Equipment profile of South African Occupational Hygiene Approved Inspection Authorities

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Dissertation accepted in fulfilment of the requirements for the degree Masters of Heath Science in Occupational Hygiene at the North-West University

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DECLARATION

A research team conducted and carried out this study. Contributions of each member are outlined in Table 1 below.

Table 1: Authors' contributions

Name	Contribution
Mrs A Engelbrecht Student	• Designed the study. • Researched literature. • Developed an online questionnaire. • Analysed and interpreted the data. • Wrote the dissertation.
Mr CJ Van Der Merwe Supervisor	• Assisted with ethics, protocol and study approval. • Assisted with data collection, analysis and interpretation. • Guided the study's formulation. • Reviewed the dissertation.
Prof A Franken Co-supervisor	• Assisted with ethics, protocol and study approval. • Assisted with data collection, analysis and interpretation. • Guided the study's formulation. • Reviewed the dissertation.
Mrs C Conradie Independent person	• Recruited the participants. • Administrated the data collection process. • Emailed and contacted relevant parties.

End of table

I declare that I have approved this dissertation, and that my role in the study, as indicated above, is representative of my actual contributions, and that I hereby give my consent that is may be published as part of A Engelbrecht's MHSc in Occupational Hygiene dissertation.

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Mrs A Engelbrecht	Mr CJ Van Der Merwe
______________________	______________________
Prof A Franken	Mrs C Conradie

PREFACE

This dissertation was prepared for the examination of the Master of Health Sciences in Occupational Hygiene degree. It follows the *NWU Referencing Guide*, a type of Harvard referencing style, except for Chapter 3. Chapter 3 is written in article format, adhering to the specifications required by the journal *Occupational Health Southern Africa*. Consequently, references in each chapter are listed alphabetically, except for those in Chapter 3, which are presented numerically in accordance with the journal's requirements.

While the Harvard referencing style typically discourages the use of footnotes, they were included in Chapter 2 for a specific reason: to improve readability by providing context for the information that follows. Chapter 1 provides a general introduction, outlines the problem statement, and details the study's aims and objectives. Given the limited literature available on South African Approved Inspection Authorities and their monitoring equipment, Chapter 2 includes a brief literature review that focuses on the regulatory obligations in South Africa concerning employee health and safety, and the regulatory requirements for occupational health and hygiene professionals.

Chapter 3, formatted as an article, presents the core findings of this study intended for publication in the journal *Occupational Health Southern Africa*. The results and discussions have been combined under a single heading for clarity and ease of reading, as the figures are extensive, and addressing each figure individually enhances comprehension. Because certain hazards require multiple parameters to be assessed, the equipment lists were extensive. As a result, only the models among the top five mostly selected equipment were presented in the graphs. Graphs displaying the equipment brands, however, is a true representation of the total amount of equipment from such brand. A more comprehensive list of the equipment types and models are summarised in Annexure A.

All the pie charts were generated using the GraphPad Prism version 10 software. Due to rounding, the values may not add up to 100%. It should be noted that this equipment profile is not intended to set rules for verifying AIA practices but to provide AIAs with the necessary information for making informed discissions. The researchers acknowledge the journal’s word limit of 3500 words, however, for examination purposes and in order to fulfil the aim of creating an equipment profile, Chapter 3 will exceed this word limit. Chapter 4 includes the main findings of the study, recommendations, limitations, and future study ideas. Also answering the research question and discussing the achievement of the objectives.

The Department of Employment and Labour's (DoEL) *Requirements for Approval as an Approved Inspection Authority: Occupational Health and Hygiene* booklet (2012) was used throughout this study, as it was the most current and relevant version available during the research and dissertation writing process. Although the DoEL released a newer version on 3 December 2024, this occurred after the dissertation was completed. Additionally, the updated booklet does not include the Annexure of equipment, which served as a crucial guideline for developing the questionnaire and structuring the dissertation. Therefore, the 2012 version remains more relevant to this study's context and objectives.

ACKNOWLEDGEMENTS

This dissertation and the research behind it would not have been possible without the exceptional support of my supervisors, Mr. C.J. Van Der Merwe, and co-supervisor, Prof. A. Franken. Mr. Van Der Merwe's enthusiasm, expertise, and unwavering patience throughout the study were truly inspiring. His dedication, including countless hours of tireless effort and late nights assisting with the write-up, was truly remarkable. Prof. Franken's meticulous attention to detail and consistent encouragement kept me focused and motivated. I am deeply grateful to both for their invaluable guidance and the wealth of knowledge they have shared with me.

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It is a true pleasure and privilege to acknowledge my dear family. Koos and Elsabe Engelbrecht, my parents, thank you for raising me to be the person I am today. Your teachings on perseverance and your belief in my potential have been a guiding force. To my siblings and siblings-in-law, Leandrie, MC, Reuben, Jolien, and my twin sister Ellarie, thank you for your unwavering support. We have always encouraged each other, striving to meet high standards, yet never giving up on one another. Nanna and Miena, your love and support have been a constant anchor in my life.

Lastly, I want to express my deepest gratitude to my dear husband, Ruan Bronkhorst, who has sacrificed many evenings, prepared meals, comforted me, and urged me to keep pushing forward. You have been my pillar of strength.

Above all, I thank my Heavenly Father for granting me this opportunity and blessing me with the wonderful people mentioned above. His strength and guidance have enabled me to complete this chapter of my life.

"I can do all this through Him who gives me strength" – ***Philippians 4:13***

ABSTRACT

Title: Equipment profile of South African Occupational Hygiene Approved Inspection Authorities

The right to safe and harm-free working environments is provided for by the *Bill of Rights,* and reinforced by key legislative acts, such as the *Mine Health and Safety Act* 29 of 1996 and the *Occupational Health and Safety Act* 85 of 1993 (OHS Act). The OHS Act, in particular, mandates employers to maintain workplaces that are free from hazards, ultimately requiring the appointment of occupational hygiene professionals to uphold health and safety standards (SANS 2012:2). Specialised in hazard monitoring, Approved Inspection Authorities (AIAs) are sanctioned by the Chief Inspector to perform certified health and safety assessments. Their authorisation and approval are based on their strict adherence to the national standards set by the South African National Accreditation System. These standards outline the personnel, facilities, and equipment requirements. The extent of an AIA's regulatory framework, or the different regulated hazards an AIA is allowed to assess, is based on the AIA's knowledge, expertise, and the appropriateness of their equipment. To guide AIAs, the Department of Employment and Labour (DoEL) published a list of equipment that highlights the types of equipment AIAs should use to assess the applicable hazards within their regulatory frameworks (SANS, 2012:5; SANAS, 2012:12).

While the DoEL's equipment list outlines the basic equipment AIAs can retain for approval, staying up to date with rapidly advancing technology can be challenging for both new and more experienced AIAs. Equipment proliferation also affects the curricula of educational institutions, which aim to provide students with fit-for-purpose training. This raises an important question: What equipment is currently used by occupational hygiene AIAs, and why is it important?

There are two main reasons why these questions matter. First, AIAs face a dual challenge. While trying to ensure competency, accuracy, and validity in their occupational hygiene operations, AIAs are also required to stay up to date with the latest technological advancements (SANS, 2023:12). Second, occupational hygiene students need to receive training that prepares them for real-world situations, and that is aligned with industry needs (Alanazi & Benlaria, 2023:5).

The selection of equipment available on the market requires AIAs to choose the instruments based on their prioritised needs and the available information about this equipment. But, although manufacturers provide literature, the benefits, and capabilities of their equipment, the information AIAs need in order to make informed decisions are not as readily available (AIHA, 2017).

Since the DoEL's equipment recommendations were last updated in 2012[1], gathering the necessary information to make informed equipment decisions can be difficult. This can be particularly challenging for new AIAs trying to choose the right equipment.

To address these challenges, a practical solution involved creating an equipment profile of national AIAs. This detailed profile aimed to identify the prevalent equipment and methodologies used by industry professionals. By identifying these prevalences, AIAs can have a reference point for comparison, and educational institutions can tailor their curricula to ensure fit-for-purpose training aligned with industry needs. This initiative aims to streamline the transition of occupational health and hygiene graduates into the workforce and provide clarity for companies, especially startups, seeking guidance on acquiring equipment that is both effective and in line with industry expectations.

Employing a mixed methods research approach of sequential exploratory design, registered occupational hygienists — each representing one of the 53 registered Type A AIAs, and whereof only 11 responded to the questionnaire — were invited to an online survey. This survey was created and administered using the Google Forms platform and required AIAs to answer questions pertaining to the equipment and methods they currently employ for hazard monitoring. After doing a data analysis of the number of equipment, the most frequently selected equipment models, and brands, the popularity of instruments was calculated based on the number of times selected as well as the number of units currently used. The calibration frequencies, buying drivers, and hazard evaluation methods were also investigated. The quantitative data was then used to assist with the interpretation of qualitative data. These findings were reported as the representing equipment profile of participating AIAs.

Findings showed the consistent preference participating AIAs had for user-friendly, reliable, and cost-effective monitoring equipment. Highlighting the importance of equipment practicality. Differences in the calibration practices, however, emphasises the need for clear guidelines on the external calibration frequency necessary for all equipment.

While the most prevalent equipment and methods were established, these findings also reinforce how academic curricula can bridge the gap between the current and prospective industry-needs.

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1 Within the brochure - Requirements for approval as an approved inspection authority: occupational health and hygiene (2012:12).

Educational institutions can update their equipment inventories by incorporating both prevalent, and less popular equipment types while also enhancing students' technical skills through the adoption of both old and new equipment models. This could prepare students for real-world challenges, encourage work-readiness, and ensure their curricula aligns with industry-needs. While this study had a few limitations, it still provides occupational health and hygiene professionals with a detailed equipment profile of AIAs currently in practice. However, the lack of participation may affect the representativeness of this profile since only 11 of the 53 recruited AIAs participated. The potential biases from self-reported data could also affect the accuracy of these results. Future studies are, therefore, encouraged to combine questionnaires with interviews or direct observations. This mixed-methods approach could help verify self-reported data and enhance its accuracy. While consulting with industry experts during the design process could ensure even more comprehensive data to be collected.

Word count: 882

Key terms: Equipment inventory, fit-for-purpose training, SANS accreditation, requirements for approval, instruments, exposure monitoring, evaluation, health and safety hazards**.**

LIST OF ABBREVIATIONS

The table below explains the meaning of various abbreviations and acronyms used in this dissertation, along with the page number where each is first defined or used. Nonstandard acronyms that appear only occasionally are not included in this list.

Table 2: List of abbreviations, acronyms, and definitions

Abbreviation	Definition	Page
AIAs	Approved Inspection Authority: Defined in the Occupational Health and Safety Act: an inspection authority approved by the chief inspector: provided that an inspection authority approved by the chief inspector with respect to any service shall be an approved inspection authority with respect to that service only.	20
AIHA	The American Industrial Hygiene Association (USA).	22
ANSI	American National Standards Institute (USA): Publishes consensus standards on ventilation.	31
ASHRAE	American Society of Heating, Refrigerating, and Air-conditioning Engineers (USA).	38
DoEL	Department of Employment and Labour (previously Department of Labour) (SA).	20
HSE	Health and Safety Executive (UK): Integrates policies and practices for workplace well-being, safety, and environmental sustainability.	30

Continues on next page

Abbreviation	Definition	Page
IAQ	Indoor Air Quality.	27
ILO	The International Labour Organization: A specialised agency of the United Nations which aims at social justice concerning labour issues. ILO is a tripartite organisation with government, workers' and employers' representatives.	20
ISO	International Standardization Organization.	22
ND	Noise dosimeter.	32
NIHL	Noise-Induced Hearing Loss: It is permanent and irreversible loss of hearing that usually occurs due to exposure to excessive environmental noise.	30
NIOH	The National Institute for Occupational Health (SA).	37
NIOSH	The National Institute for Occupational Safety and Health (USA).	30
NWU	North-West University.	42
OHS Act	The Occupational Health and Safety Act 85 of 1993 (SA): The aim of the OHS Act is to provide for the safety and health of persons at work and in connection with the use of plants and machinery. It further protects people other than people at work from hazards arising out of or in connection with the activities at work.	20

Continues on next page

Abbreviation	Definition	Page
OHP	Occupational Hygiene Professional	22
OHSA	Occupational Safety and Health Administration (USA): The occupational safety and health administration is a large regulatory agency of the United States department of labour that originally had federal visitorial powers to inspect and examine workplaces.	-
RH	Relative Humidity: The amount of moisture in the air compared to the total amount that the air could contain at saturation at the same temperature.	33
ROH	Registered Occupational Hygienist (SA): The person who is an Occupational Hygienist with a professional occupational hygiene organisation recognised by the Chief Inspector of the Department of Employment and Labour, and is qualified, trained and experienced scientist or engineer who can conduct occupational hygiene monitoring and provides professional advice and recommendations on workplace associated hazards.	22
ROHA	Registered Occupational Hygiene Assistant (SA): The person who is a registered occupational hygiene assistant with a professional occupational hygiene organisation recognised by the Chief Inspector of the Department of Employment and Labour, and is qualified, trained and experienced and expected to be primarily engaged in the measurement of health stressors. He/she will work under the mentorship and supervision of a ROH.	22

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Abbreviation	Definition	Page
ROHT	Registered Occupational Hygiene Technologist (SA): The person who is a registered occupational hygiene technologist with a professional occupational hygiene organisation recognised by the Chief Inspector of the Department of Employment and Labour, and is qualified, trained and experienced in the planning of occupational hygiene monitoring surveys, as well as their evaluation and interpretation, advising on basic control procedures and writing of occupational hygiene monitoring/survey reports.	22
SAIOH	Southern African Institute of Occupational Hygiene (SA).	60
SANAS	The South African National Accreditation System (SA): The only national body responsible for carrying out accreditations in respect of conformity assessment, as mandated through the accreditation for conformity assessment, Calibration and Good Laboratory Practice Act (Act 19 of 2006).	20
SANS	South African National Standards (SA).	21
SLM	Sound level meter.	31
TWA	Time-Weighted Average: A concentration averaged over a specified time period (e.g., An 8-hour workday or a 40-hour workweek).	28

Continues on next page

Abbreviation	Definition	Page
WBGT	Wet-Bulb Globe Temperature: A simple and suitable technique to measure the combined effects of environmental factors related to heat stress	33
	End of table	

The list of abbreviations and definitions were compiled using the references on the next page.

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LIST OF SYMBOLS AND UNITS

The table below explains the meaning of various symbols and units used in this dissertation.

Table 3: List of symbols and units

Symbols and units	Meaning
%	Percentage
±	Plus-minus
>	Greater than
<	Less than
≥	Greater or equal than
≤	Less or equal than
Δ	Difference
°C	Degree Celsius
lx	Lux—the unit of measurement of light intensity levels.
dB(A)	The unit of measurement of an A-weighted sound pressure level.

End of list

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1 GENERAL INTRODUCTION

1.1 Introduction

With over two million fatalities and illnesses reported annually by the International Labour Organization (ILO), occupational hygiene plays an important role in the protection of worker health (ILO, 2021). In South Africa, this responsibility is enforced through legislation such as the *Occupational Health and Safety Act* 85 of 1993 (OHS Act), which mandates strict compliance with health and safety legislation (Department of Labour, 2012:4).

Friend and Kohn (2023:2) argue that employee health and safety often take a back seat to profitability concerns. However, the OHS Act mandates the implementation of health and safety standards to protect workers in different industries. This responsibility, discussed in Section 8 of the OHS Act, lies with the employer (*Occupational Health and Safety Act* 85 of 1993). To that effect, the employer is obligated to do an initial risk assessment of hazardous environmental conditions in the workplace. If a risk of exposure is identified, the exposure must be monitored and compared to legislated exposure limits. Risk assessments are essential as they assist in identifying potential hazards before causing harm, allowing for proactive interventions to protect employee health and safety (Schoeman & Van den Heever, 2014:42).

The Department of Employment and Labour (DoEL)[2], however, regarded it unreasonable for employers to be specialists in occupational health and hygiene (Department of Labour, 2012:5). Consequently, the DoEL made provision for Approved Inspection Authorities (AIAs). This provision allows AIAs to conduct exposure assessments and recommend interventions to control hazardous conditions, ensuring that workplaces adhere to health and safety regulations.

Occupational health and hygiene AIAs are approved by the DoEL's Chief Inspector and accredited by the South African National Accreditation System (SANAS).[3]

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2 Prior to 2012 the Department of Employment and Labour was known as the Department of Labour.

3 SANAS refers to both the accreditation system and the entity responsible for accreditation. SANAS is the only juristic person and accreditation body in the Republic of South Africa for the accreditation of conformity assessment, calibration, and monitoring of good laboratory practices.

Accreditation by SANAS is based on the inspection bodies' adherence to SANS 17020[4] procedures, personnel competence, and occupational and environmental hygiene instrumentation (Department of Employment and Labour, 2023:9).

SANS 17020 (2012:15) also outlines requirements for Type A, B, and C inspection bodies. The classification of AIAs depends on the specific activities they undertake and the level of independence they maintain. Inspection activities can be categorised as "first-party," "second-party," or "third-party" (SANS, 2020:10).

Type A AIAs are considered "third-party" inspection bodies, as they are fully independent of the activities they inspect. This independence ensures objectivity and impartiality during the inspection process. In contrast, Type B AIAs are part of a larger organisation and are limited to providing their inspection, monitoring, and evaluation services internally within that same organisation. Although they are not fully independent, Type B AIAs maintain a degree of separation to uphold their internal compliance processes. Type C AIAs, the third classification, allow personnel of the same organisation to be involved in activities such as designing, manufacturing, supplying, installing, or maintaining the items being inspected. However, to prevent conflicts of interest, these inspection bodies must ensure that individuals involved in such activities do not participate in the inspection of the same items (SANS, 2012:15).

For approval — in adherence to SANS 17020 — the occupational and environmental hygiene equipment of the AIAs should be tailored to the regulated monitoring services they wish to provide. These services include, among others, the monitoring of airborne contaminants, heat and cold stress, noise (personal and area), indoor air quality, and illumination surveys, all of which require specialised equipment for accurate assessment. For instance, monitoring airborne contaminants requires air sampling pumps, while noise hazards are assessed with sound level meters. Each piece of equipment is specialised to accurately measure the specific hazard it was designed for (Department of Labour, 2012:12). Another factor for approval that must be considered, is the capacity for equipment to be maintained and calibrated (Department of Employment and Labour, 2023:12).

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4 SANS 17020:2012 refers to the South African National Standard for *Conformity assessment: Requirements for the operation of various types of bodies performing inspection* is the South African national standard that is the identical implementation of ISO/IEC 17020:2012 and is adopted with the permission of the International Organization for Standardization.

These factors ensure that the equipment of the AIAs is appropriate and reliable. The requirements for the authorisation of an AIA entail the appointment of occupational hygiene professionals (OHPs)[5] who are adequately qualified, trained, and experienced. OHPs must possess relevant legal knowledge certificates and be registered with recognised professional bodies. The AIA should define and document competence requirements for each inspection and monitoring activity, including knowledge of the AIA's management systems and technical procedures.

Additionally, OHPs are required to undergo regular monitoring, training, and evaluation to ensure their continued competence. Professional judgement is essential for conformity assessments while oversight by registered Occupational Hygienists (ROH), or Technologists (ROHT) is necessary to maintain inspection practices of a high standard. Active supervision and mentorship are mandatory for less experienced personnel, particularly Occupational Hygiene Assistants (ROHA)[6] (Department of Employment and Labour, 2023:9).

1.2 Problem statement

The international standard, ISO 31000:2018-02[7], describes risk assessment as the process of risk identification, analysis, and evaluation. The gathering of information is important as part of the identification phase of a risk assessment. During information gathering, an OHP is allowed to identify possible hazards in order to make informed decisions regarding appropriate equipment and methods required to quantitatively evaluate health and safety exposure (Schoeman & Van den Heever, 20141:40).

In some instances, regulations require that exposure quantification assessments are carried out by AIAs in accordance with prescribed methods and procedures using specific occupational and environmental hygiene equipment. In other instances, OHPs rely on their own discretion when selecting the equipment and methods used (AIHA, 2021). As technology advances, the landscape of occupational and environmental hygiene monitoring equipment transforms rapidly, posing a challenge for AIAs to stay up to date.

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5 In the context of this study, occupational hygiene professionals collectively refer to registered occupational hygiene assistants, technologists and hygienists.

6 In accordance with SANS 17020, a ROHA is declared competent through onsite witnessing, talk-through assessments, and simulations. The ROHA is briefed and authorised by the ROH before carrying out any work. Debriefings are held between the ROH and ROHA during and after the completion of occupational hygiene work.

7 ISO 31000:2018 the International Standard for *Risk Management: Principles* that comprehensively outlines the approach of identifying, analysing, evaluating, training, monitoring, and communicating risks.

For instance, the shift from traditional air sampling pumps to modern real-time air monitors requires not only new equipment but also retraining of staff to ensure accurate data collection. Unfortunately, the advantages offered by newly developed equipment over old, but still functioning, equipment may not justify the capital outlay required. In some instances, a lack of transitioning towards newer equipment, may indeed be hampered by out-dated legislation. For example, regulations governing illuminance measurements do not specify the type of illuminance meters required for evaluating different lamps, even though their accuracy depends on the type of lamp used for calibration (ATP Instrumentation, 2022). This issue was also highlighted by Bizjak (2020:755), who argues that illuminance measurements of LEDs are often inaccurate when light meters are calibrated using standard unpolarised incandescent light. Manufacturers supply illuminance meters specifically calibrated for high accuracy measurement of LED lighting, for example the Goldilux LED Lux meter (AMS Haden, 2025).

This evolving technological landscape also has significant implications for the training of future OHPs. Martin *et al.* (2011:7) and Jackson (2013:1) highlight the importance for students to acquire industry-relevant skills. Acquiring industry-relevant skills can be achieved by introducing students to the most prevalent instruments used in practice. Considering the proliferation of occupational and environmental hygiene monitoring equipment, this requirement presents a challenge to educational institutions that must maintain up-to-date equipment. The equipment available at educational institutions should, therefore, reflect the diversity of new equipment available on the market as well as older equipment used by AIAs. By creating a profile of the occupational and environmental hygiene monitoring equipment used by AIAs, educational institutions will be able to use the equipment profile — disseminated after the completion of this study — to expand their equipment inventory and enhance practical training modules, design updated lab spaces and bridge the gap between education and industry practice.

Other stakeholders who may benefit from having access to a profile of the occupational and environmental hygiene monitoring equipment used by AIAs are occupational and environmental hygiene monitoring equipment providers. Factors such as buying drivers and preferred brands may assist them in providing for the specific needs of AIAs. While the monitoring of vibration and radiation stressors is common, this study will focus on equipment used to monitor the hazards as described by the DoEL (Department of Labour, 2012:12). This study will, therefore, determine the equipment used for the monitoring of airborne contaminants, heat and cold stress, noise (personal and area), indoor air quality, and illumination surveys.

1.3 Aims

This study aimed to create a profile of the occupational and environmental hygiene equipment prevalent within the South African AIA occupational health and hygiene industry using a questionnaire. A questionnaire was created using the DoEL's brochure[8] as a guideline regarding the outline and questions. This questionnaire was used to obtain the required information from AIAs. Although published in 2012, the requirements in the brochure continue to guide AIAs in South Africa as no major revisions have been introduced to the guideline.

This study focused exclusively on inspection bodies classified as Type A. These are fully independent commercial AIAs, who do not have any affiliation with the activities they inspect, ensuring objectivity. Type B AIAs, although authorised to perform monitoring and evaluation services, are excluded from the study due to their integration within larger organisations to which they exclusively provide services (SANS, 2012:15; SANS, 2020:10).

Additionally, occupational hygiene professionals and inspection bodies regulated under the *Mine Health and Safety Act* 29 of 1996, and its associated regulations, are not included in the scope of this study. However, AIAs contracted by mines to conduct specific evaluations, which are only temporary activities, were included.

1.4 Objectives

The objectives of this study included:

1. the identification of the equipment used by South African AIAs employing a detailed questionnaire; and
2. the creation of an equipment profile based on the gathered data.

1.5 Research question

What is the current profile of occupational and environmental hygiene monitoring equipment used by selected South African AIAs?

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[8] Department of Labour (South Africa). 2012. Requirements for approval as an approved inspection authority: occupational health and hygiene.

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CHAPTER 2 LITERATURE STUDY

This chapter presents a literature review providing the necessary context for interpreting the results and findings discussed in Chapter 3.

The first section provides an overview of the legal and regulatory framework for occupational health and safety in South Africa and then proceeds to discuss the role of Approved Inspection Authorities (AIAs). The second section introduces the reader to a selection of hazards and the equipment and methods used for their assessment. These hazards include air contaminants, noise (personal and area), heat and cold stress, illumination and finally indoor air quality (IAQ). The third section deals with the commercial aspects of the equipment regarding suppliers and the buying drivers considered by AIAs during the procurement process. Lastly, the fourth section emphasises the importance of aligning academic curricula with industry needs to ensure relevant education and training.

2.1 Legal and regulatory framework for occupational health and safety in South Africa and the role of approved inspection authorities

The *Constitution of the Republic of South Africa*, enacted in 1996, outlines citizens' rights and obligations. Chapter 2, known as the *Bill of Rights*, guarantees the right to an environment that is not harmful to health and well-being. The *National Environmental Management Act* 107 of 1998 on its part recognises the importance of protecting both the worker and the work environment as part of its broader environmental governance objectives. In South Africa, two key laws — the *Mine Health and Safety Act* 29 of 1996 (MHS Act) and the *Occupational Health and Safety Act* 85 of 1993 (OHS Act) — govern workplace health and safety specifically, protecting workers from occupational hazards.

The OHS Act is the primary legislation governing the health and safety of employees at work. It aims to protect workers — and anyone connected to work activities, machines, or equipment — from workplace hazards. This act is enforced by the Department of Employment and Labour (DoEL) to prevent workplace injuries and illnesses. Most workplaces, such as offices and factories, are governed by the OHS Act, but environments such as mines, ships, and fishing vessels fall under different regulations. The MHS Act governs mining activities and environments. All registered boats and the work done thereon falls under the *Merchant Shipping Act* 57 of 1951.

A study done by Oluoch *et al.* (2017:46) found that 40%–50% of the world's population is exposed to hazardous conditions in the workplace. The degree of harm, however, depends on the hazardous characteristics of the stressor, the duration, and the concentration of exposure (Cherrie *et al.,* 2021:100). The OHS Act mandates employers to ensure a safe workplace. Section 8 of the OHS Act outlines how employers should provide a safe working environment which includes steps to eliminate or control hazardous exposures (*Occupational Health and Safety Act* 85 of 1993). AIAs enable occupational health and safety compliance in South Africa by providing objective investigations, testing, and analyses, ultimately helping to protect individuals from workplace hazards and promoting compliance with national health and safety legislation (Schoeman & Van den Heever, 2014:40). An AIA is defined as an individual or company possessing specialised knowledge, equipment and expertise to conduct investigations, tests, and analyses. They provide objective findings related to:

- workplace hazards and the exposure of individuals to these hazards;
- health and safety risks associated with any task, equipment, substances, or work environment, and
- compliance with health and safety standards set out by the OHS Act (*Occupational Health and Safety Act* 85 of 1993).

While AIAs analyse and evaluate various workplace hazards, some are not regulated by specific regulations, whereas others are (Department of Employment and Labour, 2023:5). Hazards that are governed by specific regulations include:

- Asbestos: *The Asbestos Abatement Regulations* (2020) require AIAs to perform specialised monitoring. The regulation further stipulates, within section 5, that risk assessments must be performed by a competent person at intervals not exceeding two years, and furthermore that the risk assessment must be reviewed by an AIA at least at intervals not exceeding six years.
- Lead: *Lead Regulations* (Department of Labour, 2001) outline protective measures for workers exposed to lead in industrial settings. In section 6 it is mandated to have exposure assessments performed every two years.
- Noise-Induced Hearing Loss: *Noise-Induced Hearing Loss Regulations* (Department of Labour, 2003) prescribe guidelines for noise monitoring and control in workplaces. It is statutory to conduct noise exposure assessments whenever an employee’s eight-hour time-weighted average (TWA-8 hrs) exposure may be equal to, or exceeds, 85 dBA.

- Hazardous Chemical Agents: *Regulations for Hazardous Chemical Agents* (Department of Employment and Labour, 2021) require AIAs to assess chemical exposure every two years and ensure compliance with safety limits.

The DoEL publishes a list of AIAs in South Africa. According to the latest list, there are 54 AIAs in the country (Department of Employment and Labour, 2024). Of these, one AIA is based in Namibia, and two are classified as Type B AIAs, meaning they are restricted to providing services exclusively to the companies they are owned or managed by (SANS, 2012:15). This leaves 51 Type A AIAs that are authorised to provide services to any company or industry across South Africa.

The regulatory scope of these 51 AIAs is categorised as follows:

- Fifty AIAs are authorised to operate under the *Noise-Induced Hearing Loss Regulations*, GNR No. R307 of 7 March 2003.
- Forty-nine AIAs are approved to conduct services under the *Lead Regulation*, GNR No. R236 of 28 February 2002, and the *Hazardous Chemical Agents Regulations*, GNR No. R11263 of 29 March 2021.
- Forty-six AIAs are certified to inspect following the *Asbestos Abatement Regulations*, GNR No. 11196 of 10 November 2020 (Department of Employment and Labour, 2024).

Geographically, the majority of AIAs are concentrated in the Gauteng province, with 29 of the 51 AIAs based there. The Western Cape and KwaZulu-Natal provinces have the second and third highest number of AIAs, respectively. In contrast, the provinces with the fewest AIAs — Free State, Limpopo, and Mpumalanga — each have only one AIA in their respective localities.

2.2 Occupational hygiene hazards and the equipment and methods for their assessment

In South Africa, AIAs are required to use specific equipment, as listed by the Department of Employment and Labour (2012:12), to evaluate workplace hazards. This equipment must be up to standard with national or international standards to ensure accurate and repeatable results. Additionally, national standards require AIAs to maintain reliable equipment and, whether it’s old or new, most occupational hygiene equipment requires regular calibration (SANS, 2012:5).

Occupational stressors can be broadly categorised as ergonomic, psychosocial, chemical, biological, or physical. These categories encompass a wide range of workplace hazards, including hazardous chemicals, dust, gases, vapours, mists, smoke, fumes, fibres, noise, vibration, extreme heat and cold, ionising and non-ionising radiation, as well as biological hazards like mould, fungi, bacteria, and viruses (Steer & Langley, 2020:5).

This study, however, focused on the occupational and environmental hygiene equipment AIAs should possess to examine the hazards of air contaminants, noise (personal and area), extreme heat and cold, illumination and indoor air quality.

2.2.1 Air Contaminants

Air pollution refers to the presence of one or more contaminants in the atmosphere that may cause health problems (WHO, 2024). These air contaminants can include hazardous chemical agents (HCAs) in various forms. HCAs may appear as solids, such as dust and fibres, gases like carbon monoxide, or liquids and mists, such as sodium hypochlorite — commonly known as bleach (HSA, 2022:14).

In response to growing concerns over chemical exposure, the South African Minister of the DoEL introduced the updated *Regulations for Hazardous Chemical Agents* in 2021. The scope of these regulations was extended to cover not only employers and employees dealing with HCAs, but also manufacturers, importers, suppliers, and retailers.

Importantly, the regulations stipulate that only AIAs are permitted to conduct air monitoring, which must be carried out every two years for HCAs that have established maximum and restricted limits (Collier, 2021; Department of Employment and Labour, 2021:13).

Air monitoring is an important aspect of occupational hygiene and is defined by the DoEL (2021:3) as the process of determining the concentration of hazardous chemical agents in the air. The most common method for sampling air contaminants is the use of a sampling train, which consists of a sampling pump that draws air through the media at a constant flow rate. The sampling media is connected to the pump using a flexible tube such as Tygon tubing (Casella, 2022:6). Personal exposure to hazardous chemical agents is assessed by placing the sampling media within an employee's breathing zone (HSE, 2006), while area sampling involves positioning the sampler in a static location to evaluate the effectiveness of control measures (NIOSH, 1977:37).

2.2.2 Noise

Noise exposure can initially result in a temporary threshold shift (TTS), where hearing sensitivity decreases but eventually returns to normal without causing permanent damage. Continued or repeated exposure to excessive noise can, however, lead to a permanent threshold shift (PTS), where severe and irreversible damage to the auditory system occurs (Dadhich *et al.,* 2024:2712). While the effects of Noise-Induced Hearing Loss (NIHL) may initially be temporary, prolonged exposure to high noise levels ultimately causes permanent auditory impairment.

Noise-induced hearing loss (NIHL) can, therefore, transition from a reversible condition to a chronic and irreversible disorder, underscoring the importance of early intervention and prevention (Johnson *et al.,* 2017:15). Johnson *et al.* (2017:15) identifies noise exposure as the leading, but preventable, cause of hearing loss, NIHL being one of the most prevalent occupational health conditions worldwide. NIHL frequently occurs among individuals exposed to hazardous noise levels in workplace environments (Dadhich *et al.,* 2024:2712; Johnson *et al.,* 2017:15; Stanovska *et al.,* 2024:1).

The preventability of NIHL is strongly emphasised in literature (Dadhich *et al.,* 20242721; Johnson *et al.,* 2017:15), and in South Africa, by the *Noise-Induced Hearing Loss Regulations* (NIHL Regulations). These regulations legally obligate employers to prevent or mitigate exposure to harmful noise levels. Employers are, therefore, required to implement preventive measures that protect workers' hearing. Additionally, these regulations require AIAs to evaluate noise levels in workplaces and help employers to prevent the occurrence of NIHL (Department of Labour, 2003:8). Noise monitoring should be conducted by an AIA, at least every 24 months as part of the hearing conservation programme. Section 11(2)(a) of the NIHL Regulations also mandates AIAs to conduct these evaluations under the national standard, SANS 10083:2023 [9] which provides the requirements for the measurement and assessment of occupational noise for hearing conservation purposes (Department of Labour, 2003:7).

To accurately evaluate noise exposure, the DoEL mandates that AIAs use integrating sound level meters (SLMs) that meet the accuracy requirements set out in SANS 61672-1:2023[10] and SANS 61672-2:2022[11] for Type-2 SLMs.

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9 SANS 10083:2023 – The measurement and assessment of occupational noise for hearing conservation purposes.

10 SANS 61672-1:2023 - Electroacoustics: Sound level meters, Part 1: Specifications.

11 SANS 61672-2:2023 - Electroacoustics: Sound level. meters, Part 2: Pattern evaluation tests and give details for the tests that are necessary for validating the conformance of SLMs.

Additionally, AIAs should be equipped with sound calibrators compliant with SANS 60942:2003[12], and personal noise exposure should be measured using dosimeters that comply with IEC 61252:2017[13] (Department of Labour, 2012:12). The specifications for noise dosimeters (ND) are specified by the American National Standard Institute (ANSI) standard ANSI S1.25-1978[14].

A typical SLM consists of three main components. The microphone, detecting sound and converting it into an electrical signal, and the electronic circuit, processing signals by amplifying weaker signals, and then filtering them (David *et al.,* 2013:21). Filtering — such as A-weighting filtering for human hearing or C-weighting for loud sounds — ensures that the sound measurements reflect how humans perceive the different frequencies (Scott, 2018). Finally, the display presents the processed signals as sound levels, in decibels (dB) (David *et al.,* 2013:21).

While SLMs can be used to measure personal noise exposure, SLMs are primarily used to evaluate and determine noisy tasks, processes, and areas. NDs, on the other hand, are used specifically for personal noise evaluations (TSI, 2021). Since NDs are small wearable noise monitoring devices, they are attached to employees' shoulders and worn throughout a work shift. This enables noise dosimeters to measure the total amount of noise to which employees are exposed, as opposed to evaluating just one noise source at a time (TSI, 2021). Personal noise evaluations are, therefore, essential as they provide real-time data on individual exposure levels during a work shift, ensuring that a worker's exposure does not exceed the exposure limits (CDC, 2016).

While SANS 10083:2023, is recommended for use by the DoEL, other often-used methods include ANSI/ASA S3.44-2016-Part 1[15] standard which is a modified version of the International Standards Organization standard ISO 1999:2013[16] and SANS 10103:2008[17].

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12 SANS 60942:2003 refers to the South African National Standard for Electroacoustics: Sound calibrators.

13 IEC 61252:2017 refers to the International Standard for Amendment 2 - Electroacoustics: Specifications for personal sound exposure meters. It is an international standard commissioned by the International Electrotechnical Commission in 1993 — amended 2017 — that specifies the requirements for personal sound exposure meters.

14 ANSI/ASA S1.25-1987 refers to the American National Standard for Specifications for noise dosimeters.

15 ANSI/ASA S3.44-2016 Part 1 - Acoustics: Specification of Measurement Procedures for Noise Emissions from Sources, Part 1: Machinery and Equipment.

16 ISO 1999:2013 refers to the International Standard for Acoustics: Estimation of noise-induced hearing loss.

17 SANS 10103:2008 - The measurement and rating of environmental noise with respect to annoyance and to speech communication

2.2.3 Heat Stress

Heat stress occurs when the body is unable to effectively dissipate excessive heat. This heat can either be generated internally by muscle activity during physical exertion or absorbed from the surrounding environment (Copernicus Climate Change Service, 2024). This excess heat could overwhelm the body's thermoregulatory mechanisms, which may result in extreme variations in the body's core temperature (Schoeman & Van den Heever, 2015:27). When the body's core temperature exceeds 38°C, essential physiological processes begin to deteriorate, potentially leading to various heat-related disorders.

The primary conditions caused by heat exposure are heat rash, heat cramps, dehydration, heat exhaustion, heat syncope, and heat stroke. Heat rash is caused by blocked sweat glands, causing skin inflammation (Schoeman & Van den Heever, 2015:28). Heat cramps are caused by electrolyte imbalances and dehydration, experienced after excessive fluid losses, such as through perspiration (Sawka *et al.,* 2015:58).

Dehydration is also a major contributor to other heat disorders, from causing a reduction in the volume of blood to impairing the body's ability to cool down (McDermott *et al.,* 2017:877). Heat exhaustion, for example, is caused by a reduction in blood volume and decreased blood flow to the skin, which impairs the body's ability to cool itself. This condition can lead to symptoms such as weakness, fainting, and headaches (Schoeman & Van den Heever, 2015:29). Dehydration also contributes to heat syncope, a condition characterised by dizziness and fainting (syncope), which typically occurs when a person stands up too quickly after sitting for a long time (NIOSH, 2016:57).

The most severe heat-related illness, heat stroke, develops when the body's thermoregulatory mechanisms fail, causing the core temperature to rise rapidly, sometimes above 40°C (Casa *et al.,* 2015:987). Without prompt treatment, heat stroke can result in long-term organ damage, permanent disability, or even death due to the critical impact of high temperatures on cellular and neurological function (Leon & Bouchama, 2015:611).

The *Environmental Regulations for Workplaces* require employers to implement precautionary control measures to avoid heatstroke among their employees. These regulations require employers to ensure that the time-weighted average (TWA) Wet-Bulb Globe Temperature (WBGT) index of any working environment, determined over one hour, does not exceed 30°C (Department of Labour, 1987:4). The WBGT index combines several environmental factors — air temperature, humidity, wind speed, and radiant heat — into a single metric for assessing heat stress risks (Carter *et al.,* 2020:2).

The WBGT is widely used for monitoring heat exposure in occupational settings. It is measured using a heat stress monitor that integrates three types of thermometers: a dry-bulb thermometer to measure air temperature, a globe thermometer to measure radiant heat, and a wet-bulb thermometer to evaluate the cooling effect of air movement and the impact of relative humidity (RH) (Ekici, 2017:4). While the WBGT monitor captures all relevant environmental parameters, other equipment recommended by the DoEL, are the whirling hygrometer, globe thermometer, kata thermometer, and anemometers — either vane or hot wire (Department of Labour, 2012:12).

In addition to these instruments, SANS 7243:2021[18], the national standard for evaluating heat stress, emphasises the importance of considering all environmental and physiological parameters when assessing worker exposure. The SANS 7243:2021 standard is also referenced in the *Draft Physical Agents Regulations* as the preferred heat stress exposure monitoring method (Department of Employment and Labour, 2022:11).

Compliance to these regulations ensures the proper evaluation and management of heat stress in the workplace, contributing to the prevention of heat-related disorders and safeguarding employee health (Department of Labour, 1987:3).

2.2.4 Cold Stress

The balance between heat production and heat loss determines the net effect on the human body's core temperature, also referred to as heat storage. A positive change in heat storage occurs when the body produces more heat than it dissipates, increasing core temperature. Conversely, a negative heat balance occurs when heat production is lower than heat loss to the environment, causing a drop in core temperature (Castellani & Tipton, 2016:443). This decrease in core temperature is also known as hypothermia. Hypothermia is a thermal condition characterised by symptoms such as uncontrollable shivering, low blood pressure, and irregular heart rhythms (Schoeman & Van den Heever, 2015:22). Other physiological responses to extended periods of suboptimal temperatures include vasoconstriction (Guo *et al.,* 2024:800; Schoeman & Van den Heever, 2015:22) During vasoconstriction, blood flow to and temperature in the extremities decrease, while blood viscosity increases (Schoeman & Van den Heever, 2015:22).

18 SANS 7243:2021 - Ergonomics of the thermal environment: Assessment of heat stress using the WBGT (wet bulb globe temperature) index.

The reduction in blood flow limits adequate heat delivery to the tissues, ultimately resulting in the formation of ice crystals. Initially, ice crystals form outside the cells in exposed tissues. With prolonged cold exposure, ice crystals can also begin to form within the cells. This process damages cell membranes, leading to electrolyte imbalances. As the osmolarity gradient across the membrane increases, the cell membrane may rupture, ultimately leading to cell death (Basit *et al.,* 2023).

In South Africa, Regulation 2 of the *Environmental Regulations for Workplaces* prohibits employers from allowing employees to work in environments where the TWA dry-bulb temperature taken over four hours is lower than 6°C unless the employer takes reasonable measures to protect such employees against the cold (Department of Labour, 1987:3). The *Draft Physical Agents Regulations*, however, proposes stricter guidelines, stipulating a minimum allowable temperature of 10°C over the same duration. These updated regulations also require employers to assess exposure to cold stress by monitoring both the dry-bulb temperature and air velocity to determine the average environmental equivalent chill temperature[19] (Department of Employment and Labour, 2022:10).

To accurately measure cold stress, AIAs should equip themselves with the necessary equipment. According to the Department of Employment and Labour[20] (DoEL, 2012:12), the essential equipment for cold stress assessment includes a dry-bulb thermometer for measuring air temperature and a hot-wire anemometer for assessing air velocity, both of which are important for evaluating the severity of cold exposure. This equipment enables the calculation of the environmental equivalent chill temperature (Department of Employment and Labour, 2022:10).

The ISO 7243:2017 standard is part of a series of standards designed for evaluating thermal environments, which includes guidelines for hot, moderate, and cold conditions. ISO 11079:2007[21] outlines methods and strategies for assessing thermal stress from exposure to cold environments. These methods apply to continuous, intermittent, and occasional exposure, regardless of the type of work and whether work takes place indoors or outdoors.

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19 Equivalent chill temperature means the expression of wind-chill reflecting the cooling power of wind on exposed skin.

20 Although the term DoEL is used throughout the literature review, the reference list will refer to the Department of Labour (DoL), for references published earlier than 2012 as this was the name used prior to 2012.

21 ISO 11079:2007 - Ergonomics of the thermal environment: Determination and interpretation of cold stress when using required clothing insulations (IREQ) and local cooling effects.

2.2.5 Illumination

According to Tong *et al.* (2023:1), visual information accounts for approximately 90% of the sensory inputs people use to interpret their environment, making proper illumination essential. With illuminance defined as the intensity of light falling on a surface and measured in lux, it directly influences the transmission of visual information (Department of Labour, 1987:2; Tong *et al.,* 2023). The quality of workplace lighting is important since it can affect both employee health, as well as their work efficiency.

Insufficient lighting can lead to visual fatigue, for example, headaches, reduced visual function, blurred vision, and slower reaction times (Fryc & Tabaka, 2019:346). Due to visual impairment, the likelihood of workplace accidents could increase (Tong e*t al.,* 2023:1). Prolonged exposure to poor lighting can contribute to job dissatisfaction as employees may feel distracted and less productive (Schoeman & Van den Heever, 2015:154).

While high productivity, fewer accidents, and improved morale are associated with sufficient lighting, well-lit environments also facilitate better housekeeping and cleanliness, as employees are discouraged from storing any unnecessary materials in hidden or poorly lit areas (Schoeman & Van den Heever, 2015:154). Excessive exposure to light, however, can also have negative effects and could result in glare, which can compromise visual performance and comfort (Schoeman & Van den Heever, 2015:154). There are various types of glares, including disability glare which is characterised by temporary vision loss or visual impairment. It occurs when intense light enters the eye and scatters within the cornea and lens, reducing the contrast of the retinal image. This reduces the ability to recognise objects and increases the risk of accidents.

Discomfort glare, on the other hand, does not impair vision but causes symptoms such as eye strain, dry or watery eyes, and headaches. It is perceived as visual discomfort and arises from uncomfortably high luminance contrasts within the visual field (Ticleanu, 2021:458).

Employers are legally required to provide working environments with adequate lighting so that the health and safety of employees can be ensured. Providing adequate lighting not only includes the effective use of both artificial and natural lighting, but also takes into account the nature of work, glare, uniformity, and flickering (Department of Employment and Labour, 2022:11).

The *Environmental Regulations for Workplaces* further mandates protecting employee health and well-being by preventing glare that may impair vision (Department of Labour, 1987:5). Illuminance levels are measured with meters that measure light intensity using a sensor known as a photocell. This semiconductor converts incoming light into electrical current, with the current produced being directly proportional to the amount of light detected (Instrument Choice, 2020). The current from the photocell is amplified by the lux meter and converted to a reading that is displayed on the instrument (ATP Instrumentation, 2022).

To assess workplace illumination accurately, it is recommended to use a lux meter that is both cosine-corrected and colour-corrected (Department of Labour, 2012:12). Colour correction ensures that the lux meter's sensitivity aligns with the human eye's spectral response to light. This correction is achieved using integrated optical filters.

These filters selectively transmit light based on its wavelength, and in doing so, only the wavelengths that closely match the human visual response curve are measured. Cosine correction, on the other hand, allows the lux meter to interpret light striking its sensor from different directions (Smith, 2005:282).

Measurement readings are also dependent on the type of light to measure by the lux meter. Different types of lamps provide light of different wavelengths. For example, fluorescent lamps generate visible light at a wavelength of less than 400 nm. In contrast, incandescent lamps produce light across the entire wavelength spectrum. Lux meters are calibrated using different types of light. This is done to ensure that the photocell accurately simulates the human eye's response to light of different wavelengths (ATP Instrumentation, 2022).

The *Draft Physical Agents Regulations* specifies that lighting assessments must be conducted following national standards such as SANS 10114-1:2023[22], and SANS 10389-1:2003[23], focusing on exterior lighting for work and safety.

These standards ensure that employers adhere to guidelines for maintaining appropriate lighting conditions across various workplace settings, including emergency illumination (Department of Employment and Labour, 2022:12; SANS, 2020:5). An evaluation method often used to assess emergency lighting is provided for by SANS 10114-2:2020, *Interior lighting, Part 2: Emergency lighting.*

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22 SANS 10114-1:2023 - Interior lighting, Part 1: Artificial lighting indoors.

23 SANS 10389-1:2003 - Exterior lighting, Part 1: Artificial lighting for exterior areas for work and safety.

This section of SANS 10114 outlines the fundamental principles and specifies the luminous requirements and minimum operating durations for interior emergency lighting systems. While it does not apply to private homes, its guidelines can be used for common access areas in multi-storey buildings.

2.2.6 Indoor Air Quality

The *Draft Physical Agents Regulations* requires employers to ensure good indoor air quality (IAQ), and that employees are not exposed to any biological, chemical or physical hazards that may affect the IAQ (Department of Employment and Labour, 2022:13). The National Institute for Occupational Health is of opinion that the perceived comfort of employees within a working environment is an important indicator of good IAQ (NIOH, 2023).

IAQ can, therefore, be defined as the totality of attributes of indoor air that can affect people's health and well-being (Department of Employment and Labour, 2022:13). These attributes include the air exchange rate, RH, temperature, and air movement, as well as the presence of air pollutants such as nitrogen oxides (NO_x), mould spores, radon gas, volatile organic compounds (VOCs), particulate matter, and carbon monoxide (CO) within the working environment (NIOH, 2023; Tran *et al.,* 2020:2).

Since employees spend most of their time, about 70% indoors, the mitigation of air pollutants and the improvement of IAQ is very important (Abhijith *et al.,* 2022:1). Abhijith *et al.* (2022:2) highlighted the adverse effects of high CO_2 concentrations which include headaches, concentration loss, and higher risks for asthma. While the most common health effects are respiratory related, exposure to air pollutants can also affect the nervous, and cardiovascular systems (Dimitroulopoulou, 2023:2). It has also been found that the concentration span of employees decreases in an environment with low ventilation rates, high air temperatures and low RH. Additionally, exposure to varying RH may cause eye irritations and voice disruptions.

While all the attributes affect IAQ, the stronger correlation between low ventilation rates and high temperatures with poor IAQ is highlighted by Abhijith *et al.* (2022:2). To ensure the comfort and well-being of employees in the workplace, the *Draft Physical Agents Regulations* (2022:13) require employers to regularly evaluate their artificial ventilation systems. Compliance with the SANS 10400-O standard must also be confirmed by a competent person, and at intervals not exceeding 24 months. The evaluations should consider the indicators of thermal comfort namely dry-bulb temperature, air velocity, relative humidity and the presence of other airborne contaminants. Additionally, these IAQ tests should account for the number of air changes per type of occupancy (Department of Employment and Labour, 2022:13).

The equipment recommended by the DoEL (2012:12) for IAQ evaluations are hot wire anemometers, pitot static tubes, and manometers. Standards that are commonly used to assess IAQ at workplaces include the American Society of Heating, Refrigeration and Air Conditioning Engineers standards, ASHRAE 55:2020,[24] and ASHRAE 62.1:2013.[25]

2.3 Commercial Aspects of Equipment

While occupational hygiene professionals (OHPs) face the dual challenge of keeping up with the rapidly advancing industry and the lack of guiding information, they may struggle to gather relevant and useful information to determine the most applicable equipment and methods to use (AHIA, 2017). National standards further require AIAs to maintain reliable equipment, regardless of its age, through costly annual and biannual calibrations. Additionally, AIAs are obligated to acquire only standardised instruments, as outlined in SANS 17020.

Given the extensive range of equipment AIAs should maintain for approval, regular replacement of instruments can be a challenge. Using outdated or poorly maintained equipment can, however, lead to inaccurate results, unreliable performance or excessive repair costs (SANS 2012:12). In light of these challenges, this section explores the commercial aspects of equipment procurement, providing insights into suppliers, their location, and the brands they offer. It also examines the factors AIAs take into consideration when purchasing new equipment. These insights, called "buying drivers", highlight what AIAs value most in their purchasing decisions, such as practicality, reliability, and cost-effectiveness.

2.3.1 Suppliers of Occupational and Environmental Hygiene Equipment in South Africa

An array of companies in South Africa, some of which are listed below, provide specialised equipment for environmental and occupational hygiene monitoring. These suppliers play a role in supporting the industry by providing equipment to evaluate, monitor, and assess workplace hazards in accordance with health and safety regulations.

ACDC Dynamics, with its head office in Longmeadow and additional branches in Richmond Park, Pinetown, Riverhorse, and Germiston, supplies a broad array of industrial equipment, including equipment for environmental and occupational health monitoring (ACDC Dynamics, 2024).

24 ASHRAE 55:2020 refers to the American Standard for *Thermal environmental conditions for human occupancy*.
25 ASHRAE 62.1:2013 - Thermal environmental conditions for human occupancy.

Action Instruments SA (Pty) Ltd., based in Johannesburg, distributes a variety of specialised equipment for monitoring environmental and occupational conditions. The company represents brands such as Enerac, which manufactures combustion and emission gas analysers, Lambrecht, which produces weather stations and wind speed sensors, and Sonel, known for thermal imagers and light meters (Action Instruments SA (Pty) Ltd, 2021).

AMS Haden, headquartered in Honeydew, with representation across Mpumalanga, KwaZulu-Natal, North-West, Free State, and the Western Cape, has been supplying specialist instrumentation since 1973. Their equipment supports a variety of industries, focusing on environmental monitoring, occupational hygiene, mine ventilation, and heating, ventilation, and air conditioning (HVAC) systems (AMS Haden, 2024).

Apex Scientific South Africa offers a wide range of laboratory and monitoring equipment across major South African cities, including Durban, Cape Town, Johannesburg, Pretoria, Bloemfontein, and Gqeberha. Their product catalogue includes data loggers for temperature and humidity monitoring, as well as digital lux meters, which are important for maintaining safe working conditions (Apex Scientific South Africa, 2024).

Envirocon Instrumentation, located in Northcliff, Gauteng, is a prominent supplier of occupational hygiene monitoring equipment. The company is involved in the sales, marketing, distribution, and servicing of a wide range of environmental equipment. Envirocon represents leading brands such as Quest Technologies, Sensidyne/Gilian, RAE Systems, TSI, Morphix Technologies, Aquaria, METONE Equipment, ETS Lindgren, SIGNAL Equipment, and HORIBA (Envirocon Instrumentation, 2020).

Hanna Instruments, originally founded in Italy in 1978 and now based in the USA, is renowned for its user-friendly, accurate testing equipment. Among their product offerings is the portable lux meter HI97500, widely used in occupational environments to ensure appropriate lighting conditions (Hanna Instruments (Pty) Ltd, 2023).

Inspection Tool Specialist, located in Gqeberha, operates as an online-only business, offering convenient access to measurement and monitoring equipment. They supply well-known brands such as Benetech, PCE, Wintact, and Tomlin Tools, providing essential equipment for environmental and occupational hygiene assessments (Inspection Tool Specialist, 2024).

Mouser Electronics is a supplier of advanced measuring equipment, including Extech sound level meters, B&K temperature meters, Fluke humidity meters, and other environmental monitoring devices from Simpson Electric Company and Global Specialists (Mouser Electronics, 2024).

Rayten Engineering Solutions specialises in air quality monitoring and is the South African distributor of IMR environmental equipment. Their services and products are essential for maintaining air quality standards in occupational environments (Rayten Engineering, 2024).

Run Rite Electronics Pty Ltd., a family-run business founded in 1996 and based in Pinetown, KwaZulu-Natal, focuses on distributing instrumentation for process control and occupational health. They supply products from brands such as Cirrus, doseBadge, Tasi, Center, Delta Ohm, MiniRae, and Tenmars, which are crucial for ensuring compliance with health and safety regulations (Run Rite Electronics Pty Ltd, 2024).

Schauenburg Systems is headquartered in Kempton Park and is part of Schauenburg International GmbH, a German holding company. The company specialises in advanced technological solutions for occupational hygiene and environmental monitoring (Schauenburg Systems, 2024).

Sedulitas is a South African health and safety consulting firm, also supplying occupational hygiene equipment. They offer products from brands such as Larson Davis, AccuFit, Sibata, Radon's DOSEman, Biosdefender, Escort ELF, and LSI Lastem, providing a comprehensive solution for monitoring various workplace hazards (Sedulitas, nd.).

Testo South Africa (Pty) Ltd., based in Kempton Park, operates as a subsidiary of Testo, a global leader in the development of portable measurement technology. Testo's headquarters are located in the Black Forest, Germany, and their product range includes equipment for measuring temperature, humidity, and air quality (Testo South Africa (Pty) Ltd, 2024).

Three-D Agencies, established in 1977, supplies cable accessories and specialised instrumentation to various South African industries. The company has branches in Johannesburg, Cape Town, and Durban. They provide products such as Hikmicro thermal detectors and Uni-T lux meters, which are essential for occupational hygiene assessments (Three-D Agencies, 2024).

2.3.2 Buying Drivers in the Selection of Occupational and Environmental Hygiene Equipment

The International Labour Organization's (ILO) encyclopaedia of occupational health and safety (2011) discusses the considerations required when selecting monitoring equipment. In addition to the performance characteristics, the practical aspects also need to be considered. These could include portability, required source of energy, calibration and maintenance requirements, and availability of the required expendable supplies. These aspects will be determined by the expected conditions of use, for example, available infrastructure, climate and location. Consulting OHPs, however, are required to make purchasing decisions based on limited information (AIHA, 2017).

To assist AIAs with their decision-making process when buying occupational and environmental hygiene equipment, this study aims to create an equipment profile for South African AIAs, including the buying drivers[26] for preferring certain equipment over others. Knowing the equipment's capabilities based on consistently defined specifications should make purchasing decisions easier (AIHA, 2017).

2.4 Education and Training for Industry-Ready Occupational Hygiene Professionals

Performing a quantitative risk assessment to evaluate the likelihood of a hazard affecting an employee often requires the use of specialised occupational and environmental hygiene equipment (Cherrie *et al.,* 2021:100). Alanazi and Benlaria (2023:2) emphasise the importance of industry-relevant training in preparing graduates to enter the workforce. By using widely recognised training resources such as hazard evaluation methods and instruments, students become familiar with commonly used equipment, thereby developing the technical competencies necessary for their roles (Alanazi & Benlaria, 2023:5).

Packer (2022:2) highlights that the inability to operate equipment effectively is one of the primary frustrations of employers when hiring a new employee. The author outlines several concerns regarding newly graduated professionals, including a lack of technical skills and fundamental competencies such as teamwork, leadership, critical thinking, and problem-solving.

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26 Buying drivers are the factors that influence an AIA's — or the consumer's — decision-making process when buying a product.

However, by actively addressing industry needs and adapting curricula accordingly, educational institutions can help bridge the gap between academics and the workforce, ensuring that graduates are better equipped to meet the expectations and demands of employers in their respective industries (Alanazi & Benlaria, 2023:1).

Strategic educational objectives, such as graduate attributes, often align with the needs of relevant industries, ensuring that the curriculum reflects industry demands (Manwaring, *et al.,* 2019:423). At the North-West University (NWU), graduate attributes are defined as the extent to which the blend of knowledge, skills, and applied competence reflects the purpose of the qualification and is evident in the competencies of the graduate. In preparing graduates, the NWU outlines four domains with desired attributes. These four domains are work readiness, essential transferable skills, responsible and engaged members of society, and character and personal development.

Focusing on the domain of work readiness, NWU aims to prepare graduates for industry by developing multidisciplinary, interdisciplinary, and transdisciplinary perspectives. This approach fosters an improved integration of understanding specific issues or concepts, enabling students to apply their specialised knowledge and professional skills to both theoretical and evolving practical contexts. Graduates are expected to possess the ability and knowledge necessary to competently perform the technical skills relevant to their industry (NWU, 2023:14).

2.5 Conclusion

In conclusion, this literature review illustrates the different aspects of occupational hygiene, emphasising the importance of thorough hazard assessment in promoting worker health and well-being. South Africa’s regulatory framework, composed of various acts and regulations, requires compliance across different occupational environments, often requiring the use of standardised monitoring equipment and methods. The overview of the variety of equipment, approval requirements, suppliers and purchasing considerations reflects the challenges AIAs encounter in selecting suitable instruments. Furthermore, it highlights the benefits of a clear equipment profile to support informed choices. To the author’s knowledge, no similar studies have specifically examined the equipment profiles of occupational hygiene practising companies, highlighting a gap in the literature. Overall, this review suggests that enhancing occupational hygiene practices and aligning educational programmes with industry needs can positively influence workplace safety and regulatory adherence.

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CHAPTER 3 MANUSCRIPT: EQUIPMENT PROFILE OF SOUTH AFRICAN OCCUPATIONAL HYGIENE APPROVED INSPECTION AUTHORITIES

Instructions for authors as outlined within the guidelines for the journal *Occupational Health Southern Africa*

Journal information

This journal aims to provide a platform for engagement between scholars and emerging and established occupational health professionals by publishing high-quality, peer-reviewed research articles, opinions, reports, and related news matters.

The editorial content of this journal focuses on occupational medicine, nursing, and hygiene, as well as primary healthcare at the workplace, safety, and other employee health benefits.

The journal is the only journal within sub-Saharan Africa, dedicated to occupational health disciplines. Furthermore, it has been accredited by the South African Department of Higher Education (DHET); listed in the African Index Medicus; and is on the International Committee of Medical Journal Editors (ICMJE) journals list. This journal, therefore, follows the ICMJE's recommendations for the conduct, reporting, editing, and publication of scholarly work in medical journals.

Additional manuscript submission requirement

In addition to following the Uniform Requirements for Manuscripts Submitted to Biomedical Journals, all manuscripts and articles should conform to the style requirements for publication in Occupational Health Southern Africa.

General requirements

- Scientific writing style, as well as good grammar, must be used.
- Content must be organised in a logical sequence.
- Articles must be relevant and scientifically significant.
- In the case of research and review articles, the method must be sound.

Style requirements

- The manuscript must be written in Arial, font size 11 using 1.5 line spacing.
- Margin widths should be 2.54 cm all around.
- Round percentages accurately to 1 decimal point. Leading zeros should be included, e.g., $p < 0.05$, not $p < .05$.
- Scientific measurements must be expressed in SI units.
- Abbreviations and acronyms should only be used if necessary and defined on first use, but not in the abstract.
- Only proper names should have capital letters. Quotation marks should only be used for direct quotes.
- Other than in Tables and Figures, footnotes[a] must not be used.
- Pages should be numbered consecutively.

References

- All statements should be appropriately referenced.
- References should be set out in the Vancouver style according to the International Committee of Medical Journal Editors: http://www.nlm.nih.gov/bsd/uniform_requirements.html.
- References should be inserted in the text as superscript numbers, after the full stop, and listed at the end of the article in numerical order (not alphabetically).
- Only approved abbreviations of journal titles should be used.
- References must be of excellent quality (use primary sources from peer reviewed journals wherever possible).
- Personal communication and unpublished observations may be cited in the text, but not in the reference list.
- The accuracy of references is the author's responsibility.

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[a] While the journal guidelines require that footnotes not be used, they have been included in this version of the article to enhance readability for examination purposes. The footnotes will be removed prior to submission.

Equipment profile of South African Occupational Hygiene Approved Inspection Authorities

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Key terms: equipment inventory, fit-for-purpose training, SANAS accreditation, requirements for approval, instruments, exposure monitoring, industry-needs.

Abstract

Background: Occupational hygiene focuses on protecting workers from workplace hazards, a responsibility reinforced by legislative frameworks and supported by Approved Inspection Authorities (AIAs). To stay abreast of industry advancements and the evolving landscape of hazard evaluation, AIAs must adapt to the rapid proliferation of equipment. Similarly, educational institutions need to ensure that their training programmes equip students with relevant skills and resources. Considering the aforementioned, there is a growing need to establish the specific equipment and methods used in hazard evaluations, enabling alignment between academic training and industry practice.

Objectives: This study aims to create a comprehensive profile representing the occupational and environmental hygiene equipment prevalent within the South African occupational health and hygiene industry.

Methods: Using the Google Forms platform, an online questionnaire was created and distributed to registered occupational hygienists representing the 53 South African AIAs.

Results: Equipment profiles were created and categorised according to the seven different hazards they evaluate. Each profile details the predominant models and types of equipment used by AIAs for evaluation. Additionally, this study identified commonly used evaluation methods and data-capturing techniques. While most AIAs prefer traditional data collection methods, a growing number have incorporated newer technologies. Overall, AIAs displayed standardised practices, with only a few expressing uncertainties regarding calibration requirements.

Conclusion: This study provides valuable insights into the equipment profiles, calibration practices and evaluation methods used by AIAs to evaluate hazards. Findings highlight a preference for user-friendly, reliable, and cost-effective equipment, with some variations in calibration practices and limited use of advanced data-capturing techniques. While certain brands and models are widely used and should feature in training programmes to ensure that students become familiar with them, less commonly used instruments should also be used. This comprehensive approach should enhance students' technical adaptability and improve their ability to work with a variety of instruments.

Word count: 294

3.1 Introduction

As the primary legislation overseeing workplace health and safety, the *Occupational Health and Safety Act* 85 of 1993 (OHS Act), obligates employers to mitigate workplace hazards as far as is reasonably practicable. To identify these hazards, employers are required to conduct a risk assessment.[1] Such assessments allow for proactive interventions to protect employees' health and safety.[2] The extent of potential harm, however, depends on the nature of the hazard, exposure duration, and concentration, thereby necessitating a quantitative assessment. These quantitative assessments often require specialised occupational and environmental hygiene equipment and expertise to compare exposure levels to the relevant occupational exposure limits (OELs).[3]

Recognising the need for occupational health and safety compliance through objective investigation, testing, and analysis, the Department of Employment and Labour (DoEL) [b] makes provision for Approved Inspection Authorities (AIAs), who aim to protect employees from workplace hazards and promote compliance with national safety legislation and standards.[2,4] In some instances, regulations require that AIAs use prescribed methods and specific occupational and environmental hygiene equipment for exposure quantification assessments.[5] In other cases, South African AIAs use discretion in their choice of equipment and methods.[6,7]

Although the DoEL outlines a list of equipment required for assessing hazards within different regulatory frameworks, the wide variety of equipment brands and suppliers present AIAs with complex purchasing decisions. These decisions must be made with limited information with regards to the instruments' ease of use, durability, and practicality, while also ensuring compliance with national or international standards to guarantee accurate and reliable monitoring.[4,7]

Educational institutions, on the other hand, face the challenge of keeping up with technological advancements in occupational hygiene equipment. This is particularly important, as they should equip graduates with industry-relevant skills to prepare them for the workforce and enhance their employability.[8, 9,10]

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[b] Prior to 2012, the DoEL was known as the Department of Labour (DoL).

This study aims to create a profile of the equipment commonly used within the South African occupational health and hygiene industry. Since AIAs need to consider both performance and practical aspects when selecting equipment, the proposed equipment profile may serve as a valuable tool in their decision-making process. Additionally, this profile can help educational institutions align their curricula with industry needs, ensuring that graduates are trained to operate monitoring equipment that is most frequently used.[10]

3.1.1 Methods

A mixed-methods research approach of sequential exploratory design was used to obtain the qualitative and quantitative data for this study. This strategy involved running a questionnaire as the primary sampling instrument to collect data. Qualitative data collected were analysed to generate quantitative data which was further analysed for interpretation. The quantitative data was then used to assist with the interpretation of the qualitative data.[11]

3.1.2 Questionnaire and recruitment process

A questionnaire, annexure E, was developed using the list of basic equipment outlined by the DoEL, required for approval as an AIA, as a starting point. This list divides equipment into seven categories according to the hazards that should be monitored.[4] These seven categories include airborne contaminants, heat- and cold stress, personal- and area noise, indoor air quality, and illumination, all of which require specialised equipment for accurate assessment. Similarly, the questionnaire was divided into seven sections, each focusing on a particular hazard and key equipment profiling variables. These variables included the types and models of equipment, average age, calibration frequency, buying drivers, data capturing methods as well as evaluation methods.

Respondents could answer questions by selecting predetermined options — represented by checkboxes and visual presentations for easy identification — or by typing their answers. To profile the most commonly used equipment types and models, for example, respondents had to select the applicable types and models they owned with checkboxes representing the quantity ranges. The popularity of each equipment type was assessed based on the frequency of selection and the total number of units reported. The total number of units were calculated by adding the minimum value of the reported ranges. In other instances, respondents could select the applicable options or rank certain variables. In these instances, the value (n) reflects the frequency of respondents that selected a particular option.

To obtain support for this research project, the professional registration body for Occupational Hygiene Professionals (OHPs) in South Africa — the Southern African Institute for Occupational Hygiene (SAIOH) — was approached. Additionally, the Association for Occupational Hygiene Approved Inspection Authorities (OHAIA) was also approached. Both institutions supported the study by providing a goodwill letter.

From May to June 2023, a paid advertisement was circulated via SAIOH members' email network. This e-mail contained the goodwill letters, the ethics approval certificate and a link to the informed consent (IC) form hosted on Google Forms (Google LLC; Mountain View (CA), USA).

The e-mail addresses of recipients who completed the IC form and who indicated that they were prepared to partake in the study, were automatically saved in Google Sheets (Google LLC; Mountain View (CA), USA) upon submission. A link to the questionnaire was then sent to the participants by an independent third party. After two months, the independent third party, having sole access to the data stored in Google Forms and Google Sheets, exported the data to Microsoft Excel (Version 365: Microsoft Corporation; Redmond (WA), USA) to be analysed by the researchers.

Unfortunately, participation was low, and the Human Research Ethics Committee (HREC) was consulted for advice on how to increase engagement through incentivisation. A revised ethics application was submitted, outlining the provisions for an incentive in the form of a discount voucher on training offered by the North-West University to OHPs.

Feedback obtained during the initial recruitment effort was used to refine the questionnaire. Additional equipment and methods that had previously been overlooked were incorporated, and its clarity and completeness were improved.

A second recruitment effort took place during November 2023 and March 2024. This time a personalised email containing the goodwill letters, the ethics approval certificate and a link to the IC form was distributed by the independent third party to the responsible occupational hygienists of 53 Type A categorised AIAs using the contact details listed by the DoEL. The DoEL regularly updates and publishes these details in the public domain. Recipients who completed the IC form were sent a link to the survey conducted using Google Forms (Google LLC; Mountain View (CA), USA). Participant responses were automatically saved in Google Sheets (Google LLC; Mountain View (CA), USA) upon submission.

After a period of five months, the independent third party — having sole password protected access to the data stored in Google Forms and Google Sheets — exported the data to Microsoft Excel (Version 365: Microsoft Corporation; Redmond (WA), USA) to be analysed by the researchers. A total of 11 OHPs, representing 21% of the 53 Types A categorised AIAs, responded to the questionnaire.

Despite implementing various recruitment strategies, running the recruitment process for an extended period and offering an incentive to participants, our study faced a low response rate. A recent study on professional occupational hygiene practices within Spanish-speaking nations reported an initial response rate of 22%. After excluding respondents who did not meet the inclusion criteria, the final response rate was 17%.[12] Despite this limitation, the study was published and contributed valuable insights. While the response rate of this study is also low, the data obtained provide important insights into the equipment profile of AIAs in South Africa. Since not all AIAs answered every question, fewer responses were analysed in some cases. Similarly, AIAs were allowed to select multiple answers resulting in more than 11 responses in some instances. The raw data were aggregated to generate categorical summaries and frequency tables for further analysis and interpretation.

The analysis also revealed that manufacturing and industrial production is the most serviced sector, with 91% of AIAs providing occupational and environmental hygiene assessments in this industry. The public and social sector follows at 36%, highlighting the role of AIAs in ensuring regulatory compliance and workplace safety in government institutions and public services. Additionally, 27% of AIAs service the primary sector, which includes forestry and mining, where mines frequently outsource occupational hygiene assessments to AIAs in order to meet legislative and operational requirements. The corporate and commercial sector accounts for 18%, reflecting the increasing focus on occupational health in office environments and business operations. Lastly, 9% of AIAs provide services to the transportation and logistics sector, demonstrating a smaller yet relevant demand for occupational hygiene expertise in industries managing goods movement and supply chains. It is important to note that the percentages do not sum to 100%, as AIAs often operate across multiple industries and were allowed to select more than one sector in the survey.

3.1.3 Ethics

This study received ethics approval from the Health Research Ethics Committee (HREC) of the North-West University (NWU) Potchefstroom Campus (ethics number NWU-00119-22-A1), ensuring adherence to ethical standards for research involving human participants.

The committee reviewed and approved the study's protocol, confirming that adequate measures were taken to protect the anonymity, confidentiality, and voluntary participation of all respondents.

Anonymity was maintained with no personal or identifying information collected by the questionnaire, and with all the IC declarations securely managed by an independent third party. The questionnaire responses were also managed by an independent third party. Participants providing their IC were informed of their right to withdraw at any time during the study without penalty, ensuring voluntary participation. The study posed minimal risks, with the only inconvenience being the time taken by participants to complete the questionnaire. Precautionary measures were taken to minimise the time taken to complete the questionnaire by including options that only need to be selected.

The inclusion criteria were designed to recruit registered occupational hygienists representing Type A categorised AIAs. This ensured the exclusion of vulnerable individuals, as all participants met the professional and educational standards required to practice as registered hygienists.

The findings of this study will be disseminated through a peer-reviewed journal accessible to participants by virtue of their registration with SAIOH, ensuring transparency and access to the results.

3.2 Results and Discussion

The results and discussion have been consolidated under a single heading to align with the interpretive nature of qualitative research. Integrating the results with the discussion allows for a more fluid, narrative-style presentation, where interpretations are presented alongside the findings. All pie charts in this study were generated using GraphPad Prism (Version 10: GraphPad Software; Boston (MA), USA). Due to rounding, the values may not add up to 100%. Additionally, only the top five models are shown in each instance, therefore, the sum of models included may not match the percentage shown in the brand pie charts.

3.2.1 Air Contaminants

While air contaminants encompass a variety of airborne hazards, including various types of dusts, gases, vapours, mists, smoke, fumes, and fibres, this study defines air contaminants specifically as dusts in their most basic form, such as particulates not otherwise regulated/classified (PNOR/C).[13]

The participating AIAs, collectively, own at least 327 air sampling pumps. Of these, a significant majority (237) are *Gilian GilAir-3* models as illustrated in Figure 1(A). This establishes *Gilian GilAir-3* as the most used air sampling pump among the participating AIAs.

Gilian GilAir-3 and *Gilian GilAir-5* sampling pumps require OHPs to use slotted screwdrivers to adjust the flow rate in contrast to the *Gilian GilAir Plus* model where the flow rate is set digitally by using buttons.

The reason for the Gilian *GilAir-3* and *Gilian GilAir-5* finding favour amongst AIAs, in contrast to the more modern *Gilian GilAir Plus*, can only be speculated upon. It may be ascribed to AIAs finding older equipment more reliable than newer, digital models.[14,15] Convenience, however, comes at a premium, and the popularity of the *Gilian GilAir-3* may instead reflect prudent financial considerations by AIAs with the *Gilian GilAir Plus* being almost 70% more expensive.

It is interesting to note that sampling pumps were mainly represented by only two manufacturers: *Gilian* (90%) and *Casella* (10%). This distribution highlights a strong industry preference for *Gilian-branded* pumps. This could be due to a difference in price or due to the market prominence of the supplier of Gilian products.

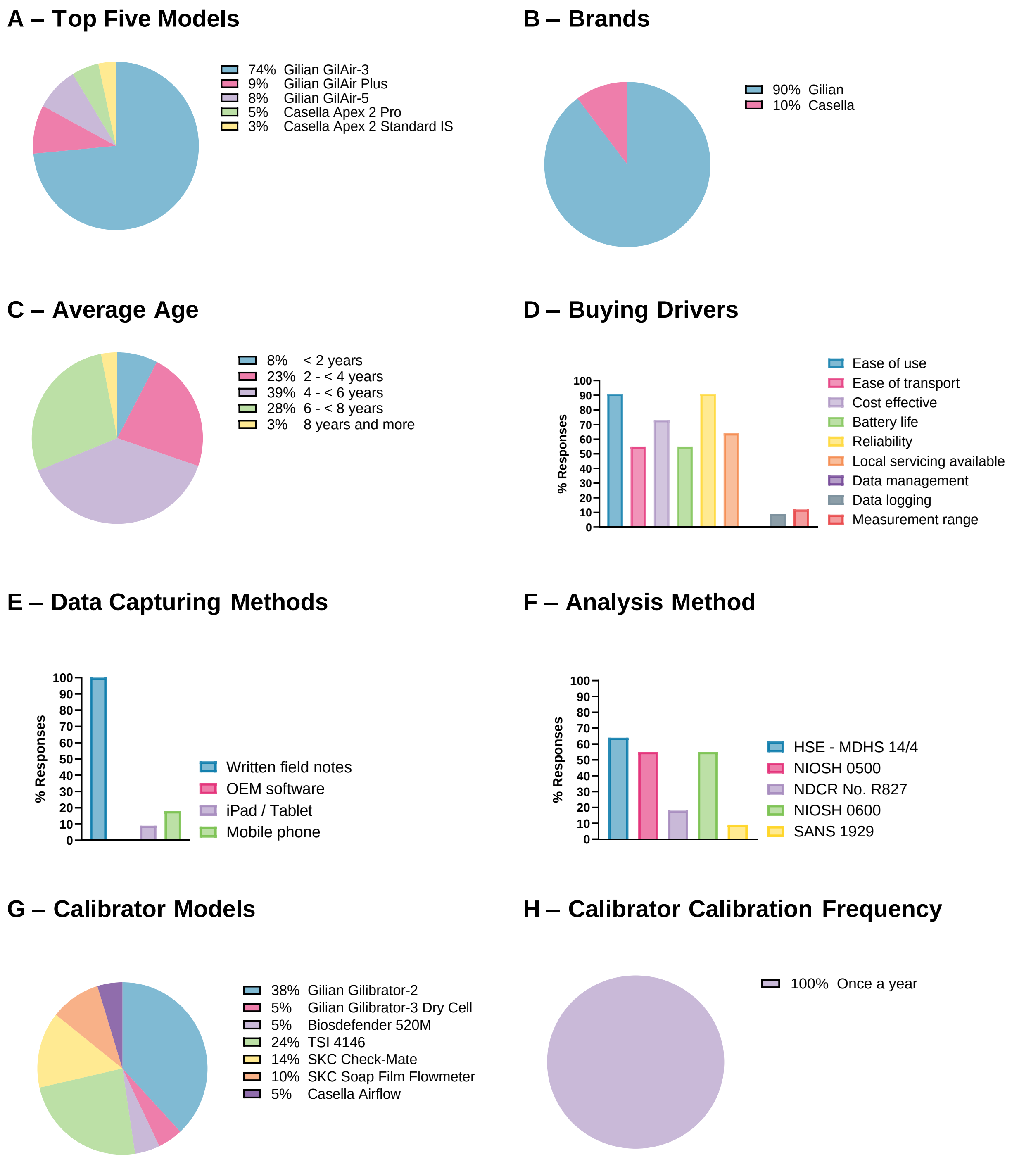

Figure 1: Air contaminants equipment profile.

In addition to identifying the models in use, the study examined the age distribution of the air sampling pumps to assess the balance between older and newer equipment. Among the 327 pumps reported, the majority (70%) were older than four years, with 28% between six and eight years old.

To gain insight into the factors influencing air sampling pump selection, AIAs were asked to identify their buying drivers — key factors guiding purchase decisions. As shown in Figure 1(D), *ease of use* and *reliability* emerged as the top buying drivers, each receiving a 91% response rate. These were prioritised above other factors such as *cost effectivity*, *local servicing available*, *ease of transport, measurement range, data logging* and *data management* even though AIAs could have selected all the available options. In this context, it may be argued that the preference for *Gilian GilAir* pumps appears to be linked to their ease of use and reliability. These findings emphasise the importance of user-friendly and reliable equipment.

The data capturing methods summarised in Figure 1(E) were more straightforward, with all the AIAs using written paper-based field notes to capture data. Some have, however, started to embrace technological advancements in the form of iPads/Tablets or mobile phones. Educational institutions should be encouraged to expose students to both traditional and advanced data-capturing technologies since it could help bridge this gap and enhance student preparedness for future industry needs.

The methods employed for sampling specific contaminants, such as particulates not otherwise classified/regulated (PNOC/R), or nuisance dust, are shown in Figure 1(F). The Health and Safety Executive's (HSE) Methods for the determination of hazardous substances (MDHS14/4) guidance was identified as the most frequently used method (32%). It was interesting to note that three AIAs reported using the method prescribed by the *National Dust Control Regulations*, 2024. This regulation falls under the *National Environmental Management: Air Quality Act* 39 of 2004 and is regulated by the Department of Forestry, Fisheries and the Environment.

The purpose of this regulation is to prescribe the measures for dust control as well as steps to prevent nuisance from dust.[16] This goes to show that AIAs are frequently requested to provide services for purposes other than those regulated by the *Occupational Health and Safety Act* 85 of 1993.

The data also provided an opportunity to explore practical challenges faced by AIAs. For example, one AIA highlighted difficulties with frequently broken cassettes when using the Institute of Occupational Medicine (IOM) samplers for sampling dusty workplace areas. Although IOM samplers are preferred for sampling inhalable aerosols, this feedback highlights the need for more robust equipment in specific scenarios.[17] Such insights can inform both industry practices and the selection of training equipment to reflect real-world challenges more accurately. Of the seven different calibrators displayed in Figure 1(G), the *Gilian Gilibrator 2* was the most frequently selected, followed by *TSI's* portable *Model 4146*, which was chosen by five of the 11 AIAs. Most

AIAs reported having two to three different calibrators. Concerning the external calibration of calibrators, all 11 AIAs reported sending them for calibration annually. The *Guidelines Concerning Calibration Intervals and Recalibration* (SANS TG 05-06) defines calibration intervals as the period where there is a high probability for the instrument to remain within the desired specifications.[18]

The terms *external calibration* and *calibration* are used throughout the result discussions and can be distinguished as follows: while some equipment requires in-service checks — also referred to as calibration or intermediate checks — these processes refer to the routine on-site tests which are performed by the operator to confirm the instrument's functionality within a required operational limit. In the context of this study, *calibration* refers to the standardised process by which a certified calibration laboratory or manufacturer ensures that the instrument's measurements reflect known reference values.[19] On the other hand, intermediate checks are performed before surveys to ensure confidence in the calibration status of monitoring equipment. These in-service calibrations should be conducted according to defined procedures and, although these checks do not replace external calibration, they may extend the calibration intervals when the results are favourable.[20]

3.2.2 Area Noise

Noise exposure evaluations were divided into *area noise* and *personal noise* evaluations to have enhanced understanding of the models, types, and quantities of sound level meters (SLMs) and noise dosimeters (NDs) employed by AIAs.

Figure 2(A) and Figure 2(B) summarise the SLM profiles of AIAs who collectively own at least 37 SLMs, with the most popular model being the *Svantek SV 971*, followed by the *3M / QUEST 1200* and *Casella CEL-240*. Notably, of the three most popular SLMs, only the *Casella CEL-240* is a Type-2 meter, while the others are Type-1.

This indicates a clear preference for more accurate instruments, as Type-1 SLMs are designed for precision noise evaluations.[21] Although no specific *Casella* model was most frequently used, *Casella* appeared as the leading brand overall, representing 32% of the total SLMs owned, followed closely by *3M / TSI / QUEST* at 30%. One AIA also highlighted the *Casella CEL-490* as *"highly rated by calibration laboratories",* emphasising its reliability despite being less commonly reported.

Figure 2: Area Noise equipment profile.

The age range of SLMs further highlights the balance between older and newer equipment in use (Figure 2(C)). Of the 37 SLMs reported, the majority (36%) are between six and eight years old, while only 28% are newer than four years old (with 17% being newer than two, and 11% aged between two and less than four years). A smaller proportion (11%) is over eight years old.

As shown in Figure 2(D), *ease of use* was selected by all 11 AIAs. Considering that noise measurements can be complex, it makes sense that OHPs would place a high premium on the capability of instruments to make it easier to collect data. What is unexpected, is that technological advancements appear to hold less influence as buying drivers, with *data management* not being considered as important (27%).

Despite the relative unimportance of data management capabilities, there are indications of gradual implementation of newer technologies in terms of data-capturing. For example, Figure 2(E) reveals that two AIAs use iPads/Tablets, or mobile phones for noise evaluation, and data-capturing, while 36% reported using Original Equipment Manufacturer (OEM) software.

Legislated methods and standards used during area noise evaluations are summarised in Figure 2(F), where *SANS 10083* is shown as the most used standard (100%), followed by the *Occupational Health and Safety Act* 85 of 1993 (OHS Act) (46%). It must be pointed out that reference to the OHS Act as a "method" for noise measurements, indirectly implies the Noise-Induced Hearing Loss Regulations and by implication, SANS 10083. This indicates that AIAs align their practices with recognised national legislation and standards, ensuring consistency and reliability in noise evaluation outcomes.

Similar to air sampling pumps, AIAs need to perform routine in-service checks to ensure that the SLM functions correctly. Calibrators used for SLMs and NDs are instrument-specific as they are required to produce a sound pressure level and frequency identical to that with which the SLMs were factory-calibrated.

As with SLMs, calibrators are also classified as Type-1 or Type-2 calibrators.[21] SLM calibrators used by AIAs are summarised in Figure 2(G) and includes the predominantly used *3M / QUEST QC-10 calibrator,* and *Casella CEL-120/2* calibrator. Figure 2 (H) displays the calibration frequency for SLM calibrators, with all 11 AIAs reporting that they send their calibrators for calibration annually. Incorporating industry-relevant equipment, such as *Svantek* and *Casella* SLMs, into training programmes ensures that students gain hands-on experience with equipment they are likely to encounter in practice.

3.2.3 Personal Noise

When comparing the equipment profiles of SLMs and NDs, there are some notable differences and similarities. Of the 11 participating AIAs, 10 AIAs reported owning a collective total of 122 NDs. With 96% being *Casella*-branded, *Casella* is, as is the case with SLMs, once again established as the leading brand as shown in Figure 3(B).

Figure 3: Personal noise equipment profile.

In contrast to the SLM profile — where *Svantek* and *3M / TSI / QUEST* were the dominating models — *Casella* dominated both the first- and second-most-used ND models. Specifically, the *Casella dBadge 2* and the *Casella CEL 350 IS* should be mentioned, each accounting for 48% of the top five NDs. The preference by AIAs for the *CEL 350 IS*, a newer model of the earlier dBadge series, proves the selection of equipment models built on previously proven successful designs while technological advancements are still incorporated.[22]

Another difference between SLMs and NDs is in the average age intervals of the two types of equipment. Whereas most SLMs were reported to be between six and eight years old, 75% of NDs are newer than six years old (Figure 3(C)). This difference could indicate that AIAs update their ND inventory more frequently, possibly due to the increased wear and tear experienced by NDs being worn by workers, possibly in rough working environments, and therefore requiring frequent replacement.

A comparison of buying drivers for SLMs and NDs reveals both shared priorities and unique trends. As with SLMs, *ease of use* remained a top priority for NDs, accounting for 90% of the responses (Figure 3(D)). Interestingly, features such as *data management* and *measurement range* received the fewest responses for both equipment types, suggesting that AIAs generally prioritise the usability and durability of equipment over more advanced functionalities.

A trend in terms of often-used data-capturing methods emerges as Figure 3(E) displays a similar picture as with previous profiles, with all AIAs reporting the use of written paper-based field notes, supplemented by the use of OEM software and to a lesser extent the use of iPads/Tablets and mobile phones. An increase in the use of OEM software in comparison to that of SLMs may suggest a growing incorporation of digital tools by manufacturers for relatively newer equipment. Despite these differences, the two profiles share important methodological and operational similarities. For both SLMs and NDs, the *SANS 10083* standard was the most reported method used for noise evaluations as indicated in Figure 3(F).

Figure 3(G) displays a wider variety of calibrators than reported for SLMs with Figure 3(H) showing that most AIAs calibrate their ND calibrators externally every year. Gaining some valuable insights into the personal noise evaluation practices of AIAs, these findings highlight the importance of equipping students with training that includes *Casella* NDs, particularly the *dBadge 2* and *CEL-350 IS*, to align with current industry preferences. Students should also be trained using less common NDs, to ensure that they have the technical skills for operating various types, brands, and models.

3.2.4 Heat stress

Considering the heat stress equipment profile, AIAs collectively selected nine different heat stress monitors of which the top five are shown in Figure 4(A).

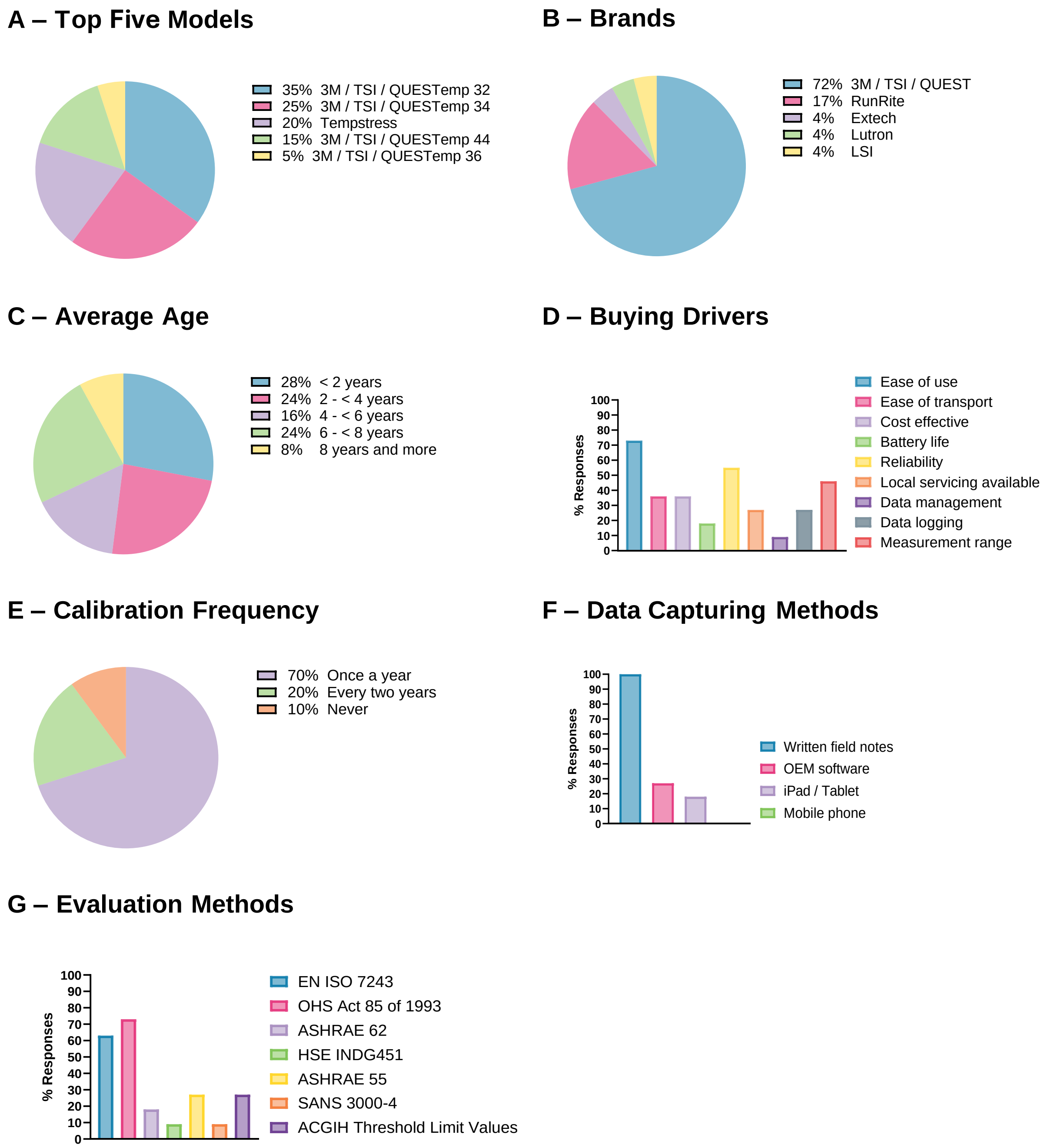

Figure 4: Heat stress equipment profile.

Figure 4(A) refers to three different models in the *QUESTemp* range, with the only difference between them being the absence of data logging capabilities of the *QUESTemp 32*. This may, again, be ascribed to the cost implication associated with data logging features.

These nine monitors were from five different brands, where *3M / TSI / QUEST* represented the most frequently (72%) selected monitors making it the leading brand (Figure 4(B)). The age distribution of heat stress monitors, as summarised in Figure 4 (C), reveals an almost equal reliance on both older and newer technologies. While 52% of the reported monitors are less than two to four years old, 48% are aged four to more than eight years. This balance suggests that AIAs value both the proven durability of older models and the enhanced capabilities of newer ones, reflecting a practical approach to equipment management. The popularity of *3M / TSI / QUESTemp* monitors could be ascribed to their reliability and robust performance. When asked about the most prioritised buying drivers, participants consistently emphasised *ease of use* as the top priority (Figure 4(D)).

One AIA added a special remark on the durability of "older" *Tempstress* models. However, RunRite Electronics, being South Africa's sole manufacturer and distributor of *Tempstress Heat Stress Monitors,* announced that this equipment brand will be discontinued.[23] This may negatively affect AIAs, not only because *Tempstress* was the second most prevalent brand, but since many AIAs relied on the instrument's durability. Further investigation into the buying drivers revealed that *measurement range* ranked among the top three. This is an interesting result, as the measurement range required for heat- and cold-stress monitors is relatively narrow, similar to the range to which the human body is accustomed.

Figure 4(E) indicates that most AIAs (70%) calibrate their monitors on an annual basis. This practice aligns with the high priority placed on ensuring reliable and accurate performance, particularly given the potential consequences of inadequate monitoring in high-risk, thermally challenging environments, such as heat stress and heat exhaustion.[24] In terms of methodologies (Figure 4(F)), AIAs predominantly prefer written paper-based field notes for capturing data over other methods. Furthermore, eight of the 10 AIAs reported using the *OHS Act* 85 of 1993 as their preferred heat stress method. While the *OHS Act,* and more particularly the *Environmental Regulations for Workplaces, 1987,* provide the thermal limits and required evaluation durations, it does not give the measurement specifications.[25] The international standard ISO 7243 on the other hand, gives specifics regarding each parameter that has to be considered as well as measurement specifications.[26]

The equipment profile for heat stress, as discussed in these findings, suggests that educational institutes should encourage student training with the dominant *3M / TSI / QUEST* heat stress monitors, while also encouraging their competency in using unfamiliar monitors. By familiarising students with the most used equipment, institutions can prepare them for practical fieldwork more successfully.

3.2.5 Cold stress

After profiling cold stress equipment, the findings revealed the diverse range of equipment owned by AIAs, with a collective of 35 different equipment types and models reported by the 11 participating AIAs. Figure 5(A) highlights the top five based on their prominence. Given that cold stress evaluations require measurements of both air velocity and dry-bulb temperature, the equipment profile for cold stress evaluations consists of a longer and more diverse equipment list (Annexure A).[5]

Of the 35 equipment types collectively reported, ten models are capable of measuring air velocity, while seven models can simultaneously measure both air velocity and temperature. The widespread use of *Extech Data Loggers* and *TSI VelociCalc 9515* probe anemometers reflects their prevalence in cold stress evaluations. Interestingly, the basic *whirling hygrometer* ranks among the top three most used devices, demonstrating that AIAs still value simpler, cost-effective instruments.

The prominence of *3M / TSI / QUEST* as a leading brand for cold stress is evident in Figure 5(B), where it ranks as the most frequently used brand for air and temperature monitoring. *3M / TSI / QUEST* offers a broad range of reliable and versatile equipment, which likely contributes to its popularity among AIAs. Most cold stress monitors reported are relatively new, with an average age of four to six years, suggesting that AIAs are maintaining a balance between established and newer technologies in their equipment inventory.

As with other equipment profiles in this study, AIAs prioritise *ease of use* (100%) when selecting cold stress monitoring equipment. Figure 5(D), however, shows that additional factors such as *cost-effectiveness*, *reliability*, and *ease of transport* influence purchasing decisions. These considerations highlight the challenges AIAs face in balancing performance, affordability, and operational convenience when managing equipment for cold stress evaluations.

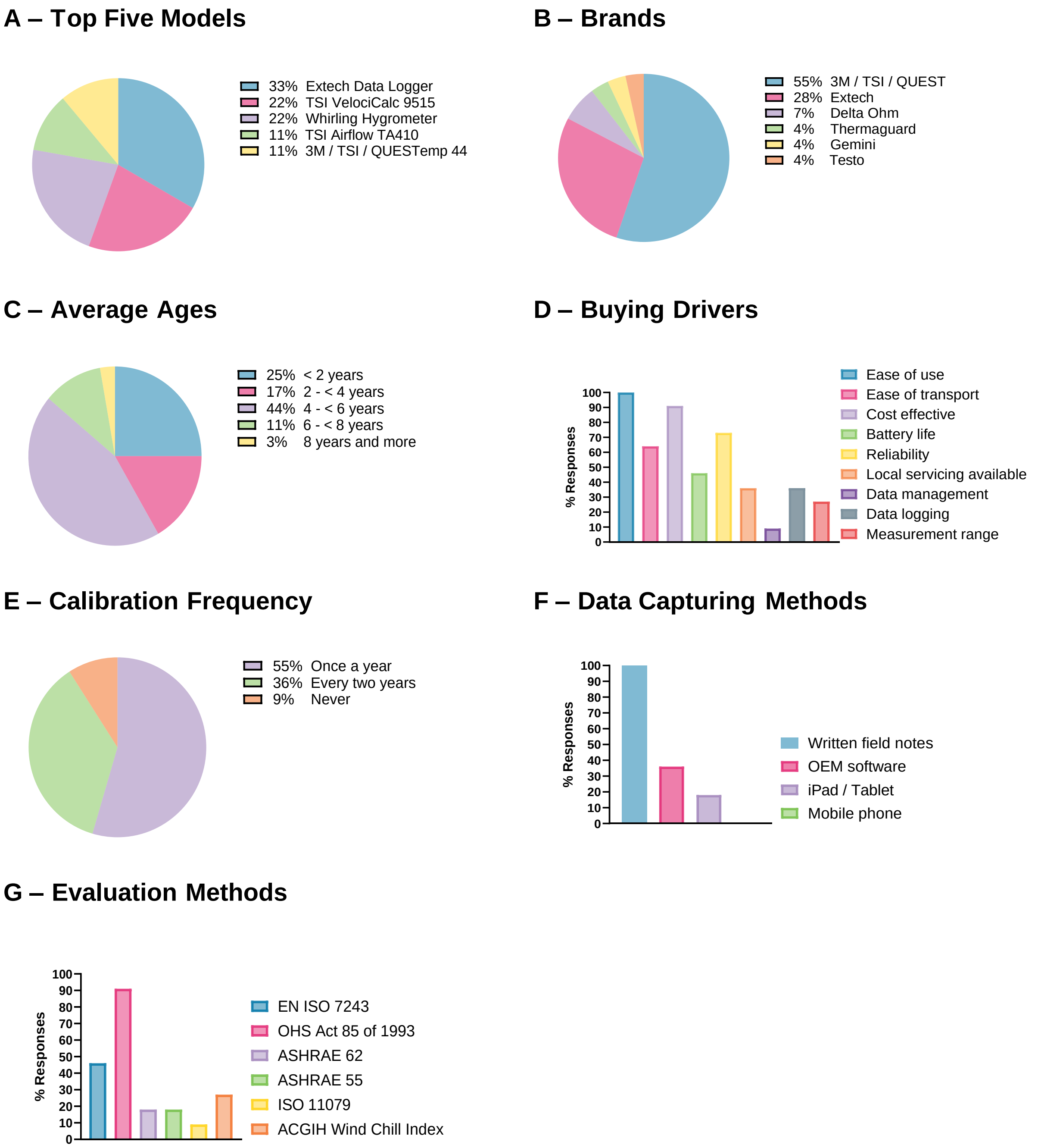

Figure 5: Cold stress equipment profile.

Once promulgated, the *Draft Physical Agent Regulations, 2022*, will require more representative environmental measurements such as the dry-bulb and air velocity to calculate the environmental equivalent wind temperature. The areas highlighted by this study can help educational institutions improve the alignment of their inventory and training programs with industry needs. Having the preferred brands (*3M / TSI / QUEST*), and the popular models (*Extech Data Loggers*) feature in academic training programmes, would ensure an easy transition from learning to working environments.

3.2.6 Illumination

A total of 40 different models and types of lux meters were reported across the 11 participants. Of these, the top five most used lux meters account for 38 units (Figure 6(A)). Notably, eight AIAs reported owning *Goldilux Autoranging* lux meters, which dominate the list, representing 71% of the top five most frequently used models. One AIA, however, did not specify the number of units owned, which may suggest that the prominence of *Goldilux* could be even greater. A total of six brands were identified in the survey, with *Goldilux* emerging as the leading brand (Figure 6(B)). Interestingly, while the *Goldilux Autoranging* lux meter is the most reported device, the *Goldilux LED* lux meter is reported to be less used, suggesting a preference for general-purpose lux meters over specialised models. Alternatively, the lack of LED-specific legislated requirements may hamper the transition to modern lux meters.

Lux meters also stand out for their durability, with 38% of units reported as being over eight years old, marking them as the longest-used equipment among the profiles studied. This long lifespan aligns with the primary buying drivers for illumination equipment, as shown in Figure 6(D), where *cost-effectiveness* and *reliability* rank among the top three considerations. These findings suggest that AIAs prioritise equipment that balances affordability with dependable performance over time.

External calibration practices for lux meters show a high degree of standardisation among AIAs. Ninety-one per cent of participants reported sending their lux meters for external calibration annually, with only one AIA reporting a biennial frequency. The adherence to regular calibration schedules reflects compliance with standard requirements of maintaining the accuracy, validity, and reliability of evaluation equipment.[4,18, 19]

When capturing data during illumination surveys, AIAs overwhelmingly favour written paper-based field notes, as all 11 participants reported using this method (Figure 6(F)). Two AIAs, however, indicated supplementary methods, including iPads/Tablets and OEM software.

As for illumination evaluation methodologies, AIAs rely equally on the *SANS 10114-1 standard* and the *OHS Act* 85 of 1993 (Figure 6(G)). The *Mine Health and Safety Act 29 of 1996* follows as the second most frequently selected illumination method (39%). The dominance of *Goldilux* as a brand and the preference for durable, cost-effective equipment indicate that academic training programmes should include these meters in their training programs.

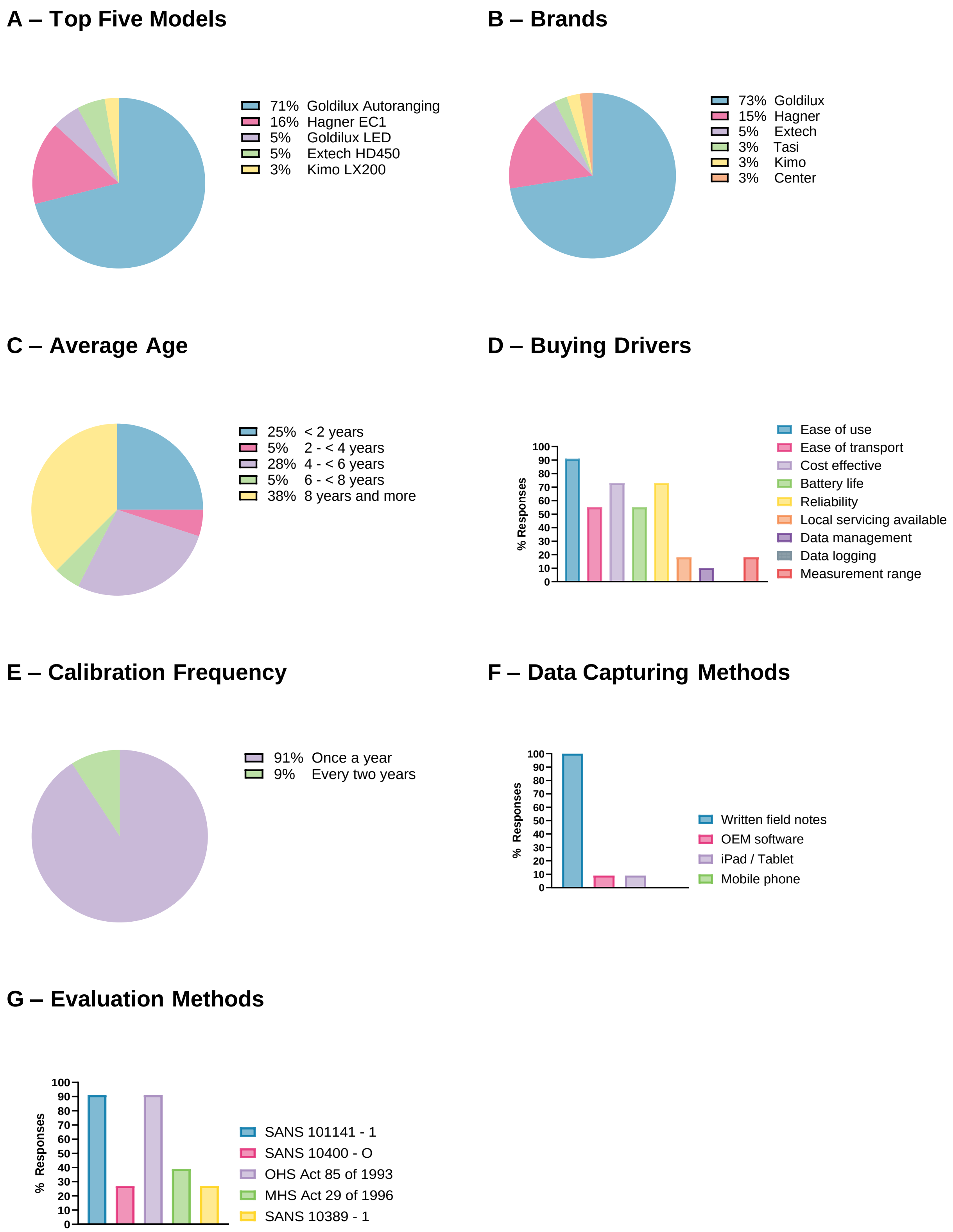

Figure 6: Illumination equipment profile.

3.2.7 Indoor Air Quality

The final equipment profile established in this study focuses on indoor air quality (IAQ) monitors.

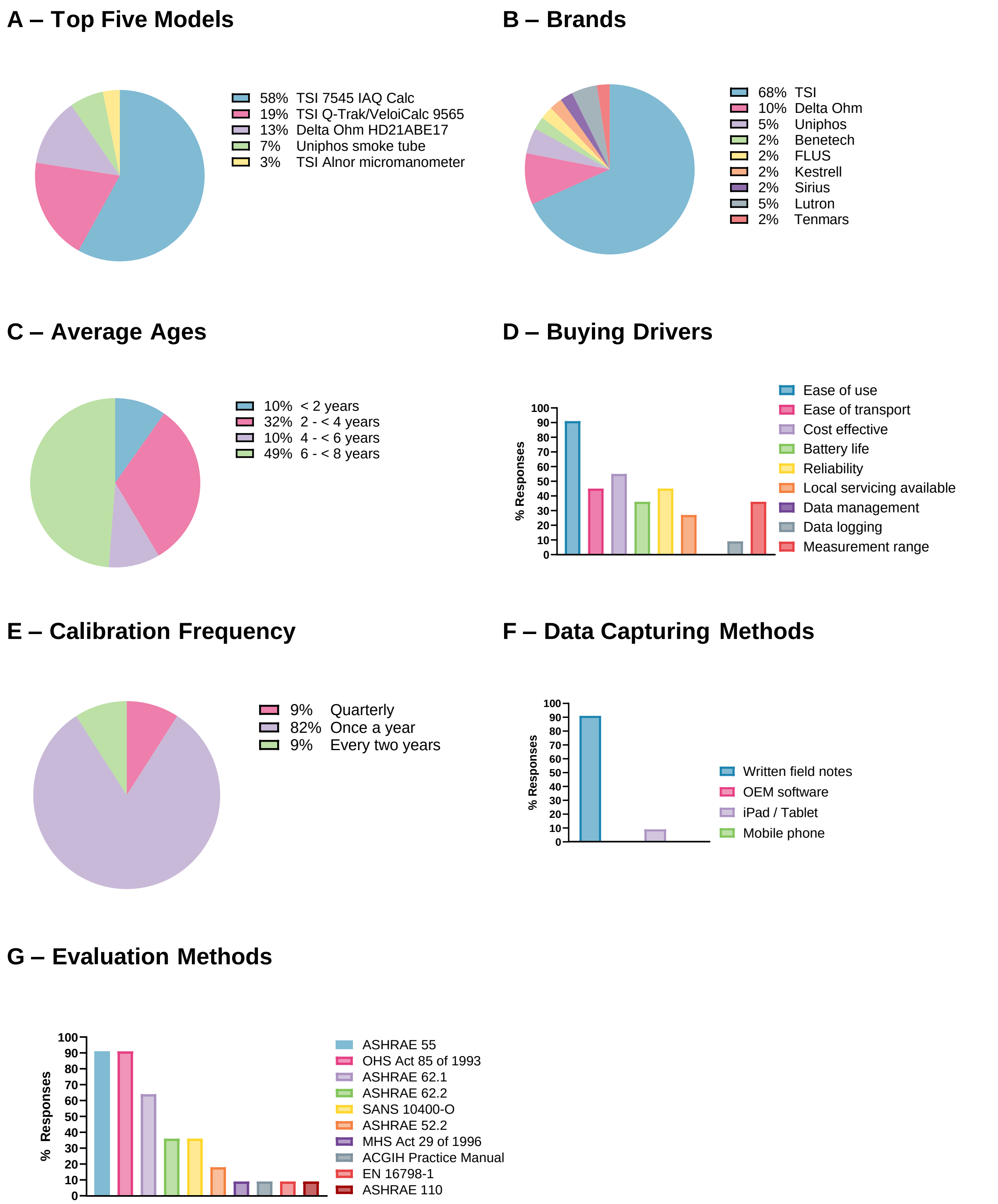

Figure 7: Indoor air quality equipment profile.

IAQ evaluations, like cold stress assessments, require the measurement of multiple parameters, including thermal conditions (air temperature, velocity, and relative humidity) and airborne contaminants such as carbon monoxide (CO) and carbon dioxide (CO_2). These requirements, as outlined in the *Draft Physical Agents Regulations*, 2022, require AIAs to retain a diverse range of equipment to accurately evaluate IAQ.[5]

Ten of the 11 participating AIAs reported performing IAQ evaluations, collectively using 41 different equipment types and models. The TSI *IAQ Calc 7545* is shown as the most used IAQ monitor, representing 58% of the top five monitors reported in Figure 7(A). *TSI* also stood out as the leading brand, accounting for 27 (68%) of all branded units (Figure 7(B)). The *IAQ Calc 7545's* popularity is likely due to its ability to measure multiple parameters — CO, CO_2, temperature, and relative humidity — enabling the three AIAs to evaluate most IAQ parameters, excluding air velocity.[28] Among the three AIAs using this monitor, two AIAs indicated supplementing their IAQ inventory and practices with additional equipment such as the TSI Q-Trak and TSI Alnor for velocity and temperature measurements, as well as another multi-parameter monitor without velocity or pressure capabilities.

Across all 10 AIAs, six different multi-parameter monitors were reported that could measure CO, CO_2, temperature, and relative humidity. Of these, two (the *Delta Ohm* and *TSI Q-Trak/VelociCalc 9565*) also measured atmospheric pressure.

Among the 15 unique IAQ monitors identified (Annexure A), eight could measure air velocity, and three had atmospheric pressure capabilities, reflecting the diversity in equipment functionality required for IAQ assessments.

Figure 7(C) highlights the longstanding importance of IAQ evaluations. Notably, 49% of IAQ monitors were reported to be between six and eight years old, while 42% were less than four years old. This trend of acquiring newer equipment aligns with the increased emphasis that IAQ received during the COVID-19 pandemic.

Measuring indoor CO_2 concentrations became a widely used method during this period. Not only does CO_2 effectively serve as a tracer gas in estimating ventilation rates by indicating how effectively polluted indoor air is being replaced with outdoor air, but it was also found that virus-laden aerosols accumulate similarly to CO_2.[29]

By diluting indoor CO_2 concentrations, the effectiveness of ventilation and, by extension, the level of risk for airborne disease transmission could be determined. This heightened the focus on IAQ evaluation and monitors.[29]

The reported preference for *cost-effectiveness* as the second most important buying driver (55%, Figure 7(D)), and the highest number of AIAs reporting annual calibration frequencies (82%, Figure 7(E)) emphasise the dual pressures AIAs face: balancing budget constraints with the need to maintain equipment accuracy and comply with calibration standards. Interestingly, none of the three AIAs using the comprehensive TSI *IAQ Calc 7545* indicated cost as a buying consideration, which could be an indication that the functionality and reliability of the IAQ monitor outweighed their cost concerns for this model.

To conclude the IAQ equipment profile, evaluation and data-capturing methods were inquired to understand AIAs' preferences regarding traditional versus newer techniques. Figure 7(F) reveals that AIAs predominantly use minimal technology for data-capturing. Ninety-one per cent of AIAs prefer using written paper-based field notes to capture data. While Figure 7(G) shows the variability in the evaluation methods AIAs employ, *ASHRAE 55* (91%) and the *OHS Act* (91%) were the most frequently selected methods. *ASHRAE 55*, referring to *Thermal Environmental Conditions for Human Occupancy*, outlines the methods for assessing IAQ based on the satisfaction and thermal of occupants. While this standard does not directly prescribe IAQ-specific pollutant measurement methods, it still focuses on maintaining optimal thermal environments by reducing the suboptimal conditions that could reduce the quality of IAQ.[30] The *OSH Act* 85 of 1993, on the other hand, does not currently have regulations for the maintenance of IAQ itself, but rather different regulations for thermal conditions, and air pollutants.

However, the *Draft Physical Agents Regulation, 2022,* may provide a better guidance, once promulgated, since the required parameters to be measured are stipulated and it also requires ventilation systems to meet SANS 10400-O.[1,5] The range of methods reported, however, indicates the need for educational institutions to ensure that students are more versatile and can implement both predominantly used, as well as less popular evaluation methods. Furthermore, educational institutions should train students how to interpret measurements taken with multi-parameter monitors like the *TSI VelociCalc*, since the data of this study shows that they may be required to use it in practice.

3.3 Occupational Hygiene Industry Insights and Trends

The results presented here provide valuable insights into the registration levels of OHPs employed by the AIAs, the in-house laboratories they operate, the industry sectors they service, their preferred equipment suppliers, and the buying drivers ranked by priority.

These results contribute to a deeper understanding of the operational landscape of AIAs and offer practical insights to equipment suppliers, allowing them to match the unique requirements and priorities of AIAs with their stock presentations.

Figure 8 shows the number of OHPs employed by the AIAs and the level of certification and registration.

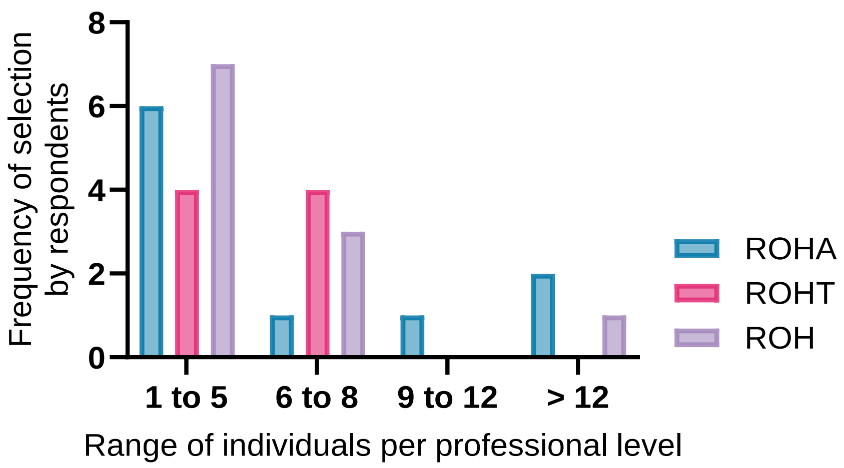

Figure 8: Frequency of selected ranges per OHP level.

In answering the question regarding the number of staff employed by an AIA, all eleven reported having OHPs at hygienist level. Only eight AIAs have OHPs at technologist level, and 10 have OHPs at assistant level. AIAs reported having fewer OHPs at technologist level than any of the other levels. Most AIAs have between one to five assistants, with the same range also reported the most frequently for hygienist-level OHPs. The notably lower number of technologists compared to assistants highlights a promising opportunity for career progress, that will enable assistants to advance to technologist roles. Administrative and laboratory staff are reported separately in Figure 9. Of the eleven AIAs, four reported having at least two laboratory staff members. Two AIAs were reported to have no less than at least five laboratory staff.

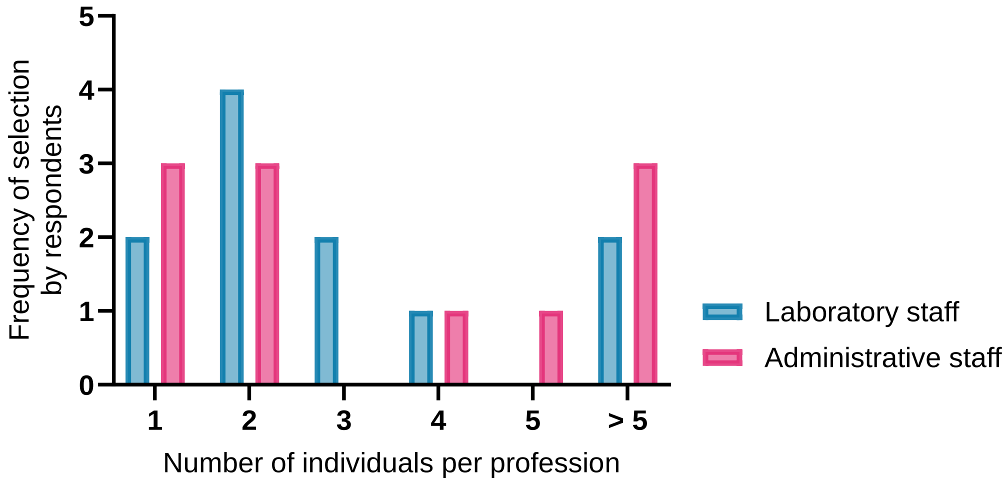

Figure 9: Frequency of selected number of support staff.

An analysis of support staff among the 11 responding AIAs revealed variations in both laboratory and administrative personnel. One AIA, despite not having an in-house laboratory, reported employing a laboratory staff member. Most AIAs had at least two laboratory personnel. Additionally, administrative staffing levels varied, though all 11 AIAs reported having administrative support staff.

Figure 10 illustrates the number of AIAs offering in-house analytical services and the type of analyses they provide.

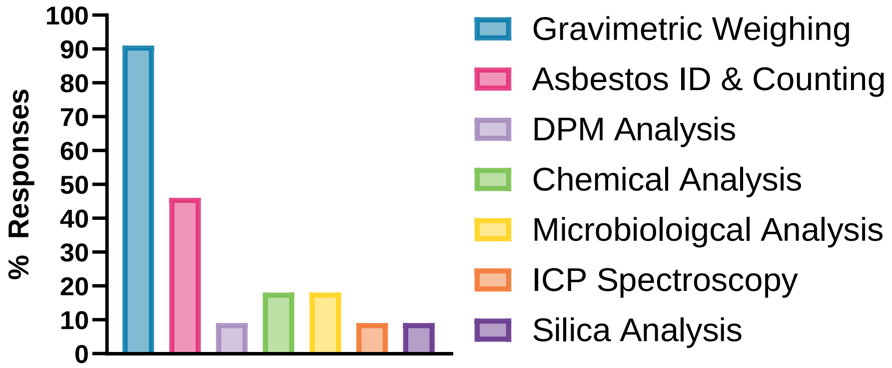

Figure 10: The number and types of analytical services offered by AIAs

Investigating the different analytical services AIAs provide, 10 out of the 11 participating AIAs reported having in-house laboratories. Figure 10 highlights gravimetrical weighing (91%) as the most common service AIAs provide. Other services AIAs perform include asbestos identification and fibre counting (46%), as well as chemical (18%) and microbiological analyses (18%).

When asked, "Who performs your gravimetric sample weighing?" the following responses were recorded: One AIA reported outsourcing the analysis, while the majority (7) indicated having their laboratory technicians weigh their samples. Of these seven AIAs, three also delegate this responsibility to their assistants, with one AIA involving technologists.

Figure 11 categorises the industries serviced by AIAs into five sectors: Primary, for example, mining and forestry, and manufacturing or industrial, public and social, corporate and commercial entities, and finally the transportation and logistics sector. While this study focused on AIAs that evaluate workplaces regulated by the OHS Act and its regulations, some AIAs may also service the mining industry, and those measurements will then adhere to the MHS Act. The figure shows the industries to which participating AIAs provide services, reflecting the frequency of selected sectors and industry overlapping among AIAs.

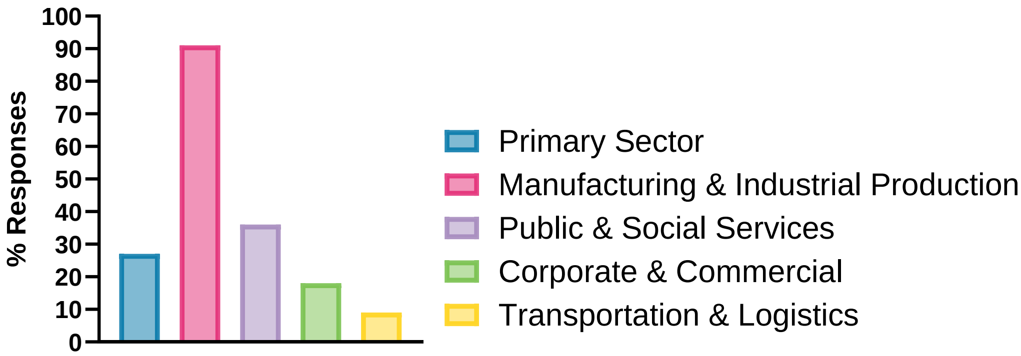

Figure 11: The industries serviced by AIAs.

Industries were categorised into the following sectors: the primary sector includes mining — although mines may have their own OHPs and are regulated by the MHS Act, they may also outsource services to AIAs — and forestry industries. The manufacturing and industrial production sector covers metal and steel work, food, textile, machinery, automotive, chemical, and fertilizer manufacturing. The public and social sector encompasses educational institutions, medical institutions, and government organisations. The corporate and commercial sector includes trade centres, trade and commerce, and corporate branches. Finally, the transportation and logistics sectors include both rail and sea transport industries.

The manufacturing and industrial production sectors cover a wide range of industries, and it is not surprising that most AIAs work in this sector. Of all 11 AIAs, only one AIA reported not working within the manufacturing sector. Four AIAs reported working in the public and social sector, three in the primary sector, with only one working in forestry specifically. Additionally, two AIAs reported working in the corporate sector, and one in transportation and logistics.

Figure 12 highlights the most popular equipment suppliers. All participating AIAs reported using Envirocon Instrumentation (100%). The second and third most popular suppliers mentioned are AMS Haden (46%) and SKC Inc. South Africa (64%), respectively.

Other frequently used suppliers include RunRite Electronics (46%), and TSI (18%). One AIA specifically reported using Technology Solutions as their preferred supplier for lux meters.

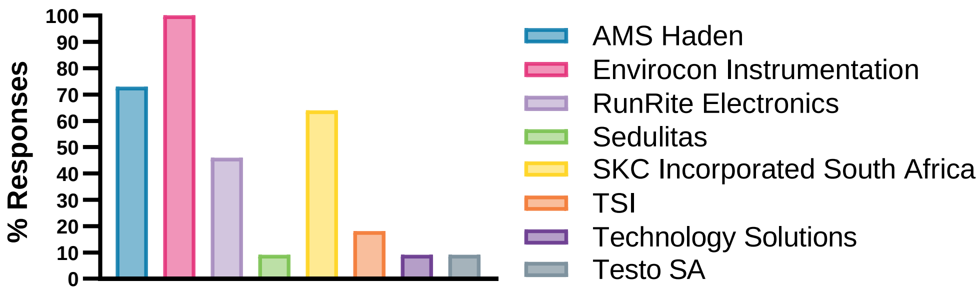

Figure 12: The most in demand equipment suppliers.

Figure 13 presents the overall ranking of key buying drivers, showing how many AIAs ranked each driver by importance irrespective of the type of instrument in question. While the key buying drivers of the specific hazard-categorised equipment types are displayed in Figure 1–7, Figure 13 highlights the importance of each driver to AIAs. To emphasise which factors are highly prioritised, and which are prioritised to a lesser extent, AIAs were required to rank these buying drivers from 1^{st} (most important) to 5^{th} (least important). These findings provide insights to both the industry and the equipment suppliers.

Reliability was ranked most frequently as the most important factor, followed by affordability. The second most important factor, based on the number of AIAs selecting it as their second choice, was durability and the availability of national servicing and calibration (each factor was selected by three AIAs). Battery life, availability of the instrument, and costs were equally third being selected by three AIAs each. Features were selected as the fourth most important factor by the AIAs with ease of access to the supplier in fifth place.

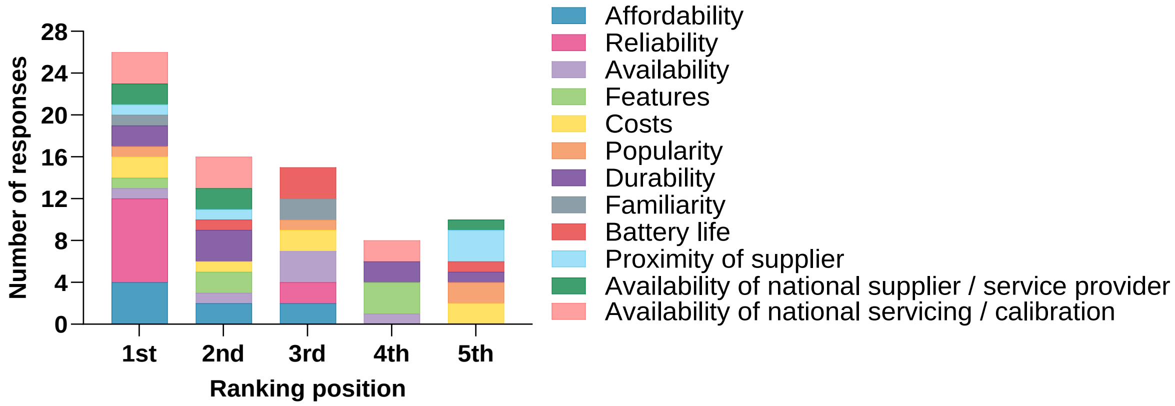

Figure 13: Ranking distribution of buying drivers among 11 AIAs.

3.4 Conclusion

The findings presented in this chapter offer a comprehensive overview of the equipment profiles, calibration practices, and evaluation methodologies employed by selected South African AIAs for assessing various occupational and environmental hazards. A consistent preference for user-friendly, reliable, and cost-effective equipment across different hazards highlights the importance of practical functionality in practice. The limited adoption of advanced data-capturing methods highlights areas for improvement, particularly providing AIAs with more useful information to enhance accuracy and operational efficiency.

The results from this project have created an equipment profile, and more importantly, an extensive list of the different brands and models of instruments used in industry. Tertiary institutions can and should use this list to expand their equipment profile to ensure that students are trained on different brands and models of instruments, to ensure that they have the necessary skills and competence to make a successful transition to the workplace. Training should include both modern and traditional techniques to ensure students are versatile. Additionally, training students with older equipment as well as with technologically advanced models could ensure accurate measurement results. Lastly, examining diverse methodological standards could improve their proficiency and deepen their understanding of hazard assessments.

This study has several limitations which are common in research. First, it relied on a questionnaire-based approach to collect self-reported data from AIAs, which can introduce biases such as over-reporting or under-reporting on specific practices or equipment. These biases may impact the accuracy of the equipment profile generated.

Additionally, the questionnaire platform lacked a drop-down option, resulting in follow-up questions that may have created uncertainty and required cross-referencing or averaging responses to obtain consistent data.

The low participation rate of AIAs could have been due to their perception that the benefit of participating did not outweigh the required time and effort. However, even when incentives were offered to encourage involvement, many AIAs still did not respond. The limited participation of AIAs is therefore more likely to stem from the limited time available to OHPs and not so much as to the perceived benefit of a study like this. Finally, the potential for ambiguous wording in some questions may have led to varying interpretations by participants, further affecting data accuracy.

The findings presented under the heading of occupational hygiene industry insights and trends, while not strictly part of the instrumentation profile, still provide valuable information regarding the staffing, service presentations, industry focus, and procurement preferences of AIAs. These findings not only contribute to academic understanding but also provide actionable insights for industry stakeholders, including equipment suppliers and policymakers.

Key Messages

1. While developing an equipment profile of AIAs highlights the variety of equipment options and different manufacturers, it emphasises a need for guidance to support AIAs in selecting fit-for-purpose equipment. This could help AIAs with their decisions when buying new equipment.
2. To prepare students for the evolving industry, it is important to integrate both modern and dated equipment into educational curricula. Similarly, students should be exposed not only to popular equipment, but also to less familiar equipment. Exposing students to a broad range of equipment and methods during training will ensure a smooth transition into the workplace.
3. Despite the low response rate, this study provides important and valuable insight into occupational hygiene practices and the prevalent equipment used. Future studies may, however, be beneficial and with more support from AIAs, they could offer better representation and more comprehensive data.

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CHAPTER 4 CONCLUDING CHAPTER.

This chapter includes the main findings of the study and recommendations for AIAs and educational institutions. Furthermore, the limitations of the study and recommendations for future studies are discussed. Additionally, this chapter reviews the aims and objectives as outlined in Chapter 1 and finally answers the research question.

4.1 Main Findings

This study aimed to create an equipment profile of South African occupational hygiene Approved Inspection Authorities (AIAs). The equipment profile was not intended to set rules or verify the practices of AIAs, its objectives were to identify the equipment types and models used in practice and to create a profile that represents their prevalence. Both AIAs and educational institutions can benefit from this equipment profile by using the findings as a guide during decision-making. It could also serve as a point of reference for updating equipment inventories.

To determine what equipment types and models AIAs prefer, as well as why, AIAs were requested to complete a questionnaire. The questionnaire focused on the equipment types and models, the number of units owned, the average age of equipment, calibration frequencies, as well as the methods used to evaluate hazards and lastly, methods used for data-capturing. These questions were organised across seven sections, with each section categorised by a particular hazard and focused exclusively on hazards such as air contaminants, area- and personal noise, heat and cold stress, illumination as well as indoor air quality (IAQ).

Because this study adopted a mixed-methods research approach with a sequential explanatory design, the prevalence of specific equipment types could be presented as the percentage of all equipment reported to be in use at that time. This percentage represented the selection frequency, which is the number of AIAs who selected the specific instrument, and the minimum number of units collectively owned by the participating AIAs. The study design, therefore, supported the use of quantitative values in assisting the interpretation of qualitative data (Creswell, 2009:70).

Some hazards are influenced by multiple parameters and require their evaluation as well. For example, to accurately evaluate IAQ, the AIA should assess the thermal conditions such as air temperature, air velocity, and relative humidity as well as airborne contaminants such as carbon monoxide (CO) and carbon dioxide (CO_2) (Department of Employment and Labour, 2022:13).

These multiple-variable hazards require AIAs to use different types of equipment simultaneously, each type designed to measure at least one of the contributing parameters. Evidently, these hazards have a vast list of instruments of which only the five most frequently selected were graphed. However, all the instruments reported are, listed in a table in Annexure A.

The first equipment profile created (Chapter 3, Figure 1) focussed on air contaminants. This profile revealed the two leading brands concerning sampling pumps, *Gilian GilAir* and *Casella with the Gilian GilAir-3* representing the most prevalent model.

Figures 2 and 3 of Chapter 3 highlight *Casella* as the predominant brand for sound level meters (SLMs), and noise dosimeters (NDs). The *Svantek SV 971* was, however, the most popular SLM model. In comparison to SLMs, noise dosimeters (NDs) were relatively newer, probably due to NDs being replaced more regularly due to wear and tear during personal noise dosimetry. This distribution highlights the dependency on more accurate measurements for personal noise exposure than for area noise evaluations.

3M / TSI / QUEST featured as the predominant brand in the heat stress, cold stress, and IAQ equipment profiles respectively. This makes *3M / TSI / QUEST* the leading brand for temperature and IAQ instruments. Chapter 3, Figure 7 highlights the impact of COVID-19 on the occupational hygiene industry, showing that the second most reported age range for IAQ monitors was between two and four years.

This trend suggests that AIAs were prompted to conduct more IAQ evaluations due to the increased emphasis on maintaining properly functioning ventilation systems as a critical measure for mitigating infection risks (Rodrigues *et al.,* 2022:226).

Of all the equipment profiles, the profile for illumination equipment had the highest number of equipment units that were more than eight years old, making it the oldest equipment type. While *Goldilux* featured as the most prevalent lux meter manufacturer, there are many other equipment brands to choose from.

AIAs were asked to identify their top buying drivers — factors influencing equipment purchasing decisions — to understand why certain brands or models are more commonly used. These findings also highlight industry needs, areas for improvement, and equipment shortcomings, offering suppliers opportunities for competitive advantage.

Overall, AIAs indicated their equipment purchasing decisions to be based upon practicality, reliability and costs. AIAs also prioritised the accuracy, validity and reliability of their equipment through regular external calibrations (SANS, 2021:4).

The importance of aligning educational curricula with industry practices has been underscored by the evaluation and data-capturing methods AIAs employ. While most AIAs use older data-capturing techniques, the gap between a technologically advancing industry and the lack of adopting newer technologies to capture data is something educational institutions can bridge. By equipping students with the necessary technical skills required for the evolving needs of the occupational hygiene industry, while also familiarising them with older techniques and equipment, the future of occupational hygiene practices and the adherence to national health and safety legislation can be strengthened. This ultimately ensures that AIAs could assist employers more effectively in providing safe working environments and protecting their employees from harm, thereby fulfilling the legal obligations of both the AIA and employer (*Occupational Health and Safety Act* 85 of 1993:12).

4.2 Recommendations

It is recommended that AIAs and educational institutions use the information from this study to evaluate their inventories against the most prevalent equipment owned by participating AIAs. AIAs could also use this profile to investigate equipment types, brands, and evaluation methods previously unfamiliar to them. Adopting newly standardised techniques and methods for hazard assessments could be the driving force for innovations and advancement in the field (Pääkkönen & Koponen, 2017:161). It is also recommended that AIAs use this profile to acknowledge the shifting workforce dynamics, evolving job roles, and advancing technologies, thereby ensuring the professionalisation of occupational hygiene practice (National Academies of Sciences, Engineering, and Medicine, 2018:13).

Educational institutions can use this equipment profile to update their inventories so that it includes both predominant and less favoured equipment types and models since it is equally essential to continuously enhance expertise and to anticipate future workplace trends (Pääkkönen & Koponen, 2017:162). Training curricula should undergo ongoing evaluation and updating based on industry feedback and emerging trends since it is essential to maintain the relevance and effectiveness of educational programmes in preparing graduates for careers in occupational hygiene (Khadim *et al.,* 2022:3).

Interdisciplinary collaboration among educators, policymakers, and industry stakeholders could prioritise curriculum development and evaluation (Khadim *et al.,* 2022:3). This could be done by establishing an advisory board comprising industry leaders who can advise institutions of industry-need to enhance educational programmes (University of Minnesota, 2024). Furthermore, it would be beneficial for students to learn how to operate and download information from the OEM software and how to use the software when reporting results.

Lastly, Kiran *et al.* (2019:1) stress the importance for national Occupational Health and Hygiene professionals to establish uniform service provisions by implementing general definitions, approaches, and standards, ensuring the professionalisation of occupational hygiene practice. It is recommended that industry professionals collaborate with policymakers since, as emphasised by Newman (2023:147), interdisciplinary cooperation can foster creativity, innovation, and unconventional thinking, especially in addressing real-world policy issues (Huutoniemi, 2016:164).

4.3 Limitations

The limitations of this study, which will be discussed separately, include: the exclusion of certain industries; limited scope of hazards; self-reported data; limited questionnaire functionalities, and low participation.

Because this study only recruited registered occupational hygienists from DoEL-regulated Type A AIAs, the occupational hygiene professionals (OHPs) and practices that fall under Type B AIAs and those regulated by the *Mine Health and Safety Act* 29 of 1996, although some AIAs service mines, were excluded. These criteria were implemented to ensure that the results obtained focused on Type A AIAs who render services as part of a primary commercial undertaking. Examining the operational distinctions between these various organisations might have yielded additional information and improved involvement since more OHPs could have taken part. The scope of this study was limited to the basic hazards addressed by the DoEL in their Brochure, *Requirements for approval as an approved inspection authority* (Department of Labour, 2012:12). Only hazards such as air contaminants, noise, thermal extremes, illumination, and IAQ were included, while hazards such as ionising- and non-ionising radiation, and vibration were excluded. Investigating other hazards could have presented better insights into the number of AIAs evaluating “specialised hazards” (Department of Labour, 2012:12).

The study relied on self-reported data. Self-reported data can often be subject to biases such as over-reporting, or under-reporting certain information. This, in turn, could affect the accuracy of the study's findings.

The accuracy of these findings is also affected by the limited functionalities of Google Forms. Google Forms does not have sub-optional drop-down functionalities. Therefore, AIAs were not allowed the opportunity to select the information of applicable quantities or ranges on individual instruments. Since AIAs could not provide specific information on every instrument owned, data sets had to be cross-referenced and or averaged.

Lastly, one of the biggest limitations of this study was the low number of participating AIAs. Even though more than eleven AIAs have shown interest in participating — indicated by their declarations of informed consent — very few could find the time to complete the questionnaires. Precautionary measures were implemented, for instance, all the questions were multiple-choice questions which only required to be clicked and selected. To reward participants for their time, they were awarded incentives after the successful submission of a questionnaire. However, the extensive efforts did not outweigh the time constraints AIAs face.

These results, therefore, only reflect the prevalence within the practices of the respondents. Although the participation rate may have influenced the representativeness of this study's findings for national AIAs, it has still provided valuable and important insights.

4.4 Future Studies

One promising area for future studies is the exploration of emerging technologies, such as real-time sensor-based tools. By comparing how modern equipment performs against older equipment, the results of such a study could provide the occupational hygiene industry with great insights into improving the accuracy, cost-effectiveness, and efficiency of their practices.

Longitudinal studies could track the lifespan of occupational hygiene equipment. These findings would benefit AIAs by providing them with the necessary information regarding their equipment calibration frequencies, as well as the accuracy, validity, and reliability of their equipment.

Replicating this study but shifting its focus to Type B, or C AIAs as well as occupational hygiene in mining practices could allow future studies to provide valuable insights into hygiene activities within different regulatory frameworks. Lastly, future studies could also investigate how well the curricula of educational institutions align with industry needs. These studies could survey recent graduates, employers, and academic personnel to identify the gaps in training and propose curriculum updates that will prepare students for real-world challenges.

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ANNEXURES A: EQUIPMENT TABLE

Table 4: Sum of the range minimum of reported equipment models.

Air pumps	Min	Sound Level Meters	Min	Noise Dosimeters	Min
Gilian Gilair-3	236	Svantek SV 971	9	Casella dBage 2	60
Gilian Gilair Plus	30	3M / Quest 1200	7	Casella Cel 350 IS	59
Gilian Gilair-5	27	Casella Cel-240	7	Svantek SV104 IS	3
Casella Apex 2 Pro	17	Casella 62 X	5	Landtek SL- 1256DOS	1
Casella Apex 2 Standard IS	11	Quest Sound Pro RTA	2	Quest Noise Pro DLX	1
Casella Tuff	6	Rion N-32	2		
		3M / Quest 1900	2		
		Rion NL-52	1		
		Rion NL-14	1		
		Cirrus CR 171B	1		
Heat Stress Monitors	**Min**	**Indoor Air Quality**	**Min**	**Cold stress Monitors**	**Min**
3M / TSI Questemp 32	7	TSI 7545 IAQ Calc	18	Extech Temperature Data Logger	6
3M / TSI Questemp 34	5	TSI Q-trak VeloiCalc 9565	6	TSI Veloci-Calc 9515	4
Tempstress	4	Delta Ohm HD	4	Whirling Hygrometer	4
3M / TSI Questemp 44	3	Uniphos smoke tube	2	TSI Airflow TA410	2
3M / TSI Questemp 36	1	TSI Micromanometer	1	3M / TSI Questemp 44	2
LSI	1	Benetech Hot Wire	1	3M / TSI Questemp 34	2
Lutron	1	Flush Hot Wire	1	Delta Ohm HD21ABE17	2
Extech HT30	1	Kestrell Vane Anemometer	1	Extech SDL 350	2
3M / TSI Questemp 15	1	Lutron AQ-9901SD	1	TSI Alnor 501	1
Illumination	**Min**	Sirius Data Logger ST-501	1	3M / TSI Questemp 32	1
Goldilux Autoranging	27	Tenmars TM380	1	Thermaguard 101	1
Hagner EC1	6	TSI Veloci-Calc 9515	1	TSI Airflow TA430	1
Goldilux LED Lux Meter	2	TSI Alnor AM410	1	TinyTag Ultra 2	1
Extech HD450	2	TSI Alnor CF930	1	TSI Alnor CF930	1
Kimo LX200	1	Lutron Hot Wire	1	TSI IAQ-Calc 7545	1
Center 531 LED Lux Meter	1			TSI Airflow LCA 501	1
Tasi TA632	1			Testo 405-V1	1
				Dry-bulb thermometer	2

Note: The questionnaire was designed to allow AIAs to report their equipment numbers in ranges, providing greater anonymity and simplifying the reporting process. As a result, the figures in the Annexure represent the sum of the minimum values of the ranges selected by the AIAs who reported owning each equipment type.

ANNEXURES B: LANGUAGE CERTIFICATE

WOORDE WAT WERK
WORKING WORDS

Venita de Kock
BA HONS. • PEG
084 588 5008
venita.dekock@gmail.com

5 December 2024

LANGUAGE EDITING STATEMENT

I, Jannetje Levina De Kock hereby declare that the thesis

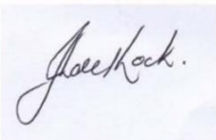
Equipment Profile of South African Occupational Hygiene Approved Inspection Authorities

By Ansulè Engelbrecht

Student Number: 30386187
for submission to the OHHI, NWU.

- has been edited for language correctness and spelling.
- has been edited for consistency (repetition, long sentences, logical flow)

No changes have been made to the document's substance and structure (nature of academic content and argument in the discipline, chapter and section structure and headings, order and balance of content, referencing style and quality).



J L DE KOCK

ANNEXURES C: ETHICS APPROVAL LETTER

Private Bag X1290, Potchefstroom
South Africa 2520

Tel: 086 016 9698
Web: http://www.nwu.ac.za/

North-West University Health Research Ethics Committee (NWU-HREC)

Tel: 018 299-1206
Email: Ethics-HRECApply@nwu.ac.za (for human studies)

27 November 2022

ETHICS APPROVAL LETTER OF STUDY

Based on approval by the North-West University Health Research Ethics Committee (NWU-HREC) on 27/11/2022, the NWU-HREC hereby approves your study as indicated below. This implies that the NWU-HREC grants its permission that, provided the general conditions specified below are met and pending any other authorisation that may be necessary, the study may be initiated, using the ethics number below.

Study title: Equipment profile of South African Occupational Hygiene Approved Inspection Authorities
Principal Investigator/Study Supervisor/Researcher: Mr CJ van der Merwe
Student: A Engelbrecht - 30386187

Ethics number:

N	W	U	-	0	0	1	1	9	-	2	2	-	A	1
Institution				Study Number						Year			Status	

Status: S = Submission; R = Re-Submission; P = Provisional Authorisation; A = Authorisation

Application Type: Single study
Commencement date: 27/11/2022
Expiry date: 30/11/2023

Risk: Minimal

Approval of the study is provided for a year, after which continuation of the study is dependent on receipt and review of an annual monitoring report and the concomitant issuing of a letter of continuation. A monitoring report is due at the end of November annually until completion of the study.

General conditions:

While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, the following general terms and conditions will apply:

- *The principal investigator/study supervisor/researcher must report in the prescribed format to the NWU-HREC:*
  - *Annually on the monitoring of the study, whereby a letter of continuation will be provided annually, and upon completion of the study; and*
  - *without any delay in case of any adverse event or incident (or any matter that interrupts sound ethical principles) during the course of the study.*
- *The approval applies strictly to the proposal as stipulated in the application form. Should any amendments to the proposal be deemed necessary during the course of the study, the principal investigator/study supervisor/researcher must apply for approval of these amendments at the NWU-HREC, prior to implementation. Should there be any deviations from the study proposal without the necessary approval of such amendments, the ethics approval is immediately and automatically forfeited.*
- *Annually a number of studies may be randomly selected for active monitoring.*
- *The date of approval indicates the first date that the study may be started.*
- *In the interest of ethical responsibility, the NWU-HREC reserves the right to:*

- *request access to any information or data at any time during the course or after completion of the study;*
- *to ask further questions, seek additional information, require further modification or monitor the conduct of your research or the informed consent process;*
- *withdraw or postpone approval if:*
  - *any unethical principles or practices of the study are revealed or suspected;*
  - *it becomes apparent that any relevant information was withheld from the NWU-HREC or that information has been false or misrepresented;*
  - *submission of the annual monitoring report, the required amendments, or reporting of adverse events or incidents was not done in a timely manner and accurately; and/or*
  - *new institutional rules, national legislation or international conventions deem it necessary.*
- *NWU-HREC can be contacted for further information via Ethics-HRECApply@nwu.ac.za or 018 299 1206*

Special conditions of the research approval due to the COVID-19 pandemic:

Please note: Due to the nature of the study i.e. (online collection of quantitative data from Approved Inspection Authorities (AIAs) using an electronic questionnaire), this study will be able to proceed during the current alert level, following receipt of the approval letter. No additional COVID-19 restrictions have been placed on the study except that the researcher must ensure that before proceeding with the study that all research team members have reviewed the North-West University COVID-19 Occupational Health and Safety Standard Operating Procedure.

The NWU-HREC would like to remain at your service and wishes you well with your study. Please do not hesitate to contact the NWU-HREC for any further enquiries or requests for assistance.

Yours sincerely,

Digitally signed by Prof Petra Bester
Date: 2022.11.28 09:01:39 +02'00'

Chairperson NWU-HREC

Current details:(23239522) G:\My Drive\9. Research and Postgraduate Education\9.1.5.4 Templates\9.1.5.4.2_NWU-HREC_EAL.docm
20 August 2019
File Reference: 9.1.5.4.2

ANNEXURES D: PLAGIARISM REPORT

12835439:Ch_1_and_2_for_TII.pdf

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7	Zakari Mustapha, Clinton Aigbavboa, Wellington Thwala. "Contractor Health and Safety Compliance for Small to Medium-Sized Construction Companies", Routledge, 2017 Publication	<1%

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9	Zakari Mustapha, Clinton Aigbavboa, Wellington Thwala. "Contractor Health and	<1%

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★ www.ncbi.nlm.nih.gov

Internet Source

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ANNEXURES E: QUESTIONNAIRE

Creating an Equipment profile of South African Occupational Hygiene Approved Inspection Authorities

Introduction:

This study aims to create a detailed equipment profile of the evaluation equipment currently used by South African AIAs within the Occupational Health and Hygiene industry. The equipment profile can then be used by national AIAs to benchmark their equipment profile against the average range of equipment currently used in the industry. Furthermore, this profile can be used by educational institutions to expand their range of equipment and ensure adequate training with the appropriate equipment, thereby enhancing the skills and employability of their graduates.

The equipment that will be focused on are the equipment required to evaluate the basic hazards in terms of Annexure 1 of the Requirements for approval as an Approved Inspection Authority: Occupational Health and Hygiene as published by The Department of Labour (2012:12). Hazards included in this study are airborne contaminants, noise, heat stress, cold stress, illumination, and ventilation. This study will therefore only focus on establishing what equipment AIAs use to evaluate these basic hazards.

The objectives are:

1. To establish what equipment South African AIAs currently use by requesting South African AIAs to complete a questionnaire regarding the current equipment used by them.
2. To create an equipment profile based on the data gathered by the questionnaire answers.

Research Information:
Research project title: Equipment profile of South African Occupational Hygiene Approved Inspection Authorities.
Ethics number: NWU-00119-22-A1

Researcher:

Name: Ansulè Engelbrecht

Student number: 30386187

Email address: eansule@gmail.com

Contact number: 066 264 6492

Supervisor:

Name: Mr Corné Van Der Merwe

Email address: corne.vandermerwe@nwu.ac.za

Contact number: 082 855 6006

HREC contact person:

Name: Ms Carolien van Zyl

Email address: carolien.vanzyl@nwu.ac.za

Contact number: 018 299 1206

Air contaminants Sampling equipment

* Indicates required question

1. **Which AIR CONTAMINANT SAMPLING PUMPS do you use? Please chooses the most relevant answer/s.**
You may choose more than one option.
Check all that apply.

☐ GILIAN GILAIR-3 PERSONAL SAMPLING PUMPS

☐ GILIAN GILAIR-5 PERSONAL AIR SAMPLING PUMP

☐ GILIAN GILAIR PLUS SAMPLING PUMP

☐ TSI SIDEPAK AM520

☐ TSI SIDEPAK AM520i

☐ SKC AIRCHECK 52 SAMPLE PUMP

☐ SKC AIRCHECK CONNECT

☐ SKC AIRCHECK ESSENTIAL

☐ SKC AIRCHECK TOUCH

☐ SKC AIRCHECK XR5000

☐ SKC AIRLITE SAMPLING PUMP

☐ SKC GRAB AIR BAG SAMPLE PUMP

☐ SKC POCKET PUMP TOUCH

☐ SKC UNIVERSAL 44 XR

☐ SKC PCXR4

☐ SKC UNIVERSAL PCXR8

☐ Prefer not to answer

☐ Other: ____________

2. **If you use other air sampling pumps, please specify.**

____

____

____

____

____

3. **How many of each pump do you have ?**
Check all that apply.

	1 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	>30	Not applicable
GILIAN GILAIR-3 PERSONAL SAMPLING PUMPS	☐	☐	☐	☐	☐	☐	☐	☐
GILIAN GILAIR-5 PERSONAL AIR SAMPLING PUMP	☐	☐	☐	☐	☐	☐	☐	☐
GILIAN GILAIR PLUS SAMPLING PUMP	☐	☐	☐	☐	☐	☐	☐	☐
TSI SIDEPAK AM520	☐	☐	☐	☐	☐	☐	☐	☐
TSI SIDEPAK AM520i	☐	☐	☐	☐	☐	☐	☐	☐
SKC AIRCHECK 52 SAMPLE PUMP	☐	☐	☐	☐	☐	☐	☐	☐
SKC AIRCHECK CONNECT	☐	☐	☐	☐	☐	☐	☐	☐
SKC AIRCHECK ESSENTIAL	☐	☐	☐	☐	☐	☐	☐	☐
SKC AIRCHECK TOUCH	☐	☐	☐	☐	☐	☐	☐	☐

	1 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	> 30	Not applicable
SKC AIRCHECK XR5000	☐	☐	☐	☐	☐	☐	☐	☐
SKC AIRLITE SAMPLING PUMP	☐	☐	☐	☐	☐	☐	☐	☐
SKC GRAB AIR BAG SAMPLE PUMP	☐	☐	☐	☐	☐	☐	☐	☐
SKC POCKET PUMP TOUCH	☐	☐	☐	☐	☐	☐	☐	☐
SKC UNIVERSAL 44 XR	☐	☐	☐	☐	☐	☐	☐	☐
SKC PCXR4	☐	☐	☐	☐	☐	☐	☐	☐
SKC UNIVERSAL PCXR8	☐	☐	☐	☐	☐	☐	☐	☐
Prefer not to answer	☐	☐	☐	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐	☐	☐	☐

4. **Why you prefer using the above-indicated evaluation equipment? You may choose more than one option.**

Check all that apply.

☐ Ease of use
☐ Cost effective
☐ Long battery life
☐ Reliability on and off site
☐ Practicality
☐ Prefer not to answer
☐ Other: ______________________

5. **What is the mean age of your sampling pumps? ***
Check all that apply.

- [ ] < 2 years
- [ ] 2 - 4 years
- [ ] 4 - 6 years
- [ ] > 8 years
- [ ] Prefer not to answer
- [ ] Other: ____________________

6. **How often are these equipment calibrated by an Accredited laboratory? (Accredited laboratory: A laboratory that has been confirmed to be competent to preform calibration by an independent 3rd party)**
*** This does not include the day-to-day calibration done by AIAs themselves before and after surveys ***
Check all that apply.

- [ ] Before every survey
- [ ] After every survey
- [ ] Weekly
- [ ] Monthly
- [ ] Quarterly
- [ ] Every year
- [ ] Every 1 - 2 years
- [ ] Every 1 - 3 years
- [ ] Prefer not to answer
- [ ] Other: ____________________

7. **Sampling for NUISANCE dust, what METHOD/s do you use? ***
Check all that apply.

- [ ] NIOSH 0500
- [ ] NIOSH 0600
- [ ] SANS 1929: 2011
- [ ] National Dust Control Regulations (No. R827) (2013)
- [ ] ISO 14000
- [ ] ISO 17020
- [ ] ISO 15767:2003
- [ ] ISO 7708:1995
- [ ] ISO 10882-1:2011
- [ ] EPA method 201A
- [ ] EN 12341: 2014
- [ ] HSE - MDHS 14/4
- [ ] Prefer not to answer
- [ ] Other: ____________________

8. **Do you use other sampling methods than listed above? Please list these methods.**

9. **What method of data capturing do you use?** *

Check all that apply.

- [ ] Written field notes
- [ ] Original Equipment Manufacturer (OEM) software
- [ ] iPad/ Tablet
- [ ] Prefer not to answer
- [ ] Other: ______________________

10. **What are the TOP 10 CHEMICALS your AIA sample for? Please list these chemicals** *

Sampling equipment calibration

11. **What calibration equipment do you use to calibrate your sampling pumps with?**
You may choose more than one option

Check all that apply.

- [ ] GILIAN GILIBRATOR CALIBRATOR-2 BUBBLE FLOW CALIBRATOR

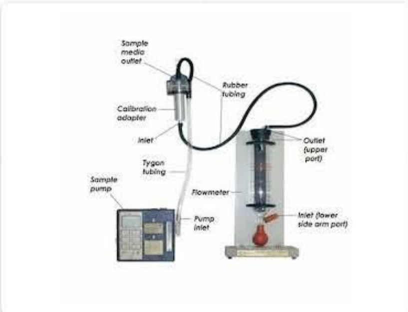
- [ ] GILIAN GILIBRATOR 3 - DRY CELL

☐ SKC CHECK-MATE AIR SAMPLING CALIBRATOR

☐ SKC CHECK-MATE FLOW CALIBRATOR

☐ SKC ECONOMICAL FIELD ROTAMETERS / STANDARD ROTAMETERS

☐ SKC PNEUMATIC TEST KIT



☐ SKC SOAP FILM FLOWMETER

☐ TSI 4146

☐ BIOSDEFENDER 520M VOLUMETRIC PRIMARY FLOW CALIBRATOR

☐ Prefer not to answer

☐ Other: ____________

12. **If you use her calibrators, please specify.**

Noise

Evaluation equipment - Area Noise

13. **Which SOUND LEVEL METERS do you use? Please chooses the most relevant answer/s.**
You may choose more than one option
Check all that apply.

☐ QUEST SD200 SOUND DETECTOR

☐ QUEST SE400 INTRINSICALLY SAFE SOUND LEVEL METER

☐ QUEST SOUND PRO - REAL TIME ANALYSER

☐ SVANTEK SV 971

☐ SVANTEK SV 973

☐ SVANTEK SM 277 PRO OUTDOOR NOISE MONITORING STATION

☐ SVANTEK SV 200A

☐ SVANTEK SV 307 - NOISE MONITORING TERMINAL

☐ SKC SOUNDCHECK ESSENTIAL SOUND LEVEL METER

☐ BRUEL & KJAER TYPE 2250 LIGHT CLASS 1 SOUND LEVEL METER AND ANALYZER

☐ BRUEL & KJAER TYPE 2250-S CLASS 1 SOUND LEVEL METER AND ANALYSER

☐ BRUEL & KJAER TYPE 2270-S TWO CHANNEL SOUND LEVEL METER AND ANALYSER

☐ Prefer not to answer

☐ Other: __________

14. **If you use other sound level meters please specify.**

____

____

____

____

____

15. **How many of each device do you have ? ***
Check all that apply.

	1 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	>30	Not applicable
QUEST SOUND DETECTOR	☐	☐	☐	☐	☐	☐	☐	☐
QUEST SE400 INTRINSICALLY SAFE SOUND LEVEL METER	☐	☐	☐	☐	☐	☐	☐	☐
QUEST SOUND PRO - REAL TIME ANALYSER	☐	☐	☐	☐	☐	☐	☐	☐
SVANTEK SV 971	☐	☐	☐	☐	☐	☐	☐	☐
SVANTEK SV 973	☐	☐	☐	☐	☐	☐	☐	☐

SVANTEK SM 277 PRO OUTDOOR NOISE MONITORING STATION	☐	☐	☐	☐	☐	☐	☐	☐
SVANTEK SV 200A	☐	☐	☐	☐	☐	☐	☐	☐
SVANTEK SV 307 - NOISE MONITORING TERMINAL	☐	☐	☐	☐	☐	☐	☐	☐
SKC SOUNDCHECK ESSENTIAL SOUND LEVEL METER	☐	☐	☐	☐	☐	☐	☐	☐
BRUEL & KJAER T TYPE 2250 LIGHT CLASS 1 SOUND SOUND LEVEL METER AND ANALYZER	☐	☐	☐	☐	☐	☐	☐	☐
BRUEL & KJAER TYPE 2250-S CLASS 1 SOUND LEVEL METER AND ANALYSER	☐	☐	☐	☐	☐	☐	☐	☐
BRUEL & KJAER TYPE 2270-S TWO CHANNEL SOUND LEVEL METER AND ANALYSER	☐	☐	☐	☐	☐	☐	☐	☐
Prefer not to answer	☐	☐	☐	☐	☐	☐	☐	☐

16. **Why you prefer using the above-indicated evaluation equipment? You may choose more than one option.** *

Check all that apply.

- [ ] Ease of use
- [ ] Cost effective
- [ ] Long battery life
- [ ] Reliability on and off site
- [ ] Practicality
- [ ] Prefer not to answer
- [ ] Other: ______________________

17. **What is the mean age of your sampling pumps?** *

Check all that apply.

- [ ] < 2 years
- [ ] 2 - 4 years
- [ ] 4 - 6 years
- [ ] > 8 years
- [ ] Prefer not to answer
- [ ] Other: ______________________

18. **How often are these equipment calibrated by an Accredited laboratory? (Accredited laboratory: A laboratory that has been confirmed to be competent to preform calibration by an independent 3rd party)**
*** This does not include the day-to-day calibration done by AIAs themselves before and after surveys *** *

Check all that apply.

- [ ] Before every survey
- [ ] After every survey
- [ ] Weekly
- [ ] Monthly
- [ ] Quarterly
- [ ] Every year
- [ ] Every 1 - 2 years
- [ ] Every 1 - 3 years
- [ ] Prefer not to answer
- [ ] Other: ______________________

19. **What AREA NOISE evaluation METHOD/s do you use?** *

Check all that apply.

- [ ] SANS 10083:2013
- [ ] SANS 10103-1
- [ ] OHSAct (85 of 1993) - Regulation 7: Noise induced hearing loss Regulations
- [ ] Mine Health and Safety Regulations, MHSAct (29 of 1996)
- [ ] ISO 1996-2
- [ ] ISO 13474:2009
- [ ] ISO 11204: 2010
- [ ] ISO 9612:2009
- [ ] ISO 1999:2013
- [ ] Canadian standard CSA Z107.56-13 (R2018)
- [ ] Australian Standard 1259-1982
- [ ] OSHA's Occupational Noise Exposure Standard (29CFR 1910.95)
- [ ] The Control of Noise at Work Regulations 2005
- [ ] ANSI/ASA S3.44-2016/Part 1 / ISO 1999:2013 (MOD)
- [ ] MSHA – Mining Safety and Health Administration, 30 CFR Part 62
- [ ] Prefer not to answer
- [ ] Other: ____________________

20. **Do you use other evaluation methods than listed above? Please list these methods.**

____

____

____

____

____

21. **What method of data capturing do you use?** *

Check all that apply.

- [ ] Written field notes
- [ ] Original Equipment Manufacturer (OEM) software
- [ ] iPad/ Tablet
- [ ] Prefer not to answer
- [ ] Other: ____________________

Evaluation equipment calibration - Sound level meters

22. **What calibration equipment do you use to calibrate your evaluation equipment with?** *
You may choose more than one option
Check all that apply.

☐ 3M AcoustiCal AC-300

☐ SKC AcoustiCHECK CALIBARTOR

☐ TSI QUEST AcoustiCal AC-300 CALLIBRATOR CLASS 1

☐ 3M QUEST QC-10 CALIBRATOR

☐ Prefer not to answer

☐ Other: ____________

23. **If you use other calibrators, please specify.**

____

____

____

____

____

Evaluation equipment - Personal noise exposure

24. **What Noise Dosimeters do you use? Please chooses the most relevant answer/s.** *
You may choose more than one option.
Check all that apply.

☐ 3M QUEST EDGE PERSONAL NOISE DOSIMETERS

☐ SVANTEK SV104

☐ SVANTEK SV104 IS (INTRINSICALLY SAFE)

☐ SKC NOISECHECK IS (INTRINSICALLY SAFE) PERSONAL NOISE DOSIMETER

☐ TSI QUEST EDGE 5 PERSONAL NOISE DOSIMETER

☐ CASELLA CEL 350 IS MICRO NOISE DOSIMETER

☐ BRUEL & KJAERS TYPE 4448 PERSONAL NOISE DOSIMETER

☐ Other: ____________

☐ Prefer not to answer

25. **What Noise Dosimeters do you use? You may choose more than one option.** *
Check all that apply.

	1 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	>30	Not apllicable
3M QUEST EDGE PERSONAL NOISE DOSIMETERS S	☐	☐	☐	☐	☐	☐	☐	☐
SVANTEK SV104	☐	☐	☐	☐	☐	☐	☐	☐
SVANTEK SV104 IS (INTRINSICALLY SAFE)	☐	☐	☐	☐	☐	☐	☐	☐
SKC NOISECHECK IS (INTRINSICALLY SAFE) PERSONAL NOISE DOSIMETER	☐	☐	☐	☐	☐	☐	☐	☐
TSI QUEST EDGE 5 PERSONAL NOISE DOSIMETER	☐	☐	☐	☐	☐	☐	☐	☐
CASELLA CEL 350 IS MICRO NOISE DOSIMETER	☐	☐	☐	☐	☐	☐	☐	☐

	1 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	>30	Not apllicable
BRUEL & KJAERS TYPE 4448 PERSONAL NOISE DOSIMETER	☐	☐	☐	☐	☐	☐	☐	☐
Prefer not to answer	☐	☐	☐	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐	☐	☐	☐

26. **Why you prefer using the above-indicated evaluation equipment? You may choose more than one option.** *

Check all that apply.

- ☐ Ease of use
- ☐ Cost effective
- ☐ Long battery life
- ☐ Reliability on and off site
- ☐ Practicality
- ☐ Prefer not to answer
- ☐ Other: ____________________

27. **What is the mean age of your personal noise dosimeters?** *

Check all that apply.

- ☐ < 2 years
- ☐ 2 - 4 years
- ☐ 4 - 6 years
- ☐ > 8 years
- ☐ Prefer not to answer
- ☐ Other: ____________________

28. **How often are these equipment calibrated by an Accredited laboratory? (Accredited laboratory: A laboratory that has been confirmed to be competent to preform calibration by an independent 3rd party) * This does not include the day-to-day calibration done by AIAs themselves before and after surveys *** *

Check all that apply.

- [ ] Before every survey
- [ ] After every survey
- [ ] Weekly
- [ ] Monthly
- [ ] Quarterly
- [ ] Every year
- [ ] Every 1 - 2 years
- [ ] Every 1 - 3 years
- [ ] Prefer not to answer
- [ ] Other: ____________________

29. **What PERSONAL NOISE evaluation METHOD/s do you use?** *

Check all that apply.

- [ ] ANSI S1.25-1978
- [ ] OHSA 29CFR 1904.10
- [ ] OSHA 1910.95
- [ ] MSHA – Mining Safety and Health Administration, 30 CFR Part 62
- [ ] Australian Standard AS/NZS 1269:2005
- [ ] OCCUPATIONAL HEALTH AND SAFETY AUTHORITY Act (CAP. 424)
- [ ] The Control of Noise at Work Regulations 2005 No. 1643
- [ ] Prefer not to answer
- [ ] Other: ____________________

30. **Do you use other evaluation methods than listed above? Please list these methods.**

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31. **What method of data capturing do you use?** *
Check all that apply.

- [ ] Written field notes
- [ ] Original Equipment Manufacturer (OEM) software
- [ ] iPad/ Tablet
- [ ] Prefer not to answer
- [ ] Other: ______________________

Evaluation equipment calibration - Personal noise dosimeter

32. **What calibration equipment do you use to calibrate your NOISE DOSIMETERS with?** *
You may choose more than one option
Check all that apply.

- [ ] 3M AcoustiCal AC-300

- [ ] SKC AcoustiCHECK CALIBARTOR

- [ ] TSI QUEST AcoustiCal AC-300 CALLIBRATOR CLASS 1

- [ ] 3M QUEST QC-10 CALIBRATOR
- [ ] Prefer not to answer
- [ ] Other: ______________________

33. **If you use other calibrators, please specify.**

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Heat stress

Evaluation equipment

34. **What HEAT STRESS MONITORS do you use? Please choose the most relevant answer/s.**
You may choose more than one option. *

Check all that apply.

☐ TSI QUESTEMP 32 AREA HEAT STRESS MONITOR

☐ TSI QUESTEMP 34 AREA HEAT STRESS MONITOR

☐ TSI QUESTEMP 36 AREA HEAT STRESS MONITOR

☐ TSI QUESTEMP 44 AREA WATERLESS WET BULB HEAT STRESS MONITOR

☐ TSI QUESTEMP 46 AREA WATERLESS WET BULB HEAT STRESS MONITO

☐ TSI QUESTEMP 48 AREA WATERLESS WET BULB HEAT STRESS MONITOR

☐ 3M QUESTEMP 44 HEAT STRESS MONITOR

☐ 3M QUESTEMP 46 HEAT STRESS MONITOR

☐ 3M QEUSTEMP 48N HEAT STRESS MONITOR

☐ Other: ____________

☐ Prefer not to answer

35. **If you use other MONITORS , please specify.**

____

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36. **What HEAT STRESS MONITORS do you use? Please choose the most relevant answer/s.**
You may choose more than one option.
Check all that apply.

	1 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	> 30	Not applicable
TSI QUESTEMP 32 AREA HEAT STRESS MONITOR	☐	☐	☐	☐	☐	☐	☐	☐
TSI QUESTEMP 34 AREA HEAT STRESS MONITOR	☐	☐	☐	☐	☐	☐	☐	☐
TSI QUESTEMP 36 AREA HEAT STRESS MONITOR	☐	☐	☐	☐	☐	☐	☐	☐
TSI QUESTEMP 44 AREA WATERLESS WET BULB HEAT STRESS MONITOR	☐	☐	☐	☐	☐	☐	☐	☐
TSI QUESTEMP 46 AREA WATERLESS WET BULB HEAT STRESS MONITO	☐	☐	☐	☐	☐	☐	☐	☐
TSI QUESTEMP 48 AREA WATERLESS WET BULB HEAT STRESS MONITOR	☐	☐	☐	☐	☐	☐	☐	☐

	1 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	> 30	Not applicable
3M QUESTEMP 44 HEAT STRESS MONITOR	☐	☐	☐	☐	☐	☐	☐	☐
3M QUESTEMP 46 HEAT STGRESS MONITOR	☐	☐	☐	☐	☐	☐	☐	☐
3M QUESTEMP 48N HEAT STRESS MONITOR	☐	☐	☐	☐	☐	☐	☐	☐
Prefer not to answer	☐	☐	☐	☐	☐	☐	☐	☐

37. **Why you prefer using the above-indicated evaluation equipment? You may choose more than one option.** *

Check all that apply.

- ☐ Ease of use
- ☐ Cost effective
- ☐ Long battery life
- ☐ Reliability on and off site
- ☐ Practicality
- ☐ Prefer not to answer
- ☐ Other: ______________________

38. **What is the mean age of your sampling pumps?** *

Check all that apply.

- ☐ < 2 years
- ☐ 2 - 4 years
- ☐ 4 - 6 years
- ☐ > 8 years
- ☐ Prefer not to answer
- ☐ Other: ____________________

39. **How often are these equipment calibrated by an Accredited laboratory? (Accredited laboratory: A laboratory that has been confirmed to be competent to preform calibration by an independent 3rd party)**
*** This does not include the day-to-day calibration done by AIAs themselves before and after surveys *** *

Check all that apply.

- ☐ Before every survey
- ☐ After every survey
- ☐ Weekly
- ☐ Monthly
- ☐ Quarterly
- ☐ Every year
- ☐ Every 1 - 2 years
- ☐ Every 1 - 3 years
- ☐ Prefer not to answer
- ☐ Other: ____________________

Evaluation methods

40. **Evaluation HEAT STRESS, what METHOD/s do you use?** *

Check all that apply.

- ☐ EN ISO 7730
- ☐ EN ISO 14505
- ☐ EN ISO 7243: 2017
- ☐ EN ISO 7933: 2004
- ☐ OHSAct (No 85 of 1993) - Environmental Regulations for Workplaces, Sub- Regulation 2
- ☐ ASHRAE 55 - 2020
- ☐ ASHRAE 62
- ☐ ASHRAE 113
- ☐ HSE - Heat stress in the workplace (INDG451)
- ☐ NIOSH 106: 2016
- ☐ Prefer not to answer
- ☐ Other: ____________________

41. **Do you use other evaluation methods than listed above? Please list these methods.**

42. **What method of data capturing do you use?** *

Check all that apply.

- [ ] Written field notes
- [ ] Original Equipment Manufacturer (OEM) software
- [ ] iPad/ Tablet
- [ ] Prefer not to answer
- [ ] Other: ____________

Cold stress

Evaluation equipment

43. **What COLD STRESS MONITORS do you use? Please choose the most relevant answer/s.** *
You may choose more than one option.

Check all that apply.

- [ ] TSI Q-TRAK VELOCICAL 9565 AIR VELOCITY METER

- [ ] TSI 5725 VELOCICALC ROTATING VANE ANEMOMETER

☐ TSI ALNOR RVA501 HAND HELD VAN ANEMOMETER

☐ TSI 9545a HOT WIRE ANEMOMETER

☐ TSI TA410 HOT WIRE ANEMOMETER

☐ WHIRLING HYGROMETER

☐ TSI QUESTEMP 44 AREA WATERLESS WET BULB MONITOR

☐ TSI QUEST 46 AREA WATERLESS WET BULB MONITOR

☐ TSI QUESTEMP 48 AREA WATERLESS WET BULB MONITOR

☐ Other: ____________

☐ Prefer not to answer

44. **If you use other COLD STRESS MONITORS , please specify.**

45. **How many of each monitor do you have?** *
Mark only one oval per row.

	1 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	> 30	Not apllicable
TSI Q-TRAK VELOCICAL 9565 AIR VELOCITY METER								
TSI 5725 VELOCICALC ROTATING VANE ANEMOMETER								
TSI ALNOR RVA501 HAND HELD VAN ANEMOMETER								
TSI 9545a HOT WIRE ANEMOMETER								
TSI TA410 HOT WIRE ANEMOMETER								
WHIRLING HYGROMETER								
TSI QUESTEMP 44 AREA WATERLESS WET BULB MONITOR								

	1 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	> 30	Not apllicable
TSI QUEST 46 AREA WATERLESS WET BULB MONITOR								
TSI QUESTEMP 48 AREA WATERLESS WET BULB MONITOR								
Prefer not to answer								

46. **Why you prefer using the above-indicated evaluation equipment? You may choose more than one option.** *

Check all that apply.

- [ ] Ease of use
- [ ] Cost effective
- [ ] Long battery life
- [ ] Reliability on and off site
- [ ] Practicality
- [ ] Prefer not to answer
- [ ] Other: ____________________

47. **What is the mean age of your sampling pumps?** *

Check all that apply.

- [ ] < 2 years
- [ ] 2 - 4 years
- [ ] 4 - 6 years
- [ ] > 8 years
- [ ] Prefer not to answer
- [ ] Other: ____________________

48. **How often are these equipment calibrated by an Accredited laboratory? (Accredited laboratory: A laboratory that has been confirmed to be competent to preform calibration by an independent 3rd party)** *
*** This does not include the day-to-day calibration done by AIAs themselves before and after surveys ***

Check all that apply.

- [ ] Before every survey
- [ ] After every survey
- [ ] Weekly
- [ ] Monthly
- [ ] Quarterly
- [ ] Every year
- [ ] Every 1 - 2 years
- [ ] Every 1 - 3 years
- [ ] Prefer not to answer
- [ ] Other: ____________________

Evaluation method - Cold Stress

49. **What COLD STRESS evaluation METHOD/s do you use?** *

Check all that apply.

- [ ] OHS Act (85 of 1993): The thermal requirements of the Environmental Regulations for Workplaces,
- [ ] ISO 11079
- [ ] ISO 15743
- [ ] EN ISO 13732-1:2009
- [ ] EN ISO 7243: 2017
- [ ] European Standard (EN511)
- [ ] ASHRAE 62
- [ ] ASHRAE 55
- [ ] ASHRAE 113
- [ ] Prefer not to answer
- [ ] Other: ____________________

50. **Do you use other evaluation methods than listed above? Please list these methods.**

____
____
____
____
____

51. **What method of data capturing do you use?** *

Check all that apply.

- [ ] Written field notes
- [ ] Original Equipment Manufacturer (OEM) software
- [ ] iPad/ Tablet
- [ ] Prefer not to answer
- [ ] Other: ____________________

Illumination

Evaluation equipment

52. **What ILLUMINANCE METERS do you use? Please choose the most relevant answer/s.** *
You may choose more than one option.
Check all that apply.

- [ ] HIOKI FT3424 LIGHT METER

- [ ] GOSSEN M502G ILLUMINANCE METER MAVOLUX

- [ ] GOSSEN M502B MAVOLUX LUX METER

- [ ] GOLDILUX AUTORANGING LIGHT METER

☐ GOLDILUX LED LUX METER

☐ KIMO LUXMETER LX 100

☐ KIMO LX50 LIGHT METER

☐ Prefer not to answer

☐ Other: ____________

53. **If you use other illuminance meters, please specify.**

____

54. **What ILLUMINANCE METERS do you use? Please choose the most relevant answer/s.** *

You may choose more than one option.

Check all that apply.

	1 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	> 30	Not applicable
HIOKI FT3424 LIGHT METER	☐	☐	☐	☐	☐	☐	☐	☐
GOSSEN M502G ILLUMINANCE METER MAVOLUX	☐	☐	☐	☐	☐	☐	☐	☐
GOSSEN M502B MAVOLUX LUX METER	☐	☐	☐	☐	☐	☐	☐	☐
GOLDILUX AUTORANGING LIGHT METER	☐	☐	☐	☐	☐	☐	☐	☐
GOLDILUX LED LUX METER	☐	☐	☐	☐	☐	☐	☐	☐
KIMO LUXMETER LX 100	☐	☐	☐	☐	☐	☐	☐	☐
KIMO LX50 LIGHT METER	☐	☐	☐	☐	☐	☐	☐	☐
Prefer not to answer	☐	☐	☐	☐	☐	☐	☐	☐

55. **Why you prefer using the above-indicated evaluation equipment? You may choose more than one option.** *

Check all that apply.

- [ ] Ease of use
- [ ] Cost effective
- [ ] Long battery life
- [ ] Reliability on and off site
- [ ] Practicality
- [ ] Prefer not to answer
- [ ] Other: ______________________

56. **What is the mean age of your sampling pumps?** *

Check all that apply.

- [ ] < 2 years
- [ ] 2 - 4 years
- [ ] 4 - 6 years
- [ ] > 8 years
- [ ] Prefer not to answer
- [ ] Other: ______________________

57. **How often are these equipment calibrated by an Accredited laboratory? (Accredited laboratory: A laboratory that has been confirmed to be competent to preform calibration by an independent 3rd party)**
*** This does not include the day-to-day calibration done by AIAs themselves before and after surveys *** *

Check all that apply.

- [ ] Before every survey
- [ ] After every survey
- [ ] Weekly
- [ ] Monthly
- [ ] Quarterly
- [ ] Every year
- [ ] Every 1 - 2 years
- [ ] Every 1 - 3 years
- [ ] Prefer not to answer
- [ ] Other: ______________________

Evaluation method - Illumination

58. **What Illuminance evaluation METHOD/s do you use?** *

Check all that apply.

- [ ] ISO 21783
- [ ] SANS 10400-O: 2011
- [ ] ISO 8995 -1: 2002
- [ ] SANS 101141 - 1: 2020 Code of practice of interior lighting, Part1: Artificial lighting of interior
- [ ] SANS 10389 - 1: 2003: Code of practice of exterior lighting, Part 1: Artificial lighting for exterior areas
- [ ] OHSAct (No 85 of 1993) - Environmental Regulations for Workplaces - Illumination
- [ ] British Standard, BS 667:2005 Illuminance Meters – Requirements and Test methods
- [ ] Health and Safety Executive, HSG38 - Lighting at Work
- [ ] Mine Health and Safety Act 29 of 1996 and Safety Act 29 of 1996
- [ ] Prefer not to answer
- [ ] Other: ______________________

59. **Do you use other evaluation methods than listed above? Please list these methods.**

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60. **What EMERGENCY LIGHTING evaluation method do you use?** *
You may choose more than one option.
Check all that apply.

- [ ] SABS 0400-1990
- [ ] Mine Health and Safety Act 29 of 1996 and Safety Act 29 of 1996
- [ ] ISO 30061: 2007
- [ ] ISO 20086: 2019
- [ ] SANS 10400-O: 2011
- [ ] OHSAct (No 85 of 1993) - Environmental Regulations for Workplaces - Illumination
- [ ] BS 5266-1:2016 - Code of Practice for the emergency lighting of premises (British Standard)
- [ ] BS 5839-6:2019 - Code of Practice for fire detection and fire alarm systems for buildings (British Standard)
- [ ] BS EN 1838:2013 Lighting applications. Emergency lighting (British Standard)
- [ ] BS EN 50172:2004 Emergency escape lighting systems (British Standard)
- [ ] IEC 60598-2-22 Ed. 5.0 b:2021 Luminaires - Part 2-22: Particular requirements - Luminaires for emergency lighting
- [ ] Prefer not to answer
- [ ] Other: ______________________

61. **Do you use other evaluation methods than listed above? Please list the methods.**

____
____
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62. **What method of data capturing do you use?** *
Check all that apply.

- [ ] Written field notes
- [ ] Original Equipment Manufacturer (OEM) software
- [ ] iPad/ Tablet
- [ ] Prefer not to answer
- [ ] Other: ______________________

Ventilation

Evaluation equipment

63. **Which Indoor Air Quality (IAQ) monitors do you use? Please chooses the most relevant option.** *

You may choose more than one option.

Mark only one oval.

◯ TSI Q-TRAK 7565 INDOOR AIR QUAILITY MONITOR

◯ TSI Q-TRAK 7575 MULTI DIGITAL INDOOR AIR QUALITY MONITOR

◯ TSI Q-TRAK VELOCICAL 9565 AIR VELOCITY METER

◯ TSI Q-TRAK PLUS INDOOR AIR QUALITY MONITOR

◯ TSI QUEST EVM7 - ENVIRONMENTAL MONITOR

◯ 3M EVM-7 ENVIRONMENTAL MONITOR

◯ Prefer not to answer

◯ Other: ____________

64. **Which Indoor Air Quality (IAQ) monitors do you use? Please chooses the most relevant option.** *

You may choose more than one option.

Check all that apply.

	1 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	> 30	Not applicable
TSI Q-TRAK 7565 INDOOR AIR QUAILITY MONITOR	☐	☐	☐	☐	☐	☐	☐	☐
TSI Q-TRAK 7575 MULTI DIGITAL INDOOR AIR QUALITY MONITOR	☐	☐	☐	☐	☐	☐	☐	☐
TSI Q-TRAK VELOCICAL 9565 AIR VELOCITY METER	☐	☐	☐	☐	☐	☐	☐	☐
TSI Q-TRAK PLUS INDOOR AIR QUALITY MONITOR	☐	☐	☐	☐	☐	☐	☐	☐
TSI QUEST EVM7 - ENVIRONMENTAL MONITOR	☐	☐	☐	☐	☐	☐	☐	☐
3M EVM-7 ENVIRONMENTAL MONITOR	☐	☐	☐	☐	☐	☐	☐	☐
Prefer not to answer	☐	☐	☐	☐	☐	☐	☐	☐

65. **Why you prefer using the above-indicated evaluation equipment? You may choose more than one option.** *
Check all that apply.

- [ ] Ease of use
- [ ] Cost effective
- [ ] Long battery life
- [ ] Reliability on and off site
- [ ] Practicality
- [ ] Prefer not to answer
- [ ] Other: ____________________

66. **What is the mean age of your sampling pumps?** *
Check all that apply.

- [ ] < 2 years
- [ ] 2 - 4 years
- [ ] 4 - 6 years
- [ ] > 8 years
- [ ] Prefer not to answer
- [ ] Other: ____________________

67. **How often are these equipment calibrated by an Accredited laboratory? (Accredited laboratory: A laboratory that has been confirmed to be competent to preform calibration by an independent 3rd party)
* This does not include the day-to-day calibration done by AIAs themselves before and after surveys** *
Check all that apply.

- [ ] Before every survey
- [ ] After every survey
- [ ] Weekly
- [ ] Monthly
- [ ] Quarterly
- [ ] Every year
- [ ] Every 1 - 2 years
- [ ] Every 1 - 3 years
- [ ] Prefer not to answer
- [ ] Other: ____________________

Evaluation method - Ventilation

68. **What IAQ evaluation METHOD/s do you use?** *
Check all that apply.

- [ ] ASHRAE 62.1
- [ ] ASHRAE 62.2
- [ ] ASHRAE 52.2-2017
- [ ] SANS 10400-O: 2011
- [ ] BS 5925 Code of Practice for Ventilation Principles and Designing for Natural Ventilation (British Standard)
- [ ] EN 13141-1:2004 Ventilation for buildings. Performance testing of components/ products for residential ventilation. Externally and internally mounted air transfer devices.
- [ ] EN 13141-4:2011 Ventilation for buildings. Performance testing of components/ products for residential ventilation. Fans used in residential ventilation systems.
- [ ] EN 13141-5:2004 Ventilation for buildings. Performance testing of components/ products for residential ventilation. Cowls and roof outlet terminal devices.
- [ ] EN 13141-11:2015 Ventilation for Buildings - Performance Testing of Components/ products for Residential Ventilation Part 11: Supply Ventilation Units
- [ ] EN ISO 9972:2015 - Thermal Performance of Buildings - Determination of Air Permeability of Domestic Buildings – (Single or Single & Multi) Fan Pressurization Method
- [ ] Mine Healthe and Safety Act (29 of 1996) Guideline for the Compilation of a Mandatory Code of Practice for the Management of Working in Confined Spaces at Mines.
- [ ] OHSAct (85 of 1993): Environmental Regulations for Workplaces, 1987, Regulation 5 - Ventilation
- [ ] ISO 10121-1:2014 Test method for assessing the performance of gas-phase air cleaning media and devices for general ventilation — Part 1: Gas-phase air cleaning media
- [ ] ISO 10121-2:2013 Test methods for assessing the performance of gas-phase air cleaning media and devices for general ventilation — Part 2: Gas-phase air cleaning devices (GPACD)
- [ ] ISO 16890-1:2016 Air filters for general ventilation — Part 1: Technical specifications, requirements and classification system based upon particulate matter efficiency (ePM)
- [ ] ISO 16890-2:2022 Air filters for general ventilation — Part 2: Measurement of fractional efficiency and air flow resistance
- [ ] ISO 16890-3:2016 Air filters for general ventilation — Part 3: Determination of the gravimetric efficiency and the air flow resistance versus the mass of test dust captured
- [ ] ISO 29463-1:2017 High efficiency filters and filter media for removing particles from air — Part 1: Classification, performance, testing and marking
- [ ] Prefer not to answer
- [ ] Other: ______________________

69. **Do you use other evaluation methods than listed above? Please list these methods.**

General question

Please choose the most relevant answer/s. You may choose more than one option.

70. **Rank the following in the order of importance when considering buying equipment.** *

Mark only one oval per row.

	1st	2nd	3rd	4th	5th	6th	7th	Prefer not to answer
Afordability								
Reliability								
Availability								
Features								
Costs								
Popularity								
Durability								
Familiarity								
Prefer not to answer								

71. **Please indicate where you buy your equipment from. You may choose more than one option.** *

Check all that apply.

- [ ] AMS Haden
- [ ] Sadulitas
- [ ] SKC Inc. South Africa
- [ ] Envircon Instrumentation
- [ ] Thermo Fisher Scientific
- [ ] TSI
- [ ] Control Equipment Pty Ltd
- [ ] Apex Environmental
- [ ] Pine Environmental
- [ ] Prefer not to answer

72. **What industries do you primarily survey?** *

Mark only one oval.

- ( ) Mining
- ( ) Car (automotive) manufacturing
- ( ) Food manufacturing
- ( ) Metalworking
- ( ) Textile
- ( ) Machinery
- ( ) Chemicals
- ( ) Fertilizer
- ( ) Prefer not to answer
- ( ) Other: ______________________

73. **How many laboratory personnel does your AIA have?** *
The duties of a laboratory personnel may include: sample weighing; pump calibration; asbestos counting etc.

Mark only one oval.

- ( ) 1
- ( ) 2
- ( ) 3
- ( ) 4
- ( ) 5
- ( ) More than 5
- ( ) Prefer not to answer
- ( ) Other: ______________________

74. **How many administrative personnel does your AIA have?** *
Check all that apply.

- [ ] 1
- [ ] 2
- [ ] 3
- [ ] 4
- [ ] 5
- [ ] More than 5
- [ ] Prefer not to answer
- [ ] Other: ____________________

75. **How many *Occupational Hygiene Assistants* does your AIA have?** *

Mark only one oval.

- ( ) 1-2
- ( ) 3-4
- ( ) 4-5
- ( ) 5-8
- ( ) 9-12
- ( ) More than 12
- ( ) Prefer not to answer
- ( ) Other: ____________________

76. **How many *Occupational Hygiene Technologists* does your AIA have?** *

Mark only one oval.

- ( ) 1-2
- ( ) 3-4
- ( ) 4-5
- ( ) 5-8
- ( ) 9-12
- ( ) More than 12
- ( ) Prefer not to answer
- ( ) Other: ____________________

77. **How many *Occupational Hygienists* does your AIA have?** *

Mark only one oval.

- 1-2
- 3-4
- 4-5
- 5-8
- 9-12
- More than 12
- Prefer not to answer
- Other: ____________________

78. **Who does your gravimetrical sample weighing? You may choose more than one option.** *

Check all that apply.

- Occupational Hygiene Assistant
- Occupational Hygiene Technologist
- Lab technician
- Prefer not to answer
- Other: ____________________

79. **Who preforms your pre-survey calibrations? You may choose more than one option.** *

Check all that apply.

- Occupational Hygiene Assistant
- Occupational Hygiene Technologist
- Lab technician
- Prefer not to answer
- Other: ____________________

80. **What evaluation equipment do you, if any, LEASE ?** *
Please also indicate how many, estimated, per site survey.

You may choose more than one answer.

Check all that apply.

	Not applicable	No, we never LEASE	1 - 2	2 - 4	4 - 6	6 - 8	8 - 10	Prefer not to answer
Sampling pumps	☐	☐	☐	☐	☐	☐	☐	☐
Sound level meters	☐	☐	☐	☐	☐	☐	☐	☐
Noise dosimeters	☐	☐	☐	☐	☐	☐	☐	☐
Heat stress monitors	☐	☐	☐	☐	☐	☐	☐	☐
Cold stress monitors	☐	☐	☐	☐	☐	☐	☐	☐
Illuminance meters	☐	☐	☐	☐	☐	☐	☐	☐
Ventilation monitors	☐	☐	☐	☐	☐	☐	☐	☐
Prefer not to answer	☐	☐	☐	☐	☐	☐	☐	☐

81. **What evaluation equipment do you, if any, BORROW?** *
Please also indicate how many, estimated, per site survey.

You may choose more than one answer.

Check all that apply.

	Not applicable	No, we never BORROW	1 - 2	2 - 4	4 - 6	6 - 8	8 - 10	Prefer not to answer
Sampling pumps	☐	☐	☐	☐	☐	☐	☐	☐
Sound level meters	☐	☐	☐	☐	☐	☐	☐	☐
Noise dosimeters	☐	☐	☐	☐	☐	☐	☐	☐
Heat stress monitors	☐	☐	☐	☐	☐	☐	☐	☐
Cold stress monitors	☐	☐	☐	☐	☐	☐	☐	☐
Illuminance meters	☐	☐	☐	☐	☐	☐	☐	☐
Ventilation monitors	☐	☐	☐	☐	☐	☐	☐	☐
Prefer not to answer	☐	☐	☐	☐	☐	☐	☐	☐

Feedback

Please give us your feedback.

82. Are there any questions you would have liked to be added?

83. What would you like to learn from this study?

84. Do you have any recommendations?

85. Any other remarks?

THANK YOU !

I sincerely appreciate your time and efforts to help better my study.