AIHA UNIVERSITY™ Frameworks

Technical Framework

Guidance on Use of Direct Reading Instruments

aiha.org

Version 2 | June 29, 2020

About AIHA®

Founded in 1939, the American Industrial Hygiene Association® (AIHA®) is one of the largest international associations serving the needs of industrial/occupational hygiene professionals practicing in industry, government, labor, academic institutions, and independent organizations. For more information, visit www.AIHA.org

AIHA University™

AIHA University offers cutting-edge education and training developed for current and aspiring industrial hygiene and OEHS professionals. From face-to-face courses to online instruction to webinars and professional frameworks, AIHA University is your go-to-resource for affordable and accessible education at every step of your career.

Frameworks

AIHA® and its appointed members and volunteers worked collaboratively to develop the following guides, known as Frameworks, which outlines the knowledge and skills a competent person should possess and be able to demonstrate in a specific topic or specialty.

A **Technical Framework** defines the core knowledge and skills required by an individual for effective performance in a specific practice or expertise. These frameworks are widely used as a resource for individuals looking to expand or refresh their knowledge or skills or the development of a new training program within an organization.

This Framework is not intended to define or stipulate Direct-Reading Instruments practitioner criteria. It is the employer's responsibility to ensure that each employee understands their specific job and has met the minimum criteria established by relevant regulations and standards, and the specific industry, facility or project.

Acknowledgments

Recognizing the AIHA® members and volunteers who provided their time and expertise to this project:

Authors

- Dawn Bolstad-Johnson, MPH, CIH, CSP, FAIHA
- Robert Campbell, PE
- Tim Carter, MS, CIH
- Nancy Doherty, CIH
- Christopher Fish, CIH, CSP, REHS
- William Geer, MS, CIH
- Ashton Haus
- Donna S. Heidel, MS, CIH, FAIHA
- Joselito Ignacio, MA, MPH, CIH, CSP, REHS
- William J. Mills III, PhD, M.Sc., CIH, C.Chem.
- Justine Parker, CIH, CSP, CHMM, CPH
- Spencer Pizzani, MS, CIH, Registered Specialist - Exposure Decision Analysis
- Philip Smith, PhD, CIH, FAIHA
- John Snawder, PhD, DABT
- Ying Zhen, CIH, CSP

Contributors

- Stacy Calhoun, PMP
- Conor O'Malley

Abbreviations/Acronyms

ACGIH	American Conference of Governmental Industrial Hygienist
AIHA	American Industrial Hygiene Association
ANSI	American National Standards Institute
BoK	Body of Knowledge
CFR	Code Of Federal Regulations
DRI(s)	Direct-Reading Instrument(s)
FEMA	Federal Emergency Management Agency
HazMat	Hazardous Materials
KSA	Knowledge, Skills and Abilities
LOD	Limit of Detection
LOQ	Limit of Quantitation
NFPA	National Fire Protection Association
NIOSH	National Institutes of Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit
PPE	Personal Protective Equipment
ppm	parts per million (volume)
REL	Recommended Exposure Limit
RTDSC	Real-Time Detection Systems Committee
SESS	Standardized Equipment Specification Sheets
TLV	Threshold Limit Value
TWA	Time Weighted Average
(US)EPA	(United States) Environmental Protection Agency

Table of Contents

Version	Date	Comment
1	May 26, 2020	Initial version approved by Workgroup and AIHA board.
2	June 29, 2020	Editorial corrections only. No content changes.

Background

AIHA® and its members and volunteers worked collaboratively to develop the technical framework, known as the Body of Knowledge (BoK), which outlines the knowledge and skills a competent person should possess and be able to demonstrate when operating direct-reading instruments (DRIs). The subject-matter-expert project team included representatives from the AIHA® Real-Time Detection Systems Committee (RTDSC), government enforcement and research agencies, the industrial hygiene profession and academia.

In April 2019, a panel of subject-matter experts was selected to expand the body of knowledge for all users to competently employ all types of DRIs used in evaluation of chemical and physical agents and decision-making relevant to health, safety, and environmental evaluations, and in emergencies.

As a result, a draft BoK was created and made available to external stakeholders, allied professionals, and AIHA® members and volunteers to collect input, perspective, and feedback from relevant stakeholders to identify the essential knowledge and skills required for competent use of DRIs.

This BoK replaces the 2015 version (titled Field Use of Direct-Reading Instruments for Detection of Gases and Vapors) and is expanded to cover principles pertaining to all DRIs and all users in all applications for occupational health and safety. This revision includes updated knowledge, skills and abilities for competent usage of DRIs based on the degree of trust or responsibility vested in the user. Finally, the BoK identifies resources for improvement in the identified competencies.

1.0 | Purpose and Application

Purpose

The purpose of the Direct-Reading Instrument Body of Knowledge is to establish a practical framework for the appropriate use of DRIs, provide guidance on common challenges with their use, and identify references for the further development of competencies. This BoK applies to all DRIs, including those used for any chemical, physical, and biological agents or conditions.

AIHA is dedicated to protecting worker health by compiling and disseminating information to develop and advance the professional practice of DRI usage for the purpose of detection, identification and quantification of chemical or physical agents. With this BoK, AIHA hopes to improve the collective community of practice for the use of DRIs by individuals at all skill levels and reduce errors in DRI usage that contribute to avoidable illness, injury, and death among workers.

Application

This BoK establishes the knowledge, skills, and abilities (KSAs – collectively, competencies) required to appropriately operate a DRI based on the level of responsibility or trust invested in the user. This model was chosen by AIHA to provide an easily understood structure, visually organize the growth of competency required for role advancement, and provide context for existing structures and environments in which such instrumentation may be used. The competencies presented in this BoK are designed to encompass nearly all DRIs used to protect human health or to evaluate the environment.

AIHA does not intend to propose a method by which individual competencies can be verified, or by which an organization can evaluate a specific policy, program, or strategy. However, AIHA encourages the use of a method of verification whereby transfer or retention of KSAs are demonstrated or validated practically and independently. AIHA will use this BoK for the development of training programs.

This BoK provides guidance on common difficulties and current challenges in the appropriate use of DRIs. This content is provided to assist individuals in anticipating and avoiding conditions or actions that may lead to adverse outcomes. Each item described in this BoK were identified by concerned professionals based on their professional experiences.

The appropriate usage of DRIs requires alignment from a diverse set of stakeholders, including organizational leadership, technical professionals, administrators, and instrument manufacturers. AIHA believes that the content of this BoK is applicable to a wide range of professions, functions and roles at organizations of all sizes, and that it provides the most value when used as a common ground for discussion and advancement.

How to Use This Body of Knowledge

Individuals and organizations may use this BoK to improve, plan, or evaluate their usage of DRIs. Some questions that this BoK can help answer include:

- Do instrument users have the necessary competencies to operate an instrument appropriately?
- Does a given program or policy address the elements of appropriate use (such as functional testing)?
- Are workers at risk for any of these common difficulties?
- Does a training program evaluate all the identified competencies for basic users?
- Where can I find more information about DRI usage?

Individuals may find this BoK most useful to evaluate their capabilities in relation to the competencies identified for each tier of user, and to identify new competencies to develop and expand in order to warrant additional trust.

Organizations may find this BoK most useful in evaluating or establishing policies, programs, or procedures related to DRIs; reviewing or revising training and competency verification; developing guidance for purchasing and talent acquisition; benchmarking against industry standards; and identifying, evaluating, and managing risk.

2.0 | Direct Read Instrument (DRI) User Competencies

About User Competencies

This BoK identifies four tiers of the DRI user, based on the degree of trust (or responsibility) retained from individuals or organizations. Competencies are identified for each tier, which are the minimum KSAs required to appropriately operate instrumentation at that level. Each competency was carefully formulated by a team of instrumentation experts and is included because it was deemed of critical importance to the appropriate usage of DRIs for a specific tier. Users who require development in one or more competencies may use any combination of training, education, or experience to obtain the required KSAs. Each competency should be verified.

Individuals may possess a given competency for one type of instrument and may not possess the same competency for another type of instrument due to limitations on experience or education, or due to instrument complexity, or for other reasons. Competencies should be verified on the type of instrument intended for that user's role at that tier.

Tier 1 – Basic User

Basic Users operate specific DRI(s) as directed to collect information or monitor their own environment. They execute pre-determined actions based on instrument responses (such as alarms, data, and error messages). Basic Users know how to verify that an instrument has

been correctly prepared and know where to get support when an instrument is not functioning properly. A Basic User might be issued an instrument for their use at the beginning of a work shift.

What a Basic User would say: "I know how to make sure my instrument is working. I know what to do, or whom to tell, when it alarms or gives me trouble."

Basic Users may include but are not limited to:

- law enforcement officers assigned to assess a situation initially;
- a worker in a chemical manufacturing company operating in a potentially hazardous area where the hazards are known;
- a researcher working in a chemical laboratory who may need to evacuate under some conditions; and
- a worker performing inventory on volatile organic compounds (VOC) storage tanks.

Table 1: Tier 1 - Basic Users' Required KSAs and Competencies

Domains	Knowledge, Skills, and Abilities (KSAs)
1. Verify that the instrument is functioning correctly	
	a. Identify how to turn the instrument on/off, and set the appropriate mode of operation.
	b. Verify that equipment has been appropriately prepared for the intended use (e.g. periodic or preparatory calibration/verification, right sensor for environment).
	c. Confirm that the equipment is ready to use (e.g., on and actively monitoring, has enough power, time and date set, conduct pre-operational check).
	d. Understand instrument response times and how long it will take the instrument to respond.
2. Demonstrate proper usage	
	a. Understand what the instrument is meant to do.
	b. Understand what the instrument can and cannot detect.
	c. Understand the appropriate operating environment of the instrument (heat/cold, humidity, dusty condition, explosive environment, hazmat, clean room).
	d. Identify the potential for instrument interferences. (e.g., radio, humidity, temperature, presence of other chemicals)
	e. Describe where to place the instrument for monitoring, including considerations for instrument height.

3. Recognize and respond to instrument outputs and alarms	
	a. Identify information output when the instrument is running.
	b. Identify normal and acceptable levels and levels that require an action (e.g. evacuation, added ventilation, PPE use) on the instrument output.
	c. Ability to recognize alarms (what they sound, look or feel like) and the cause of the alarm (why they are going off).
	d. Knowledge of the pre-determined action(s) to take in response to alarm or instrument outputs or failure (e.g. evacuation).
	e. Respond to all instrument alarms as true alarms (never assume an alarm is false).
4. Troubleshooting	
	a. Recognize when the instrument is not operating properly.
	b. Know the pre-determined action(s) to take if the instrument is not operating properly.
	c. Understand where to get help.

Tier 2 - Intermediate User

Intermediate Users operate selected DRI(s) appropriate for characterized activities. They execute actions based on specific and pre-determined instructions or plans. Intermediate Users may assist Tier 1 Users on their team or elsewhere in their facility. They may maintain and prepare instruments for many Basic Users.

What an Intermediate User would say: "I know how to make sure my instrument, and those of my team, are working properly as part of a program."

Intermediate Users may include but are not limited to:

- a person with instrument calibration and maintenance responsibility at a firehouse;
- an instrument manager on an urban search and rescue team;
- an industrial hygiene technician in an environmental health and safety department;
- a safety specialist monitoring heat stress for a team of people; and
- a confined space attendant.

Table 2: Tier 2 - Intermediate Users' Required KSAs and Competencies	
Domains	**Knowledge, Skills, and Abilities (KSAs)**
1. Verify that the instrument is functioning correctly	
	a. Identify how to turn the instrument on/off, and set the appropriate mode of operation.
	b. Verify that equipment has been appropriately prepared for the intended use (e.g. periodic or preparatory calibration/verification, right sensor for environment).
	c. Confirm that the equipment is ready to use (e.g. on and actively monitoring, has enough power, time and date set, conduct pre-operational check).
	d. Understand instrument response times and how long it will take the instrument to respond.
	e. Understand how and when to perform functional test (bump test).
	f. Understand how and when to calibrate or zero the instrument.
2. Demonstrate proper usage	
	a. Understand what the instrument is meant to do.
	b. Understand what the instrument can and cannot detect.
	c. Understand the appropriate operating environment of the instrument (heat/cold, humidity, dusty condition, explosive environment, hazmat, clean room).
	d. Identify the potential for instrument interferences. (e.g., radio, humidity, temperature, presence of other chemicals)
	e. Describe where to place the instrument for monitoring, including considerations for instrument height.
	f. Identify potential cross sensitivity, sensor poisons and acceptable conditions for use.
	g. Configure the instrument, set alarm limits, set data logging parameters.
	h. Download, store and process instrument data.
3. Recognize and respond to instrument outputs and alarms	
	a. Identify information output when the instrument is running.
	b. Identify normal and acceptable levels and levels that require an action (e.g. evacuation, added ventilation, PPE use) on the instrument output.
	c. Ability to recognize alarms (e.g. what they sound, look or feel like) and the cause of the alarm (why they are going off).
	d. Knowledge of the pre-determined action(s) to take in response to alarm (e.g. evacuation, reporting).
	e. Respond to all instrument alarms as true alarms (never assume an alarm is false).
4. Troubleshooting	
	a. Recognize when the instrument is not operating properly.
	b. Know the pre-determined action(s) to take if the instrument is not operating properly.
	c. Understand where to get help.
	d. Understand when the instrument accuracy is compromised.
	e. Understand when the instrument needs to be recalibrated or zeroed.
	f. Understand when the instrument needs to be returned for manufacturer service.

Table 2: Tier 2 - Intermediate Users' Required KSAs and Competencies (continued)	
Domains	**Knowledge, Skills, and Abilities (KSAs)**
5. Equipment maintenance	
	a. Understand the required information to be included in the calibration logs/records.
	b. Understand the proper charging/power of instrument.
	c. Ensure proper cleaning (method, selected solvent, interval) of the instrument.
	d. Ensure proper storage of instrument.
	e. Identify periodic maintenance intervals and equipment components and consumables.
	f. Perform end user-service (sensor replacement, filter replacement).

Note. Shaded boxes are unique competencies to this specific tier.

Tier 3 – Specialist User

Specialist Users employ the appropriate DRI(s) for each need based on their understanding of instrument capabilities and the circumstances of use. They possess the technical knowledge required to design sampling plans, evaluate uncharacterized environments, and interpret and present data to make determinations. Specialist Users understand the general principle of operation for instruments and can execute end-user troubleshooting. They ensure that the correct instruments are employed by Intermediate and Basic Users.

What a Specialist User would say: "I know how to select direct read instruments for exposure assessments. I know how to set-up sampling strategies for specific agents and unknown environments. I know how to respond to and address instrument abnormalities. I can set-up data management plans and data monitoring parameters. I can interpret data."

Specialist Users may include but are not limited to:

- an industrial hygienist using DRI for exposure assessment;
- a hazmat team leader responsible for characterizing unknown environments; and
- an incident safety officer hazmat fire captain, hazmat lieutenant, FEMA task force responder, and safety oversight practitioner.

Table 3: Tier 3 - Specialist Users' Required KSAs and Competencies	
Domains	**Knowledge, Skills, and Abilities (KSAs)**
1. Verify that the instrument is functioning correctly	
	a. Identify how to turn the instrument on/off, and set the appropriate mode of operation.
	b. Verify that equipment has been appropriately prepared for the intended use (e.g. periodic or preparatory calibration/verification, right sensor for environment).
	c. Confirm that the equipment is ready to use (e.g. on and actively monitoring, has enough power, time and date set, conduct pre-operational check).
	d. Understand instrument response times and how long it will take the instrument to respond.
	e. Understand how and when to perform functional test (bump test).
	f. Understand how and when to calibrate or zero the instrument.
2. Demonstrate proper usage	
	a. Understand what the instrument is meant to do.
	b. Understand what the instrument can and cannot detect.
	c. Understand the appropriate operating environment of the instrument (heat/cold, humidity, dusty condition, explosive environment, hazmat, clean room, etc.).
	d. Identify the potential for instrument interferences (e.g., radio, humidity, temperature, presence of other chemicals).
	e. Describe where to place the instrument for monitoring, including considerations for instrument height.
	f. Identify potential cross sensitivity, sensor poisons and acceptable conditions for use.
	g. Configure the instrument, set alarm limits, set data logging parameters.
	h. Download, store and process instrument data.
	i. Create monitoring plans for predictable environments.
	j. Identify necessary uses and limitations of DRI.
3. Recognize and respond to instrument outputs and alarms	
	a. Identify information output when the instrument is running.
	b. Identify normal and acceptable levels and levels that require an action (e.g. evacuation, added ventilation, PPE use) on the instrument output.
	c. Ability to recognize alarms (what they sound, look or feel like) and the cause of the alarm (why they are going off, etc.).
	d. Knowledge of the pre-determined action(s) to take in response to alarm (e.g. evacuation, reporting, etc.).
	e. Respond to all instrument alarms as true alarms (never assume an alarm is false).
	f. Determine when to apply correction factors when applicable, if the instrument is not calibrated to the targeted agent.

Table 3: Tier 3 - Specialist Users' Required KSAs and Competencies (continued)	
Domains	**Knowledge, Skills, and Abilities (KSAs)**
4. Troubleshooting	
	a. Recognize when the instrument is not operating properly.
	b. Know the pre-determined action(s) to take if the instrument is not operating properly.
	c. Understand where to get help.
	d. Understand when the instrument accuracy is compromised.
	e. Understand when the instrument needs to be recalibrated or zeroed.
	f. Understand when the instrument needs to be returned for manufacturer service.
5. Equipment maintenance	
	a. Understand the required information to be included in the calibration logs/records.
	b. Understand the proper charging/power of instrument.
	c. Ensure proper cleaning (e.g. method, solvent, interval) of the instrument.
	d. Ensure proper storage of instrument.
	e. Identify periodic maintenance intervals and equipment components and consumables.
	f. Perform end user-service (sensor replacement, filter replacement).
6. Instrument selection	
	a. Understand how characterization of an environment informs selection of instrumentation.
	b. Understand how hazard characteristics relate to instrument selection.
	c. Understand general limitations of the instrument and how different DRI can be used in concert with other approaches.
	d. Ensure the instrument is safe and appropriate for the environment.
	e. Complete a systematic evaluation of the performance characteristics (limit of quantification, resolution, response time) and feature set of the instrument to determine fitness for purpose (See Appendix B for the AIHA SESS).
	f. Employ proper DRI for anticipated hazards in operational conditions.
	g. Identify hazards that may arise from unusual conditions.
	h. Create justification for correct instrument purchases.
	i. Understand how multiple instrument types can be used to characterize unknown environments.
7. Data interpretation	
	a. Interpret the instrument data to take pre-determined actions.
	b. Calculate values from instrument output data when applicable.
	c. Compare data to established values.

Note. Shaded boxes are unique competencies to this specific tier.

Tier 4 – Advanced User

Advanced Users evaluate DRI performance and qualify the DRI for use based on instrument performance and fitness for purpose. These users understand the technical principles of operation and may develop novel techniques or new technologies to evaluate unusual conditions and design new methods. These users investigate and solve complex problems and unpredictable situations, and they may provide programmatic oversight. They add value on emergency response strategies; instrument selection; and detection method selection, modification, and development.

What an Advanced User would say: "I have a comprehensive range of knowledge of DRIs and I am capable of recognizing limitations of instruments that I am using or recommending for use. I understand what the instruments can detect, and more importantly, what they cannot detect as well as how they fit into the design of sampling strategies."

Advanced Users include but are not limited to:

- a testifying subject matter expert in DRI;
- a user of complex detection technology;
- a person responsible for characterizing a work environment for reoccupancy after a significant hazmat event; and
- a researcher designing detection technology and methods for emerging hazards.

Table 4: Tier 4 - Advanced Users	
Domains	**Knowledge, Skills, and Abilities (KSAs)**
1. Verify that the instrument is functioning correctly	
	a. Identify how to turn the instrument on/off, and set the appropriate mode of operation.
	b. Verify that equipment has been appropriately prepared for the intended use (e.g. periodic or preparatory calibration/verification, right sensor for environment).
	c. Confirm that the equipment is ready to use (on and actively monitoring, has enough power, time and date set, conduct pre-operational check).
	d. Understand instrument response times and how long it will take the instrument to respond.
	e. Understand how and when to perform functional test (bump test).
	f. Understand how and when to calibrate or zero the instrument.
2. Demonstrate proper usage	
	a. Understand what the instrument is meant to do.
	b. Understand what the instrument can and cannot detect.
	c. Understand the appropriate operating environment of the instrument (heat/cold, humidity, dusty condition, explosive environment, hazmat, clean room, etc.).
	d. Identify the potential for instrument interferences (e.g., radio, humidity, temperature, presence of other chemicals).
	e. Describe where to place the instrument for monitoring, including considerations for instrument height.
	f. Identify potential cross sensitivity, sensor poisons and acceptable conditions for use.
	g. Configure the instrument, set alarm limits, set data logging parameters.
	h. Download, store and process instrument data.
	i. Create monitoring plans for predictable environments.
	j. Identify necessary uses and limitations of DRI.
	k. Create, review and approve monitoring plans for predictable and unpredictable situations.
3. Recognize and respond to instrument outputs and alarms	
	a. Identify information output when the instrument is running.
	b. Identify normal and safe levels on the instrument output.
	c. Ability to recognize alarms (what they sound, look or feel like) and the cause of the alarm (why they are going off).
	d. Knowledge of the pre-determined action(s) to take in response to alarm (e.g. evacuation, reporting, etc.).
	e. Respond to all instrument alarms as true alarms (never assume an alarm is false).
	f. Determine when to apply correction factors when applicable, if the instrument is not calibrated to the targeted agent.

Table 4: Tier 4 - Advanced Users (continued)	
Domains	**Knowledge, Skills, and Abilities (KSAs)**
4. Troubleshooting	
	a. Recognize when the instrument is not operating properly.
	b. Know the pre-determined action(s) to take if the instrument is not operating properly.
	c. Understand where to get help.
	d. Understand when the instrument accuracy is compromised.
	e. Understand when the instrument needs to be recalibrated or zeroed.
	f. Understand when the instrument needs to be returned for manufacturer service.
5. Equipment maintenance	
	a. Understand the required information to be included in the calibration logs/records.
	b. Understand the proper charging/power of instrument.
	c. Ensure proper cleaning (method, solvent, interval) of the instrument.
	d. Ensure proper storage of instrument.
	e. Identify periodic maintenance intervals and equipment components and consumables.
	f. Perform end user-service. (sensor replacement, filter replacement)
6. Instrument selection	
	a. Understand how characterization of an environment informs selection of instrumentation.
	b. Understand how hazard characteristics relates to instrument selection.
	c. Understand general limitations of the instrument and how different DRIs can be used in concert with other approaches.
	d. Ensure the instrument is safe and appropriate for the environment.
	e. Complete a systematic evaluation of the performance characteristics (e.g. limit of quantification, resolution, response time) and feature set of the instrument to determine fitness for purpose. (See Appendix B for the AIHA SESS).
	f. Employ proper DRI for anticipated hazards in operational conditions.
	g. Identify hazards that may arise from unusual conditions.
	h. Create justification for correct instrument purchases.
	i. Understand how multiple instrument types can be used to characterize unknown environments.
	j. Identify instrumentation for use in new, unusual or complex situations.
	k. Demonstrate comprehensive understanding of the range of detection capabilities and the principles of operation of DRIs and related technologies.
7. Data interpretation	
	a. Interpret the instrument data to take pre-determined actions.
	b. Calculate values from instrument output data when applicable.
	c. Compare data to established values.

Note. Shaded boxes are unique competencies to this specific tier.

3.0 | Guidance on DRI Usage

In addition to establishing specific competencies for the use of DRIs, appropriate usage includes avoiding misapplications which may result in injury, illness, or death.

The authors of this BoK have identified several factors common to misuse of DRIs. These factors are presented below with guidance to build awareness and prevent illness and injury.

Basic Understanding of Instrument Operation

Using any instrument requires basic understanding of instrument operation. Among considerations for how the instrument is used are factors such as operability (is it on?), orientation and placement, operating conditions, consumable components, sensor response time, sensor minimum or maximum detectable magnitudes, and battery life.

Instrument users must understand key principles of operation to ensure valid instrument response.

Incomplete Hazard Evaluation

DRIs cannot replace a hazard evaluation that determines what agents might be present. Evaluating and employing an instrument requires understanding the context of use as well as the agent(s) to be monitored.

Although DRIs can be used for screening and characterization, consideration should be given to potential hazards they may not detect. If necessary, DRIs should be used as part of a process that includes a complete hazard evaluation, in conjunction with other methods.

Qualification and Selection of Instruments

Evaluating and selecting an instrument requires an understanding of the agents to be monitored, the context of monitoring, and the performance characteristics of the potential instruments to be used. Performance characteristics can vary widely between and within instrument classes, makes and models, and sensors. These characteristics must be considered in relation to critical factors such as types of agents detected, limit of quantification for a specific agent, and accuracy of detection. Collectively, an instrument

must be fit for purpose for the identified context. It is possible to select an instrument that detects a specific agent but is not fit for purpose for other reasons.

Systematic Evaluation of Performance Characteristics

Evaluating instruments is a complex task and should be approached carefully, especially for unusual agents or conditions. The AIHA Real-Time Detection Systems Committee has developed a Standardized Equipment Specification Sheet (SESS), which can be found in Appendix B. The SESS was developed based on an identified need to assist users with identifying relevant equipment performance characteristics (such as limit of quantification, resolution, or response time) to determine fit for purpose. The SESS can be used for any kind of DRI. Completing a systematic evaluation can prevent errors caused by misunderstanding the capabilities of an instrument or sensor. Such an evaluation also can reduce the risk of accidents resulting from instrument misuse or reliance on an instrument that is not fit for purpose.

The instrument feature set should also be evaluated, which may include factors such as radio communications, data interface type, and display illumination.

Sensor Cross-Sensitivities

Sensors are designed to respond to specific chemical or physical agents, or classes of agents. In many cases, the presence of other agents may interfere with accurate detection. This interference is known as cross-sensitivity, and it may cause readings to be inaccurately high or low, or produce no reading at all even when the agent in question is present. For example, some carbon monoxide electrochemical sensors will also respond to hydrogen or acetylene.

When documentation is unclear, contact the manufacturer or perform verification testing.

Correction Factors

Correction factors are applied before (by programming) or after (by calculation) the detection of a specific agent to identify the magnitude of another.

Some users erroneously believe that an instrument that detects a class of agents will be able to distinguish between those agents. This belief may lead to conditions where an instrument provides a reading, but the actual concentration of the target agent is different.

As a rule of thumb, if the target agent and the calibration agent are different, a correction factor is needed.

Deadbanding, Limit of Detection and Limit of Quantification

Deadbanding is the practice of filtering the display of an instrument based on the range of readings. For example, an instrument may be programmed to provide a reading of 0 ppm at all concentrations below a detection of 0.23 ppm. Over a set value, a concentration will be displayed. Deadbands may not be explicitly identified in instrument documentation. If a deadband is below a relevant exposure limit, the user may believe that there is no detection whereas in fact an exposure limit is actually exceeded.

Each instrument also has a limit of detection (LOD) and limit of quantification (LOQ). Below the LOD, the agent may be present but is too low for the instrument to register a response. Below the LOQ, the agent may be detected but cannot be quantified. LOD and LOQ may vary between models or sensors that are interchangeable within the same instrument, or between models of the same make.

Before qualifying an instrument for use, ensure that the LOD, LOQ, and deadbands are clearly understood and appropriate relative to the agent and conditions of use. This is especially important if detections need to be made at low magnitudes, or if they may affect the ability to escape from a hazardous area. Special caution should be used with agents for which any detection indicates the presence of unacceptable risk.

Reality Check on Results

Evaluating and employing an instrument requires understanding the context of use as well as the agent(s) to be monitored. The judgment of the user is also important. When results are identified that seem counterintuitive, unusual, or questionable, additional review should be conducted.

Common examples include “zero” readings where some background should exist, negative readings, or readings that are extremely high relative to the expected range of values. Instruments cannot provide a reality check for results or conditions. Performing operability checks and verifying against independent instruments is recommended when inexplicable results are identified.

Inappropriate Termination of Monitoring and User Uncertainty

In the experience of the authors, in serious accidents where DRI usage was a key control, investigations have often identified that the instrument used for monitoring was turned off at the time of the incident. Reasons for this vary. They may include habituation of employees to acceptable conditions, pressures on employees related to productivity, alarm fatigue, or insufficient battery life.

Additionally, users must understand what actions are appropriate based on alarms, unusual or suspicious monitoring results, or instrument inoperability. User uncertainty may lead to actions that are inappropriate for conditions or that undermine the effectiveness of monitoring, such as termination of monitoring, silencing alarms, or ignoring trouble conditions.

Those responsible for determining procedures should do the following: clearly establish conditions under which monitoring may terminate, stipulate how to respond to important warning factors or trouble conditions, and communicate when (and to what degree) user judgment may be exercised. Verification should be performed to ensure that any such procedures are followed.

Human Factors in DRI Usage

Instrumentation is only as effective as the manner and context in which it is used. When instruments are operated directly by individuals, human factors should be considered, including:

- cognitive biases, such as the optimism bias (“It won’t happen to me”);
- habituation to acceptable results in succession;
- annoyance at alarms, especially when loud or frequent;
- dependence on interpreting single-mode signals (such as a “fault light”);
- tendency to chunk tasks or build incomplete schema; and
- concerns over reprisal for reporting trouble or causing delays.

When the role of DRIs in any process is established, these six factors should be considered to ensure reinforcement of the desired behavior of users.

4.0 | Training Resources

Manufacturer's training is always the first resource for a particular instrument. Many manufacturers have in-depth training on their specific instruments. It is important to learn the basic operational features of a particular DRI directly from the manufacturer. This Body of Knowledge should serve as a guide of transfer of knowledge for the skills identified for each user tier of responsibility.

- Manufacturers training: required, recommended, certified
- Organizational training: in-house, instructor, verification
- AIHA courses/Professional development courses (PDCs)
    - Advanced Application of 4-Gas/PID Sensor Technology
    - Introduction to New Knowledge for Real-Time Detection Systems Equipment – NEW!
    - Methods and Applications for Real-Time Chemical Detection – Day 2
    - Certificate Program: Field Use of Direct Reading Instruments for the Detection of Gases and Vapors-Operations Level

5.0 | Resources

The following resources, reviewed by designated subject-matter experts, are provided as a means to gain knowledge in the use of DRIs for gas and vapor detection.

- ACGIH. (2009a). Calibration of Gas and Vapor Samplers. A monograph of the ACGIH Air Sampling Instruments Committee. Cincinatti, OH, American Conference of Governmental Industrial Hygienists (ACGIH) pages.
- ACGIH. (2009b). Confined Space Testing. A monograph of the ACGIH Air Sampling Instruments Committee. American Conferenceof Governmental Industrial Hygienists (ACGIH). pages.
- ACGIH (2009c). *Direct-Reading Instruments for Gas and Vapor Detection A Monograph of the ACGIH(R) Air Sampling Instruments Committee*. ASI18, Cincinnatti, OH, American Conference of Governmental Industrial Hygienists (ACGIH). https://www.acgih.org/forms/store/ProductFormPublic/direct-reading-instruments-for-gas-and-vapor-detection
- ACGIH (2009d). *An Overview of Air Sampling Methodologies: Instrumentation and Analytical Techniques for Evaluation of Atmospheric Contaminants:A Monograph of the ACGIH(R) Air Sampling Instruments Committee*, American Conference of Governmental Industrial Hygienists (ACGIH). https://www.acgih.org/forms/store/ProductFormPublic/an-overview-of-air-sampling-methodologies-instrumentation-and-analytical-techniques-for-evaluation-of-atmospheric-contaminants
- AIHA. (2016). The Future of Sensors: Protecting Worker Health Through Sensor Technologies. Falls Church, VA, American Industrial Hygiene Association. 100 pages. https://aiha-assets.sfo2.digitaloceanspaces.com/AIHA/resources/Get-Involved/AIHA_Future-of-Sensors_web_updated.pdf
- ANSI (2016). ANSI/ASSE Z117.1-2016: Safety Requirements for Entering Confined Spaces, ANSI/ASSP. https://webstore.ansi.org/Standards/ASSE/ANSIASSEZ1172016
- Chou, J. (1999). *Hazardous gas monitors : a practical guide to selection, operation and applications*. New York, McGraw-Hill.
- IAFF (2001). Detection Devices Air Sampling Instruments, Unit 6 In *IAFF Training for Hazardous Materials: Technician Manual, IAFF No. 0031*, International Association of Fire Fighters (IAFF).p.
- NFPA (2018). NFPA 472: Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents, National Fire Protection Association. https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=472

- NIOSH. (2019). "Right Sensors Used Right: A Life-cycle Approach for Real-time Monitors and Direct Reading Methodologies and Data. A Call to Action for Customers, Creators, Curators, and Analysts." Accessed Dec. 08, 2019, from https://blogs.cdc.gov/niosh-science-blog/2019/05/16/right-sensors-used-right/.
- NSC (2012). Ch. 17: Direct Reading Instruments for Gases, Vapors and Particulates, In *Fundamentals of Industrial Hygiene*,. B.A. Plog and PJ Quinlan. Itasca,IL, National Safety Council (NSC).p.
- OSHA. "Direct 'Readiing Instruments." Accessed, from https://www.osha.gov/SLTC/directreadinginstruments/standards.html.
- OSHA (2014). Section II: Chapter 3-Technical Equipment: On-site Measurements, In *OSHA Technical Manual (OTM) -OSHA Instruction TED 01-00-015 [TED 1-0.15A]*, Occupational Safety and Health Administration (OSHA).p. https://www.osha.gov/dts/osta/otm/otm_ii/otm_ii_3.html
- OSHA (2019a) "Code of Federal Regulations (CFR)." 29 CFR 1910. 120 -Hazardous waste operations and emergency response. DOI. accessed. https://www.ecfr.gov/cgi-bin/text-idx?SID=d25e9cadf9258f12070b3b6ba507c905&mc=true&node=se29.5.1910_1120&rgn=div8
- OSHA (2019b). Permit-required confined spaces. Washington, DC, OSHA29 CFR 1910.146. https://www.ecfr.gov/cgi-bin/text-idx?SID=ee31852d2e6fa18e38dcc52a4cbbd09f&mc=true&node=se29.5.1910_1146&rgn=div8
- Owens, P. (2017). Purchasing the Best Instrument *The Synergist*. Falls Church, VA, AIHA pages. https://synergist.aiha.org/201707-purchasing-the-best-instrument
- Smith, P. A. and G. W. Cook, Eds. (2013). *Important Instrumentation and Methods for the Detection of Chemicals in the Field*. Falls Church, VA, American Industrial Hygiene Association (AIHA). https://online-ams.aiha.org/amsssa/ecssashop.show_product_detail?p_mode=detail&p_product_serno=2020&p_cust_id=271399&p_order_serno=&p_promo_cd=&p_price_cd=&p_category_id=&p_session_serno=46305390&p_trans_ty=
- USEPA. (1995). Emergency Response To Hazardous Material Incidents. Office of Solid Waste and Emergency Response (OSWER).

Appendix A | How to Evaluate Competencies

There are many ways to evaluate competencies for each Tier described in this Body of Knowledge. This table is not intended to be mandatory; it is provided as a guide to be used in the evaluation of competencies described in each tier.

DOMAINS	APPLICABLE Tier User Levels				DEMONSTRATION OF TRANSFER OF KNOWLEDGE
1. Verify that the instrument is functioning correctly					
COMPETENCIES	***TIER LEVELS***				***EVALUATION***
	1	***2***	***3***	***4***	
a. Identify how to turn the instrument on/off, and set the appropriate mode of operation.	X	X	X	X	Demonstrate where the on/off button is located and how to operate it, and how to adjust modes of operation (e.g. measurement parameters, survey mode versus catalogue).
b. Verify that equipment has been appropriately prepared for the intended use (e.g. periodic or preparatory calibration/ verification, right sensors for environment).	X	X	X	X	Demonstrate how to review the equipment to determine if it has been calibrated and if the alarms (if applicable) have been set for the user.
c. Confirm that the equipment is ready for use. (e.g. on and actively monitoring, has enough power, time and date set, conduct pre-operational check).	X	X	X	X	Demonstrate that they understand how to recognize that the equipment is on: what the display looks like when it is "on" compared to when it is "off." Determine if the equipment was properly setup and charged.
d. Understand instrument response times and how long it will take the instrument to respond.	X	X	X	X	Demonstrate that they understand instrument response times. How long does it take for the reading to get to the instrument output?
e. Understand how and when to perform functional test (bump test).		X	X	X	Describe when a functional/bump test must be conducted. Explain the purpose of the test. Demonstrate how to conduct a functional/bump test. Describe how to do a field check to ensure that the instrument is responding correctly. For example, on an oxygen meter, the user could exhale on the instrument, observe the instrument go into alarm, and then, observe the reading bounce back to normal.
f. Understand how and when to calibrate or zero the instrument.		X	X	X	Describe when instrument calibration must be conducted. Explain the purpose of calibration. Demonstrate how to calibrate or explain where to send the device for calibration.

DOMAINS	APPLICABLE Tier User Levels				DEMONSTRATION OF TRANSFER OF KNOWLEDGE
2. Demonstrate proper usage					
COMPETENCIES	***TIER LEVELS***				***EVALUATION***
	1	***2***	***3***	***4***	
a. Understand what the instrument is meant to do.	X	X	X	X	Summarize the understanding of why a DRI is being used in the work environment. Does the instrument alert the user to a hazardous atmosphere/environment? Is the instrument to log exposure for routine assessment?
b. Understand what the instrument can and cannot detect.	X	X	X	X	Summarize what the real-time instrument can and cannot detect. For instance, a combustible gas meter cannot be used to measure "toxic" gases; a slow response noise dosimeter cannot be used for impulse/ impact noise.
c. Understand the appropriate operating environment of the instrument (e.g. heat/cold, humidity, dusty condition, explosive environment, hazmat, clean room).	X	X	X	X	Explain the operating limits of the instrument - for example, if it is being used in hot or cold ambient temperature extremes or humidity levels out of the range. What conditions (e.g. rain, extreme dust, electromagnetic fields, incompatible gases/sensor poisons) may limit the DRI from working correctly?
d. Identify the potential for instrument interferences (e.g. radio, humidity, temperature, presence of other chemicals).	X	X	X	X	Orally describe all instrument interferences – radio, humidity, temperature, cross sensitivities. The user should understand what interferences can impact the reading on the instrument.
e. Describe where to place the instrument for monitoring, including considerations for instrument height.	X	X	X	X	Summarize the understanding of the difference in monitoring height for the work environment. Where is it appropriate to attach a DRI to oneself/clothing? (e.g. breathing zone, collar, hardhat, waist, inside or outside coverall/chemical protective clothing?) What is the consequence of attaching a DRI in the wrong place? Does the user understand the concept of breathing zone? Do they know the difference and potential hazards if wearing an instrument at belt height or at shoulder height and why those differences matter?
f. Identify potential cross sensitivity, sensor poisons, and acceptable conditions for use.		X	X	X	Explain what incompatible non-target agents may impact the accuracy of the DRI and where to obtain information on DRI incompatibilities.
g. Configure the instrument, set alarm limits, set data logging parameters.		X	X	X	Demonstrate pre-operational instrument setup to include setting alarm limits, data logging, correction factors, units, and time and date.
h. Download, store and process instrument data.		X	X	X	Demonstrate how to download data and how the information would be processed.
i. Create Monitoring Plans for predictable environments.			X	X	Describe how to create a monitoring plan and what each DRI would detect.
j. Identify necessary limitations of DRI.			X	X	Identify limitations of DRI and how the limitations could be used as a method of evaluation. For example: using an oxygen sensor as a broad band detector.

k. Create, review and approve monitoring plans for predictable and unpredictable situations.				X	Describe how to create a monitoring plan for an unpredictable situation.

DOMAINS	APPLICABLE Tier User Levels				DEMONSTRATION OF TRANSFER OF KNOWLEDGE
3. Recognize and respond to instrument outputs and alarms					
COMPETENCIES	***TIER LEVELS***				***EVALUATION***
	1	***2***	***3***	***4***	
a. Identify information output when the instrument is running.	X	X	X	X	Describe what information is provided by the instrument when it is running (e.g. lights, display information).
b. Identify normal and safe levels on the instrument output.	X	X	X	X	Describe what "normal acceptable levels" are on the instrument output. Describe hazardous or unacceptable levels that require action.
c. Ability to recognize alarms (what they sound, look or feel like) and the cause of the alarm (why they are going off).	X	X	X	X	Describe the purpose of the alarm on the instrument and be able to recognize the sound and/or feel of the alarm(s).
d. Knowledge of pre-determined action(s) to take in response to alarm (e.g. evacuation, reporting).	X	X	X	X	Orally describe what actions to take in response to an instrument alarm.
e. Respond to all instrument alarms as true alarms (never assuming an alarm is false).	X	X	X	X	Summarize the understanding what to do in the event of an alarm (The user should know to leave the work area immediately). There should be pre-determined procedures for alarms so that the user is not trying to turn the alarm off in a hazardous environment. Users should fully understand the potentially serious consequences of silencing or ignoring alarms.
f. Determine when to apply correction factors when applicable if the instrument is not calibrated to the targeted agent.			X	X	Summarize the understanding of the concept of correction factors and demonstrate when to use them (if the instrument is calibrated to methane but the environment monitored as a gasoline spill).

DOMAINS	APPLICABLE Tier User Levels				DEMONSTRATION OF TRANSFER OF KNOWLEDGE
4. Troubleshooting					
COMPETENCIES	***TIER LEVELS***				***EVALUATION***
	1	***2***	***3***	***4***	
a. Recognize when the instrument is not operating properly.	X	X	X	X	Recognize when the instrument is not operating properly (clogged line, no lights, no sound, error messages, blank display) and should understand that they must leave the work environment to a safe area to troubleshoot the instrument.

b. Know the pre-determined action(s) to take if the instrument is not operating properly.	X	X	X	X	Describe the pre-determined actions to take if the instrument is not operating properly (evacuate the area).
c. Understand where to get help.	X	X	X	X	Explain whom to contact for help when the instrument is not working correctly. Explain what to do when the instrument is not working correctly (e.g. the user should understand not to continue working with an instrument that is not functioning properly).
d. Understand when the instrument accuracy is compromised.		X	X	X	Explain conditions that may reduce the accuracy of instrument response or otherwise make the instrument unreliable.
e. Understand when the instrument needs to be recalibrated or re-zeroed.		X	X	X	Explain when and why an instrument may need to be recalibrated or re-zeroed. (instrument drift, sensor saturated/overloaded).
f. Understand when the instrument needs to be serviced by the manufacturer.		X	X	X	Explain when the DRI must be returned to the manufacturer. What types of end-user servicing does the manufacturer allow and not allow for your device?

DOMAINS	APPLICABLE Tier User Levels				DEMONSTRATION OF TRANSFER OF KNOWLEDGE
5. Maintenance					
COMPETENCIES	***TIER LEVELS***				***EVALUATION***
	1	***2***	***3***	***4***	
a. Understand the required information to be included in the calibration logs/records.		X	X	X	Specify what information should be recorded/logged to document instrument calibration, and specify the retention schedule for records.
b. Understand the proper charging/power of instrument.		X	X	X	Explain how to maintain the DRI in state of readiness. Is the device always plugged in? Is there a charging period required prior to use?
c. Ensure proper cleaning of the instrument.		X	X	X	Explain standard cleaning and/or decontamination of the device. When must the DRI be cleaned? Are internal components cleaned or replaced on a scheduled basis?
d. Ensure proper storage of instrument.		X	X	X	Describe how and where the instrument is stored. Always on charger? In a clean dry storage location?
e. Identify periodic maintenance intervals and equipment components and consumables.		X	X	X	Explain the scheduled maintenance tasks for the device and intervals for each task for the device. Know what components must be replaced (e.g. filters, bulbs) if there is a periodic replacement schedule, or when components and consumables must be replaced.
f. Perform end user service (e.g. sensor replacement, filter replacement).		X	X	X	Demonstrate instrument maintenance services that the user is expected to perform for the device.

DOMAINS	APPLICABLE Tier User Levels				DEMONSTRATION OF TRANSFER OF KNOWLEDGE
6. Instrument selection					
COMPETENCIES	***TIER LEVELS***				***EVALUATION***
	1	***2***	***3***	***4***	
a. Understand how characterization of an environment informs selection of instrumentation.			X	X	Describe how environmental conditions would dictate selection of instrumentation (temperature extremes, altitude).
b. Understand how hazard characteristics relates to instrument selection.			X	X	Describe how certain anticipated hazards would dictate the use or non-use of certain direct read instrumentation (e.g. high heat – in fire situations, in potentially explosive environments).
c. Understand general limitations of the instrument and how different DRIs can be used in concert with other approaches.			X	X	Describe the limitations of specific direct-reading instrumentation and how a comprehensive sampling plan may require the use of traditional industrial hygiene sampling methods.
d. Ensure the instrument is safe and appropriate for the environment.			X	X	Describe when the instrument can and cannot be used in certain environments.
e. Complete a systematic evaluation of the performance characteristics (e.g. limit of quantification, resolution, response time) and feature set of the instrument to determine fitness for purpose. (See Appendix B for the AIHA SESS).			X	X	Demonstrate how to find the instrument information required on the spec sheet (found in Appendix B of this document and in the AIHA Reporting Specifications for Electronic Real Time Gas and Vapor Detection Equipment document).
f. Employ proper equipment for anticipated hazards in operational conditions.			X	X	Describe how the selected instrumentation could be used in conditions with anticipated hazards.
g. Identify hazards that may arise from unusual conditions.			X	X	Describe situations that may occur that would create a hazard.
h. Create justification for correct instrument purchases.			X	X	Describe why the instrument is needed, what it will detect and what it will not be able to detect.
i. Understand how multiple instrument types can be used to characterize unknown environments.			X	X	Describe how DRIs can work together to characterize an environment.
j. Identify instrumentation for use in new, unusual or complex situations.				X	Describe how direct-reading instrumentation could be used to evaluate unusual situations.

k. Demonstrate comprehensive understanding of the range of detection capabilities and the principles of operation of DRIs and related technologies.				X	Demonstrate a solid understanding of multiple types of direct-reading instrumentations, specifying detection range and limitations and how the instruments could all work together.

DOMAINS	APPLICABLE Tier User Levels				DEMONSTRATION OF TRANSFER OF KNOWLEDGE
7. Data interpretation					
COMPETENCIES	***TIER LEVELS***				***EVALUATION***
	1	***2***	***3***	***4***	
a. Interpret the instrument data to take pre-determined actions.			X	X	Describe how to use the data provided by the instrumentation to take pre-determined actions (e.g. stop work, evacuate).
b. Calculate values from instrument output data when applicable.			X	X	Demonstrate how to calculate average, peak, minimum, maximum, data points, and so on provided by the DRI.
c. Compare data to established values.			X	X	Demonstrate how to compare data obtained from DRI to standards such as OSHA PEL, NIOSH REL or ACGIH TLVs.

Appendix B | AIHA - Standardized Equipment Specification Sheet for Real-Time Detectors

The Standardized Equipment Specification Sheet (SESS) was developed by the Equipment Verification Working Group, a subcommittee of the AIHA Real-Time Detection Systems Committee, which included stakeholders representing equipment manufacturers as well as military, government, academic, emergency response, and commercial end-users.

The resulting tool, the Standardized Equipment Specification Sheet (SESS), provides information about the specifications for direct-reading instruments in a standardized format

The two SESS forms are the Instrument Specification Sheet and the Sensor Specification Sheet. One Instrument Specification Sheet could be accompanied by multiple Sensor Specification Sheets since instruments may be equipped with multiple sensors. Manufacturers should fill out one Instrument Specification Sheet per instrument and as many Sensor Specification Sheets as needed.

Instrument Sheet

Sensor Sheet

AIHA - Standardized Equipment Specification Sheet for Real-time Detectors

INSTRUMENT SHEET

Manufacturer:_____

Instrument Name / Model No.:_____

General Information	
Hazard Type	
Instrument Life Expectancy	
Instrument Type	
Manufacturer	
Sensor Types	
Display	
Battery Type	
Dimensions-Stripped	
Dimensions with Accessories	
Low Battery Indication	
Weight (with/without Accessories	
Warranty	
Approval Standard (s)	

Safety	
Hazardous Area Rating & Classification	
Ingress Protection Rating	

Maintenance	
Bump Test Interval	
Calibration Interval	
Factory service Interval	
Instrument Life Expectancy	

** Refer to SESS Manual, 3.2.8

Revision # (Date):_____

Template Revision: (25 August 2015) Standardized Equipment Specification Sheet

Data Management	
Data Logging Memory	
Computer Interface	
Software Required to Access Data (Version)	

Instrument Performance	
Continuous Operating Time **	
Battery Operating Time	
Sampling Rate	
Response Time T_{90}	
Response Time T_{50}	
Start-up to T_{90} after 24-hour Storage	
Start-up to T_{90} after 7-day Storage	
Start-up to T_{90} after 30-day Storage	

Error-State Notification	
High/Low Temperature	
High/Low Humidity	
Over Range	
Pump Flow Restriction	

Instrument Readings	
Instantaneous Reading Frequency	
STEL	☐ Yes / No ☐
TWA	☐ Yes / No ☐
Peak	☐ Yes / No ☐
Alarms/Indicators	
Alarm Set Points	

AIHA - Standardized Equipment Specification Sheet for Real-time Detectors

Sensor Sheet

Manufacturer:_____

Instrument Name / Model No.:_____

General Information	
Hazard Type	
Sensor Type	
Warranty	

Maintenance	
Bump Test Interval	
Calibration Interval	
Factory service Interval	
Life Expectancy of Sensor	

Sensor Performance	
Measuring Range	
Minimum Detection Limit	
Resolution/Sensitivity	
Accuracy/Uncertainty	
Linearity	
Recovery Time	
Response Time T_{90}	
Response Time T_{50}	
Start-up to T_{90} after 24-hour Storage	
Start-up to T_{90} after 7-day Storage	
Start-up to T_{90} after 30-day Storage	
Life Expectancy of Sensors	

Interferences	
Contaminant:	Effect:

Cross-Sensitivities	

Sensor Readings	
STEL	
TWA	
PEAK	
Alarms/Indications	
Alarm Set Points	

Additional Information:

Revision # (Date:_____)

WE ARE AIHA

This is what we do.

Every single day, we work to empower those who apply scientific knowledge to protect all workers from occupational hazards.

This is how we do it.

We are experts in what we do. We use our knowledge to better protect people and the environment.

We are supportive. We exist to serve Occupational Health and Safety professionals, and are constantly searching for new ways to do so.

We are inclusive. We know we are all stronger when knowledge is shared among people coming from diverse backgrounds and across our allied professions.

We are forward-looking. We are growing and evolving with the industry, always looking ahead.

This is why we do it.

Working together, we all share one goal:

A world where all workers are healthy and safe.

The AIHA brand is evolving. To learn more about the process and find FAQs and more, please visit us at **aiha.org**

AIHA™

HEALTHIER WORKPLACES | A HEALTHIER WORLD

3141 Fairview Park Dr., Suite 777, Falls Church, VA 22042