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Noise Induced Hearing Loss and Hearing Conservation in the Iron and Steel Industry in South Africa

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Executive Summary

This report covers a Department of Labour commissioned survey on noise and noise induced hearing loss (NIHL) in seven primary producers and one secondary producer in South Africa's iron and steel Industry. The potential for excessive noise exposure in the iron and steel industry, the size of the South African industry and the lack of knowledge of noise exposure and hearing conservation practices locally prompted the survey reported in this document. The objectives of the survey were:

1. *To verify the current designation of noise zones as described in companies' occupational hygiene reports;*
2. *To assess workers' exposure levels by conducting area and personal noise (dosimetry) measurements;*
3. *To analyse and audit current hearing conservation practices;*
4. *Based on company records, to determine the extent of NIHL diagnosed by the companies over the past decade;*
5. *To verify records of current hearing threshold levels of workers by independently conducting audiometric testing;*
6. *To compile recommendations for improvement of existing hearing conservation practices that can be implemented in the South African iron and steel industry;*
7. *Based on best practices and expert advice, to develop a standard inspector check-list for noise in the iron and steel industry.*

Methods

The survey was conducted in two parts. The first part was carried out by the Occupational Hygiene department and the second part by the Occupational Medicine department of the National Institute for Occupational Health (NIOH). The Occupational Hygiene department was tasked with assessing the occupational noise exposure while the Occupational Medicine department assessed the hearing conservation programme and the noise induced hearing loss diagnosed in the identified companies. At each factory visited the occupational hygiene team

conducted a factory walkthrough and observations of workers' hearing conservation practices, administered a questionnaire and did area and personal noise measurements. The first element of the Occupational Medicine assessment involved obtaining information regarding the hearing conservation policy and practices in the company. The second part of the assessment involved a review of a sample of employee medical records. This review was done to assess whether there was documentation of baseline and periodic audiograms and an appropriate response to evidence of declining hearing. The third part of the Occupational Medicine assessment was to determine the number of cases of NIHL identified by the company over the past 10 years and review the medical files of the employees with NIHL to ascertain whether appropriate interventions had followed the diagnosis. Finally, a sample of the employees whose medical records were reviewed had an audiogram done by an independent external audiometric service to compare the in-house company audiograms with those done by the external service provider.

Results

All eight companies had a documented policy or standard procedure for noise and noise induced hearing loss or both. Details were scanty in some of these documents, however.

Information and training on noise was done in all worksites, and in the main covered the key topics and was evaluated, in four companies, by competency testing. A notable finding was that a high proportion of workers could not demonstrate correct fitting of hearing protective devices (see Table 9).

In all eight workplaces area and personal noise exposure levels equal or above 85 dB(A) were measured. The percentage of measurements ≥ 85 dB(A) in each company ranged from 48% to 91% (but it should be noted that worst case scenario sampling strategy was followed). Area noise measurement equalled or exceeded 105 dB(A) in four of the eight workplaces.

All companies did baseline, periodic and exist audiometry, but 100% compliance with scheduled testing was not reached by all companies (Tables 10 and 11). It was notable that interventions to prevent hearing loss in employees identified with early hearing loss were not usually recorded in medical files in all companies.

The estimated average annual incidence of noise induced hearing loss varied from 0.6/1000/year to 8.3/1000/year. COIDAct submission on determination of a 10 percentage loss of hearing (PLH) was the rule.

There were notable differences between in-house and external audiograms: differences > 20 dB(A) were found in the majority of audiograms in two companies (see Table 13).

The survey identified a range of good practices that will be of interest to occupational health and safety practices in the industry.

Recommendations

This report includes a discussion of the findings and concludes with a list of recommendations, as well as a **checklist** *to assist inspectors in their evaluation of a company's hearing conservation programmes (see Appendix 6). The more important recommendations are summarised below.*

Policy and Procedures

At a minimum each company should have a Hearing Conservation Policy and Standard Operating Procedure/s that enable a comprehensive programme to be run within the company. The documents should describe the programme in detail and the roles and responsibilities of the various stakeholders responsible for hearing conservation.

Assessment of exposure (to include area and personal noise measurements)

Personal noise measurements must form part of workplace noise assessments in addition to the area noise assessments.

AIA Survey reports and recommendations

AIA reports should include specific recommendations on noise control.

Noise control practices including HPD's Information and training

Noisy equipment and tools exceeding 85dB(A) must be identified and demarcated and hearing protection pictograms displayed at workstations.

Health and Safety Representatives must be involved in the implementation of noise control, and workers should be involved in the selection of hearing protectors to improve 'buy-in'.

All supervisors and managers must wear hearing protection within demarcated noise zones for workers to follow suit ('leadership by example').

The correct wearing of HPDs (e.g. earplugs) in noise zones, or whenever noise is present, must be emphasized in training and supervised.

Information and Training

All noise measurement results, hearing conservation practices, noise control and medical surveillance must be explained to workers in simple easy terms and a record of these communications must be kept.

All workers and contractors must be trained on aspects of noise exposure and hearing conservation including noise sources and how to avoid unnecessary noise exposure.

An evaluation tool to measure the effectiveness of training should be adopted particularly with reference to insertion of HPDs and the health risks of exposure to noise.

Medical surveillance (including: policy, baseline, periodicals, exits, action plans for declining audiograms)

A detailed Standard Operating Procedure should be put in place with regards to medical surveillance for noise induced hearing loss and this should have action lines that initiate remedial processes prior to the employee having compensable disease.

Systems need to be in place to ensure that audiograms are done annually or twice-yearly as appropriate and that non-compliance is identified and corrected.

Medical files should contain specific exposure information as well as recommendations made and evidence of noise control measures taken to prevent worsening of the hearing loss e.g. intention to or relocation of employee should be documented in medical records.

Occupational Health Nurses and Occupational Medical Practitioners' group analysis of audiograms should be communicated to managers and health and safety teams to complement health risk assessments in order to provide guidance to prioritise areas for control measures.

Audiometric verification

Quality assurance programmes for audiometry should be considered.

An electronic system to verify that audiograms are done as appropriate e.g. 6 monthly, annually or 2 yearly should be in place.

Considerations should be given to interventions to protect an employee's hearing as soon as it is evident from audiograms that hearing loss is occurring. A 5 PLH is the action level used by a number of companies but this level should not be a requirement for initiating intervention, rather an obvious trend in hearing decline over time should be the action level.

Noise induced hearing loss

A specific formal written plan should be put in place for employees who have compensable hearing loss to prevent further worsening of their condition.

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List of Abbreviations

AIA	*Approved Inspection Authority*
DoL	*Department of Labour*
dB(A)	*Decibels, A-weighted*
HPDs	*Hearing Protection Devices*
HCP	*Hearing Conservation Programmes*
ISO	*International Organization for Standardization*
KHz	*Kilohertz*
Leq	*Equivalent Continuous Noise Level*
NIOH	*National Institute for Occupational Health*
NIHL	*Noise Induced hearing Loss*
NRR	*Noise Reduction Rating*
NIOSH	*National Institute for Occupational Safety and Health*
OMP	*Occupational Medical Practitioner*
OHP	*Occupational Health Practitioner*
OEL	*Occupational Exposure Limit*
PTS	*Permanent Threshold Shift*
PLH	*Percentage Loss of Hearing*
SAISI	*South African Iron & Steel Institute*
SANS	*South African National Standards*
SAQA	*South African Qualifications Authority*
TTS	*Temporary Threshold Shift*
WHO	*World Health Organisation*

1. Introduction

The National Institute for Occupational Health (NIOH) was commissioned by the Department of Labour (DoL) to investigate the current noise exposure levels and noise induced hearing loss (NIHL) in seven primary producers and one secondary producer in South Africa's iron and steel Industry and to make recommendations on effective hearing conservation practices for the industry.

The iron and steel sector has been identified by the DoL as being among the highest risk industries for injury. One of the aspects identified as needing urgent attention in this industry was the evaluation of noise and NIHL with a view to facilitate planning of prevention strategies.

Noise, the result of numerous activities in our modern society, has a negative influence on the health, productivity and job satisfaction of the labour force. The negative effects of noise include causing permanent hearing damage, masking of wanted sounds such as verbal communication and interference with the nervous and cardiovascular systems. Protection of hearing is regarded as the most important aim, mainly because NIHL is irreversible and the result thereof is experienced by the worker long after exposure has ceased.

Exposure to harmful sounds causes damage to the hair cells as well as the auditory, or hearing, nerve. Impulse sound (short duration, high intensity noise) can result in immediate hearing loss that may be permanent. This kind of hearing loss may be accompanied by tinnitus, a ringing, buzzing, or roaring in the ears or head. Hearing loss and tinnitus may be experienced in one or both ears, and tinnitus may continue constantly or occasionally throughout a lifetime. Continuous, long-term exposure to loud noise can also damage the structure of hair cells, resulting in permanent hearing loss and tinnitus, although the process occurs more gradually than for impulse noise.

In its initial stages the shift in hearing threshold might be temporary (TTS) and some recovery might be experienced after a period of no exposure, but with increasing time and/or intensity it becomes permanent (PTS). The onset and progress of NIHL is painless and therefore often unnoticeable by the individual until irreversible damage has already occurred. The magnitude of the risk will depend on the noise intensity, its frequency, duration of exposure and individual

susceptibility. A single value, the A-weighted sound level in decibel (dB(A)), is used to evaluate the hearing damage risk.

2. Literature Review

The iron and steel industry was described by Narlawar et al., 2006 as "one of the world's most important industries ever since it was first founded". Hazards are inherent because of the large size of the plants, the massive equipment and the constant movement of large masses of bulky and heavy materials. In addition to the high level of noise exposure, workers are also exposed to temperatures up to 1,800°C, toxic or corrosive substances, and respirable airborne contaminants. Steel manufacturing is also one of the noisiest industries. The major sources of noise in the steel manufacturing industry include fume extraction systems and vacuum systems when using steam ejectors, electrical transformers and the arc process in electrical arc furnaces, rolling mills and the large fans used for ventilation. Noise induced hearing loss is the most commonly observed health condition in the workers of iron and steel industry (Narlawar et al., 2006).

In South Africa, the iron and steel industry is one of the largest employers with approximately 55 000 employees working in the primary iron and steel production sector. South Africa was ranked by the World Steel Association as the 21st largest crude steel producing country in the world and is the largest in Africa, with approximately 7.6 million tonnes of crude steel produced every year (SAISI, 2010).

Effects of Noise and NIHL

The effects of noise can be non-auditory or auditory. Non-auditory effects are defined as "all those effects on health and well-being which are caused by exposure to noise with the exclusion of effects on the hearing organ" (van Dijk, 1986). Amongst others these health effects are a lack of concentration, irritation, fatigue, headaches and sleep disturbances (Nandi and Dhatrak, 2008).

Auditory effects include the risk of hearing loss or injury to the ears with increasing sound intensity. NIHL is generally used to denote the cumulative, permanent loss of hearing that develops gradually after months or years of exposure to high levels of noise (Nandi and

Dhatrak, 2008). The risk is a function of the intensity and length of time an employee is exposed to the noise as well as the individual's susceptibility to NIHL. Factors that influence the development of NIHL are (among others) age, hereditary and systemic diseases, infection of the middle ear, toxic drugs, fatigue and smoking (Harmadji and Kabullah, 2004). There is currently no medical or surgical treatment to cure NIHL, thus it is important to prevent NIHL with noise protectors and reduced noise exposure.

Occupational NIHL tends to be bilateral and symmetrical, usually affecting the higher frequencies (3k, 4k or 6k Hz) and then spreading to the lower frequencies (0.5k, 1k or 2k Hz) (Nandi and Dhatrak, 2008).

The World Health Organization estimated that occupational NIHL costs approximately 0.2% to 2% of the gross domestic product of developed nations. It is also estimated that more than 4 million disability-adjusted life years were lost globally as a result of occupational NIHL and that more than 16% of global deafness is attributable to occupational noise exposure (WHO, 1997). According to Ologe et al., 2006, NIHL is rated among the top ten work related problems, and is the most prevalent irreversible industrial disease and the biggest compensable occupational hazard (Ologe et al., 2006).

Legislation

The two main standard-setting agencies impacting on the development of legislative requirements in South Africa with regards to noise are the International Organization for Standardization (ISO) and the South African National Standards (SANS). Both agencies specified an occupational exposure limit of 8hr/day, 40hr/week, **equivalent continuous noise level (Leq) of 85dB(A)** *(ISO, 1990, SANS, 2004). The legal requirements with respect to occupational noise exposure in South Africa are specified in the Department of Labour (DoL) Noise Induced Hearing Loss (NIHL) Regulations, promulgated under the Occupational Health and Safety Act of 1993 (DoL, 2003b).*

The occupational exposure limit (OEL) is set at a noise rating level of 85 dB(A) normalized to a nominal working day of 8 hours (L_{Req}, 8h). The legislation requires the employer to implement a hearing conservation programme (HCP) when workers are exposed to noise rating levels at, or above, this limit. The HCP must include issues such as: information and training, noise control,

noise monitoring, audiometric testing, demarcation of noise zones and the use of hearing protection devices (HPDs). In South Africa, NIHL is currently considered compensable when an exposed individual experiences a 10% or more increase in percentage loss of hearing (PLH) from baseline at 500, 1000, 2000, 3000 and 4000 Hz (DoL, 2003a).

Hearing Conservation Programme (HPDs, attitude, behaviour, training)

NIHL from both impulse and continuous noise may be prevented by implementing a comprehensive hearing conservation programme which includes (among others): worker training, engineering control strategies, demarcation of noise zones, audiometric testing and regular use of hearing protection devices (DoL, 2003b).

Although it is ideal to reduce hazardous noise exposure through engineering controls, it is often impractical, costly, or scientifically impossible to eliminate all harmful noise (Hong et al., 2005). Hearing protection devices (HPDs) are often used in addition to these controls, however improper and inconsistent use of these devices has been noted. Several factors are reported to influence the wearing of hearing protection devices, some of which are health beliefs, perceived risk, and perceived probability of risk as well as perceived benefits and comfort of wearing the device. A study by Reddy et al., 2012, found that modifying factors (gender, noise level), situational factors (union climate), and cognitive-perceptual factors (perceived benefits and barriers) were significant predictors of the use of HPDs in African workers (Reddy et al., 2012).

NIHL in the Iron and Steel Industry

No studies have previously been published in South Africa on NIHL in the iron and steel industry but work has been done in other developing countries. A study in Nigeria found that despite a high awareness of noise as an occupational hazard amongst Nigerian steel workers, the availability and use of hearing protection was still poor. Only workers at the heart of the production process such as mill floor and finishing stage, were considered to be exposed to harmful noise and thus eligible for hearing protective devices. In addition, defective, damaged or lost hearing protectors were not replaced, probably accounting for the reason why only 27% of their subjects had hearing protectors (Ologe et al., 2005).

The prevalence of permanent hearing shift was measured among workers of Indian iron and steel enterprises. Although the majority of workers reported that they were aware of the benefits

of using HPDs, a big proportion of workers did not use them in both the casting and forging units, and only 17% of the workers overall used HPDs. The reasons stated for not using HPDs were: 40% found the devices uncomfortable, 10% were not used to wearing them, 30% admitted to negligence, and around 25% said management did not provide HPDs at the work place (Singh et al., 2012).

Ketabi and Barkhordari, 2010, identified age and work history as two important factors in relation to NIHL in workers of an Iranian axial parts factory. According to their results, although the rate of NIHL varied in workers of the punching and cutting sections, the relationship between hearing loss and age and work history was significant (Ketabi and Barkhordari, 2010).

Narlawar et.al, 2006, reported in a study on hypertension and hearing impairment in workers of the iron and steel industry in India that hypertension and hearing loss are significantly associated with duration of exposure and they also found that hypertension was more common in workers with hearing impairment. Definite correlation was found between levels of sound in different sections and noise-induced health problems (Narlawar et al., 2006).

Studies on NIHL in South Africa

A study of hearing loss in white South African gold miners was conducted by Heseel and Sluis-Cremer in 1987. The study found that hearing protectors were not generally used by miners and many of those that used HPDs did not use them all the time. Hearing protectors were not available at many of the mines, or the miners were not aware of their availability. The study stated that the use of personal protective devices is difficult underground because of the heat and humidity. There was also a concern that miners using hearing protection will not be able to hear sounds that might alert them to dangerous situations. This study found that a significant noise problem existed in the South African gold mining industry, resulting in hearing losses in excess of what would have been expected in a developed country and causing significant social impairment in the mining population (Hessel and Sluis-Cremer, 1987).

Another study conducted among gold miners reported on the relationship between their TB status and hearing loss. This study was the first to demonstrate a significant relationship between TB and deterioration in hearing thresholds. Gold miners with TB, especially those with more than one episode of TB, presented with significantly poorer hearing thresholds and a more

pronounced decline in hearing over time independent of noise exposure. The exact cause is likely to be a complex interaction between TB, including its treatment, and associated risk profile (Brits et al., 2012).

The potential for excessive noise exposure in the iron and steel industry, the size of the South African industry and the lack of knowledge of noise exposure and hearing conservation practices locally prompted the survey reported in this document. The objectives of the survey were:

1. *To verify the current designation of noise zones as described in companies' occupational hygiene reports;*
2. *To verify workers noise exposure levels by doing spot area measurements and personal noise exposure (dosimetry);*
3. *To analyse and audit current hearing conservation practices;*
4. *Based on company records, to determine the extent of NIHL diagnosed by the companies over the past decade;*
5. *To verify records of current hearing threshold levels of workers by independently conducting audiometric testing;*
6. *To compile recommendations for improvement of existing hearing conservation practices that can be implemented in the South African iron and steel industry;*
7. *Based on best practices and expert advice, to develop a standard inspector check-list for noise in the iron and steel industry.*

3. Methodology

A cross sectional survey was conducted in eight major iron and steel companies in South Africa (seven primary producers and one secondary iron and steel producer) to determine whether there was over-exposure to noise, to evaluate hearing conservation practices and to determine the extent of noise induced hearing loss diagnosed in this industry. The eight companies chosen by the DoL included **all** *the primary iron and steel companies in South Africa. A secondary iron and steel company was also selected to participate in the study to ensure that all the provinces in South Africa were represented. The findings of the study may therefore be seen as representative for the primary iron and steel industry in South Africa but not for the secondary iron and steel industry.*

The survey was conducted in two parts. The first part was carried out by the Occupational Hygiene department and the second part by the Occupational Medicine department of the National Institute for Occupational Health (NIOH). The Occupational Hygiene department was tasked with assessing the occupational noise exposure while the Occupational Medicine department assessed the hearing conservation programme and the noise induced hearing loss diagnosed in the identified companies.

Below is a brief description of the eight companies identified by the Department of Labour to participate in the survey.

Table 1: List of Participating Companies

Company	Type of industry	No of permanent employees	No of contract employees
Company A	Primary iron and steel plant	7000	6808
Company B	Primary iron and steel plant	541	328
Company C	Primary iron and steel plant	650	753
Company D	Secondary steel plant	246	6
Company E	Primary iron and steel plant	2700	2100
Company F	Primary iron and steel plant	2587	2354
Company G	Primary iron and steel plant	1696	450- 500
Company H	Primary iron and steel plant	2711	310

3.1 Occupational Hygiene

The Occupational Hygiene section of the study included the following elements:

At each factory visited the occupational hygiene team conducted a factory walkthrough and observations of workers' hearing conservation practices as well as familiarisation with the layout and noise zones. This was followed by an interview conducted with the Health and Safety Manager (and other members of the team) and the completion of a questionnaire covering the following aspects of the company's hearing conservation programme (HCP): information and training, assessment of exposure, noise survey reports and recommendations, medical surveillance, hearing protection equipment and policies and procedures (the full questionnaire is appended to this report); The remainder of the time was spent conducting noise measurements at the factory:

- *Area measurements were taken at positions approximating measurement locations selected in previous noise surveys. The purpose of these measurements was to verify the results obtained during these surveys, as well as verifying the current demarcation of areas as noise zones; the meter was positioned at the task location or close to the worker's ear; The measurements were taken over a long enough time period (typically a few minutes) to be representative of the noise being measured;*
- *Personal noise measurements (dosimetry) were carried out on employees from different plants and production areas. Employees were selected by management from work areas known to have high noise levels ("worst case"); the purpose of these measurements was to ascertain potential exposure of individuals performing work in designated noise zones. The monitor (dosimeter) was placed on the worker's shoulder, close to the ear and measurements were taken over a sufficiently long time to be representative of the worker's exposure (typically a few hours, up to a full shift).*

The noise measurements were taken with a Quest type 1, integrating sound level meter and the personal noise dosimetry was carried out with CEL dBadge type 2 dosimeters. The calibration of the instruments was checked before and after measurement using a Quest class 1 and a CEL class 2C acoustic calibrator, respectively. All the instruments were externally calibrated by a SANAS accredited laboratory (calibration certificates attached in the appendix). The area and personal noise exposure levels were conducted in accordance with the SANS Code of Practice

10083, 2004: "The measurement and assessment of occupational noise exposure for hearing conservation purposes" (SANS, 2004).

Short interviews were conducted with the employees selected for the noise dosimetry to ascertain their level of training, awareness and participation in various aspects of the company's HCP; the standard questionnaire used for these interviews is shown in the Appendix 2.

3.2 Occupational Medicine

3.2.1 Hearing Conservation Policy

The first element of the Occupational Medicine assessment involved interviewing a staff member of the health and safety team as well as a member of the clinical team with regards to the hearing conservation policy and practices in the company. A hearing conservation policy checklist (Appendix 3) was developed by adapting the internationally recognised National Institute for Occupational Safety and Health (NIOSH) hearing policy checklist. The checklist included information on training of employees regarding noise, medical surveillance as well as actions to be taken on evidence of declining hearing and noise induced hearing loss. The interview was then compared to the company's written policy.

3.2.2 Medical Record Review

The second part of the assessment by the NIOH medical team involved a review of a sample of employee medical records. This review was done to assess whether there was documentation of baseline and periodic audiograms and an appropriate response to evidence of declining hearing. The record review was limited to permanent employees as access to contract staff's medical files would be logistically difficult as they are not kept by the company. The sample of employee medical records was chosen by (1) identifying a department of the company that had noise exposure levels above 85dB(A), using the Occupational Hygiene area and dosimeter readings; and (2) randomly selecting employees from a list of all the employees in the chosen department and obtaining their medical records.

3.2.3 Review of Noise Induced Hearing Loss Records

The third part of the assessment was to determine the number of cases of NIHL identified by the company over the past 10 years and reviewing the medical files of the employees with NIHL to

ascertain whether appropriate interventions had followed the diagnosis. A list of employees with NIHL and their medial files were requested from the company.

The review was done in accordance with a checklist (Appendix 4).

Consent forms (Appendix 5) were signed by the employees to allow the researchers to view their medical records.

3.2.4 Audiometric Verification

A sample of the employees whose medical records were reviewed had an audiogram done by an independent external audiometric service provider to compare the in-house company audiograms with those done by the external service provider. Employees whose audiograms were most recent were selected for repeat audiograms. As far as was possible, the original testing conditions were replicated.

3.2.5 Sampling Strategy for Record Review

A mixed random and non-random sample of 100 employees was targeted to have their records reviewed from each company, giving a collective sample of 800 employees that would participate in the study. This sample represented from 5% to 50% of employees and was a feasible number to review in the time period along with providing a sufficiently large sample from which to draw conclusions. The sample of 100 employees in each company comprised employees who were diagnosed with NIHL over the past 10 years – in most instances also still employed at the company – together with randomly selected permanent employees from the selected department in the company to make the total to 100. The department was selected using the occupational hygiene data in order to verify that employees in the chosen department were exposed to ≥ 85 dB(A).

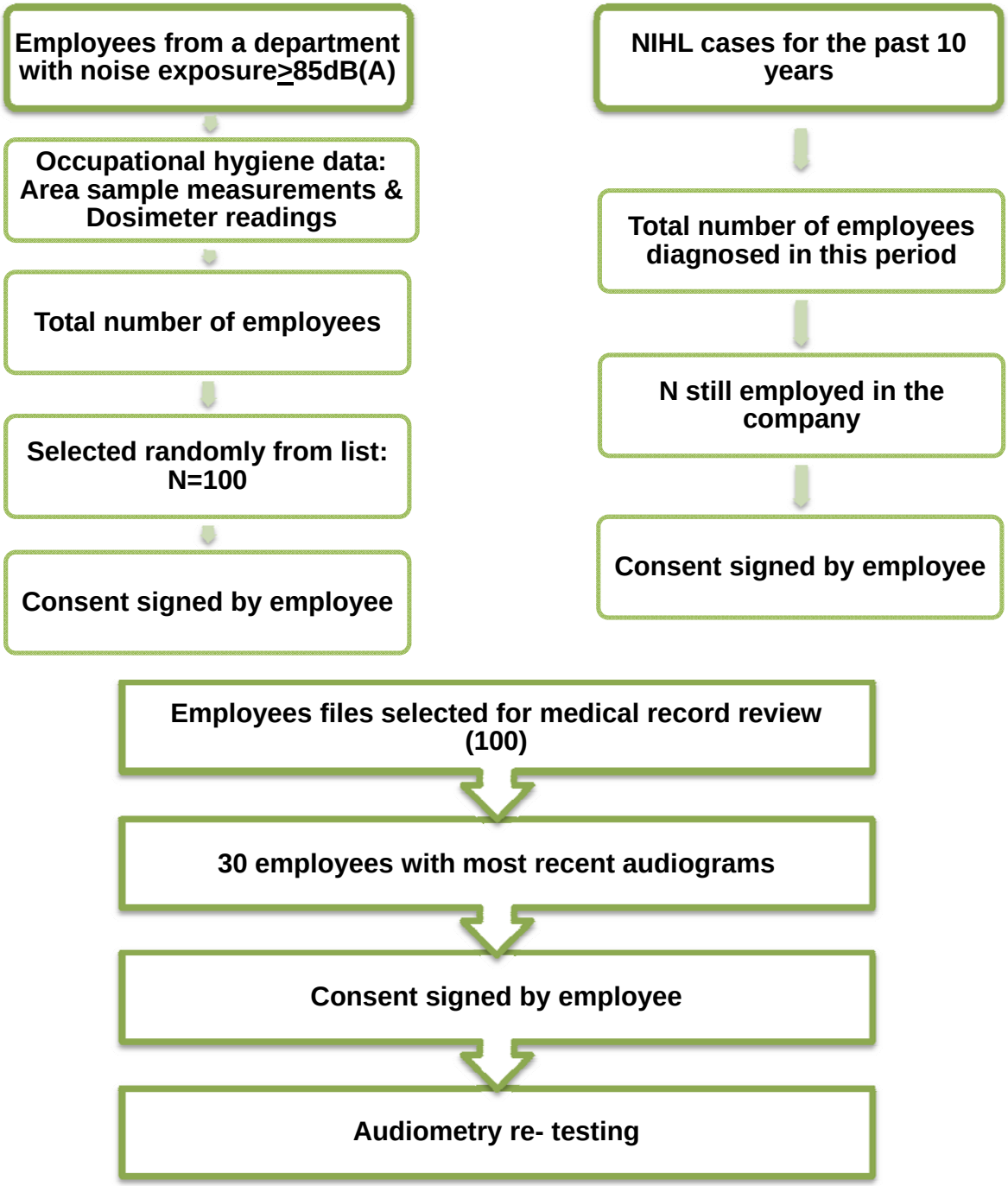

Figure 1: Sampling strategy for review of medical records and audiometry re-testing

Table 2, below, lists the actual number of employees who participated in each company.

Table 2: Number of participating employees by company

Company	No. of medical files reviewed in the chosen department	No. of medical files reviewed from employees diagnosed with NIHL	No. of audiograms done
Company A	60	37	17
Company B	81	21	20
Company C	34	8	20
Company D	27	1	19
Company E	59	7	24
Company F	27	7	21
Company G	29	0	20
Company H	54	6	12

3.2.6 Response Rate

The response rate in the eight different iron and steel companies ranged from 17.1% to 100%. The low response in some companies, particularly in Company G, was due to reluctance of employees to give consent (not unavailability of records), partly consequent on logistic difficulties like varied shift patterns resulting in poor employee access.

Table 3: Response rate by company

Company	Response rate in the chosen department	Response rate in the NIHL employees	Response rate for audiometric retesting
Company A	100%	100%	56.7%
Company B	100%	100%	66.7%
Company C	100%[a]	89%	100%
Company D	Not ascertained[b]		
Company E	63.4%	77.8%	77.4%
Company F	42.6%	17.1%	56.8%
Company G	38.7%	0%	83.3%
Company H	66.7%	100%	50%

[a] *Employee records were available but not all were reviewed due to time constraints.*

[b] *Employees' consent for review of records was only concluded during the survey and hence a random sample could not be obtained.*

3.3 Study Limitations

During the surveys a number of companies experienced industrial action and one had to reduce working days. It is postulated that this had an effect on the response rate of employees.

Regarding the Occupational Hygiene measurements, it is important to note that due to the large scale of the sites and limited time it was not possible to measure every activity during this study. In addition, some processes were not taking place at the time of the visits and could not be assessed. However, the aim of this study was not to carry out a detailed noise survey but rather to assess the effectiveness of the companies hearing conservation practices and programmes.

Some medical records were incomplete and in these cases the researchers concluded that the activity being evaluated had not been done, rather than classifying it as missing information.

One of the objectives of the study was to determine the extent of noise induced hearing loss in the identified companies. This was done by obtaining from the company records of NIHL cases

over the past 10 years. This approach was considered more informative than a survey of NIHL in current employees since the healthy worker effect would probably have led to an underestimate of NIHL if only current employees were included. This approach, however, relied on companies providing records of NIHL, and information could not be validated as most of those employees were no longer working for the companies. The estimates of NIHL should therefore be considered at the low end of the true burden of disease.

An additional limitation of the study relates to the evaluation of "in-house" audiometry by the occupational health services of the companies. There is no reference body for audiometric testing in the workplace in South Africa. Consequently a gold standard testing facility for audiometric testing is not currently available and the external evaluation of the quality of in-house audiometry was therefore a measure of repeatability rather than of validity. Nevertheless, the repeat audiograms were done by an experienced external provider with calibrated equipment and a national footprint. Lack of repeatability may be explained by many factors but indicates that a review of quality assurance and testing procedures by in-house testers is required.

4. Results

4.1 Policy on Hearing Conservation

All eight companies had a documented policy or standard on hearing conservation. However, only four of the eight companies (A, B, F and H) had a written standard operating procedure for monitoring NIHL. All policies stipulated that exposure assessments should be determined to inform medical surveillance of employees at high risk. Policies and procedures stipulated that baseline medical assessments were to be done at the beginning of employment with the company and periodic assessment to be conducted on exposed employees at least annually, aligned with exposure levels. In one company where no documented standard operating procedure was available, it was reported that there was a procedure, known to clinic staff, and had been practiced from 2003. All companies reported that exit audiograms are done as part of assessment for exit medicals and employees were either issued with copies of results of exit assessments at exit or on request.

Company policies on hearing conservation were further scrutinised focusing on four main areas, namely information and training, medical surveillance, record keeping and referral of employees with hearing loss.

Table 4: Key policy components for the 8 companies

Company vs. key policy components	A	B	C	D	E	F	G	H
Exposure Assessment/ Noise Risk Assessment	+	----	+	+	+	+	----	+
Identification of employees at risk	+	----	+	+	+	+	----	+
Noise Monitoring and Assessment	+	+	+	+	+	+	----	+
Noise Control	+	----	+	+	+	+	----	+
Employee Training and Education	+	+	+	+	+	+	----	+
Baseline and Periodic Audiometric Testing	+	+	+	+	+	+	----	+

+ Component included, ---- component not included in the policy.

4.2 Assessment of Noise Exposure

The eight sites visited complied with the requirement to designate the areas in the workplace as noise zones with appropriate signage. It was however noted that some signage was in need of cleaning and maintenance.

Table 5: Average noise levels dB(A) for selected departments at 8 companies in the Iron and Steel Industry

Plant ID	Department and average Noise level dB(A)				
A	Steel Production & BOF: 84	Coke plant &cutting area: 86	Cold Mill: 92	Galvanizing & Temper Mill: 94	Sinter Plant: 98
B	Off line (Recycle): 94	Melt Shop: 94	Mills: 102		
C	Iron making, Corex&Midrex: 87	Hot Strip Mill: 88	Hot Strip Basmnt: 90	Steel Mill Melt Shop: 95	
D	QC: 81	Small parts & Core Shop: 94	Sand Plant: 94	Fettling & VW Production: 102	Foundry & Prod: 102
E	Coke Plant & Steel Plant: 88	Unitrans Bar Mill: 90	Billet Bar Rod Mill: 94	Iron Blast Furnace: 97	
F	Structures Work Shop: 78	Iron Plant Melt Shop: 85	Flat Products: 88	Steel Plant 1 & 2 & Mill: 90	Pulverized Fuel: 98

The average noise levels are colour coded as follows: Green is ≤ 85 dB(A); shades of red represent levels from 85 dB(A) to dark red 95 dB(A), and black for >100 dB(A)

Table 6: Area noise measurements in 8 factories studied - ranges and medians and percentage exceedance of the Occupational Exposure Limit (OEL)

Factory studied	Number of measurements	Min dB(A)	Max dB(A)	Median dB(A)	Percent (%) > 85 dB(A)
A	26	84	100	93	87
B	49	94	102	94	100
C	66	75	102	88	50
D	32	74	108	94	87
E	31	71	100	83	68
F	108	62	105	85	58
G	27	72	107	87	78
H	68	70	112	87	92

Table 7: Personal noise measurements in 8 factories studied - ranges and medians and percentage exceedance of OEL

Factory studied	Number of measurements	Min dB(A)	Max dB(A)	Median dB(A)	Percent (%) > 85 dB(A)
A	15	83	97	89	77
B	15	85	98	91	88
C	12	79	99	85	62
D	15	77	102	92	91
E	15	75	97	88	48
F	12	80	96	85	50
G	23	69	103	89	63
H	13	84	102	94	63

The results in Tables 5 to 7 show that approximately 50% - 100% of both area and personal measurements in ALL companies exceeded the 85 dB(A) limit.

Companies B and D were in the 88dB(A)–94dB(A) levels for both personal worker and areas noise exposure and should endeavour to reduce their noise emissions by process changes, engineering controls, noise refuges etc.

Analysis of the relation of the area to personal median noise levels showed that factories with well controlled area levels were 40% more likely to have well controlled personal noise exposures. This reinforces the intuitive expectation that both measures are important to accurately describe the noise exposure in a workplace.

On the face of it, the best controlled companies were companies C, E, F and G. However, as production varies from day to day and month to month, it is inaccurate to put too much emphasis on the results of these measurements. It is believed that a "measure" of the health and safety culture or the number of cases of NIHL per 1000 employees per year may be a better indicator of effective noise control.

4.3 Noise Control Practices Including Hearing Protective Equipment

In general, noise control engineering options were not used to their fullest advantage, although some companies adopted good controls, for example one not only erected double glazing in control rooms but also put in three doors to keep the noise out. Changing of nozzles of flame heaters to reduce noise was another engineering control practice observed during the study.

Good practice such as identifying and demarcating noisy equipment exceeding 85 dB(A) with hearing protection pictograms was observed and should be an example to follow.

At only one company were noise levels displayed at workstations to increase workers' awareness. This is a low cost measure to promote a culture of attention to health and safety and should be encouraged.

Noise signage was often seen to be in need of some attention and should be kept clean and visible: another example of "low hanging fruit" to promote health and safety culture at little cost.

No company had a written 'Buy Quiet' and 'Quiet-by-Design' approach in place. Some said that they did take into account this aspect of good practice; however it was not a formal, written company policy.

Several observations of poorly maintained reusable earplugs indicated that employees should be trained to care for their earplugs properly. Proper storage for HPDs should be provided by companies for employees to achieve a sufficient level of care and hygiene. Work place audits to check the state of workers HPDs are practised by a few companies, and should be practised by all to achieve effective noise control.

Workers' involvement in selection of HPDs, practised by a few companies, should be practised by all to achieve "buy in" for workers and effective noise control.

Several companies had made a decision to issue HPDs with a high Noise Reduction Rating (NRR), preferably custom-made earplugs, to high risk employees. This policy and its implementation should be a high priority for the iron and steel industry.

4.4 Information and Training

All companies had an information and training programme carried out by either qualified health and safety officers (C, D and F) or qualified trainers (A, B, E, G and H) as recognised by SAQA. Although all policies did not stipulate when this training should take place, it was reported from all companies that this is done within the first year of employment or when moving to a noisy department with exposure above 85dB(A). In six of the eight companies (A, B, C, D, F and H) training is initially done at induction and then annually, except for D which is planning refresher training but not yet implemented it. In the rest of the companies, training is done at no stipulated time but within the first year of employment (E and G). Four companies reported that they conducted re-training on identification of a five percentage loss of hearing (PLH), although only in small number of cases was evidence of this found in the employee's file.

Good practices identified were the issuing of a certificate of training or competence to employees who have undergone training and evaluation. This was seen to motivate employees to take this training seriously and to some extent was an incentive for those who attended to pass the post-training evaluation. Another good practice was keeping a record of the training certificate in the medical file as this would enhance collaboration between the different aspects of the programme.

According to the Noise Induced Hearing Loss Regulation a comprehensive training programme incorporates a minimum of the following topics:

i) information on the sources of noise in the company
ii) health risks of exposure to noise
iii) the need to use hearing protection
iv) the correct use and maintenance of the hearing protection
v) the procedures to follow when reporting defective hearing protectors
vi) limitations of hearing protective device, and
vii) The need for regular audiograms to be done

Information and training programmes conducted in the companies included six of the essential components in two of the eight companies (A and E) and at least four of the components in the other companies. Seven of the eight companies did not include sources of noise and limitations of hearing protection devices in the information and training programme. Two of the eight companies did not include the need and importance of regular audiometric testing in their training programme.

Table 8: Summary of information and training programmes in the 8 companies

Company/ Information and Training Programme	A	B	C	D	E	F	G	H
Information and training programme covers at least 5 topics	+	+	+	----	+	+	+	----
Evaluation of training by formal testing	+	----	+	----	+	+	----	----
Training evaluation by observation during walk through by Health and Safety team	----	+	----	----	----	----	+	+
Training conducted by trainers accredited by SAQA	+	+	----	----	+	----	----	----
Certificate of training issued& copy kept in medical file or electronically available at the medical station	+	+	+	----	+	+	----	----

+ Component part of the programme ----component not part of the programme.

Training evaluation (A, C, E and F) was conducted through a formal evaluation test after which a certificate of training or competence was issued to employees and a copy kept in the medical file (A) or personnel file (C). Fifty percent of the companies conducted evaluations to assess effectiveness of training only through direct observations when conducting workplace walk-through. Formal evaluations were therefore an evaluation of training conducted and not necessarily an indication of the effectiveness of the training from a behavioural change or impact perspective. The results of the observation and interview of employees in the 8 companies are summarised in the table below.

Table 9: Information and training results from interviews and workers personal noise exposures

	A	B	C	D	E	F	G	H
Training on correct wearing of HPD	*No information*	*Only provided for custom-made hearing devices*	*Only provided for custom-made hearing devices*	*No information*	*Only provided for custom-made hearing devices*	*No information*	*No information*	*Provided by the PPE supplier*
Workers asked to demonstrate how to fit HPD	*6 correct* *9 failed*	*All 15 failed*	*11 correct* *1 failed*		*4 correct* *11 failed* *4 not wearing*	*All 17 failed*	*20 correct* *3 failed*	*3 correct* *11 failed*
Last received training on noise	*3 out of 15 could not remember*	*All could not remember*	*10 in 2012* *1 in 2011* *1 could not remember*		*2 in 2012* *5 in 2011* *6 could not remember*	*6 out of 17 could not remember*	*10 in 2012* *11 in 2011* *1 before 2011* *1 never*	*2 in 2011* *12 could not remember*
Number who reported having a hearing test	*7 in 2011* *8 in 2012*	*All 15*	*7 in 2011* *5 in 2012*		*9 in 2011* *10 in 2012*	*15 in 2011* *2 in 2012*	*15 in 2011* *8 in 2012*	*3 in 2011* *11 in 2012*

Table 9 (cont'd): Information and training results from interviews and workers personal noise exposures

	A	B	C	D	E	F	G	H
Employees experiencing difficulties with hearing	*Two*	*None*	*3 of 12*	*No information*	*1 of 19*	*None*	*None volunteered*	*6 of 14*
Workers trained on noise	*12 of 15*	*0 of 15*	*11 of 12*		*7 of 19*	*All 17- H&S induction*	*22 of 23*	*2 of 14*
Understood effects of noise	*13 of 15*	*All 15*	*All 12*		*All 19*	*All but one*	*20 of 23*	*All 14*
Not concerned about noise in the work place	*10 of 15*	*All 15*	*8 of 12*		*11 of 19*	*7 of 17*	*20 of 23*	*All*
Percent exposed at over 85 dB(A)	*86%*	*100%*	*50%*	*86%*	*68%*	*60%*	*85%*	*92%*
Average noise dose dB(A) (n)	*91 (14)*	*93 (15)*	*92 (12)*	*93 (14)*	*88 (19)*	*89 (15)*	*93 (23)*	*97 (13)*

The fact that 43 out 108 (40%) of the employees interviewed could not remember when were they last trained indicates that the level and/or frequency of training needs to be improved in most companies. Also, the fact that more than half of the employees (67/108 or 62%), could not demonstrate the correct way of fitting their hearing protectors is a major concern and suggest that the training is not as effective as it should be.

4.5 AIA Survey Reports and Recommendations

In the main the AIA reports were long and complex. Too much emphasis was put on measuring with too little attention on progress, or lack of it, towards a quieter work place. Reports containing practicable recommendations were abundant. However reports of levels before and after controls were installed were not noted. Current international best practice for measurement strategy proposes that the best use of measurements is to monitor controls to evaluate their effectiveness.

Controls are designed to reduce workers' exposure to noise, therefore a more effective measure of the effectiveness of a workplace noise control programme could be the noise dose received by a worker as measured by a personal dosimeter.

4.6 Medical Surveillance

All eight companies conducted medical surveillance in the form of audiometric testing, at baseline, periodically and at exit medical assessment. All companies had noise policies or standards compliant with the Noise Regulations but as can be seen in the tables and figures that follow 100% compliance in practice was not achieved in many companies.

Audiometric testing was conducted in-house by trained occupational health nurses. In six of the eight companies the occupational health nurses' audiometry certificates were valid at the time of conduct of the survey and in two companies nurses had certificates that had expired and were to be renewed.
Audiometric testing was conducted using equipment based in the company medical stations and all equipment in the companies visited had valid calibration certificates.

4.1.1 Baseline audiometric testing

Medical record review in the eight companies revealed that baseline audiometric testing was done either as a baseline for the employee's total career and/or a baseline for the current company where the employee was newly employed in the current company but having worked in a noisy area elsewhere. In the latter situation, the employee would have to bring in a copy of the baseline from the previous company/industry or a copy of an exit audiogram. Table 4 and

Figures 1 and 2 below illustrate results of record reviews with regards to baseline audiometric testing in the companies and evidence of percentage loss of hearing at baseline.

Table 10: Baseline audiometric testing in study companies and evidence of percentage loss of hearing at baseline

	Baseline done in accordance with Circular Instruction 171		Evidence of PLH at baseline audiogram		PLH at the time of the baseline audiometry
	Yes	No	Yes	No	Range (%)
A	98.3%	1.7%	15%	85%	1.1 - 11.4
B	92.6%	7.4%	72.8%	27.2%	1.1-68.7
C	97%	3%	41%	59%	1.1-8.7
D	67.9%	32.1%	73.7%	26.3%	1.1-16.5
E	98.3%	1.7%	76.3%	23.7%	1.0-19.
F	92.6%	7.4%	51.9%	48.1%	0
G	86.2%	13.8%	64%	36%	1.1-2.7
H	68.5%	31.5%	100%	-	1.1- 16.9

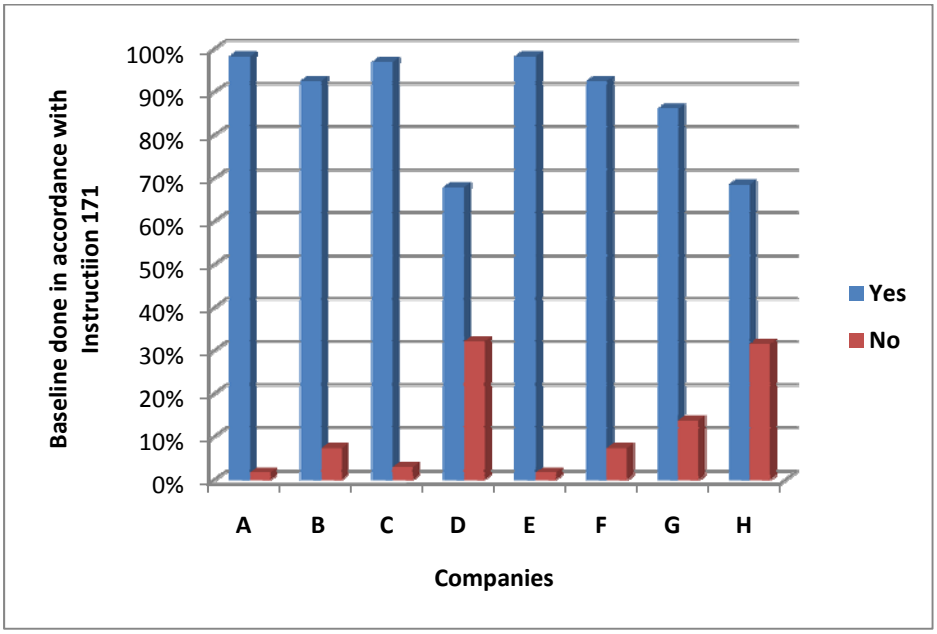

Figure 2: Baseline audiometric testing in 8 companies

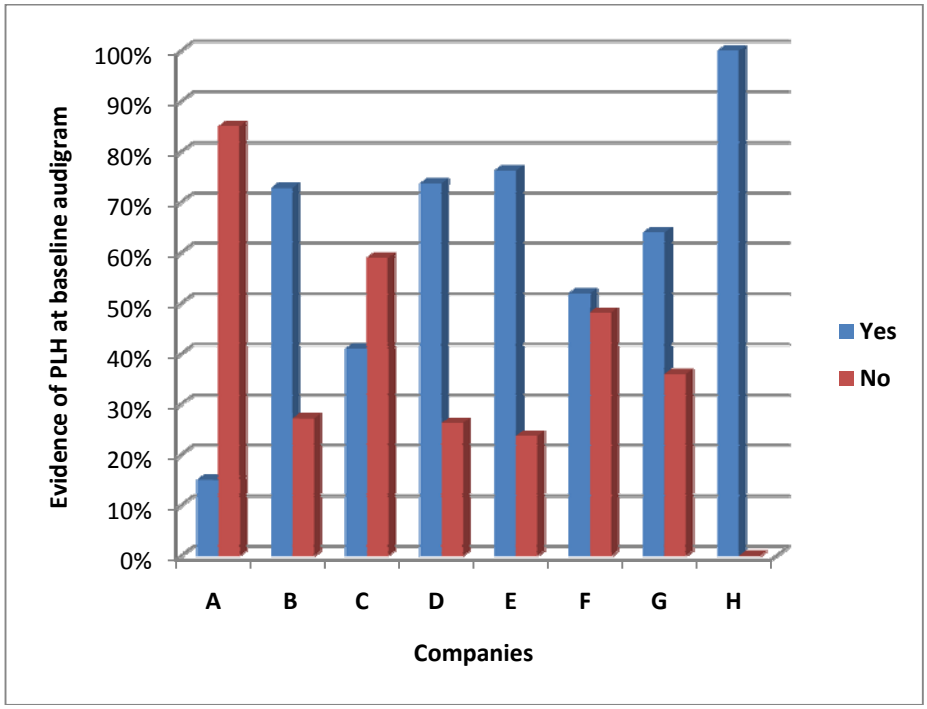

Figure 3: PLH at baseline audiometric testing

4.1.2 Periodic audiograms

It was policy in all companies to do periodic audiograms annually for exposed employees except office staff where these were usually done every 2 - 4 years in different companies. In four of the companies, periodic audiograms were conducted annually for all staff as there was no information within the clinic on surveys conducted indicating which areas were above 105dB(A). In other companies clinics did not have a list of employees working in the areas with noise levels above 105dB(A). In three of the companies it was indicated that office staff also undergo audiometric testing as there was no indication of which areas had certain noise levels but they were aware that the whole plant had been declared a noise zone. Clinic staff did not have an indication of how often office staff spent time in the plant, but they knew that some office staff were potentially exposed.

Of the eight companies visited, three showed evidence of periodic audiometric assessments being aligned and informed by input from occupational hygiene noise surveys. In all three companies this information was available electronically to the clinic staff as a reference for where different employees consulted at the clinic worked, thus influencing how they would be managed.

In three of the companies, targeted annual periodic audiometric testing was conducted sporadically, i.e. not annually, as frequency of testing scheduled by the clinic was not adhered to. In other companies there were systems in place to schedule employee departments and to indicate how many employees adhered to their scheduled audiometric testing. In one company information on employees' attendance for testing as scheduled was communicated at the end of the month so that adherence by department was publicised internally. This was noted as a good practice.

It was difficult to assess compliance of frequency of audiometric testing with legislation because mandated frequency is determined by employee noise exposure and this was not usually available. However, each file was assessed based on the information available. A factor that was also considered was how often the employee was supposed to have undergone testing according to policy, despite lack of information on noise levels. It was noted that in four of the eight companies (B, E, F and H) audiometric testing had been conducted sporadically before

2008/2009, or conducted regularly but every two years. Audiometric testing in these companies was however conducted annually after the aforementioned period. These were then assessed based on the current practice as being compliant with legislation where testing was conducted at least annually.

Results of record review in eight companies are shown below with regards to periodic audiograms, compliance with legislation and evidence of threshold shift from baseline.

Table 11: Periodic audiograms, compliance with legislation and evidence of threshold shift from baseline in various companies

Company	Frequency of audiograms		Compliance with legislation		Evidence of threshold shift		
	Sporadically	**Annually**	**yes**	**No**	**Yes**	**No**	**Unclear**
A	1.7%	98.3%	98.3%	1.7%	16.7%	83.3%	0
B	71.6%	28.4%	71.6%	28.4%	45.7%	44.4%	9.9%
C	6%	94%	100%	0%	32%	68%	
D[a]	100%	0%	0%	100%	14.3%		83.7%
E	0	100%	100%	0%	35.6%	64.4%	
F	0	100%	Unsure		37%	63%	
G	0	100%	100%	0%	28 %	72%	0
H	0	100%	11.1%	88.9%	48.1%	51.9%	

[a] *Company D used a non-computerised audiometry testing system and a manual filing system for audiograms separate from individual medical files. No medical file demonstrated compliance with requirements for periodic audiograms but audiograms may have been done and filed elsewhere. This could not be checked as the audiograms were not filed systematically (neither alphabetically nor by department).*

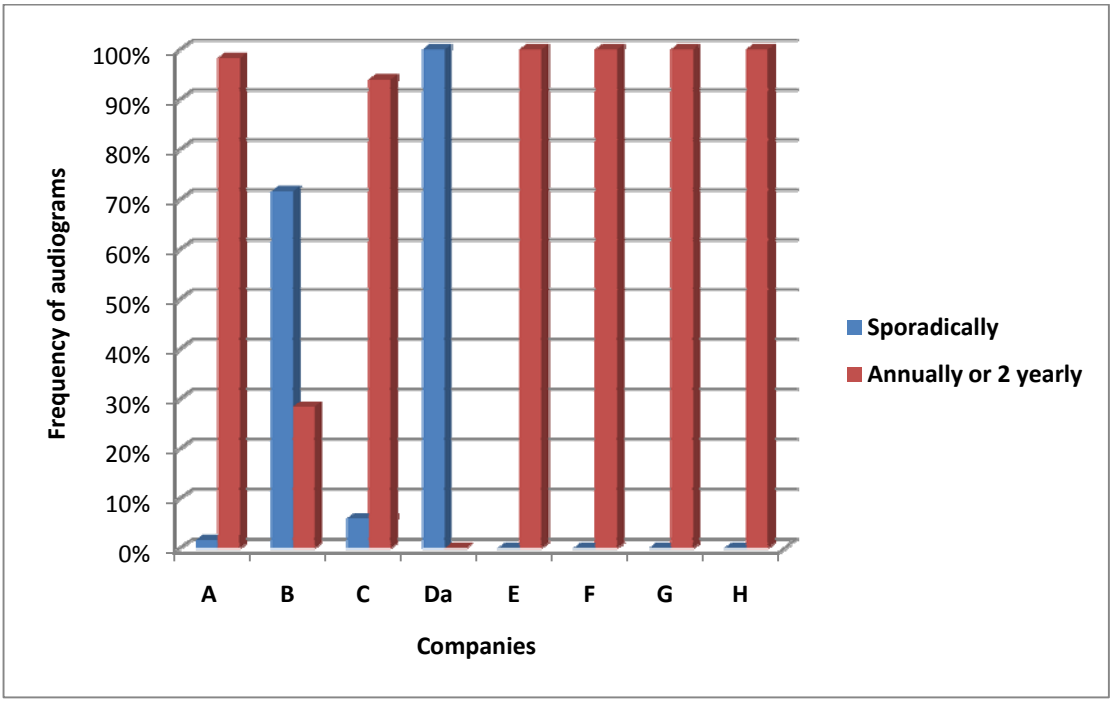

Figure 4: Periodic audiometric testing in 8 companies

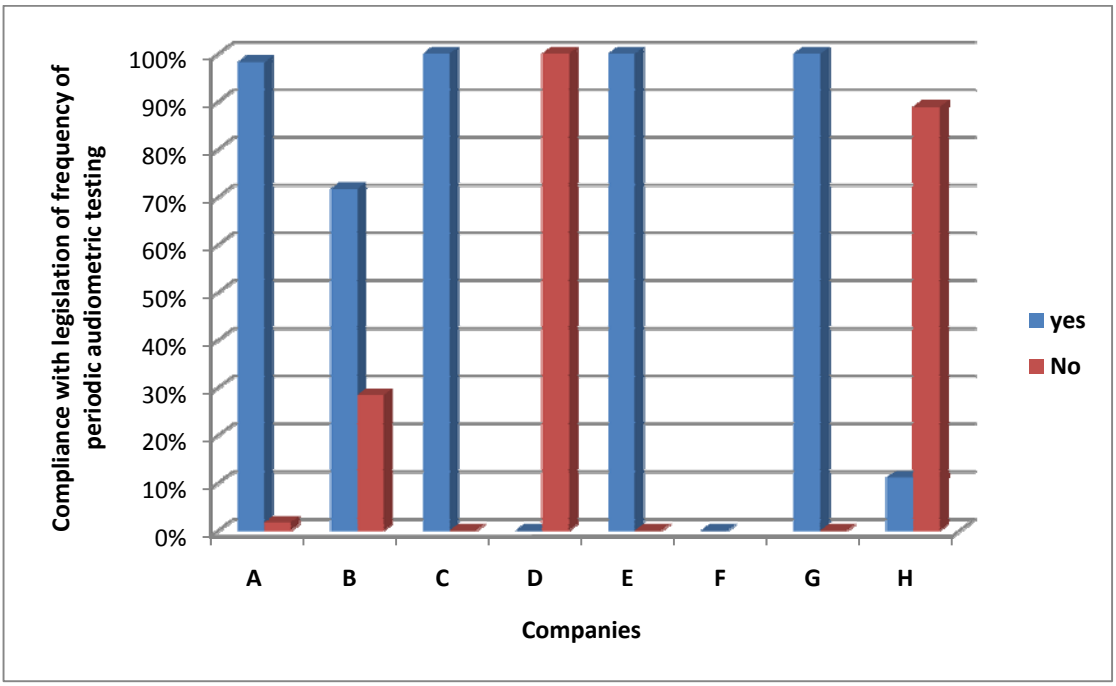

Figure 5: Compliance with legislation of periodic audiometric testing conducted in 8 companies

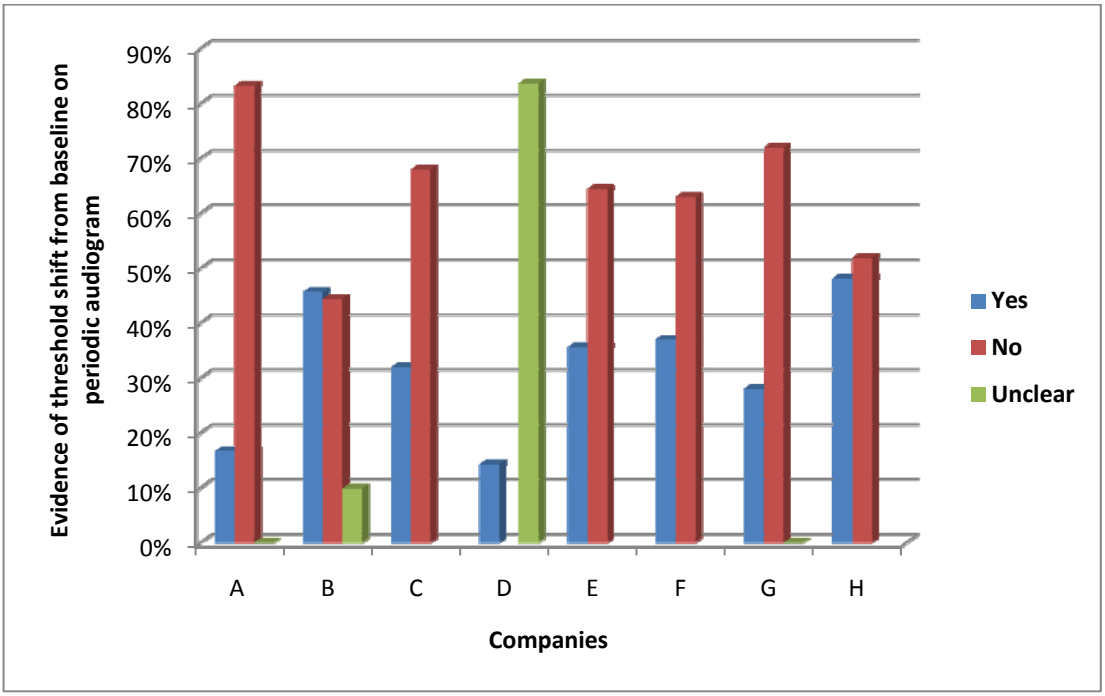

Figure 6: Periodic audiometry-Evidence of threshold shift from baseline in 8 companies

4.1.3 Action plan for declining hearing thresholds

Table 12: Actions taken following hearing decline following periodic audiometric testing.

	Evidence of threshold shift (No of employees)	Nothing recorded in the medical file	Test was repeated after no exposure to noise	Diagnostic audiogram was done	More training was done	The employee was relocated
A	10	20%	40%	60%	10%	0
B	37	91.9%	8.1%	0	8.1%	0
C	11	73%	0	9%	23%	0
D[a]	Unobtainable					
E	21	76.2%	14.6%	9.4%	0	0
F	10	50.0%	10%	0	50%	0
G	26	96.2%	3.8%	0	3.8%	0
H	5	16.67%	16.67%	66.67 %	0	0

[a] *It was not possible to collect these data for company D.*

Audiometric testing conducted at company level are screening tests for early detection of trends towards decline in hearing and also to some extent to detect abnormality to be referred for further investigation. In all the companies, audiometric tests were reviewed by occupational health practitioners for individual analysis. However it seemed that this analysis was focused on detection of abnormality rather than early identification of deviation from baseline testing. This was seen in most of the records where a threshold shift from baseline was noted but nothing was documented in the medical file. It should be noted though that documentation of interventions is not necessarily recorded in medical files; hence Table 6.3 should be read with this in mind.

Good practice noted in four companies was individual analysis and review of every test by an Occupational Medical Practitioner (OMP) and in three group analysis of the results conducted for employees from similar workplaces. This showed the link of medical surveillance with occupational hygiene as information from group analysis would be discussed with occupational hygiene regarding reassessment and review of controls in the particular worksite.

It was also noted in some companies that action was taken at a PLH of 5, in the form of retraining, investigating hearing protection and controls and even relocation. This was also documented in the companies' standard operating procedure, and was noted as a proactive intervention rather than waiting for PLH of 10. This was a commendable practice. However, interventions should be considered in employees with declining hearing even before a PHL of 5 is reached.

Another good practice from individual assessment was where OMPs would identify employees with multiple risk factors and susceptibility and recommend early action to be taken in the form of diagnostic testing, retraining and even relocation where possible. This included individual risk factors like medical conditions and medication that could accelerate or predispose an individual to NIHL even at the exposure level where other employees would not acquire NIHL.

In other companies, it was reported that employees working in areas where noise levels were above 105dBA had undergone audiometric testing six monthly for a period of three years. This was converted to annual audiometric testing when the OMP did not identify any adverse trends in these employees' audiogram results. The focus was also on other forms of noise controls

including custom made hearing protective devices. This was also good practice and in line with legislation.

4.6.4 Exit audiograms

All eight companies reported that it was standard practice for employees to be issued with copies of exit audiograms when they leave the company.

4.6.5 Audiometric verification

Audiometric testing verification was conducted to compare a sample of audiograms done in-house at each company with audiograms done by an external service provider on the same employees.

Table 13: Comparison of audiometric tests conducting within companies to those conducted by an external service provider

	A	B	C	D	E	F	G	H
Audiograms for comparison	16	20	20	19	24	21	20	12
Concordant	8	0	4	0	2	2	4	0
10-19 dB difference	3	3	10	7	11	14	14	6
20-29 dB difference	5	7	6	9	8	3	2	4
30-39 dB difference	0	4	0	1	3	1	0	2
>40 dB difference	0	6	0	2	0	1	0	0

There are many factors that could contribute to significant variability between the audiogram done in-house and the audiogram done by the external service provider. Some of these include employees' compliance, recent ear infection, and different testing conditions like noise exposure before testing and machine calibration. It is notable, though, that differences above 20 dB(A) were seen in the majority of audiograms in some of these companies.

4.6.1 Noise induced hearing loss

Information on Noise Induced Hearing Loss cases diagnosed in the past 10 years (2002-2012) was obtained from the companies. This information was used to determine the burden of NIHL in the companies. Additionally, in most of the companies employees diagnosed with NIHL who were still in the employ of the company were identified so that the survey could review their

medical records, provided they consented for this to be done. This information was important to determine how these cases were managed within the programme.

NIHL files were reviewed to understand how companies had conducted baseline audiometric testing, periodic reviews, investigations and management of cases once they were diagnosed. It had to be taken into consideration that in two companies none of the files from the NIHL cases was available for review as employees had not consented. In these companies compensation files that had been submitted to the Compensation Commissioner were reviewed, but details on how these employees were managed could not be accessed. In another company none of the files of the NIHL diagnosed employees was available for review and compensation files were not available for review. In another company, Company H, information and files were only available from 2008 as it was reported that no information was kept/ available prior to this date. Company C only began operating in the late 1990's and NIHL from exposure in the company would not be expected until late 2000.

Results of the analysis are summarised are in Table 8 below.

Table 14: Cumulative incidence and estimated average annual incidence (the risk of acquiring NIHL)

Company	A	B	C	D	E	F	G	H[a]
NIHL/ number of employees in the company in 2012	47/ 7000	45/ 541	9/ 650	10/ 246	40/ 2700	63/ 2587	25/ 1696	9/ 2953
Cumulative Incidence over 10yrs (per 1000)	6.7	83	14	41	15	24	15	6
Estimated average annual incidence (per 1000/year)	0.7	8.3	1.4	4.1	1.5	2.4	1.5	0.6

[a] *Cases documented and filed from 2008 in this company, no information on cases diagnosed before 2008.*

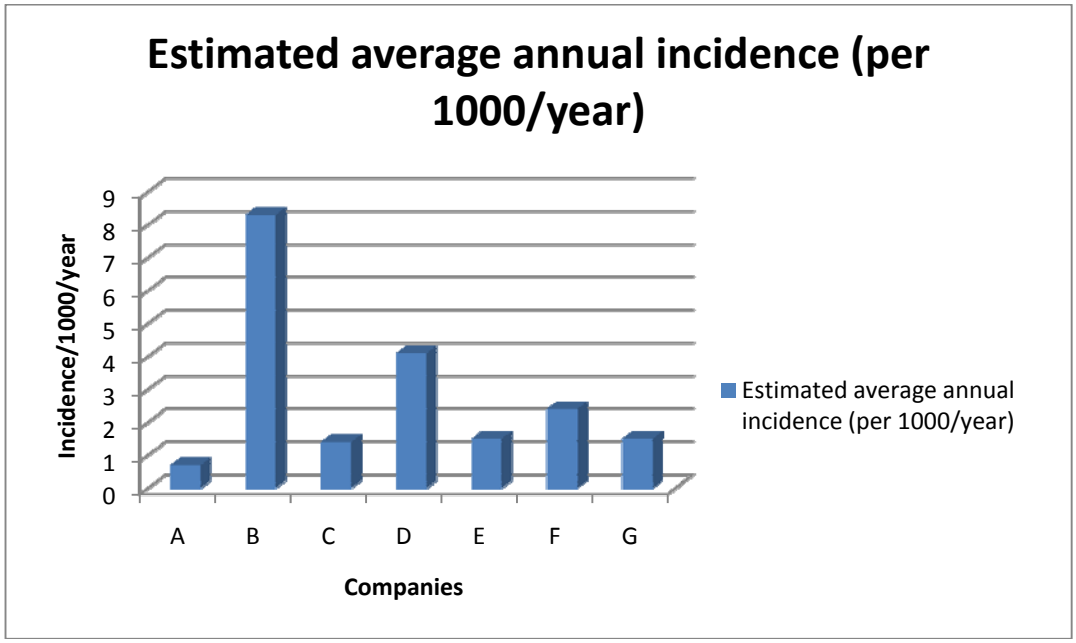

Figure 7: Estimated annual incidence of Noise Induced Hearing Loss in various companies.

It should be noted that not all cases of NIHL can be attributed to the present company as some cases had had noise exposure prior to joining the company.

Company H was not included in the graph above as there was no information on noise induced hearing loss available for the period before 2008. In this company, there was a total number of nine NIHL cases from 2008, thus resulting in an estimated average annual incidence of 0.6 per 1000/year from 2008.

4.6.2 Record review of NIHL cases

Table 15: Interventions on employees identified with a 10 PLH

Co.	No. of employees with NIHL	Referred for compensation	More training	Relocation	Dismissed	Other than referral for compensation, no evidence of other actions
A	37	100%	21.6%	10.8%	0	67.6%
B	21	85.7%	0	0	0	100%
C	9	100%	n/a[a]			
D	10	100%	n/a[a]			
E	07	100%	14.3%	28.6%	0	0
F	7	85.7%	42.9%	0	0	57.1%
G	n/a[a]					
H	06	83.3%	0	0	-	33.3%

n/a[a] none of employees within this group consented for their files to be reviewed.

5. Discussion

This study into the hearing conservation practices within eight iron and steel companies across South Africa showed that some categories of employees are at risk of acquiring noise induced hearing loss due to exposure levels that exceeded the exposure limit of 85dB(A). This study revealed differences in hearing conservation practices across the eight companies which varied from comprehensive to not having a written standard operating procedure on monitoring noise induced hearing loss. The discussion will be based on the objectives as set out in the methodology of this survey. A list of good practices identified and more detailed recommendations follow in the next section.

1. ***To verify the current designation of noise zones as described in companies' occupational hygiene reports***

All work areas surveyed that were designated as noise zones by the companies were found to be correctly designated as noise zones.

2. ***To assess workers' exposure levels by conducting area and personal noise (dosimetry) measurements***

The results show that approximately 50% - 100% of both area and personal measurements taken within plant and production areas in ALL companies exceeded the 85 dB(A) limit.

Companies B and D were in the 88dB(A)–94dB(A) levels for both personal worker and areas noise exposure and should endeavour to reduce their noise emissions by process changes, engineering controls, noise refuges etc.

Analysis of the relation of the area to personal median noise levels showed that factories with well controlled area levels were 40% more likely to have well controlled personal noise exposures.

3. ***Analyse and audit current hearing conservation practices***

The survey provided an opportunity to analyse current hearing conservation practices and evaluate if companies could translate policy intentions into good governance and practices. Early intervention by occupational clinic staff when first indications of hearing loss are noted, even before the 10PLH is reached, was one good practice that showed that interventions beyond the minimum statutory requirements are possible. It is important that companies monitor and continuously evaluate hearing conservation practices and their contribution to the overall objectives of the programme. This should be done at a company level but also at an industry level in the form of peer evaluation where companies get the opportunity to share and discuss examples of good practices that resulted in positive outcomes in terms of NIHL.

4. ***Based on company records, to determine the extent of NIHL diagnosed by the companies over the past decade***

One of the objectives of the survey was to determine the extent of NIHL diagnosed by companies over the past decade based on company records. As part of this survey, the study team reviewed company records of NIHL cases diagnosed within the company and cases submitted for compensation from 2002 to 2012. The incidence of NIHL was lower than found in studies in other developing countries. The reason for the lower incidence is not known but under-ascertainment and under-reporting are possible explanations.

It is worth noting that most of the recommendations in the NIHL Regulation stipulate what employers should do at a programme level, but reflecting these interventions or programmes at an individual level requires clinical administrative capacity which can be evaluated through careful review of clinical records. It was noted that study companies had different practices regarding documentation and collation of information to be used for each individual in line with the individual's clinical assessment. This was evident as shown in the medical surveillance section of the Results. Cross-sectional studies are very likely to underestimate NIHL due to the healthy worker effect. Consequently company records of NIHL were used to estimate cumulative incidence and estimated average annual incidence to determine the extent of NIHL from 2002 to 2012. Cumulative Incidence is the most appropriate measure to estimate the risk of acquiring occupational noise induced hearing loss for an individual working in the iron and steel industry within the last decade.

From the current cumulative incidence, companies will be able to review various components of the programme aiming at reducing the incidence of NIHL at a company level over the next 10 years.

5. To verify records of current hearing threshold levels of workers by independently conducting audiometric testing

The purpose of conducting audiometric testing was to check the reliability of the current audiometric testing procedures. This is important in the context of in-house testing by the same company exposing people to noise.

Records of current hearing threshold levels of workers in the study companies were compared to hearing thresholds determined by an independent audiometric service provider. It was not feasible to conduct independent audiometric testing under the same conditions as done by the in-house company tester. . Nevertheless, this exercise provided useful information that should be considered when companies conduct audits of their services. In particular, conducting testing on a sample of employees using two separate audiometers (company and external service providers) concurrently should be considered. Testing concurrently would ascertain if the technique is repeatable, eliminate time delays during which significant hearing changes can occur and would ensure that the same testing conditions exist for both tests.

6. ***To compile recommendations for improvement of existing hearing conservation practices that can be implemented in the South African iron and steel industry***

Although some companies had sound hearing conservation programmes, there was evidence from this survey that gaps existed in the current hearing conservation practices in all eight study companies. Recommendations have been developed to address the gaps. These recommendations – which include noise measurements, noise control techniques, information and training, audiometric testing, job rotation, and the use of hearing protection devices – have been found to be the most feasible methods for the protection of industrial workers from noise exposure at work in developing countries (Singh et al., 2012).

7. ***Based on best practices and expert advice, to develop a standard inspector checklist for noise in the iron and steel industry.***

A standard checklist for use by the Department of Labour inspectors when visiting companies has been developed based on standard practices and expert advice. The checklist is comprehensive but concise enough to be utilised at a visit to gather pertinent information in evaluating hearing conservation practices. There is a need for the inspector to be familiar with certain concepts for them to be able to interpret the findings correctly.

6. Conclusion

The survey revealed that all eight companies included in this survey had areas of noise exposure above the legislated level of 85dB(A) which put a number of employees at risk of developing noise induced hearing loss. The difference between the companies lies in the effective implementation of the hearing conservation programme that covers all aspects as per Policy checklist (Appendix 3). Companies are advised to look at all aspects of the programme and go beyond just adhering to legislative requirements since by the time a PLH of 10% is reached, there is a substantial decline in hearing which is irreversible.

The implications for conservation of employees' hearing would be the need for proper implementation of hearing conservation practices known to be effective and establishment of effective monitoring and evaluation systems. More explicit recommendations are listed in the next section of the document.

7. Recommendations and Good Practice

7.1 Recommendations

A number of aspects of hearing conservation programmes that were reviewed required attention and recommendations will be given in the aforementioned domains.

i.) Policy and Procedures

At a minimum each company should have a Hearing Conservation Policy and Standard Operating Procedure/s that enables a comprehensive programme to be run within the company and details the operation of the programme. The documents should detail the roles and responsibilities of the various stakeholders responsible for hearing conservation and should contain the following elements:

1. Responsibilities

1.1 Health and Safety team

1.2 Occupational Hygienists or contracted AIA

1.3 Occupational Health Clinic

1.4 Training department

1.5 Supervisors

1.6 Employees

2. Noise Evaluation and Surveillance Procedures

2.1 Identification of hazardous noise areas

2.2 Noise exposure measurements: area measurements & personal monitoring

2.3 Re-monitoring when there are changes

3. Noise Control Practices

3.1 Engineering and administrative controls

3.2 Personal protective devices

- *Types of Hearing Protective Devices*
- *Selection of the HPDs*
- *Issuing of the HPDs*
- *Use of the HPDs*
- *Maintenance of the HPDs*

4. Medical Surveillance

4.1 Audiometric Testing

4.2 Action plan for remedial measures

5. Training Programme

6. Programme Evaluation

7. Standard Operating Procedures

8. Record Keeping

For companies with multiple sites there should be an effort for each site to locally adapt their company's main policy and customize it to suit the needs of their workforce taking their exposure and other parameters into account.

ii.) **<u>Assessment of exposure (to include area and personal noise measurements)</u>**

Personal noise measurements must form part of workplace noise assessments in addition to the area noise assessments.

The legal requirement of a maximum of two-year intervals between surveys of noise exposure must be complied with.

iii.) **<u>AIA Survey reports and recommendations</u>**

AIA reports must comply with the minimum requirements and include specific recommendations on noise control.

Instrumentation calibration is essential for surveys and the dates on the calibration certificates must correspond with the dates noted in the reports.

iv.) Noise control practices including HPD's information and training

All noise measurement results, hearing conservation practices, noise control and medical surveillance must be explained to workers in simple, easy terms and a record of these communications must be kept.

Noisy equipment and tools exceeding 85dB(A) must be identified and demarcated with hearing protection pictograms displayed at workstations.

Noise protection signs must be kept clean and visible; these may be displayed also on noisy machines, in addition to the general zone signposting; missing signage of noise zones must be replaced immediately.

Employees exposed to high noise levels should be given hearing protection devices (HPDs) with a high Noise Reduction Rating, preferably custom-made hearing protection.

Health and Safety Representatives must be involved in the implementation of noise control and workers involved in the selection of hearing protectors to improve 'buy-in'.

All supervisors and managers must wear hearing protection within demarcated noise zones for workers to follow suit ('leadership by example');

The correct wearing of HPDs (e.g. earplugs) in noise zones, or whenever noise is present, must be emphasized in the training and supervised. Operators of noisy equipment/tools and anyone else working in proximity to the noise source must be regarded as at risk.

v.) Information and Training

All workers and contractors must be trained on aspects of noise exposure and hearing conservation including noise sources and how to avoid unnecessary noise exposure. Training must be given by a competent person. Records of all training must be signed by the individual as well as the trainer and kept on file.

Retraining must be given to workers and frequency of re-training should be increased in selected settings, this is especially important when there is evidence of deteriorating hearing during periodical examinations even before a 10 PLH is noted.

An evaluation tool to measure the effectiveness of training should be adopted particularly with reference to insertion of HPDs and the health risks of exposure to noise.

Information on health risks of noise must be sufficiently emphasised in the general health and safety training.

Hearing protective devices must always be accompanied by appropriate training and re-training on their correct use to achieve good fit, storage and maintenance.

vi.) Medical surveillance (including: policy, baseline, periodicals, exits, action plans for declining audiograms)

Detailed Standard Operating Procedures should be put in place with regards to medical surveillance for noise induced hearing loss and this should have action lines that initiate remedial processes prior to the employee having compensable disease.

Systems need to be in place to ensure that regular audiograms are done on an annual or six-monthly basis as appropriate.

Medical files should contain specific exposure information as well as recommendations made and evidence of noise control measures taken to prevent worsening of the hearing loss e.g. custom made hearing protectors or relocation of employee should be documented in medical records.

Occupational Health Nurses and Occupational Medical Practitioners' group analysis of audiograms should be communicated to managers and health and safety teams to complement health risk assessments in order to provide guidance to prioritise areas for control measures.

Well-preserved medical files with a systematic of categorising of information, ideally using standardised lists and forms, to ensure all information is recorded appropriately is necessary.

vii.) Audiometric verification

The level of professional conduct within the clinical services should be maintained with regards to certification and calibration of equipment used and staff performing testing. Quality assurance programmes for audiometry should be considered.

An electronic system to verify that regular audiograms are done as appropriate e.g. six-monthly, annually or 2 yearly should be in place.

Considerations should be given to interventions to protect an employee's hearing as soon as it is evident from audiograms that hearing loss is occurring. A 5 PLH is the action level used by a number of companies but this level should not be a requirement for initiating intervention, rather an obvious trend in hearing decline over time should be the action level.

viii.) Noise induced hearing loss

All workers with a PLH deterioration of more than 10% require a diagnostic audiogram and formal referral for compensation if indicated.

A specific formal written plan should be put in place for employees who have compensable hearing loss to prevent further worsening of their condition.

7.2 Good Practice

A number of aspects of good practices were identified during this study which gives guidance to the industry.

i) Policy and procedures

A written health and safety policy was available. Hearing conservation related matters were reported and discussed by employees during toolbox talks and in committee meetings;

The hearing conservation policy was made available to workers and was related to matters discussed during H&S meetings, safety talks or production meetings.

Proactive hearing conservation programmes demonstrated noticeable outcomes.

Managers who were seen to be committed to the noise conservation programme.

ii) Assessment of exposure (to include area and personal noise measurements)

Assessments were re-done immediately after major changes were made to work systems and machinery. Records of these were made available to Safety Representatives and Safety Committee.

The recommendations in reports were practical and actioned according to a plan in line with some hierarchy of noise controls.

iii) AIA Survey reports and recommendations

AIA were used in the noise exposure assessments, reports were available and repeated on the average every 24 months.

iv) Noise control practices

In all sites the general good maintenance of machinery, equipment and tools was thought to generally contribute to less noise being emitted.

Custom made HPDs were provided to selected employees, notably those with early decline in hearing or based in areas with very high noise exposure.

Signage and noise zoning was implemented and standard operating procedures (SOPs) on noise control were available.

v) Information and Training

Training was done on induction and its content was in line with the appropriate medical surveillance programme and records kept. Refresher training was conducted annually.

Information and training programmes are delivered by competent persons and/or persons trained to provide training as recognised by SAQA.

Introduction of strategies to increase uptake of training and also objective means (tests) to evaluate effectiveness of training. Strategies include incentive schemes for employees who have completed training and have evidence of understanding information from training. Training competency certificate was linked to eligibility for payment of bonuses in one company.

vi) Medical surveillance- (including: policy, baseline, periodicals, exits, action plans for declining audiograms)

Ongoing communication between occupational hygiene and occupational medicine clinic with regards to sharing information and updates on noise levels from latest surveys conducted.

Baseline audiograms are done before or within 30 days of commencement of employment and periodically – all done in accordance with SANS 10083 (Sections 17-18) for the measurement and assessment of occupational noise for hearing conservation purposes.

Software that allows for group analysis of results of audiometric testing and advice, particularly if any trends suggest review of workplace controls.

Documentation of noise exposure on audiograms.

Individual analysis by OHP and OMP respectively to identify threshold shift and whether this is temporary or permanent.

Documentation of what was found and what the intended management includes for each employee with results that need to be acted upon.

Early intervention by occupational clinic staff when early changes are noted suggestive of hearing loss, even before the 10PLH is reached. Companies have indicated that some measures include taking action at a threshold of 5% loss of hearing to avoid further deterioration.

*Feedback and appraisal from the clinic to Occupational hygiene, safety and employee representatives through safety meetings on attendance / uptake of the programme through attendance at the scheduled time***.**

vii) Noise induced hearing loss

Employees diagnosed with NIHL who showed a 10PLH were appropriately referred for diagnostic audiograms and subsequently submitted for compensation. The Health and Safety Representatives were involved in the assessment. Audiometric testing was done on all employees exposed to noise rating levels that exceeded the 85dB(A) noise rating limit.

Clear actions were taken when hearing decline was first detected at 5PLH to prevent progression of hearing loss to 10PLH.

8. Acknowledgments

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Appendix 1 – Records Review (Field Questionnaire)

TOPIC / QUESTION	YES	NO	EVIDENCE / COMMENT
1. Information and Training			
1.1. Is information and training on noise provided to all workers at risk of NIHL?			
1.2. Are training records kept?			
1.3. Is refresher training conducted annually?			
1.4. Is the training provided by a competent person?			
1.5. Are supervisors / managers involved in the training?			
1.6. Was the effect of the training programme evaluated?			

1.1 Training records – should include employee's name, date, type of training, name of trainer, employee's signature

1.4 Competent person – a person who has adequate practical experience and theoretical knowledge in all aspects of work performed

1.6 Effect of the training can be evaluated by competency tests or by actual reduction in cases of NIHL

TOPIC / QUESTION	YES	NO	EVIDENCE / COMMENT
2. Assessment of Exposure			
2.1. Was the assessment of workers' exposure to noise included in a health risk assessment?			
2.2. Were the H&S Representatives involved in the assessment?			
2.3. Were personal noise exposure levels measured?			
2.4. Were area noise levels measured?			
2.5. Were the noise measurements conducted by a noise AIA?			
2.6. Are exposures to noise being reassessed at least every 24 months?			
2.7. Are exposures reassessed immediately after major changes of work systems and machinery occur?			
2.8. Are the records of the assessments and measurements available to the H&S representatives and committees?			

TOPIC / QUESTION	YES	NO	EVIDENCE / COMMENT
3. *Survey Reports & Recommendations*			
3.1. Are noise survey reports available for perusal by H&S reps and inspectors?			
3.2. Are the recommendations included in the reports practicable?			
3.3. Have the recommendations provided in the report been actioned?			
3.4. Were engineering controls used to reduce exposures to noise?			
3.5. Were administrative controls used to reduce exposures to noise?			
3.6. Are the H&S representatives and workers involved when selecting / implementing controls?			

3.3 Action plans must include names of responsible persons and due dates for implementation
3.4 Engineering controls, such as: enclosures, silencers, noise absorption materials, vibration control
3.5 Administrative controls, such as: job rotation, SOPs, training and instruction

TOPIC / QUESTION	YES	NO	EVIDENCE / COMMENT
4. ***Medical Surveillance***			
4.1. Is a system of medical surveillance implemented for all exposed employees?			
4.2. Are baseline audiograms conducted within 30 days of commencement of employment?			
4.3. Are periodic audiograms conducted as prescribed in SANS 10083?			
4.4. Do employees exposed to noise rating levels at or above 105 dB(A) undergo audiometric testing as prescribed in the above Code?			
4.5. Is a reassessment conducted when employees' percentage loss of hearing (PLH) deteriorates by 10% or more?			
4.6. Are cases where PLH equals or exceeds 10% reported?			

4.3 Periodic audiogram – for the first 3 years annually, thereafter may be extended to a maximum of 2 years, provided no referral threshold shift is evident

4.4 Periodic audiogram – every 6 months until it is established that no referral threshold shift is evident, thereafter interval may be extended to a maximum of 1 year

4.5 Reassessment – repeat audiogram, inform H&S rep / committee, retrain employee, reassess controls

4.6 Report to DoL provincial director on WCL1/2 form; note here <u>how many</u> cases reported

TOPIC / QUESTION	YES	NO	EVIDENCE / COMMENT
5. *Hearing Protection Equipment (HPE)*			
5.1. What types of HPE are used on this site?			
5.2. Is there a written HPE programme for this site?			
5.3. Is there a written procedure for the issuing of HPE?			
5.4. Is the capability of the HPE to keep exposures below the noise rating limit assessed?			
5.5. Were employees consulted during the HPE selection process?			
5.6. Are employees trained in the correct use and care of the HPE?			
5.7. Is employees' capability to use HPE medically assessed?			

5.2 HPE programme meaning written procedures / standards dealing with: training and re-training, consultation, selection, fitting, issuing, medical examinations, maintenance and storage (see questions below)

5.4 Simple method: $L_{Aeq,8}$ – [(NRR-7)x0.5] = Estimated $L_{Aeq,8}$ under the protector

TOPIC / QUESTION	YES	NO	EVIDENCE / COMMENT
6. *Policies and Procedures / Administrative*			
6.1. Is there a written company policy on hearing conservation?			
6.2. Is the policy readily available to all employees?			
6.3. Is there a company policy / procedure for "buying quiet"?			
6.4. Are hearing conservation related matters reported and discussed during H&S meetings / safety talks / production meetings?			

6.1 The policy should include a management commitment to comply with legislation and towards continuos improvement

6.2 A "buy quiet" policy should include requirements aimed at purchasing equipment that is "low noise", e.g. by requesting vendors to specify noise emission rates

Name, designation and contact details of the person/s providing the information	Occupational Hygienist

Appendix 2 – Worker's Interview

Questions	Input / Observation
When were you last given training on noise?	
What are the main health risks of noise?	
Do you use hearing protection in your job?	
What type of hearing protectors do you use?	
Will you show me how do you put on hearing protectors correctly?	
When last did you have a hearing test?	
Do you experience any difficulties with your hearing?	
Do you have any concerns regarding noise in this workplace?	

Appendix 3 – Hearing Conservation Policy Checklist

Company Name:

Date:

1. *Is there a written Hearing Conservation Programme (HCP) policy at your company?*
   Y ☐ *N* ☐
2. *Is there a written Standard Operating Practice (SOP) for noise induced hearing loss at your company?* *Y* ☐ *N* ☐
3. *Do you have training and information on noise for workers?*
   Y ☐ *N* ☐

   (If yes… please proceed to answer question 3)

Information and training

4. *Are the following incorporated into the (noise) training programme for workers?*

   a) What the noise sources are *Y* ☐ *N* ☐
   b) The health risk of exposure to noise *Y* ☐ *N* ☐
   c) The need to wear hearing protection *Y* ☐ *N* ☐
   d) The correct use of the hearing protection *Y* ☐ *N* ☐
   e) The maintenance of the hearing protection *Y* ☐ *N* ☐
   f) The limitations of hearing protection *Y* ☐ *N* ☐
   g) The procedures for reporting and replacing defective hearing protectors *Y* ☐ *N* ☐
   h) The necessity for regular audiograms *Y* ☐ *N* ☐

5. *When is (noise) training first done with a new employee?*
   a) Before placement of the employee ☐
   b) Within 3 months of employment ☐
   c) Within the first year of employment ☐
   d) Another time. Please specify ☐
   ……...

6. *After the initial training, how frequently is retraining carried out?*
   a) *Yearly* ☐
   b) *If there is evidence of a threshold shift on audiogram* ☐
   c) *Never* ☐
   d) *Other. Please specify* ☐

   ……
   ……
   …..

7. *What measures does the company take to ensure that the trainers are competent?*.....
   .....
   .....
   .....
   .....

8. *Do you evaluate the effectiveness of your training?* *Y* ☐ *N* ☐

9. *How do you do this?*.....
   .....
   .....
   .....
   .....

10. *Are records of training kept?*
    Y ☐ *N* ☐

Audiograms

11. *Are audiograms done at your company?* *Y* ☐ *N* ☐

12. *What is the minimum level of noise exposure at which regular audiograms are done in your company?*
    .....

13. *Are baseline audiograms carried out on all these employees?*
    Y ☐ *N* ☐ *Other* ☐

    Please specify
    .....
    .....

14. *Are periodical audiograms done annually?*
    Y ☐ *N* ☐ *Other* ☐

Please specify

……..
.....
.....

15. Are there areas where the level of noise exposure is above 105dB(A)?

Y ☐ *N* ☐

If yes, how frequently do employees who work in these areas have audiograms?.....
.....
.....

16. Are the audiograms done

a) In-house ☐
b) Outside the company ☐

17. What evidence is there that the person doing the audiogram is competent?

.....
.....
.....

18. What are the minimum PHL when these actions listed below are taken?

a) Retraining on noise.....
b) Diagnostic audiology referral.....
c) Relocation.....
..

Records

19. Is there a record that shows audiometric calibration procedures were carried out?

Y ☐ *N* ☐ *Other* ☐

Please specify

……..
.....
.....
.....

20. After audiograms are done, is there a record that these have been analysed and looked at by an occupational medical or nurse practitioner?

Y ☐ *N* ☐ *Other* ☐

Please specify……..
……
……

21. Are department group audiograms analysed and commented on?

Y ☐ *N* ☐ *Other* ☐

Please specify……
…….....
.....
.....

22. Are employees given a copy of their exit audiogram on leaving employment?

Y ☐ *N* ☐ *Other* ☐

Please specify…….....
.....
.....

Referrals

23. In the event of a 10 % PLH from the baseline determined in an employee. Who is informed?

a) The employee ☐
b) The health and safety committee ☐
c) The occupational hygiene team for reassessment of noise controls ☐
d) The compensation commissioner when submitting for a claim ☐
e) Other. ☐

Please specify……
……

24. What do you do when an employee has temporary threshold shift evident on audiogram?

……
……
……
……
……

25. *What do you do when an employee has permanent threshold shift evident on audiogram?*

    ……
    ……
    ……
    ……
    ……..

Appendix 4 – Record review for Noise study for Department of Labour

1. Patient History

Name:
.....

Age:..... Employee No. : ……

2. Occupational history:

a) *Worked for the current employer since: .....*

b) *Current department:*
.....

Worked here since:……..

c) *If the employee worked in another department in this company. What was the previous department:.....*

Worked here since:……

d) *Previous industry worked in:.....*

Duration worked here:……..

Current department:

e) *Is the employee exposed to noise?* *Y* ☐ *N* ☐

f) *For how long has he been exposed?.....*

g) *What type of hearing protection does the employee use?.....*

h) *Has it been documented in the medical notes that the employee has received training on noise and hearing conservation?* *Y* ☐ *N* ☐

i) How long is the employee exposed to noise a day?.....

Unknown ☐

3. Other risk factors:

a) Past history of trauma to the ear/s, occupational or otherwise? Y ☐ *N* ☐ *Unknown* ☐

If Y which ear, date, how?

.....

b) Previous ear infections (acute or chronic) Y ☐ *N* ☐ *Unknown* ☐

If Y which ear, date

.....

c) Is there documentation of complaints of tinnitus, ear discharge, ear pain, or other ear symptoms? Y ☐ *N* ☐ *Unknown* ☐

If yes please indicate with dates

.....
.....
.....

d) Is there documentation of neurological problems: Multiple sclerosis, Auto immune disease, or other? Y ☐ *N* ☐ *Unknown* ☐

If Yes, please state the diagnosis.

.....
.....
.....

e) Is there documentation of previous ear surgery? Y ☐ *N* ☐ *Unknown* ☐

If yes, which ear?.....

procedure done.....

Date.....

f) Is there documentation of exposure to other loud noise e.g. loud music in taxi's, car, home, in a band Y ☐ *N* ☐ *Unknown* ☐

If yes, please describe

.....
.....
.....
.....

g) *Has the employee been referred to an ENT specialist? Y ☐ N ☐ Unknown ☐*

If yes. What diagnosis was made.....Date.....

4. Examination findings on record:

a) *Previous examinations of the ear: Evidence of scaring, evidence of acute or chronic infection with dates*

.....
.....
.....
.....

b) *Other neurological signs at examination*

.....
.....
.....
.....

5. Audiograms:

5.1. Baseline Audiogram

a) *Was a baseline audiogram done in line with instruction 171?* *Y* ☐ *N* ☐

b) *Was there hearing loss evident?* *Y* ☐ *N* ☐

If yes, what was the PHL?.....

c) *If no baseline audiometry was done, when was the first audiometry done? Date.....*

Was there evidence of hearing loss? *Y* ☐ *N* ☐

If so, what was the PHL?.....

5.2. Screening audiograms

a) *Has it been documented that the test was performed after 16 hours of no noise exposure (hearing protection devises may be used)* Y☐ N☐

b) *How often are audiograms done?*

If noise exposure >85dB - annual audiograms.....

If noise exposure >105dB- 6/12 audiograms.....

Is this consistent with the legislated requirements? Y☐ N☐

c) *Was there any evidence of threshold shift (a 10 dB confirmed threshold shift from the baseline average at 2kHz, 3kHz and 4 kHz)?* Y☐ N☐

If yes, what was done after this was recognised?

- ☐ *Nothing was done*
- ☐ *The test was repeated after no noise exposure*
- ☐ *A diagnostic audiogram was done*
- ☐ *More training of the employee was done around hearing conservation*
- ☐ *The employee was relocated*

Date of last audiogram:

5.3. Diagnostic audiogram

a) *Was a diagnostic audiogram done?* Y☐ N☐

If diagnostic audiogram not done, stop here!!!

b) *Was the diagnostic audiogram done by*

- ☐ *A person registered with the HPCSA*
- ☐ *A graduate in speech therapy and audiology*
- ☐ *A person with a certificate recognised by the DoL and DMR*

c) *Was the diagnostic audiogram normal?* Y☐ N☐

If abnormal:

Was there bilateral hearing loss? Y☐ N☐

Losses greatest at .....frequency.

Are other frequencies losses? Y☐ N☐

Can be diagnosed as noise induced hearing loss? Y☐ N☐

d) *What was the PLH?.....*

Was this more than 10% of the baseline PLH if no baseline was done or was the PLH 10%? Y☐ N☐

If there is PLH>10% was this confirmed by another test? Y☐ N☐

If the PLH was >10, what was the permanent disablement? (PLH/2).....

e) *Was the employee referred for compensation?* Y☐ N☐

f) *If 2 diagnostic audiometry tests were inconsistent,*

☐ *Was a 3rd test done?*

☐ *Was the employee referred to an ENT?*

g) *If NIHL was diagnosed what was done:*

☐ *Nothing was done*

☐ *More training of the employee was done around hearing conservation*

☐ *The employee was relocated*

☐ *The employee was dismissed*

Appendix 5 – Information Document and Consent Form

NOISE INDUCED HEARING LOSS IN THE SOUTH AFRICAN IRON AND STEEL INDUSTRY STUDY

Hello Worker,

Introduction:

We, the National Institute for Occupational Health are helping the Department of Labour do research on Noise Induced Hearing Loss in the South African Iron and steel industry. Research is just the process to find the answer to a question. In this survey we want to find out how workers who work with noise are looked after by their company and the Iron and Steel industry as a whole in terms of hearing protection.

Invitation to participate: *We are asking for your permission to allow us to look at your medical records that are held within the company and possibly doing a hearing test if you are selected.*

This information document will help you to decide if you want to participate. Before you agree to take part you should fully understand what is involved. If you have any questions that this information leaflet does not fully explain, please do not hesitate to ask the study doctor whose contact details are at the end of the document.

What is involved in the study*: Some workers have been randomly chosen based on the level of noise that they are exposed to, or if they are known to have some hearing loss, to be part of our study. The medical records of these workers will be looked at with special attention paid to the hearing tests. We will not interview you but only look at your medical file. We will select a few of the employees whose medical file we review and do a hearing test on them so that we can compare this with the hearing tests in the medical file.*

Risks: *There are no risks of being involved in the survey. Your medical records will be looked at by doctors who will keep all personal information confidential. No compensation will be given to you for allowing your records to be looked at.*

Benefits: *Although you may not benefit directly from the study, the information that will be gained from your participation will enable the department of Labour and your company as well as other Iron and Steel companies to ensure that workers who work with noise are adequately protected and monitored.*

Participation is voluntary *and you can withdraw at any time during the study period. Refusal to participate will not cause you to suffer any discrimination or punishment in your workplace.*

Confidentiality: *All efforts will be made to keep personal medical information confidential. The survey will be done by an independent organization and no personal information will be given to your employer. Once the information is analyzed no one will be able to identify you.*

For any additional information, please contact Dr Odette Abrahams at the NIOH, Occupational Medicine Department on (011) 712 6415.

CONSENT TO PARTICIPATE IN THE NOISE INDUCED HEARING LOSS IN THE SOUTH AFRICAN IRON AND STEEL INDUSTRY STUDY

I confirm that I have been provided with the necessary information about the nature, process, risks, discomforts and benefits of the survey. I have also received, read and understood the above written information (Information document and Informed Consent) regarding the study. I am aware that what is being asked of me is to look at my medical file and possibly have a hearing test if I am selected. Once my medical file has been reviewed the results, including personal details, will be anonymously processed into reports. I am participating willingly. I have had time to ask questions and have no objection to participate in the study. I understand that there is no penalty should I wish to discontinue with the survey and my withdrawal will not affect my employment within the company in any way.

Participant's signature: .....…… Date.....

Witness's signature .....…….... Date.….....

Appendix 6 – Inspector Checklist for Workplace Noise

TOPIC / QUESTION	YES	NO	OBSERVATION / EVIDENCE
1. *Company Policies and Procedures*			
1.1. Is a written company policy on hearing conservation available to workers?			
1.2. Is there a written standard operating procedure for hearing conservation?			
2. *Information and Training*			
2.1. Is information and training on noise provided to all workers at risk of NIHL?			
2.2. Is refresher training conducted annually?			
2.3. Are training records kept?			
2.4. Is training efficacy evaluated?			
3. *Assessment of Exposure*			
3.1. Are noise exposure levels assessed by an AIA at least every two years?			
3.2. Are personal noise exposure levels measured?			
4. *Noise Control*			
4.1. Have the recommendations provided in the AIA report been actioned?			
4.2. Are engineering controls methods used to reduce exposures to noise?			
4.3. Are noise zones signposted?			
4.4. Are hearing protectors used correctly by all exposed workers?			
5. *Medical Surveillance*			
5.1. Are baseline audiograms available for all employees working in noise zones?			
5.2. Is screening audiometric testing conducted at the prescribed intervals?			
5.3. Are exit audiograms performed on terminated / transferred employees?			
5.4. Is reassessment conducted when employees' PLH exceeds 10% from baseline?			

TOPIC / QUESTION	YES	NO	OBSERVATION / EVIDENCE
5.5. Are cases where PLH exceeds 10% reported as required by legislation?			
5.6. Is there calibration certificate for the audiometric equipment in accordance with SANS?			
6. Hearing Protection Equipment (HPE)			
6.1. Is there a written HPE programme / procedure?			
6.2. Are employees trained in the correct use and care of the HPE?			
6.3. Were employees consulted during the HPE selection process?			
7. Communication and reporting			
7.1. Are the records of noise assessments and measurements available to H&S representatives and workers?			
7.2. Are hearing conservation related matters reported and discussed during H&S meetings and safety talks?			

Notes:

1. *Workers must be familiar with the company policy, which should include a management commitment towards reduction of NIHL and continuous improvement*
2. *Training records – should include employee's name, date, type of training, name of trainer, employee's signature*
3. *Evidence for efficacy of training might be obtained from test results, from questioning employees on matters related to NIHL, and from actual reduction in cases of NIHL*
4. *Action plans following survey recommendations must include names of responsible persons and due dates for completion*
5. *Engineering controls may include: enclosures, silencers, acoustic absorption materials, vibration controls, equipment repair and maintenance, etc.*
6. *Periodic audiogram – for the first 3 years annually, thereafter may be extended to a maximum of 2 years, provided no referral threshold shift is evident; for employees with noise exposure equal or exceeding 105 dB(A) every 6 months until it is established that no referral threshold shift is evident, thereafter interval may be extended to a maximum of 1 year*
7. *Hearing protection programme meaning written procedures / standards dealing with: training and refresher training, consultation, selection, fitting, issuing, medical examinations, maintenance and storage of HPDs*

Appendix 7 – Calibration Certificates

sanas Calibration Laboratory
148 1302

M AND N ACOUSTIC SERVICES CC
Co. Reg. No: 2009/059193/23 VAT NO: 4300255876
P.O. Box 61713, Pierre van Ryneveld, 0045
Shop 13, Ryneveld Corner Shopping Centre,
cnr Fouche & Van Ryneveld Sts, Pierre van Ryneveld, 0045
Tel: 012 689 2007/8 • Fax: 086 211 4690
E-mail: calservice@mweb.co.za

CERTIFICATE OF CALIBRATION

CERTIFICATE NUMBER	2012-0388
ORGANISATION	NATIONAL HEALTH LABORATORY SERVICES-NIOH
ORGANISATION ADDRESS	PRIVATE BAG X 8, SANDRINGHAM, 2131
CALIBRATION OF	INTEGRATING SOUND LEVEL METER and ½" MICROPHONE
CALIBRATED BY	M. NAUDÉ
MANUFACTURERS	QUEST, BRÜEL and KJAER
MODEL NUMBERS	1900 and 4936
SERIAL NUMBERS	CC 8090029 and 2064436
DATE OF CALIBRATION	27 FEBRUARY 2012
RECOMMENDED DUE DATE	FEBRUARY 2013
PAGE NUMBER	PAGE 1 OF 4

This certificate is issued in accordance with the conditions of approval granted by the South African National Accreditation System (SANAS). This Certificate may not be reproduced without the written approval of SANAS and M and N Acoustic Services.

Calibrations performed by this laboratory are in terms of standards, the accuracies of which are traceable to national measuring standards as maintained by NMISA

The measurement results recorded in this certificate were correct at the time of calibration. The subsequent accuracy will depend on factors such as care, handling, frequency of use and the amount of different users. It is recommended that re-calibration should be performed at an interval, which will ensure that the instrument remains within the desired limits and/or manufacturer's specifications.

The South African National Accreditation System (SANAS) is member of the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA). This arrangement allows for mutual recognition of technical test and calibration data by member accreditation bodies worldwide. For more information on the arrangement please consult www.ilac.org

M.W. DE BEER (SANAS TECHNICAL SIGNATORY)

29 February 2012
DATE OF ISSUE

Only Member : Marianka Naudé

sanas
Calibration Laboratory
148 1302

M AND N ACOUSTIC SERVICES CC
Co. Reg. No: 2009/079193/23 VAT NO: 4300255876
P.O. Box 61713, Pierre van Ryneveld, 0045
Shop 13, Ryneveld Corner Shopping Centre,
cnr Fouche & Van Ryneveld Sts, Pierre van Ryneveld, 0045
Tel: 012 689 2007/8 • Fax: 086 211 4690
E-mail: calservice@mweb.co.za

CERTIFICATE OF CALIBRATION

CERTIFICATE NUMBER	2012-0362
ORGANISATION	NIOH
CALIBRATION OF	dBADGE and ½" MICROPHONE
CALIBRATED BY	M. NAUDÉ
MANUFACTURER	CEL
MODEL NUMBERS	350 and 252
SERIAL NUMBERS	1061505 and 6146
DATE OF CALIBRATION	24 FEBRUARY 2012
RECOMMENDED DUE DATE	FEBRUARY 2013
PAGE NUMBER	PAGE 1 OF 4

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M.W. DE BEER (SANAS TECHNICAL SIGNATORY)

27 February 2012
DATE OF ISSUE

Only Member : Marianka Naudé

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CERTIFICATE OF CALIBRATION

CERTIFICATE NUMBER	2012-0361
ORGANISATION	NIOH
CALIBRATION OF	dBADGE and ½" MICROPHONE
CALIBRATED BY	M. NAUDÉ
MANUFACTURER	CEL
MODEL NUMBERS	350 and 252
SERIAL NUMBERS	1061503 and 6081
DATE OF CALIBRATION	24 FEBRUARY 2012
RECOMMENDED DUE DATE	FEBRUARY 2013
PAGE NUMBER	PAGE 1 OF 4

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M.W. DE BEER (SANAS TECHNICAL SIGNATORY)

27 February 2012
DATE OF ISSUE

CASELLA CEL

Certificate of Conformity and Calibration

Instrument Type	CEL-350/IS	
Serial Number	4911223	
Firmware revision	V1.13	
Microphone Type	CEL-252	
Serial Number	22267	

Test Conditions:-

Temperature	21	°C
Humidity	26	%RH
Pressure	1010	mBar

Test Engineer:- Andrew Whitfield

Date of Issue:- December 10, 2011

Equipment Used

Fixed Frequency Calibrator:	**CEL-110.1**	**Serial Number:**	**Eq No.10787**
Multi-Frequency Calibrator:	**B&K-4226**	**Serial Number:**	**Eq No.10991**
Signal Generator:	**Stanford Research Systems DS360**	**Serial Number:**	**33854**

Declaration of conformity

This test certificate confirms that the instrument specified above has been successfully tested to comply with the manufacturer's published specifications. This also confirms compliance with EN 61252:1997.

Tests are performed using equipment traceable to national standards in accordance with Casella's ISO 9001:2008 quality procedures. This product is certified as being compliant to the requirements of the CE Directive.

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor $k=2$, providing a level of confidence of approximately 95%.

This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

Test Summary :-

Self generated Noise test	All Tests Pass
Frequency weightings A/C/Z	All Tests Pass
Level Linearity tests	All Tests Pass
Response to short duration signals	All Tests Pass
Response to unipolar pulses	All Tests Pass
Overload indicator	All Tests Pass
Time weightings tests	All Tests Pass
C-weighting peak response	All Tests Pass
Acoustic Tests	All Tests Pass

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E-mail:
info@casellameasurement.com

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USA

TF: (800) 366-2966
Fax: (603) 672-8053
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info@casellaUSA.com

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28230 Las Rozas - Madrid

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Fax:- + 34 91 636 01 96
E-mail: online@casella-es.com

Tested to test sheet TP385 revision 02

CASELLA CEL

Certificate of Conformity and Calibration

Instrument Type	CEL-350/IS	
Serial Number	4911233	
Firmware revision	V1.13	
Microphone Type	CEL-252	
Serial Number	21271	

Test Conditions:-

Temperature	22	°C
Humidity	30	%RH
Pressure	1000	mBar

Test Engineer:- Andrew Whitfield

Date of Issue:- December 12, 2011

Equipment Used

Fixed Frequency Calibrator:	**CEL-110.1**	**Serial Number:**	**Eq No.10787**
Multi-Frequency Calibrator:	**B&K-4226**	**Serial Number:**	**Eq No.10991**
Signal Generator:	**Stanford Research Systems DS360**	**Serial Number:**	**33854**

Declaration of conformity

This test certificate confirms that the instrument specified above has been successfully tested to comply with the manufacturer's published specifications. This also confirms compliance with EN 61252:1997.

Tests are performed using equipment traceable to national standards in accordance with Casella's ISO 9001:2008 quality procedures. This product is certified as being compliant to the requirements of the CE Directive.

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95%.

This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

Test Summary :-

Self generated Noise test	All Tests Pass
Frequency weightings A/C/Z	All Tests Pass
Level Linearity tests	All Tests Pass
Response to short duration signals	All Tests Pass
Response to unipolar pulses	All Tests Pass
Overload indicator	All Tests Pass
Time weightings tests	All Tests Pass
C-weighting peak response	All Tests Pass
Acoustic Tests	All Tests Pass

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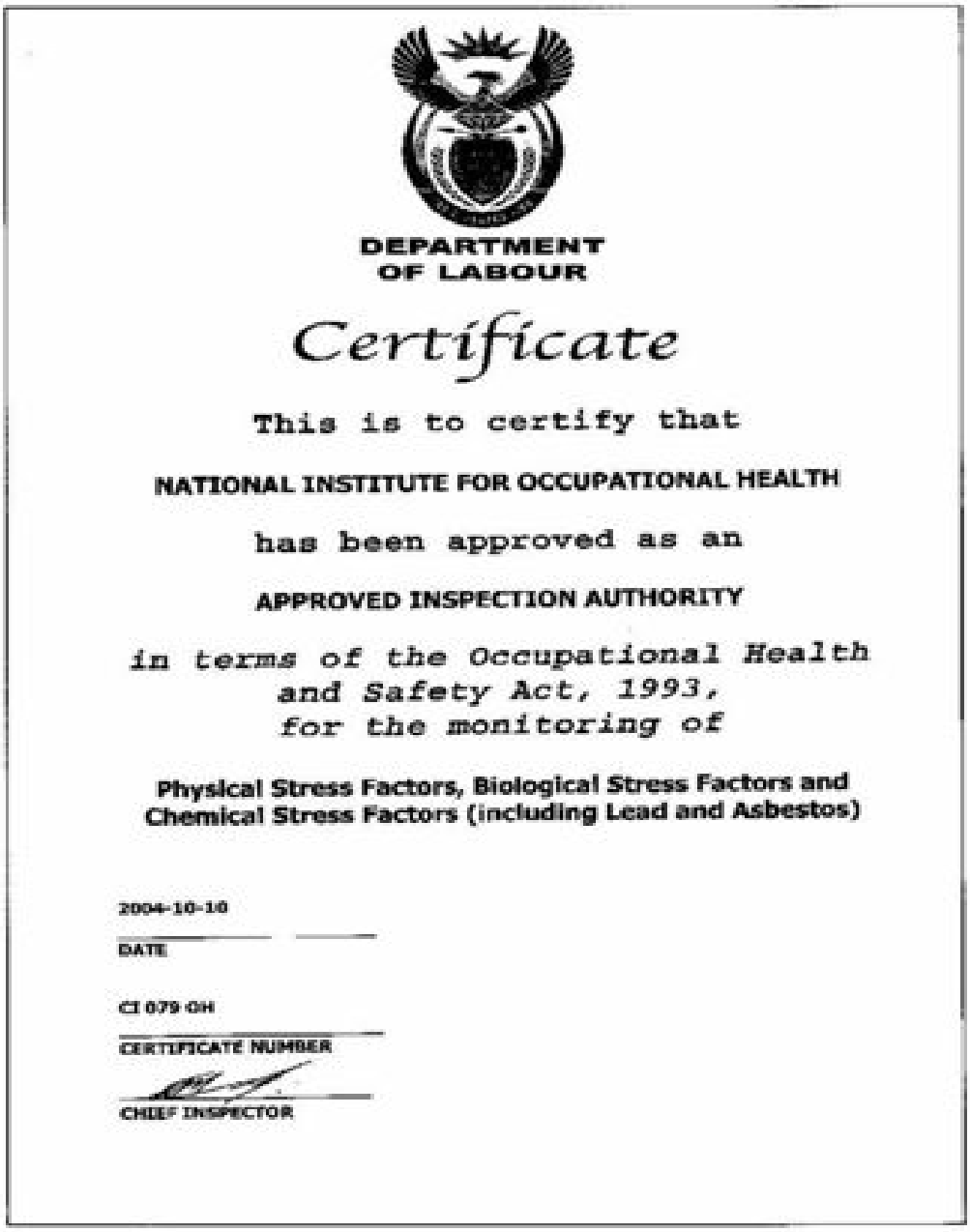
Tested to test sheet TP385 revision 02



DEPARTMENT
OF LABOUR

Certificate

This is to certify that

NATIONAL INSTITUTE FOR OCCUPATIONAL HEALTH

has been approved as an

APPROVED INSPECTION AUTHORITY

in terms of the Occupational Health and Safety Act, 1993, for the monitoring of

Physical Stress Factors, Biological Stress Factors and Chemical Stress Factors (including Lead and Asbestos)

2004-10-10
DATE

CI 079 OH
CERTIFICATE NUMBER

CHIEF INSPECTOR