Martec Environmental Consultants Ltd.
Waterbrow Wood, Gressingham, LANCASTER LA2 8LX
Tel: 01524 222000
Fax: 01695 768188
Email: info@MartecEnviro.co.uk Website: www.noise.sh

Sheepmount Athletic Stadium & Playing Fields
Sheepmount
Carlisle
CA3 0LE

VIBRATION ASSESSMENT
Whole-body & Hand-arm Vibration

* * *

Author:-

M A Kenyon MSc BSc MIOA

Report Date: 16th July 2015

Site Visited: 21st and 23rd April 2015

Job No: 20150820 7110 Carlisle WBV and HAV

Loughborough Office:
8 Bayliss Close, Quorn
Loughborough LE12 8PF

Ormskirk Office:
131 New Court Way, Ormskirk, Lancs L39 2YT

Staffordshire / Cheshire Office:
2, Betley Hall Gardens, Betley, Crewe CW39BB

CONTENTS

1.0 INTRODUCTION

Diane Campbell of Sheepmount Athletic Stadium requested that Martec carry out a survey to identify whether employees are likely to be exposed above either the Exposure Action Value [EAV] or Exposure Limit Value [ELV] of The Control of Vibration at Work Regulations 2005.

This report presents the results of the measurements, and draws conclusions as to the magnitudes of whole-body and hand-arm vibration transmitted to the operator's body or hands during "typical" operations.

2.0 THE REGULATIONS

Further and more comprehensive details of the Control of Vibration at Work Regulations 2005 in regard to hand-arm vibration can be read in the HSE publications INDG175 and L140. The following is a brief extract of INDG1755.

2.1 The Exposure Action Value

The exposure action value (EAV) is a daily amount of vibration exposure above which employers are required to take action to control exposure. The greater the exposure level, the greater the risk and the more action employers will need to take to reduce the risk. For whole-body vibration

the EAV is a daily exposure of 0.5 m/s2 A(8) and for hand-arm vibration the EAV is a daily exposure of 2.5 m/s2 A(8).

2.2 The Exposure Limit Value

The exposure limit value (ELV) is the maximum amount of vibration an employee may be exposed to on any single day. For whole-body vibration the ELV is a daily exposure of 1.15m/s2 hand-arm vibration the ELV is a daily exposure of 5 m/s2 A(8). It represents a high risk above which employees should not be exposed.

2.3 Requirements

The Control of Vibration at Work Regulations require employers to

- assess the vibration risk to employees;
- decide if they are likely to be exposed above the daily exposure action value (EAV) and if they are:
    - introduce a programme of controls to eliminate risk, or reduce exposure to as low a level as is reasonably practicable;
    - provide health surveillance (regular health checks) to those employees who continue to be regularly exposed above the action value or otherwise continue to be at risk;
- decide if they are likely to be exposed above the daily exposure limit value (ELV) and if they are:

  - take immediate action to reduce their exposure below the limit value;
- provide information and training to employees on health risks and the actions taken to control those risks;
- consult a trade union safety representative or employee representative on the proposals to control risk and to provide health surveillance;
- keep a record of the risk assessment and control actions;
- keep health records for employees under health surveillance
- review and update risk assessments regularly.

3.0 **PROCEDURE**

Measurements were carried out in accordance with the procedures described in HS(G)88 and BS 6472:1987 and ISO 5349-1:2001.

Measurements were carried out at each axis for each hand incorporating the appropriate weighting; these individual levels were then used to derive the “root sum of squares” value as specified in ISO 5349 as the basis of risk evaluation; this factor is known as the “vibration total value”.

An integral triaxial accelerometer was attached to the operators’ hands using a hand strap. The hand strap is not likely to interfere with normal

operations. The instrument used for the hand arm vibration measurements was a SVAN 106 Vibration Analyser (s/n 36364) with a Svan accelerometer hand strap (s/n 41768). For the whole body measurements the instrument was a Svan 948 Sound and Vibration Analyser (s/n 6593) together with a Dytran 5313A accelerometer (s/n 135).

The instruments had been laboratory calibrated in the preceding two years.

Measurements were made for ride-on equipment and powered hand tools as stipulated by the client.

The first day of measurements [21/4/15] was entirely of Whole Body Vibration for ride-on equipment at Stoney Holme Golf Course, St Aidan's Road, Carlisle CA1 1LS; the second day [23/4/15] was mainly Hand Arm Vibration measurements undertaken both at Stoney Holme and at Sheepmount Stadium.

3.1 Uncertainty of daily exposure evaluations

It should be noted that The EU Good Practice Guide on Whole Body Vibration states:

The uncertainty of vibration exposure evaluation is dependent on many factors, see EN 14253:2003, including:

- *Instrument / calibration uncertainty,*
- *Accuracy of source data (e.g. manufacturer's emission data),*

- *Variation of machine operators (e.g. experience, driving speeds or styles),*
- *Ability of the worker to reproduce typical work during measurements,*
- *Repeatability of the work task,*
- *Environmental factors (e.g. rain, wind, temperature),*
- *Variations in the machine and suspension systems (e.g. is there a need for maintenance, has the machine been warmed-up?).*

Where vibration magnitude and exposure time are measured the uncertainties associated with the evaluation of A(8) and VDV can mean that the calculated value can be as much as much 20% above the true value to 40% below. Where either the exposure time or the vibration magnitude is estimated — e.g. based on information from the worker (exposure time) or manufacturer (magnitude) — then the uncertainty in the evaluation of daily exposure can be much higher."

With regard to hand arm vibration measurements, it should be noted that the measurements reflect the vibration levels at the time of the measurements and for that operator; if the operations were to be performed more or less "aggressively", vibration levels could alter, as could the exposure times for the various operations. Therefore vibration levels are also dependant on tightness of "grip" and method used.

4.0 RESULTS

Table 1 – Summary of Vibration Measurements WBV [m/s²]

Equipment / Notes	Filename	aw [m/s^2]	aw [m/s^2]	aw [m/s^2]
Ransomes Commander 3520 - upto 2 hour cutting				
Start up	@8200067	0.154	0.214	0.217
Restart	@8200068	0.142	0.159	0.128
Cutting	@8200069	0.283	0.317	0.369
End Cutting	@8200070	0.423	0.437	0.461
End Transit	@8200071	0.32	0.394	0.548
Kubota Utility	@8200072	0.342	0.336	0.315
Jacobson Greensking - Start up	@8200073	0.016	0.028	0.031
Switch to cut	@8200074	0.737	0.45	0.571
Transit in	@8200075	0.375	0.489	0.453
Kubota STV 36 - transit out	@8200076	0.355	0.345	0.498
Kubota M6040 Tractor - Tipping	@8200085	0.448	0.551	0.4
Jacobson Eclipse 322 - out	@8200086	0.299	0.278	1.083
Cutting	@8200087	0.364	0.432	0.742
In	@8200088	0.262	0.26	0.635
Cushman 1600D	@8200091	0.433	0.326	0.384
Jacobson Triking - out	@8200138	0.449	0.375	0.678
Jacobson Triking - operation	@8200139	0.338	0.341	0.406
Jacobson Triking - in	@8200140	0.478	0.407	0.675

Table 2 – Summary of Vibration Measurements HAV [m/s²]

Equipment	Filename	ahv 4-6 [m/s^2]
Bosch 9" Angle Grinder RH	@RES841	3.913
Bosch 9" Angle Grinder LH	@RES842	3.780
Hitachi 4.5" angle grinder RH	@RES843	2.818
Hitachi 4.5" angle grinder LH	@RES844	5.052
Bosch Jig-saw	@RES845	4.271
Stihl Blower RH	@RES846	1.227
Stihl Blower LH	@RES847	0.812
Stihl Vac/Blower RH	@RES848	1.834
Stihl Vac /Blower LH	@RES849	7.780
Stihl Hedge Cutter RH	@RES850	1.500
Stihl Hedge Cutter LH	@RES851	1.252
Komatsu Backpack Blower RH	@RES852	5.728
Komatsu Backpack Blower LH	@RES853	6.699
Komatsu Strimmer RH	@RES854	2.360
Komatsu Strimmer LH	@RES855	2.070
Komatsu Zenoah Strimmer RH	@RES856	4.046
Komatso Zenoah Strimmer LH	@RES857	7.320
Billy Goat Vac. RH	@RES858	2.828
Billy Goat Vac. LH	@RES859	2.618
Pressure Wash RH	@RES863	1.369
Pressure Wash LH	@RES864	1.366
Stihl Chainsaw RH	@RES865	4.009
Stihl Chainsaw LH	@RES866	7.422
Cobra Mower RH	@RES867	4.672
Cobra Mower LH	@RES868	4.597
Honda Rotavator RH	@RES869	7.328
Honda Rotavator LH	@RES870	5.963
Flymo RH	@RES871	3.240
Flymo LH	@RES872	4.018
Kawasaki Strimmer RH	@RES873	6.109
Kawasaki Strimmer LH	@RES874	7.388
Stihl Blower RH	@RES875	1.899
Stihl Blower LH	@RES876	1.596
Stihl Blower RH	@RES877	4.251
Stihl Blower LH	@RES878	3.789
Ransomes Dennis RH	@RES879	3.479
Ransomes Dennis LH	@RES880	4.634
Stihl MS211 Chainsaw RH	@RES881	2.780
Stihl MS211 Chainsaw LH	@RES882	2.483
Stihl MS391 Chainsaw RH	@RES883	3.277
Stihl MS391 Chainsaw LH	@RES884	4.178
Milwaukee 18v drill RH	@RES885	1.784
Milwaukee 18v drill RH	@RES886	1.895
Makita EEEC Drill	@RES887	2.226
Makita 110v hammer drill RH	@RES888	5.188
Makita 110v hammer drill LH	@RES889	4.416
Bench Grinder RH	@RES890	2.160
Bench Grinder LH	@RES891	2.591
Bosch 9" Grinder RH	@RES892	3.388
Bosch 9" Grinder LH	@RES893	2.815
Bosch 4.5" Grinder RH	@RES894	1.714
Bosch 4.5" Grinder LH	@RES895	2.965
Long handled hedge cutter RH	@RES896	4.300
Long handled hedge cutter LH	@RES897	6.434

Both hands measured where applicable RH (Right Hand) LH (Left Hand)

From the above it can be seen that for hand-arm vibration many of the tools produce vibration levels above 5 m/s^2, including, the Hitachi 5" grinder, Stihl Vac, Komatsu Blower, Komatsu Zenoah Strimmer, Stihl Chainsaw, Honda Rotovator, Kawasaki Strimmer, Makita 110v hammer drill and Long Handled hedge cutter with measured levels between 5.1 and 7.8 m/s^2.

For whole-body vibration the highest levels recorded were for the Jacobson Greenking at the "switch to cut" phase of the operation.

By using the vibration levels from above (highest level used where applicable) plus the HSE's hand-arm and whole-body vibration calculators, we can determine the time it would take to breach the EAV and ELV for each vehicle and piece of equipment (see 4.1 and 4.2 below).

4.1 WBV (Time to reach EAV / ELV)

	Measured or estimated vibration magnitude				Time (hh:mm) to reach	
Operation description	a_w x-axis m/s²	a_w y-axis m/s²	a_w z-axis m/s²	Highest Axis	EAV 0.5 m/s² A(8)	ELV 1.15 m/s² A(8)
Ransommes Commander 3520						
Start up	0.154	0.214	0.217	y	22:16	>24hrs
Restart	0.142	0.159	0.128	y	>24hrs	>24hrs
Cutting	0.283	0.317	0.369	y	10:09	>24hrs
End Cutting	0.423	0.437	0.461	y	5:20	>24hrs
End Transit	0.32	0.394	0.548	y	6:34	>24hrs
Kubota Utility	0.342	0.336	0.315	x	8:43	>24hrs
Jacobson Greensking						
Start up	0.016	0.028	0.031	y	>24hrs	>24hrs
Switch to Cut	0.737	0.45	0.571	x	1:52	9:56
Transit In	0.375	0.489	0.453	y	4:16	22:34
Kubota STV 36 - transit out	0.355	0.345	0.498	z	8:03	>24hrs
Kubota M6040 Tractor - tipp	0.448	0.551	0.4	y	3:21	17:46
Jacobson Eclipse 322						
Out	0.299	0.278	1.083	z	1:42	9:01
Cutting	0.364	0.432	0.742	z	3:37	19:13
In	0.262	0.26	0.635	z	4:57	>24hrs
Cushman 1600D	0.433	0.326	0.384	x	5:26	>24hrs
Jacobson Triking						
Out	0.449	0.375	0.678	z	4:21	23:00
Operation	0.338	0.341	0.406	y	8:46	>24hrs
In	0.478	0.497	0.675	y	4:07	21:51

HSE Approved Exposure Calculator

4.2 HAV (Time to reach EAV / ELV)

	Vibration magnitude m/s² r.m.s.	Time to reach EAV 2.5 m/s² *A* (8)		Time to reach ELV 5 m/s² *A* (8)	
		hours	minutes	hours	minutes
Bosch 9" Grinder	3.913	3	16	13	4
Hitachi 4.5" Grinder	5.05	1	58	7	51
Bosch Jig-saw	4.271	2	44	10	58
Stihl Blower	1.227	>24		>24	
Stihl Vac / Blower	7.78	0	50	3	18
Stihl Hedge Cutter	1.5	22	13	>24	
Komatsu Backpack Blower	6.699	1	7	4	27
Komatsu Strimmer	2.36	8	59	>24	
Komatsu Zenoah Strimmer	7.32	0	56	3	44
Billy Goat Vac.	2.828	6	15	>24	
Pressure Wash	1.369	>24		>24	
Stihl Chainsaw	7.422	0	54	3	38
Cobra Mower	4.597	2	22	9	28
Honda Rotovator	7.328	0	56	3	43
Flymo	4.018	3	6	12	23
Kawasaki Strimmer	7.388	0	55	3	40
Stihl Blower	4.251	2	46	11	4
Ransommes Dennis	4.634	2	20	9	19
Stihl MS211 Chainsaw	2.78	6	28	>24	
Stihl MS391 Chainsaw	4.178	2	52	11	27
Milwaukee 110v Hammer Drill	1.895	13	55	>24	
Makita EEEC Drill	2.226	10	5	>24	
Bench Grinder	2.591	7	27	>24	
Bosch 9" Grinder	3.388	4	21	17	25
Bosch 4.5" Grinder	2.965	5	41	22	45
Long Handled Hedge Cutter	6.434	1	12	4	50

HSE Approved Exposure Calculator

4.3 Using the Tables (Examples)

Whole Body Vibration

The highest level for whole-body vibration was recorded during use of the Jacobson Greenking at the "switch to cut" or cutting phase of the operation (at the x-axis) with a level of 0.737 m/s^2. For this operation it would take 1 hour 52 minutes to reach the daily personal exposure action level (EAV) of 0.5 m/s^2 and 9 hours 56 minutes for the exposure action limit (ELV) of 1.15 m/s^2. At the other end of the scale it would take over 10 or 24 hours respectively to reach the EAV and ELV for the Ransommes Commander when cutting (0.317 m/s^2 at the y-axis).

Hand Arm Vibration

The highest level of hand-arm vibration was recorded during use of the Stihl Vac / Blower at 7.78 m/s^2. For this operation it would take 50 minutes to reach the daily personal exposure action level (EAV) of 2.5 m/s^2 and 3 hours 18 minutes to reach the exposure action limit (ELV) of 5 m/s^2. At the other end of the scale it would take over 24 hours to reach the EAV for the Stihl Blower at 1.23 m/s^2.

5.0 CONCLUSIONS

It is unlikely that the ELV for whole-body vibration will be breached for any of the ride-on equipment, although in some instances and for some operations it is possible that the EAV may be breached if exposure is not controlled.

For hand-arm vibration it is possible that both the EAV and ELV will be breached, again if exposure is not controlled

The tables above can be used to assist with limiting and thus controlling exposure.

The risk from WBV and HAV needs to be managed. These controls should include:

1. A policy on vibration management – roles and responsibilities. This should be communicated to all.
2. Provision of information, instruction and training about the risk to health from exposure to vibration including symptoms from HAVS and company and employee controls to reduce risk.
3. Occupational health screening to identify any issues. At its simplest this could include e.g. initial screening questionnaires.
4. Purchasing policy - selecting lower vibration tools and equipment where possible.

5. Reducing exposure time where possible and staying below times to reach the EAV or ELV – see tables above.
6. Providing information about tools that produce unusually high levels of vibration – see tables above.

APPENDIX 1

QUALIFICATIONS AND EXPERIENCE OF M.A. KENYON

My full name is Melville Alexander Kenyon. I am the principal of the firm of Martec Environmental Consultants Ltd, a consultancy company that specialises in environmental noise assessment and control. I hold a Bachelor's degree in Engineering and a Master's degree in Environmental Acoustics. I am a member of the professional body for noise and vibration specialists, the Institute of Acoustics and have sat on the British Standards Committee dealing with noise in buildings [BS.8233:1999].

My company is on the panel of noise advisers to the Clay Pigeon Shooting Association and I have lectured at Liverpool John Moores University on the Diploma of Acoustics course and at Manchester Metropolitan University on their Environmental Health degree course. Martec is a member of the professional body The Association of Noise Consultants.

I have some 33 years experience of dealing with problems caused by noise and vibration, both regarding noise and vibration in the environment, the workplace and the home. The firm of Martec Environmental Engineering was formed 40 years ago. During that time we have advised many groups of both residents and developers about the problems of noise and vibration in the environment.