Mõõdistamistunnistus

MEASUREMENT CERTIFICATE

Akrediteeritud L151

Mõõdistamistunnistuse nr:
Number of Measurement Certificate: **3-033-14**

Kuupäev:
Date: **13.02.2015**

Tellija:
Customer: **OÜ TerraMil**

Objekt:
Measurement site **Estonian Defence Forces central proving ground**
July 22nd, 2014

Aadress:
Address: **Kuusalu parish, Harjumaa county**

Töö sisu:
Content of work: **Measurement of acoustic parameters in defence structures**

Mõõdistusparameetrid:
Measurement parameters:

Müratasеme määramine (M302:09.10.2014)
Determination of sound power level (M302:09.10.2014)

Vibratsiooni mõõtmine (M304:09.09.2013)
Vibration measurement (M304:09.09.2013)

Mark and model of measuring device		Measurement range	Traceability
Noise analyser Brüel & Kjaer (S313)	Type 2260	31,5:16k Hz, 44,4…95 dB	OÜ Tehnokontrollikeskus, nr. KL-15-1-029 → Kalibrator B&K 4226, national etalon of Denmark
Logging noise analysers Casella (S309)	CEL-350/K5	70…140 dB(A)	Inspecta Estonia OÜ, nr. KL-165-2-131 → Kalibrator B&K 4226, national etalon of Denmark
Vibration measuring set Brüel & Kjaer (S308)	WB 3461	0,306…5 m/s^2, WBV: 0,4…100 Hz HAV: 31,5-1000 Hz	Inspecta Estonia OÜ, nr. KL-165-3-016 → Etalonvibroandur B&K8305, national etalon of Denmark

Allkirjad:
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Dokument koosneb mõõdistamistunnistusest ja -tulemuste kokkuvõttest kokku 11 lehel ning on välja antud ühes (1) allkirjastatud eksemplaris.

The document consists of a Certificate of Measurement with a Summary of Results on a total of 11 pages in one (1) signed copy

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2 Noise level

2.1 Definitions

The terms and abbreviations used in this chapter, this text, the tables and the figures have been explained below:

$L_{pA,eq,T}$, $L_{pC,eq,T}$	The equivalent noise level that has been corrected with the A or C filter; the energetic equivalent of a sound (sound exposition) that is present for a certain time period, expressed in dB(A)
$L_{pA,max}$, $L_{pC,max}$	The maximum noise level measured as the root-mean-square of the 125 µs measuring window registered, and corrected with A or C filter, during the whole measurement period
$L_{pC,peak}$	The absolute maximum value of the sound pressure, corrected with the C filter, during the measurement period.

2.2 Normative documents

2.2.1 *Work health and work safety requirements for an environment affected by noise, the noise limits in a work environment, and the noise measurement procedure. Regulation No. 108 of April 12, 2007, from the Government of the Republic of Estonia.*

Excerpt from 2.2.1

§ 3. Noise limits and the action values of countermeasures in a work environment

(1) The daily noise exposure level affecting a worker (in case of an 8 hour work day) may not exceed 85 dB(A), and the peak sound pressure of noise (also in case of impulsive sound) may not exceed 137 dB(C).

(2) If the noise exposure level of a worker exceeds 80 dB(A) or the peak sound pressure 135 dB(C) (hereinafter the action value of measures), measures for reducing the effect of noise must be implemented.

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(6) In determining the daily noise exposure level affecting a worker, the attenuation provided by the individual hearing protectors worn by the worker shall be taken into account.

End of excerpt

2.3 Measurement method

The measurement method used for measuring the noise levels is in accordance with the international standard ISO 1996-1:2006. Integrating noise analysers that satisfy the Class 2 requirements provided in standard EVS-EN IEC 60804:2001, Electroacoustics – Integrating-averaging sound level meters, were used to evaluate the noise level inside the bunker caused by the 150 mm projectiles hitting the surroundings of the bunker. The noise analysers registered the peak sound pressure and the equivalent sound pressure in 10 second intervals in the 70-145 dB range.

The layout of the noise analysers in the bunker has been described in Table 2. The measured and calculated results have been provided in Table 3. Measurement and calculation results have been compared, in accordance with the recommendations provided in interna-

3 Vibration levels

3.1 Normative documents

3.1.1 Work health and work safety requirements for an environment affected by vibration, the vibration limits in a work environment, and the vibration measurement procedure", regulation No. 109 of April 12, 2007, from the Government of the Republic of Estonia

Excerpt from 3.1.1.

§ 3. Vibration limits and the action values of measures in a work environment

(1) The daily limit for a worker's exposure A(8) to whole-body vibration is 1.15 m/sec^2.

(2) If the daily exposure to whole-body vibration A(8) exceeds 0.5 m/sec2 (hereinafter the application value of whole-body vibration measures), measures that reduce the effect of vibration must be implemented.

(3) The daily limit for a worker's exposure A(8) to hand-arm vibration is 5.0 m/sec^2.

(4) If the daily exposure to hand-arm vibration A(8) exceeds 2.5 m/sec2 (hereinafter the application value of hand-arm vibration measures), measures that reduce the effect of vibration must be implemented.

End of excerpt

3.2 Measurement method

The used measurement method is in accordance with standards EVS-EN 14253:2004+A1:2007, EVS-ISO 2631-1:2002 (evaluation of exposure to whole-body vibration), and ISO 2631-2:2003 (evaluation of vibration in buildings).

To measure the vibration level, a sensor was placed on the floor of the structure. A weight was placed on it to ensure contact with the surface of the floor. The measurement signal of the sensor was registered within the 0.4...100 Hz range with a multi-channel integrating analyser simultaneously in three orthogonal axes. The reference X-axis was horizontally perpendicular in relation to the longitudinal axis of the structure, the Y-axis was parallel in relation to the horizontal level of the longitudinal axis of the structure, and the Z-axis was vertical in relation to the longitudinal axis.

3.3 Results

The measurement results have been presented in Table 4. For informative reasons, Table 4 also provides the legal vibration limit in a traditional work environment during an 8-hour exposure, which cannot be directly compared to the measurement results, but rather indicate the scale of the measurement results.

From the limits described during the evaluation and comparison of the measurement results, it may be concluded that in a situation, where the surroundings of a completely buried structure are hit by 150 mm calibre howitzer shells, the level of vibration inside the structure remains well below the dangerous limit.

Table 2: measurement results of whole-body vibration

No.	Measurement site	Time		Duration	Measurement axis	Maximum vibration level, "S" time weighted		Legal limit. 8 h average (re. EE law)
		Start	Finish			$a_{w,max}$	$U(a_{w,max})$	$a_{w,max}$
		[hh:mm:ss]	[hh:mm:ss]			[m/s^2]	[m/s^2]	[m/s^2]
1	Shelter floor, centre of axes	9:20:38	13:15:08	3:54:30	X	0,21	0,01	1,25
					Y	0,2	0,01	1,25
					Z	0,19	0,01	1,25