

**E N E R G Y
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Wildfire Smoke Guideline for the Oil and Gas Industry

**How to Prepare and
Respond to Wildfire
Smoke Hazards and Risks**

National Safety Association
for Canada's Energy Industry

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Preface

Purpose

This guideline aims to establish a framework for managing the risks associated with wildfire smoke exposure for workers in the Canadian oil and gas industry.

It provides practical recommendations to ensure compliance with health and safety regulations while minimizing health risks to employees working in outdoor and high-risk environments.

Project Scope and Limitations

This guideline applies to any operations or facilities, including camp-type facilities, where wildfire smoke exposure poses unique challenges.

Each employer should determine through their hazard and risk assessment, specific prevention, mitigation and response requirements.

Each company should have a written practice to manage wildfire smoke hazards.

The guide does not supersede the authority of government officials.

Always obey and follow orders from government officials in emergencies and use the resources provided in this guide to stay informed.

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1.0 Introduction

A large portion of the oil and gas industry operates in forested areas where there is a significant risk of wildfire and smoke.

Wildfires can cause harm to people, personnel entrapment, damage to facilities and negatively impact operations.

Smoke from wildfires poses a risk to the health and safety of personnel, reducing visibility and increasing the potential harm from long-term exposure to high concentrations of wildfire smoke.

It is essential for organizations to integrate wildfire risk assessments and response plans into their operations. These include training, site orientation, health risk assessments and the development of a communication plan.

This guide is intended for individuals responsible for health and safety, planning, preparedness and business continuity related to wildfire in the oil and gas industry. It aims to provide effective and reasonable measures to prepare for the risks from smoke.

1.1 Using this guide

This guide is designed to provide a broad introduction to the hazards and risks posed by wildfire smoke.

The guide is divided into three key parts:

- **Part 1:** Lists key legislation as part of an organization's core responsibilities when mitigating impacts from wildfire smoke.
- **Part 2:** Identifying the risks of wildfire smoke, conducting assessments and how to respond to incidents.
- **Part 3:** Understanding, preparing and how to implement potential actions or practices for the risks associated with wildfires.

2.0 Part 1: Regulatory review

In Canada, employers must treat wildfire smoke as a hazardous substance under applicable occupational health and safety (OHS) laws. Although there are no specific exposure limits for wildfire smoke, exposure limits exist for some constituents (e.g., carbon monoxide).

Key regulatory references:

Alberta

- Alberta's **Occupational Health and Safety Code** require employers to eliminate or control workplace hazards, including airborne contaminants. Specific provisions include:
 - » **Part 2 – Hazard Assessment, Elimination and Control:**
 - » Requires assessment of potential hazards and identification of controls.
 - » **Part 4 – Chemical Hazards, Biological Hazards, and Harmful Substances:**
 - » Requires assessment and control of exposure to airborne contaminants
 - » **Part 18 – Personal Protective Equipment:**
 - » Outlines requirements for the provision, use and maintenance of respiratory protection.

British Columbia

- Under British Columbia's **Workers Compensation Act** and **Occupational Health and Safety Regulation (OHSR)**:
 - » **Section 5.48 – Exposure to Airborne Contaminants:** Requires employers to ensure that workers are not exposed to harmful levels of airborne substances, including wildfire smoke components.

» **Section 8.32 – Respiratory Protection:**

Employers must provide respirators and ensure proper fit-testing and training when airborne contaminants exceed allowable levels.

» **Part 4 – Emergency Preparedness and Response, Indoor Air Quality:** Employers must have plans to address hazardous air quality conditions during emergencies.

Saskatchewan

• Saskatchewan’s **Occupational Health and Safety Regulations:**

» **Section 307 – Air Quality:** Employers must monitor and maintain safe air quality levels and implement controls to reduce exposure to harmful airborne substances.

» **Section 96 – Protective Equipment:** Requires employers to provide appropriate protective equipment, including respiratory protection, based on risk assessments.

Organizations should consult government websites and resources for more information on provincial or territorial OHS legislation.

3.0 Part 2: Smoke hazards and assessment

Smoke from wildfires can pose health concerns based on an exposed worker’s current health conditions, smoke density, duration, concentration of particulate matter (PM) and carbon monoxide (CO).

This section offers guidance and information on:

- Hazards associated with wildfire smoke
- Health effects of smoke exposure

- Composition of wildfire smoke and its byproducts
- Smoke behaviour and movement
- How to monitor and measure smoke levels and its byproducts
- Best practices for responding to wildfire smoke conditions
- Suggested responses to different levels of wildfire smoke

» **Note:** The suggested responses are intended to highlight areas of particular concern and offer guidance to minimize risk to health and safety. They are not a replacement for government or company directives.

3.1 Smoke hazards

An active wildfire front is often seen as the main risk to health and safety from a wildfire. However, the effects of wildfire smoke can be far more widespread than the fire itself, resulting in hazardous concentrations of smoke that can drift over vast areas.

In addition to health risks, wildfire smoke can severely reduce visibility, hamper operations and increase the risk of incidents.

Previous wildfire incidents have led to heavy smoke, requiring the evacuation of non-essential personnel from facilities and operations.

3.2 Health effects of smoke exposure

Common symptoms of smoke exposure:

- Coughing
- Throat irritation
- Irritated sinuses
- Shortness of breath

- Chest pain
- Headaches
- Stinging eyes
- Runny nose
- Worsening asthma conditions

While wildfire smoke affects everyone differently, both healthy and high-risk individuals may experience symptoms from smoke exposure.

High-risk individuals who may experience adverse health effects include:

- People with respiratory conditions such as lung cancer, asthma or chronic obstructive pulmonary disease (COPD), including chronic bronchitis and emphysema
- People with cardiovascular conditions, including angina, previous heart attack, congestive heart failure or irregular heartbeat
- People who are pregnant and their developing fetuses
- Diabetics
- Smokers
- Anyone engaged in outdoor work that involves moderate to heavy physical exertion (e.g., scaffolders, industrial bricklayers, iron workers, swamper, etc.)

Individuals with heart disease may experience:

- Chest pain
- Rapid heartbeat
- Shortness of breath
- Fatigue

Individuals with pre-existing respiratory conditions such as allergies, asthma or COPD may experience:

- Difficulty breathing
- Coughing, with or without mucus

- Chest discomfort
- Wheezing
- Shortness of breath

Additionally, wildfire smoke often occurs alongside high temperatures. Combined exposure to smoke and heat can further increase health risks.

Wildfire Smoke Composition and Potential By-products

Smoke from wildfires is a mixture of gases and fine particles from burning trees and other plant materials. The composition of smoke will vary depending on fuel type and conditions. Smoke is primarily composed of carbon dioxide, water vapour, Carbon Monoxide (CO), Particulate matter (PM), hydrocarbons and other organics, nitrogen oxides and trace minerals.

In general, PM is the major pollutant of concern from wildfire smoke. Particulate is a general term for a mixture of solid particles and liquid droplets suspended in the air. The particulates formed in wildfires tend to be very small (less than 2.5 microns in diameter) and are excellent at scattering light, which reduces visibility. These small particulates are often referred to as PM2.5.

In addition to these pollutants, trace amounts of other organic compounds may be present in wildfire smoke. The specific composition of these organic pollutants depends on the materials burned and the conditions of combustion. For instance, the burning of synthetic materials, such as plastics and rubber, could also release volatile organic compounds and semi-volatile organic compounds, which may pose additional health hazards.

Carbon Monoxide Exposure

Carbon monoxide (CO) is a tasteless, colourless and odourless gas produced by the incomplete combustion of carbon-based fuels. Anyone close to a fire, especially if it is smouldering, may be exposed to CO. Symptoms of CO exposure include headaches, weakness, dizziness, confusion and visual impairment.

Ash Particles

Due to the wildfire's proximity to facilities, there is a potential for ash particles to be present and that depending on the amount could also present a hazard due to their caustic nature and potential to impact on human health, such as eye and lung irritation.

As wildfires spread ash over wide areas, its ability to infiltrate water sources and air necessitates precautions to mitigate worker exposure.

4.0 Smoke behaviour

Smoke is highly influenced by local wind conditions, and the direction that smoke travels is highly erratic.

Since smoke concentrations change constantly, it is essential to practice vigilance and caution during smoke events (see: Monitoring for Smoke).

Large vertical smoke columns can create their own updrafts and downdrafts, causing sudden changes to the local weather, including shifting or erratic winds. In some cases, they can even produce their own lightning.

During a weather, smoke concentrations may increase significantly in low-lying areas such as valley bottoms where air is poorly mixed.

5.0 Monitoring and measuring for smoke & byproducts

Companies should be prepared in advance of the wildfire season and conduct appropriate monitoring for smoke conditions.

Many monitoring stations across North America and Canada utilize web-based applications that provide real-time and potential smoke conditions. Companies should also conduct research on any local or regional monitoring systems that also collect local air monitoring data, such as the Wood Buffalo Environmental Association in Fort McMurray, Alberta.

6.0 Measuring particulate levels using instruments

If there are no local monitoring stations that you can leverage, each company or operator should identify its site-specific monitoring program and protocols.

There are a variety of instruments available to measure particulates. Monitors can be portable or fixed for area monitoring.

See Appendix A - Table 5 for monitoring conditions do not have a CO concern.

Two common methods used for real-time wildfire smoke particulate monitoring are light scattering and beta attenuation.

Light Scattering

Light scattering devices such as optical particle counters or nephelometers are often used to measure wildfire smoke in both portable and fixed monitors. These devices shine a light source at a stream of air and measure the amount of light scattered or absorbed by the particles in the air to estimate particulate concentration.

Devices that use light scattering methods can be lower in cost to operate and maintain, allow for real-time data and can detect rapid changes in particulate levels due to their quick response times. Optical particle counters and nephelometers provide information about total particulate concentrations. They are used in conjunction with size-selective devices such as cyclones to estimate the concentration of specific particle size fractions (e.g. PM_{2.5}).

- Examples: PurpleAir-II, TSI DustTrak, TSI SidePak, Aeroqual Ranger Portable Dust Monitor, BlueSky Air Quality Monitor, AirAssure Indoor Air Quality Monitor, Aeroqual AQM65, Aeroqual Dust Sentry Series Dust Monitors, Aeroqual AQS Series, Aeroqual AQM Series, Thermo Scientific™ ADR1500 Area Dust Monitor

Beta Attenuation

Beta Attenuation Mass Monitor (BAM) devices use beta radiation to determine the mass concentration of particulate matter in air. Air passes through a size-selective inlet at a known flow rate to a filter where particulate is collected. The amount of beta particles that pass through the filter is measured and used to calculate the mass concentration of particulate in the air sample.

- Example: Met-One Environmental Beta-Attenuation Mass Monitor (E-BAM), Thermo Scientific™ 5014i Beta Continuous Ambient Particulate Monitor

Optical particle counters or nephelometers can provide precise data regarding particle sizes and concentration but can be affected by humidity and temperature which can affect measurement accuracy. BAM devices are regarded as highly accurate but can be a more significant investment for initial purchase and maintenance compared to light scattering devices. Some devices combine both BAM and light scattering methods to utilize the advantage of both methods.

Example: Thermo Scientific™ Model 5030i SHARP Particulate Monitor.

7.0 Measuring carbon monoxide levels

Monitoring carbon monoxide (CO) levels is critical in ensuring the health and safety of workers and emergency responders near a wildfire.

While carbon monoxide (CO) is less of a risk to health and safety during a wildfire than particulates, CO poisoning can occur after exposure to very high concentrations or after exposure to lower concentrations for a prolonged period.

The risk of CO poisoning decreases rapidly as you move further away from the fire. Anecdotal evidence suggests that CO exposure can become a concern when an active fire is within approximately 5 km. Smouldering fires may release higher ground-level CO concentrations than wind-driven active fires (e.g., crown fires).

CO exposure is challenging to control since the typical control measures used for smoke particulates do not trap CO (e.g., high-efficiency HVAC filters and air-purifying respirators such as N95 filtering-facepiece disposable respirators).

Furthermore, for facilities that operate on-site compressed breathing air refill stations for the use of supplied-air respirators (e.g., self-contained breathing apparatus), sustained elevated wildfire smoke and CO emissions can have significant negative effects upon the production of safe on-spec breathing air. Refer to Appendix A on breathing air quality management for more details.

CO detectors

Having CO detection on-site will warn workers of dangerous levels of CO.

CO detectors should be used when fires are close to a site and when sheltering inside clean air shelters if the time spent indoors exceeds one hour. As with all gas detection equipment, CO detectors must be maintained, calibrated and bump tested according to manufacturer specifications.

Particular consideration should be given to the method of “zeroing” CO sensors in a wildfire scenario. If measurable CO is present, ambient air may not be appropriate. Bottles of compressed “zero air” are commercially available and should be considered.

Appendix A - Table 4 provides a recommended response protocol based on measured CO levels in a workplace. This table is intended to apply to workers during working hours.

8.0 Air quality modelling

Many jurisdictions in Canada provide modelling or estimates of air quality using the Air Quality Health Index (AQHI) forecast system. In Canada, the scale ranges from 1 to 10, with 10 indicating a high health risk. The US scale ranges from 1 to 100.

AQHI represents the forecast of a semi-quantitative health risk rating for outdoor air pollution within the next 12-hour period. AQHI is based on a mixture of pollutants including PM2.5. The current AQHI ratings for different locations in Canada are published at www.airhealth.ca. While useful as a predictive/planning tool, AQHI ratings have their limitations:

- They are not available for many regions of Canada. Local AQHI conditions can be dramatically impacted by the proximity and wind direction of a wildfire.
- It was intended for the general population as opposed to oil and gas workers. As such it was intended to serve members of the population who would not be at an oil and gas production facility, such as children, those of advanced age and those with significant health problems.
- It was not intended for use by groups that have readiness for managing wildfire smoke (e.g. on-site air quality monitoring, respiratory protection programs, ventilation systems tailored for smoke management [as opposed to typical residential/commercial HVAC systems]).

Modelling and Tools: (Additional information and tools can be found [here](#)).

- The air quality model forecast maps are generated twice a day by [Environment and Climate Change Canada](#).
 - » The maps show the dispersion of wildfire smoke, the total levels of fine particulate matter (PM2.5), ground level ozone (O3) and nitrogen dioxide (NO2) hourly emissions for the next 72 hours. These are the three pollutants used to calculate the Air Quality Health Index (AQHI).

- The [BlueSky Western Canada Smoke Forecasting System](#) provides detailed smoke forecasts from BC to Manitoba during the fire season. BlueSky produces a new 60-hour model forecast of hourly ground level PM2.5 values, twice daily (early morning and mid-afternoon).
 - » This is a valuable resource, and should be used though it must be kept in mind that it is a modelled forecast and may not perfectly predict the time or location of PM2.5 events nor properly capture rapidly changing local conditions.
- [BC Smoky Skies British Columbia](#) partners with provincial and federal agencies and the University of British Columbia (UBC) to produce smoke forecasts.
 - » These forecasts predict ground level concentrations of fine particulate matter up to 48 hours in the future. Forecasts are available during the summer forest fire season.

In areas without continuous particulate matter (PM) monitoring (Air Quality Health Index), particle levels can be estimated using a visibility index. This is particularly effective during wildfires, when timely information is critical. Even in areas with continuous particulate monitoring, the visibility method is a quick and effective means of assessing air quality because smoke concentrations can change quickly and vary over short distances.

8.1 Visibility

One less reliable way of potentially determining smoke concentrations is through the visibility method. There are several methods and models that can be used for estimating smoke for those situations where access to monitoring results are not available. See [Resource](#) document for examples

9.0 Part 3: best practices for responding to smoke conditions

This focuses on:

- Establishing a Communications Plan
- Recommended Response and Communication Protocol for worker exposure during working hours.
- Identifying and preparing buildings or other locations where workers may occupy in order to reduce exposure to wildfire smoke.
- Identify and manage a respiratory protection plan and equipment, including support systems.

10.0 Communications planning

Pre-Season Communication Planning

- Establish who is accountable for establishing the communications plan and confirm that systems and tools are in order to be able to communicate to ALL workers regardless of location or workforce type (eg. Contractor) what the smoke conditions are and the required risk-mitigation actions:
 - » Confirm which site function or department has responsibility for distributing smoke-conditions updates (e.g. Safety, Operations, Emergency Services) and the “hours of operation”.
 - » Company Radio system, email distribution list contractor coordinators, etc.

- » Confirm how often and/or what changes in smoke conditions warrant an updated site-wide communication.
- Review any pre-season forecasts that may be available on potential wildfire conditions for the upcoming year.
- Send our toolbox talks and/or bulletins to workers to review key information related to wildfire smoke.

In-Season Communication during Smoke Condition changes

- Work with departments, such as industrial hygiene, safety, operations and/or key decision makers on what needs to be communicated at what frequency.
- Monitor modelling and air quality data (local and/or onsite) to determine any Communications that may be required.
- Consider the frequency and conditions that you should be communicating. Real time, forecasted, etc.
- Consider remote workers (field technicians, surveyors, environmental consultants, etc.) and establish alternate methods for communications such as cell phones.

11.0 Sheltering in place/clean air shelters/off-site clean air sanctuaries

Staying indoors is an effective strategy and response to smoke hazards resulting from wildfires and provides the best protection in tightly closed, air-conditioned buildings. However, not all indoor facilities should be treated the same.

In non-air conditioned or poorly sealed buildings, staying inside with doors and windows closed may offer little protection (i.e. due to infiltration of wildfire air contaminants into the building).

Effective clean air shelters should be identified before an event occurs such as camps, control rooms, critical office complexes, health clinics, emergency-response facilities.

During severe smoke events, clean-air sanctuaries or shelters can provide a place for workers to get out of the smoke. These also can be located off-site in large commercial buildings, camps, educational facilities, hospitals, shopping malls or any place with effective air conditioning and particle filtration.

12.0 Controls for indoor air quality

Establishing and maintaining good quality air inside buildings and facilities is critically important during situations such as changing wildfire smoke conditions.

The key to this solution is to engineer and maintain those permanent and temporary heating, ventilation and air conditioning (HVAC) systems.

12.1 Building Air Handling System Optimizations for Wildfire Smoke

Following the hierarchy of controls, the most effective way to protect indoor workers and to provide a “clean air shelter” for outdoor workers is to upgrade building HVAC systems.

The following strategies should be reviewed well in advance of fire season with your site's or third-party HVAC specialists to determine the optimal smoke-protection enhancements.

Particulate Filter Upgrades

During wildfires, when smoke can penetrate even tightly sealed structures, upgrading to the highest MERV-rated filter that the HVAC system can reliably accommodate offers a practical defense. By filtering out wildfire smoke effectively, upgraded air handling systems help maintain a healthier indoor environment during prolonged exposure events. These upgrades should especially be considered for camp accommodations to reduce the long-term smoke exposure for workers (e.g. 24-hour average or multi-day exposure time-weighted average).

When integrated into HVAC systems, these filters trap smoke particles before they circulate indoors, significantly reducing the concentration of harmful contaminants that can irritate the respiratory system or worsen indoor air quality.

All HVAC system particulate filters carry an HVAC industry-standard particulate-trapping efficiency rating known as the Minimum Efficiency Reporting Value (MERV) scale. While the MERV rating of filters selected for routine use varies, generally speaking, the standard filters used in commercial buildings and camp/motel accommodations do not have a sufficiently high MERV rating to effectively capture wildfire smoke particulates (PM_{2.5}).

Optimizing the MERV rating of HVAC the filtration system plays a crucial role in enhancing an air handling system's ability to combat wildfire smoke infiltration in buildings.

Rated on a scale from 1 to 16, higher numbers indicate greater filtration efficiency. MERV ratings from 11 to 14 are particularly effective for capturing fine particles like those

found in wildfire smoke, including soot and microscopic pollutants down to 0.3–1.0 micrometres in diameter.

Commercial air handlers are commonly set up in stages, with an initial filter bank for the larger particulates followed by a secondary filter bank with a higher MERV. High-MERV filters (e.g., >10) result in higher filter cost, shorter filter life and potentially increased pressure drop across the HVAC system and are generally not used during routine HVAC conditions for general-duty commercial spaces.

Multiple factors need to be considered when selecting filters for wildfire smoke. The physical filter bank setup and filter size/availability of higher-rated filters need to be considered, in addition to the pressure drop across the filter bank. Some HVAC systems cannot accept filters that would effectively trap wildfire smoke particulates.

Increasing the MERV rating of filters has some disadvantages. A MERV rating beyond the system's design range may restrict airflow in some systems, requiring professional assessment. These higher-rated filters will also plug up far more quicker with regular dust (e.g. road dust), requiring additional replacement filters and associated staffing to change them.

Make-up Air Adjustments

Most HVAC systems have the ability to adjust the amount of fresh air that is drawn into the system (known as "make-up" air). During the worst smoke periods, reducing or eliminating make-up air can be an effective strategy to maintain much-improved conditions inside a building. Will need to be monitored.

Building Pressure-Balance Adjustments

All buildings leak air. During prolonged wildfire-smoke periods, smoky outdoor air leaking into building compromises their

protective capability. If a building HVAC system has an effective particulate-trapping filter configuration (i.e. higher-MERV rated filters as described above), optimizing building pressurization (i.e. exhaust capacity versus supply air into selected spaces) can help reduce infiltration of smoky outdoor air.

12.2 Portable Filtration Units

In wildfire scenarios, where outdoor air becomes hazardous and building HVAC system optimizations cannot achieve the desired level of indoor air quality, portable air-filtration systems can be used as a supplemental tool to also improve indoor air quality by reducing exposure to smoke and other airborne pollutants. There are multiple sizes and styles of these devices.

12.2.1 Air cleaners

Air cleaners can be effective at reducing indoor particulate levels. Most are not effective at removing gases and odours. For removing gases and odours you require using sorbent filter (eg. activated charcoal)

Air cleaner effectiveness is usually reported in terms of efficiency but airflow should also be considered. These two factors together are measured as the Clean Air Delivery Rate (CADR). This is a better measure of how a device will actually perform.

Devices that remove gases and odours are relatively costly, both to purchase and maintain. The filtering medium can quickly become overloaded and may need to be replaced often.

12.2.2 Portable HEPA Fan Systems

An industrial/commercial portable filtration unit combining a fan and a filter bank terminating with a High-Efficiency Particulate Air (HEPA) filter is called a HEPA negative-air unit. These are commonly marketed to the asbestos and mould-abatement industries. HEPA filters are robust devices that can trap at least 99.97 per cent of particles as small as 0.3 micrometres (i.e., essentially scrubbing out all the wildfire smoke particulates). These filters can be highly effective tools for reducing indoor smoke levels.

They are available in a wide range of physical sizes/airflow capacities, making it possible to scrub smoke particles from large buildings such as work camps. They are relatively inexpensive and widely available in more populated areas from tool-rental providers.

By continuously filtering and circulating air, they help lower the presence of harmful wildfire-related contaminants, minimizing the risk of respiratory irritation or discomfort.

Their portability sets them apart from fixed air purifiers, allowing users to position them in key areas like work camp common areas, office spaces, workshops, health clinics and commercial kitchens at work camps.

Humidifiers

Humidifiers are not air cleaners. They will not significantly reduce the amount of particulate matter in the air during a smoke event or remove gases like carbon monoxide.

However, humidifiers and dehumidifiers (depending on the environment) may slightly reduce pollutants through condensation, absorption and other mechanisms. The greater benefit of running a humidifier in an arid environment during a smoke event is to reduce stress on the respiratory system by keeping the mucus membranes moist.

12.3 Impact of CO on camp facilities

For worksites that have camps or other living accommodations, worker exposure to CO also needs to be managed for non-working hours. Health Canada has published various guidance documents related to residential CO exposure.

Exposure limits for 1-hour and 24-hour averaged exposure times were derived by Health Canada to protect the entire population for both short and prolonged exposures to CO.

The recommended maximum exposure limits for CO are derived from the toxicokinetic models. Exposure to indoor air concentrations above these limits may result in potential health effects, especially for susceptible individuals.

Residential Maximum Exposure Limits for Carbon Monoxide: Table 1

Averaging time	Concentration		Critical Effects
	mg/m ³	ppm	
1h	28.6	25	Reduction in maximum duration of exercise in health individuals
24h	11.5	10	Adverse effects have been observed with individuals with coronary artery disease

References:

“Residential Indoor Air Quality Guideline: Carbon Monoxide” (<https://www.canada.ca/en/health-canada/services/publications/healthy-living/residential-indoor-air-quality-guideline-carbon-monoxide.html>).

“Guidance for Cleaner Air Spaces during Wildfire Smoke Events” (Sept 2020 Health Canada: <https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidance-cleaner-air-spaces-during-wildfire-smoke-events.html>).

13.0 Personal Protective Equipment – Respirators and Breathing Apparatus

13.1 Respiratory Protective Equipment

Respiratory protection equipment and plan for use should be established prior to the wildfire season.

For a tight-fitting respirator to be effective the wearer must be clean shaven where the mask seals to the face.

As part of pre-season wildfire smoke response planning, sites should verify and or establish:

As part of pre-season wildfire smoke response planning, sites should verify and or establish:

- Fit-testing and respirator training resources for respirator users
- What styles/levels of respiratory protection will they use for which work groups when facing increasing smoke concentrations.
- Minimum stocking levels for respirator program supplies.

All workplace respirator use should be defined by the company's required respiratory program. (also known as a "Respirator Code of Practice" or "Management Program").

In Canada, CSA Standard Z94.4 establishes the requirements for the selection, use and care of respirators; it's principles apply to use of respirators during wildfires. Refer to the regulatory requirements in your area.

To provide protection during a smoke event, respiratory protection must be able to filter tiny smoke particles (around 0.1 to 0.3 microns diameter) and must fit properly, providing an airtight seal around the wearer's face.

For these reasons only true respirators should be used to protect workers from wildfire smoke and workers must be trained and fit tested to the respirator they are using.

A reminder that air-purifying respirators offer zero protection from carbon monoxide (CO).

Other types of face coverings that serve other purposes should not be used for wildfire smoke protection, such as:

- "Dust masks" that do not meet established respirator performance standards. These are commonly available at hardware stores, marketed to the general public. These do not meet the testing/approval standards required for workplace respiratory protection as defined by provincial/territorial regulations. They do not have established particle-trapping efficiency.
- Bandannas or "gaitors" – have inadequate fit and particle-trapping efficiency to offer smoke protection.
- Surgical masks - designed to filter air coming out of the wearer's mouth (as opposed to smoke particles being inhaled) and do not provide a tight facial seal.

Respirators have an industry-standard rating scale for particle-trapping efficiency (somewhat similar to the MERV scale for HVAC filters). At minimum, N95 filtration is recommended but P100 filtration is preferred. Different styles of respirator offer different features and protection capabilities in a wildfire-smoke context.

With the exception of certain positive-pressure powered-air-purifying (PAPR) or supplied-air respirator (SAR) types. For example, there are welding and abrasive-blasting respirators in common use in western Canadian O&G facilities that do not require workers to be clean-shaven nor fit-tested. These models offer excellent wildfire-smoke protection in addition to protection from the particulates generated by their work activities.

13.2 Eye Protection

Eye protection should be used by outdoor workers to reduce eye irritation due to wildfire smoke. The type of eye protection required will depend on smoke conditions and the tasks to be performed.

The minimum eye protection recommended is tight fitting-safety glasses. Goggles are preferred because they provide a better seal and are more effective at preventing eye contact with smoke components. A full-face respirator can be used to provide both respiratory protection and eye protection.

Table 2 identifies a hierarchy of wildfire-smoke respirators for typical Operations and Maintenance tasks (arranged in increasing order of cost and protection).

Table 2 Wildfire Smoke Respiratory equipment

Respirator Type	Protection & Key Features	Comments
Entry-level disposable filtering-facepiece respirators (at N95 particulate rating)	The minimum recommended standard for wildfire smoke protection	May be less comfortable than other models described below. Hard for user to verify correct fit (i.e. "seal checks" are challenging to perform). Generally widely available.
Enhanced disposable filtering-facepiece respirators	Enhanced protection and comfort compared to entry-level N95s. Models available with some of these features: <ul style="list-style-type: none"> • exhalation valves (less likely to fog safety glasses, more comfortable to wear [cooler]). • N99 or 100 filtration capability. • Organic-vapour treatment to reduce smoke odours (often marketed for welding applications). • Individually packaged in "flat-packs" (easy to keep in a coveralls pocket clean ready to use). 	All of these features enhance some combination of fit, comfort, and/or protection. A disposable respirator combining all of these features may not be available. These performance improvements come at increased cost and these more specialized models may be less available at times of peak demand.

<p>Elastomeric half-mask respirator with P100 filters (or combination organic vapour-P100 cartridge)</p>	<ul style="list-style-type: none"> • Recommended for use in adverse smoke conditions • More reliable fit and protection than disposable filtering-facepiece respirators • Allows use of combination cartridges to effectively trap wildfire smoke odours in addition to particulates 	<p>Eliminates ongoing cost of disposable filtering-facepiece respirator; the P100 filter should last many weeks of wildfire smoke use. Fit can be easily verified by the user before use via positive and negative-pressure “user fit checks”. May tradespeople are already fit-tested and equipped with these respirators.</p>
<p>Elastomeric full-face respirator with P100 filters (or combination organic vapour-P100 cartridge)</p>	<ul style="list-style-type: none"> • Offers further enhanced protection against smoke particles (5X higher than filtering-facepiece or elastomeric ½ mask respirators). • Also offers protection against eye irritation from smoke. 	<p>Similar advantages to elastomeric ½ mask respirators. Costs is ~5X higher and harder to use for workers who need prescription lenses.</p>
<p>Loose-fitting powered air-purifying respirator (PAPR)</p>	<ul style="list-style-type: none"> • By far the coolest model to wear in summer heat. • Can be worn over a moderate amount of facial hair, does not require fit-testing. • Models available that include an impact-rated face shield, hardhat, and earmuffs (i.e. an integrated PPE system). • Offers enhanced protection against smoke particles (2.5X higher than filtering-facepiece or elastomeric ½ mask respirators). • Full-face mask offers excellent eye protection from smoke irritation. 	<p>Highest initial and operating cost of all these options, but also offers best comfort and nearly the best protection. May have the highest acceptance by workers when faced with severe smoke conditions for Emergency work.</p>

Full-face supplied air respirators (i.e. self-contained breathing apparatus [SCBA] and supplied air breathing apparatus [SABA]).

- Offers highest degree of protection from PM2.5 particulates, offers generous protection from carbon monoxide (CO) as well.
- Full-face mask offers excellent eye protection from smoke irritation.

Use of supplied air respirators should not be considered a sustainable solution for continued full production rate operations. Capacity for producing breathing air (BA) of acceptable quality and number of cylinders and SCBA sets will be limiting factors. See also Appendix A regarding managing breathing air quality during smoke events. Workers must be trained on this equipment, fit-tested, and clean-shaven. Supplied-air respirator systems that supply ambient air (e.g. “Breather box” filtration panels) should not be used for this purpose without in-depth evaluation by an industrial hygienist.

14.0 Compressed breathing air quality management during wildfire events

Breathing air (BA) compressors draw in ambient outdoor air to fill compressed air cylinders (aka “SCBA or air trailer bottles”). These compressor/fill-station systems have limited ability to remove air contaminants from entering the breathing air cylinder. The air quality standards for compressed breathing air are very strict, as defined by CSA Standard Z180.1.

Sustained wildfire smoke impinging on a site’s breathing air facility can overwhelm the facility’s ability to produce on-spec breathing air. A lack of breathing air cylinders can then in turn affect a site’s ability to perform certain types of Operations, Maintenance, and Emergency work.

Worst-case scenarios could lead to shutdown of a facility if supplied-air respirators for safe operation are needed.

Wildfire Air Contaminants and Associated Breathing Air Mitigations

The following sections lay out risk mitigations to ensure sustainment of breathing air operations and maintenance tasks as impacted by wildfire smoke.

There are three air contaminants of concern from wildfire smoke that sites need to be prepared to manage: carbon monoxide (CO), fine particulates (PM2.5), and small concentrations of organic compounds detectable as smoke odours. CSA Standard Z180.1 has criteria for all of these.

General steps to prepare for a wildfire smoke season should include:

1. Establish a Breathing Air technician qualification/ staffing level, to re-fill when smoke is minimal is the single easiest and most effective strategy. This may require an increased cylinder capacity (both in the high-pressure “cascade system” attached to the compressor as well as the site’s inventory of air trailers, SCBA cylinders, and SABA egress bottles).

2. Establish a relationship with an alternate supply of breathing air in a different geographic location that is less likely to be simultaneously affected by smoke. “Mutual-aid” fire station relationships are one way to accomplish this strategy.

Assuming that a facility must operate their breathing air (BA) fill station during sustained wildfire smoke events, the main operability challenges and associated recommended risk mitigations are as follows in Table 3.

Table 3 – Compressed Breathing Air Filling Mitigation during Wildfire Smoke Conditions

Wildfire Smoke Air Contaminant or Operational Challenge	Mitigation	Comments
Particulates (PM2.5) and organic compounds	<ol style="list-style-type: none"> 1. Re-locate BA intake into building instead of outdoors. 2. Add supplemental particulate-trapping portable ventilators inside the BA facility to scrub particulates out of the air (e.g. HEPA filtered). 3. Change particulate filters more often, and have extra spares on hand. 4. Change organic vapour sorbent cartridge more often and have extra spares on hand. 	Fill-station technicians need to have the BA compressor-service training necessary to change filters and collect and submit breathing air samples after doing this work on the system.
Carbon monoxide (CO)	<ol style="list-style-type: none"> 1. Utilize a compressor system that has a reactive CO-to-CO2 sorbent system. 2. Stock extra sorbent filter packages. 3. Have extra CO detector parts and supplies on-hand (e.g. calibration gas, spare sensor). 4. Bump-test the CO sensor more often (suggested daily under smoke conditions). 	Building HVAC system filters have no ability to trap CO. Under sustained wildfire scenario, it is expected that the indoor CO concentration would gradually equilibrate to the outdoor concentration.

15.0 Operational shutdown & evacuation

Due to either the wildfire smoke or the actual wildfire, companies will need to have in place an operational plan for different operational scenarios, which include situations from partial shutdown to full shut down and/or evacuation.

Evacuations of at-risk and non-essential personnel should be considered when smoke levels exceed a site's ability to manage them effectively.

In a smoke event, reduced operations can usually be maintained with a smaller essential workforce operating with strict safety precautions.

Increased monitoring of personnel activities including communications and hazard assessments should be included in the strategy.

16.0 Summary

Wildfire smoke presents a potential health and operational risk to the Canadian oil and gas industry, particularly in remote and forested regions.

This guideline provided a structured approach to assess, manage and respond to these wildfire smoke hazards and risks in order to protect workers while maintaining business continuity.

Work with your internal resources as available or look to securing external subject matter expertise to assist you in either developing or implementing your Wildfire Smoke Management Program.

For additional resources on wildfire safety, visit [EnergySafetyCanada.com/Resources](https://www.EnergySafetyCanada.com/Resources).

APPENDICES

Appendix A:

TABLE 4: Recommended CO Response Protocol for worker exposure during working hours

Air Quality Co (PPM, Suggested 1 Hour Average)	Reponse protocol
0 to <5 ppm	<ul style="list-style-type: none"> No action required.
≥5 to <13 ppm	<ul style="list-style-type: none"> Consider communication with the workforce regarding CO monitoring activities and measured concentrations. Consider management involvement in planning next steps if CO levels increase. No adverse health effects are expected from CO concentrations between 5-13ppm. No special work adaptations required.
≥13 TO <25 PPM	<ul style="list-style-type: none"> Communication with the workforce regarding CO monitoring activities, measured concentrations and actions required. Consider deploying additional CO monitoring equipment to measure concentrations at the work team / work location level. Management action required. Non-essential outdoor workers to be relocated to areas with CO <13 ppm. Essential outdoor workers should limit their time outdoors. CO monitoring equipment should be used by each outdoor work team. A competent person (e.g. Industrial Hygienist) should be engaged to determine acceptable time-weighted average exposures based on work task(s), location(s) and shift duration. Work camp accommodations/facilities should be evaluated to determine if relocation of workers may be required.

≥25 ppm (1 hour avg), ≥75 ppm for 30 min
- OR -
≥125 ppm at any time

- CO levels in this range are rare in wildfire smoke situations, generally requiring an active fire near the worksite with specific weather conditions. Communication with the workforce regarding CO monitoring activities, measured concentrations and actions required.
- Immediate management action required. Management should consider evacuation of all non-essential personnel and need to actively manage CO exposure for all essential personnel.
- Adverse health effects are possible from sustained exposure to CO concentrations in these ranges.
- Non-essential outdoor workers to be relocated to areas with CO <13 ppm.
- Only critically essential or emergency outdoor work should be performed, and supplied air respirators (SCBA/SABA) must be used.
- If supplied air respirators are not used, each outdoor worker must use CO monitoring equipment. A competent person (e.g., an Industrial Hygienist) should be engaged to determine acceptable time-weighted average exposures based on work task(s), location(s), and shift duration.
- Work camp accommodations/facilities should be evaluated to determine if relocation of workers may be required.

Descriptors in the table have been intentionally left open for the reader to determine (e.g., Tier 1/2, good/bad, Advisory level, poor/moderate, etc.)

Appendix B:

TABLE 5 provides suggested actions in response to monitoring levels of PM_{2.5} when CO levels are not an over exposure concern (eg. < 13ppm).

	Health messages for at-risk personnel	Health messages for all other personnel	Recommended actions
1 - 3 hour average PM _{2.5} 0 - 175µg/m ³	Continue with usual outdoor activities. Reduce or reschedule prolonged strenuous activities and limit time spent outdoors.	Ideal air quality for outdoor activities. Be aware of health effects of smoke and related symptom.	<ul style="list-style-type: none"> No Action Required. Be aware of forecast (current, daily, tomorrow). Advise workers about: health effects of smoke, related symptoms, and ways to reduce exposure. If the smoke event is projected to be prolonged, evaluate and notify possible cleaner air shelter sites and prepare evacuation plans for at-risk populations.
1-3 hour average PM _{2.5} 176 - 300 µg/m ³	Avoid prolonged strenuous activities and stay indoors if possible.	Reduce or reschedule prolonged strenuous activities outdoors, especially if you experience symptom.	<ul style="list-style-type: none"> Communications plan initiated. Consider cancelling non-essential outdoor activities. Restrict or eliminate access to the site by other visitors, Consider the distribution and use of respirators and masks. Optional use of N95 for outdoor workers. Keep windows and doors closed to prevent smoke from entering buildings and vehicles. Consider HVAC adjustments to prevent smoke from entering buildings. (eg. Use highest possible MERV filter during forest fire season, consider flow adjustments and periodic shutdown of air intake.)

1 - 3 hour average PM2.5 301 - 500 µg/m ³	Avoid all strenuous activities and stay indoors if possible.	Avoid prolonged strenuous activities and stay indoors if possible.	<ul style="list-style-type: none"> • Daily Communications to workforce. • Review outdoor worker designation based on needs and business continuity. • Consider having at-risk personnel go to designated air shelters. • Keep windows and doors closed to prevent smoke from entering buildings and vehicles. • Consider the distribution and use of respirators for outdoor workers who might require N95/half msk with P100 who have been fit tested. • Optional use of N95 for non-outdoor workers. • Perform HVAC adjustments to prevent smoke from entering buildings.
1 - 3 hour average PM2.5 >500 µg/m ³	Avoid all strenuous activities and stay indoors.	Avoid all strenuous activities and stay indoors.	<ul style="list-style-type: none"> • Daily Communications to workforce. • Evaluate outdoor worker assignments and confirm those required by business needs and continuity. • Essential-outdoor workers must wear N95/half msk with P100 and have been fit tested. • Consider upgrading respiratory protection to full-faced respirators with OV-P100 with fit tested. • Perform HVAC adjustments to prevent smoke from entering buildings and monitor filters.

Many jurisdictions cite an 8-hour time-weighted average occupational exposure limit of 3 mg/m³ respirable or 10 mg/m³ total for particles not otherwise classified. However, this value is inappropriate for wildfire smoke as it only applies to particulate that is insoluble or poorly soluble in water and has low toxicity. This OEL may not represent the particle size found in wildfire smoke.

Descriptors in the table have been intentionally left open for the reader to determine (e.g., Tier 1/2, good/bad, Advisory level, poor/moderate, etc.)

In the absence of data or communications during smoke conditions, complete a field hazard assessment to determine whether respirators are required.

Note: You may need to change your averaging period based on changing conditions

Appendix C: proposed annual smoke preparation and execution plan by month

Month	Activity	Additional Details
January	Check Smoke Monitor Readiness.	<ul style="list-style-type: none"> Confirm stock levels of consumables. Check smoke monitor sensor calibration status and send to manufacturer if due.
January	Inspect Designated Air Shelters & conduct HVAC Preparation.	<ul style="list-style-type: none"> HVAC systems and monitoring and managing prior to, during and after an event. Provide best practices. Consult HVAC specialists to assess site-specific needs and system compatibility. Ensure HVAC systems are ready for smoke events by adjusting for high-efficiency filters (MERV 13 or higher).
February	Smoke Monitor Deployment Plan.	<ul style="list-style-type: none"> Initiate in-house calibration of smoke monitors.
February	Assess Breathing Air Filling equipment and staffing.	<ul style="list-style-type: none"> Ensure maintenance is up to date on compressor system. Assess inventory of air trailers, SCBA cylinders, and SABA egress bottles. Determine an alternate breathing air filling location, if required.
March	RPE Inventory is evaluated to ensure sufficient stock.	<ul style="list-style-type: none"> Ensure worker training, fit-testing, and respirator inventory is adequate.
March	Smoke Management Communication and Field set up of monitors.	<ul style="list-style-type: none"> Prepare communication package for smoke monitoring. Confirm distribution list for communications. Confirm any remote locations that will require a specific monitoring strategy.
April	Start Smoke Monitoring and Reporting.	<ul style="list-style-type: none"> Confirm all smoke monitors are operational and ready to deploy. Verify communication of smoke monitoring data and dashboard reports.
May to Sept	Monitor equipment. Ongoing Communications during wildfire season.	<ul style="list-style-type: none"> Regular maintenance and ongoing calibration.
October	Monitor maintenance and demobilize.	<ul style="list-style-type: none"> Gather or Winterize monitors.
November	Lessons Learned session.	<ul style="list-style-type: none"> Conduct a lessons learned.



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