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INTELLECT

Exploring Technologies, Advancing Innovation



Gas Detector Calibration Laboratory (GCL), NIOSH

**Analytical Chemistry Application Laboratory:
Delivering Precision For Research and Sustainability,
Malaysian Nuclear Agency**

INTRODUCTION

Welcome to the September 2025 edition of INTELLECT, the quarterly magazine of NIOSH that explores technologies and advances innovation in the field of Occupational Safety and Health (OSH). Intellect is a platform for exchanging information, sharing knowledge and experiences and highlighting the latest developments and achievements of NIOSH and its partners. Intellect aims to benefit all the stakeholders in the OSH community, including research institutes, laboratory service providers, universities, academicians, government and private sectors, employers and students.

We hope that Intellect will inspire and inform you about the exciting and important works that NIOSH and its partners are doing to enhance OSH standards and practices in Malaysia and beyond. We also welcome other organisations who are interested in promoting or sharing their laboratory facilities and services in the field

of OSH. We welcome your feedback and suggestions on how to improve our magazine and services. We would love to hear from you and feature your contributions in our future issues.

If you have any stories, projects, or achievements that you would like to showcase in our magazine, please feel free to contact us at penerbitan@niosh.com.my. Thank you for your support and interest in NIOSH. We look forward to hearing from you and serving you better.



Your OSH preferred partner



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Publisher

NIOSH
Lot 1, Jalan 15/1, Section 15, 43650 Bandar Baru Bangi,
Selangor Darul Ehsan, Malaysia.
Tel : 03-8769 2100
Fax : 03-8926 2900
Email : penerbitan@niosh.com.my
Website : www.niosh.com.my

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GAS DETECTOR CALIBRATION LABORATORY (GCL)

Ts. Haji Mohd Esa Bin Haji Baruji, Mohd Fadzli Ismail & Muzhafar Bin Ibrahim
Consultation, Research and Development Department, NIOSH

1. INTRODUCTION TO Gas Detector Calibration Laboratory (GCL)

Background

There are a few terms used in the occupation for gas detectors such as gas detection instrument/ equipment, gas indicator, or atmosphere testing and monitoring equipment. Gas can be defined as a state of matter characterised by very low density and viscosity (relative to liquids and solids), comparatively great expansion and contraction with changes in pressure and temperature, ability to diffuse readily into other gases, and ability to occupy with almost complete uniformity the whole of any container (Gas Detection Handbook, 2007). Meanwhile, a gas detection instrument or gas detector is defined as a device composed of electrical, optical, mechanical, or chemical components that sense and respond to the presence of gas mixtures. Whereas, calibration is a procedure by which the performance of a detector is verified to maximise the accuracy of its readings. Calibration is performed by: (1) comparing the instrument with a known standard, and (2) adjusting the instrument reading to match the standard. Therefore, in short, gas detector calibration refers to an instrument's measuring accuracy relative to a known traceable concentration of test gas. The detector compares the sensor's response to a known concentration of test gas. Calibration ensures that the gas detector works accurately.

A gas detector can be used to detect combustible or flammable or explosive gas, toxic or noxious or irritant gas and oxygen gas. Common gases that are detected and calibrated are Carbon dioxide (CO₂), Oxygen (O₂), Methane (CH₄) or explosive gas (LEL), Hydrogen sulphide (H₂S) and Carbon monoxide (CO). They are commonly used in the Marine, Oil and Gas, Pharmaceutical, Process Industry, Petrochemical and sewerage industries.

Many lives have been lost throughout the world by confined space-related accidents. Most of the victims were either overcome by toxic fumes or died from gas explosions. The incidents generally reveal a marked lack of safety measures and complete disregard for occupational safety and health (OSH) legislation by employers and workers themselves. Most, however, can be brought down to lack of training, incompetence by supervisory management, cost cutting with personnel cutting corners to get the job done on time and within budget and a total lack of understanding that GAS CAN KILL! (Safe Working in Confined Spaces Edition 2, 2006).

In 2005, under the JICA-NIOSH building capacity project, NIOSH sent one of the staff to gain experience and knowledge about gas detectors at a few related government agency and education institutions in Tokyo & Fukuoka, Japan. Mr. Hj. Mohd. Esa bin Hj. Baruji, the acting manager of OSD was selected by the NIOSH management to be there for capacity-building purpose. He is a pioneer trainer and module developer for the NIOSH confined space programme, as well as in Malaysia. NIOSH also sent 2 officers namely Mr. Hj. Mohd. Esa and Mr. Mohd Nazif bin Mohd. Zaidan to Dräger Headquarter (R&D and Production) at Lubeck, Germany for familiarisation with gas detector production and technical Dräger Malaysia Sdn Bhd's (Subang, Selangor), Mr Robert Loh (Rtd). The programme focused on the inside of gas detector construction, structure, installation and commissioning. The training was delivered by the pioneer and technical expert in Dräger Headquarters. As an international leader in safety technology, Dräger develops innovative equipment and solutions trusted by people all over the world. No matter where Dräger products are used: it's always about life. Whether for use in industrial, clinical, or mining applications, in firefighting or rescue services, Dräger products protect, support and save lives. The slogan of "Technology for Life" means more than merely guaranteeing technical excellence. It means assuming responsibility for the lives of those who use the products and depend on them. Technology for Life is the guiding principle and the central challenge that draws on inspiration and motivation. GCL chose Dräger as benchmark because of its corporate culture and core capabilities, which include customer involvement, staff engagement, innovation, and quality.



Figure 1: In front of Dräger Germany



Figure 2 : Technical familiarisation Training



Figure 3 : Sharing session with Drager's technical expert



Figure 4 : Other training session with Drager's technical expert

Our Journey

Initially, NIOSH Gas Detector Calibration Laboratory (GCL) was established under the Industrial Hygiene Analytical Laboratory (IHAL) in 2009 with NIOSH financial allocation. The earlier team for GCL was:

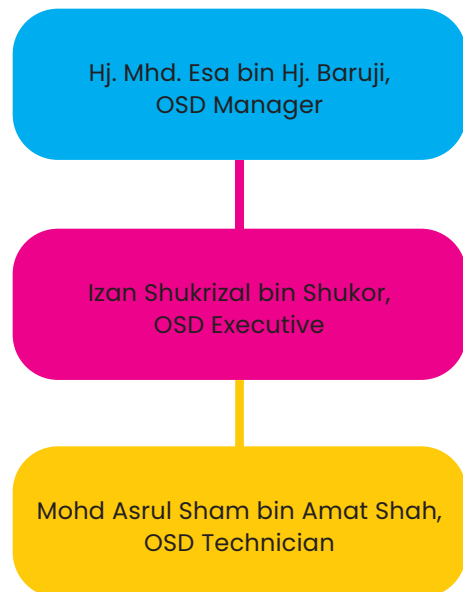


Figure 5 : GCL Organisation Chart (2009)

The idea to develop the GCL emerged after NIOSH identified the demand from industries related to the calibration of gas detectors while conducting classes and activities related to confined space programmes namely Authorised Entrant & Standby Person for Confined Space and Authorised Gas Tester & Entry Supervisor for Confined Space. GCL's mission is to assist industries in complying with the Industry Code of Practice for Safe Working in a Confined Space (ICOP CS) 2010, Occupational Safety and Health Act (OSHA) 1994 and Factories and Machinery (Safety, Health and Welfare) Regulations 1970. The requirement emphasize on ensuring safety in an atmosphere of ICOP CS 2010, and the essential calibration of gas detector - used at the workplace as in clause 8.6.5(b).

NIOSH has more than 150 gas detectors used for training, research, consultation and exhibition activity across the country (with 6 regional offices encompassing more than 10 site offices) that must be calibrated timely and properly to set the standard for the industry.

Indirectly, the laboratory, will save thousands of ringgit on calibration requirements. It will also become a venue for confined space programme participants' experiential learning, which will enhance their understanding of gas detector calibration as well as maintenance purposes. The laboratory is also open for external visits and collaboration. On average, a total of 50 visitors visited the laboratory yearly for various purposes.



Figure 6 : Function of GCL NIOSH

1. In 2011, GCL was restructured under the Occupational Safety Division (OSD), CRDD, NIOSH, meanwhile the manual and procedures are still documented by Industrial Hygiene Analytical Lab (IHAL). OSD was established to lead consultancy activities related to occupational safety, for instance, Confined Space Risk Assessment (CSRA), audit, and inspection. NIOSH's GCL indirectly expands its laboratory functions by involving CSRA activities and offer gas testing as well as monitoring in external operations. The establishment of this laboratory has also made GCL a reference laboratory in the study of confined space and gas detector calibration. GCL achieved another milestone when it was accredited with Skim Akreditasi Makmal Malaysia (SAMM) by the Department of Standards, Malaysia based on ISO/IEC 17025 under the field of Electrical Testing in 2016.



Figure 7 : Gas Detector Calibration Laboratory (GCL)

There were 2 residents approved signatories accredited under the scheme which are

1. Mr. Mohd. Esa bin Baruji and
2. Mr. Mohd Fadzli bin Ismail

In 2018, CRDD decided to combine all OSH laboratories under OSH Hazard Evaluation and Control Technology Centre (OSHECT), including GCL. In fulfilling the aspiration to be a leading centre of excellence in OSH, GCL also embarking on on-site calibration for portable gas detectors in the year 2022 (ongoing for SAMM accreditation extension of scope endorsement). In addition to the present approved signatories, Mr. Mohd Fikri bin Hakim Abdullah was proposed to be the on-site calibration approved signatory.

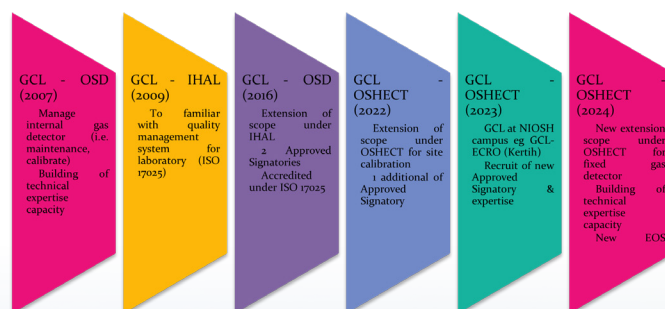


Figure 8 : Development of GCL in NIOSH from 2009 to 2025 (Planning)

To date, more than 250 units of portable gas detectors were successfully calibrated, comprising more than 10 different models. Currently, GCL is capable of calibrating detectors with a sensor such as Methane, Oxygen, Carbon monoxide, Hydrogen sulphide, Carbon dioxide, Chlorine (Cl₂), Ammonia (NH₃) and volatile organic compound (VOC). GCL also provides advisory services concerning the proper usage, maintenance and storage of the gas detector. GCL is committed to finding opportunities in developing this laboratory in the future as summarised in Figure 11.8 that also include the way forward. GCL hopes to provide the best quality service to our customers and it is our responsibility to fulfil the satisfaction of our customers.

GCL Team

Laboratory Advisor (LA)

Ts. Hj. Mohd. Esa is the Principal Consultant/ Principal Researcher at CRDD, NIOSH Malaysia since 2018. In 1997, he was awarded the Bachelor of Engineering in Electronics from the University of Manchester Institute Science & Technology (UMIST), Manchester, United Kingdom. He pursued his Masters in Industrial Safety Management from the National University of Malaysia on 2003. He is a registered:

1. Industrial Researcher in MyGRANTS, Ministry of Higher Education (Registration No.: 88067);
2. Assessment Panel for OSH Program – Malaysia Qualifications Agency (MQA) (APP MQA No.: 2252);
3. Ex-Officio of NIOSH to Malaysian Society for Occupational Safety and Health (MSOSH) (Membership No.: 1184); and
4. Professional Technologist in Manufacturing and Industrial Technology (ME) field (Certificate No.: PT20110256).

With nearly 25 years of working experience in industry and the institute, his passion for OSH is endless, which inspire him to become an expert in the OSH field. In the consultation area, he is specialised in 1) OSH legislation compliance (e.g. process safety management, confined space risk assessment), 2) OSH solutions (e.g. development of HIRARC, risk management, safety inspection, audit, OSH management system), 3) OSH advisory (e.g. customized/ in-house training development such as Electrical Safety, Lock Out Tag Out Test Out [LOTOTO], Permit To Work [PTW], OSH Induction), and 4) Laboratory services (e.g. advisor, laboratory management representative, approved signatory, equipment calibration, testing and industrial hygiene analytical process).

He was also involved in more than 11 OSH research projects as head project and researcher with amounted value of up to more than RM7 million. He has presented and published his research findings as well as written books at the national and international seminar/ conference levels.

He has also contributed to the nation as a central committee in OSHMP2025, NCOSH, HRD Corp, NSC W, OSH Lead auditor/ panel, trainer, assessor, examiner, approved signatory, guideline & laboratory advisor, journal editorial board & review panel, expert review, panel judge, prominent writer & author, lecturer, competent person (confined space & scaffolder). He was also involved in technical committee, working group and ex-officio during the formulation of the Malaysian Standards, Industry Code of Practices and Guidelines and National Occupational Skills Standard (NOSS) with :National Council of OSH (NCOSH), DOSH, Department of Skills Development (DSD), Ministry of Human Resources, SIRIM, Department of Standards Malaysia (DSM), Ministry of International Trade and Industry, CIDB, Ministry of

Works, and MSOSH. He had experience attending and consulting on relevant OSH competency and leadership programmes in a few countries such as Japan, Germany, Saudi Arabia, Singapore, Cambodia, India and Taiwan (The Republic of China).

2. GCL Services & Way Forward

Currently, the laboratory offers services such as gas detector calibration, research collaboration, inter-laboratory comparison and site calibration. The details are as below:

1. Gas detector calibration:
 - conducted in a controlled environment to comply with the calibration procedures;
 - performed in triplicate to acquire the best measurement uncertainty;
 - performed by competent personnel and technical experts; and the result is endorsed by the Approved Signatory, which is approved by the Department of Standards Malaysia.
2. Research calibration:
 - Gas sensor validation and verification for the marine sector;
 - Atmospheric measurement and monitoring in water tunnel; and
 - Atmospheric monitoring for air environment.
3. Inter-calibration comparison:
 - Proficiency test among the accredited laboratory for electrical testing; and
 - Sharing and exchanging information regarding gas detector calibration.
4. On-site Testing and Calibration (with the acceptable environmental condition):
 - In-house gas detector calibration at other NIOSH branch offices;
 - In-house gas detector calibration at client premise; and
 - Site testing at any venue especially at an industrial area/ park.
5. Exploring the scope of calibration for fixed/ permanent gas detector:
 - Focus on workplace areas such as calibration, workshop and workstation;
 - Extended to a public area such as a shopping complex, airport and public station.
6. Calibration with the manufacturer:
 - Sensor manufacturing and validation;
 - Certified technical centre for gas detector maintenance, repair and calibration.

Table 1 : Below is the summary of GCL activity:







Items	Activities/ Organisations	Year
Accreditation	ISO 17025:2017	2016
	Extension of Scope ISO 17025:2017: Site Calibration	2022
Talks/ Sharing	FB Live: The importance of calibration  https://fb.watch/d_0qkU35PN/	2021
Exhibition	Carnival OSH 4 US	2021
	Carnival OSH	2022
	World OSH Day	2022
Inter-Laboratory Comparison	One GasMaster Sdn Bhd	2019
	Active Acoustic Engineering Sdn Bhd	2020, 2021
	National Metrology Institute of Malaysia (NMIM)	2021
Collaboration	Universiti Malaysia Terengganu (UMT)	2022
Training	Drager: CC Vision instruction briefing	2012
	MSA: Operational and calibration for gas detector calibration	2012
Infographics	 https://gcl-infographic.tumblr.com/	2020 - 2021

Table 2 : List of gas detectors calibrated by GCL

Activities/ Organisations	Year
MSA 	Altair 5X
	Altair 5XiR
	Altair 4X
Dräger 	X-AM 8000
	X-AM2500
	X-AM 7000
	X-AM 3000
	X-AM 3500
	X-AM 5600
Rae System 	MultiRae PGM 6208
	MiniRae Lite PGM 7300
Bw Technologies 	MicroClip XL

3. FEW LIST OF GCL'S CLIENTS

1. PETRONAS Gas Berhad.
2. Linde Engineering Malaysia Sdn. Bhd.
3. EP Engineering Sdn Bhd.
4. Metcal Technologies Sdn Bhd.
5. Interglen Sdn. Bhd.
6. Bird Technology Sdn. Bhd.
7. Universiti Sains Malaysia (USM).

NIOSH Regional & Site Offices (Kepala Batas, Manjung, Ayer Keroh, Senai, Pengerang, Kuantan, Kertih, Kota Bahru, Kuching, Bintulu, Kapit, Miri, Labuan, Kota Kinabalu, Sandakan and Tawau).

4. ACHIEVEMENT AND ACTIVITIES SMM Accreditation

Schedule NO: SMM 412 (Issue 2, 1 March 2022 replacement of SMM 412 dated 18 April 2021) GAS DETECTOR CALIBRATION LABORATORY (GCL) SCOPE OF CALIBRATION: ELECTRICAL * The expanded uncertainties are based on an estimated confidence probability of approximately 95% and have a coverage factor of $k=2$ unless stated otherwise.			
Instrument Calibrated/ Measurement Parameter		Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm) [*]
Portable Gas Detector			
CH ₄		52 % LEL to 64 % LEL	1 % LEL (0.05 Vol%)
H ₂ S		18 ppm to 22 ppm	2 ppm
CO		57 ppm to 63 ppm	2 ppm
O ₂		14 Vol % to 16 Vol %	0.4 Vol %
CO ₂		2.3 Vol % to 2.7 Vol %	0.06 Vol %
Signatories:			
1. Mohd. Esa Baruji 2. Muhammad Akmal bin Muzhafar Azman Wong			

Figure 5 Researcher conducting face mask testing.



Figure 9 : Research Collaboration with Universiti Malaysia Terengganu (UMT)



Figure 10 : Visit to the National Metrology Institute of Malaysia (NMIM)



Figure 11 : Exhibition "OSH 4 All" at Port Dickson



Figure 12 : Visit from Authorised Gas Tester & Entry Supervisor (AGTES) for confined space participants program



Figure 14 : FB Live: OSHTalk



Figure 15 : Visit from Confined Space Safety (CST) participants



Figure 16 : Site Calibration Portable Gas Detector at NIOSH Regional Office

ANALYTICAL CHEMISTRY APPLICATION LABORATORY: DELIVERING PRECISION FOR RESEARCH AND SUSTAINABILITY

Dr Zalina Laili and Azian Hashim
 Waste Technology and Environment Division Malaysian Nuclear Agency

Analytical Excellence at the Malaysian Nuclear Agency

The Analytical Chemistry Application (ACA) Laboratory plays a vital role in supporting research, monitoring, and technical services that require exceptional analytical accuracy and precision. Established to support the Malaysian Nuclear Agency's chemical analysis work, the laboratory provides reliable, high-quality analytical services for government, industry, and research institutions. Equipped with state-of-the-art instruments, the ACA Laboratory conducts elemental and ion analyses on a wide range of environmental, industrial, and food samples for both public and private sectors. The laboratory's commitment to precision and quality ensures that every analysis contributes valuable scientific data for decision-making in environmental protection, industrial safety, and nuclear research.



Analysts at the Analytical Chemistry Application (ACA) Laboratory performing chemical and elemental analyses to support research and technical services

Comprehensive Analytical Capabilities

To meet diverse analytical needs, the ACA Laboratory offers a suite of advanced nuclear and conventional techniques:

- **Neutron Activation Analysis (NAA)** – A nuclear-based, non-destructive technique capable of detecting and quantifying more than 30 elements, including rare earth elements.
- **Inductively Coupled Plasma Mass Spectrometry (ICP-MS)** – A highly sensitive method used to measure trace and heavy metals at very low concentrations (ppb level).
- **Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES)** – Used for quantifying metals such as aluminium, calcium, copper, iron, magnesium, sodium, lead, and zinc at higher concentration levels (ppm range).
- **CHNS Analyzer** – Determines carbon, hydrogen, nitrogen, and sulfur content in various samples such as soil, plants, and sediment.
- **Ion Chromatography (IC)** – Enables precise determination of inorganic and organic anions and cations at concentrations as low as 0.5 ppm.

Through these analytical capabilities, the ACA Laboratory supports diverse projects such as environmental assessment studies, waste characterization, nuclear forensics, and quality control, providing essential analytical data that contribute to informed environmental management and decision-making.





Neutron Activation Analysis (NAA)



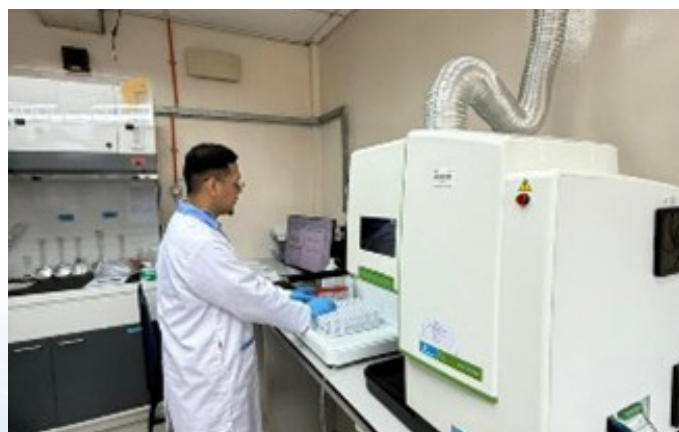
CHNS Analyzer



Ion Chromatography (IC)



Inductively Coupled Plasma Mass Spectrometry (ICP-MS)



Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES)

Research and Development (R&D) Activities

The Analytical Chemistry Application (ACA) Laboratory focuses its research and development (R&D) activities on four main areas: air quality, environmental forensics, nuclear forensics, and food safety. These research areas demonstrate the laboratory's commitment to applying analytical and nuclear techniques to address challenges in environmental protection, public safety, and sustainable development.

- **Air Quality:** Studies on atmospheric pollution, element distribution, and bioindicators to assess the environmental impact of industrial activities.
- **Environmental Forensics:** Investigations on contamination pathways, pollution source identification, and environmental monitoring for better management and regulatory support. This area also includes studies on marine and coastal pollution, microplastic assessment, sediment

transport tracing, elemental profiling for origin tracing, and nutrient studies on eutrophication and harmful algal blooms (HABs).

- **Nuclear Forensics:** Analytical characterization of radioactive and nuclear materials to support nuclear security, regulatory enforcement, and forensic investigations.
- **Food Safety:** Assessment of radionuclides and trace elements in food and water to ensure safety, quality, and compliance with regulatory standards.

Through these research areas, the ACA Laboratory continues to strengthen its analytical expertise and contribute to scientific advancement and environmental sustainability. Many of the ACA Laboratory's research programmes are supported through international collaborations and funding, including Coordinated Research Projects (CRPs) under the International Atomic Energy Agency (IAEA), the Regional Cooperative Agreement (RCA), and the Forum for Nuclear Cooperation in Asia (FNCA). These partnerships enhance technical capacity, promote knowledge sharing, and strengthen the laboratory's contribution to regional and global scientific initiatives.



Research and development activities at the Analytical Chemistry Application Laboratory (ACA), focusing on environmental, nuclear, and food-related analyses



Training and knowledge-sharing activities at the Analytical Chemistry Application (ACA) Laboratory to strengthen analytical skills and collaboration among researchers and students

Ensuring Quality and Reliability

Quality assurance lies at the heart of the ACA Laboratory's operations. The team implements stringent internal quality control procedures, participates in inter-laboratory comparison programs, and adheres to internationally recognised analytical standards. Every result is traceable, validated, and scientifically defensible, ensuring the highest level of confidence in research and regulatory applications. In line with continuous improvement, the Neutron Activation Analysis (NAA) Laboratory is working toward ISO/IEC 17025 accreditation to strengthen its credibility and ensure compliance with international standards. This strong focus on reliability and accuracy has positioned the ACA Laboratory as a trusted partner for government agencies, academic institutions, and industries. Its analytical services help clients achieve regulatory compliance, support innovation, and strengthen decision-making through credible, data-driven results.

Training, Collaboration, and Knowledge Sharing
Beyond analytical services, the ACA Laboratory contributes to capacity building through training and technical guidance. It regularly provides hands-on sessions for university students, equipping them with practical experience in analytical instrumentation and data interpretation. This initiative helps nurture the next generation of analytical chemists and supports

the growing research ecosystem. The laboratory also collaborates with research institutions and industry partners to exchange expertise in analytical methods, nuclear science applications, and quality assurance practices. These collaborations strengthen technical capacity and foster a culture of scientific excellence.

Strengthening Future Capabilities

As analytical needs continue to grow, the ACA Laboratory remains focused on expanding its capabilities through technological innovation, method development, and staff expertise. The team envisions a future where advanced chemical analysis continues to drive environmental stewardship, nuclear safety, and scientific progress.

By combining technical excellence, modern instrumentation, and a strong culture of quality, the Analytical Chemistry Application Laboratory continues to deliver precision in every analysis, strengthening research, protecting the environment, and promoting sustainable practices.



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Contact Us :

National Institute of Occupational Safety and Health Malaysia (NIOSH)
Institut Keselamatan dan Kesihatan Pekerjaan Negara (199201011539)
Kementerian Sumber Manusia



Lot 1, Jalan 15/1, Seksyen 15,
43650 Bandar Baru Bangi,
Selangor Darul Ehsan



Tel: 03-8769 2100
Fax: 03-8926 5655

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