Asian-Pacific Newsletter

ON OCCUPATIONAL HEALTH AND SAFETY

Volume 13, number 2, July 2006

Noise and vibration

Asian-Pacific Newsletter on Occupational Health and Safety

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Published by the
Finnish Institute of Occupational Health
Topeliuksenkatu 41 a A
FI-00250 Helsinki, Finland

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The electronic version of the Asian-Pacific Newsletter on Occupational Health and Safety on the Internet can be accessed at the following address:
http://www.occuphealth.fi/Asian-PacificNewsletter

The issue 3/2006 of the Asian-Pacific Newsletter deals with ergonomics.

Photograph on the cover page:
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Printed publication:
ISSN 1237-0843
On-line publication:
ISSN 1458-5944

Finnish Institute of Occupational Health

Contents

Challenges for Noise Control Programmes

In Europe, around 50 million subjects are exposed to hazardous levels of environmental noise, with a risk of noise-induced hearing loss (NIHL) and tinnitus. The economical losses are also substantial, and can be divided into direct and indirect costs. Direct costs are relatively easy to estimate and mainly consist of the medical examinations, compensations due to occupational diseases and hearing protectors. Indirect costs on the other hand are much more difficult to estimate. Nevertheless, it is quite clear that noise affects production, causing quality problems and absences from work. Hearing handicaps cause social isolation at work and in family life and increase unemployment. It is estimated that indirect costs are at least 10 times higher than direct costs. In many countries NIHL remains one of the leading health-related problems.

In addition, approximately double this number of workers is exposed to disturbing noise, decreasing productivity and causing communication difficulties.

In the European community, protection against noise is controlled by Frame Directive 86/188/EEC and by a new individual noise Directive 2003/10/EC. The new directive fixes the daily noise exposure levels and peak sound pressures for exposure limit values and exposure action values:

a) Exposure limit values: $L_{EX,8h}$=87 dB(A) and P_{peak}=200 Pa, respectively
b) Upper exposure action values: $L_{EX,8h}$=85 dB(A) and P_{peak}= 140 Pa, respectively
c) Lower action values: $L_{EX,8h}$=80 dB(A) and P_{peak}=112 Pa, respectively.

When applying the exposure limit values, the determination of the worker's effective exposure must take account of the attenuation provided by the individual hearing protectors (HPDs) worn by the worker. Exposure action values on the other hand do not take account of the effect of any such protection.

In risk assessment, the following factors must be included: a) exposure to impulse noise, b) combined effects from the interactions between noise and ototoxic substances and between noise and vibrations, c) any effects on the health and safety of workers belonging to particularly sensitive groups. When the noise exposure level exceeds the lower exposure action values, the employer must make HPDs available to workers and in the case that the noise exposure level matches or exceeds the upper action values, HPDs must be used. HPDs shall be selected to eliminate the risk to hearing loss or at least to reduce the risk to a minimum. However, the Directive does not define the contents of the actions needed nor how the actions should be organized.

The new noise Directive has to be harmonized with the national legislation by 2006 at the latest. Its implementation into practice will be a challenge for research institutes, administrative organizations and their national and European co-operation. A tool for workplaces and occupational health centres for this purpose could be a database that includes all environmental and health-related factors that may be involved in the development of NIHL. The creation of such a database requires a great deal of validated data on the effects of various risk factors both separately and in combination with each other. At present much more research and knowledge is needed on factors behind NIHL. In order to get epidemiologically reliable study material, research institutes are now networking.

As shown above, the level, type and duration of exposure, including any exposure to impulse noise, have to be included in risk assessment. In addition, the employer must pay special attention to the availability of hearing protectors with adequate attenuation characteristics and also consider the risks caused by the use of HPDs. The last requirement is included in the noise Directive even though there are only few studies completed to quantify the increased risk for accidents in noisy environments. Some evidence however, does exist. Among shipyard workers the risk of noise and hearing loss together accounted for 43% of the injuries according to a case-control study. Hearing loss greater than 20 decibels, and noise exposure greater than 83 decibels were found to be safety hazards. In Finland some fatal accidents have been reported among railroad workers wearing radio equipped HPDs whose confused senses have not warned of an approaching train.

As a summary on the tasks and challenges of risk assessment we may conclude the following:

1. The main responses due to exposure to noise are NIHL and also increased risk of accidents.
2. In dose evaluations we must consider exposure to ototoxic chemicals and vibration in addition to the noise level and its physical characteristics.
3. In order to identify workers with special sensitivity to noise, we have to evaluate blood pressure, serum cholesterol, smoking habits and use of ototoxic drugs. The presence of these risk factors simultaneously may explain increased sensitivity to NIHL.
4. In the case that occupational health care personnel has good cause to suspect a risk of NIHL, all exposure evaluations and risk assessments have to be re-evaluated. This will require fast reactions on the part of health care professionals.

The number of parameters is too numerous to have a simple comprehensive model for risk assessment purposes. Some trials already exist that provide a data base to collect the relevant data, such as, for instance NoiseScan. Its present version 4.0 can be used to encourage workplaces to take on technical controlling measures as it shows the effect of reduced noise exposure levels on the development of hearing loss.

Noise control and the continuous development of a better sound environment is a leading principle in the European safety strategy. This means that demands for controlling measures for hearing protection purposes are only the first target that should be enhanced to meet the requirements for good communication and a comfortable environment at workplaces. These topics are sure to receive more attention in future research programmes.

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Noise-induced hearing loss and compliance with the hearing conservation programme in Malaysia

Noor Hassim Ismail, Anza Elias, Malaysia

Introduction

Noise is one of the more widely and frequently experienced problems of the industrial work environment. Occupational noise problems occur in many industries; for example, the textile, metal and chemical industries. These problems occur as consequences of development and industrialization. Noise-induced hearing loss usually progresses unnoticed until it begins to interfere with communication, posing a serious safety hazard and a decrease in the quality of life.

Studies in Malaysia

In Malaysia, noise exposure in the workplace is legislated under the Factories and Machinery Act (Noise Exposure) Regulations 1989, and the Occupational and Safety Health Act 1994. These regulations make it mandatory to measure, assess and control noise levels and workers' exposure to noise. The permissible exposure level for continuous exposure during an eight-hour working day is 90 dB(A); for impulse noise it is 140 dB(A) and the action level is 85 dB(A). (1)

There are various studies on occupational hearing loss in Malaysia. The results of the Hearing Impairment Survey in Local Industries, which involved 45,974 workers sampled from 302 factories in 1990, confirmed that 26.9% of industrial employees had a hearing threshold at 3000 Hz to 6000 Hz that was higher than normal, and 21.9% of workers already had detectable hearing impairment. Only 51.2% of workers had normal hearing. This survey revealed that all industrial sectors had confirmed risks of permanent hearing damage. The textile industry was found to have the highest risk (60% of workers), followed by the basic metal industry, the chemical products industry, the beverage industry, and the nonmetallic mineral product industry (2).

Noor Hassim and Rampal found that quarry workers were exposed 2.0 to 7.0 times the permissible dose (permissible dose = 1.0 per day) (3). Maisarah and Said (4) studied the prevalence of hearing loss and the use of hearing protection devices among factory workers exposed to noise. There were 542 subjects, 442 of them were exposed to a noise level of ≥ 90 dB whereas 82 subjects were working in quiet areas. All workers who were exposed to noise were given hearing protection devices. The study revealed that the hearing loss among workers who were exposed to noise was 83% and that of the unexposed group was 31.7%. The researchers also found that only 4.1% of the workers wore the hearing protective devices all the time at work, 64% never wore them and the remaining only wore them once.

Table 1. Compliance with elements of the hearing conservation programme

Elements	Compliance	
	Yes n (%)	No n (%)
1. Safety and Health Policy	164 (98.2)	3 (1.8)
2. Personal Monitoring	127 (76.0)	40 (24.0)
3. Provision of hearing protection devices	155 (92.8)	12 (7.2)
4. Training and Education Programme	130 (77.8)	37 (12.2)
- Training at least twice a year	104 (80.0)	26 (20.0)
- Education about the effects of noise	118 (90.8)	12 (9.2)
- Education about the importance of HPD and correct techniques	122 (93.8)	8 (6.2)
5. Audiometry tests	124 (74.3)	43 (25.7)
- Free from noise for 14 hours before test	104 (83.9)	20 (16.1)
- Test of new workers at high risk workplaces	59 (47.60	65 (52.4)
- Scheduled audiometry	80 (64.5)	44 (35.50
- Assessment and treatment for NIHL	78 (62.9)	46 (37.1)
- Repeat test for TSTS	52 (41.9)	72 (58.1)
- Education on the importance of HPD to those with TSTS	88 (71.0)	36 (29.0)
6. Noise control	102 (61.1)	65 (38.9)
- Engineering control and reduction of the duration of exposure	55 (53.9)	48 (46.6)
- Engineering control only	39 (38.2)	
- Reduction of the duration of exposure only	8 (7.8)	
7. Record keeping	114 (68.4)	53 (31.7)
- Having a person in charge	111 (97.4)	3 (2.6)
- Keep records 5 years after employees stop working	109 (95.6)	5 (94.4)

HPD – Hearing protection device; NIHL – Noise induced hearing loss; TSTS – Temporary standard threshold shift

Table 2. Relationship between compliance to hearing protection programme and status of ownership

Ownership	Comply (n=69)	Partially comply (n=98)					
		6* (n=35)	5* (n=15)	4* (n=22)	3* (n=11)	2* (n=11)	1* (n=4)
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Europe (n=12)	7 (58.3)	1 (8.3)	2 (16.6)	1 (8.3)	1 (8.3)-	-	
America (n=10)	8 (80.0)	1 (10.0)	-	1 (10.0)	-	-	-
Australia (n=3)	1 (33.3)	1 (33.3)	1(33.3)	-	-	-	-
Malaysia (n=102)	36 (35.5)	22 (21.6)	10 (25.0)	14 (13.7)	7 (6.9)	9 (8.8)	4 (4.4)
Asia+ (n=40)	17 (42.5)	10 (25.0)	2 (5.0)	6 (15.0)	3 (7.5)	2 (5.0)	-
Indonesia (n=2)	-	1 (50.0)	-	-	-	1 (50.0)	-
India (n=1)	1 (100)	-	-	-	-	-	-
Japan (n=23)	9 (39.1)	7 (30.4)	1 (4.3)	4 (17.4)	2 (8.7)	-	-
Korea (n=6)	3 (50.0)	1 (16.7)	1 (16.7)	1 (16.7)	-	-	-
Lebanon (n=1)	1 (100)	-	-	-	-	-	-
Singapore (n=4)	3 (75.0)	-	-	-	-	-	-
Taiwan	-	-	-	-	1 (33.3)	1 (33.3)	1(33.3)

* Elements of the hearing conservation programme, + Excluding Malaysia

Compliance with the hearing conservation programme in Malaysia

The objective of the hearing conservation programme is to protect workers and to prevent any hearing loss due to exposure to noise at workplace. All industries in Malaysia where workers are exposed to a noise level at or above 85 dB(A) for 8 hours should be included under the hearing conservation programme. The elements of the hearing conservation programme under the noise regulations (1) are as follows:

a. Policy on the hearing conservation programme
b. Noise survey
c. Noise control
d. Education and training
e. Audiometry testing
f. Provision of hearing protective devices
g. Record keeping on all the above activities.

A cross-sectional study by Nor Saleha (5) involving 167 industrial enterprises was conducted to determine the industries' compliance with the hearing conservation programme and the association between compliance and the prevalence of hearing impairment and standard threshold shift. It was found that 42.3% of these industrial enterprises complied with the programme. The percentage of compliance with safety and health policy was the highest (98.2%), followed by the provision of hearing protection devices. The lowest compliance percentage was for noise control (61.7%). (Table 1)

There were significant associations ($p < 0.05$) between compliance and total workers, status of ownership, and having an officer in charge of the company's hearing conservation programme. Table 2 shows the relationship between compliance with the hearing protection programme and the status of ownership of the industrial enterprises.

Summary

Noise is one the hazards faced by workers. Even though noise has been shown to occur in the workplace, there are steps that the authorities and parties responsible can take to mitigate its impact. The level of compliance with the hearing conservation programme among employers in local industrial enterprises is still not up to the standard of companies in European countries. Small and medium-sized enterprises are less compliant with the Programme than bigger companies. This is a very important piece of information and should spur the enforcement agency to react.

References

1. Malaysian Government. Factories and Machinery Regulations (Noise exposure) 1989. In Factories and Machinery Act 1967 & Regulations 1989;349–63. Kuala Lumpur: ILBS.
2. Department of Occupational Safety and Health of Malaysia (Previously named Factories and Machinery Department) Report, Ministry of Labour Malaysia 1991.
3. Noor Hassim I, Rampal KG. Noise at quarry. Proceeding on 2nd workshop IRPA 1991–1992, UKM: 1993;703–6.
4. Maisara SZ, Said H. The noise exposed factory workers: the prevalence of sensorineural hearing loss and their use of hearing protection devices. The Medical Journal of Malaysia 1993;48(3):280–92.
5. Nor Saleha IT. Compliance on hearing conservation protection programme in industries in Negeri Sembilan. Masters thesis 2004. National University of Malaysia, 2004.

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Communication and noise

Erkko Airo, Finland

Introduction

The tasks and nature of work have changed during the last century in many ways. One of these ongoing changes has been the growing significance of speech communication at work. During the 20th century the amount of purely physical work reduced, while the amount and importance of information work grew. (1) The increasing amount of speech communication, speaking, and its importance at work has raised new concerns that occupational hygienists and health care professionals need to address.

Workplace acoustics and employers' actions on noise reduction have not always developed at the same pace as the importance of verbal communication: need to speak and need to hear speech in less than ideal conditions is common at workplaces. In some professions this development seems to have led to a growing number of voice disorders, while in other cases modern communication equipment has been taken into use. Communication technology has solved some problems, but there are questions related to these devices that require answers.

In addition to changing traditional work environments, the development of information and communication technology has created new kinds of acoustical environments where the communication sound itself is the source of disturbance or even noise exposure. For example, thousands of people in Finland and millions worldwide work in call-centres and open-plan offices, and cellular phones are used at work and outside work – most of us are exposed to communication and entertainment, or *media noise*, in most places and at all ages.

Speech intensive work in low noise environment

Teachers' work in schools and day care centres is communication intensive – even so that one's voice can be characterized as his or her most important tool.

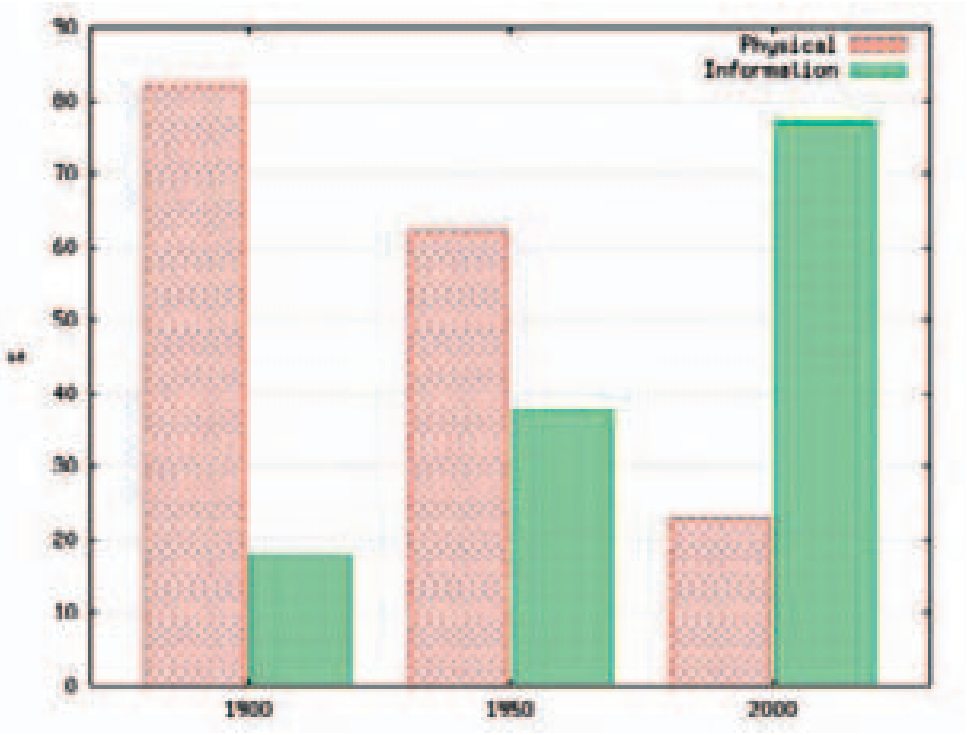

Figure 1. Change in the relative amount of physical work and communication intensive information work during the 20th century.

The majority of the day care centre teachers speak 30–50% of their working time, and more than 40% of that time with raised or loud voice (2). Similar findings have been made in other educational professions (3–5).

In the typical sense of the word, day care centres and schools are not noisy workplaces. The measured noise exposure levels of day care centre teachers have been moderate, around 75 dB, and the risk of hearing loss is therefore not substantial (2, 6). Nevertheless, the reported sound levels from 65 to 80 dB are high, when considered as background noise levels for speech communication (2, 7). Speaking, as well as speech reception, is disturbed in such conditions.

Noise and excessive reverberation are in the top three of the perceived problems in the work environment among the day care centre teachers. Background noise and reverberation are not analogous, but they are related. Improving the room acoustics or reducing the reverberation by adding absorption will also lower the background noise level. The optimal amount of absorption material in a classroom equals the ceiling area, and it should be placed on more than one surface of the room. It is possible to achieve measurable and subjectively perceivable improvements with acoustical treatment: reduced reverberation and, according to the user comments, rooms where speaking is easier than before. (2, 8)

Even though long speaking time and high speech level – which in turn is related to background noise and poor acoustics – seem to be significant risk factors of vocal disorders, it is important to notice that they are not the only causes, and the improvement of speaking environment by technical measures is not enough. Vocal hygiene education and speech therapy have also been found to improve the voice quality and to reduce the frequency of vocal symptoms (9–12).

Communication in noisy environments

Sometimes speech communication is necessary in workplaces where high background noise seriously degrades the speech recognition or causes noise exposure. Achieving required communication quality and appropriate hearing protection at the same time is the main challenge in such conditions. Various technical solutions are available: hearing protectors with communications capability, intercom systems with insert earphones or headphones, and all these as wired and wireless versions. Finding the right solution may be as simple as choosing a suitable hearing protector, but usually several factors are to be considered: the nature of work, noise type and level at the workplace, user mobility and comfort, as well as integration with possibly existing hearing protection or communication system need to be taken into account.

The simple solution case could be, for example, an industrial workplace where the verbal communication is needed but it is not an integral part of the work, and those communicating are close to each other. European standard EN 458 includes a guideline on appropriate hearing protection level (Table 2). A protected ear canal sound level of greater than 85 dB leads to risk of hearing loss, and a level of less than 70 dB leads to a sense of isolation and bars communication. The majority of noise exposures in industry are less than 95 dB, which means that, according to the given recommendation, the most effective hearing protectors are too effective in most cases. This situation is called overprotection, and addressing the problem, a few manufacturers have introduced hearing protection products designed to allow some high frequency sound through, which provides less attenuation and more natural sound perception, as well as ease of communication. These hearing protectors typically provide effective noise reduction of 15–20 dB, which is sufficient for most workplace noise environments.

If more attenuation is actually needed, or higher level of speech recognition and long distance communication required, communications radio hearing protectors that can be used as pairs or as groups, and full-scale intercom systems may be applicable solutions.

Table 1. Prevalence of functional and organic voice disorders among day care centre personnel (n=262).

Type of voice disorder	Prevalence (%)
Functional	21
Organic	29
- laryngitis	19
- nodules	6
- minor changes	10

Table 2. Appropriate hearing protector attenuation according to EN458.

Sound level inside hearing protector (dB)	Protector attenuation level
> 85	Insufficient
80–85	Acceptable
75–80	Optimal
70–75	Acceptable
<70	Overprotection

Table 3. Communications headset type and average daily personal sound exposure levels calculated from ambient noise level ($L_{EP,d,ext}$) and communication sound level ($L_{EP,d,MIRE}$).

Headset	$L_{EP,d,MIRE}$	range	$L_{EP,d,ext}$	n
earmuff	73	53–92	85	29
headphone	81	64–96	83	19
all	76	53–96	84	48

Radio and television broadcast production work is an example of a complex combination of communication needs and high level noise. In a recent study, the noise exposure of the production personnel and the communications and hearing protection devices they use were evaluated (13).

The production teams and their technical staff are exposed to a wide range of noise levels during live productions like concerts and sports events. While the average noise exposure levels are around 80–85 dB, the equivalent sound level at some work positions during an event may be as high as 100 dB. An intercom system is used for communication, and their work performance is highly dependent on the system and its functionality. The communications headsets are usually either headphones or modified hearing protectors (earmuffs). Communication volume level is user adjustable and electronic level limiters are not typically in use. Therefore, the communication is a potential source of additional exposure.

The effect of the communication on the noise exposure was studied by measuring the actual sound pressure level at the entrance of the ear using a measurement method called Microphone In Real Ear, or MIRE technique (ISO 11904–1:2003). In this case the measured sound level is a combination of the external sound level attenuated by the headset and the communication sound.

The measured in-ear communication volume levels against ambient noise level for both types of headsets are shown in figure 2 and table 3. The ear canal sound pressure levels, and calculated noise exposure levels, were typically higher when earphones were used than in case of earmuffs–even when the outside sound levels were approximately equal. Logically, earmuffs were used more often in events with high noise levels, and headphones were rarely used when the external noise level was above 90 dB. The average daily noise exposure levels of both types of headset were less than 85 dB, but there were exceeding values among both earmuff and headphone users: the noise exposure level of two earmuff users and seven headphone users (total n=48) were above the limit.

In this case the choice of headset type was made at the beginning of each work session. While it seems that, at most times the experienced professionals were able to choose the right kind of headset, the number of too high sound exposure levels among headphone users indicates that misjudgements were also made. Thus, non-attenuating headsets should only be used in definitely quiet work environments, and if such a possibility to select the protection level is necessary, proper information about each work situation's noise level must be made available.

Effective communications hearing protectors provide enough attenuation to ensure sufficient margin for proper speech recognition in presence of high noise levels. Approved communications hearing protectors also have an electronic level limiter to keep the noise exposure from communication signal at acceptable level. In the most extreme noise conditions double protection may be necessary, which will typically require custom solutions, as products with communications capabilities may not be readily available. Another case where custom solutions are probably needed is integration of new communications devices, existing intercom systems *and* hearing protection.

Modern work–new kind of exposure

Call centres are modern workplaces with special challenges related to room acoustics and extensive use of communication devices. In a way, they are a combination of the previous examples: work is communication intensive and headphones are used for communication. The environmental noise level is usually low, the main source of ambient background noise being distracting speech from other desks or workstations.

Call centre operators have been reported to suffer from several ailments and problems: acoustical fatigue, hyperacusis (collapsed tolerance to sound stimuli), tinnitus, vocal disorders, acoustic shock symptoms due to high level transient signals, and, at times high noise exposure (14–18). The prevalence of the problems and their inter-relations are yet not confirmed, and further research is necessary.

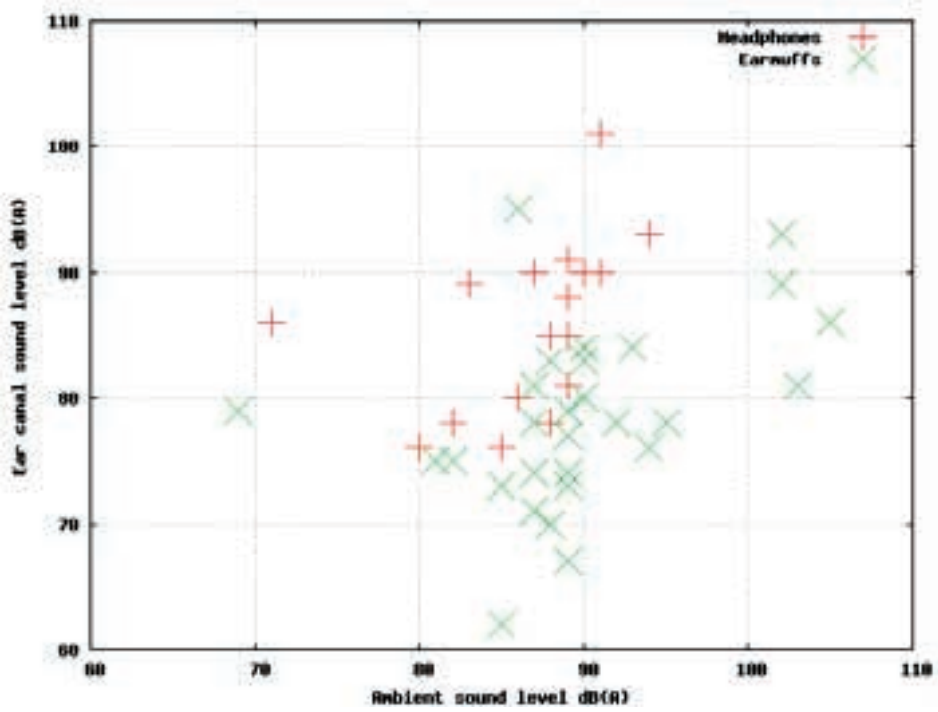

Figure 2. Relation of ambient sound pressure level (L_{Aeq}) and ear canal sound level inside the headset of communications headphones (red) earmuff (green) users.

References

1. Ruben RJ. Redefining the survival of the fittest: communication disorders in the 21st century. Laryngoscope, 2000;110:241–5.
2. Sala E, Airo E, Olkinuora P, Simberg S, Ström U, Laine A, Pentti J, and Suonpää J. Vocal loading among day care center teachers. Log Phon Vocol 2002;27:21–8.
3. Buekers R, Biernes E, Kingma H, Marres EHMA. Vocal load as measured by the voice accumulator. Folia Phoniatr Logop 1995;47:252–61.
4. Ohlsson A-C, Brink o, Löfqvist A. A voice accumulator – validation and application. J Speech Hear Res 1989;32:451–7.
5. Masuda T, Ikeda Y, Manako H, Komiyama S. Analysis of vocal abuse: fluctuations in phonation time and intensity in 4 groups of speakers. Acta Otolaryngol 1993;113:547–52.
6. Sala E, Laine A, Airo E, Olkinuora P. Päiväkotien ääniergonomiaselvitys: päiväkotien kasvatushenkilöiden äänihäiriöt ja niiden työperäiset taustatekijät. Turun yliopistollinen keskussairaala, 2000; Turku.
7. Truchon-Gagnon C, Hetu R. Noise in day-care centers for children. J Noise Control Eng 1988;30:57–64.
8. Pekkarinen E, Viljanen V. Acoustic conditions for speech communication classrooms. Scand Audiol 1991;20:257–63.
9. Carding PN, Irmgarde A, Docherty GJ. A study of the effectiveness of voice therapy in the treatment of 45 patients with nonorganic dysphonia. J Voice 1999;13:72–104.
10. Chan RWK. Does the voice improve with vocal hygiene education? A study of some instrumental voice measures in a group of kindergarten teachers. J Voice 1994;8:279–91.
11. MacKenzie K, Millar A, Wilson JA, Sellars C, Deary IJ. Is voice therapy an effective treatment for dysphonia? A randomised controlled trial. Br Med J 2001;323:658–61.
12. Roy N, Gray S, Simon M, Dove H, Corbin-Lewis K, Stemple JC. An evaluation of the effects of two treatment approaches for teachers with voice disorders: a prospective randomized clinical trial. J Speech Lang Hear Res 2001;44:286–96.
13. Airo E, Olkinuora P, Toppila E, Järvinen A, Savolainen A. Noise Exposure of Broadcast Production Personnel. Papers of the BNAM 2004 CD-ROM, Acoustical Society of Finland, Helsinki 2004. (Also available at: http://www.acoustics.hut.fi/asf/bnam04/webprosari/papers/o42.pdf)
14. Chiusano SV, Lees PSJ, Breysse PN. An Occupational Noise Exposure Assessment for Headset-Wearing Communication Workers. Applied Occupational & Environmental Hygiene 1995;10:476–81.
15. Dajani H, Kunov H, Seshagiri B. Real-time Method for the measurement of noise exposure from communication headsets. Applied Acoustics 1996;49:209–24.
16. Darlington P. Noise Dose and Acoustic Shock from Headsets, paper presented at the AES 114th Convention, Amsterdam, Netherlands, 2003. (http://www.appledynamics.com/White%20Papers/15.6.2005)
17. Hinke K, Braske K. Tinnitus og pludselig uventet impulsstøj hos telefonister på et telecenter. 50 Nordiska Arbetsmiljömötet 30 augusti – 1 september 2004, Reykjavik, Island.
18. Health and Safety Executive. Noise – Acoustic Shock, http://www.hse.gov.uk/noise/acoustic.htm (16.6.2005)

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Mechanization, vibration and the Indian workforce

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Economy and mechanization

The overall growth index of industrial production in India during April–October 2005 was 8.4 percent (1). The driving forces behind this are the availability of technology and an opening of global markets. Despite the buoyancy in the economy, the Indian workforce remains in a stage of transition from non-mechanized to highly mechanized job requirements. The current mechanization is not accompanied by practices and legislations required for safe usage of machines. All possible effects on the health of workers need to be visualized for a programme to be sustainable. The current article aims to focus on the impact of occupational vibration on health of workers in relation to mechanization.

Health hazards of vibration in the Indian context

The human response to vibration depends on the part of the body that is exposed. There are two broad types of vibration to which workers are exposed:

1. Vibration transmitted to the whole body (whole-body vibration) through a supporting surface, for example, the feet of a standing person on a vibrating platform or the buttocks of a seated operator of a vehicle. Worldwide, disorders of the back, especially low back pain, have been causally linked to whole-body vibration (2). An increase in the number of highly mechanized industries therefore poses a threat to the health of workers.

The National Institute of Miners' Health, Nagpur, conducted vibration surveys in various mines of the country. It was found that in opencast mines, operators of heavy earth-moving machineries were at greater health risk from exposure to vibration. Regular work-related back ache is more common among tractor-driving farmers (40%) than non-tractor-driving farmers (18%), reported a study conducted on farmers in north India (3). In the agricultural sector, use of tractors and power tillers is increasing. Similarly, in the transportation industry, an estimated 1.2 million trucks (4) (9 tons capacity) are in use across the country, covering nearly 0.1 million kilometers. In most of the cases, these truck drivers are regularly exposed to whole-body vibration for more than eight hours a day in the course of their work.

2. Vibration applied to a part of the body is known as segmental vibration. When vibration is applied to the hand, it is termed hand-arm vibration. An example is jackhammer operators in mines. Hand-arm vibration is work-re-

lated exposure to vibration that mainly affects people who regularly use pneumatic, electric, hydraulic or gasoline-powered hand tools. Hand-arm vibration exposure may lead to an irreversible condition of the fingers and hands called hand-arm vibration syndrome, a syndrome that involves a combination of vascular and sensori-neural damage. While finger blanching is a result of decreased blood flow, losses in touch perception and dexterity are also commonplace due to nerve damage (5).

The clinical presentation of hand-arm vibration hazard is not yet well elicited in the Indian context, and the prevalence of hand-arm vibration syndrome in India is hardly documented. The classical hand-arm vibration or vibration-induced white finger is not common because of the tropical climate. However, Dasgupta & Harrison (6) studied 66 drillers, and 35 blasters as control subjects, from limestone mines in India. They reported a significantly higher prevalence of tingling, numbness, paraesthesiae (18.2%), pain in fingers, wrists, arms, etc. (31.7%), stiffness of the hand (13.6%) and hyperhydrosis (48.5%) among drillers as compared to control subjects. The prevalence of ulnar neuropathy and soft tissue wasting in hands was also significantly higher among the drillers. They concluded that complaints of neurological symptoms were significantly more prevalent among drillers than in a matched group of controls not exposed to hand-arm vibration.

Extent of problem

India's labour force reached 375 million in 2002 (7). With an expansion rate of two percent per annum, the employment figure in 2006 is estimated to be 400 million. Since 14% of the total employment is in industry (8), the industrial workforce in India is now around 56 million. Table 1 depicts the common sources of vibration in different industries of India.

The actual, total number of subjects exposed to occupational vibration directly varies with the degree and extent of mechanization in the industry. Records of two mechanized mines were examined to determine the percentage of the mining population regularly exposed to occupational vibration. According to the unpublished results of this examination, an average of 18–20% employees was found to be exposed to vibration at work (9).

Approximately 10 million subjects working in all the industries are at risk from hand-arm or whole-body vibration, assuming that 20% of the workforce is occupationally exposed to vibration. Extended shift duration of 10 hours or more is common in unorganized and private sectors of industry, and poses a geometrically increasing risk.

Contributing factors

Old equipments vibrate more. Proper maintenance may help up to a certain period, but the equipment should be replaced thereafter. If the machine in use is not ergonomically designed to attenuate harmful vibration, it is not safe. Mining and the transportation industry largely depend on old equipments, and the process of replacement is very slow.

Table 1. Sources of vibration in industry

Industry	Type of vibration	Common source of vibration
Agriculture	Whole body	Tractors, back-hoes
Construction	Whole body	Heavy equipment vehicles, e.g. bull-dozers, graders, excavators
	Hand-arm	Pneumatic tools, jackhammers, jack-leg, stoppers, vibrating concrete breakers
Electrical	Hand-arm	Hilte guns, drills, saws
Foundries	Hand-arm	Air compressed grinders, discs, rotaries, jitter-bugs
Iron and steel	Hand-arm	Impact wrenches, grinders
Machine tool	Hand-arm	Impact wrenches, grinders
Mining	Whole body	Jumbo drills, dumpers, dozers, shovels, back-hoes
	Hand-arm	Rock drills, grinders
Riveters	Hand-arm	Rivet guns, impact wrenches
Transport	Whole body Hand-arm	Buses, trains, helicopters, jeeps, trucks, motorcycles, motorboats

Dumper vibration measurement

Bulldozer – common source of harmful vibration

Lack of awareness has added to the complexity of the problem. While adverse physical conditions such as poor ventilation, respiratory particulate matters, poor illumination, noise, extreme temperatures, humidity and radiation are areas of common concern, occupational vibration has received little attention in developing countries. The authors scanned 63 articles published between 2003 and 2006 in the Indian Journal of Occupational and Environmental Medicine, a leading journal in the field of occupational health. No article/research paper on occupational vibration had been published during this period.

Monitoring of equipment-induced vibration is hardly implemented in industry. Moreover, Indian legislation does not provide specific guidelines for evaluation and monitoring of vibration at the workplace. The process of generating awareness needs to be initiated through mandatory provisions. The regulatory authorities in industry and mines should emphasize the control of vibration-related hazards.

Impact of the problem

The direct impact of workplace vibration is not easily ascertained for all of industry. Further, it is difficult to quantify owing to the uncertain dose-effect relationship. Vibration exposure, however, has been causally linked to increased backache, joint pain, and fatigue among exposed workers. Musculoskeletal disorders were found to be predominant (38.7%) in an estimate (10) of occupational diseases in India. It can be rationally presumed that a large part of this is because of exposure to vibration. This also increases the rate of absenteeism and the cost of treating musculoskeletal disorders, and it results in poor productivity. The affected worker may even lose his job because of increasing disability that is generally considered to be of non-occupational origin.

Action

There is an urgent need to

1. Study the problem and determine its magnitude
2. Identify areas of concern
3. Formulate specific rules regarding monitoring and adoption of preventive measures. The safe limits prescribed by ISO (11, 12) may be adopted
4. Increase awareness of vibration hazard and its ill effects on health among both workers and management.

These steps will result in a healthier and more productive workforce through

1. Decreased burden of sickness
2. Increased productivity
3. Savings through reduced costs for medical treatment
4. Decrease in sickness absenteeism
5. Improved employer-employee relationships through health care.

Acknowledgements

The authors are thankful to Mrs. Shilpa V. Ingole of this Institute for providing library and information services.

References

1. http://indiabudget.nic.in/es2005-06/chapt2006/chap71.pdf
2. Bovenzi M, Hulshof CTJ. An updated review of epidemiologic studies on the relationship between exposure to whole-body vibration and low back pain (1986–1997). Int Arch Occup Environ Health 1999;72:351–65.
3. Kumar A, Varghese M, Mohan D, Mahajan P, Gulati P, Kale S. Effect of whole-body vibration on the low back. A study of tractor-driving farmers in north India. Spine 1999 Dec 1;24(23):2506–15.
4. Transport corporation of India limited: http://www.tcil.com/transport.asp
5. Cliff Wolcott. Bad Vibrations: Hand-Arm Vibration Exposure and HAVS Prevention – http://www.occupationalhazards.com/safety_zones.
6. Dasgupta AK, Harrison J. Effects of vibration on the hand-arm system of miners in India. Occup Med 1996;46(1):71–8.
7. Report of the committee on India vision 2020. Planning commission, Govt. of India. December 2002. p. 35.
8. Internet resource: Distribution of workforce. Regional Strategy on occupational health and safety in SEAR countries. WHO Regional Office for South East Asia, World Health House, New Delhi (2006). p. 8
9. Mandal BB, Srivastava AK. Risk from vibration in Indian mines. Indian Journal of occupational and environmental medicine. Indian Association of Occupational Health. (Submitted for publication)
10. Global burden of diseases and injuries due to occupational factors. Discussion paper. Office of Global & Integrated Environmental Health. NW 1996.
11. IS0 2631–1:1997. Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration – Part 1: General requirements. Switzerland: International Organization for Standardization, 1997.
12. IS0 5349:1986. Mechanical Vibration – Guidelines for the Measurement and the Assessment of Human Exposure to Hand Transmitted Vibration. Switzerland: International Organization for Standardization, 1986.

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Way of building safety culture at workplaces for Vietnamese workers

Le Van Trinh, Vietnam

To achieve development, people always create and adjust their work environment to make it more comfortable, thereby increasing the quality of life. Achieving a balance between economic development, social progress and environmental protection is a global concern in order to realize sustainable development. This fact requires the implementation and development of socio-economic policies accompanied with corporate social responsibility (CSR). The Vietnamese people also recognize this.

CSR is not understood merely in relation to legislation and culture, but also in relation to issues affecting the life and working activities of employees who are exposed day after day; the influencing factors include workshop arrangements and production lines with their machinery and equipment. These ensure both productivity and the safety and health of employees, as well as environmental protection.

Enterprises are implementing CSR through the building and application of a code of conduct (COC) based on the Vietnamese legislation: labour laws, the law on trade union, the law on public health, the law on environmental protection, etc. International conventions ratified by the Government of Vietnam are also taken into account. The implementation of these COCs shows the commitment of enterprises to economic sustainable development by increasing the living standards of employees, their families and the community at large. Thus, the human factor is very important in the occupational safety and health efforts of enterprises.

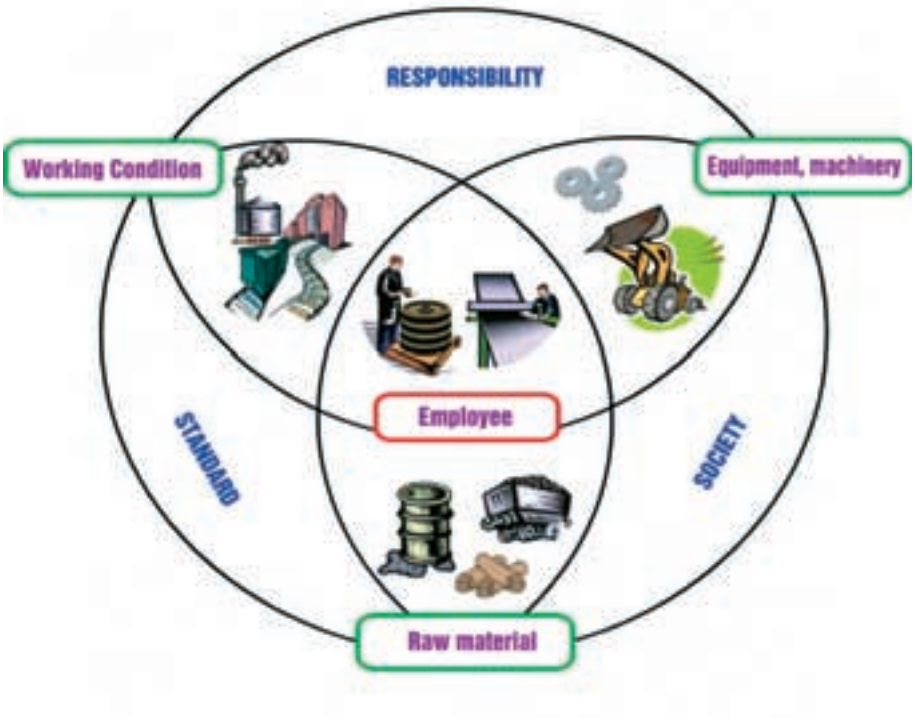

Figure 1. The factors affecting the employee

Former UN Secretary General Javier Pérez de Cuéllar has said: "Of course, development means change but change does not create the separation; it creates the specific characteristics of society and individual. First of all, development must bring the better life which is accepted by the community. And I am sure that this definition of development will be promoted by the culture". Sustainable development is development covering various areas, including the economic, cultural, environmental and technological sectors. These areas in turn are affected by humans and their culture. In other words, culture is a covering factor determining sustainable development. However, the target of development is human beings and bettering their life; therefore human beings play a very important role in development. Man and his culture in production and life in general is the basic target of sustainable development.

The working life of an individual lasts about 30 years. This is his/her most important time; therefore working conditions have an important effect on the individual's quality of life and personality. Many factors in the working conditions can affect the health and safety of employees, such as arrangement of

equipment, machinery, the pace of work, its intensity and other facilities related to production. Adjustment of these factors to make them reasonable and safe and to ensure the safety and health of employees is called Occupational Safety and Health (OSH).

Recently, the GDP in Vietnam has grown by about 8% annually and the country's economy is considered to be the most stable in the world. This success has been accomplished through the good policy of the Vietnamese Communist Party and the Government, a policy where OSH is considered to be one of the most important tasks for ensuring sustainable development. Owing to this, in the past few years OSH has obtained certain achievements. Most enterprises have an OSH committee; this is often chaired by the vice director, with the president of the trade union as the vice chairman of the committee. This committee is responsible for OSH at the enterprise.

The number of enterprises, mainly non-State owned enterprises, is increasing rapidly. In December 2005 there were 180,000 small and medium-sized enterprises (SMEs) throughout country. Many of them were not implementing OSH well: employees did not have training, or if they did, their training was insufficient. In consequence, injuries and occupational diseases have been increasing.

Statistics of the Ministry of Labour, Invalid and Social Affair (MOLISA) show that during the first six months of 2006, there were 24,000 occupational accidents causing 2,800 deaths. According to the Ministry of Health (MOH), in 2004 among 1,000,000 employees whose health had been checked, almost 40% had diseases related to the work environment; among 60,000 employees diagnosed, 14% suffered from occupational diseases. The reasons are many; one of them is employees' and employers' low level of awareness on OSH.

According to ILO statistics, 50% of the employees who had occupational injuries or who developed occupational diseases did so because of a lack of OSH knowledge. The corresponding figure in a study done by the National Institute of Labour Protection (NILP) was 72%. Most of those interviewed said that they had no OSH training; they did not know how to identify hazards and how to protect themselves. The study also showed that 70% of the employees are satisfied with their present working conditions even though they are not in good condition, especially in enterprises producing building materials, such as cement, tiles, bricks, etc. We also found that most of the workers are farmers who have only a primary school education. They are ready to accept any job, provided they can earn money.

Vietnam is now facing a great challenge in protecting the health and life of the working population. The first in the series of tasks to solve is to raise awareness of and responsibility for OSH among employers and employees. The trade union as well as other socio-political organizations should have the responsibility to guide the employees in order to ensure OSH in a comprehensive way: "Safety culture at the workplace".

The Vietnam Trade Union, through the National Institute of Labour Protection, has risen to the challenge, not only by giving training and education but also by launching action initiatives and building the mode of safety culture for employees. The action initiatives have had slogans such as "Be creative and initiate, raise productivity and the quality of products" and "Clean village, better fields". The most effective and famous has been the action initiative: "Green, clean, and beautiful ensure OSH", which was launched by the trade union in 1996 and has now become very popular. This action initiative not only mobilizes employees to participate in improving working conditions but also motivates employers positively to participate in comparison with each other in order to improve OSH in their enterprises.

At present, the NILP is implementing several projects in order to create a better way to work for the good of employees' health and safety. The aim is to raise employees' awareness and responsibility as concerns OSH and to enhance the effectiveness of the action initiative "Green, clean, and beautiful ensure OSH". The projects, which concentrate especially on workplaces, have three target actions:

- To promote, mobilize and educate employers and employees to participate in the improvement of working conditions. The goal is to have a workplace without accidents and occupational diseases (zero accident campaign)
- To raise the self-awareness of every worker, thus creating safe working practices and making them habit
- To make the employees understand that ensuring OSH also increases productivity and product quality, therefore bring them a life with "sufficient prosperity and good spirits".

After a short period of implementation in several industrial parks, some achievements have been seen. The employees have adopted some good practices in doing their jobs. However, the next steps are more challenging, because good practices are not formed overnight. Vietnam is an agricultural country (prior to 1990, 70% population were farmers). During the past 15 years of economic restructuring, a million former agricultural workers became workers employed in factories and services. It is not easy for them to change their habits, to work in a new way in industry and services.

The aim of our activity is to build the model of a worker whose knowledge and action correspond with those of workers in industrialized countries. To achieve this model, NILP implements the project on raising CSR, including ensuring OSH for employees and building the model of "Safety culture at the workplace". The objective of the project is to establish social behaviour on OSH and to integrate this into the consciousness and life style of every employer and individual. These model workers should be the examples for the new generation of workers and they should work in a new way that reflects the slogan "Safety culture at the workplace".

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ICOH2006:

Centennial celebrations, scientific new knowledge and much exchange of practical information

Photos by Suvi Lehtinen

The International Commission on Occupational Health, ICOH, celebrated its 100-year anniversary on 11–16 June 2006 in Milan, Italy. The place of the current Congress was the birthplace of the Commission a hundred years ago.

The International Commission on Occupational Health was founded in 1906 after the opening of the Simplon tunnel between France and Italy. During the construction of the tunnel, a high number of workers lost their lives due to occupational injuries but especially due to diseases caused by poor living conditions in which they lived. A total of 10,000 lives were lost during the tunnel work.

The occupational health and safety experts of the time decided that this should never recur, and founded the Permanent Commission – International Association on Occupational Health, which preceded the current International Commission on Occupational Health.

The Italian Organizers of the ICOH2006 Congress, Professor Vito Foa, Professor Pier-Alberto Bertazzi and Professor Marco Maroni, just to mention a few of the persons who contributed to the organization and arrangements of the Congress, did a great job, and the Congress was a huge success, which will certainly be remembered by all the participants.

Centennial Session

On Tuesday 13 June, the actual birthday of ICOH, a Centennial Plenary was organized where several Awards were granted. A total of three Centennial Awards were given, one to the Clinica del Lavoro Institute which has been the home of ICOH for the last century and will continue to be so in the future. Professor Pier-Alberto Bertazzi received this Award on behalf of the Institute. The other two Awards were granted to Professor Sven Hernberg who has served as member of the ICOH Board, two terms as Vice-President and two terms as Presi-

Dr. Shyam Pingle from India acted as chair of the Asian and Latin American Session, which gathered a total of some 35 experts.

dent of ICOH, and to Professor Jerry Jeyaratnam who served twelve years as ICOH Secretary-General from 1989 to the year 2000.

Distinguished Awards were granted to the previous Presidents of ICOH, to previous presidents of ICOH Congresses, as well as to Professor Moccaldi of ISPESL, which has been most generous in providing facilities and resources for the ICOH Secretariat.

Also, a Centennial Declaration of ICOH was signed. (see www.icohweb.org)

Asian and Latin American Session on Occupational Health and Safety

The Asian and Latin American Session was organized with the help of financial support from the US National Institute for Occupational Safety and Health. Professor Bonnie Rogers was the key player in ensuring the funding. The ICOH Scientific Committee on Occupational Health and Development, who organized this Session, expresses its heartfelt thanks to both the US NIOSH and Professor Rogers for the financial support without which the organization of this Session would not have been possible.

The Session was chaired by Dr. Shyam Pingle and contained six papers.

Dr. Patricia Canney reported on OSH programmes in Colombia especially in response to challenges posed by globalization. She said that it is important to have well-defined strategies where all stakeholders are key actors. Globalization brings about positive developments but also threats particularly in countries where the infrastructures for education, health and technology are weakly developed.

Challenges posed by globalization to OSH were also discussed by Professor Veronica Herrera from Chile. She reported on the changes to which workers must adapt, brought about by globalization and new organizational cultures because of companies and industries moving from one country to another.

Sustainable workplace improvement through training and benchmarking was presented by Dr. Shrinivas Shanbhag from India. He emphasized the need for trained experts in occupational health and safety, while encouraging workplace level training in occupational health and safety. He described the initiative of a large private enterprise to train health and safety change agents at enterprise level. The results have been promising.

Photo by Suvi Lehtinen

Professor Veronica Herrera and Dr. Patricia Canney exchange information.

The progress of participatory oriented training (PAOT) activities in Vietnam was described by T. That Khai and presented in his absence by Dr. Kazutaka Kogi. The approach uses farmer volunteers as trainers who then help in training good practices in occupational health and safety to the farmers. The aim of the PAOT is to support people in making changes, to encourage multifaceted improvements, and to proceed in a step-by-step improvement of working and living conditions.

Dr. Catharina Wesseling from Costa Rica described the SALTRA experience in Central America. She said that the whole programme consists of elements to support and enhance capacity building in occupational safety and health. It is a long-term programme, university-based, intersectoral, multidisciplinary, and utilizes synergies with other regional OSH programmes.

Occupational health and safety in the mining sector in China was prepared by Dr. Li Dehong and presented by Professor Hua Fu. He reported that there are still many accidents in mines, and this is one of the targets for improvements in occupational safety and health in China. The main causes of the accidents are gas blasting and floods. One approach could be to develop basic occupational health services, a method which has been piloted in China in several counties already.

All the presentations provoked lively discussion.

The aim is to publish at least the papers concerning the Asian Region in the forthcoming issues of the Asian-Pacific Newsletter in order to also allow the exchange of information to those who were not in a position to attend the ICOH Congress and the Asian and Latin American Session in particular.

ICOH issues

Dr. Kazutaka Kogi was elected as Vice-President of ICOH. Professor Sin Eng Chia of Singapore was elected to the ICOH Board. Professor Hua Fu of China, Ian Eddington of Australia, and Professor Ken Takahashi of Japan continue in the ICOH Board. The list of the members of the ICOH Board is available at http://www.icohweb.org/board.asp.

The next ICOH World Congress will be organized on 22–27 March 2009 in Cape Town, South Africa.

Suvi Lehtinen

Photo by Suvi Lehtinen

ICOH2006:

Observations on the ICOH sessions dealing with noise

The theme of this 100-year jubilee conference was "Renewing a century of commitment to a healthy, safe and productive life", thereby emphasizing its dedication to responding to the challenges of a new century. The theme was reflected in many sessions and presentations, thus clearly spurring forward action to promote working conditions, risk assessment and improvement of workers' health and wellbeing.

It was pointed out in several plenary sessions that noise poses one of the most severe threats to workers' health even though definite progress has been realized, especially in industrialized countries. Despite this, however, much remains to be done in order to raise occupational health and safety efforts to the level required to ensure safety. The role of networking and of international co-operation in all safety work was stressed.

A good example was the special session organized on "Risk of hearing loss from noise and chemicals".

The issue is very topical, as combined exposure to noise and ototoxic chemicals has to be taken into account in the new European Noise Directive. More than 750 chemicals belong to this group. The most important and most commonly used chemicals falling into this group are styrene, toluene, xylene, N-hexane, carbon disulfide and their mixtures.

A "NoiseChem" study on this topic was carried out as a European project in order to give practical guidelines that can be applied at places of work. The interactions between noise and chemicals were clearly established. It was also demonstrated that some other environmental and individual factors have at least an additive, if not a potentiating, effect on hearing. Also emphasized was the role of impulse noise, which was suspected to be very hazardous together with solvents.

To summarize this session, we can conclude that occupational exposure to organic solvents is associated with an increased probability of developing hearing loss. It was also revealed that combined exposure to noise and organic solvents is associated with a substantially higher risk of hearing loss than isolated exposure to either of these factors. Moreover, it was shown that there is a relationship between the concentration of organic solvents and hearing threshold shifts, especially at high frequencies.

Based on the "NoiseChem" findings, we can also conclude that the current national occupational exposure limit (OEL) values for solvents do not account for possible solvent ototoxicity and perhaps do not provide sufficient protection for exposed populations. In working to solve the problem, we will need a new global "NoiseChem" policy. The content of such a policy proposal could be:

- To acknowledge that hearing may be affected by chemical exposure
- To consider the ototoxicity of chemicals to be a hazard and the combined exposure of such chemicals with noise to be a still greater hazard
- To review the guidelines on permissible levels for each agent in the presence of the others, taking into account that synergistic effects within current limits may occur
- To stress the importance of hearing conservation in the case of exposure to any of the chemicals concerned
- To consider alternative protection measures whenever possible.

Moreover it was proposed that exposure to pesticides and fumigants can also pose a risk for hearing and that the effects of chemicals on balance can be an early indication of neurotoxicity.

Jukka Starck

Bhopal revisited – the tragedy of lessons ignored

Annie Rice, ILO

"Those who cannot remember the past are condemned to repeat it"
George Santayana, Spanish philosopher, 1863–1952

Photo by the ICFTU/ICEF mission

The Bhopal plant. In the foreground, tank 610 from which the MIC escaped after water entered the tank. In its 20 March 1985, report, Union Carbide Corporation speculated on the possibility of sabotage. A much more credible explanation for the water ingress is faulty maintenance procedures, as explained to the trade mission to Bhopal.

During the early morning hours of 3 December 1984 at least 2,500 people were killed by the release of a toxic cloud of methyl isocyanate gas from a runaway chemical reaction at a Union Carbide plant in Bhopal, India. This was the start of the world's worst chemical disaster. In the months and years that followed thousands of local residents presented with multiple symptoms and ill-health with devastating consequences for their livelihoods and future.

At the time, many people in developed countries viewed the Bhopal tragedy as an isolated event in a far away land that resulted from conditions and factors endemic to developing countries. Statements were made by governments and the chemical industry that such an accident could not occur in the industrialized Western countries. Some even suggested that accidents like Bhopal were to be expected, the price that must be paid for technological development.

So it was that on 31 March 1985, four months after the accident, the International Confederation of Free Trade Unions and the International Federation of Chemical, Energy and General Workers' Unions, dispatched a mission[1] to Bhopal. Its purpose was to study the causes and effects of the gas leak and to make recommendations to help prevent similar accidents from occurring in India or elsewhere in the world – in other words, to help prevent further Bhopals.

Our investigation and report (1) detailed a number of alarming weaknesses in the safety of the Bhopal plant, beginning with the basic design of the process equipment. We determined that the Bhopal disaster was caused by a combination of factors, including the long-term storage of MIC in the plant, the potentially undersized vent gas scrubber, the shutdown of the MIC refrigeration units, the use of the backup tank to store contaminated MIC, the company's failure to repair the flare tower, leaking valves, broken gauges, and cuts in manning levels, crew sizes, worker training, and skilled supervision. The accident might have been prevented if Union Carbide Corporation (the parent company) had done more to follow up its 1982 safety inspection, or if UCIL (the Indian subsidiary) or the government had heeded the complaints of trade unions representing the Bhopal workers. The mission concluded that the governments of India and the state of Madhya Pradesh did not cause, and were not directly responsible for the gas release. However, stronger occupational safety and environmental regulations and stricter enforcement could have helped prevent it.

The specific items which caused the tragedy and the specific way they came together on the night of the accident may have been unique, but the underlying causes...

- insufficient attention to safety in the process design
- dangerous and irresponsible operating procedures
- inadequate maintenance
- faulty equipment
- cutbacks in staff
- inadequate training
- lack of management and government response to safety complaints
- the siting of potentially dangerous plants in heavily populated areas
- lack of information
- lack of disaster planning

... were not unique.

In the experience of the members of the mission, the factors which led to the Bhopal disaster were common to many chemical manufacturing and other industrial processes around the world. The conditions were not the inevitable result of technological progress, but dis-

[1] *Members of the mission included a number who had considerable experience with the technical aspects of the process and the accident. The author was a member of the mission in 1985.*

crete and well-recognized problems that could have been prevented. The mission drew many lessons from its investigation, not least of which was that, unless better national and international regulations were developed and strictly monitored by managers, trade unions and governmental authorities, the next disaster would be only a matter of time.

As a result of the mission's recommendations, a Resolution (2) was adopted by the ILO's International Labour Conference in 1985. This called on its tripartite constituents (governments, employers' and workers' organizations) to take concerted action to develop the legislation, policies, infrastructure and practical measures to improve the control of hazards related to the production and use of hazardous substances.

This was followed by a practical manual (3) aimed at assisting countries in establishing a well-defined and systematic approach to major hazard control. It was designed to deal with the safety aspects of siting, planning, design, construction and operation of plants. It explains how to identify major hazard installations and describes the components of a major hazard control system, as well as planning for emergencies, both on-site and in the surrounding community.

The Bhopal disaster certainly prompted considerable progress in regulations and administration at all levels in its wake. The great tragedy remains that, although a new level of awareness was created about hazardous substances and industrial risks, the lessons have in many instances been ignored. The result is a long string of major accidents in both industrialized and developing countries since.

Even before the ILO could bring out its Major Hazard Control Manual, for example, the Chernobyl disaster had claimed many dead and over 300,000 evacuated, the Herald of free Enterprise had sunk in the English Channel with over 180 deaths. Many of the factors in the accidents recall those in the Bhopal disaster, and which were targeted in the ILO Resolution – unsafe design, poor operating practices, etc.

In the years that followed, further international guidance was developed, including an ILO Code of Practice (4) intended for all those who have responsibility for the prevention of major industrial accidents. This provides guidance for the setting up of an administrative, legal and technical system for the control of major hazard installations. It also seeks to protect workers, the public and the environment by preventing major accidents from occurring in the first place and minimizing the consequences of a major accident should one occur. In this respect it speaks to competent authorities, works managements, emergency services, government inspectors, as well as to employers' and workers' organizations.

In 1993, the International Labour Conference adopted a Convention on the Prevention of Major Industrial Accidents, and an accompanying Recommendation (5). The main effect of this was to put the requirements detailed in the previous documents in a succinct and binding form for the Member States which would ratify the Convention. Unfortunately, only 11 countries have ratified it. (Albania, Armenia, Belgium, Brazil, Colombia, Estonia, Lebanon, Netherlands, Saudi Arabia, Sweden and Zimbabwe. Asia and Pacific countries are noticeable by their absence from this list.)

Whatever it is that is preventing governments from ratifying C174 is also allowing major industrial accidents to continue. To name but a few:

- 1993, a major fire at the Kader Industrial (Thailand) Co. toy factory in Bagkok killed 188 workers, most of them young women
- 2000, a series of explosions in a fireworks factory in Enschede, Netherlands, left 22 dead and nearly a thousand injured
- 2000, a fire in a knitwear and garment factory near the Bangladesh capital of Dhaka claimed the lives of 48 workers. Just a few months later, in August 2001, another fire in a similar factory killed a further 24 workers in Dhaka
- 2001, an ammonium nitrate explosion in a fertilizer factory in Toulouse, France killed 31 people and devastated the neighbourhood
- 2000–2006, disaster after disaster over recent years has left mining the most deadly industry in China. Explosions routinely kill tens of workers each.

The Bhopal disaster provided many lessons. Many of the lessons have been taken up by the international community and individual states. But still too many are being ignored, as testified by the continuing toll of accidents such as those mentioned above. Perhaps the biggest tragedy is when the lessons are learned but ignored.

References

1. ICFTU/ICEF. The Trade Union Report on Bhopal, Brussels/Geneva, 1985. Also available on: http://www.ilo.org/public/english/protection/safework/chemsfty/bhopal/icftu.pdf
2. ILO Resolution concerning the Promotion of Measures against Risks and Accidents Arising out of the Use of Dangerous Substances and Processes in Industry. ILO Annual Labour Conference 1985.
3. ILO, Major Hazard Control – A Practical Manual, Geneva, 1988.
4. ILO, Prevention of Major Industrial Accidents, Geneva, 1991.
5. ILO, C174 Prevention of Major Industrial Accidents Convention, and R181 Prevention of Major Industrial Accidents Recommendation, 1993.

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The Bhopal disaster 1984

– working conditions and the role of the trade unions

Ingrid Eckerman, Sweden

Background

The Bhopal Gas Leak, India 1984 is the largest chemical industrial accident ever. 520,000 persons were exposed to the gases, and 8,000 died during the first weeks. 100,000 persons received permanent injuries. The catastrophe has become the symbol of negligence to human beings on the part of transnational corporations. The direct cause of the gas leak in Bhopal was the large amounts of water that entered tank 610, containing 43 tonnes of methyl isocyanate (MIC). A run-away reaction started, which was accelerated by contaminants, high temperatures and other factors.

There are still different opinions as to the cause of the Bhopal disaster and as to who was responsible. According to the Union Carbide, it was sabotage by a disgruntled worker. However, analysis of causes and consequences show that irrespective of the direct cause of the leakage, there are only two parties responsible for the *magnitude* of the disaster: the Union Carbide Corporation and the Governments of India and Madhya Pradesh. The most important factors were plant design and economic pressure. The latter led to the deterioration not only of the safety systems but also of the staff policy, which in its turn contributed to the occurrence of the disaster. The governments not only failed to implement occupational safety regulations before the leakage, but also failed to provide adequate medical treatment and rehabilitation afterwards.

Staffing policy

To be an operator at the MIC plant in the beginning, one had to be either a graduate in science or to hold a diploma in engineering. Later, eight weeks of training was enough. Workers and operators were given more responsibility than their training and competence equiped them to cope with. In 1982, most of the original MIC operators had resigned. Workers from other plants were asked to take MIC plant training. After only 14 days of training in the MIC unit, they were asked to take charge of a regular plant operator's position independently. Secrecy issue hampered the workers' acquisition of knowledge. The manuals were kept in the safe custody of the manager. The plant operating manual was available only in English.

During the training period, technicians were treated as casual workers. After the training, they were only paid an hourly rate. A technician who accepted a job at the MIC plant got a paper about receiving six months of training, but after five weeks he was asked to stop the training and to take charge as a full-fledged plant operator. In the matter of promotions, individuals with little experience but with unquestioning loyalty to the bosses were invariably selected before others. A demand for extra safety precautions led to warnings that appointments could be terminated.

Contract workers without safety equipment did dangerous work that should have been done by machines. Workers and operators were routinely exposed to toxic chemicals such as MIC, carbon tetrachloride, trimethylamine, alpha-napthol and carbaryl dust. They seldom had the equipment recommended in the manuals.

In 1983 and 1984 there were personnel reductions in order to cut costs. Workers were encouraged to take early retirement, 300 temporary workers were laid off, and another 150 permanent workers were put in a pool to be assigned to jobs as needed. The operating shifts were cut from twelve to six and the maintenance shifts from six to two. The positions of second-shift and third-shift maintenance supervisor had been eliminated just a few days before the disaster. On the night of the disaster, there were no trained engineers on the site. The responsible production supervisor who was on duty had been transferred from a Carbide battery plant only one month before.

Operators were examined by the plant doctor every six months; examination included blood and urine tests. The employees were never told the results of these examinations. The management of Union Carbide India Ltd (UCIL) advised the workers to develop resistance against toxic substances by drinking six or seven glasses of milk a day and eating a high-protein diet of fish and eggs.

Company policy forbade employees to speak for the company without authorization, especially in emergency situations.

The personnel management policy led to an exodus of skilled personnel to better and safer jobs.

Previous warnings

In 1976, the two trade unions reacted because of pollution within the plant. Letters were sent to the managers of the plant and the factory inspector as well as to the Ministry of Labour of Madhya Pradesh. They never received any answers. In 1981, a worker was splashed with phosgene. In panic he ripped off his mask, thus inhaling a large amount of phosgene gas; he died 72 hours later. The managers blamed the worker for removing his mask. The workers' union pointed out that it was the malfunctioning valve that led to the accident, and that the worker had not been provided with a PVC overall.

In January 1982, there was a phosgene leak, when 24 workers were exposed and had to be admitted to hospital. None of the workers had been or-

dered to wear protective masks. After this accident, the workers agitated for safer working conditions. In February 1982, an MIC leak affected 18 workers. In August 1982, a chemical engineer came into contact with liquid MIC, resulting in burns over 30 percent of his body. In October 1982, there was a leak of MIC, methylcarbaryl chloride, chloroform and hydrochloric acid. As an operator was opening a valve in an MIC pipeline, the joint linking it to several other pipes unexpectedly broke. In attempting to stop the leak, the MIC supervisor suffered intensive chemical burns and two other workers were severely exposed to the gases. During 1983 and 1984, leaks of the following substances regularly took place in the MIC plant: MIC, chlorine, monomethylamine, phosgene, and carbon tetrachloride, sometimes in combination.

The night of the disaster

Those in charge of the MIC plant on the evening of 2 December were not familiar with the factory's complex maintenance procedures, and they knew nothing about MIC or phosgene. The supervisor was convinced that there could not be a leak as production had been stopped.

The supervisor from the day shift had left instructions on flushing the pipes leading from the MIC tanks to the vent gas scrubber with water. He forgot to mention the slip-binds that should have been placed at each end of the pipes. When the worker placed the stopcocks, he was not sure that they tightened completely, because of corrosion and rust. He cut off the water. The supervisor told him to clean the filters. When the worker turned on the water, it came out only through three of the four drain-cocks. He was told to keep the water running, and that the night shift would turn it off.

The workers maintain that entry of water through the plant's piping system during the washing of lines was possible because a slip-bind was not used, the downstream bleeder lines were partially clogged, many valves were leaking, and the tank was not pressurized. Carried with the water were iron rust filings from corroding pipe walls, residue of the salt compounds that had blocked the lines being washed, and other contaminants that speeded up the reaction.

The role of trade unions

At the UCIL plant in Bhopal, the workers were organized in two competing trade unions. The management tried to use the rivalry to its advantage in contract negotiation. Not until 1984 was the Union Carbide Karmachari Sangh recognized.

The workers' unions reacted as early as 1976, because of the pollution within the plant (see above). After the leak in 1982, the trade union printed 6,000 posters with warning texts that were distributed throughout the community. The Hindu union leader went on a hunger strike at the entrance to the factory. The result was that all political and trade union meetings inside the factory were banned. One UC staff member burnt the principal union's tent. In the ensuing scuffle, several people were injured. The two trade union leaders were laid off. Meetings and processions were held throughout the city. As the UCIL staff regarded the plant as "one of the safest ships in the modern industrial fleet", the demonstrations were considered to be a campaign by agitators wanting higher salaries and shorter working hours.

After this, the union changed its focus from the potential danger to all workers and the surrounding neighbourhood because of hazardous design, to the need to protect individual workers. The national trade unions did not take any active part in the protests after the leakage of 1984. The trade union leaders were not arrested together with other activists in the June 1985 midnight scoop. It is said to be due to a deal, made with the police, that the unions would not take part in the demonstrations.

The Union Research Group in Bombay formed the Trade Union Relief Fund, to support the workers' struggle for alternative food production at the UCIL plant. In 1985, 400 people stormed into the plant to begin a sit-in to protest over job losses. The occupation of the plant did not end until December 1985, when UCIL made a large cash settlement with the workers. However, the campaign was criticized on various grounds.

When the Bhopal Gas Affected Women's Stationery Workers' Union marched to Delhi in 1988 to fight for their rights, they got no support from the trade unions in Delhi.

Observers from two international trade unions came to Bhopal after the leakage. This resulted in the report "The Trade Union Report on Bhopal", that was written "in response to our Indian affiliates".

Today, trade unions from across the world express solidarity with the cause of Bhopal gas victims. A joint appeal was issued in 2003 by trade union representatives from over 25 countries.

Comments

Deficiencies in the management of UCIL can be summarized as follows:

- Lack of skilled operators because of the staffing policy
- Lowering of safety management because of staff reductions
- Insufficient plant maintenance
- Lack of emergency response plans.

The two main theories as to how the water entered the tank are the sabotage theory and the water washing theory. UC has pointed out contradictions in the statements from the witnesses.

However, sabotage would have been improbable if

- maintenance had been good
- the safety systems had been working
- the saboteur would have wanted to save his own life and health.

The local trade unions were the first to react to the hazards at the Bhopal plant. We do not know whether they were aware of the plans for closing down the plant. It is likely that there would have been forceful protests against the risks of unemployment, although from a public health and environmental perspective, closing down the plant would have been absolutely the best action.

Literature

Eckerman I. The Bhopal Saga – Causes and Consequences of the World's Largest Industrial Disaster. Hyderabad, India: Universities Press (Private) India Ltd, 2004.

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The Global Network of WHO Collaborating Centres in Occupational Health: Work Plan 2006–2010 approved

The Global Network of WHO Collaborating Centres in Occupational Health held its seventh meeting on 8–9 June 2006 in Stresa, Italy, immediately before the ICOH World Congress. The previous meetings of the Network had been held in 1992 in Moscow, in 1994 in Beijing, in 1997 in Bogota, in 1999 in Helsinki, in 2001 in Chiang Mai, and in 2003 in Iguassu Falls. Of the 64 Collaborating Centres, a total of 45 were represented at this particular meeting. Professor Marco Maroni and his co-workers did a great job in organizing the meeting.

Only two weeks after the Meeting a very sad message reached us: Professor Marco Maroni had suddenly passed away. The international occupational health community lost a dedicated and enthusiastic leader, and shares the grief of his family and colleagues.

Photo by Suvi Lehtinen

The contents of the six Activity Areas were carefully and thoroughly discussed in the meeting.

Work Plan 2006–2010

During 2001–2005, Network activities were carried out through fifteen Task Forces dealing with the topics of:

1. Guidelines
2. Intensive partnership in Africa
3. Child labour/adolescent workers
4. Elimination of silicosis
5. Health care workers
6. Health promotion
7. Psychosocial factors at work
8. Promotion of occupational safety and health in small enterprises and in the informal sector
9. Prevention of musculoskeletal disorders
10. Preventive technology
11. Training programmes and modules
12. Internet resources and networks
13. National profiles and indicators
14. Economic evaluation of interventions, and
15. Global burden of disease.

The six Activity Areas that will serve as the basis for work during the next five years are:

1. Global situation analysis
2. Evidence for action, and national policies and action plans
3. Practical approaches to identify and reduce occupational risks
4. Education, training, and technical materials
5. Development and expansion of occupational health services, and
6. Communication and networking.

During the two days, all the 120 people participating in the Network meeting discussed, modified and approved the six Activity Area work plans, two topics at a time. The idea is that the projects carried out within the six Activity Areas are regional, involve several Collaborating Centres and several countries, and produce practical tools to improve working conditions and workers' health. Every participant had the possibility to select his/her own topic of participation as well as the project proposal to which the institutions committed themselves to contribute.

The work plan of the Network for 2006–2010 is accessible at: http://www.who.int/occupational_health/network/2006compendium/en/index.html

Global Plan of Action on Workers' Health

The Global Plan of Action was introduced by Dr. Maria Neira, Director of the Environment and Public Health Division at WHO Headquarters. She reminded the participants of the fact that the target group of occupational

health encompasses half of the world's population. Poor working conditions result in a high number of occupational fatalities, accidents and injuries, as well as occupational diseases. Over 2 million deaths because of occupational accidents, injuries and diseases and 160 million new cases of work-related diseases a year are the toll that is paid due to poor working conditions. Among the challenges she mentioned was the changing world of work, which means that new exposures are introduced while the old ones still remain. The weak capacity of the public system, inadequate focus on occupational health, and social inequities were also mentioned as major challenges for occupational health and safety in the years to come. Addressing the lack of competent occupational health personnel was given as a primary focal point in forthcoming activities. Migration, precarious work, and sectors and occupations involving a high risk all call for special attention. In addition, Dr. Neira pointed out that children and elderly are among the most vulnerable groups in need of special attention.

As principles for global action, Dr. Neira listed the following: All workers have the right to safe and decent work; the workplace can be used as a setting for promoting health and safety; workers' health requires a coordinated response; and workers' health can be addressed through non-health agendas as well as through health agendas.

These global action principles all call for our joint efforts.

Photo by Suvi Lehtinen

The Declaration ws signed by Dr. Max Lum (right), Mr. Kaj Elgstrand (signing), Dr. Eduardo Algranti, Professor Harri Vainio (far back), Professor Sin-Eng Chia, Dr. Mary Ross, and Professor Marco Maroni.

Declaration on Workers' Health

A Declaration on Workers' Health was compiled in order to emphasize the importance of occupational health and safety on the agenda of WHO and all Member Countries. The Declaration was signed by the Advisory Committee of the Global Network of WHO Collaborating Centres in Occupational Health. The institutions represented in the Global Advisory Committee are: US NIOSH; the National Institute for Working Life, Sweden; the Finnish Institute of Occupational Health; the Institute for Pesticide Safety and Health Risk Prevention, Italy; the National Institute of Occupational Health, South Africa; the National University of Singapore; and FUNDACENTRO, Brazil.

The Declaration is accessible at: http://www.who.int/occupational_health/Declarwh.pdf.

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The 26th UOEH and the 7th IIES International Symposium

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as of 22 May 2006