

Fixed Atmospheric Sensors

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Contents

SCOPE.....	1
OBJECTIVE	1
FIXED ATMOSPHERIC DETECTION SYSTEMS	1
DEFINITIONS.....	2
ROLES AND RESPONSIBILITIES	3
TYPES OF HAZARDS.....	4
Nitrogen (N ₂), Argon (Ar) and Helium (He)	4
Carbon Dioxide (CO ₂)	5
Carbon Monoxide (CO)	5
Nitrogen Dioxide (NO ₂)	5
Oxygen (O ₂)	5
Gas concentrations at Lower Explosive Limits (LEL)	5
Toxic materials	6
Refrigerants	6
TYPES OF SENSORS	6
TYPES OF INSTALLATIONS	7
SENSOR SYSTEM COMPONENTS	7
Annunciator panel	8
SENSOR RECOMMENDATIONS	8
Sensor placement	9
Sensor Alarm Activation Thresholds	9
Remote Sensor Monitoring	10
SENSOR OPERATIONAL SEQUENCES.....	11
Monitored Sensor Activation	11
SENSOR EMERGENCY RESPONSE PLAN	12
Generic Sensor Plans	12
SENSOR MAINTENANCE.....	14
REPORTING.....	15
RESOURCES	15
APPENDIX 1 – CAMPUS SENSOR INVENTORY	16
APPENDIX 2 – LOWER EXPLOSIVE LIMITS FOR COMMON SUBSTANCES	29
APPENDIX 3 – SENSOR EMERGENCY RESPONSE PLAN TEMPLATE	31
APPENDIX 4 – SIGNAGE EXAMPLE	33

SCOPE

This document applies to all owners of fixed atmospheric sensors and to all projects.

OBJECTIVE

This document is intended as a reference for project managers and supervisors who are managing capital projects, renovations, or regular operations involving the installation or maintenance of fixed atmospheric sensors.

This document was developed jointly by the Office of Risk Management, Facilities, and faculty Health, Safety and Risk Managers. For information on specific elements of this document and how they may apply to your respective circumstances, contact:

- Facilities Health and Safety Officer
- Faculty of Science Health, Safety and Risk Manager
- Faculty of Medicine Health, Safety and Risk Manager
- Faculty of Engineering Health, Safety and Risk Manager
- Office of Risk Management – ext. 5982

FIXED ATMOSPHERIC DETECTION SYSTEMS

Certain compressed gases or liquefied materials require additional engineering control measures to safeguard the health and safety of all personnel in a hazard zone. These engineering control measures may include vented cabinets, local exhaust systems, and dilution ventilation. The installation of fixed atmospheric detection systems in a hazard zone supplements these engineering control measures.

The installation of fixed atmospheric detection systems must be based on the requirements of the authority having jurisdiction (such as the *Ontario Fire Code*), objective scientific evidence, the level of risk for a hazardous situation, and accepted industrial best practices (including National Fire Protection Association (NFPA) standards). Some of the questions to ask when considering the installation of fixed atmospheric detection systems are:

- What are the physical characteristics of the gas or liquid?
- What hazards exist in the event of an equipment leak or breach?
- Is the substance acutely toxic?
- What is the potential exposure level, namely the level of exposure to the substance that is unsafe?
- Does the substance have properties making it safely detectable at a level below the exposure value?
- What are the unique environmental factors specific to the work area?

It is important to note that sensors are warning systems; therefore, when a sensor is activated, a hazard – and potential for a greater hazard – exists that requires action. When a sensor reaches a pre-determined activation level, an electronic signal is sent to a controller, which can be configured to automatically start various mitigation measures, such as:

- Closing off the gas supply;
- Increasing emergency exhaust ventilation;

- Sounding a local alarm (which may be audible, visual or both); and/or
- Notifying other authorities who are monitoring the sensor.

DEFINITIONS

The following terminology is used throughout this document.

Ceiling (C) – concentration of a substance that should not be exceeded during any part of the working exposure.

Corrosive gas – a gas that causes visible destruction of, or irreversible alterations to, living tissues by chemical action at the point of contact. One example of a corrosive gas is ammonia.

Fixed atmospheric sensor – a stationary measurement device used to passively detect hazardous levels of atmospheric contaminants. The sensor (or group of sensors) is maintained in continuous operation with the interval between sampling not exceeding 30 minutes.

Flammable gas – a gas at ambient temperature and pressure that forms a flammable mixture with air at a concentration of 13 percent by volume or less, or a gas which, at ambient temperature and pressure, forms a range of flammable mixtures with air greater than 12 percent by volume, regardless of the lower limit. Examples of flammable gases are acetylene, carbon monoxide, methane, hydrogen and propane.

Health, Safety and Risk Manager – dedicated resource providing full-time support to specific faculties and services on risk, environmental, and health and safety issues.

Highly toxic gas – a substance with a median lethal concentration (LC₅₀) in air of 200 ppm by volume or less of gas or vapour.

Inert gas – A nonreactive, non-flammable, noncorrosive gas. Examples include argon, helium, krypton, neon, and nitrogen. Inert gases can create asphyxiation hazards.

Lower Explosive Limit (LEL) – the lowest concentration of a material in air that can burn or explode, expressed as a percentage. When concentrations of the chemical in the air are below the LEL, the chemical mixture is “too lean” to burn.

Sensor – the physical equipment fixed in place and used to sample the atmosphere in the hazard zone. Sensors consist of sensing elements specially selected to measure the substance in question.

Sensor Emergency Response Plan – detailed instructions produced by the work area supervisor (such as the lab manager, PI, etc.) directing initial actions in the event of a sensor activation.

Short-term exposure value (STEV) – a 15-minute time weighted average (TWA) exposure that should not be exceeded at any time during a workday, even if the eight-hour TWA is within the threshold limit value-time weighted average (TLV-TWA). The TLV-STEL is the highest concentration to which workers can be exposed continuously for a short period of time without suffering from 1) irritation, 2) chronic or irreversible tissue damage, 3) dose-rate-dependent toxic effects, or 4) narcosis of

sufficient degree to increase the likelihood of accidental injury, impaired self-rescue, or materially reduced work efficiency.

Supervisor – means a person who has charge of a workplace or authority over a worker or another person. Depending on the workplace relationship, a supervisor may include, for example, the president, vice-presidents, directors, deans, managers or principle investigators. The determination as to whether a person is a supervisor does not depend on that person’s job title: it depends on whether the person is responsible for a location (for example, an office or laboratory) where the work is performed on a paid or unpaid basis or whether the person gives direction to complete the work performed by workers, students, visitors, volunteers or learners. The terms “supervisor”, “lab manager” and “principal investigator” are used interchangeably in this document to denote a supervisor.

Threshold Limit Value (TLV) – the level of a substance to which a worker can be exposed without adverse effects. It is associated with a time factor that specifies whether the worker is exposed over an 8-hour day, 40 hours a week, for an entire working lifetime (TLV-TWA) or for a 15-minute period (TLV-STEL).

Time weighted average (TWA) – average concentration of a substance to which nearly all workers may be repeatedly exposed without adverse effect over a conventional 8-hour workday, 40-hour workweek, day after day, for a working lifetime.

Toxic gas – a gas that has a lethal concentration (LC₅₀) in air of 2000 ppm or less by volume of gas (highly toxic has an LC₅₀ of 200 ppm or less). Examples of toxic gases include carbon monoxide and chlorine.

Unstable reactive gas – a gas that, in the pure state or as commercially produced, will vigorously polymerize, decompose, or condense; become self-reactive; or otherwise undergo a violent chemical change under conditions of shock, pressure, or temperature.

Upper Explosive Limit (UEL) – the highest concentration of a material in air that can burn or explode, expressed as a percentage. When concentrations of the chemical in air are above the UEL, the chemical mixture is “too rich” to burn.

Worker – means a person who performs work or supplies services to the University. Students hired by the University to perform paid work-study program duties or co-operative education placement duties for the University are considered workers. The terms “student”, “graduate student”, “visitor”, “volunteer” or “learner” similarly refer to a person who may be considered a worker for the purposes of this document.

ROLES AND RESPONSIBILITIES

In addition to the responsibilities of workplace parties documented in [Procedure 14-1 – Internal Responsibilities Procedure for Health and Safety Issues](#) and described in [Policy 77 – Occupational Health and Safety](#), responsibilities unique to fixed atmospheric sensors are defined below.

Workers

- Report sensor activations to appropriate authority (e.g. lab supervisor, facility manager, Protection Services, etc.).
- Do not obstruct or otherwise hinder the sensor.
- Follow established sensor emergency response plan(s).

Supervisors

- Assess requirements for atmospheric sensors in conjunction with Health, Safety and Risk Manager and facility manager.
- Coordinate requests for atmospheric sensors with their facility manager and Facilities.
- Produce sensor emergency response plans for sensors under their responsibility.
- Train lab personnel on sensor emergency response plans.
- Ensure that sensors are ready for maintenance when notified that maintenance is required.

Health, Safety and Risk Managers/facility managers

- Assist lab supervisors in assessing requirements for atmospheric sensors in new and existing spaces.
- Assist lab supervisors in producing sensor emergency response plan(s) where required.

Facilities

- Assist lab supervisors in assessing requirements for atmospheric sensors in new and existing spaces.
- Schedule regular calibration activities and notify end users of service dates.
- Maintain sensors in working order.
- Monitor and respond to sensors under their authority, where applicable.
- Maintain campus inventory of fixed atmospheric sensors.

Protection Services

- Monitor and respond to emergencies on campus, including by providing first aid.
- Establish a perimeter around the hazard zone and await support from other resources (e.g. Office of Risk Management, Ottawa Fire Department, HAZMAT unit, etc.).

Office of Risk Management

- Maintain and review fixed atmospheric sensor documents.
- Serve as subject matter experts on, and provide recommendations for, fixed atmospheric sensors.

TYPES OF HAZARDS

Sensors can be installed to detect a number of atmospheric hazards. Below are listed some of the most common substances for which sensors are installed at uOttawa. Sensors for other, unique hazardous substances may also be installed to provide an additional form of end-user protection.

Nitrogen (N₂), Argon (Ar) and Helium (He)

These inert gases are simple asphyxiants: sufficient volumes of these gases will displace oxygen from an area. Typically, these gases have no warning properties and are undetectable. Prolonged

exposure to low oxygen conditions can lead to unconsciousness and death. Initial symptoms of oxygen deprivation include rapid breathing, rapid heart rate and fatigue. Although additional symptoms may occur, there may also be no apparent symptoms prior to unconsciousness. Oxygen deficiency occurs more rapidly in confined, poorly ventilated areas. In low concentrations, these gases do not have physiological effects. These gases are non-flammable.

Carbon Dioxide (CO₂)

Much like inert gases, carbon dioxide is a simple asphyxiant and is heavier than air; therefore, it will accumulate in low or confined areas. Unlike the simple asphyxiants above, carbon dioxide produces a physiological response with prolonged exposure and established exposure values (time weighted average (TWA) of 5000 ppm and short-term exposure value (STEV) of 30,000 ppm). CO₂ is a non-flammable gas. In most cases, an oxygen sensor will be sufficient to warn of a hazardous condition.

Carbon Monoxide (CO)

Carbon monoxide is a chemical asphyxiant. CO combines easily with the hemoglobin in red blood cells to form carboxyhemoglobin, which significantly inhibits the body's ability to process oxygen. Carbon monoxide is referred to as "the silent killer": it is undetectable in the atmosphere and has a reasonably low time weighted average (TWA) of 25 ppm. CO is a flammable gas and is slightly heavier than air.

Nitrogen Dioxide (NO₂)

Nitrogen dioxide (for the purposes of fixed gas detection systems) is a by-product of combustion from internal combustion engines and the burning of fossil fuels. It is heavier than air and has a TWA of 3 ppm and STEV of 5 ppm. While NO₂ is available as a compressed gas, it is not generally present at uOttawa.

Oxygen (O₂)

Although not a fuel itself, oxygen can create hazardous conditions. Oxygen is essential to breathing and low oxygen levels (19% or less) can cause health symptoms such as rapid breathing, rapid heart rate, clumsiness, fatigue, and in low concentrations, death. As an oxidizer, compressed oxygen encourages combustion; even small increases in the atmospheric oxygen content may promote fire or explosion. For this reason, oxidizers must be stored separately from incompatible gases (i.e. flammable gases). A normal level of atmospheric oxygen is about 20.9%.

Gas concentrations at Lower Explosive Limits (LEL)

Hazardous conditions can occur when a particular concentration of a specific gas mixes with the surrounding atmosphere. If the concentration of the gas is within the explosive range (i.e. above the LEL and below the UEL), the atmosphere is hazardous. The lower explosive limits (LEL) for common flammable gases are listed below.

- Hydrogen – 4%
- Methane – 5%
- Carbon monoxide – 12.5%

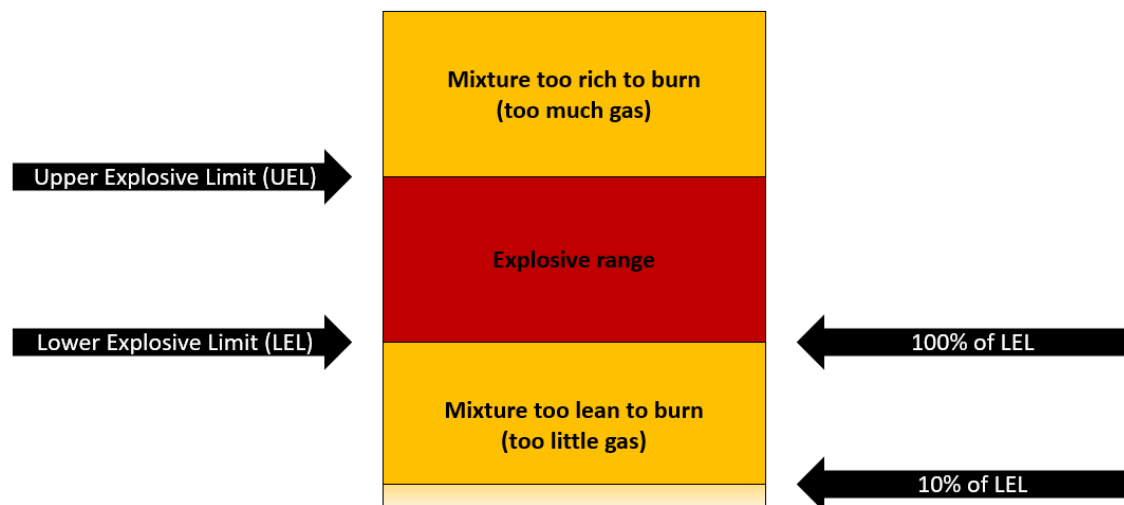


Figure 1 - Example of Mixture Ratio Levels

Toxic materials

Sensors are installed for other toxic materials, including corrosive, oxidizing, and reactive gases; however, these sensors are substance-specific and unique to the hazard in question. Examples of toxic gases are chlorine and phosgene. Lab users who are considering the use of such gases must discuss requirements to install substance-specific sensors with their Health, Safety and Risk Manager and/or facility manager.

Refrigerants

Refrigerant systems at uOttawa use R22, R123, R134A and R410A. In sufficient volumes, refrigerants can be hazardous and their warning properties are limited. New infrastructure will be equipped with R410A or R134, since these hydrofluorocarbon (HFC) do not contribute to ozone depletion, unlike R22, which is a hydrochlorofluorocarbon (HCFC). Simple asphyxiation is the primary health risk associated with refrigerants; however, certain refrigerants do have exposure values (e.g. R134A has a TWA of 1000 ppm).

TYPES OF SENSORS

Although sensors are installed across campus for a variety of substances, the most common ones detect the hazards listed above. Note that a single sensor is not capable of detecting all hazardous conditions; consequently, depending on individual requirements, several sensors may be required. In certain circumstances, operational requirements may dictate that multiple sensors must be installed to detect a single hazardous material.

Single Stage Sensors

Single stage sensors monitor and activate at a single calibration point. While a single stage sensor will function as intended and warn users of a potential hazard, the single alarm activation point must be carefully selected: it must be high enough to provide suitable warning to users but not at a level that sets off nuisance alarms.

Dual Stage Sensors

Dual stage sensors **are recommended for all fixed atmospheric detection systems**: the initial warning notifies the user(s) of a hazard in the immediate area, prompting them to take action at a

reduced level of risk without escalating the situation to a full response. The second stage alarm notifies users of an emergency requiring immediate intervention, and is often linked to a monitoring authority (e.g. Protection Services, Facilities, etc.), which in turn initiates an emergency response protocol.

TYPES OF INSTALLATIONS

Fixed atmospheric sensors can be installed in two different ways.

Capital Project Installation

Project teams manage the installation of sensors that are part of capital projects (e.g. new infrastructure, major renovations, etc.). Once the project is complete, the management and long-term maintenance of the sensors must be transferred to Operations (i.e. Facilities' Instrumentation Department) to ensure that these sensors are regularly maintained.

Project teams use a Maximo request to transfer sensor ownership. The request must include information on the installation as noted below in the section entitled *Sensor System Components*.

Operational Installation

Lab users and facility managers use Maximo requests to manage the installation of sensors that are operational in nature. The Instrumentation group at Facilities manages the request and ongoing maintenance of the sensor.

Appendix 1 lists the atmospheric sensors on campus.

SENSOR SYSTEM COMPONENTS

Sensors installed in new or renovated spaces require the following components:

- Sensor unit;
- Two strobe lights
 - one inside the work area
 - one outside the work area, in the hallway over or near the main entrance to work area
- Alarm horn that can be heard from inside the work area
- Controller unit(s)
- Relay unit(s)
- Annunciator panel (to relay multiple sensors)
- Wiring and conduit from power (and back-up) source



Figure 2 - Example Atmospheric Sensor

Annunciator panel

It is recommended that buildings with multiple sensors relay these sensors to an annunciator panel located outside the anticipated hazard zone. For example, atmospheric sensors in the ARC building are relayed to an annunciator panel on the ground level, away from the immediate hazard zone(s). This type of installation allows first responders to safely investigate the alarm in question before entering the hazard zone. If required, the panel may be connected to the University network to remotely monitor the sensor. The Facilities' Instrumentation Department holds annunciator panel design standards.

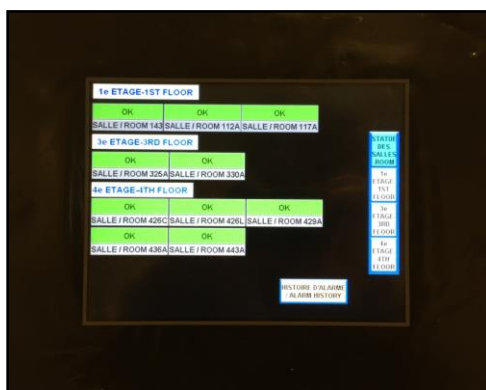


Figure 3 – Example annunciator panel.

SENSOR RECOMMENDATIONS

Although each location must be independently assessed to determine the need for a sensor as part of a fixed atmospheric detection system, it is **generally recommended** to have atmospheric sensors in the locations noted below. **Existing engineered controls (such as vented cabinets, local exhaust and general dilution ventilation) need to be considered when determining sensor requirements.**

- Flammable/combustible gases
 - Sensors for flammable or combustible gases provide early detection of potentially explosive atmospheres. Sensors are recommended for flammable and combustible gases that are not detectable by their physical properties¹ below the LEL. Depending on the requirements and the gas properties, the sensor may be able to detect a reasonably wide spectrum of gases. The gas vapour density will determine whether the sensor(s) should be located higher up the wall (i.e. for lighter-than-air gases) or closer to the floor (i.e. for heavier-than-air gases). Sensors to detect gas levels reaching 60% LEL must be connected to a monitoring system and equipped to remotely shut down the gas source. Appendix 2 provides lower explosive limits (LELs) for common substances.
- Toxic gases
 - Toxic gases may be undetectable and/or toxic at low exposure levels; therefore, early warning of a potential hazard is critical. Sensors for toxic gases are unique to the substance monitored, which include corrosive and reactive materials. Sensors for toxic gases must be connected to a monitoring system and equipped to remotely shut down the gas source. A remote shutdown is not required for materials whose gauge pressure is under 15 psi, so long as these materials are constantly attended and emergency shutoff valves are readily accessible. Sensors are not required for toxic substances

¹ NFPA 55 – Compressed Gases and Cryogenic Fluids Code (2013 Edition); section 12.3.2.8.8

whose physiological warning properties are below their defined occupational exposure value.² Warning properties must be listed on the material safety data sheet.

- Oxygen-deficient and enriched atmospheres
 - The potential for an oxygen-deficient atmosphere is determined by calculating the volume of the intended work location, determining the volume of the gas, the rate of a potential leak, and calculating the total potential displacement of oxygen. If the resulting oxygen concentration could be pushed below 19.5%, an atmospheric sensor is recommended. The gas level needed to produce an oxygen-enriched atmosphere can be similarly determined, in this case with the sensor’s alarm activation threshold set at 23.5% oxygen or above. These are sole-purpose oxygen sensors, with the sensor requiring more frequent maintenance and/or replacement. It is recommended that sensors be placed at the source of the emission or at reasonable breathing zones within the expected hazard area, such as one metre from the source. In most cases, an oxygen sensor will be sufficient to warn of a hazardous condition.

Sensor placement

Sensor placement depends on the hazard, namely within the first expected hazard zone. For example, heavier-than-air flammable gases will accumulate and collect in low-lying areas; therefore, sensors for substances with vapour densities greater than 1 should be placed nearer to the ground. In contrast, sensors for substances with vapour densities less than 1 should be placed higher up the wall.

In work areas that house support closets containing a source cylinder that feeds a remote work area, multiple sensors are required to monitor the source location and the point-of-use location.³

Sensor Alarm Activation Thresholds

Sensor alarm activation thresholds are determined in advance of sensor commissioning and must be able to detect the presence of the monitored gas at or below its occupational exposure limit, time weighted average exposure limit (TWA) or short term exposure limit (STEV).⁴ We recommend that sensor alarm activation thresholds be set to detect a conservative level of the monitored substance. The following table provides **general recommendations** for alarm activation thresholds.

Sensor	Installation Location	Low Alarm	High Alarm	Notes
Flammable	Depends on gas vapour density.	10% LEL	20% LEL	Monitor high alarm. Sensors reaching 60% LEL must be equipped to remotely shut down the process.
Oxygen Deficient	Near hazard area and/or near breathing zones.	< 20% O ₂	< 19.5% O ₂	Monitor high alarm.

² NFPA 55 – Compressed Gases and Cryogenic Fluids Code (2013 Edition); section 7.9.6.1

³ NFPA 55 – Compressed Gases and Cryogenic Fluids Code (2013 Edition); section 7.9.6.5.3

⁴ NFPA 55 – Compressed Gases and Cryogenic Fluids Code (2013 Edition); section 7.9.6.6

Sensor	Installation Location	Low Alarm	High Alarm	Notes
Oxygen Enriched	Near hazard area	> 21.0% O ₂	> 23.5% O ₂	Monitor high alarm.
Toxic	Depends on gas vapour density.	One-half (½) the TWA or STEV of the subject gas.	TWA of the substance being monitored or one-half (½) STEV in unoccupied environment.	Monitor high alarm. Sensors reaching high alarm must be equipped to remotely shut down the process.
Carbon dioxide*	Near hazard area and/or near breathing zones.	2500 ppm	5000 ppm	Monitor high alarm.
Carbon monoxide (lab; greater than 1% concentration)	Breathing zones.	12.5 ppm	25 ppm	Monitor high alarm.
Carbon monoxide (parking)	Breathing zones.	25 ppm	50 ppm	Ventilation activates at low alarm; audible alarm monitored for high alarms.
Nitrogen dioxide (parking)	Breathing zones.	1.5 ppm	3 ppm	Ventilation activates at low alarm; audible alarm monitored for high alarms.

* In most cases, an oxygen sensor will be sufficient to warn of a hazardous condition.

Figure 4 - General Recommendations for Alarm Activation Thresholds

As an example, hydrogen at atmospheric concentrations between 4% and 75% is an explosive mixture under ideal conditions. Thus, the lower explosive limit (LEL) for hydrogen is 4%. In fixed gas detector systems, sensor alarm activation thresholds have been set at 10% and 20% of the LEL for low and high alarms, respectively. This common practice provides a safety factor that gives users an opportunity for early intervention to address an otherwise hazardous situation.

None of these general recommendations precludes setting a more conservative sensor alarm activation threshold; however, users must exercise caution to ensure that the sensor alarm activates at a level that requires action but not at a level so low that it generates false (or nuisance) alarms.

Remote Sensor Monitoring

Remote sensor monitoring is available and is required for all emergency scenarios (i.e. high-level flammable, toxic, and reactive materials) and dual stage sensors. Other sensors may be monitored at the discretion of the sensor owner and in collaboration with the internal monitoring unit. **It is**

incumbent on the sensor owner – in collaboration with the HRSM – to produce an appropriate sensor emergency response plan prior to commissioning the sensor.

SENSOR OPERATIONAL SEQUENCES

Each sensor unit within a given control system must have its own operational sequence; typically, this sequence is provided by the organization that supplies or commissions the sensor. The operational sequence will specify:

- The physical location of the sensor, including room number and location inside the monitored area (i.e. ARC room 330, west wall);
- The specifications of the sensor, including model, serial number, etc.;
- The full name and chemical formula of the gas monitored;
- Sensor activation set points (low/high), including any activation delay;
- Duration of sensor activation;
- The operational sequence of the sensor, including:
 - The activation sequences. For example, upon reaching the calibrated threshold, the sensor will activate the local alarm, including the audible horn and visual strobe both inside and outside the work area, increase ventilation in work area, alert the monitoring unit, etc.;
 - Any automated actions initiated by the monitoring system (e.g. notify monitoring unit, activate/deactivate ventilation);
 - The deactivation sequence (e.g. after 10 consecutive seconds below activation limit, sensor deactivates).
- Automated actions in the event of sensor failure (e.g. the remote closing of valves or solenoids, increased ventilation, user and monitoring unit notification, etc.)

Monitored Sensor Activation

When a monitored sensor⁵ activates, the monitoring unit is notified and an appropriate response must be initiated. Protection Services will respond to emergencies on campus and concurrently notify a designated, competent person familiar with the work area. The designated persons is required to:

- Initiate immediate corrective action, in accordance with the sensor emergency response plan; and
- Notify users of additional hazardous conditions that could occur given the incident-specific sensor activation.

Protection Services uses the Vertere web-based platform to obtain contact information for the location(s) in question. All contact information used by Protection Services is maintained in confidence and is used exclusively for emergency situations in work areas. Lab users are responsible for keeping their contact information up-to-date.

Additional campus resources (such as Facilities, Faculty Health, Safety and Risk Managers, facility managers, Office of Risk Management) will be notified and will report to the scene during work hours to provide assistance, as necessary.

⁵ NFPA 55 – Compressed Gases and Cryogenic Fluids Code (2013 Edition); section 7.9.6.3

Limited after-hours resources are available in the event of activation; however, it is the sensor owner's responsibility to develop and implement a response plan in the event of a sensor activation.

Protection Services will not conduct activities on behalf of lab users (e.g. closing cylinders, moving laboratory materials, etc.).

SENSOR EMERGENCY RESPONSE PLAN

Prior to their commissioning, all sensors, regardless of whether they are monitored, require a written sensor emergency response plan. The plan must be developed by the sensor owner/supervisor/lab manager/principal investigator and must be reviewed and approved by the Health, Safety and Risk Manager for the faculty or service. The plan must also be provided to Protection Services, the Office of Risk Management, and the monitoring service provider (where applicable). The plan must include the following information:

- Gas monitored (including the full name and chemical formula of substance);
- Concentration of gas;
- Exposure limits for the gas (in ppm or mg/m³), including the established time-weighted average (TWA), the short-term exposure limit (STEL) and the ceiling (C), where established. Information on exposure limits is available from:
 - [Regulation 833 – Control of Exposure to Biological or Chemical Agents](#);
 - the table in the *2015 Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices* published by the American Conference of Governmental Industrial Hygienists (ACGIH);
 - the Health, Safety and Risk Manager; and/or
 - the Office of Risk Management.
- Potential harm caused by the specific substances, including effects on human health, infrastructure, environment, etc.;
- Emergency contact information for the designated person(s) responsible for the work area, or reference to Vertere. This will include direct phone numbers for the following personnel:
 - The principal investigator;
 - The lab manager (if applicable);
 - Post-doctoral personnel (if applicable); and/or
 - Senior graduate student(s) (if applicable).
- Description of immediate action required.

Additional information that may be included in a sensor emergency response plan:

- Communication plan for lab users in the event of sensor alarm activation;
- Emergency response equipment and training appropriate for the substance(s) in question;
- A schedule of regular emergency training drills involving work area personnel and University officials.

A template for a sensor emergency response plan is available in Appendix 3. Anyone requiring assistance to develop a sensor emergency response plan should contact the [Health, Safety and Risk Manager](#).

Generic Sensor Plans

The following generic plans may be implemented as part of a location-specific sensor emergency response plan. Users should also write up a more detailed plan specific to their operations, one that

includes provisions for notifying colleagues when alarms are activated, how to manage work interruptions, and how to use signage on work area entrances to alert external users (refer to examples in Appendix 4)

Carbon Dioxide (CO₂)

Activation of the low alarm sensor (2500 ppm) initiates a distinct audible and visual alarm signal both inside and outside the work area. If safe to do so, trained personnel should close the source cylinder(s) and pause work until the sensor has deactivated. Upon deactivation, personnel may return to the work area and institute further corrective action (when necessary) to address the condition leading to the alarm.

Activation of the high alarm sensor (5000 ppm) initiates a distinct audible and visual alarm signal both inside and outside the work area. If safe to do so, trained personnel should close the source cylinder(s) and pause work until the sensor has deactivated. Upon deactivation, personnel may return to the work area and institute further corrective action (when necessary) to address the condition leading to the alarm.

Oxygen (O₂)

Activation of the low alarm sensor (19.5%) initiates a distinct audible and visual alarm signal both inside and outside the work area. If safe to do so, trained personnel should close the source cylinder(s) and evacuate the immediate area until the sensor has deactivated. Upon deactivation, personnel may return to the work area and institute further corrective action (when necessary) to address the condition leading to the alarm.

Activation of the high alarm sensor (23.5%) initiates a distinct audible and visual alarm signal both inside and outside the work area. If safe to do so, trained personnel should close the source cylinder(s), extinguish all heating elements, and evacuate the immediate area until the sensor has deactivated. Upon deactivation, personnel may return to the work area and institute further corrective action (when necessary) to address the condition leading to the alarm.

Nitrogen Dioxide (NO₂)

Activation of the low alarm sensor (2.5 ppm) initiates a distinct audible and visual alarm signal both inside and outside the work area. If safe, trained personnel should cease activities until the sensor has deactivated. Low alarm activation increases general ventilation. Upon deactivation, personnel may return to the work area and institute further corrective action (when necessary) to address the condition leading to the alarm.

Activation of the high alarm sensor (5 ppm) initiates a distinct audible and visual alarm signal both inside and outside the work area. If safe, trained personnel should cease all activities and evacuate the area until the sensor has deactivated. High alarm activation increases general ventilation. Upon deactivation, personnel may return to the work area and institute further corrective action (when necessary) to address the condition leading to the alarm.

Carbon Monoxide (CO)

Activation of the low alarm sensor (12.5 ppm) initiates a distinct audible and visual alarm signal both inside and outside the work area. If safe, trained personnel should close the cylinder(s) and cease activities until the sensor deactivates. Low alarm activation increases general ventilation.

Upon deactivation, personnel may return to the work area and institute further corrective action (when necessary) to address the condition leading to the alarm.

Activation of the high alarm sensor (25 ppm) initiates a distinct audible and visual alarm signal both inside and outside the work area. If safe, trained personnel should close the cylinder(s) and cease activities, and personnel should evacuate until the sensor deactivates. High alarm activation increases general ventilation. Upon deactivation, personnel may return to the work area and institute further corrective action (when necessary) to address the condition leading to the alarm.

Lower Explosive Limit (LEL)

Activation of the low alarm sensor (10% LEL) initiates a distinct audible and visual alarm signal both inside and outside the work area. If safe, trained personnel should close the cylinder(s) and cease activities until the sensor has deactivated. Upon deactivation, personnel may return to the work area and institute further corrective action (when necessary) to address the condition leading to the alarm.

Activation of the high alarm sensor (20% LEL) initiates a distinct audible and visual alarm signal both inside and outside the work area. If safe, trained personnel should close the cylinder(s) and cease activities, and personnel should evacuate until the sensor has deactivated. High alarm activation increases general ventilation. If sensor reaches 50% LEL, gas system(s) must be shut down remotely. Protection Services will be notified by remote monitoring; notify the Office of Risk Management. The Fire Department may be required. Upon deactivation, personnel may return to the work area and institute further corrective action (when necessary) to address the condition leading to the alarm.

Refrigerants (R22 / R123 / R134A / R410A)

Activation of the low alarm sensor initiates a distinct audible and visual alarm signal both inside and outside the work area until the sensor has deactivated. Upon deactivation, personnel may return to the work area and institute further corrective action (when necessary) to address the condition leading to the alarm.

Activation of the high alarm sensor initiates a distinct audible and visual alarm signal both inside and outside the work area. Personnel should cease source activities, close sources, and evacuate until the sensor has deactivated. Upon deactivation, personnel may return to the work area and institute further corrective action (when necessary) to address the condition leading to the alarm.

SENSOR MAINTENANCE

Sensors are centrally maintained by Facilities' Instrumentation Department and are regularly calibrated, generally every quarter. To calibrate the sensor, the technician requires access to the sensor for a few moments to perform the necessary servicing. As a result, area users must ensure that the calibration technician has access to the sensor. If the technician requires special access to enter a room (such as clean rooms, hazardous waste rooms, etc.), Facilities and area users will need to coordinate to ensure that the calibration can take place at a mutually convenient time within the quarterly service window.

Calibration reports are maintained by Facilities' Instrumentation Department and are available upon request.

Facility managers and lab users will be notified if sensors require further service, such as replacement components. Owners of fixed atmospheric sensors may be responsible for costs associated with their atmospheric sensor.

REPORTING

Every sensor activation – including low-level alarms – must be reported by the sensor owner or person reporting the activation to Protection Services (in emergencies). They must also submit an [Accident, Incident, Occupational Illness or Near Miss report](#).

RESOURCES

This document is based on the following references, which are available from the Office of Risk Management.

- Ontario Fire Code
- NFPA 55 – Compressed Gases and Cryogenic Fluids Code (2013)
- NFPA 853 – Standard for the Installation of Stationary Fuel Cell Power Systems (2015)
- Ontario *Regulation 833 – Control of Exposure to Biological or Chemical Agents*
- American Conference of Governmental Industrial Hygienists – *Threshold Limits Values (TLVs) for Chemical and Physical Agents and Biological Exposure Indices (BEIs)*

APPENDIX 1 – CAMPUS SENSOR INVENTORY

Building	Faculty / Service	Room	Qty	Sensor	Calibration	Organization	Strobe	Delay	Operational Sequence	Monitored	Procedure (Protection)
ANX	Parking / Housing	Garage - Stairway C	1	CO		Opera					
ANX	Parking / Housing	Garage - Elevators	1	CO		Opera					
ANX	Parking / Housing	Garage - room 001	1	CO		Opera					
ANX	Parking / Housing	Garage - Stairway A	1	CO		Opera					
ANX	Parking / Housing	Garage - NE	1	CO		Opera					
ANX	Parking / Housing	Garage - SE	1	CO		Opera					
ARC	Science	143 (Loading Zone)	1	O ₂	19.0%	QEL	Y	Instantaneous	Upon activation of an alarm, the stobe and on-board audible horn activate.	N	N/A
ARC	Science	112A (Closet)	1	O ₂	19.0%	QEL	Y	Instantaneous	Upon activation of an alarm, the stobe and on-board audible horn activate.	N	N/A
ARC	Science	117A (Closet)	1	O ₂	19.0%	QEL	Y	Instantaneous	Upon activation of an alarm, the stobe and on-board audible horn activate.	N	N/A
ARC	Science	426L (Closet)	1	O ₂	19.0%	QEL	Y	Instantaneous	Upon activation of an alarm, the stobe and on-board audible horn activate.	N	N/A
ARC	Science	429A (Closet)	1	O ₂	19.0%	QEL	Y	Instantaneous	Upon activation of an alarm, the stobe and on-board audible horn activate.	N	N/A
ARC	Science	436A (Closet)	1	O ₂	19.0%	QEL	Y	Instantaneous	Upon activation of an alarm, the stobe and on-board audible horn activate.	N	N/A
ARC	Science	443A (Closet)	1	O ₂	19.0%	QEL	Y	Instantaneous	Upon activation of an alarm, the stobe and on-board audible horn activate.	N	N/A
ARC	Science	426C	1	CO	12 ppm	QEL	Y	Instantaneous	Upon activation of an alarm, the stobe and on-board audible horn activate.	N	N/A
ARC	Science	143 (Loading Zone)	1	CH ₄	20%	QEL	Y	Instantaneous	Upon activation of an alarm, the stobe and on-board audible horn activate.	N	N/A
ARC	Science	325A	1	LEL	20%	QEL	Y	Instantaneous	Upon activation of an alarm, the stobe and on-board audible horn activate.	N	N/A
ARC	Science	330A	1	LEL	20%	QEL	Y	Instantaneous	Upon activation of an alarm, the stobe and on-board audible horn activate.	N	N/A
ARC	Science	333B	1	H ₂	20%	QEL	Y	Instantaneous	Upon activation of an alarm, the stobe and on-board audible horn activate.	N	N/A
ARC	Science	336A	1	H ₂	20%	QEL	Y	Instantaneous	Upon activation of an alarm, the stobe and on-board audible horn activate.	N	N/A
ARC	Science	333B	1	HCl	20%	QEL	Y	Instantaneous	Upon activation of an alarm, the stobe and on-board audible horn activate.	N	N/A
ARC	Science	333B	1	Cl ₂	20%	QEL	Y	Instantaneous	Upon activation of an alarm, the stobe and on-board audible horn activate.	N	N/A
BIO	Science	409	1	CO	12 ppm	QEL	Y	Instantaneous	When any sensor in a specific room detects 12 ppm CO or greater, the local strobes for the room in question (one outside the door, one inside the door) will activate instantaneously. The alarm will stop when the level drops below 9 ppm.	N	N/A
BIO	Science	409	1	CO	12 ppm	QEL	Y	Instantaneous	When any sensor in a specific room detects 12 ppm CO or greater, the local strobes for the room in question (one outside the door, one inside the door) will activate instantaneously. The alarm will stop when the level drops below 9 ppm.	N	N/A
BIO	Science	404	1	CO	12 ppm	QEL	Y	Instantaneous	When any sensor in a specific room detects 12 ppm CO or greater, the local strobes for the room in question (one outside the door, one inside the door) will activate instantaneously. The alarm will stop when the level drops below 9 ppm.	N	N/A
BIO	Science	404	1	CO	12 ppm	QEL	Y	Instantaneous	When any sensor in a specific room detects 12 ppm CO or greater, the local strobes for the room in question (one outside the door, one inside the door) will activate instantaneously. The alarm will stop when the level drops below 9 ppm.	N	N/A
BIO	Science	525	1	CO	12 ppm	QEL	Y	Instantaneous	When any sensor in a specific room detects 12 ppm CO or greater, the local strobes for the room in question (one outside the door, one inside the door) will activate instantaneously. The alarm will stop when the level drops below 9 ppm.	N	N/A
BIO	Science	525	1	CO	12 ppm	QEL	Y	Instantaneous	When any sensor in a specific room detects 12 ppm CO or greater, the local strobes for the room in question (one outside the door, one inside the door) will activate instantaneously. The alarm will stop when the level drops below 9 ppm.	N	N/A

Building	Faculty / Service	Room	Qty	Sensor	Calibration	Organization	Strobe	Delay	Operational Sequence	Monitored	Procedure (Protection)
BIO	Science	526	1	CO	12 ppm	QEL	Y	Instantaneous	When any sensor in a specific room detects 12 ppm CO or greater, the local strobes for the room in question (one outside the door, one inside the door) will activate instantaneously. The alarm will stop when the level drops below 9 ppm.	N	N/A
BIO	Science	526	1	CO	12 ppm	QEL	Y	Instantaneous	When any sensor in a specific room detects 12 ppm CO or greater, the local strobes for the room in question (one outside the door, one inside the door) will activate instantaneously. The alarm will stop when the level drops below 9 ppm.	N	N/A
BIO	Science	511	1	CO	12 ppm	QEL	Y	Instantaneous	When any sensor in a specific room detects 12 ppm CO or greater, the local strobes for the room in question (one outside the door, one inside the door) will activate instantaneously. The alarm will stop when the level drops below 9 ppm.	N	N/A
BIO	Science	511	1	CO	12 ppm	QEL	Y	Instantaneous	When any sensor in a specific room detects 12 ppm CO or greater, the local strobes for the room in question (one outside the door, one inside the door) will activate instantaneously. The alarm will stop when the level drops below 9 ppm.	N	N/A
BIO	Science	510	1	CO	12 ppm	QEL	Y	Instantaneous	When any sensor in a specific room detects 12 ppm CO or greater, the local strobes for the room in question (one outside the door, one inside the door) will activate instantaneously. The alarm will stop when the level drops below 9 ppm.	N	N/A
BIO	Science	510	1	CO	12 ppm	QEL	Y	Instantaneous	When any sensor in a specific room detects 12 ppm CO or greater, the local strobes for the room in question (one outside the door, one inside the door) will activate instantaneously. The alarm will stop when the level drops below 9 ppm.	N	N/A
BIO	Science	405	1	CO	12 ppm	QEL	Y	Instantaneous	When any sensor in a specific room detects 12 ppm CO or greater, the local strobes for the room in question (one outside the door, one inside the door) will activate instantaneously. The alarm will stop when the level drops below 9 ppm.	N	N/A
BKS	Parking	Garage - SW	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	N	N/A
BKS	Parking	Garage - SW	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	N	N/A
BKS	Parking	Garage - SW	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	N	N/A
BKS	Parking	Garage - SW	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	N	N/A
BKS	Parking	Garage - SW	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	N	N/A

Building	Faculty / Service	Room	Qty	Sensor	Calibration	Organization	Strobe	Delay	Operational Sequence	Monitored	Procedure (Protection)
BKS	Parking	Garage - SE	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	N	N/A
BKS	Parking	Garage - SE	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	N	N/A
BKS	Parking	Garage - SE	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	N	N/A
BKS	Parking	Garage - SE	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	N	N/A
BKS	Parking	Garage - SE	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	N	N/A
BKS	Parking	Garage - NW	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	N	N/A
BKS	Parking	Garage - NW	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	N	N/A
BKS	Parking	Garage - NW	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	N	N/A
BKS	Parking	Garage - NW	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	N	N/A

Building	Faculty / Service	Room	Qty	Sensor	Calibration	Organization	Strobe	Delay	Operational Sequence	Monitored	Procedure (Protection)
BKS	Parking	Garage - NW	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	N	N/A
BKS	Parking	Garage - NE	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	N	N/A
BKS	Parking	Garage - NE	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	N	N/A
BKS	Parking	Garage - NE	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	N	N/A
BKS	Parking	Garage - NE	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	N	N/A
CBY	Engineering	D02	1	CH ₄	Low - 10% High - 20%	QEL	N	10 seconds	Upon activation of an alarm, the stobe and on-board audible horn activate.	Y	<p>Alarm "Low" methane detector D02 - Presence of methane in the cold room No 2 (10% of the Lower Explosive Limit). Dispatch advised to the Protection Officer to proceed to CBY D02 to inform possible occupants that the response procedure is being initiated and that SOPs for exiting the room D02 apply. Dispatch contacts D02 Cold Room 2 Manager and the backups. Manager: Robert Delatolla (Cell - 613-276-7765; Office - 2677). First Back-up: Mohammed Abdallah, PhD cand. in charge of the project in D02 (Cell - 613-513-9838; Office - 6149). Second Back-Up: Yannick Marcerou. Research Assistant working on the project (Home - 613-366-2035; Office - 6149; Cell - 6613-265-3385. Once on site, open the door of the cold room No 2 as well as the door of the room D02 in order to dilute the methane contained in the room until the alarm goes off.</p> <p>Alarm "High" methane detector D02 - Presence of methane in the cold room No 2 (25% of the Lower Explosive Limit). Dispatch advised to the Protection Officer to proceed to CBY D02 to inform possible occupants that the response procedure is being initiated and that SOPs for exiting the room D02 apply. Dispatch contacts D02 Cold Room 2 Manager and the backups. Manager: Robert Delatolla (Cell - 613-276-7765; Office - 2677). First Back-up: Mohammed Abdallah, PhD cand. in charge of the project in D02 (Cell - 613-513-9838; Office - 6149). Second Back-Up: Yannick Marcerou. Research Assistant working on the project (Home - 613-366-2035; Office - 6149; Cell - 6613-265-3385. Once on site, open the door of the cold room No 2 as well as the door of the room D02 in order to dilute the methane contained in the room. Prevent anyone from entering the cold room without a respiratory protection system. Unplug every power cord located inside and outside the cold room No 2.</p>

Building	Faculty / Service	Room	Qty	Sensor	Calibration	Organization	Strobe	Delay	Operational Sequence	Monitored	Procedure (Protection)
CBY	Engineering	D204	1	CH ₄	Low - 10% High - 20%	QEL	N	10 seconds	Upon activation of alarm, an alarm signal is sent to Protection Dispatch. The alarm will remain active until the condition has been cleared. A local silence function will not affect the alarm to Protection Services. The annunciator panel, located upon entry to D300 level provides additional information on the alarm. Local alarms will activate audibly within the room where the alarm is located.	Y	THIS ALARM HAS BEEN GENERATED BY THE QEL GAS DETECTOR LOCATED IN HALL CLOSE TO CBYD321. THIS PANEL WILL INDICATE WHICH GAS AND WHICH ROOM. CONTACT THE APPROPRIATE AUTHORITY AS INDICATED ON THE QEL PANEL.
CBY	Engineering	D219A	1	CH ₄	Low - 10% High - 20%	QEL	N	10 seconds	Upon activation of alarm, an alarm signal is sent to Protection Dispatch. The alarm will remain active until the condition has been cleared. A local silence function will not affect the alarm to Protection Services. The annunciator panel, located upon entry to D300 level provides additional information on the alarm. Local alarms will activate audibly within the room where the alarm is located.	Y	THIS ALARM HAS BEEN GENERATED BY THE QEL GAS DETECTOR LOCATED IN HALL CLOSE TO CBYD321. THIS PANEL WILL INDICATE WHICH GAS AND WHICH ROOM. CONTACT THE APPROPRIATE AUTHORITY AS INDICATED ON THE QEL PANEL.
CBY	Engineering	D407	1	CH ₄	Low - 10% High - 20%	QEL	N	10 seconds	Upon activation of alarm, an alarm signal is sent to Protection Dispatch. The alarm will remain active until the condition has been cleared. A local silence function will not affect the alarm to Protection Services. The annunciator panel, located upon entry to D300 level provides additional information on the alarm. Local alarms will activate audibly within the room where the alarm is located.	Y	THIS ALARM HAS BEEN GENERATED BY THE QEL GAS DETECTOR LOCATED IN HALL CLOSE TO CBYD321. THIS PANEL WILL INDICATE WHICH GAS AND WHICH ROOM. CONTACT THE APPROPRIATE AUTHORITY AS INDICATED ON THE QEL PANEL.
CBY	Engineering	D407A	1	CH ₄	Low - 10% High - 20%	QEL	N	10 seconds	Upon activation of alarm, an alarm signal is sent to Protection Dispatch. The alarm will remain active until the condition has been cleared. A local silence function will not affect the alarm to Protection Services. The annunciator panel, located upon entry to D300 level provides additional information on the alarm. Local alarms will activate audibly within the room where the alarm is located.	Y	THIS ALARM HAS BEEN GENERATED BY THE QEL GAS DETECTOR LOCATED IN HALL CLOSE TO CBYD321. THIS PANEL WILL INDICATE WHICH GAS AND WHICH ROOM. CONTACT THE APPROPRIATE AUTHORITY AS INDICATED ON THE QEL PANEL.
CBY	Engineering	D219A	1	C ₃ H ₈	20%	QEL	N	10 seconds	Upon activation of alarm, an alarm signal is sent to Protection Dispatch. The alarm will remain active until the condition has been cleared. A local silence function will not affect the alarm to Protection Services. The annunciator panel, located upon entry to D300 level provides additional information on the alarm. Local alarms will activate audibly within the room where the alarm is located.	Y	THIS ALARM HAS BEEN GENERATED BY THE QEL GAS DETECTOR LOCATED IN HALL CLOSE TO CBYD321. THIS PANEL WILL INDICATE WHICH GAS AND WHICH ROOM. CONTACT THE APPROPRIATE AUTHORITY AS INDICATED ON THE QEL PANEL.
CBY	Engineering	D219A	1	H ₂	20%	QEL	N	10 seconds	Upon activation of alarm, an alarm signal is sent to Protection Dispatch. The alarm will remain active until the condition has been cleared. A local silence function will not affect the alarm to Protection Services. The annunciator panel, located upon entry to D300 level provides additional information on the alarm. Local alarms will activate audibly within the room where the alarm is located.	Y	THIS ALARM HAS BEEN GENERATED BY THE QEL GAS DETECTOR LOCATED IN HALL CLOSE TO CBYD321. THIS PANEL WILL INDICATE WHICH GAS AND WHICH ROOM. CONTACT THE APPROPRIATE AUTHORITY AS INDICATED ON THE QEL PANEL.
CBY	Engineering	D302	1	H ₂	20%	QEL	N	10 seconds	Upon activation of alarm, an alarm signal is sent to Protection Dispatch. The alarm will remain active until the condition has been cleared. A local silence function will not affect the alarm to Protection Services. The annunciator panel, located upon entry to D300 level provides additional information on the alarm. Local alarms will activate audibly within the room where the alarm is located.	Y	THIS ALARM HAS BEEN GENERATED BY THE QEL GAS DETECTOR LOCATED IN HALL CLOSE TO CBYD321. THIS PANEL WILL INDICATE WHICH GAS AND WHICH ROOM. CONTACT THE APPROPRIATE AUTHORITY AS INDICATED ON THE QEL PANEL.
CBY	Engineering	D313	1	H ₂	20%	QEL	N	10 seconds	Upon activation of alarm, an alarm signal is sent to Protection Dispatch. The alarm will remain active until the condition has been cleared. A local silence function will not affect the alarm to Protection Services. The annunciator panel, located upon entry to D300 level provides additional information on the alarm. Local alarms will activate audibly within the room where the alarm is located.	Y	THIS ALARM HAS BEEN GENERATED BY THE QEL GAS DETECTOR LOCATED IN HALL CLOSE TO CBYD321. THIS PANEL WILL INDICATE WHICH GAS AND WHICH ROOM. CONTACT THE APPROPRIATE AUTHORITY AS INDICATED ON THE QEL PANEL.
CBY	Engineering	D319	1	H ₂	20%	QEL	N	10 seconds	Upon activation of alarm, an alarm signal is sent to Protection Dispatch. The alarm will remain active until the condition has been cleared. A local silence function will not affect the alarm to Protection Services. The annunciator panel, located upon entry to D300 level provides additional information on the alarm. Local alarms will activate audibly within the room where the alarm is located.	Y	THIS ALARM HAS BEEN GENERATED BY THE QEL GAS DETECTOR LOCATED IN HALL CLOSE TO CBYD321. THIS PANEL WILL INDICATE WHICH GAS AND WHICH ROOM. CONTACT THE APPROPRIATE AUTHORITY AS INDICATED ON THE QEL PANEL.

Building	Faculty / Service	Room	Qty	Sensor	Calibration	Organization	Strobe	Delay	Operational Sequence	Monitored	Procedure (Protection)
CBY	Engineering	D321	1	H ₂	20%	QEL	N	10 seconds	Upon activation of alarm, an alarm signal is sent to Protection Dispatch. The alarm will remain active until the condition has been cleared. A local silence function will not affect the alarm to Protection Services. The annunciator panel, located upon entry to D300 level provides additional information on the alarm. Local alarms will activate audibly within the room where the alarm is located.	Y	THIS ALARM HAS BEEN GENERATED BY THE QEL GAS DETECTOR LOCATED IN HALL CLOSE TO CBYD321. THIS PANEL WILL INDICATE WHICH GAS AND WHICH ROOM. CONTACT THE APPROPRIATE AUTHORITY AS INDICATED ON THE QEL PANEL.
CBY	Engineering	D406	1	H ₂	20%	QEL	N	10 seconds	Upon activation of alarm, an alarm signal is sent to Protection Dispatch. The alarm will remain active until the condition has been cleared. A local silence function will not affect the alarm to Protection Services. The annunciator panel, located upon entry to D300 level provides additional information on the alarm. Local alarms will activate audibly within the room where the alarm is located.	Y	THIS ALARM HAS BEEN GENERATED BY THE QEL GAS DETECTOR LOCATED IN HALL CLOSE TO CBYD321. THIS PANEL WILL INDICATE WHICH GAS AND WHICH ROOM. CONTACT THE APPROPRIATE AUTHORITY AS INDICATED ON THE QEL PANEL.
CBY	Engineering	D407	1	H ₂	20%	QEL	N	10 seconds	Upon activation of alarm, an alarm signal is sent to Protection Dispatch. The alarm will remain active until the condition has been cleared. A local silence function will not affect the alarm to Protection Services. The annunciator panel, located upon entry to D300 level provides additional information on the alarm. Local alarms will activate audibly within the room where the alarm is located.	Y	THIS ALARM HAS BEEN GENERATED BY THE QEL GAS DETECTOR LOCATED IN HALL CLOSE TO CBYD321. THIS PANEL WILL INDICATE WHICH GAS AND WHICH ROOM. CONTACT THE APPROPRIATE AUTHORITY AS INDICATED ON THE QEL PANEL.
CBY	Engineering	D415	1	H ₂	20%	QEL	N	10 seconds	Upon activation of alarm, an alarm signal is sent to Protection Dispatch. The alarm will remain active until the condition has been cleared. A local silence function will not affect the alarm to Protection Services. The annunciator panel, located upon entry to D300 level provides additional information on the alarm. Local alarms will activate audibly within the room where the alarm is located.	Y	THIS ALARM HAS BEEN GENERATED BY THE QEL GAS DETECTOR LOCATED IN HALL CLOSE TO CBYD321. THIS PANEL WILL INDICATE WHICH GAS AND WHICH ROOM. CONTACT THE APPROPRIATE AUTHORITY AS INDICATED ON THE QEL PANEL.
CBY	Engineering	D510	1	H ₂	20%	QEL	N	10 seconds	Upon activation of alarm, an alarm signal is sent to Protection Dispatch. The alarm will remain active until the condition has been cleared. A local silence function will not affect the alarm to Protection Services. The annunciator panel, located upon entry to D300 level provides additional information on the alarm. Local alarms will activate audibly within the room where the alarm is located.	Y	THIS ALARM HAS BEEN GENERATED BY THE QEL GAS DETECTOR LOCATED IN HALL CLOSE TO CBYD321. THIS PANEL WILL INDICATE WHICH GAS AND WHICH ROOM. CONTACT THE APPROPRIATE AUTHORITY AS INDICATED ON THE QEL PANEL.
CBY	Engineering	D313	1	CO	12 ppm	QEL	N	10 seconds	Upon activation of alarm, an alarm signal is sent to Protection Dispatch. The alarm will remain active until the condition has been cleared. A local silence function will not affect the alarm to Protection Services. The annunciator panel, located upon entry to D300 level provides additional information on the alarm. Local alarms will activate audibly within the room where the alarm is located.	Y	THIS ALARM HAS BEEN GENERATED BY THE QEL GAS DETECTOR LOCATED IN HALL CLOSE TO CBYD321. THIS PANEL WILL INDICATE WHICH GAS AND WHICH ROOM. CONTACT THE APPROPRIATE AUTHORITY AS INDICATED ON THE QEL PANEL.
CBY	Engineering	D319	1	CO	12 ppm	QEL	N	10 seconds	Upon activation of alarm, an alarm signal is sent to Protection Dispatch. The alarm will remain active until the condition has been cleared. A local silence function will not affect the alarm to Protection Services. The annunciator panel, located upon entry to D300 level provides additional information on the alarm. Local alarms will activate audibly within the room where the alarm is located.	Y	THIS ALARM HAS BEEN GENERATED BY THE QEL GAS DETECTOR LOCATED IN HALL CLOSE TO CBYD321. THIS PANEL WILL INDICATE WHICH GAS AND WHICH ROOM. CONTACT THE APPROPRIATE AUTHORITY AS INDICATED ON THE QEL PANEL.
CBY	Engineering	D320	1	CO	12 ppm	QEL	N	10 seconds	Upon activation of alarm, an alarm signal is sent to Protection Dispatch. The alarm will remain active until the condition has been cleared. A local silence function will not affect the alarm to Protection Services. The annunciator panel, located upon entry to D300 level provides additional information on the alarm. Local alarms will activate audibly within the room where the alarm is located.	Y	THIS ALARM HAS BEEN GENERATED BY THE QEL GAS DETECTOR LOCATED IN HALL CLOSE TO CBYD321. THIS PANEL WILL INDICATE WHICH GAS AND WHICH ROOM. CONTACT THE APPROPRIATE AUTHORITY AS INDICATED ON THE QEL PANEL.

Building	Faculty / Service	Room	Qty	Sensor	Calibration	Organization	Strobe	Delay	Operational Sequence	Monitored	Procedure (Protection)
CBY	Engineering	D320	1	C ₂ H ₄	20%	QEL	N	10 seconds	Upon activation of alarm, an alarm signal is sent to Protection Dispatch. The alarm will remain active until the condition has been cleared. A local silence function will not affect the alarm to Protection Services. The annunciator panel, located upon entry to D300 level provides additional information on the alarm. Local alarms will activate audibly within the room where the alarm is located.	Y	THIS ALARM HAS BEEN GENERATED BY THE QEL GAS DETECTOR LOCATED IN HALL CLOSE TO CBYD321. THIS PANEL WILL INDICATE WHICH GAS AND WHICH ROOM. CONTACT THE APPROPRIATE AUTHORITY AS INDICATED ON THE QEL PANEL.
CBY	Engineering	D320	1	C ₃ H ₆	20%	QEL	N	10 seconds	Upon activation of alarm, an alarm signal is sent to Protection Dispatch. The alarm will remain active until the condition has been cleared. A local silence function will not affect the alarm to Protection Services. The annunciator panel, located upon entry to D300 level provides additional information on the alarm. Local alarms will activate audibly within the room where the alarm is located.	Y	THIS ALARM HAS BEEN GENERATED BY THE QEL GAS DETECTOR LOCATED IN HALL CLOSE TO CBYD321. THIS PANEL WILL INDICATE WHICH GAS AND WHICH ROOM. CONTACT THE APPROPRIATE AUTHORITY AS INDICATED ON THE QEL PANEL.
CBY	Engineering	D320	1	NO	10 ppm	QEL	N	10 seconds	Upon activation of alarm, an alarm signal is sent to Protection Dispatch. The alarm will remain active until the condition has been cleared. A local silence function will not affect the alarm to Protection Services. The annunciator panel, located upon entry to D300 level provides additional information on the alarm. Local alarms will activate audibly within the room where the alarm is located.	Y	THIS ALARM HAS BEEN GENERATED BY THE QEL GAS DETECTOR LOCATED IN HALL CLOSE TO CBYD321. THIS PANEL WILL INDICATE WHICH GAS AND WHICH ROOM. CONTACT THE APPROPRIATE AUTHORITY AS INDICATED ON THE QEL PANEL.
CRX	Facilities	C043	1	R410A	200 ppm	Honeywell	Y		Lower - 200 ppm; Upper - 900 ppm	N	
CTE	Facilities	Chiller 4; Ad 3	1	R134A	200 ppm	Honeywell			Lower - 200 ppm; Upper - 900 ppm		
CTE	Facilities	Chiller 4; Ad 2	1	R134A	200 ppm	Honeywell			Lower - 200 ppm; Upper - 900 ppm		
CTE	Facilities	Chiller 4; Ad 1	1	R134A	200 ppm	Honeywell			Lower - 200 ppm; Upper - 900 ppm		
CTE	Facilities	Chiller 3; Ad 3	1	R134A	200 ppm	Honeywell			Lower - 200 ppm; Upper - 900 ppm		
CTE	Facilities	Chiller 1; Ad 2	1	R123	30 ppm	Honeywell			Lower - 30 ppm; Upper - 900 ppm		
CTE	Facilities	Chiller 1; Ad 1	1	R123	30 ppm	Honeywell			Lower - 30 ppm; Upper - 900 ppm		
CTE	Facilities	Pit 1; Ad 17	1	O ₂	19%	Honeywell			Lower - 19%; Upper - 23%		
CTE	Facilities	Pit 2; Ad 19	1	O ₂	19%	Honeywell			Lower - 19%; Upper - 23%		
CTE	Facilities	Pit 2; Ad 20	1	CO ₂	1000 ppm	Honeywell			Lower - 1000 ppm; Upper - 1800 ppm		
CTE	Facilities	Pit 1; Ad 18	1	CO ₂	1000 ppm	Honeywell			Lower - 1000 ppm; Upper - 1800 ppm		
DMS	Facilities	13020	1	R134A	200 ppm	Honeywell	Y		Lower - 200 ppm; Upper - 900 ppm	Y	
DMS	Parking	Garage - P1	1	CO		Honeywell					
DMS	Parking	Garage - P1	1	CO		Honeywell					
DMS	Parking	Garage - P1	1	CO		Honeywell					
DMS	Parking	Garage - P1	1	CO		Honeywell					
DMS	Parking	Garage - P1	1	CO		Honeywell					
DMS	Parking	Garage - P2	1	CO		Honeywell					
DMS	Parking	Garage - P2	1	CO		Honeywell					
DMS	Parking	Garage - P2	1	CO		Honeywell					
DMS	Parking	Garage - P2	1	CO		Honeywell					
DMS	Parking	Garage - P2	1	CO		Honeywell					
DMS	Parking	Garage - P2	1	CO		Honeywell					
DRO	Science	O23C	1	C ₃ H ₈	Low - 10% High - 20%	QEL	N		Upon activation, local audible alarm activates and a signal is sent to Protection Services.	Y	Instructions: During working hours: Pubalee Bera at ext. 6425 or cell (613) 608-5467 or Panos Argyropoulos at ext. 4580 or cell (613) 698-2950. After hours: Send three Officers to the area. One should block access from the east side (facing 141 LP) entrance to DRO and Bio2 and look through the door toward opposite wall to notice colour of the warning light. One should block access from the loading dock (facing Lot V). One should enter DRO by the side entrance and go towards the loading zone and look through the loading zone door, near stair B, at the gas monitor (located on the right wall) to notice colour of the warning light. To note, if light detector is yellow = the concentration of flammable vapours is below flammability level, entry permitted. If light on detector is red = do not enter area. Report the findings to Pubalee Bera at ext. 6425 or cell (613) 608-5467 or Panos Argyropoulos at ext. 4580.

Building	Faculty / Service	Room	Qty	Sensor	Calibration	Organization	Strobe	Delay	Operational Sequence	Monitored	Procedure (Protection)
DRO	Science	023C	1	C ₃ H ₈	Low - 10% High - 20%	QEL	N		Upon activation, local audible alarm activates and a signal is sent to Protection Services.	Y	Instructions: During working hours: Pubalee Bera at ext. 6425 or cell (613) 608-5467 or Panos Argyropoulos at ext. 4580 or cell (613) 698-2950. After hours: Send three Officers to the area. One should block access from the east side (facing 141 LP) entrance to DRO and Bio2 and look through the door toward opposite wall to notice colour of the warning light. One should block access from the loading dock (facing Lot V). One should enter DRO by the side entrance and go towards the loading zone and look through the loading zone door, near stair B, at the gas monitor (located on the right wall) to notice colour of the warning light. To note, if light detector is yellow = the concentration of flammable vapours is below flammability level, entry permitted. If light on detector is red = do not enter area. Report the findings to Pubalee Bera at ext. 6425 or cell (613) 608-5467 or Panos Argyropoulos at ext. 4580.
DRO	Science	128	1	H ₂	Low - 10% High - 20%	QEL	N		Upon activation, local audible alarm activates and a signal is sent to Protection Services.	N	N/A
DRO	Science	129	1	C ₃ H ₈	Low - 10% High - 20%	QEL	N		Upon activation, local audible alarm activates and a signal is sent to Protection Services.	Y	Instructions: During working hours: Pubalee Bera at ext. 6425 or cell (613) 608-5467 or Panos Argyropoulos at ext. 4580 or cell (613) 698-2950. After hours: Send two Officers to the area. One should block access from the east side (facing 141 LP).
DRO	Science	140	1	CO	12 ppm	QEL	N		Upon activation, local audible alarm activates.	N	N/A
DRO	Science	140	1	CO	12 ppm	QEL	N		Upon activation, local audible alarm activates.	N	N/A
DRO	Science	140	1	CO	12 ppm	QEL	N		Upon activation, local audible alarm activates.	N	N/A
DRO	Science	140	1	CO	12 ppm	QEL	N		Upon activation, local audible alarm activates.	N	N/A
DRO	Science	140	1	CO	12 ppm	QEL	N		Upon activation, local audible alarm activates.	N	N/A
DRO	Science	140	1	CO	12 ppm	QEL	N		Upon activation, local audible alarm activates.	N	N/A
DRO	Science	421	1	CO	12 ppm	QEL	N		Upon activation, local audible alarm activates.	N	N/A
DRO	Science	422	1	CO	12 ppm	QEL	N		Upon activation, local audible alarm activates.	N	N/A
DRO	Facilities	Basement Mechanical	1	R22	100 ppm	QEL	N	N/A		N	N/A
DRO	Facilities	Basement Mechanical	1	R22	100 ppm	QEL	N	N/A		N	N/A
FRL	Parking / Housing	Garage	4	CO	25 ppm		N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below X ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more for at least 1 minute, or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 50 ppm, the audible alarm will deactivate instantaneously.	N	N/A
FRL	Parking / Housing	Garage	5	CO	50 ppm		N	N/A		N	N/A
HMN	Parking	Garage - Pillar A2	1	CO	25 ppm	QEL	N	30 seconds	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more for at least 1 minute, or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	Y	N/A
HMN	Parking	Garage - Pillar B3	1	CO	25 ppm	QEL	N	30 seconds	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more for at least 1 minute, or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	Y	N/A
HMN	Parking	Garage - Pillar A6	1	CO	25 ppm	QEL	N	30 seconds	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more for at least 1 minute, or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	Y	N/A

Building	Faculty / Service	Room	Qty	Sensor	Calibration	Organization	Strobe	Delay	Operational Sequence	Monitored	Procedure (Protection)
HMN	Parking	Garage - Pillar B6	1	CO	25 ppm	QEL	N	30 seconds	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more for at least 1 minute, or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	Y	N/A
HMN	Parking	Garage - Pillar C9	1	CO	25 ppm	QEL	N	30 seconds	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more for at least 1 minute, or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	Y	N/A
HMN	Parking	Garage - Pillar C5	1	CO	25 ppm	QEL	N	30 seconds	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more for at least 1 minute, or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	Y	N/A
HMN	Parking	Garage - Pillar F9	1	CO	25 ppm	QEL	N	30 seconds	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more for at least 1 minute, or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	Y	N/A
HMN	Parking	Garage - Pillar F6	1	CO	25 ppm	QEL	N	30 seconds	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more for at least 1 minute, or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	Y	N/A
HMN	Parking	Garage - Pillar F2	1	CO	25 ppm	QEL	N	30 seconds	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more for at least 1 minute, or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	Y	N/A
HMN	Parking	Garage - Pillar C2	1	CO	25 ppm	QEL	N	30 seconds	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more for at least 1 minute, or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	Y	N/A
HSY	Parking	Garage - Pillar B	1	CO	25 ppm	Armstrong			Exhaust fans activate upon condition of 25 ppm. A high alarm of 75 ppm also is calibrated.	N	N/A
HSY	Parking	Garage - Pillar K	1	CO	25 ppm	Armstrong			Exhaust fans activate upon condition of 25 ppm. A high alarm of 75 ppm also is calibrated.	N	N/A
HSY	Parking	Garage - Pillar P	1	CO	25 ppm	Armstrong			Exhaust fans activate upon condition of 25 ppm. A high alarm of 75 ppm also is calibrated.	N	N/A
MNN	Parking / Housing	Garage - Pillar C2-C3	1	CO							
MNN	Parking / Housing	Garage - Pillar C6	1	CO							
MNN	Parking / Housing	Garage - Pillar A7	1	CO							
MNT	Facilities	0010 - Tunnel Mechanical Room	1	R22		QEL	Y			N	
MRT	Facilities	0012	1	R134A		Honeywell					

Building	Faculty / Service	Room	Qty	Sensor	Calibration	Organization	Strobe	Delay	Operational Sequence	Monitored	Procedure (Protection)
PMC (600)	Facilities	Basement Mechanical	1	R22	500 ppm		N	Instantaneous	Local, audible alarm activates if low (500 ppm) alarm is activated. If high (1000 ppm) alarm is activated, the exhaust fan will be activated instantaneously and will continue to operate until the volume drops below the deactivation threshold.	N	N/A
PMC (600)	Facilities	014	1	R134A	200 ppm	Honeywell			Lower - 200 ppm; Upper - 900 ppm		
PRZ	Parking	Garage - Pillar H8	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	Y	N/A
PRZ	Parking	Garage - Pillar J2	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	Y	N/A
PRZ	Parking	Garage - Pillar F12	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 50 ppm CO or more or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to 40 ppm, the audible alarm will deactivate instantaneously.	Y	N/A
RDU	Parking / Housing										
RGN	Medicine	4503	1	O ₂	19.5%		N	Instantaneous	When O2 levels drop below 19.5%, an audible, local alarm is activated.	Y	REGULAR HOURS AND AFTER HOURS Dispatch advised RGN Protection Officer to proceed to location of Alarm (RGN 4503 & RGN 4506) to inform possible occupant that response procedure is being initiated and that the SOP for exiting the room applies. RGN Protection Officer to block open door to aid ventilation. Protection Officer to remain in hall until alarm ceases - the room will then be safe for entry. Dispatch reports alarm event to Health, Safety and Risk Manager by email at cmulcahy@uottawa.ca.
RGN	Medicine	4506	1	O ₂	19.5%		N	Instantaneous	When O2 levels drop below 19.5%, an audible, local alarm is activated.	Y	REGULAR HOURS AND AFTER HOURS Dispatch advised RGN Protection Officer to proceed to location of Alarm (RGN 4503 & RGN 4506) to inform possible occupant that response procedure is being initiated and that the SOP for exiting the room applies. RGN Protection Officer to block open door to aid ventilation. Protection Officer to remain in hall until alarm ceases - the room will then be safe for entry. Dispatch reports alarm event to Health, Safety and Risk Manager by email at cmulcahy@uottawa.ca.
RGN	Medicine	4149	1				N			Y	Emergency Procedure Plastination Facility, Room 4149. Pathology Department, Roger Guindon Hall. The Plastination Facility has been specially designed to allow for the safe handling of large volumes of Acetone, a highly volatile and flammable toxic chemical. The room is grounded and all potentially spark generating items have been removed to the outside of the room. The Acetone is either stored closed in flammable storage cabinets or open in freezers designed to maintain the acetone below its flash point. Two types of alarm are present in the facility, temp and access (both linked to Protection Services).
RGN	Facilities	3003A	1	R123	30 ppm	Honeywell			Lower - 30 ppm; Upper - 900 ppm		
RGN	Facilities	3003A	1	R123	30 ppm	Honeywell			Lower - 30 ppm; Upper - 900 ppm		
RGN	Facilities	3003A	1	R123	30 ppm	Honeywell			Lower - 30 ppm; Upper - 900 ppm		
SCS	Parking	Garage - Level 0 - A1	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 35 ppm CO, or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to X ppm, the audible alarm will deactivate instantaneously.	Y	N/A
SCS	Parking	Garage - Level 0 - B4	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 35 ppm CO, or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to X ppm, the audible alarm will deactivate instantaneously.	Y	N/A

Building	Faculty / Service	Room	Qty	Sensor	Calibration	Organization	Strobe	Delay	Operational Sequence	Monitored	Procedure (Protection)
SCS	Parking	Garage - Level 0 - G4	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 35 ppm CO, or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to X ppm, the audible alarm will deactivate instantaneously.	Y	N/A
SCS	Parking	Garage - Level 0 - E1	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 35 ppm CO, or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to X ppm, the audible alarm will deactivate instantaneously.	Y	N/A
SCS	Parking	Garage - Level 00 - B1	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 35 ppm CO, or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to X ppm, the audible alarm will deactivate instantaneously.	Y	N/A
SCS	Parking	Garage - Level 00 - B4	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 35 ppm CO, or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to X ppm, the audible alarm will deactivate instantaneously.	Y	N/A
SCS	Parking	Garage - Level 00 - G4	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 35 ppm CO, or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to X ppm, the audible alarm will deactivate instantaneously.	Y	N/A
SCS	Parking	Garage - Level 00 - F1	1	CO	25 ppm	QEL	N	Instantaneous	When any sensor detects 25 ppm CO or more, general ventilation is activated. Upon dropping below 15 ppm, the ventilation will deactivate after a 180-second minimum run-time. When any sensor detects 35 ppm CO, or if a sensor has a fault condition, the controller's audible alarm is activated. Once the level drops to X ppm, the audible alarm will deactivate instantaneously.	Y	N/A
SCS	Facilities	Arena 1 (West - W101)	1	CO	12.5 ppm		N	Instantaneous	Upon activation of alarm, ventilation activates in arena 1, arena 2, zamboni room 1 and zamboni room 2.	Y	N/A
SCS	Facilities	Arena 1 (West - W101)	1	CO	12.5 ppm		N	Instantaneous	Upon activation of alarm, ventilation activates in arena 1, arena 2, zamboni room 1 and zamboni room 2.	Y	N/A
SCS	Facilities	Arena 1 (West - W101)	1	CO	12.5 ppm		N	Instantaneous	Upon activation of alarm, ventilation activates in arena 1, arena 2, zamboni room 1 and zamboni room 2.	Y	N/A
SCS	Facilities	Arena 1 (West - W101)	1	CO	12.5 ppm		N	Instantaneous	Upon activation of alarm, ventilation activates in arena 1, arena 2, zamboni room 1 and zamboni room 2.	Y	N/A
SCS	Facilities	Zamboni Room 1 (West - C103)	1	CH ₄		QEL	N	Instantaneous		Y	N/A
SCS	Facilities	Zamboni Room 2 (East - C118)	1	CH ₄		QEL	N	Instantaneous		Y	N/A
SCS	Facilities	C105	1	CH ₄		QEL	N	Instantaneous		Y	N/A
SCS	Facilities	C105	1	R123		QEL	N	Instantaneous		Y	N/A
SCS	Facilities	C107A	1	NH ₃	10 ppm	Armstrong	Y	N/A		Y	
SCS	Facilities	C107A	1	NH ₃	300 ppm	Armstrong	N/A	N/A		N/A	
SCS	Facilities	C108	1	CO		QEL	N			N	
SCS	Facilities	C102 (Public Hallway)	1	NH ₃	5 ppm	Armstrong	Y	N/A		Y	

Building	Faculty / Service	Room	Qty	Sensor	Calibration	Organization	Strobe	Delay	Operational Sequence	Monitored	Procedure (Protection)
STM	Engineering	0015	1	CO ₂		QEL				N	
STM	Engineering	0015	1	O ₂		QEL				N	
STM	Engineering	0015	1	LEL		QEL				N	
STM	Engineering	0015	1	LEL		QEL				N	
STM	Engineering	0016	1	CO		QEL				N	
STM	Engineering	0016	1	CO		QEL				N	
STM	Engineering	0016	1	NO ₂		QEL				N	
STM	Engineering	0017B	1	CO ₂		QEL				N	
STM	Engineering	0017B	1	O ₂		QEL				N	
STM	Engineering	0019	1	CO		QEL				N	
STM	Engineering	0019	1	NO ₂		QEL				N	
STM	Engineering	0019A	1	O ₂		QEL				N	
STM	Engineering	0019B	1	CO ₂		QEL				N	
STM	Engineering	0019B	1	O ₂		QEL				N	
STM	Engineering	0019B	1	LEL		QEL				N	
STM	Engineering	0019B	1	LEL		QEL				N	
STM	Engineering	0020	1	O ₂		QEL				N	
STM	Engineering	0028	1	O ₂		QEL				N	
STM	Engineering	016	1	O ₂		QEL				N	
STM	Engineering	017	1	CO		QEL				N	
STM	Engineering	017	1	CO		QEL				N	
STM	Engineering	017	1	NO ₂		QEL				N	
STM	Engineering	017	1	NO ₂		QEL				N	
STM	Engineering	128	1	CO		QEL				N	
STM	Engineering	128	1	CO		QEL				N	
STM	Engineering	128	1	NO ₂		QEL				N	
STM	Engineering	128	1	NO ₂		QEL				N	
STM	Science	216	1	O ₂		QEL				N	
STM	Science	216A	1	O ₂		QEL				N	
STM	Science	216B	1	O ₂		QEL				N	
STM	Science	470	1	O ₂		QEL				N	
STM	Science	472	1	O ₂		QEL				N	
STM	Science	475	1	O ₂		QEL				N	
STM	Science	477	1	CO ₂		QEL				N	
STM	Science	477	1	O ₂		QEL				N	
STM	Science	479	1	CO ₂		QEL				N	
STM	Science	481A	1	O ₂		QEL				N	
STM	Science	483	1	O ₂		QEL				N	
STM	Science	485	1	O ₂		QEL				N	
STM	Science	486	1	O ₂		QEL				N	
STM	Science	488	1	O ₂		QEL				N	

APPENDIX 2 – LOWER EXPLOSIVE LIMITS FOR COMMON SUBSTANCES

Gas	LEL (%)	UEL (%)	Gas	LEL (%)	UEL (%)
Acetone	2.6%	13.0%	Heptane	1.1%	6.7%
Acetylene	2.5%	100.0%	Hexane	1.2%	7.4%
Acrylonitrile	3.0%	17.0%	Hydrogen	4.0%	75.0%
Allene	1.5%	11.5%	Hydrogen Cyanide	5.6%	40.0%
Ammonia	15.0%	28.0%	Hydrogen Sulfide	4.0%	44.0%
Benzene	1.3%	7.9%	Isobutane	1.8%	8.4%
1,3-Butadiene	2.0%	12.0%	Isobutylene	1.8%	9.6%
Butane	1.8%	8.4%	Isopropanol	2.2%	--
n-Butanol	1.7%	12.0%	Methane	5.0%	15.0%
1-Butene	1.6%	10.0%	Methanol	6.7%	36.0%
Cis-2-Butene	1.7%	9.7%	Methylacetylene	1.7%	11.7%
Trans-2-Butene	1.7%	9.7%	Methyl Bromide	10.0%	15.0%
Butyl Acetate	1.4%	8.0%	3-Methyl-1-Butene	1.5%	9.1%
Carbon Monoxide	12.5%	74.0%	Methyl Cellosolve	2.5%	20.0%
Carbonyl Sulfide	12.0%	29.0%	Methyl Chloride	7.0%	17.4%
Chlorotrifluoroethylene	8.4%	38.7%	Methyl Ethyl Ketone	1.9%	10.0%
Cumene	0.9%	6.5%	Methyl Mercaptan	3.9%	21.8%
Cyanogen	6.6%	32.0%	Methyl Vinyl Ether	2.6%	39.0%
Cyclohexane	1.3%	7.8%	Monoethylamine	3.5%	14.0%
Cyclopropane	2.4%	10.4%	Monomethylamine	4.9%	20.7%
Deuterium	4.9%	75.0%	Nickel Carbonyl	2.0%	--
Diborane	0.8%	88.0%	Pentane	1.4%	7.8%
Dichlorosilane	4.1%	98.8%	Picoline	1.4%	--
Diethylbenzene	0.8%	--	Propane	2.1%	9.5%
1,1-Difluoro-1-Chloroethane	9.0%	14.8%	Propylene	2.4%	11.0%
1,1-Difluoroethane	5.1%	17.1%	Propylene Oxide	2.8%	37.0%
1,1-Difluoroethylene	5.5%	21.3%	Styrene	1.1%	--
Dimethylamine	2.8%	14.4%	Tetrafluoroethylene	4.0%	43.0%
Dimethyl Ether	3.4%	27.0%	Tetrahydrofuran	2.0%	--
2,2-Dimethylpropane	1.4%	7.5%	Toluene	1.2%	7.1%
Ethane	3.0%	12.4%	Trichloroethylene	12.0%	40.0%
Ethanol	3.3%	19.0%	Trimethylamine	2.0%	12.0%
Ethyl Acetate	2.2%	11.0%	Turpentine	0.7%	--
Ethyl Benzene	1.0%	6.7%	Vinyl Acetate	2.6%	--
Ethyl Chloride	3.8%	15.4%	Vinyl Bromide	9.0%	14.0%
Ethylene	2.7%	36.0%	Vinyl Chloride	4.0%	22.0%
Eythelen Oxide	3.6%	100.0%	Vinyl Fluoride	2.6%	21.7%
Gasoline	1.2%	7.1%	Xylene	1.1%	6.6%

Adapted from Matheson Trigas (www.mathesontrigas.com)

APPENDIX 3 – SENSOR EMERGENCY RESPONSE PLAN TEMPLATE

Example Atmospheric Sensor Emergency Plan

Gas Monitored:

Chemical Formula:

Concentration of Gas:

Exposure Limits:

- TWA –
- STEL –
- Ceiling –

Implications of the specific substance(s), including effects on human health, infrastructure, environment, etc.:

Sensor Operational Sequence

Room Number:

Location Internal to Monitoring Area:

Sensor Activation Set Points:

Sensor Activation / Deactivation Delays:

Activation Sequence:

Duration of Sensor Activation:

Automated Actions:

Deactivation Sequence:

Actions in the Event of Sensor Failure:

Emergency Contact

Principal Investigator:

Lab Manager:

Post-Doctoral Personnel:

Emergency Response Procedure:

Emergency Response Equipment:

Communication Plan for Lab Users in the Event of Sensor Activation:

APPENDIX 4 – SIGNAGE EXAMPLE



Le signal d'alarme indique un environnement d'oxygène réduit. Évacuer la zone surveillée et attendre la désactivation de l'alarme.

Alarm signal indicates oxygen-deficient environment. Evacuate monitored area and await return to normal operations.



Le signal d'alarme indique un environnement potentiellement explosif. Évacuez la zone surveillée immédiatement et appelez le Service de la protection.

Alarm signal indicates potentially explosive environment. Evacuate monitored area immediately and contact Protection Services.



Le signal d'alarme indique un environnement potentiellement toxique. Évacuez la zone surveillée immédiatement et appelez le Service de la protection.

Alarm signal indicates potentially toxic environment. Evacuate monitored area immediately and contact Protection Services.



**Le signal d'alarme indique qu'une fuite de réfrigérant est détectée.
Évacuer le zone surveillée immédiatement.**

**Alarm signal indicates
refrigerant leak detected.
Evacuate monitored area immediately.**