		
LocationName:			
Occupation:	Scientist		
Process:	Chipping Weld		
ProcessNotes:	Chipping lengths of MAG weld from base of steel bar. Tool operated with increased force applied, compared to Main ID 1611.		
MachineModel:		InsertedToolType:	
MachineModifications:		InsertedToolPhotoDirectoryName:	
MachineSize:		DataSource:	
MachineWeight(kg):	6.4	HSLReportNumber:	
MachineOperatingPressure:	6.3 Bar	HSLReportDirectoryName:	
MachineSpeed(impacts/min):	2200	ShotsPerDay:	
MachineSpeed(revs/min):		DailyExposureTime:	
MachinePower:		Checked2012Initials:	SMH
MachinePowerSource:	Pneumatic		
MachinePhotoDirName:	Photos\Chipping hammer photos		
InsertedToolCategoryID:	1		

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1615	11275	7.42	22.51	8.59	25.21	6.83	12.98	23.58	27.77	16.00			
	11276	8.51	22.40	9.10	25.63	8.51	13.18	23.81	28.51	16.00			
	11277	10.17	19.46	11.87	24.96	10.03	13.95	21.96	27.88	16.00			
	11278	7.43	26.39	7.24	28.35	7.98	12.53	28.22	31.89	16.00			
	11279	6.73	24.18	8.91	26.63	9.49	14.31	26.09	31.23	16.00			
	11280	4.61	23.53	8.41	25.40	6.62	15.67	26.21	31.25	16.00			
	11281	7.43	23.28	10.88	26.75	7.88	14.96	25.06	30.23	16.00			
	11282	8.32	23.38	11.34	27.29	8.31	15.73	25.52	31.11	16.00			
	11283	6.77	18.44	10.58	22.31	7.66	14.09	20.81	26.27	16.00			
Count:	9									Total:	144.00	seconds	

Mean:	7.49	22.62	9.66	25.84	8.15	14.15	24.58	29.57	Highest hand a _{hw} 29.6 ± 2.0 m/s ²			
Stdev:	1.51	2.40	1.56	1.72	1.11	1.14	2.29	2.00				
Time to EAV:												0:03
Time to ELV:												0:13
A(8):												

25%ile	6.77	22.40	8.59	25.21	7.66	13.18	23.58	27.88	Highest hand 75%ile 31.2m/s ²			
Median:	7.43	23.28	9.10	25.63	7.98	14.09	25.06	30.23				
75%ile	8.32	23.53	10.88	26.75	8.51	14.96	26.09	31.23				
IQ range	1.55	1.12	2.29	1.54	0.85	1.78	2.50	3.35				
Time to EAV:												0:03
Time to ELV:												0:13
A(8):												

Time-weighted mean:	7.49	22.62	9.66	25.84	8.15	14.15	24.58	29.57
Stdev:	2.88	7.87	3.54	8.76	2.91	4.84	8.47	10.03

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Dateofentrytodatabase:		30-Jul-13	
PrintDate		30-Jul-13	
MainID:	1614		
DateOfVisit:	26/10/12		
LocationName:			
Occupation:	Scientist		
Process:	Chipping weld and removing paint / rust		
ProcessNotes:			
MachineModel:		InsertedToolType:	
MachineModifications:		InsertedToolPhotoDirectoryName:	
MachineSize:		DataSource:	
MachineWeight(kg):	6.4	HSLReportNumber:	
MachineOperatingPressure:	6.3 Bar	HSLReportDirectoryName:	
MachineSpeed(im pacts/min):	2200	ShotsPerDay:	
MachineSpeed(revs/min):		DailyExposureTime:	
MachinePower:		Checked2012Initials:	
MachinePowerSource:	Pneumatic		
MachinePhotoDirName:	Photos\Chipping hammer photos		
InsertedToolCategoryID:	1		

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1614	11265	6.58	14.52	9.54	18.58	6.44	10.56	17.41	21.35	16.00			
	11266	7.87	15.16	10.96	20.30	7.89	12.17	17.81	22.97	16.00			
	11267	6.92	14.73	9.51	18.85	7.16	10.04	16.91	20.93	16.00			
	11268	4.45	14.08	5.93	15.91	4.77	7.72	15.38	17.85	16.00			
	11269	6.51	14.37	7.40	17.43	7.03	9.46	16.04	19.90	16.00			
	11270	4.50	12.39	5.90	14.44	4.52	7.28	13.75	16.20	16.00			
	11271	8.93	18.95	10.98	23.65	10.92	15.63	22.10	29.19	16.00			
	11272	6.91	20.14	10.07	23.55	8.59	15.68	22.70	28.89	16.00			
	11273	7.56	19.18	11.69	23.70	8.55	17.02	22.56	29.53	16.00			
Count:	9									Total:	144.00	seconds	

Mean:	6.69	15.95	9.11	19.60	7.32	11.73	18.29	22.98	Highest hand a_{hw} 23.0 ± 5.1 m/s²			
Stdev:	1.46	2.73	2.19	3.46	1.99	3.61	3.34	5.06				
Time to EAV:												0:07
Time to ELV:												0:31

25%ile	6.51	14.37	7.40	17.43	6.44	9.46	16.04	19.90	Highest hand 75%ile 28.9m/s²			
Median:	6.91	14.73	9.54	18.85	7.16	10.56	17.41	21.35				
75%ile	7.56	18.95	10.96	23.55	8.55	15.63	22.10	28.89				
IQ range	1.05	4.58	3.56	6.13	2.11	6.18	6.06	8.99				
Time to EAV:												0:08
Time to ELV:												0:33

Time-weighted mean:	6.69	15.95	9.11	19.60	7.32	11.73	18.29	22.98
Stdev:	2.62	5.91	3.67	7.30	3.08	5.18	6.86	9.03

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Dateofentrytodatabase:		30-Jul-13	
PrintDate		30-Jul-13	
MainID:	1612		
DateOfVisit:	24/10/12		
LocationName:			
Occupation:	Scientist		
Process:	Chipping weld and removing paint / rust		
ProcessNotes:			
MachineModel:		InsertedToolType:	
MachineModifications:		InsertedToolPhotoDirectoryName:	
MachineSize:		DataSource:	
MachineWeight(kg):	6.4	HSLReportNumber:	
MachineOperatingPressure:	6.3 Bar	HSLReportDirectoryName:	
MachineSpeed(impacts/min):	2200	ShotsPerDay:	
MachineSpeed(revs/min):		DailyExposureTime:	
MachinePower:		Checked2012Initials:	
MachinePowerSource:	Pneumatic		
MachinePhotoDirName:	Photos\Chipping hammer photos		
InsertedToolCategoryID:	1		

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1612	11245	7.98	21.42	10.07	24.98	9.14	14.34	24.79	30.07	16.00			
	11246	5.50	20.74	10.48	23.88	6.54	17.52	24.74	31.01	16.00			
	11247	5.53	20.83	9.97	23.74	6.42	17.32	24.40	30.61	16.00			
	11248	4.28	27.18	5.11	27.98	4.72	14.74	29.29	33.13	16.00			
	11249	6.37	30.90	7.11	32.34	6.90	14.49	31.27	35.15	16.00			
	11250	5.81	30.77	8.19	32.37	6.78	14.80	31.06	35.07	16.00			
	11251	3.52	26.25	7.30	27.48	3.91	15.60	27.66	31.99	16.00			
	11252	2.92	25.74	5.82	26.56	3.68	15.16	28.30	32.31	16.00			
	11253	3.68	27.26	5.19	27.99	4.20	13.61	29.32	32.60	16.00			
Count:	9									Total:	144.00	seconds	

Mean:	5.07	25.68	7.69	27.48	5.81	15.29	27.87	32.44	Highest hand a_{hw} 32.4 ± 1.8 m/s²			
Stdev:	1.61	3.94	2.12	3.20	1.80	1.33	2.68	1.80				
Time to EAV:												0:03
Time to ELV:												0:11
A(8):												

25%ile	3.68	21.42	5.82	24.98	4.20	14.49	24.79	31.01	Highest hand 75%ile 33.1m/s²			
Median:	5.50	26.25	7.30	27.48	6.42	14.80	28.30	32.31				
75%ile	5.81	27.26	9.97	27.99	6.78	15.60	29.32	33.13				
IQ range	2.14	5.83	4.15	3.01	2.57	1.11	4.53	2.12				
Time to EAV:												0:03
Time to ELV:												0:11
A(8):												

Time-weighted mean:	5.07	25.68	7.69	27.48	5.81	15.29	27.87	32.44
Stdev:	2.27	9.33	3.25	9.64	2.58	5.25	9.63	10.95

V2.2 April 2012

Tool E

Dateofentrytodatabase: PrintDate		30-Jul-13
MainID:	1572	
DateOf/visit:	05/09/12	
LocationName:		
Occupation:	Scientist	
Process:	Breaking 40N concrete	
ProcessNotes:		
MachineModel:		InsertedToolType:
MachineModifications:		InsertedToolPhotoDirectoryName:
MachineSize:	450mm	DataSource:
MachineWeight(kg):	6.3	
MachineOperatingPressure:	6-7Bar	HSLReportNumber:
MachineSpeed(im pacts/min):	2640	HSLReportDirectoryName:
MachineSpeed(revs/min):		
MachinePower:		ShotsPerDay:
MachinePowerSource:	Pneumatic	DailyExposureTime:
MachinePhotoDirName:	Photos\Test Code 2 Field Photos	Checked2012Initials:
InsertedToolCategoryID:	4	

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measure-ment time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1572	10969	8.65	12.01	8.73	17.19	5.34	5.12	10.93	13.19	30.50			
	10970	7.27	12.69	9.63	17.52	5.22	5.47	11.63	13.88	30.50			
	10971	7.75	11.44	9.14	16.56	4.99	5.08	10.00	12.28	30.50			
	10975	6.31	8.92	6.95	12.95	4.35	3.52	7.76	9.56	30.00			
	10976	5.34	9.09	6.57	12.42	3.99	2.82	8.29	9.62	30.00			
	10977	5.21	10.97	7.80	14.44	4.52	3.32	9.87	11.35	30.00			
	10978	6.41	12.11	9.02	16.40	4.74	6.08	11.62	13.94	30.00			
	10979	5.04	6.45	5.49	9.85	3.68	4.23	6.46	8.56	30.00			
	10980	5.71	8.47	5.79	11.74	4.44	4.47	8.56	10.63	30.00			
Count:	9									Total:	271.50	seconds	

Mean:	6.41	10.24	7.68	14.34	4.59	4.46	9.46	11.45	Highest hand a_{hw} 14.3 ± 2.7 m/s²				
Stdev:	1.25	2.10	1.54	2.74	0.55	1.08	1.81	1.99					
Time to EAV:												0:14	0:22
Time to ELV:												0:58	1:31
A(8):													

25%ile	5.34	8.92	6.57	12.42	4.35	3.52	8.29	9.62	Highest hand 75%ile 16.6m/s²				
Median:	6.31	10.97	7.80	14.44	4.52	4.47	9.87	11.35					
75%ile	7.27	12.01	9.02	16.56	4.99	5.12	10.93	13.19					
IQ range	1.93	3.09	2.45	4.14	0.63	1.60	2.64	3.57					
Time to EAV:												0:14	0:23
Time to ELV:												0:57	1:33
A(8):													

Time-weighted mean:	6.42	10.25	7.69	14.36	4.59	4.46	9.47	11.46
Stdev:	2.44	3.95	2.95	5.44	1.61	1.80	3.58	4.26

V2.2 April 2012

Dateofentrytodatabase:		30-Jul-13	
PrintDate		30-Jul-13	
MainID:	1573		
DateOfVisit:	06/09/12		
LocationName:			
Occupation:	Scientist		
Process:	Breaking 40N concrete		
ProcessNotes:			
MachineModel:		InsertedToolType:	
MachineModifications:		InsertedToolPhotoDirectoryName:	
MachineSize:	450mm	DataSource:	
MachineWeight(kg):	6.3	HSLReportNumber:	
MachineOperatingPressure:	6.2Bar	HSLReportDirectoryName:	
MachineSpeed(impacts/min):	2640	ShotsPerDay:	
MachineSpeed(revs/min):		DailyExposureTime:	
MachinePower:		Checked2012Initials:	
MachinePowerSource:	Pneumatic		
MachinePhotoDirName:	Photos\Test Code 2 Field Photos		
InsertedToolCategoryID:	1		

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1573	10981	6.31	8.92	6.95	12.95	4.35	3.52	7.76	9.56	30.00			
	10982	5.34	9.09	6.57	12.42	3.99	2.82	8.29	9.62	30.00			
	10983	5.21	10.97	7.80	14.44	4.52	3.32	9.87	11.35	30.00			
	10984	5.72	10.79	9.42	15.43	4.54	4.03	9.79	11.52	30.00			
	10985	5.98	9.30	7.34	13.27	4.15	4.16	8.74	10.53	30.00			
	10986	4.97	6.34	6.51	10.36	3.64	2.65	5.68	7.25	30.00			
	10987	5.81	9.19	7.46	13.19	4.06	2.85	8.06	9.46	30.00			
	10988	5.76	9.40	6.74	12.92	3.84	3.09	8.47	9.80	30.00			
	10989	6.21	11.38	9.19	15.89	4.52	3.69	10.05	11.62	30.00			
Count:	9									Total:	270.00	seconds	

Mean:	5.70	9.49	7.55	13.43	4.18	3.35	8.52	10.08	Highest hand a_{hw} 13.4 ± 1.7 m/s²			
Stdev:	0.45	1.50	1.08	1.66	0.33	0.54	1.36	1.38				
Time to EAV:												0:29
Time to ELV:												1:58
A(8):												

25%ile	5.34	9.09	6.74	12.92	3.99	2.85	8.06	9.56	Highest hand 75%ile 14.4m/s²			
Median:	5.76	9.30	7.34	13.19	4.15	3.32	8.47	9.80				
75%ile	5.98	10.79	7.80	14.44	4.52	3.69	9.79	11.35				
IQ range	0.64	1.70	1.06	1.52	0.53	0.84	1.73	1.79				
Time to EAV:												0:31
Time to ELV:												2:04
A(8):												

Time-weighted mean:	5.70	9.49	7.55	13.43	4.18	3.35	8.52	10.08
Stdev:	1.95	3.46	2.72	4.74	1.43	1.23	3.12	3.60

V2.2 April 2012

Dateofentrytodatabase:		30-Jul-13	
PrintDate		30-Jul-13	
MainID:	1575		
DateOfVisit:	06/09/12		
LocationName:			
Occupation:	Scientist		
Process:	Breaking Concrete Pad		
ProcessNotes:			
MachineModel:		InsertedToolType:	
MachineModifications:		InsertedToolPhotoDirectoryName:	
MachineSize:	450mm	DataSource:	
MachineWeight(kg):	6.3	HSLReportNumber:	
MachineOperatingPressure:	6.2	HSLReportDirectoryName:	
MachineSpeed(im pacts/min):	2640	ShotsPerDay:	
MachineSpeed(revs/min):		DailyExposureTime:	
MachinePower:		Checked2012Initials:	
MachinePowerSource:	Pneumatic		
MachinePhotoDirName:	Photos\Test Code 2 Field Photos		
InsertedToolCategoryID:	1		

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1575	10990	5.46	12.76	9.30	16.71	4.83	3.60	10.61	12.20	30.00			
	10991	5.86	11.02	7.76	14.70	4.56	3.65	9.59	11.24	30.00			
	10992	6.49	10.89	7.73	14.85	5.14	4.39	9.89	11.98	30.00			
	10993	4.41	10.24	7.41	13.39	3.52	3.30	9.14	10.33	30.00			
	10994	4.62	10.48	8.40	14.21	3.90	3.39	9.30	10.63	30.00			
	10995	5.13	8.80	8.04	12.98	3.95	4.34	8.11	10.00	30.00			
	10996	5.27	10.29	7.18	13.61	4.65	4.84	10.12	12.15	30.00			
	10997	5.73	12.90	8.63	16.54	5.25	5.26	12.41	14.46	30.00			
	10998	5.23	11.39	7.80	14.76	4.98	4.56	10.88	12.81	30.00			
Count:	9									Total:	270.00	seconds	

Mean:	5.36	10.98	8.03	14.64	4.53	4.15	10.00	11.76			
Stdev:	0.63	1.28	0.66	1.30	0.61	0.69	1.22	1.39	Highest hand a_{hw}		
Time to EAV:				0:14				0:21			
Time to ELV:				0:56				1:26	14.6 ± 1.3 m/s²		
A(8):											

25%ile	5.13	10.29	7.73	13.61	3.95	3.60	9.30	10.63			
Median:	5.27	10.89	7.80	14.70	4.65	4.34	9.89	11.98	Highest hand 75%ile		
75%ile	5.73	11.39	8.40	14.85	4.98	4.56	10.61	12.20			
IQ range	0.60	1.09	0.67	1.24	1.04	0.96	1.31	1.57	14.8m/s²		
Time to EAV:				0:13				0:20			
Time to ELV:				0:55				1:23			
A(8):											

Time-weighted mean:	5.36	10.98	8.03	14.64	4.53	4.15	10.00	11.76			
Stdev:	1.88	3.85	2.75	5.03	1.62	1.53	3.53	4.13			

V2.2 April 2012

Dateofentrytodatabase:		30-Jul-13	
PrintDate		30-Jul-13	
MainID:	1578		
DateOfVisit:	06/09/12		
LocationName:			
Occupation:	Scientist		
Process:	Demolishing brick wall		
ProcessNotes:			
MachineModel:		InsertedToolType:	
MachineModifications:		InsertedToolPhotoDirectoryName:	
MachineSize:	450mm	DataSource:	
MachineWeight(kg):	6.3	HSLReportNumber:	
MachineOperatingPressure:	6.2Bar	HSLReportDirectoryName:	
MachineSpeed(imparts/min):	2640	ShotsPerDay:	
MachineSpeed(revs/min):		DailyExposureTime:	
MachinePower:		Checked2012Initials:	
MachinePowerSource:	Pneumatic		
MachinePhotoDirName:	Photos\Test Code 2 Field Photos		
InsertedToolCategoryID:	1		

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1578	10999	7.18	12.03	10.34	17.42	4.86	3.48	10.17	11.79	30.00			
	11000	7.80	13.19	11.33	19.05	5.26	4.11	11.03	12.90	30.00			
	11001	7.57	14.83	11.67	20.34	6.06	3.83	12.66	14.55	30.00			
	11002	3.59	6.80	5.81	9.64	3.54	2.85	5.55	7.17	30.00			
	11003	3.86	6.82	5.83	9.77	2.27	2.19	5.70	6.52	30.00			
	11004	3.59	5.00	5.05	7.96	2.46	2.11	4.13	5.25	30.00			
	11005	8.40	14.14	12.03	20.38	7.91	5.80	12.86	16.17	30.00			
	11006	7.74	11.64	9.64	16.98	5.77	3.07	9.90	11.87	30.00			
	11007	7.95	12.50	9.95	17.84	6.10	3.20	10.62	12.65	30.00			
Count:	9									Total:	270.00	seconds	

Mean:	6.41	10.77	9.07	15.49	4.91	3.40	9.18	10.99	Highest hand a_{hw} 15.5 ± 4.9 m/s²			
Stdev:	2.07	3.60	2.75	4.94	1.85	1.12	3.23	3.79				
Time to EAV:												0:12
Time to ELV:												0:50
A(8):									1:39			

25%ile	3.86	6.82	5.83	9.77	3.54	2.85	5.70	7.17	Highest hand 75%ile 19.1m/s²			
Median:	7.57	12.03	9.95	17.42	5.26	3.20	10.17	11.87				
75%ile	7.80	13.19	11.33	19.05	6.06	3.83	11.03	12.90				
IQ range	3.94	6.36	5.50	9.28	2.53	0.98	5.33	5.72				
Time to EAV:												0:09
Time to ELV:												0:39
A(8):									1:25			

Time-weighted mean:	6.41	10.77	9.07	15.49	4.91	3.40	9.18	10.99
Stdev:	2.90	4.94	3.99	6.95	2.39	1.55	4.32	5.12

V2.2 April 2012

Tool F

Date of entry to database:		30-Jul-13	
MainID:	1581	PrintDate	30-Jul-13
Date of visit:	06/09/12		
LocationName:			
Occupation:	Scientist		
Process:	Breaking 40N concrete		
ProcessNotes:			
MachineModel:		InsertedToolType:	
MachineModifications:		InsertedToolPhotoDirectoryName:	
MachineSize:	560mm	DataSource:	
MachineWeight(kg):	10.5	HSLReportNumber:	
MachineOperatingPressure:	6.2Bar	HSLReportDirectoryName:	
MachineSpeed(im pacts/min):	1800	ShotsPerDay:	
MachineSpeed(revs/min):		DailyExposureTime:	
MachinePower:		Checked2012Initials:	
MachinePowerSource:	Pneumatic		
MachinePhotoDirName:	Photos\Test Code 2 Field Photos		
InsertedToolCategoryID:	4		

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1581	11026	7.02	7.15	12.55	16.06	5.61	6.42	12.43	15.07	30.00			
	11027	7.32	8.09	13.35	17.24	5.77	6.77	13.43	16.11	30.00			
	11028	6.58	7.16	12.61	15.93	5.97	6.78	12.60	15.50	30.00			
	11029	5.05	4.72	8.77	11.16	4.70	4.92	8.76	11.09	30.00			
	11030	5.93	5.87	10.97	13.78	5.62	5.60	11.15	13.69	30.00			
	11031	3.59	3.73	4.99	7.19	3.38	3.09	5.16	6.90	30.00			
	11032	8.80	9.94	19.48	23.57	6.68	8.51	19.13	21.98	30.00			
	11033	8.21	9.62	19.13	22.94	6.91	8.02	18.60	21.40	30.00			
	11034	8.16	10.02	18.49	22.56	7.21	8.06	18.11	21.09	30.00			
Count:	9									Total:	270.00	seconds	

Mean:	6.74	7.37	13.37	16.71	5.76	6.46	13.26	15.87	Highest hand a_{hw} 16.7 ± 5.6 m/s²			
Stdev:	1.67	2.29	4.94	5.60	1.18	1.73	4.72	5.05				
Time to EAV:												0:11
Time to ELV:												0:47
A(8):												

25%ile	5.93	5.87	10.97	13.78	5.61	5.60	11.15	13.69	Highest hand 75%ile 22.6m/s²			
Median:	7.02	7.16	12.61	16.06	5.77	6.77	12.60	15.50				
75%ile	8.16	9.62	18.49	22.56	6.68	8.02	18.11	21.09				
IQ range	2.24	3.76	7.51	8.77	1.08	2.42	6.96	7.40				
Time to EAV:												0:11
Time to ELV:												0:49
A(8):												

Time-weighted mean:	6.74	7.37	13.37	16.71	5.76	6.46	13.26	15.87
Stdev:	2.74	3.27	6.45	7.68	2.22	2.70	6.27	7.12

V2.2 April 2012

Dateofentrytodatabase:		30-Jul-13	
PrintDate		30-Jul-13	
MainID:	1579		
DateOfVisit:	06/09/12		
LocationName:			
Occupation:	Scientist		
Process:	Breaking Concrete Pad		
ProcessNotes:			
MachineModel:		InsertedToolType:	
MachineModifications:		InsertedToolPhotoDirectoryName:	
MachineSize:	560mm	DataSource:	
MachineWeight(kg):	10.5	HSLReportNumber:	
MachineOperatingPressure:	6.2Bar	HSLReportDirectoryName:	
MachineSpeed(im pacts/min):	1800	ShotsPerDay:	
MachineSpeed(revs/min):		DailyExposureTime:	
MachinePower:		Checked2012Initials:	
MachinePowerSource:	Pneumatic		
MachinePhotoDirName:	Photos\Test Code 2 Field Photos		
InsertedToolCategoryID:	4		

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measure-ment time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1579	11008	6.91	6.16	14.22	16.96	5.78	6.78	11.79	14.77	30.00			
	11009	8.56	8.46	20.13	23.46	7.78	9.20	16.21	20.20	29.50			
	11010	7.93	7.99	16.11	19.65	7.01	9.40	15.65	19.55	30.00			
	11011	9.02	9.81	18.24	22.59	7.20	7.90	17.62	20.61	30.00			
	11012	9.61	11.00	20.39	25.08	7.57	9.08	19.67	22.95	30.00			
	11013	8.66	9.83	18.97	23.06	7.10	8.84	17.90	21.19	30.00			
	11014	11.51	11.26	20.93	26.41	8.53	11.33	22.60	26.68	30.00			
	11015	9.35	8.81	17.44	21.66	6.53	9.16	18.60	21.74	30.00			
	11016	11.33	10.91	22.60	27.53	9.23	12.24	23.36	27.94	30.00			
Count:	9									Total:	269.50	seconds	

Mean:	9.21	9.36	18.78	22.93	7.42	9.32	18.16	21.74	Highest hand a_{hw} 22.9 ± 3.3 m/s²				
Stdev:	1.49	1.67	2.59	3.28	1.03	1.64	3.54	3.90					
Time to EAV:												0:05	0:06
Time to ELV:												0:22	0:25
A(8):													

25%ile	8.56	8.46	17.44	21.66	7.01	8.84	16.21	20.20	Highest hand 75%ile 25.1m/s²				
Median:	9.02	9.81	18.97	23.06	7.20	9.16	17.90	21.19					
75%ile	9.61	10.91	20.39	25.08	7.78	9.40	19.67	22.95					
IQ range	1.05	2.44	2.95	3.41	0.76	0.56	3.46	2.75					
Time to EAV:												0:05	0:06
Time to ELV:												0:22	0:26
A(8):													

Time-weighted mean:	9.21	9.36	18.78	22.93	7.41	9.32	18.16	21.74
Stdev:	3.37	3.50	6.72	8.25	2.65	3.47	6.91	8.13

V2.2 April 2012

Dateofentrytodatabase:		30-Jul-13	
PrintDate		30-Jul-13	
MainID:	1580		
DateOfVisit:	06/09/12		
LocationName:			
Occupation:	Scientist		
Process:	Breaking Concrete Pad		
ProcessNotes:			
MachineModel:		InsertedToolType:	
MachineModifications:		InsertedToolPhotoDirectoryName:	
MachineSize:	560mm	DataSource:	
MachineWeight(kg):	10.5	HSLReportNumber:	
MachineOperatingPressure:	6.2Bar	HSLReportDirectoryName:	
MachineSpeed(im pacts/min):	1800	ShotsPerDay:	
MachineSpeed(revs/min):		DailyExposureTime:	
MachinePower:		Checked2012Initials:	
MachinePowerSource:	Pneumatic		
MachinePhotoDirName:	Photos\Test Code 2 Field Photos		
InsertedToolCategoryID:	4		

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measure-ment time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1580	11017	7.91	5.38	10.64	14.31	4.95	6.39	12.76	15.10	30.00			
	11018	5.32	3.67	5.65	8.58	3.80	3.52	7.38	9.02	30.00			
	11019	5.53	3.44	7.25	9.75	4.01	4.14	8.43	10.21	30.00			
	11020	6.88	5.04	10.61	13.62	5.20	5.73	12.42	14.63	30.00			
	11021	6.02	4.36	9.32	11.92	4.59	5.79	9.94	12.38	30.00			
	11022	6.14	3.77	7.56	10.45	4.49	4.33	9.59	11.45	30.00			
	11023	7.35	5.58	9.80	13.46	4.84	6.08	11.80	14.13	30.00			
	11024	8.24	6.15	10.89	14.97	4.82	6.65	13.22	15.56	30.00			
	11025	7.32	6.05	12.96	16.07	4.84	7.58	14.24	16.84	30.00			
Count:	9									Total:	270.00	seconds	

Mean:	6.75	4.83	9.41	12.57	4.61	5.58	11.09	13.26	Highest hand a_{hw} 13.3 ± 2.6 m/s²				
Stdev:	1.04	1.05	2.24	2.54	0.45	1.32	2.34	2.63					
Time to EAV:												0:18	0:17
Time to ELV:												1:15	1:08
A(8):													

25%ile	6.02	3.77	7.56	10.45	4.49	4.33	9.59	11.45	Highest hand 75%ile 15.1m/s²				
Median:	6.88	5.04	9.80	13.46	4.82	5.79	11.80	14.13					
75%ile	7.35	5.58	10.64	14.31	4.84	6.39	12.76	15.10					
IQ range	1.33	1.81	3.08	3.86	0.35	2.06	3.16	3.66					
Time to EAV:												0:16	0:15
Time to ELV:												1:06	1:00
A(8):													

Time-weighted mean:	6.75	4.83	9.41	12.57	4.61	5.58	11.09	13.26
Stdev:	2.45	1.89	3.78	4.83	1.60	2.24	4.30	5.07

V2.2 April 2012

Tool G

Dateofentrytodatabase: PrintDate		30-Jul-13
MainID:	1594	
DateOfvisit:	26/09/12	
LocationName:		
Occupation:	Scientist	
Process:	Riveting	
ProcessNotes:		
MachineModel:		InsertedToolType:
MachineModifications:		InsertedToolPhotoDirectoryName:
MachineSize:		DataSource:
MachineWeight(kg):	1.3	
MachineOperatingPressure:	6.3Bar	HSLReportNumber:
MachineSpeed(impacts/min):	2160	HSLReportDirectoryName:
MachineSpeed(revs/min):		ShotsPerDay:
MachinePower:		DailyExposureTime:
MachinePowerSource:	Pneumatic	Checked2012Initials:
MachinePhotoDirName:	Photos\Chipping hammer photos	
InsertedToolCategoryID:	2	

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1594	11094	0.98	4.05	1.31	4.37	1.49	2.12	2.82	3.82	46.50			
	11095	1.42	3.92	1.45	4.41	1.90	1.98	2.81	3.93	51.75			
	11096	1.42	4.58	1.64	5.06	2.25	2.43	3.43	4.77	49.25			
Count:	3									Total:	147.50	seconds	

Mean:	1.27	4.18	1.47	4.61	1.88	2.17	3.02	4.17	Highest hand a_{hw} 4.6 ± 0.4 m/s²			
Stdev:	0.25	0.35	0.16	0.39	0.38	0.23	0.36	0.52				
Time to EAV:												2:52
Time to ELV:												11:29
A(8):												

25%ile	1.20	3.98	1.38	4.39	1.70	2.05	2.81	3.88	Highest hand 75%ile 4.7m/s²			
Median:	1.42	4.05	1.45	4.41	1.90	2.12	2.82	3.93				
75%ile	1.42	4.31	1.55	4.74	2.07	2.27	3.12	4.35				
IQ range	0.22	0.33	0.16	0.35	0.38	0.22	0.31	0.47				
Time to EAV:												3:14
Time to ELV:												10:16
A(8):												

Time-weighted mean:	1.28	4.18	1.47	4.62	1.89	2.17	3.02	4.18
Stdev:	0.77	2.43	0.86	2.68	1.13	1.27	1.77	2.45

V2.2 April 2012

Dateofentrytodatabase: PrintDate		30-Jul-13
MainID:	1597	
DateOfVisit:	26/09/12	
LocationName:		
Occupation:	Scientist	
Process:	Riveting	
ProcessNotes:		
MachineModel:		InsertedToolType:
MachineModifications:		InsertedToolPhotoDirectoryName:
MachineSize:		DataSource:
MachineWeight(kg):	1.3	HSLReportNumber:
MachineOperatingPressure:	6.3Bar	HSLReportDirectoryName:
MachineSpeed(impacts/min):	2160	ShotsPerDay:
MachineSpeed(revs/min):		DailyExposureTime:
MachinePower:		Checked2012Initials:
MachinePowerSource:		
MachinePhotoDirName:	Photos\Chipping hammer photos	
InsertedToolCategoryID:	2	

Results_ MainID:	ResultsID :	Bucking Bar (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name
		x-axis	y-axis	z-axis	ahv			
1597	11098	2.63	10.40	2.14	10.93	49.25		
	11099	2.02	9.93	2.26	10.39	49.25		
	11100	2.09	10.71	1.93	11.08	49.25		
Count:	3					Total:	147.75	seconds

Mean:	2.25	10.34	2.11	10.80	Highest hand a_{hw} 10.8 ± 0.4 m/s²
Stdev:	0.33	0.39	0.17	0.37	
Time to EAV:				0:25	
Time to ELV: A(8):				1:42	

25%ile	2.06	10.16	2.03	10.66	Highest hand 75%ile 11.0m/s²
Median:	2.09	10.40	2.14	10.93	
75%ile	2.36	10.55	2.20	11.01	
IQ range	0.30	0.39	0.17	0.35	
Time to EAV:				0:25	
Time to ELV: A(8):				1:40	

Time-weighted mean:	2.25	10.34	2.11	10.80
Stdev:	1.32	5.98	1.23	6.24

V2.2 April 2012

Dateofentrytodatabase: PrintDate		30-Jul-13
MainID:	1588	
DateOfVisit:	26/09/12	
LocationName:		
Occupation:	Scientist	
Process:	Riveting	
ProcessNotes:		
MachineModel:		InsertedToolType:
MachineModifications:		InsertedToolPhotoDirectoryName:
MachineSize:		DataSource:
MachineWeight(kg):	1.3	HSLReportNumber:
MachineOperatingPressure:	6.3Bar	HSLReportDirectoryName:
MachineSpeed(impacts/min):	2160	ShotsPerDay:
MachineSpeed(revs/min):		DailyExposureTime:
MachinePower:		Checked2012Initials:
MachinePowerSource:	Pneumatic	
MachinePhotoDirName:	Photos\Chipping hammer photos	
InsertedToolCategoryID:	2	

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1588	11073	1.13	4.52	1.65	4.94	1.61	2.17	3.12	4.13	45.25			
	11075	1.55	3.67	1.32	4.20	1.83	1.90	2.39	3.56	54.25			
	11079	1.61	5.65	1.54	6.07	2.43	2.94	3.59	5.24	44.75			
Count:	3									Total:	144.25	seconds	

Mean:	1.43	4.61	1.50	5.07	1.95	2.34	3.04	4.31	Highest hand a_{hw} 5.1 ± 0.9 m/s²			
Stdev:	0.26	0.99	0.17	0.94	0.42	0.54	0.60	0.85				
Time to EAV:												2:41
Time to ELV:												10:46
A(8):												

25%ile	1.34	4.10	1.43	4.57	1.72	2.03	2.76	3.84	Highest hand 75%ile 5.5m/s²			
Median:	1.55	4.52	1.54	4.94	1.83	2.17	3.12	4.13				
75%ile	1.58	5.09	1.59	5.51	2.13	2.55	3.36	4.68				
IQ range	0.24	0.99	0.16	0.94	0.41	0.52	0.60	0.84				
Time to EAV:												2:56
Time to ELV:												11:44
A(8):												

Time-weighted mean:	1.44	4.55	1.49	5.01	1.94	2.31	2.99	4.26
Stdev:	0.86	2.75	0.87	3.00	1.17	1.40	1.80	2.56

V2.2 April 2012

Dateofentrytodatabase: PrintDate		30-Jul-13
MainID:	1593	
DateOfVisit:	26/09/12	
LocationName:		
Occupation:	Scientist	
Process:	Riveting	
ProcessNotes:		
MachineModel:		InsertedToolType:
MachineModifications:		InsertedToolPhotoDirectoryName:
MachineSize:		DataSource:
MachineWeight(kg):	1.3	HSLReportNumber:
MachineOperatingPressure:	6.3Bar	HSLReportDirectoryName:
MachineSpeed(impacts/min):	2160	ShotsPerDay:
MachineSpeed(revs/min):		DailyExposureTime:
MachinePower:		Checked2012Initials:
MachinePowerSource:		
MachinePhotoDirName:	Photos\Chipping hammer photos	
InsertedToolCategoryID:	2	

Results_ MainID:	ResultsID :	Bucking Bar (m/s²)				Measurement time (s)	No. Shots in Meas.	Source file name
		x-axis	y-axis	z-axis	ahv			
1593	11090	2.87	7.96	2.77	8.90	49.25		
	11091	2.06	8.34	2.45	8.94	49.25		
	11092	1.65	3.41	1.66	4.14	49.25		
Count:	3					Total:	147.75	seconds

Mean:	2.20	6.57	2.29	7.33	Highest hand a_{hw} 7.3 ± 2.8 m/s²
Stdev:	0.62	2.74	0.57	2.76	
Time to EAV:				0:55	
Time to ELV: A(8):				3:43	

25%ile	1.86	5.69	2.05	6.52	Highest hand 75%ile 8.9m/s²
Median:	2.06	7.96	2.45	8.90	
75%ile	2.47	8.15	2.61	8.92	
IQ range	0.61	2.47	0.55	2.40	
Time to EAV:				0:37	
Time to ELV: A(8):				2:31	

Time-weighted mean:	2.20	6.57	2.29	7.33
Stdev:	1.36	4.41	1.40	4.79

V2.2 April 2012

Dateofentrytodatabase: PrintDate		30-Jul-13
MainID:	1584	
DateOfVisit:	25/09/12	
LocationName:		
Occupation:	Scientist	
Process:	Riveting	
ProcessNotes:		
MachineModel:		InsertedToolType:
MachineModifications:		InsertedToolPhotoDirectoryName:
MachineSize:		DataSource:
MachineWeight(kg):	1.3	HSLReportNumber:
MachineOperatingPressure:	6.3Bar	HSLReportDirectoryName:
MachineSpeed(impacts/min):	2160	ShotsPerDay:
MachineSpeed(revs/min):		DailyExposureTime:
MachinePower:		Checked2012Initials:
MachinePowerSource:	Pneumatic	
MachinePhotoDirName:	Photos\Chipping hammer photos	
InsertedToolCategoryID:	2	

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1584	11049	2.07	4.55	1.20	5.14	2.73	2.62	3.00	4.83	37.25			
	11051	1.94	5.67	1.46	6.16	2.55	3.15	3.09	5.10	72.00			
	11053	1.37	3.81	1.34	4.27	1.71	2.04	2.64	3.75	52.75			
Count:	3									Total:	162.00	seconds	

Mean:	1.80	4.67	1.33	5.19	2.33	2.60	2.91	4.56	Highest hand a_{hw} 5.2 ± 0.9 m/s²			
Stdev:	0.37	0.93	0.13	0.95	0.54	0.55	0.24	0.71				
Time to EAV:												2:24
Time to ELV:												9:37
A(8):												

25%ile	1.66	4.18	1.27	4.70	2.13	2.33	2.82	4.29	Highest hand 75%ile 5.7m/s²			
Median:	1.94	4.55	1.34	5.14	2.55	2.62	3.00	4.83				
75%ile	2.01	5.11	1.40	5.65	2.64	2.88	3.04	4.96				
IQ range	0.35	0.93	0.13	0.95	0.51	0.55	0.23	0.67				
Time to EAV:												2:08
Time to ELV:												8:35
A(8):												

Time-weighted mean:	1.79	4.80	1.36	5.31	2.32	2.67	2.92	4.60
Stdev:	1.08	2.88	0.79	3.16	1.41	1.61	1.70	2.72

V2.2 April 2012

Dateofentrytodatabase:		PrintDate		30-Jul-13	
MainID:	1589				
DateOfVisit:	25/09/12				
LocationName:					
Occupation:	Scientist				
Process:	Riveting				
ProcessNotes:					
MachineModel:		InsertedToolType:			
MachineModifications:		InsertedToolPhotoDirectoryName:			
MachineSize:		DataSource:			
MachineWeight(kg):	1.3	HSLReportNumber:			
MachineOperatingPressure:	6.3Bar	HSLReportDirectoryName:			
MachineSpeed(impacts/min):	2160	ShotsPerDay:			
MachineSpeed(revs/min):		DailyExposureTime:			
MachinePower:		Checked2012Initials:			
MachinePowerSource:					
MachinePhotoDirName:	Photos\Chipping hammer photos				
InsertedToolCategoryID:	2				

Results_ MainID:	ResultsID :	Both hands (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name
		x-axis	y-axis	z-axis	ahv			
1589	11083	2.03	9.99	2.22	10.44	52.75		
	11084	2.53	11.47	2.32	11.97	52.75		
	11555	3.00	16.13	3.90	16.86	52.75		
Count:	3					Total:	158.25	seconds

Mean:	2.52	12.53	2.82	13.09	Highest hand a_{hw}
Stdev:	0.48	3.20	0.94	3.36	
Time to EAV:				0:17	13.1 ± 3.4 m/s²
Time to ELV:				1:10	
A(8):					

25%ile	2.28	10.73	2.27	11.20	Highest hand 75%ile
Median:	2.53	11.47	2.32	11.97	
75%ile	2.76	13.80	3.11	14.42	14.4m/s²
IQ range	0.48	3.07	0.84	3.21	
Time to EAV:				0:20	
Time to ELV:				1:23	
A(8):					

Time-weighted mean:	2.52	12.53	2.82	13.09
Stdev:	1.51	7.69	1.80	8.04

V2.2 April 2012

Date of entry to database:		Print Date		30-Jul-13	
MainID:	1586				
Date of Visit:	25/09/12				
Location Name:					
Occupation:	Scientist				
Process:	Riveting				
Process Notes:					
Machine Model:			Inserted Tool Type:		
Machine Modifications:			Inserted Tool Photo Directory Name:		
Machine Size:			Data Source:		
Machine Weight (kg):	1.3		HSL Report Number:		
Machine Operating Pressure:	6.3 Bar		HSL Report Directory Name:		
Machine Speed (impacts/min):	2160		Shots Per Day:		
Machine Speed (revs/min):			Daily Exposure Time:		
Machine Power:			Checked 2012 Initials:		
Machine Power Source:	Pneumatic				
Machine Photo Dir Name:	Photos\Chipping hammer photos				
Inserted Tool Category ID:	2				

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1586	11056	1.31	5.34	1.48	5.70	1.70	2.73	3.11	4.48	44.25			
	11059	1.67	8.03	1.68	8.37	3.42	4.47	5.08	7.58	65.00			
	11061	1.32	4.50	1.25	4.85	2.09	2.34	3.14	4.44	61.00			
Count:	3									Total:	170.25	seconds	

Mean:	1.43	5.96	1.47	6.31	2.40	3.18	3.78	5.50	Highest hand a_{hw} 6.3 ± 1.8 m/s²			
Stdev:	0.20	1.84	0.21	1.83	0.90	1.13	1.13	1.80				
Time to EAV:												1:39
Time to ELV:												6:36
A(8):												

25%ile	1.32	4.92	1.37	5.28	1.90	2.53	3.13	4.46	Highest hand 75%ile 7.0m/s²			
Median:	1.32	5.34	1.48	5.70	2.09	2.73	3.14	4.48				
75%ile	1.50	6.68	1.58	7.03	2.75	3.60	4.11	6.03				
IQ range	0.18	1.76	0.21	1.76	0.86	1.06	0.98	1.57				
Time to EAV:												2:29
Time to ELV:												9:58
A(8):												

Time-weighted mean:	1.45	6.06	1.47	6.41	2.50	3.25	3.87	5.65			
Stdev:	0.85	3.81	0.87	4.00	1.62	2.09	2.42	3.58			

V2.2 April 2012

Dateofentrytodatabase:		PrintDate		30-Jul-13	
MainID:	1592				
DateOfVisit:	26/09/12				
LocationName:					
Occupation:	Scientist				
Process:	Riveting				
ProcessNotes:					
MachineModel:		InsertedToolType:			
MachineModifications:		InsertedToolPhotoDirectoryName:			
MachineSize:		DataSource:			
MachineWeight(kg):	1.3	HSLReportNumber:			
MachineOperatingPressure:	6.3Bar	HSLReportDirectoryName:			
MachineSpeed(impacts/min):	2160	ShotsPerDay:			
MachineSpeed(revs/min):		DailyExposureTime:			
MachinePower:		Checked2012Initials:			
MachinePowerSource:					
MachinePhotoDirName:	Photos\Chipping hammer photos				
InsertedToolCategoryID:	2				

Results_ MainID:	ResultsID :	Both hands		Both hands (m/s ²)		ahv	Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	y-axis	z-axis					
1592	11086	3.66	10.99	1.88	11.73	11.73	52.75			
	11087	2.36	5.22	1.55	5.93	5.93	52.75			
	11088	2.49	6.12	2.26	6.98	6.98	52.75			
Count:	3					Total:	158.25	seconds		

Mean:	2.84	7.44	1.90	8.22	Highest hand a_{hw}
Stdev:	0.72	3.10	0.35	3.09	
Time to EAV:					0:44
Time to ELV:					2:57
A(8):					8.2 ± 3.1 m/s²

25%ile	2.43	5.67	1.72	6.46	Highest hand 75%ile
Median:	2.49	6.12	1.88	6.98	
75%ile	3.08	8.55	2.07	9.36	9.4m/s²
IQ range	0.65	2.89	0.35	2.90	
Time to EAV:					1:01
Time to ELV:					4:06
A(8):					

Time-weighted mean:	2.84	7.44	1.90	8.22
Stdev:	1.74	4.99	1.13	5.37

V2.2 April 2012

Tool H

Dateofentrytodatabase:		PrintDate		30-Jul-13	
MainID:	1569				
DateOf/visit:	12/07/12				
LocationName:					
Occupation:	Scientist				
Process:	Drilling concrete block no rebar				
ProcessNotes:					
MachineModel:			InsertedToolType:		
MachineModifications:			InsertedToolPhotoDirectoryName:		
MachineSize:			DataSource:		
MachineWeight(kg):			HSLReportNumber:		
MachineOperatingPressure:	4-6 bar		HSLReportDirectoryName:		
MachineSpeed(impacts/min):			ShotsPerDay:		
MachineSpeed(revs/min):			DailyExposureTime:		
MachinePower:			Checked2012Initials:		
MachinePowerSource:	Pneumatic				
MachinePhotoDirName:	Photos\Chipping hammer photos				
InsertedToolCategoryID:	11				

Results_ MainID:	ResultsID :	Front hand (m/s ²)				Rear hand (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1569	10949	2.54	2.59	10.86	11.45	11.57	1.31	1.64	11.76	59.75			
	10950	2.48	2.43	10.48	11.04	11.15	1.30	1.66	11.35	53.25			
	10951	2.22	2.54	10.74	11.26	11.27	1.27	1.39	11.42	54.25			
	10952	2.35	2.31	10.58	11.08	10.94	1.36	1.54	11.13	54.75			
	10953	2.49	2.47	10.08	10.67	10.68	1.31	1.71	10.90	51.00			
	10954	2.35	2.27	9.63	10.17	10.28	1.35	1.59	10.49	53.75			
	10955	2.31	2.15	9.38	9.89	10.17	1.39	1.43	10.37	52.50			
	10956	2.29	2.29	9.90	10.42	9.90	1.31	1.76	10.14	52.25			
	10957	2.31	2.84	8.71	9.45	8.30	1.47	2.02	8.66	44.75			
	10958	2.30	2.44	8.58	9.21	9.36	1.44	1.95	9.67	54.75			
	10959	2.85	2.23	9.39	10.07	10.55	1.67	1.98	10.86	54.25			
	10960	3.33	2.36	7.28	8.35	9.94	1.91	2.32	10.38	52.50			
	10961	3.33	2.36	6.64	7.79	9.09	2.04	2.43	9.62	54.75			
	10962	3.42	2.42	8.72	9.67	10.26	1.75	2.32	10.67	59.25			
	10963	2.96	2.31	9.14	9.88	9.95	1.45	1.95	10.24	50.50			
Count:	15									Total:	802.25	seconds	

Mean:	2.64	2.40	9.34	10.03	10.23	1.49	1.85	10.51	Highest hand a_{hw} 10.5 ± 0.8 m/s²			
Stdev:	0.43	0.17	1.22	1.04	0.87	0.24	0.33	0.80				
Time to EAV:												0:29
Time to ELV:												1:58
A(8):									1:48			

25%ile	2.31	2.30	8.71	9.56	9.92	1.31	1.62	10.19	Highest hand 75%ile 11.0m/s²			
Median:	2.48	2.36	9.39	10.07	10.26	1.39	1.76	10.49				
75%ile	2.91	2.45	10.28	10.86	10.81	1.57	2.00	11.02				
IQ range	0.60	0.16	1.56	1.30	0.90	0.25	0.38	0.83				
Time to EAV:												0:29
Time to ELV:												1:49
A(8):									1:58			

Time-weighted mean:	2.64	2.40	9.35	10.04	10.26	1.49	1.85	10.54
Stdev:	0.80	0.64	2.69	2.78	2.78	0.45	0.57	2.83

V2.2 April 2012

Dateofentrytodatabase:		30-Jul-13	
PrintDate		30-Jul-13	
MainID:	1566		
DateOfVisit:	12/07/12		
LocationName:			
Occupation:	Scientist		
Process:	Drilling concrete pad with rebar		
ProcessNotes:			
MachineModel:		InsertedToolType:	
MachineModifications:		InsertedToolPhotoDirectoryName:	
MachineSize:		DataSource:	
MachineWeight(kg):		HSLReportNumber:	
MachineOperatingPressure:	4-6 bar	HSLReportDirectoryName:	
MachineSpeed(impacts/min):		ShotsPerDay:	
MachineSpeed(revs/min):		DailyExposureTime:	
MachinePower:		Checked2012Initials:	
MachinePowerSource:	Pneumatic		
MachinePhotoDirName:	Photos\Chipping hammer photos		
InsertedToolCategoryID:	11		

Results_ MainID:	ResultsID :	Support (m/s ²)				Throttle (m/s ²)				Measurement time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1566	10940	2.71	2.51	10.79	11.40	11.49	1.52	1.88	11.74	52.50			
	10941	2.86	2.36	10.12	10.78	10.60	1.47	1.88	10.86	50.25			
	10942	2.81	2.43	10.52	11.16	10.87	1.48	1.96	11.14	52.00			
	10943	2.71	2.36	8.56	9.28	9.68	1.48	1.78	9.96	34.25			
	10944	2.31	2.18	7.91	8.52	9.42	1.63	1.32	9.65	42.50			
	10945	2.73	2.36	8.50	9.23	9.15	1.48	1.80	9.44	40.50			
	10946	3.54	2.57	9.60	10.55	10.90	1.62	2.46	11.29	51.75			
	10947	3.58	2.35	8.91	9.89	10.09	1.60	2.21	10.45	51.25			
	10948	3.49	2.44	9.67	10.57	10.56	1.59	2.11	10.88	50.75			
Count:	9									Total:	425.75	seconds	

Mean:	2.97	2.39	9.40	10.15	10.31	1.54	1.93	10.60	Highest hand a_{hw} 10.6 ± 0.8 m/s²			
Stdev:	0.45	0.11	0.99	0.98	0.77	0.07	0.32	0.78				
Time to EAV:					0:29							
Time to ELV:					1:56							
A(8):												

25%ile	2.71	2.36	8.56	9.28	9.68	1.48	1.80	9.96	Highest hand 75%ile 11.1m/s²			
Median:	2.81	2.36	9.60	10.55	10.56	1.52	1.88	10.86				
75%ile	3.49	2.44	10.12	10.78	10.87	1.60	2.11	11.14				
IQ range	0.78	0.08	1.56	1.50	1.18	0.12	0.31	1.18				
Time to EAV:					0:26							
Time to ELV:					1:41							
A(8):												

Time-weighted mean:	3.00	2.40	9.49	10.25	10.38	1.54	1.96	10.68
Stdev:	1.09	0.81	3.30	3.54	3.54	0.52	0.72	3.64

V2.2 April 2012

Tool I

Dateofentrytodatabase: 26-Feb-13	
PrintDate 30-Jul-13	
MainID: 1664	
DateOfVisit: 12/07/12	
LocationName:	
Occupation: Scientist	
Process: Drilling concrete block no rebar	
ProcessNotes:	
MachineModel:	InsertedToolType:
MachineModifications:	InsertedToolPhotoDirectoryName:
MachineSize:	DataSource:
MachineWeight(kg): 6.9	
MachineOperatingPressure: 6 Bar	HSLReportNumber:
MachineSpeed(im pacts/min): 3420	HSLReportDirectoryName:
MachineSpeed(revs/min):	
MachinePower:	ShotsPerDay:
MachinePowerSource: Pneumatic	DailyExposureTime:
MachinePhotoDirName: Photos\Chipping hammer photos	Checked2012Initials:
InsertedToolCategoryID: 11	

Results_ MainID:	ResultsID :	Throttle (m/s²)				Support (m/s²)				Measure-ment time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1664	11546	3.41	6.10	6.99	9.88	3.31	8.16	3.55	9.50	101.50			
	11547	3.42	5.67	6.79	9.49	3.20	7.60	3.36	8.90	105.75			
	11548	3.09	5.15	6.21	8.64	3.26	7.19	3.23	8.54	103.25			
	11549	3.20	5.08	6.08	8.55	2.91	6.74	3.08	7.96	102.50			
	11550	2.89	4.76	5.66	7.94	2.94	6.53	3.10	7.81	102.25			
	11551	2.92	5.15	6.19	8.57	2.96	6.85	3.11	8.09	105.00			
	11552	3.99	6.62	8.36	11.38	3.16	8.20	3.10	9.32	101.50			
	11553	3.26	6.17	7.51	10.25	3.18	7.85	3.43	9.14	101.25			
	11554	3.21	6.99	8.39	11.38	3.13	8.53	3.36	9.69	101.75			
Count:	9									Total:	924.75	seconds	

Mean:	3.27	5.74	6.91	9.56	3.12	7.52	3.26	8.77	Highest hand a_{hw} 9.6 ± 1.3 m/s²			
Stdev:	0.33	0.77	0.99	1.26	0.15	0.72	0.17	0.70				
Time to EAV:												0:32
Time to ELV:												2:35
A(8):												

25%ile	3.09	5.15	6.19	8.57	2.96	6.85	3.10	8.09	Highest hand 75%ile 10.3m/s²			
Median:	3.21	5.67	6.79	9.49	3.16	7.60	3.23	8.90				
75%ile	3.41	6.17	7.51	10.25	3.20	8.16	3.36	9.32				
IQ range	0.32	1.02	1.32	1.68	0.24	1.31	0.26	1.23				
Time to EAV:												0:33
Time to ELV:												2:31
A(8):												

Time-weighted mean:	3.26	5.74	6.90	9.56	3.12	7.52	3.26	8.77
Stdev:	1.13	2.05	2.48	3.40	1.05	2.60	1.10	3.00

V2.2 April 2012

Dateofentrytodatabase: 26-Feb-13	
PrintDate 30-Jul-13	
MainID: 1662	
DateOfVisit: 12/07/12	
LocationName:	
Occupation: Scientist	
Process: Drilling concrete pad with rebar	
ProcessNotes:	
MachineModel:	InsertedToolType:
MachineModifications:	InsertedToolPhotoDirectoryName:
MachineSize:	DataSource:
MachineWeight(kg): 6.9	HSLReportNumber:
MachineOperatingPressure: 6 Bar	HSLReportDirectoryName:
MachineSpeed(im pacts/min): 3420	ShotsPerDay:
MachineSpeed(revs/min):	DailyExposureTime:
MachinePower:	Checked2012Initials:
MachinePowerSource: Pneumatic	
MachinePhotoDirName: Photos\Chipping hammer photos	
InsertedToolCategoryID: 11	

Results_ MainID:	ResultsID :	Throttle (m/s ²)				Support (m/s ²)				Measure-ment time (s)	No. Shots in Meas.	Source file name	
		x-axis	y-axis	z-axis	ahv	x-axis	y-axis	z-axis	ahv				
1662	11536	3.09	5.86	6.73	9.44	3.90	7.45	3.19	9.00	112.50			
	11537	2.86	5.62	6.63	9.16	3.53	7.01	3.01	8.41	101.50			
	11538	3.11	6.58	7.74	10.62	3.33	7.66	2.95	8.86	120.25			
	11539	3.14	6.91	8.09	11.09	3.10	7.63	2.45	8.59	97.75			
	11540	3.53	7.21	8.46	11.67	3.40	8.09	2.64	9.16	101.50			
	11541	2.80	6.26	7.30	10.02	3.02	6.98	2.46	7.99	102.25			
	11542	3.70	6.40	8.19	11.03	3.27	7.94	3.02	9.10	102.00			
	11543	4.52	6.20	7.57	10.78	3.84	7.77	3.17	9.23	102.25			
	11544	4.01	6.13	7.55	10.52	3.45	7.66	3.10	8.95	102.50			
Count:	9									Total:	942.50	seconds	

Mean:	3.42	6.35	7.59	10.48	3.43	7.58	2.89	8.81	Highest hand a_{hw} 10.5 ± 0.8 m/s²			
Stdev:	0.58	0.50	0.62	0.81	0.30	0.38	0.29	0.41				
Time to EAV:												0:38
Time to ELV:												2:34
A(8):												

25%ile	3.09	6.13	7.30	10.02	3.27	7.45	2.64	8.59	Highest hand 75%ile 11.0m/s²			
Median:	3.14	6.26	7.57	10.62	3.40	7.66	3.01	8.95				
75%ile	3.70	6.58	8.09	11.03	3.53	7.77	3.10	9.10				
IQ range	0.62	0.45	0.79	1.02	0.26	0.32	0.45	0.51				
Time to EAV:												0:37
Time to ELV:												2:29
A(8):												

Time-weighted mean:	3.41	6.35	7.58	10.47	3.43	7.58	2.89	8.81
Stdev:	1.26	2.17	2.59	3.57	1.18	2.55	1.00	2.96

V2.2 April 2012

ANNEX E - RIVETING GUN AND BUCKING BAR DATA

The in-use vibration measurements for the riveting hammer, Tool G, were made as described in the field measurement section of the main report. The rivets were closed using a bucking bar (as illustrated in Figure E.1) supplied with the tool. A B&K Pulse multi-channel real time frequency analyser, operating with multi-frame control, allowed simultaneous measurements of the in-use vibration to be made on the bucking bar as well as at both hand positions for the riveting gun itself.

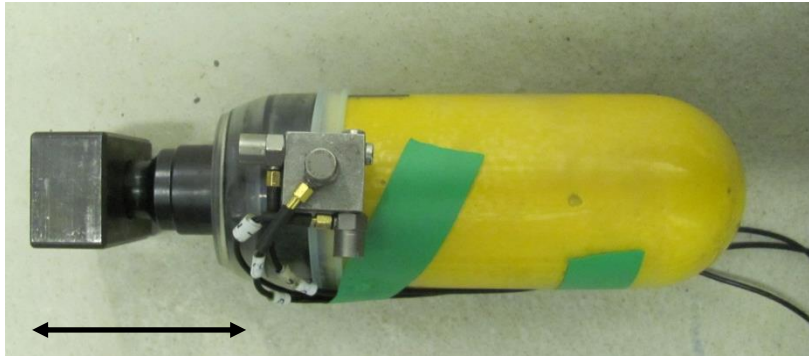


Figure E.1. The bucking bar used to close the rivets, showing the position of the mounting block and accelerometers for measurement of the in-use vibration

The head of the bucking bar is sprung to dampen the impacts from the riveting hammer in the direction shown by the arrow in Figure E.1. Measurements of the in-use vibration were made with the bucking bar held with sufficient force applied to compress the damping mechanism, reducing the free travel of the bar in absorbing the impacts transmitted by the riveting hammer. The results are identified as “high force on bar” for measurements made using the mild steel and aluminium rivets. Similarly, measurements were also made with the bucking bar held with sufficient force applied to the bar so the bar did not slip off the head of the rivet, but not too much force to prevent the free travel of the damping mechanism of the bar; the results for this condition are reported as “normal force on the bar”.

Figure E.2 below shows the mean frequency-weighted acceleration and standard deviation for the highest hand position measured on the tool, along with the upper quartile in-use value for each riveting condition. The mean frequency-weighted acceleration and standard deviation for the bucking bar is also plotted for each different in-use test condition for comparison.

The results clearly show that the mean frequency-weighted acceleration measured for the bucking bar is higher than at the highest hand position for the tool, for each test condition. The data for the tool itself seem to be unaffected by the changes in force on the bucking bar. The data indicate that the vibration transmitted to the operator or holder of the bucking bar must also be considered when assessing the risks of hand-arm vibration for riveting processes.

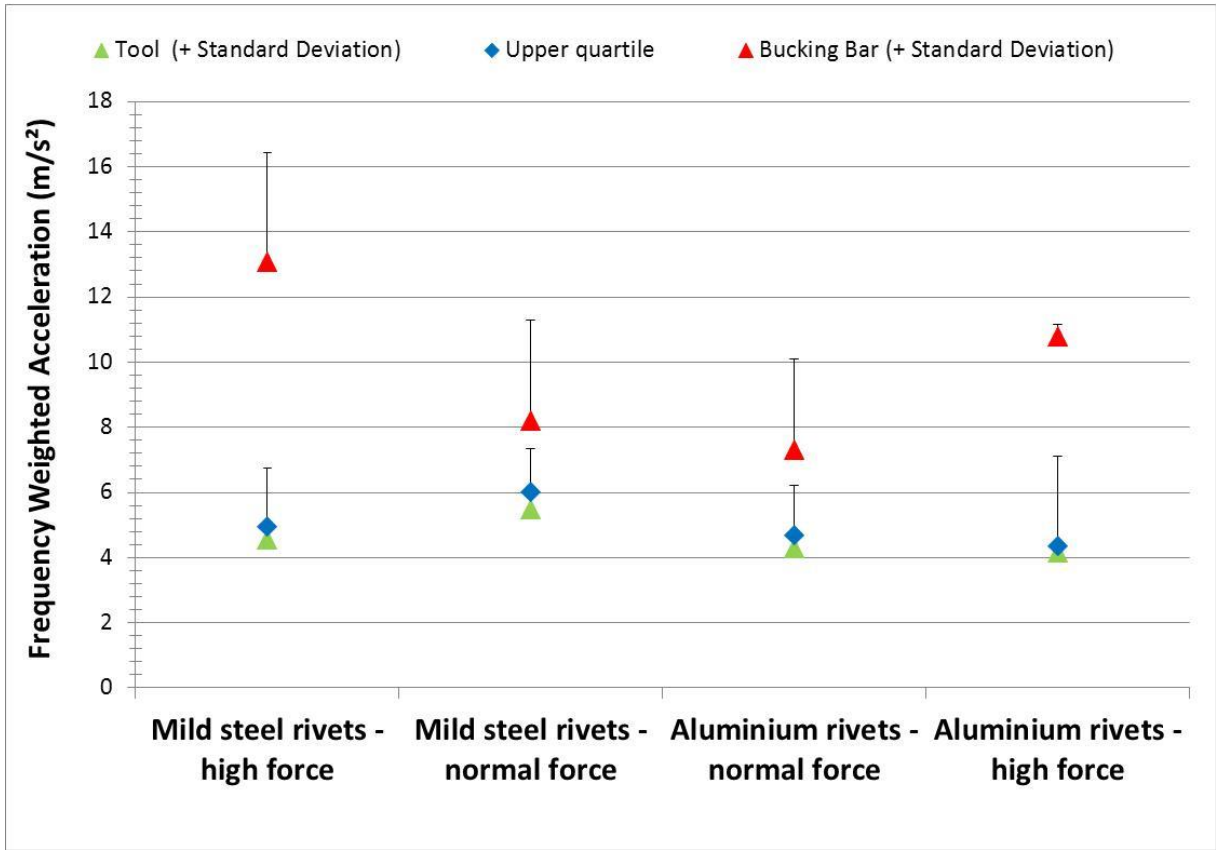


Figure E.2. Plot showing the mean frequency-weighted acceleration and standard deviation for the highest hand position measured on the riveting hammer (Tool G), and the related measurement made on the bucking bar, along with the upper quartile in-use value

ANNEX F - RESULTS OF ANOVA COMPARISONS

Table F1. Results of ANOVA for comparison of all emission test results for Tools A to G

Tool	a emission value	A new	A old, tight collar	A old, loose collar	B new	B old, tight collar	B old, loose collar	C new	C old, tight collar	C old, loose collar	D new	D old, tight collar	E new	E old, tight collar	E old, loose collar	F new	F old, tight collar	F old, loose collar	G new	
A new	3.4																			
A old, tight collar	2.8	ns																		
A old, loose collar	7.6	s	s																	
B new	2.9	ns	ns	s																
B old, tight collar	3.3	ns	ns	s	ns															
B old, loose collar	4.6	s	s	s	s	s														
C new	9.6	s	s	s	s	s	s													
C old, tight collar	9.2	s	s	s	s	s	s	ns												
C old, loose collar	10	s	s	s	s	s	s	ns	ns											
D new	11.6	s	s	s	s	s	s	s	s	s										
D old, tight collar	11.6	s	s	s	s	s	s	s	s	s	ns									
E new	2.4	0.07	ns	s	ns	0.35	s	s	s	s	s	s								
E old, tight collar	1.7	s	s	s	s	s	s	s	s	s	s	s	ns							
E old, loose collar	8.2	s	s	ns	s	s	s	s	0.93	s	s	s	s	s						
F new	9	s	s	s	s	s	s	ns	ns	0.09	s	s	s	s	ns					
F old, tight collar	6.5	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s				
F old, loose collar	9.3	s	s	s	s	s	s	ns	ns	ns	s	s	s	s	s	ns	s			
G new	3.1	ns	ns	s	ns	ns	s	s	s	s	s	s	ns	s	s	s	s	s		
G old, tight collar	2.1	s	ns	s	ns	s	s	s	s	s	s	s	ns	ns	s	s	s	s	s	s

s = significant, ns = not significant

Table F2. Results of ANOVA for comparison of emission test results for new and old dynalods with collars of 1 mm clearance

Tool	a emission value	A new	B new	C new	D new	E new	F new	G new
		3.4	2.9	9.6	11.6	2.4	9.0	3.1
A old, tight collar	2.8	ns						
B old, tight collar	3.3		ns					
C old, tight collar	9.2			ns				
D old, tight collar	11.6				ns			
E old, tight collar	1.7					ns		
F old, tight collar	6.5						s	
G old, tight collar	2.1							s

Table F3. Results of ANOVA for comparison of emission test results for old dynalods with tight collar of 1 mm clearance and loose collar of 3 mm clearance

Tool	a emission value	A old, tight collar	B old, tight collar	C old, tight collar	E old, tight collar	F old, tight collar
		2.8	3.3	9.2	1.7	6.5
A old, loose collar	7.6	s				
B old, loose collar	4.6		s			
C old, loose collar	10			ns		
E old, loose collar	8.2				s	
F old, loose collar	9.3					s

ANNEX G - HSE EMISSION AND IN-USE DATA

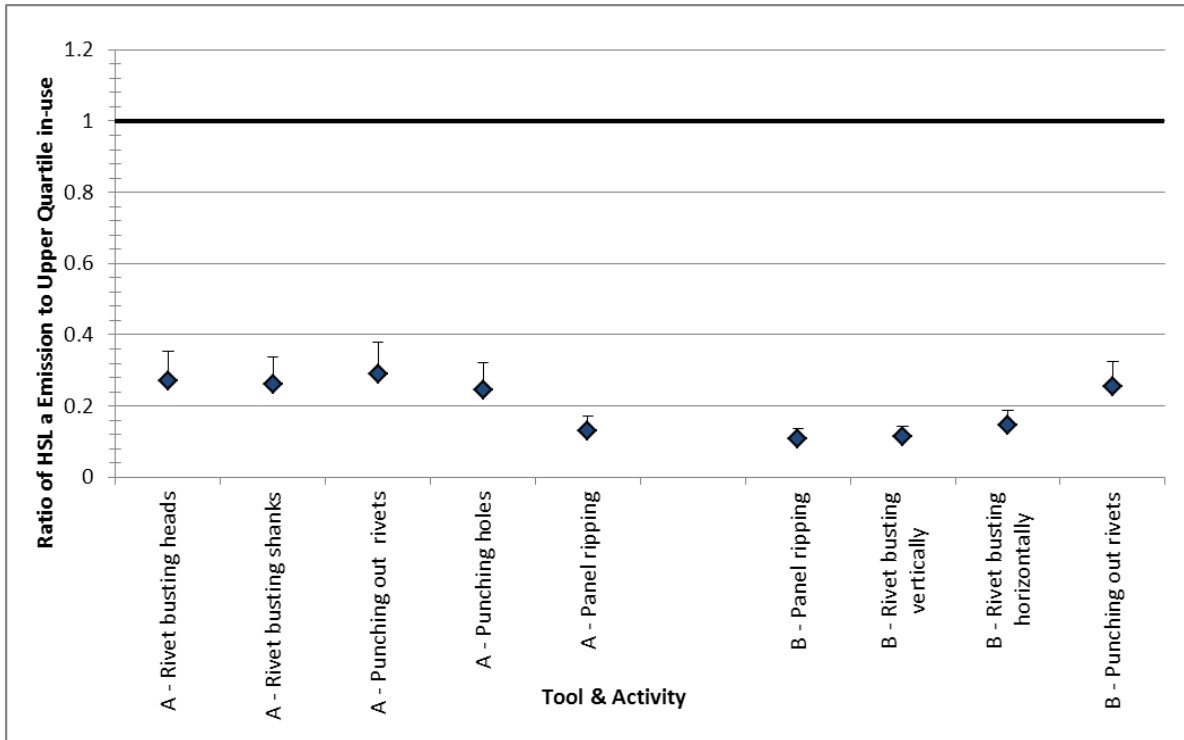


Figure G.1. Ratio of HSE measured a emission to upper quartile in-use data for the pneumatic hammers - Tools A and B (error bars indicate $a+K$)

Pneumatic Hammers - Tools A and B

Figure G.1, shows that the HSE measured a emission value for Tools A and B is only approximately one third of the upper quartile in-use vibration, for each of the field test activities. If the uncertainty K is also taken into account, the HSE $a+K$ emission value is still less than 40% of the upper quartile in-use value.

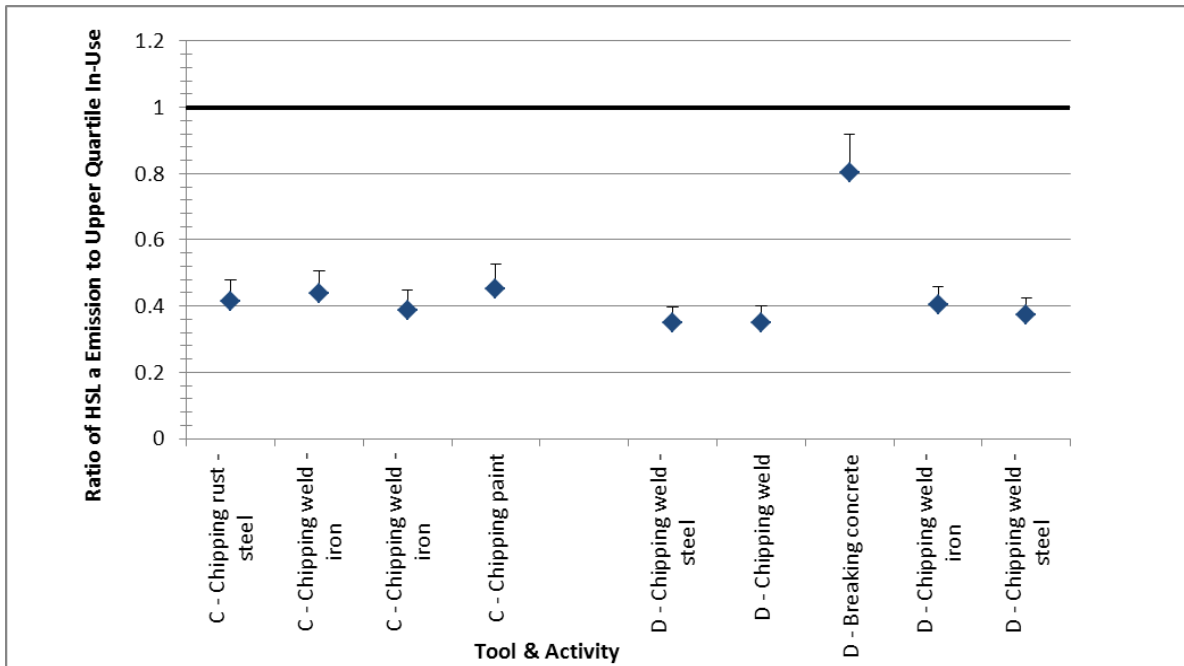


Figure G.2. Ratio of HSE measured a emission to upper quartile in-use data for the chipping hammers - Tools C and D (error bars indicate $a+K$)

Chipping Hammers – Tools C and D

In Figure G.2, the results for Tool C clearly indicate that the HSE measured *a* emission data does not reach 50% of the upper quartile in-use value, for any of the field activities. When the ratio of the $a+K$ value is taken into account, the emission test value is still only approximately 50% of the upper quartile in-use value.

A similar pattern for chipping weld activities is observed for Tool D, with the HSE measured *a* and $a+K$ emission value less than 50% of the upper quartile in-use value. Breaking concrete was the only activity for which the HSE measured *a* emission value was 80% of the in-use value. If the $a+K$ emission value is considered, the ratio increases to 92%. Breaking concrete is a lower vibration activity than the others because during the process the bit becomes more embedded in the material which has the effect of damping the vibration magnitude.

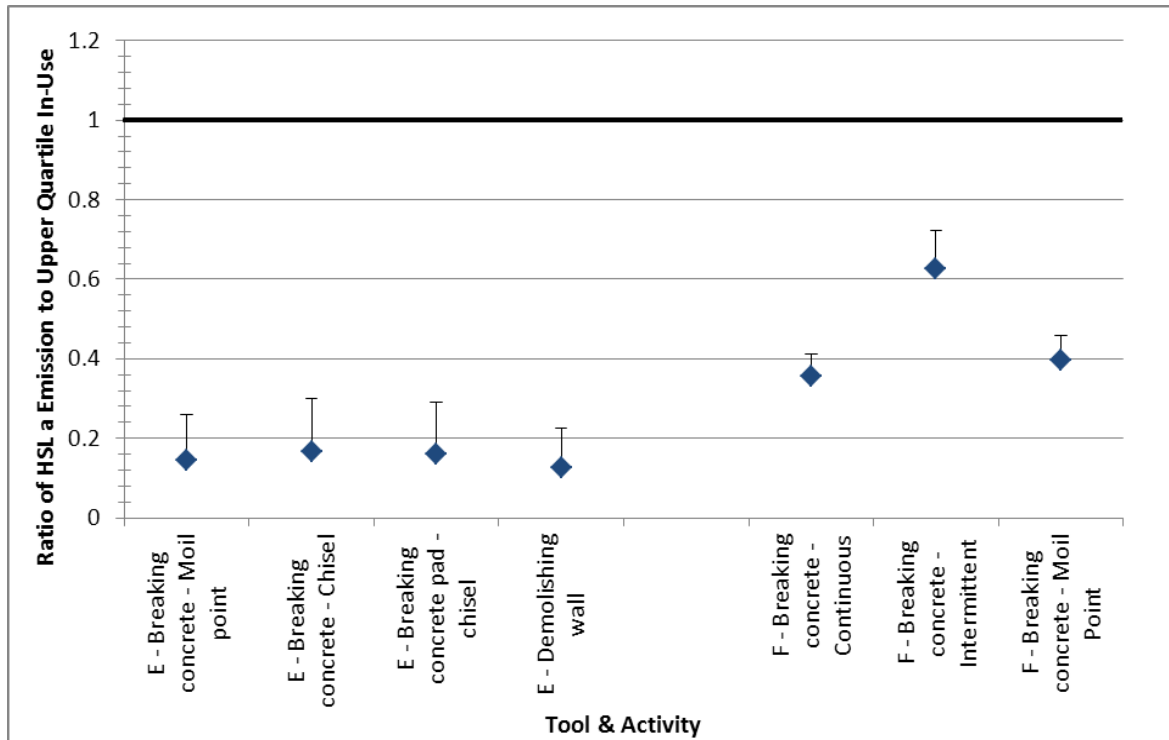


Figure G.3. Ratio of HSE measured a emission to upper quartile in-use data for the demolition hammers - Tools E and F (error bars indicate $a+K$)

Demolition Hammers – Tools E and F

The results for the demolition hammers, E and F, in Figure G.3, clearly show that the HSE measured *a* emission value is less than 20% of the upper quartile in-use value for all of the field test activities for Tool E. If the uncertainty *K* is taken into account, the ratio is still only 30% of the in-use upper quartile value. This clearly indicates that the measured *a* emission test value significantly under-estimates the in-use vibration for this tool.

The results for Tool F similarly indicate that the HSE measured *a* emission value is roughly 40 or 60% of the upper quartile in-use vibration value depending on the process. One contributor to these differences is the vibration reduction mechanism, which is easily overridden when the tool is lifted vertically up out of the medium that is being broken. The consequences of this action are that the magnitudes on the handles are increased, since the machine is effectively no longer vibration reduced. Even when the tool is operated with intermittent throttle as advised by the manufacturer to prevent vibration exposure occurring when the suspension is not effective, the *a* emission only reaches 60% of the in-use vibration.

Riveting hammer – Tool G

The results for Tool G in Figure G.4 show that the *a* emission value for the riveting hammer is around 60 to 70 % of the in-use values depending on the application.

The variability in the emission tests results is reflected in the large values of *K*, and consequently the $a+K$ values reach the upper quartile of in-use in 3 of the 4 measurement situations. In Figure G.4 there are 2 comparisons for each metal type. The first is with high force on the bucking bar and the second is with low force on the bucking bar. The differences in

application of the bucking bar do not have a significant influence on the vibration on the tool itself and therefore do not significantly affect the degree to which the HSE measured a emission value reflects the in-use vibration.

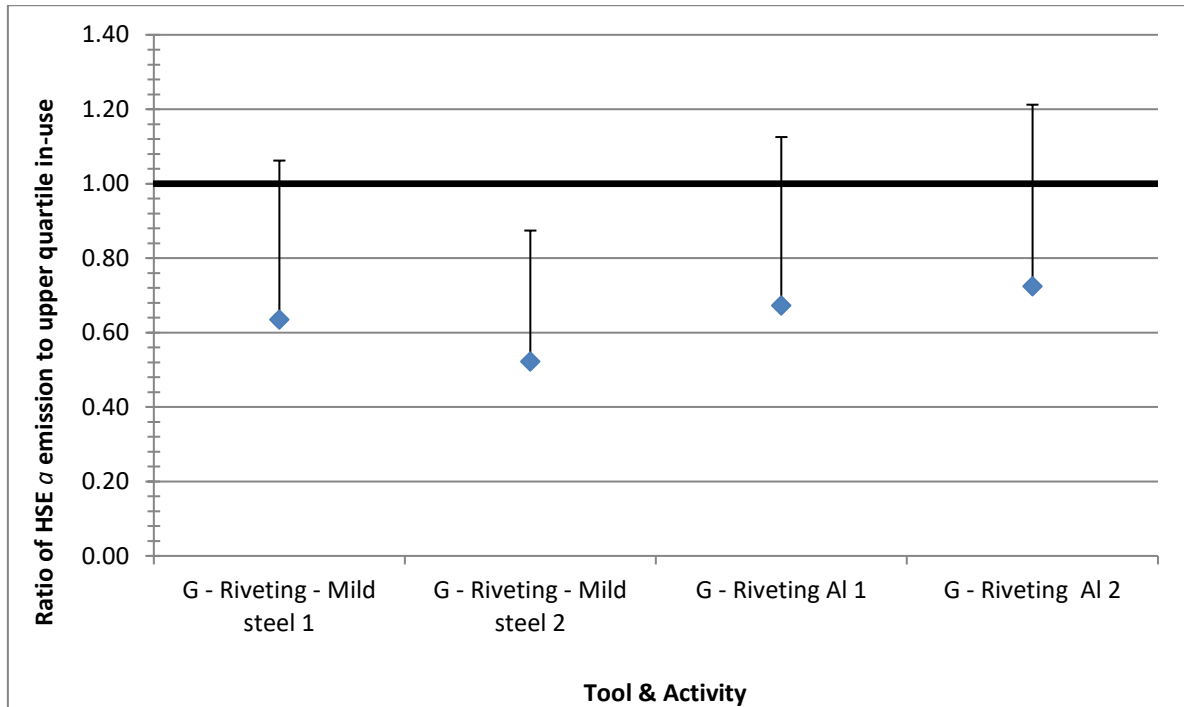


Figure G.4. Ratio of HSE measured a emission to upper quartile in-use data for the riveting hammer - Tools G (error bars indicate $a+K$)

Rock drills - Tools H and I

The results for the rock drills in Figure G.5 show that for Tool H, the a emission value is around 60% of the in-use value when the emission value obtained from the dynaload test is used. The $a+K$ value for Tool H is 70% of the in-use vibration.

For Tool I the emission value is a reasonable indicator of the in-use vibration in both cases. Tool I is the only tool tested for which this is the case. Tool I is also the only tool for which the emission test is drilling into concrete rather than using the dynaload.

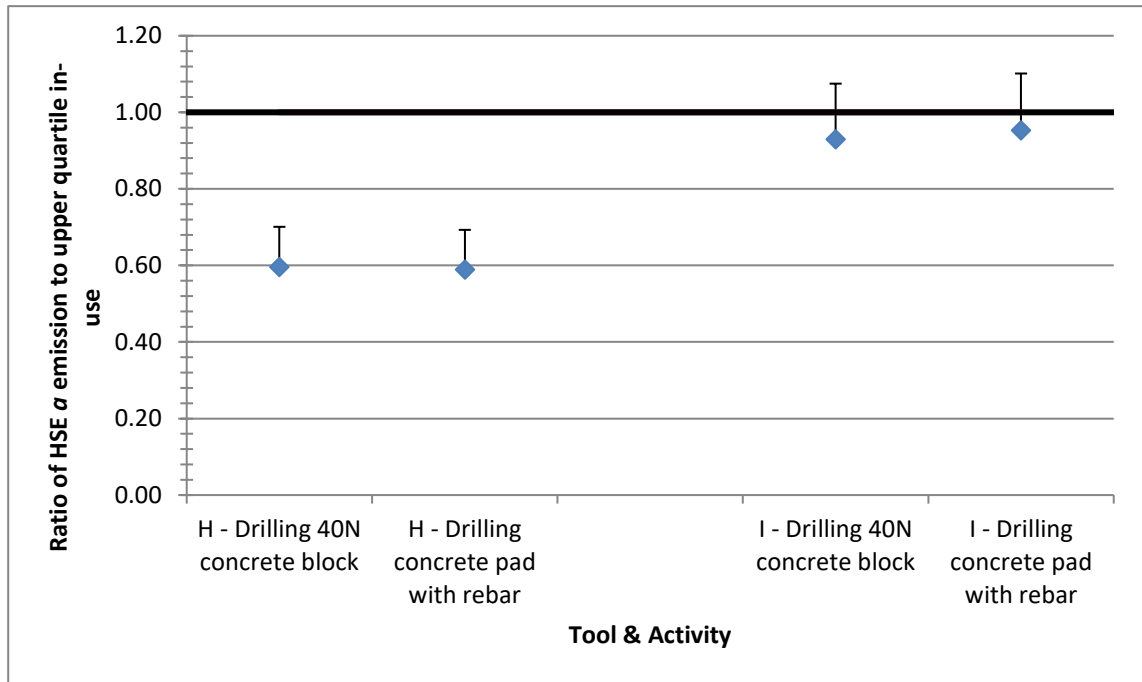


Figure G.5. Ratio of HSE measured a emission to upper quartile in-use data for the demolition hammers - Tools H and I (error bars indicate σ)

The effectiveness of British Standard BS EN ISO 28927-10:2011 concerning the vibration emission of percussive drills, hammers and breakers

Hand-Arm Vibration Syndrome (HAVS) is a painful and disabling disorder of the blood vessels, nerves and joints, caused by exposure to hand transmitted vibration, often from use of power tools. HAVS is preventable, but once damage is done, it is irreversible.

The Supply of Machinery (Safety) Regulations 2008 require manufacturers to minimise machinery vibration risk and declare vibration emission. British standard test codes can be used for this declaration.

This report will be of interest to standards makers and technical specialists dealing with hand arm vibration emission standards. It describes work carried out up until 2013 to investigate BS EN ISO 28927-10:2011, a British Standard that defines a vibration emission test code for percussive drills, hammers and breakers.

For the majority of tool types covered, the test code does not produce vibration magnitudes that represent the in-use vibration; the only exception being some rock drills. Any risk assessment based on emission values generated by this test code would be likely to result in a serious underestimate of the in-use vibration risk.

Use of the dynamic loading device (known as the dynaload) for testing vibration emissions is not suitable for generating values that reflect the upper quartile of in-use vibration magnitudes.

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