AUDIOMETRY IN THE WORK PLACE

1. INTRODUCTION

1.1 Hearing is one of our precious senses, losing it has far reaching consequences for the worker, the family and society as a whole. Employers, workers and health professionals must protect hearing as far as reasonably practicable.

1.2 Noise is a significant health hazard and implementation of Hearing Conservation Programmes is compulsory if workers are exposed to noise more than the noise rating limit.

1.3 A decision taken at the South African Mine Health & Safety Summit in 2003 stipulates that “after December 2008, there should be no cases of compensable hearing loss amongst occupationally (noise) exposed individuals” There is still a long way to go!

1.4 It is important to make a distinction between impairment, disability and handicap (WHO 1980). Impairment refers to functional abnormality due to changes in the auditory system, as in the case of Noise-Induced Hearing Loss (NIHL). Hearing disability refers to the functional limitations caused by impairment in everyday activities, primarily where communication is concerned. Handicaps refer to the social consequences of impairment, such as social isolation and unemployment.

1.5 Workers with hearing impairment require a Signal to Noise (S/N) ratio of up to 25 dB higher than those of workers with normal hearing to be able to detect, recognise and localise the sound. Due to the characteristics of the warning signals in industry and the necessity to wear hearing protection, workers with hearing impairment are more prone to accidents than workers with normal hearing.

1.6 According to ISO 1999 -1990, the range for normal hearing is 0-25 dB. However, normal conversation starts to be affected with a hearing loss of 15 dB in most frequencies.

1.7 Exposure to solvents could cause or aggravate hearing loss. Both the type of chemical and concentration are important. E.g. In a paper mill a larger proportion (23%) of the workers in the chemical section who were exposed to organic solvents had a pronounced hearing loss despite lower noise levels (80–90 dB) than workers in a non-chemical environment who were exposed to higher noise levels of 95–100 dB (Bergström et al. 1986). A combined exposure to toluene and noise increased the risk of hearing loss by 11 times (Morata et al. 1991).

1.8 Individual susceptibility also plays a significant role in noise-induced hearing loss (Chung 1982, Pyykkö et al. 1989). Factors such as mentioned below could explain up to 35% variation of NIHL:

1.8.1 Elevated blood pressure (McCormic et al. 1982, Pyykkö et al. 1989)
1.8.2 Elevated cholesterol levels (Rosen and Olin1965)
1.8.3 Smoking (Gruckshanks and Klein 1998, Rosenhall et al. 1993)
1.8.4 Regular use of analgesics. Myers and Bernstein 1965, Smith et al. 1985, Graham and Parker 1948)

2. LEGAL FRAMEWORK

2.4 SABS 1451: Standard Specification for Hearing Protectors, Part 2 – Ear Plugs
2.6 SANS 10083:2004
2.7 Compensation for Occupational Injuries and Diseases Act (Act 130 of 1993).
2.8 Compensation Commissioner circular instruction No 171 and Supplement entitled Determination of permanent disablement resulting from noise induced hearing loss and injury.

3. EFFECTS OF NOISE

Noise has physical and psychological effects on health, including:
3.1 Hearing loss or impairment
3.2 Tinnitus
3.3 Hypertension
3.4 Ischemic heart disease
3.5 Annoyance
3.6 Sleep disturbance
3.7 Changes to the immune system
3.8 Birth defects
3.9 Vasoconstriction
3.10 Stress
3.11 Increases rate of workplace incidents
3.12 Aggression and other anti-social behaviour

4. HEARING CONSERVATION PROGRAMMES

4.1 A Hearing Conservation Programme (HCP) must be in place whenever the noise in any workplace exceeds the noise rating level (NRL) of 85 dBA.

4.2 It must be based on scientific evidence derived from Hazard Identification and Risk Assessment programmes.

4.3 It must include:
4.3.1 Assessment and prediction of noise exposure in all workplaces accessed by any person.
4.3.2 The reduction of the 8h rating level, where it exceeds or is expected to exceed the NRL of 85 dBA making use of the hierarchy of controls.
4.3.3 Action steps to prohibit any person from entering or being in a workplace that exceeds the NRL unless the person is adequately protected.
4.3.4 A medical surveillance programme for all workers exposed to noise levels above the NRL.
4.3.5 Provision of Personal Protective Equipment (PPE), namely hearing protection devices, if
all other control measures are inadequate.

4.3.6 Initial and periodic training of workers and supervisors.

4.3.7 Motivation of workers to comply with HCP policies.

4.3.8 Establishment of a PPE program as part of the company's HCP.

- Procedures for selection, fitting, maintenance, storage, monitoring of use and training
- The program should state the standards the company wants to meet in the use of PPE and the legislative requirements it needs to meet.
- It must be kept in mind that attenuation of hearing protective devices also depends on environmental factors. In a cold environment, the hardening of the cushion rings causes a slight but systematic worsening in attenuation. In the winter workers use helmet liners which may nullify the attenuation of the hearing protectors. Worn out cushions and reduction in spring force also affect attenuation.

4.3.9 The referral threshold shift is to be used to evaluate the efficacy of hearing conservation programmes that involve the use of hearing protective devices and is not to be used for compensation or any other purposes (SANS 10083:2004). A referral threshold shift refers to a change or deviation for the worse of 15dB or more from the hearing level obtained from the baseline audiogram at the hearing levels of 0.5, 1, 2, 3, 4, 6, 8 kHz.

4.4 A HCP should be reviewed every two (2) years (SANS 10083:2004)

5. MEDICAL SURVEILLANCE

5.1 Workers working in noise areas or who are exposed to noise at or above the noise-rating limit must be submitted to medical surveillance. It must include a relevant history, ear examination and audiometric testing. These must be done at Initial Health Evaluation, periodic examinations and at Exit Health Evaluation.

5.2 Occupational Medicine Practitioners (OMP) and Occupational Nursing Practitioners (ONP) must be conversant with the specific statutory requirements and instructions regarding such medical surveillance.

5.3 Workers must be issued with certificates after each examination indicating the results of the audiograms and whether they are fit for the specific type of work or not.

5.4 Requirements to perform an Audiometric Test

Screening audiometers, sound booths, test environment, person conduction audiometric screening tests and test frequency must comply with statutory requirements. Automatic audiometers are more accurate than manual audiometers that use 5 dB steps and it is advisable to use automatic audiometers.

5.5 Frequency of Examinations

Audiometric tests of workers must be performed in accordance with SANS code 10083: 2004 and the Noise-Induced Hearing Loss Regulations (NIHL):

5.5.1 Baseline audiometry must be conducted on all workers expected to work in or enter a noise zone at the workplace before such workers commence employment or within 30 days of commencement of employment if valid baseline results have not yet been determined at a previous workplace.

- An otoscopic examination and medical and occupational history must be done before all audiograms.
- The baseline audiogram should consist of two (2) audiograms, done on the same day and, it should not differ from each other by more than 10 dB for any of the following measured test frequencies i.e. 0.5, 1, 2, 3 and 4 kilohertz (kHz). (SANS 10083:2004, 17.3)

- The two audiograms for a baseline audiogram should be done at least 5 -10 minutes apart, it should not be done consecutively. (SANS 10083:2004, 17.3 note 1)

- Consider the better of the 2 audiograms (the audiogram with the lowest PLH) as the baseline audiogram against all subsequent audiograms will be compared.

- If it is imposable to obtain two audiograms that comply with the requirements of regulation 11.4(6), (Mine Health and Safety act) the worker must be referred to a competent person to establish baseline-hearing levels.

- If it is impossible for the competent person to establish baseline-hearing levels the competent person may establish baseline-hearing levels by using other techniques, such as speech reception thresholds.

- A worker can have only one baseline in his/her working life. If a baseline audiogram has been done by a previous employer, a new employer can NOT do a “new” baseline. The new employer must obtain the worker’s baseline audiogram from the previous employer. Employers must provide workers with exit audiogram to present to the next employer.

5.5.2 Periodic screening audiometry should be conducted:

- Annually during the first three years of employment. Thereafter at a maximum interval of two years, if no referral threshold shift has occurred and noise exposure conditions have not intensified.

- Any worker showing a referral threshold shift should be tested annually for the next consecutive three years before biennial testing may be considered for the worker concerned.

- Every 6 months when workers are exposed to noise levels equal to or exceeding an 8-hour rating level of 105 dB until it is established that no referral threshold shift is evident, thereafter at a maximum interval of one year.

- Every 6 months when workers are regularly exposed to gunshots or other explosive events during their workday, until it is established that no referral threshold shift is evident, thereafter at a maximum interval of one year.

- Where an audiogram shows deterioration by more than 10% PLH shift from the baseline, or audiogram shows more than 10% PLH with no baseline available, the worker should be re-tested after 16 hours of no noise exposure. The worker should be advised of corrective steps and be re-tested again two (2) months later.

- Any worker showing a referral threshold shift should be tested annually for the next consecutive three (3) years before biennial testing may be considered.

5.5.3 Exit audiometry should be conducted:

On termination of service for whatever reason. A copy of the baseline- and exit audiograms must be given to the worker. An audiometry result done during the period of six months preceding the date when the exit audiometry is required is acceptable.

5.6 Timing of Tests

5.6.1 Baseline audiogram. A period of at least 16 hours with no exposure to the noise rating limit for hearing conservation is necessary before baseline testing as indicated in SANS Code 10083, clause 17.5 is required. The wearing of hearing protectors shall not satisfy this requirement.
5.6.2 Periodic screening audiometry as indicated in SANS Code 10083, clause 18.2, the wearing of hearing protection equipment that complies with the relevant part(s) of SANS 1451 will be allowed.

5.7 Audiometry test requirements according to:

5.7.1 Mine Health and Safety Act
Baseline and hearing loss average in decibels (dB) at the frequencies 0.5, 1, 2, 3 kilohertz (kHz).

5.7.2 Noise Induced Hearing Loss Regulations
Baseline and hearing loss average in decibels (dB) at the frequencies 0.5, 1, 2, 3, 4 kilohertz (kHz).

5.7.3 Instruction 171
Hearing loss average in decibels (dB) at 0.5, 1, 2, 3, 4 kilohertz (kHz).

5.7.4 SANS 10083:2004
- Baseline average in decibels (dB) at the frequencies 0.5, 1, 2, 3, 4 kilohertz (kHz).
- Pure tone audiometric tests shall at least include the frequencies: 0.5, 1, 2, 3, 4, 6 and 8 kilohertz (kHz).

5.7.5 Department of Minerals and Recourses
- Pure tone audiometric screening at 0.5 kHz, 1 kHz, 2 kHz and 3 kHz must meet the following criteria:
  - Age 16-39: pure tone average of 15 dB or less;
  - Age 40 and above: Pure tone average of 25 dB or less;
  - Irrespective of age: a threshold of 45 dB or less at 3 kHz.
- Workers with > 60 dBA pure tone hearing loss (0.5 kHz, 1, 2 and 3 kHz) are not fit to work in a noise zone at a mine.
- Serving driver for passenger and goods conveyance is no longer fit to work as a driver if there is hearing loss of > 40 dBA pure tone at 0.5, 1, 2 and 3 kHz.

6. INTERPRETATION AND MANAGEMENT OF AUDIOMETRY RESULTS

6.1 For the calculation and determination of percentage loss of hearing (PLH) for both binaural- and monaural Hearing Impairment refer to the Compensation for Occupational Injuries and Diseases Act, 1993 (No. 130 of 1993) Circular Instruction No. 171-noise

6.2 PLH values:
-10 – 10 % = Normal Hearing
10.1 – 15 % = Person becomes aware of hearing problem
>15 % = Person has hearing problems

6.3 The shape of the audiogram can reveal the cause of hearing loss. NIHL is most profound at frequencies of 3 - 6 kHz, exists in both ears and is usually greater in the left ear.

6.4 A Referral Threshold Shift (RTS) shift refers to the deviation or a change, for the worse, of more than 15 dB from the baseline audiogram at the levels 500 Hz, 1 kHz, 2 kHz, 3 kHz, 4kHz, 6kHz, or 8kHz.
6.5 The following should be done for a PLH of less than 10% from the baseline:

- **0.3 – 2.9 %**
  - Re-instruct and re-educate worker in the use of PPE
  - Repeat audiometry after 16 hours of no noise exposure
  - Assess the appropriateness of the PPE
  - Investigate noise area and use of PPE
  - Repeat the audiogram after 2 (two) months

- **3.0 – 9.9 %**
  - Re-instruct and re-educate worker in the use of PPE
  - Repeat audiometry after 16 hours of no noise exposure
  - Assess the appropriateness of the PPE
  - Investigate noise area and use of PPE
  - Repeat the audiogram after 2 (two) months

- **10% or more**
  - The audiogram must be repeated.
  - If the shift is still 10% or more remove the worker from the noise zone.
  - Refer the worker to an audiologist for a diagnostic audiometric examination.
  - The worker should be regarded as a candidate for compensable hearing loss and it must be reported to the Compensation Commissioner.
  - The date of the diagnostic audiometric evaluation should be regarded as the commencement date of the occupational hearing loss.

6.6 Percentage Binaural Impairment values:

- All existing workers of whom the baseline result shows a Percentage Binaural Impairment (PBI) of more than 1.7% could, in terms of the relevant legislation, be considered for compensation purposes. (SANS 10083:2004. 17.11.1)
  - Such workers should be removed from the noise zone as soon as possible.

6.7 The supervisor must be informed in writing of all the affected workers. He/she must investigate the cause and exert stricter control concerning the wearing of hearing protectors.

6.8 If the audiogram still shows a referral threshold shift after two months the worker must be referred to the OMP. The OMP should provide a medical opinion whether the hearing loss is work related or not.

6.9 The OMP should provide a medical opinion if the case is uncomplicated and the degree of disablement is expected to be 15% or less (PLH 30% from baseline).

6.10 The worker must be referred to an Ear, Nose and Throat Specialist if the case is complicated or the degree of disablement is expected to exceed 15% (PLH > 30% from baseline.)

6.11 Workers should preferably be removed from the noise area when their PLH is more than 15%, but definitely at more or equal to 30%.

6.12 If the OMP regards the worker as a possible candidate for compensable hearing loss in terms of the relevant legislation, the worker should be removed from the noise environment for 24 hours prior to being referred to an audiologist for diagnostic audiometric examination.
7. RECORDKEEPING

7.1 All audiometry records must be kept for 40 years after termination of employment. (Act no. 85/1993, NIHL Regulations, Section 11(f) and SANS Code 10083, clause 21)

7.2 Record of training given to a worker must be kept for as long as the worker remains employed at the workplace in which he or she is being exposed to noise. (Act 85/1993, NIHL Regulations, Section 11(g))

8. INFORMATION AND TRAINING

Training must be conducted prior to placement of workers.

Refresher training must be conducted annually or at intervals that may be recommended by the Occupational Health and Safety Committee. Workers must sign for attending information and training sessions.

Information and training sessions should include:

8.1 potential of exposure to noise
8.2 potential risk to health and safety caused by noise exposure
8.3 measures taken by the employer to protect workers from the detrimental effects of noise.
8.4 precautions to be taken by workers to protect themselves from this risk
8.5 correct use, maintenance and limitations of PPE
8.6 necessity of medical surveillance and training sessions

9. BIBLIOGRAPHY

2. Timothy C.Hain. MD. Hearing loss. February 2010
4. Dependent speech - Language Pathology and Audiology, University of Limpopo (Medunsa Campus), 2010

10. ATTACHMENT

   Diagnostic Test Battery for Diagnostic Industrial Audiology.

NOTE

The SASOM guidelines are active working documents that are reviewed regularly or as changes take place in legislation, the work or the workplace.

Your inputs and comments are therefore regarded as most valuable. Please send them to info@sasom.org.
DIAGNOSTIC TEST BATTERY FOR DIAGNOSTIC INDUSTRIAL AUDIOLOGY

Released by University of Limpopo (Medunsa Campus)
Department Speech-Language Pathology and Audiology

- Mrs. Alida Naude
  M. Communication Pathology (UP)
  Senior lecturer and Audiology coordinator
- Mrs. Peta Shakespeare Hoge
  B. Communication Pathology (UP)
  Lecturer

Compiled using the following documentation:
SANS 10883:2004 Edition 5
Occupational Health and Safety Act, Act 85 of 1993 and the Noise-induced
Hearing Loss Regulations of GNR 307 of 2003
Compensation for Occupational Injuries and Diseases Act, Act 130 of 1993, and
Circular Instruction No 171 of 2001
Martin, F.N. & Clark, J.G. 2003. Introduction to Audiology. 8th Ed. Allyn and
Bacon: Boston

1. The diagnostic test battery may only be performed by an audiologist registered with the
Health Professions Council of South Africa (HPCSA) (Certified audiometrists may only do a
baseline, periodic screening and exit audiograms on an employee for referral to an
audiologist and not for submission for compensation purposes).

- Diagnostic testing should only be performed after a period of at least 24 hours has
  elapsed since the employee was last exposed to noise. This should be clearly
  communicated to the employer and employee.
- Working in a noise zone with hearing protection is NOT allowed in the preceding 24
  hours.

2. Otoscopic examination

- To determine any visible pathology which could have led to the loss of hearing

3. Complete medical/case history

- This should include information obtained from the employer, as a clear analysis is
  required to determine the contribution of noise exposure to the supposed hearing loss
  of the employee.

4. When an employee is referred for diagnostic audiology, the audiologist should ensure that
the employer submits the following information:

- All personal details of employee i.e. Name, Address, Work Reference, Age, Identity
  Number (ID book should be present), Employee Number etc.
• A complete medical record of employee;
• A complete work record of employee, also at previous employers (if any);
• All the details and a copy of their baseline audiogram,
• Most recent routine screening test result/s and exit audiometric results from the previous employer; (where applicable)
• Complete details of the workplace in which the employee was/is exposed to noise, including actual noise rating levels, or personal noise exposure rating levels
• All previous workplaces since the baseline was established
• Total duration of exposure to noise at such workplaces
• Full specification of the hearing protectors (including their attenuation value) which were used by the employee. Where available, the actual hearing protection equipment used should be presented.

5. Two diagnostic audiograms (reference - COID 171 No 4 p 216; SANS 10083:2004 Edition 5 19.4 p 31; SANS 10083:2004 Edition 5 17.3 note 1 p 26) are conducted on an employee on the same day at different sittings (i.e. a rest period of 5-10 minutes between the two tests is compulsory).

The test battery should include (Martin & Clark, 2003):
• Pure tone air conduction at 500, 1000, 2000, 3000, 4000, 6000, and 8000 Hz. (If the results from the tests do not differ from each other by more than 10 dB at any of the following frequencies i.e. 500, 1000, 2000, 3000 and 4000 Hz, the results are considered as valid.)
• Bone conduction at 500, 1000, 2000, 3000 and 4000 Hz
• Speech Reception Threshold (SRT)
• Speech Discrimination (SD)

In cases where the client is not tested in their first language, the interpretation of speech audiometry results should be in accordance with the expertise of the audiologist. Where it is not possible to perform speech audiometry, the audiologist should mention the reason in the diagnostic report.

- Full Immitance Measurements including:
  - Tymanometry
  - Ipsilateral Reflexes
  - Contralateral Reflexes

- Recommended: Oto-acoustic emission (OAE) testing
  - Since OAE’s are present in normal ears, it can be assumed that the absence of OAE’s is a sign of irregular cochlear function which could be an indication of hearing loss. OAE testing provides a fast, objective and non-invasive method for
testing a number of abnormalities including, amongst others, the detection of the early signs of noise induced hearing loss.

- When the second audiogram is performed and the pure tone and speech audiometry correlate with the first audiogram the test procedure may end at this point.

6. When valid results are not obtained, a third test should be performed. If the audiograms are still not within the 10 dB limit, assessment should be delayed for six months. If valid audiograms are still not obtained after six months, referral to an ENT should be made. A shorten timeframe is recommended and should be done at the discretion of the audiologist.

7. When valid diagnostic audiograms are obtained, the audiogram with the lowest calculated percentage loss of hearing (PLH) should be used to determine the hearing loss for submission to the Compensation Commissioner, Mutual Association or employer for further consideration for possible compensation.

8. To determine the shift in the PLH for compensation purposes:
   - PLH of the better diagnostic audiogram – (minus) the PLH of the baseline audiogram.

9. If there’s a shift of more than 10 % in the PLH from the baseline results, the diagnostic audiometry test date should be regarded as the date of commencement of the disease.

10. All the results obtained in the determination of the shift in the PLH, including the information given by the employer, should then be referred for a medical opinion, either to:
    - an Ear Nose and Throat specialist, if the shift in the PLH (between the baseline and diagnostic results) is 30 % or more or if the case is complicated.
    - an occupational medical practitioner if the shift in the PLH (between the baseline and diagnostic results) is 30 % or less or if the case is uncomplicated.

11. Persons eligible to claim for NIHL include:
    - Employees exposed to noise in excess of 85 dB during the working day.
    - Employees whose hearing has deteriorated more than 10% (PLH) from the baseline audiogram.
    - Employees with more than 10% PLH and for whom no baseline is available.

12. Calculation of the percentage loss of hearing (PLH)
    - Use the hearing levels (HL) determined by the baseline, periodic screening, exit or diagnostic audiometry (as applicable);
    - There is a different table for each of the following frequencies:
      - 500 Hz; 1 000 Hz; 2 000 Hz; 3 000 Hz; 4 000 Hz
      - Use pure tone air conduction results only.
    - The tables are weighted to favour the more important speech frequencies.
    - In each table:
      ✓ use the threshold for the worse ear to read from the column on the left
      ✓ use the threshold for the better ear to read from the column on top
13. A diagnostic report should be submitted summarizing and explaining all the above information.

14. All records must be retained for at least 40 years.
   (reference - SANS 10083:2004 Edition 5 p 34)

Summary of diagnostic testing process:

- Pure tone audiometry (Air & Bone)
- Immunittance (Tympanometry & Reflexes)
- Speech Audiometry (SRT & SD)
- Referral for Basic Diagnostic Test Battery
- Abnormal result / complaint not explained by results (OAE / ASSR / ABR)
- Diagnostic Report explaining all the results with summary and recommendations