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Noise exposure and associated factors in the Iron and Steel sector

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National Occupational Health and Safety Conference, 27 Feb 2025, Klerksdorp

Improving Health and Safety in the Iron and Steel Industry

Noise exposure: Occupational Hygiene

Aim: To discuss general issues relating to noise exposure in the Iron and Steel Industry from an occupational hygiene perspective

Occupational hygiene is the discipline of anticipating, recognising, evaluating and controlling health hazards in the workplace.[2]

Noise: Unwanted sound which may cause damage to hearing. The uniqueness of a sound based on:

- the combinations of frequencies;
- their relative intensities and;
- their rate of onset and decay.[3]

Noise-induced hearing loss: The permanent damage to hair cells within the cochlea due to exposure to loud sounds and is irreversible.[4]

[2]https://www.saioh.co.za/page/FAQ1
[3]Principles of Occupational Health and Hygiene : An Introduction, edited by Sue Reed, et al., Taylor & Francis Group, 2020
[4] WHO World Report on Hearing: https://www.who.int/publications/i/item/9789240020481

Noise-induced hearing loss

- Most common occupational disease in RSA [5]

THE PROFILE OF OCCUPATIONAL HEALTH AND SAFETY SOUTH AFRICA

Table 12.3 Common occupational diseases from 2016 to 2019.

Compensable Disease/Injury	2016/17	2017/18	2018/19	2019/20
Noise Induced Hearing Loss	145	279	249	118
Tuberculosis HWs	141	184	257	191
Occupational Asthma	24	28	27	20
Chemical Exposure	64	68	35	41
COID Injuries	104	232	252	161

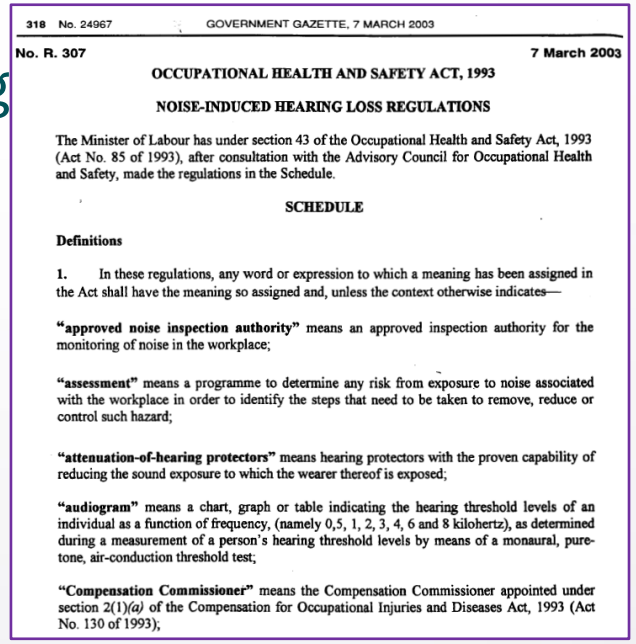
- Constitute 90% of reported occupational disease claims at Rand Mutual Assurance [6]
- The WHO estimates that approximately 16% of hearing loss in adults worldwide stems from excessive noise in the workplace [4]

[5]https://www.labour.gov.za/DocumentCenter/Publications/Occupational%20Health%20and%20Safety/The%20Profile%20Occupational%20Health%20and%20Safety%20South%20Africa.pdf

[4] WHO World Report on Hearing: https://www.who.int/publications/i/item/9789240020481

Starting point: OHS Legislation and the Hearing Conservation Programme

1. Noise Assessment Anticipate & Recognise
2. If the the 8 h rating level (LReq,8h) equals or exceeds 85 dBA then the rest of the hearing conservation program should be Evaluate implemented
3. Limit exposure with engineering and administrative controls
4. Noise zones Control
5. Hearing protection
6. Audiometric testing
7. Training
8. Review



318 No. 24967 GOVERNMENT GAZETTE, 7 MARCH 2003

No. R. 307 7 March 2003

OCCUPATIONAL HEALTH AND SAFETY ACT, 1993

NOISE-INDUCED HEARING LOSS REGULATIONS

The Minister of Labour has under section 43 of the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993), after consultation with the Advisory Council for Occupational Health and Safety, made the regulations in the Schedule.

SCHEDULE

Definitions

1. In these regulations, any word or expression to which a meaning has been assigned in the Act shall have the meaning so assigned and, unless the context otherwise indicates—

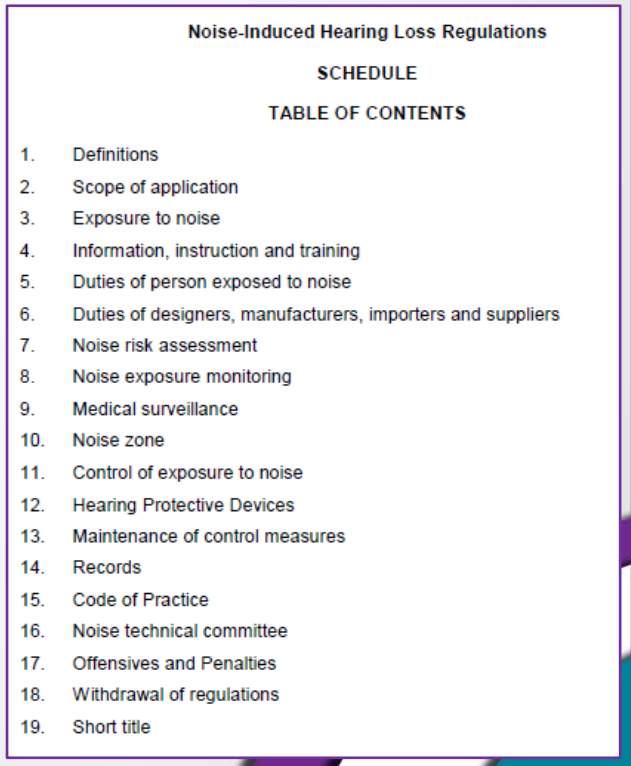
"approved noise inspection authority" means an approved inspection authority for the monitoring of noise in the workplace;

"assessment" means a programme to determine any risk from exposure to noise associated with the workplace in order to identify the steps that need to be taken to remove, reduce or control such hazard;

"attenuation-of-hearing protectors" means hearing protectors with the proven capability of reducing the sound exposure to which the wearer thereof is exposed;

"audiogram" means a chart, graph or table indicating the hearing threshold levels of an individual as a function of frequency, (namely 0,5, 1, 2, 3, 4, 6 and 8 kilohertz), as determined during a measurement of a person's hearing threshold levels by means of a monaural, pure-tone, air-conduction threshold test;

"Compensation Commissioner" means the Compensation Commissioner appointed under section 2(1)*(a)* of the Compensation for Occupational Injuries and Diseases Act, 1993 (Act No. 130 of 1993);



Noise-Induced Hearing Loss Regulations

SCHEDULE

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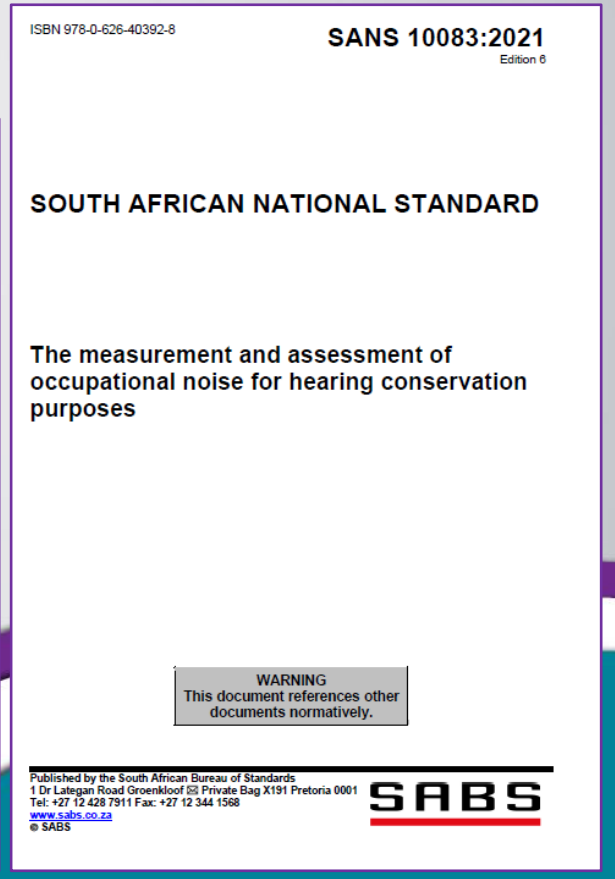

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SOUTH AFRICAN NATIONAL STANDARD

The measurement and assessment of occupational noise for hearing conservation purposes

WARNING
This document references other documents normatively.

Published by the South African Bureau of Standards
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www.sabs.co.za

Noise rating limits

- NIHL Regulations, 2003:
  - Noise rating limit: 8-hour rating level, 85 dBA at and above which hearing impairment is likely to result.

- Draft NIHL Regulations:
  - Noise action level: the value of the $L_{Req,8h}$ at or above 82 dBA for continuous noise and/or L_{peak} at or above 135 dBC for impulse noise at which specified actions or counter measures must be taken.
  - Noise rating limit: the value of the $L_{Req,8h}$ at or above 85 dBA for continuous noise and/or L_{peak} at or above 137 dBC for impulse noise at which specified actions or counter measures must be taken.

Anticipate & Recognise: High noise sources

Evaluation of Noise Exposures at a Gray and Ductile Iron Foundry by NIOSH (2015)[15]

Table 1. Time-weighted average personal noise measurement results

Plant	Job location	Shift	Duration (h:mm)	OSHA AL TWA (dBA)	OSHA PEL TWA (dBA)	NIOSH REL TWA (dBA)
1	30-inch grinder	1	9:59	94.4	93.6	97.7
1	30-inch and booth 4 grinder	1	9:46	98.7	98.4	101.8
1	Chop saw and spin blast	1	9:11	99.3	98.9	105.9
1	V-8 chipper/grinder	2	9:24	103.7	103.6	105.7
1	V-8 chipper/grinder	2	9:28	97.4	97.2	99.3
2	30-inch grinder	1	9:36	99.0	98.9	101.0
2	30-inch grinder	3	9:48	96.1	96.0	97.2
2	Casting sorter	1	9:35	98.0	97.9	98.8
2	Casting sorter	3	9:49	95.6	95.6	96.3
2	Inspector	3	9:45	95.5	95.2	97.6
2	Mold machine 2547	3	10:01	92.8	91.3	94.2
2	Mold machine 797	1	9:14	98.2	98.2	101.2
2	Shakeout/knockoff	1	9:34	101.5	101.5	102.4
2	Shakeout/knockoff	3	9:48	99.4	99.3	100.5
3	Chop saw	1	8:27	97.8	97.3	101.3
Noise exposure limits (8-hour work shift)				85	90	85
Noise exposure limits (10-hour work shift)				83.4	90	84

Metal-to-metal contact

Compressed air

Grinders and saws

Vibration from equipment

Most exposures exceeded the noise rating limit

[15]NIOSH, 2015. https://www.cdc.gov/niosh/hhe/reports/pdfs/2011-0087-3241.pdf

Anticipate & Recognise: High noise activities

Risk assessment to identify potential exposure.

- Competent person: Risk assessment (knowledge, training and experience in noise).

Activities that contribute to noise exposure in the Iron & Steel sector.

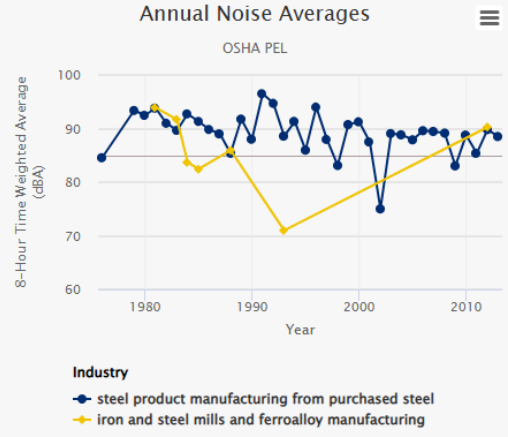
- Noise measurements at eight companies in the iron and steel industry in South Africa by Mizan et al., 2014:
  - 64.1% (261/407) of area measurements exceeded 85 dBA. 22.1% exceeded 95dBA.
  - 80.8% (97/120) of personal dose measurements exceeded 85 dBA.
  - High noise activities included
    - Extraction systems and vacuum systems when using steam ejectors.
    - Electrical transformers and the arc process in electrical arc furnaces.
    - Rolling mills.
    - Cutting activities.
    - Foundries.

[6]Mizan et al., 2014. Noise-induced hearing loss and hearing conservation in the iron and steel industry in South Africa

Anticipate & Recognise: Job exposure matrixes (JEM)

noiseJEM

USA: nearly one million occupational noise exposure measurements across 275 industries [8]



SweJEM: Noise

Sweden: The noise JEM contains 321 job families with information regarding occupational noise from 1970 to 2014.[9]

[8]https://noisejem.sph.umich.edu/
[9]https://ki.se/en/imm/research/swejem-occupational-noise

A proposed database of task-based, area and personal noise exposure measurements suitable for risk assessment in non-mining Southern African workplaces

K Linde[1], AJ Mundackal[1] and SJL Linde[2]
[1] Department of Physiology and Environmental Health, University of Limpopo, South Africa
[2] Occupational Hygiene and Health Research Initiative (OHHRI), North West University, South Africa

Table 1 : Proposed task based noise exposure JEM

Area or job type	Potential noise sources	Leq(dBA)	Risk level	Recommended control measures
Juice factory				
Fruit receiving area	Conveyor belts, fruit being unloaded from truck, fruit falling on conveyor belt.	76.7	Tolerable	Maintain conveyor belts to prevent noise levels from increasing.
Juicing plant	Juice extractors, vibrating metal structures, released steam.	94.5	Intolerable	Attach appropriate noise absorbing material to ceiling and walls. Place juicers on anti-vibration mounts. Attach metal catwalks and steps to the building with rubber lined connectors. Rotate workers between juicing plant and other quitter areas during their shift. Post information on noise exposure inside plant. Provide hearing protection with at least an SNR of 20 when entering. Provide training to workers on how to correctly use the hearing protection.
Boiler area	Released steam, blowers burners and water pumps.	84.8	Potential	Measures should be implemented to ensure L_{eq}(dBA) does not increase to above 85 dBA. Train workers on dangers of noise exposure. Maintain current control measures.

Anticipate & Recognise: Ototoxins

Chemicals that may lead to hearing loss following exposure, either alone or combination with noise. Approximately 700 substances have been identified. See SDSs
Five major categories:

1. Solvents – e.g., paints and degreasers
2. Nitriles – e.g., 3-butenenitrile and acrylonitrile
3. Pharmaceuticals – e.g., certain types of medicine
4. Heavy metals – e.g., lead and mercury
5. Chemical asphyxiants – e.g., carbon monoxide and tobacco smoke

How to manage ototoxins:

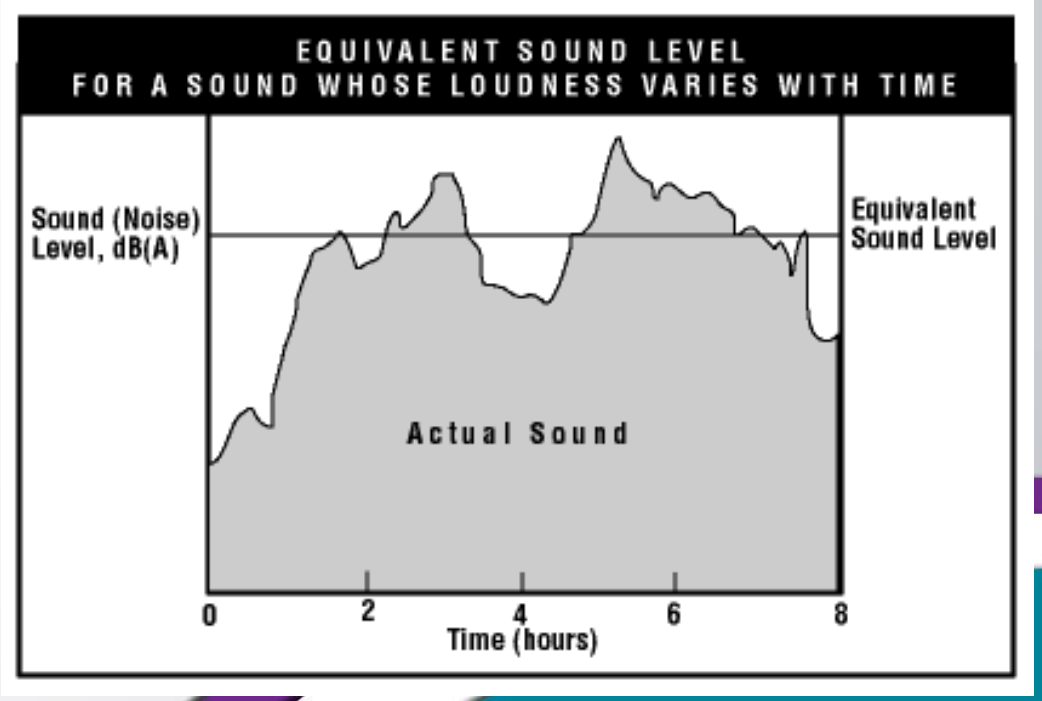
- Ototoxic substance at 50% of OEL – Included in medical surveillance
- Ototoxic substance at any level and noise with $L_{Aeq,8h}$ >80 dB(A) or $L_{C,peak}$ >135 dB(C);
- Hand-arm vibration at any level and noise with $L_{Aeq,8h}$ > 80 dB(A) or $L_{C,peak}$ > greater than 135 dB(C).

[7] AIOH https://w2.aioh.org.au/static/uploads/files/occupational-noise-and-its-potential-for-health-issues-wfhpxjbduqzn.pdf

Evaluate

- The field of occupational hygiene loves monitoring and evaluating, maybe too much…
- Noise monitoring must be done every 24 months by an approved noise inspection authority according to SANS 10083
- The need for reporting noise as more than just one L_{Aeq} value – Detailed shift exposure where peaks are identified.

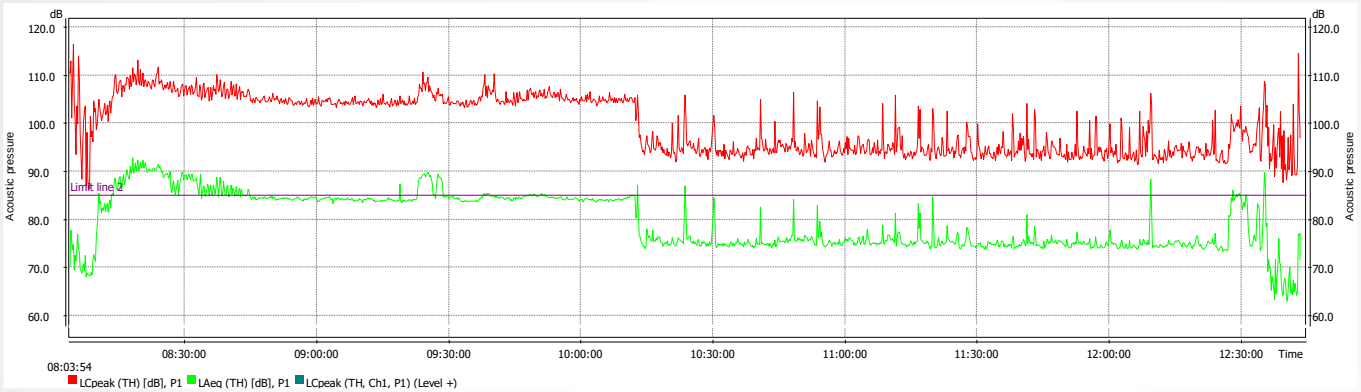
[12]Source: https://svantek.com/products/sv-104-personal-noise-dosimeter/



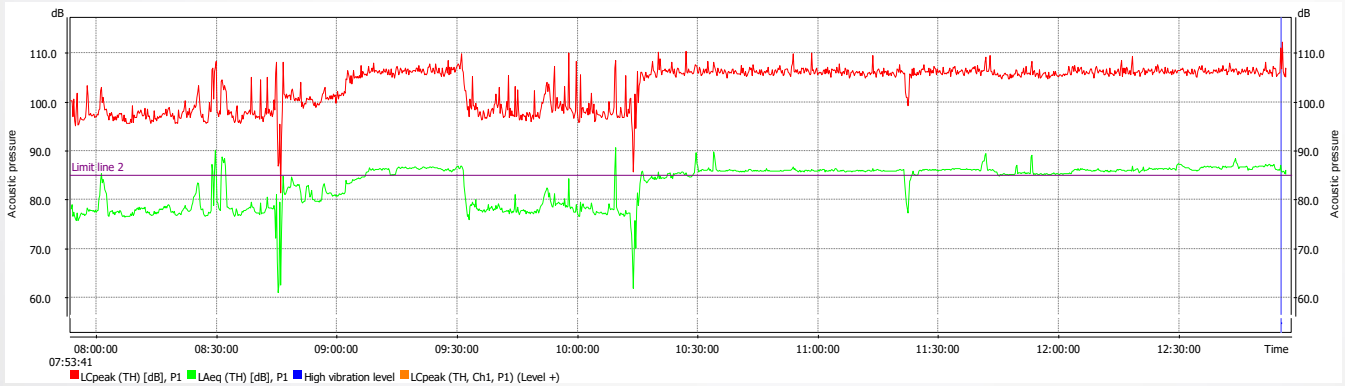
[13]https://www.ccohs.ca/oshanswers/phys_agents/noise/noise_measurement.html

Evaluate

L_{Aeq} = 83 dBA



L_{Aeq} = 84.6 dBA



Measurement of noise exposure with data visualisation and analysis.

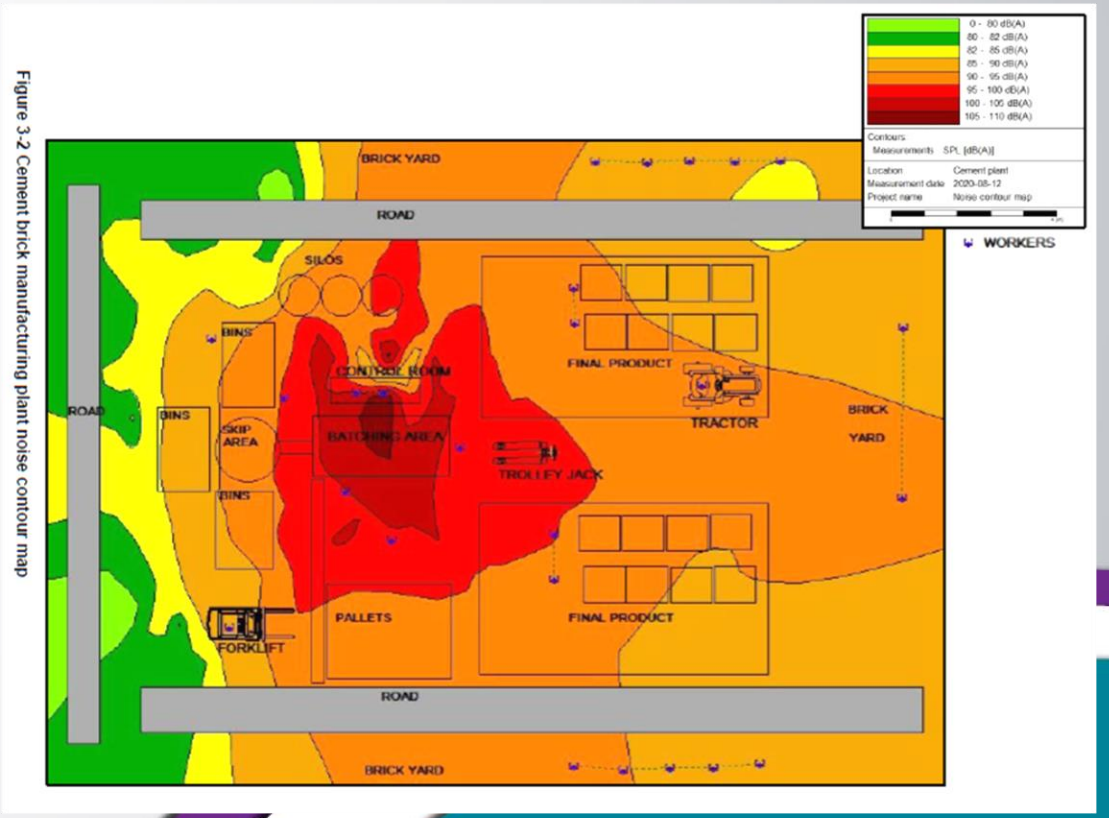
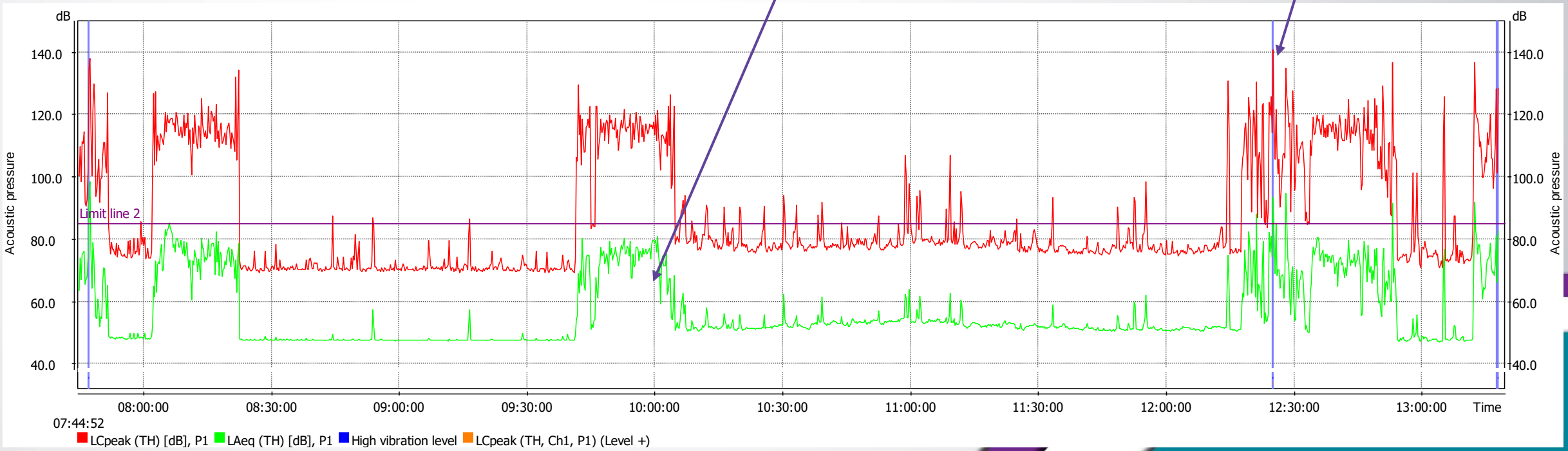


Figure 3-2 Cement brick manufacturing plant noise contour map

Evaluate: Extra information

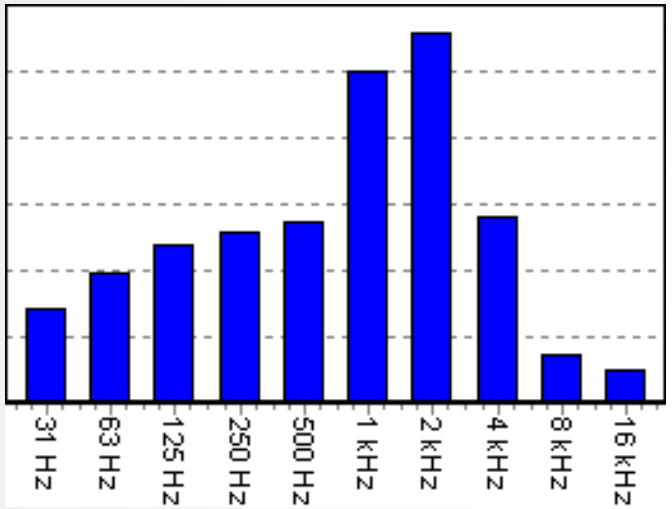
Peak noise

Peak noise is the highest instantaneous noise measured as L_{peak}.
Even though the $L_{Req,8h}$ noise may comply with 85 dBA, the L_{peak} may exceed 137 dBC due to high impact noise [11]



Evaluate: Extra information

Octave bands



Higher frequencies: Metal-to-metal contact

Lower frequencies: Transmission of noise to workbench and floor

Lower frequencies: Transmission of noise from shaker to floor

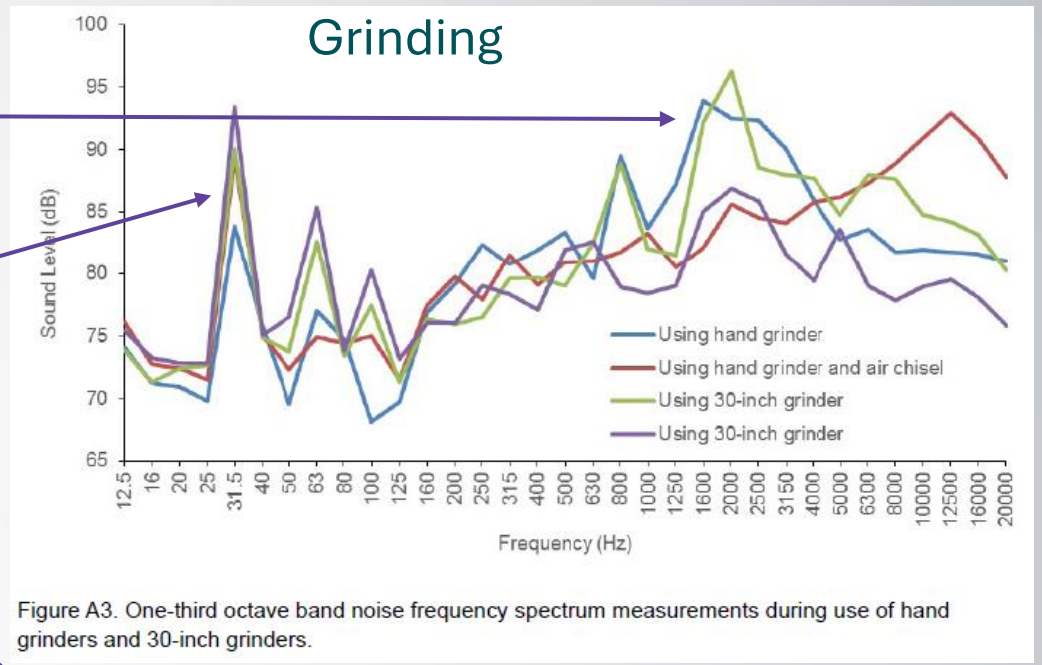


Figure A3. One-third octave band noise frequency spectrum measurements during use of hand grinders and 30-inch grinders.

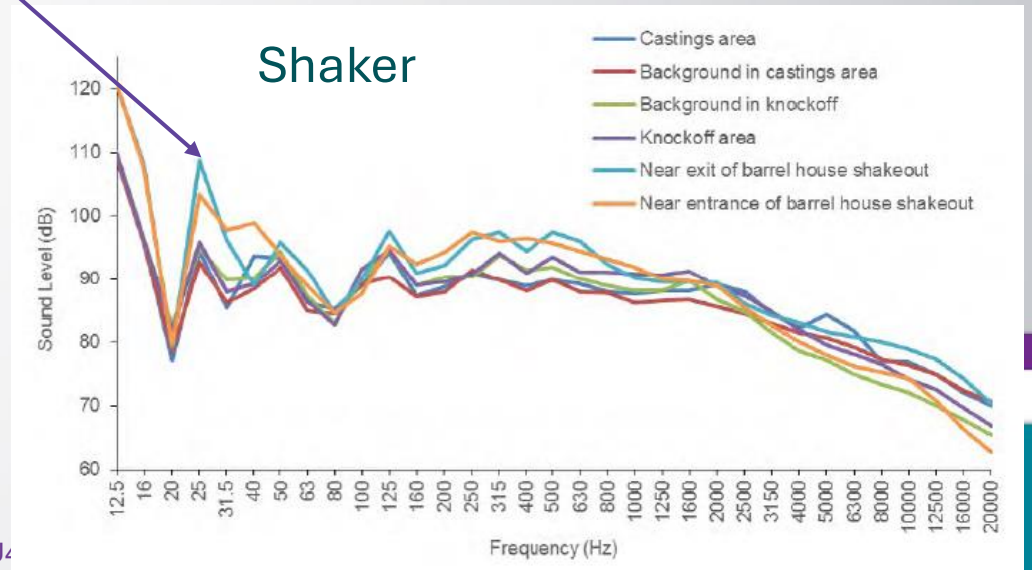


Figure A1. One-third octave band noise frequency spectrum measurements at the castings, knockoff, and barrel house shakeout in plant 2.

Noise is a combination of different frequencies, and it can be useful for engineering controls or hearing protection to know what frequencies are being emitted. Hearing is most sensitive to the frequencies present in human speech, approximately 400 Hz – 5000 Hz [11]

[10]https://www.noisemeters.com/help/faq/octavefilters/?srsltid=AfmBOopyIeOG2rRBxyHYWwmjdVIllOX0nTCEPU4
vRgZ_
[11]https://ohtatraining.org/students/fmanuals/manuals/ohta503/
[15]NIOSH, 2015, https://www.cdc.gov/niosh/hhe/reports/pdfs/2011-0087-3241.pdf

Evaluate: Extended work shifts

Exposure is dependent on exposure level and exposure time. If workers work extended shifts, the level of exposure must be reduced.

E.g., 10-hour shift = Noise rating limit of 84.03 dBA; and 12-hour shift = Noise rating limit of 83.24 dBA

Adjusted Noise Exposure Limits for Extended Work Shifts	
Time (hours)	Noise limit (
T	**85 dB**
8	85.00
9	84.49
10	84.03
11	83.62
12	83.24
13	82.89
14	82.57
15	82.27
16	81.99

[13]https://www.ccohs.ca/oshanswers/phys_agents/noise/exposure_ext.html

Control

World Health Organization

Figure 2.2 Components of an occupational hearing conservation programme

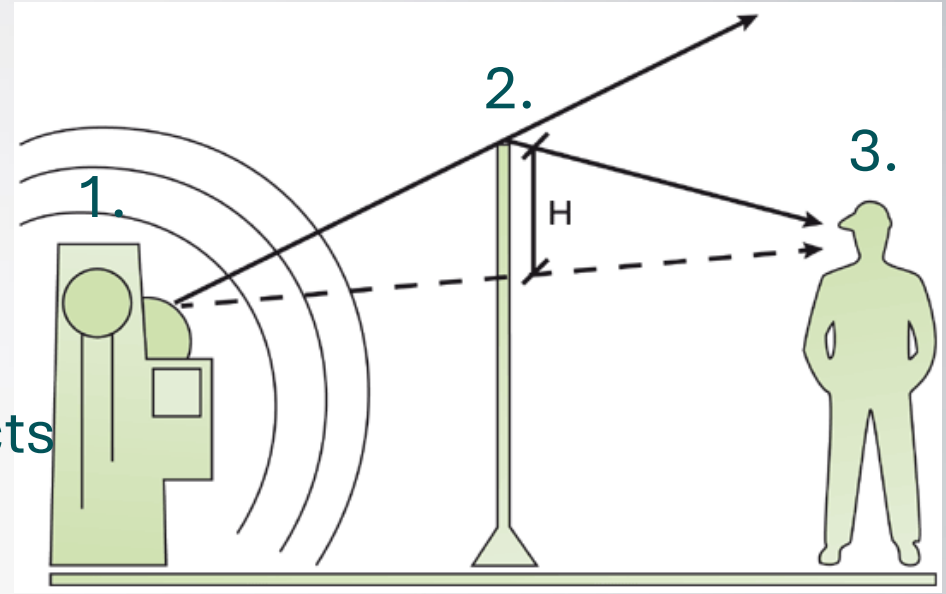
- The hearing conservation programme is central to the control of noise exposure.
- The recommendations from Occupational Hygiene Survey reports should be specific to the situation.

[4] WHO World Report on Hearing: https://www.who.int/publications/i/item/9789240020481

Control

Typical causes of noise

- Mechanical impacts
- High-velocity fluids
- High-velocity airflows
- Vibrating surface areas
- Vibrating manufactured products



1. Control at source

- Buy quiet
- Reduce speed of movement of impact
- Isolate vibrating machine
- Dampen or cover surfaces
- Reduce drop distance
- Machine maintenance
- Silencers or mufflers

2. Control in transmission path

- Enclosures
- Acoustic screen and barriers
- Relocate machines
- Remotely operated machines

3. Control at worker

- Isolate worker
- Reduce exposure time
- Hearing protection
- Continuous real-time monitoring

[4] https://www.hse.gov.uk/pubns/books/l108.htm

Control: Hearing Protection

Hearing protection devices (HPDs) are still an integral part of any noise management programme. There is a wide variety of HPDs available:

- Foam insert plugs
- Pre-molded plugs
- Custom-molded plugs
- Semi-insert or canal caps
- Ear muffs
- Combination of ear plugs and earmuffs
- Special purpose (e.g. radio communication)
- Linear ear protection (e.g. musicians)
- Level-dependant ear plugs (e.g. military)
- Electronic ear plugs (e.g. firing ranges)
- Active noise cancelling ear muffs

NB: There is no one solution for all noise exposure situations. It is important to know the details of the noise exposure characteristics in each specific workplace and to choose HPDs accordingly.
Be deliberate and proactive.

[11]https://ohtatraining.org/students/fmanuals/manuals/ohta503/

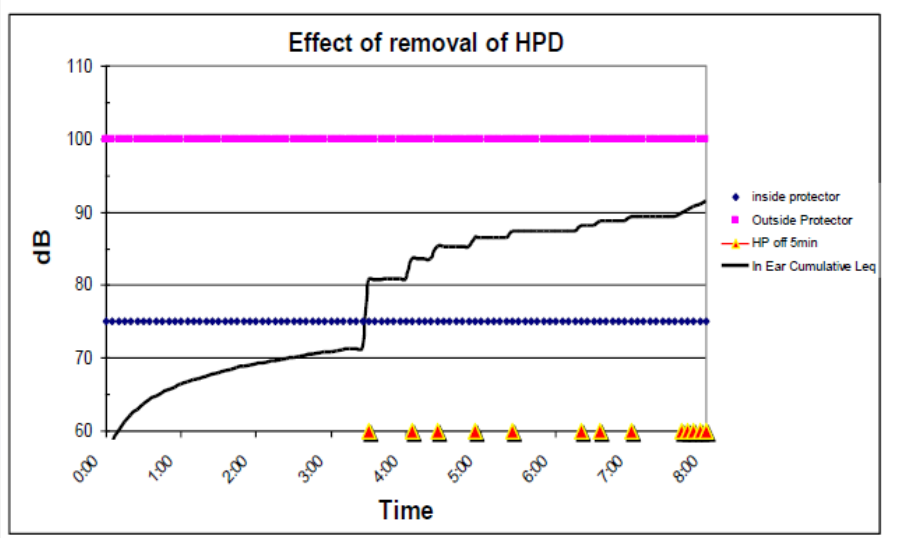
Control: Hearing Protection

Selection of HPDs

- Octave-band Method
- Noise Reduction Rating
- Noise Level Reduction Statistic
- Single Number Rating
- HML Method
- Sound Level Conversion
- Classification Method

The “best” HPD is the one that will be properly used by workers at all times when working in high-noise areas

Hearing protection fit testing



(Source: K Mikl)

Figure 5.1 – Effect of Removal of Hearing Protection Devices

[11]https://ohtatraining.org/students/fmanuals/manuals/ohta503/
[14]https://multimedia.3m.com/mws/media/2215060O/3m-psd-construction-segment-2-0-pillar-3-familiarity-ebook.pdf

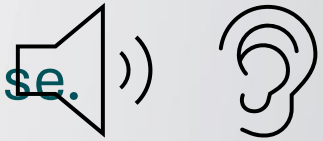
Opportunities & Challenges

Challenges:

- Exposure to noise is an inherent problem in many industries (e.g. Iron and Steel).
- Exposure control can be complicated and involve many different people (e.g. management, purchasing, engineering/maintenance, OHS, etc.).

Opportunities:

- Noise induced hearing loss is permanent but preventable.
- Risk assessment is relatively simple because we can hear noise.
- No analysis costs following exposure assessment – High number of measurement
- There is a lot of information available.
- Controls can have a big impact.



Background : Occupational Hygiene at the NWU

- 4 Year BHSc degree in Occupational Hygiene.
- MHSc with Occupational Hygiene (Research master's degree).
- PhD in Health Sciences with Occupational Hygiene .
- Please contact us if we can collaborate on research projects to help you answer specific questions in your workplace.

https://health-sciences.nwu.ac.za/occupational-hygiene

Thank you

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Useful links

https://www.hse.gov.uk/engineering/noise.htm
https://www.hse.gov.uk/noise/
https://www.hse.gov.uk/noise/goodpractice/workplacedesign.htm

https://www.ccohs.ca/oshanswers/phys_agents/noise/noise_control.html

https://www.ccohs.ca/oshanswers/phys_agents/noise/noise_measurement.html

https://ohtatraining.org/students/fmanuals/manuals/ohta503/

https://www.cdc.gov/niosh/hhe/reports/pdfs/2011-0087-3241.pdf