The noise exposure of working divers

Guidance on the Control of Noise at Work Regulations 2005

HSE information sheet

Diving Information Sheet No 14

This diving information sheet is part of a series of information sheets providing guidance on diving at work. It provides information on the levels of noise that commercial divers are exposed to as well as guidance on the responsibilities of diving contractors with respect to the Control of Noise at Work Regulations 2005 (CoNWR05).[1] This sheet discusses noise in relation to diving activities in general and divers' exposure to noise underwater in particular. More detailed guidance on noise exposure above water is provided in other HSE publications.

Background

There is a growing body of evidence that commercial divers are exposed to noise levels that put their hearing at risk. The Health and Safety Executive (HSE) funded a review[2] of the available information on diver noise exposure, to enable a clear position to be presented to the commercial diving industry.

The UK implemented new noise exposure regulations (CoNWR05) in April 2006 in compliance with a European-wide directive.[3] Their purpose is to make sure that people do not suffer damage to their hearing and requires the control of noise risks and noise exposure. The Regulations require employers to:

- assess the risk to all employees, including divers, from noise at work;
- take action to reduce the noise exposure that produces these risks by organisational and technical means;
- provide hearing protection if the noise risk cannot be reduced sufficiently by other methods;
- ensure legal limits on noise exposure are not exceeded;
- provide employees with information, instruction and training regarding noise; and
- conduct health surveillance where there is a risk to health.

Noise action values

The CoNWR05 require employers to take specific actions at certain noise action values. These relate to the levels of exposure to noise averaged over a working day or week and the maximum noise (peak sound pressure) to which a person may be exposed. Previous HSE-funded research[4,5] identified that the increased pressure and different gas mediums in the hyperbaric environment may affect these values. However, the research[5] also identified that there is insufficient understanding of the factors involved to amend them. Taking this into account, it is HSE's view that the values in CoNWR05 should be employed when considering diver noise exposure levels:

- Lower exposure action values:
  - Daily or weekly exposure of 80 dB(A)
  - Peak sound pressure of 135 dB(C)
- Upper exposure action values:
  - Daily or weekly exposure of 85 dB(A)
  - Peak sound pressure of 137 dB(C)
- Exposure limit values:
  - Daily or weekly exposure of 87 dB(A)
  - Peak sound pressure of 140 dB(C)

Noise sources

A diver is exposed to a range of noise sources and the review[2] identified that noise levels can be significant both on the surface and underwater. It was found that self-generated noise, such as breathing, purging and communications when wearing diving helmets, is a major contributor to a diver's noise exposure. The levels vary with helmet design, but some models lead to significant exposure during typical working dives. Similarly, the review identified that underwater tools generate very high noise levels and some can produce noise doses that substantially exceed the upper exposure action value after only a few minutes. The noise levels experienced in compression chambers can also be significant, particularly in older designs which may not have noise-reducing features.

The review established that the various noise sources typically result in a commercial diver's daily noise dose exceeding the exposure action values. CoNWR05 require that the risk from this exposure is either eliminated at source or, where this is not reasonably

practicable, control measures are implemented to reduce the noise to as low as reasonably practicable (ALARP).

Calculation of noise dose

An individual's noise dose takes into account the level of noise and the duration of exposure. For divers this must incorporate all noise exposure above and below water, including equipment, plant and other sources of noise which might not be directly related to the diver's immediate underwater task. HSE-funded research[4,5] highlighted the difficulties involved in noise measurement in the dry hyperbaric environment and identified that the use of hydrophones in place of microphones overcomes these issues.

The review notes that CoNWR05 identify exposure values averaged and normalised for a normal working day or weekly exposure values for nominally five working days per week. In saturation diving the divers are exposed continuously, and this would need to be taken into account for the assessment of noise exposure for such divers.

The review explains that human hearing underwater, when the external ear canal is filled with water, is less sensitive than in air. As a result, the noise exposure of a diver with 'wet' ears, as will occur when using a band mask, should be adjusted using an underwater (UW) weighting scale rather than the (A) weighting scale used in air. The reduced sensitivity of a wet ear might lead to a reduced noise risk. However, band mask type equipment does not protect the diver from mechanical impact nor waterborne ear infections and, therefore, is not considered to be a suitable method for controlling a diver's noise exposure.

HSE has developed two systems which may be used to calculate noise dose: a tabular 'ready reckoner' system and an online system. An example of the tabular system to calculate daily noise dose is provided in Annex A. Both are available at www.hse.gov.uk/noise/calculator.htm.

Responsibilities

The principle of the CoNWR05 is to reduce noise at source to a level that may be considered ALARP and to apply further control measures such as personal hearing protection for any remaining or residual risk. Where exposure to noise is likely to be above the lower action values, the dutyholder is required to arrange a specific noise risk assessment conducted by a person competent for the task. This assessment need only be sufficiently detailed to establish the general noise levels and to assist in the reduction of noise exposure to ALARP levels. Where the risk assessment establishes that exposure is likely to be at or above the upper action value there is a requirement to specifically identify and implement control measures to reduce noise exposure to ALARP. An individual's noise exposure should not be permitted to exceed the limit values.

CoNWR05 specify when the use of personal hearing protection is appropriate. Namely, that it is to be made available to employees exposed between the lower and upper exposure levels and, where exposure is above the upper level, it shall be provided. The use of personal hearing protection does not, however, change the duty to reduce levels to ALARP. The Regulations require information, instruction and training on noise risks to be provided where exposure is above the lower level.

Simply limiting noise dose by exposure time, or in the case of divers by dive time, does not follow the principle of reducing noise to ALARP levels and relies on no further noise exposure occurring for the remainder of the working day. As already identified, surface dive sites are potentially noisy environments and this approach would not, therefore, provide a solution. Consequently, alternative noise control measures are required.

Dutyholders have a responsibility under CoNWR05 to choose work equipment emitting the least possible noise in order to meet the ALARP requirement. The designers and manufacturers of equipment have a responsibility under the Supply of Machinery (Safety) Regulations 2008 (SM(S)R)[6] to ensure that noise levels produced by their equipment are as low as technically feasible. These Regulations also require manufacturers to supply the noise output level of their equipment. Diving breathing apparatus is defined as personal protective equipment (PPE) and, as such, does not fall within the scope of SM(S)R. However, European standards for umbilical supplied diving apparatus, BS EN 15333 parts 1 and 2,[6,7] require manufacturers to identify the noise levels within diving helmets and provide this information to the user. In both cases, the noise data provided are important to the assessment of noise dose. Thus, both equipment manufacturers and employers have a joint responsibility in the reduction of noise.

There is strong evidence that regular exposure above the upper action value poses a risk to hearing and employers should provide health surveillance (hearing checks) for any divers who are regularly exposed to these levels. The frequency of such checks would be dependent on the level of exposure. Additionally, if the risk assessment identifies that exposure is between the lower and upper action values, health surveillance should also be provided for any individuals who are

at particular risk, eg already suffer from hearing loss or are particularly sensitive to hearing damage. The purpose of health surveillance is to provide warning when divers might be suffering from early signs of hearing damage, give an opportunity to do something to prevent the damage getting worse, and also to check that any control measures put in place are working. It is **not** a control measure in itself.

What should diving contractors do?

Diving contractors should ensure that the risk to divers' hearing is reduced to ALARP levels.

The review conducted for HSE indicates that commercial divers are likely to be exposed to noise above the lower action value. In such cases, compliance with the CoNWR05 requires a noise risk assessment of a diver's working environment, both above and below the water surface. The results of this assessment should be employed by contractors to decide what actions are required to reduce exposure to ALARP levels and meet the requirements of the Regulations.

Contractors and equipment manufacturers both have a role in the reduction of noise at source. Active noise reduction, design features to reduce breathing noise, and the use of vented personal hearing protection are all feasible and will lead to significant reductions in diver exposure. An equipment purchase/replacement/modification policy that actively seeks to reduce noise exposure, as technical solutions become available, will be important to achieving ALARP levels and should be considered.

Data provided from health surveillance programmes can help inform strategies to reduce noise exposure. The commercial diving industry might wish to consider the implementation of such a programme to monitor divers' hearing. It should be noted that audiometry assessments performed during the HSE diving medical are not conducted as part of a health surveillance programme and will not necessarily meet the important quality control requirements needed for use in such a programme. Additionally, an audiometry assessment is only mandated during an individual's initial HSE diving medical.

References

1 *Controlling noise at work. The Control of Noise at Work Regulations 2005. Guidance on Regulations* L108 (Second edition) HSE Books 2005 ISBN 978 0 7176 6164 0 www.hse.gov.uk/pubns/books/l108.htm

2 *Review of diver noise exposure* Research Report 735 (see www.hse.gov.uk/research/index.htm)

3 European Economic Community (EEC) Directive 2003/10/EC dated 6 February 2003 (see http://eur-lex.europa.eu)

4 *Noise exposure limits for hyperbaric conditions* (Offshore Technology Report OTO 98 020) (see www.hse.gov.uk/research/offshore.htm)

5 *Noise exposure limits under hyperbaric conditions* (Offshore Technology Report OTO 2000 074) (see www.hse.gov.uk/research/offshore.htm)

6 BS EN 15333–1:2008 *Respiratory equipment. Open-circuit umbilical supplied compressed gas diving apparatus. Demand apparatus* ISBN 978 0 580 63442 0 British Standards Institution

7 BS EN 15333–2:2009 *Respiratory equipment. Open-circuit umbilical supplied compressed gas diving apparatus. Free flow apparatus* ISBN 978 0 580 59850 0 British Standards Institution

Further reading

Commercial diving projects offshore. Diving at Work Regulations 1997. Approved Code of Practice L103 HSE Books 1998 ISBN 978 0 7176 1494 3

Commercial diving projects inland/inshore. Diving at Work Regulations 1997. Approved Code of Practice L104 HSE Books 1998 ISBN 978 0 7176 1495 0

Recreational diving projects. Diving at Work Regulations 1997. Approved Code of Practice L105 HSE Books 1998 ISBN 978 0 7176 1496 7

Media diving projects. Diving at Work Regulations 1997. Approved Code of Practice L106 HSE Books 1998 ISBN 978 0 7176 1497 4

Scientific and archaeological diving projects. Diving at Work Regulations 1997. Approved Code of Practice L107 HSE Books 1998 ISBN 978 0 7176 1498 1

The Diving at Work Regulations 1997 SI 1997/2776 The Stationery Office 1997 ISBN 0 11 065170

Further information

For information about health and safety, or to report inconsistencies or inaccuracies in this guidance, visit www.hse.gov.uk/. You can view HSE guidance online and order priced publications from the website. HSE priced publications are also available from bookshops.

This document contains notes on good practice which are not compulsory but which you may find helpful in considering what you need to do.

British Standards can be obtained in PDF or hard copy formats from BSI: http://shop.bsigroup.com or by contacting BSI Customer Services for hard copies only Tel: 020 8996 9001 email: cservices@bsigroup.com.

The Stationery Office publications are available from The Stationery Office, PO Box 29, Norwich NR3 1GN Tel: 0870 600 5522 Fax: 0870 600 5533 email: customer.services@tso.co.uk Website: www.tsoshop.co.uk/ (They are also available from bookshops.) Statutory Instruments can be viewed free of charge at www.legislation.gov.uk/.

This document is available at www.hse.gov.uk/pubns/dvis14.pdf

Annex A to DVIS14

Tabular system to calculate daily noise exposure

Sound pressure level, L_{Aeq} (dB)	*Duration of exposure (hours)*								*Total exposure points*	*Noise exposure $L_{EP,d}$ (dB)*
	¼	*½*	*1*	*2*	*4*	*8*	*10*	*12*		
105	320	625	1250							
104	250	500	1000							
103	200	400	800							
102	160	320	630	1250						
101	125	250	500	1000						
100	100	200	400	800					3200	100
99	80	160	320	630	1250				2500	99
98	65	125	250	500	1000				2000	98
97	50	100	200	400	800				1600	97
96	40	80	160	320	630	1250			1250	96
95	32	65	125	250	500	1000			1000	95
94	25	50	100	200	400	800			800	94
93	20	40	80	160	320	630			630	93
92	16	32	65	125	250	500	625		500	92
91	12	25	50	100	200	400	500	600	400	91
90	10	20	40	80	160	320	400	470	320	90
89	8	16	32	65	130	250	310	380	250	89
88	6	12	25	50	100	200	250	300	200	88
87	5	10	20	40	80	160	200	240	160	87
86	4	8	16	32	65	130	160	190	130	86
85		6	12	25	50	100	125	150	100	85
84		5	10	20	40	80	100	120	80	84
83		4	8	16	32	65	80	95	65	83
82			6	12	25	50	65	75	50	82
81			5	10	20	40	50	60	40	81
80			4	8	16	32	40	48	32	80
79				6	13	25	32	38	25	79
78				5	10	20	25	30	20	78
77					8	16	20	24	16	77
76					6	13	16	20		
75					5	10	13	15		

Instructions:

- For each task or period of noise exposure in the working day look up in the table on the left the exposure points corresponding to the sound pressure level and duration (e.g. exposure to 93 dB for 1 hour gives 80 exposure points);
- Add up the points for each task or period to give total exposure points for the day;
- Look up in the table on the right the total exposure points to find the corresponding daily noise exposure (e.g. a total exposure points for the day of 280 points gives a daily noise exposure of between 89 and 90 dB).