Anhydrous ammonia safety for industrial refrigeration systems

Guide to risk identification and controls for employers

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| **About this resource**This fillable self-assessment tool is for employers using anhydrous ammonia (ammonia) in industrial refrigeration systems in B.C. Review the questions in each section to better understand the hazard, the risk, and whether your facility has effective protocols in place to protect workers from exposure to ammonia.**Disclaimer for use**Please be aware that not all requirements in the Occupational Health and Safety (OHS) Regulation related to ammonia are included. This guide is simply a tool to help you understand risk, reduce risk, and decrease the likelihood of potential violations of the *Workers Compensation Act* and OHS Regulation. This is not a compliance checklist and should not be used as such.Information and resources are also available on our [Ammonia](https://www.worksafebc.com/en/health-safety/hazards-exposures/ammonia) and [Managing risk](https://www.worksafebc.com/en/health-safety/create-manage/managing-risk?origin=s&returnurl=https%3A%2F%2Fwww.worksafebc.com%2Fen%2Fsearch%23sort%3DRelevancy%26q%3Dmanaging%2520risk%26f%3Alanguage-facet%3D%5BEnglish%5D) webpages on [worksafebc.com](https://www.worksafebc.com/en). |

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# General characteristics of anhydrous ammonia

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| **Anhydrous ammonia** **(CAS# 7664-41-7)** |
| **Pungent odour****Lighter than air, but can become heavier than air in high-humidity environments****Corrosive to skin, eyes, and respiratory tract****Flammable****Hygroscopic (readily attracts and holds water molecules)****Time-weighted average (TWA): 25 ppm****Short-term exposure limit (STEL): 35 ppm****Immediately dangerous to life and health (IDLH): 300 ppm** |

# Part A: Assessing your risk and controls

**Answer the following questions to assess the ammonia risk and controls in your facility. If you identify a deficiency, indicate the action(s) required to correct it, including the person assigned, and the due date.**

## Ammonia identification

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| How much ammonia is present on site?Is the machine room enclosure the only indoor location where ammonia is present?Response/comments     Action(s) to take, including person assigned and due date      |

## Monitoring and alarms

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| Are there continuously operating fixed gas monitors inside the ammonia machine room enclosure?Where inside the enclosure are the fixed gas monitors located?Is there a readout or display that allows a worker to check the measured concentration before entering the enclosure?Response/comments     Action(s) to take, including person assigned and due date      |
| Is there an ammonia monitoring and alarm system covering all indoor locations where ammonia is present inside piping and other equipment (i.e., in the same room or space where a loss of containment could occur)?[ ]  Yes [ ]  NoResponse/comments      | If not, which areas lack monitors?Response/comments      |
| If a pressure relief device engages because of an emergency or malfunction, will operators be notified?[ ]  Yes [ ]  NoResponse/comments      |

## Ventilation

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| Can a release of ammonia be safely exhausted to the outdoors from an ammonia machine room enclosure using a ventilation system (i.e., discharged outside without putting workers or other people at risk and without potentially drawing the ammonia back into the building)?[ ]  Yes [ ]  NoResponse/comments      |
| Was the ventilation system designed, installed, and maintained using established engineering principles?[ ]  Yes [ ]  NoResponse/comments      |
| Are ammonia machine room enclosures equipped with emergency ventilation that can be safely activated (e.g., without entry into the enclosure) in emergency situations such as an ammonia leak?[ ]  Yes [ ]  NoResponse/comments      |
| Are ventilation systems in the ammonia machine room enclosures dedicated to exhausting only ammonia?[ ]  Yes [ ]  NoResponse/comments      |
| Are ventilation systems vapour-proof and resistant to corrosion caused by ammonia?[ ]  Yes [ ]  NoResponse/comments      |
| Do the ammonia machine room enclosures have ventilation systems with fans located outside the building to keep the duct work and the enclosure under negative pressure?[ ]  Yes [ ]  NoResponse/comments      |

## Risk mitigation

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| If the ammonia system is equipped with pressure relief or similar devices:Do these devices exhaust safely to the outdoors?Are operators alerted if pressure relief devices engage because of an emergency or malfunction?[ ]  Yes [ ]  NoResponse/comments      |
| Does the ammonia piping system meet the following requirements?The system is constructed of materials designed to be resistant to corrosion caused by ammonia.It is constructed to withstand the pressures it is subjected to (e.g., it is safely routed, supported, and protected from impact damage, shock, and vibration).It is equipped with isolation or bleed valves designed to purge the lines safely of residual gases before maintenance or servicing procedures.[ ]  Yes [ ]  NoResponse/comments      |
| Are there appropriate, functioning emergency washing facilities that include the following:A tempered shower?A tempered eyewash station (15–30°C for 15 minutes) located within 6 metres (20 feet) of the hazard, while outside of the enclosure?[ ]  Yes [ ]  NoResponse/comments      |

## Service and maintenance

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| Have critical components associated with ammonia handling equipment been identified?Have servicing and maintenance activities and frequencies been determined?Are servicing and maintenance frequencies being followed?Are service and maintenance completed by adequately trained people?**Note:** Critical components may include equipment and piping containing ammonia, controls to prevent loss of containment, and/or controls to mitigate harm in case of loss of containment.[ ]  Yes [ ]  NoResponse/comments      |
| How are the ammonia ventilation systems monitored to detect failure of critical components of the system (e.g., fans, motors, air velocity)?**Note:** Monitoring could be automated or be conducted through regular manual inspections.Response/comments      |
| Are ammonia monitors calibrated at least annually or according to the manufacturer’s instructions, whichever is more often?[ ]  Yes [ ]  NoResponse/comments      |

## Other employers and/or prime contractor

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| Have all third-party workers (including contractors) been oriented and trained to the site, including emergency procedures?[ ]  Yes [ ]  NoResponse/comments      |
| If third-party workers are performing work on the ammonia refrigeration system(s), are they following the appropriate written procedures for the task, per the employer’s exposure control plan?[ ]  Yes [ ]  NoResponse/comments      |
| Is the work by third-party workers being done safely?[ ]  Yes [ ]  NoResponse/comments      |

## Labels and signage

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| Are all ammonia handling and related critical components clearly labelled and readily visible?[ ]  Yes [ ]  NoResponse/comments      |
| Can the functions of all ammonia control devices be readily determined (e.g., with the help of labels or signage)?[ ]  Yes [ ]  NoResponse/comments      |
| Are all the pipes in the ammonia machine room enclosure(s) labelled appropriately, including an indication of their contents?[ ]  Yes [ ]  NoResponse/comments      |

## Personal protective equipment (PPE)

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| Is personal protective equipment provided to workers adequate for hazardous conditions (e.g., airborne concentration, nature of release) that could be present, to protect against exposure through respiration, eyes, and skin?**Note:** See the latest version of WorkSafeBC’s publication, [Ammonia in Refrigeration Systems](https://www.worksafebc.com/en/resources/health-safety/books-guides/ammonia-in-refrigeration-systems?lang=en).[ ]  Yes [ ]  NoResponse/comments      |
| Are workers who must or may need to wear a tight-fitting respirator clean shaven where the respirator seals with their face? Have those workers passed a fit test on that respirator (specific make, model, and size) in the past year?[ ]  Yes [ ]  NoResponse/comments      |
| Do workers wear appropriate respirators during tasks that will or may involve exposure?[ ]  Yes [ ]  NoResponse/comments      |
| Do workers carry or wear appropriate respirators for the purpose of escaping from the ammonia machine room enclosure? [ ]  Yes [ ]  NoResponse/comments      |

## Training and supervision

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| What process is in place to:* Make sure all applicable workers are effectively trained on relevant procedures, plans, and documents (including those found in the exposure control plan and emergency plan)?
* Make sure workers are following all relevant procedures, plans, and documents?

Response/comments     Action(s) to take, including person assigned and due date      |

Part B: Assessing your exposure control plan

Employers are required to have an exposure control plan (ECP) in place. Answer the following questions to assess whether your exposure control plan meets the intent of the OHS Regulation requirements. If your ECP does not include an element listed below, identify the action(s) required to correct the deficiency, the person assigned, and the due date.

## Statement of purpose

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| A brief description of what the ECP is designed to do (e.g., protect workers from exposure to ammonia on site)Does your ECP include this element?[ ]  Yes [ ]  No |
| Action(s) to take, including person assigned and due date      |

## Responsibilities

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| A list of assigned responsibilities relating to the ECP (which may include specific employer representatives, supervisors, workers, joint health and safety committee, third parties, etc.)Does your ECP include this element?[ ]  Yes [ ]  No |
| Action(s) to take, including person assigned and due date      |

## Ammonia identification

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| For all ammonia on site, a description of the risk that includes:Amount of ammonia presentLocation(s) of ammoniaAmmonia’s hazardous propertiesAny other relevant detailsDoes your ECP include this element?[ ]  Yes [ ]  No |
| Action(s) to take, including person assigned and due date      |

## Risk assessment

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| An assessment of the risk that identifies how workers might be exposed:The locations, workers’ positions, work activities, and specific ways in which workers might be exposed via inhalation, contact, or ingestionThe expected extent of the exposureThe likelihood that this exposure could happenDoes your ECP include this element?[ ]  Yes [ ]  No |
| Action(s) to take, including person assigned and due date      |

## Risk control

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| A description of measures in place to control the risk of exposure associated with the identified locations, workers’ positions, work activities, and specific ways in which workers might be exposedDoes your ECP include this element?[ ]  Yes [ ]  No |
| Action(s) to take, including person assigned and due date      |

## Education and training

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| A description that addresses the following questions:Which workers must be educated and trained?What does this education and training include?When do workers receive training?How often are workers tested or retrained?How will workers demonstrate they are competent in and understand the content?Does your ECP include this element?[ ]  Yes [ ]  No |
| Action(s) to take, including person assigned and due date      |

## Written work procedures

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| Clear, step-by-step written work procedures (if performed by the employer’s workers) for controlling the risk of ammonia exposure during activities such as:Entering the ammonia machine room enclosureInspecting in limited access areas (e.g., ammonia piping and equipment on rooftops)Adding or draining oilLeak detection and controlRecharging system with ammoniaNormal shutdown of systemNormal restart of system after maintenance shutdownDoes your ECP include this element?[ ]  Yes [ ]  No |
| Action(s) to take, including person assigned and due date      |

## Hygiene facilities and decontamination procedures

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| Adequate hygiene facilities and decontamination procedures, including emergency washing stations to address eye, skin, and respiratory exposure Does your ECP include this element?[ ]  Yes [ ]  No |
| Action(s) to take, including person assigned and due date      |

## Documentation

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| Adequate documentation of procedures, including maintenance and testing records, equipment manuals, training records, and calibration and other records of inspectionDoes your ECP include this element?[ ]  Yes [ ]  No |
| Action(s) to take, including person assigned and due date      |

## Annual review

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| Annual review of the ECP in consultation with the joint committee or a worker representative to ensure the following:The ECP continues to be adequate for worker health and safety, and reflects the current workplace conditions.The ECP is fully implemented.Does your ECP include this element?[ ]  Yes [ ]  No |
| Action(s) to take, including person assigned and due date      |

## Implementation of ECP

Consider the following questions to help you assess whether your ECP is in practice and maintained.

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| Is your written ECP as described above up to date?Response/comments     Action(s) to take, including person assigned and due date      |
| Has it been fully implemented (controls in place, relevant workers educated and trained, procedures followed, etc.)?Response/comments     Action(s) to take, including person assigned and due date      |

# Part C: **Emergency plan assessment**

Employers are required to have an emergency plan in place. Answer the following questions to assess whether your emergency plan meets the intent of the OHS Regulation requirements. If your emergency plan does not include an element listed below, identify the action(s) required to correct the deficiency, the person assigned, and the due date.

## Inventory

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| An inventory that identifies:All hazardous substances that may endanger workers in an emergency, including the quantity, location(s), and nature of the hazardLocation of safety data sheets (SDSs)Does your emergency plan include this element?[ ]  Yes [ ]  No |
| Action(s) to take, including person assigned and due date      |

## Risk assessment

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| Risk assessment that addresses the following questions:What risks associated with ammonia may be on site, whether routine or emergency (risks posed by hazardous substances from accidental release, fire, or other such emergency)?What is the nature of the hazard (i.e., what are relevant health and physical hazards to workers in an emergency, and how severe could an emergency be)?Could emergency conditions arise at adjacent workplaces that may affect this workplace?Who would be at risk in an emergency?Does the risk assessment provide a clear explanation of the thought process behind the risk evaluation?What specific circumstances, events, failures, or errors could lead to an emergency?What root causes or contributing factors could lead to these specific circumstances, events, failures, or errors?What controls are in place to prevent and mitigate an emergency?What emergency conditions (e.g., maximum concentration of ammonia) are beyond what you could or would respond to without the assistance of third-party emergency responders? If an incident is beyond the site’s capabilities, who will you rely upon?Have you confirmed that third-party emergency responders are capable, willing, and available to respond to an ammonia emergency?See also questions in [OHS guideline G5.99](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-guidelines/guidelines-part-05#SectionNumber:G5.99).Does your emergency plan include this element?[ ]  Yes [ ]  No |
| Action(s) to take, including person assigned and due date      |

## Procedures — Emergency evacuation

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| Emergency evacuation procedures that address the following questions:What specific circumstances trigger an evacuation? (Be more specific than “an ammonia release.”)How will workers (including third parties) and the first aid attendant be notified of an emergency and the need to evacuate?Where are the muster points?How will appropriate muster point(s) be chosen when an emergency happens?* Have alternative muster points been identified?
* How will you confirm that workers have been safely evacuated?
* What happens if you determine that not all affected workers have reached the muster point?

Does your emergency plan include this element?[ ]  Yes [ ]  No |
| Action(s) to take, including person assigned and due date      |

## Procedures — Notification

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| Notification procedures that address the following questions:When and how will you notify adjacent employers and residences that may be affected if the risk of exposure extends beyond the workplace?When and how will you notify emergency responders?When and how will you notify relevant agencies (e.g., WorkSafeBC, Technical Safety BC, Emergency Management BC)?Who handles these notifications? If that person is absent, who is the backup?Does your emergency plan include this element?[ ]  Yes [ ]  No |
| Action(s) to take, including person assigned and due date      |

## Procedures — Internal and external emergency responders

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| Emergency response procedures that address the following questions:Who will investigate and/or bring an emergency under control, and under what circumstances?Do procedures address all the different emergencies that could occur (e.g., loss of containment from ammonia system, or loss of containment from pressure relief devices)?Do the procedures explain how an emergency will be investigated and brought under control?How and when would the following occur?* Shutdown of the ammonia refrigeration system
* Isolation of part of the system
* Use of the fire dump
* Control emergency ventilation system
* Other anticipated measures to respond to the incident

How will workers responding to the emergency be protected (including personal protective equipment and monitoring equipment)?What equipment is available for responding to an emergency, and where is it located?* What is done periodically to make sure this equipment is in good working condition?

How will an ammonia release be brought under control?How will you clean up (if possible) after bringing the situation under control?What testing will be done to determine that responders can safely enter the facility? How will this testing be done?Who will determine that the workplace can be safely reoccupied, and how will they determine this?If relying on third-party emergency responders, have you confirmed:* That they are available and willing to respond in the scope and capacity that you have identified to them?
* That they are capable of responding (including having procedures, training, and appropriate personal protective equipment)?
* If there are any limitations on their ability to respond?
* Their expected response time?

Does your emergency plan include this element?[ ]  Yes [ ]  No |
| Action(s) to take, including person assigned and due date      |

## Training

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| A provision that addresses the following questions:Who gets what training?What does this training cover?When and how often does a worker receive this training?How will workers demonstrate they are competent in and understand the training content?Does your emergency plan include this element?[ ]  Yes [ ]  No |
| Action(s) to take, including person assigned and due date      |

## Drills

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| A provision that addresses the following questions:How often will evacuation drills happen?How often will emergency response drills (to bring emergency conditions under control) happen?**Note:** Evacuation drills must be conducted annually. Emergency response drills should be held regularly. WorkSafeBC generally considers the minimum frequency to be once a year, but a prevention officer may decide that more frequent drills are necessary.Does your emergency plan include this element?[ ]  Yes [ ]  No |
| Action(s) to take, including person assigned and due date      |

## Annual review

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| --- |
| Annual review of the emergency plan in consultation with the joint committee or a worker representative to ensure the following:The emergency plan continues to ensure worker health and safety, and reflects the workplace conditions.The emergency plan is fully implemented.Does your emergency plan include this element?[ ]  Yes [ ]  No |
| Action(s) to take, including person assigned and due date      |

Implementation of emergency plan
Consider the following questions to help you assess whether your emergency plan is in practice and maintained.

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| Is your emergency plan for potential ammonia releases, fires, and explosions (as described above) up to date?Is it fully implemented (controls in place, relevant workers trained, drills performed, etc.)?When was the last:* Evacuation drill?
* Emergency response drill?

Have adjustments been made to the emergency plan, as applicable, based on lessons learned (e.g., from the results of emergency response drills)?Response/comments     Action(s) to take, including person assigned and due date      |

# Appendix: Relevant OHS Regulation requirements

See the following sections of the OHS Regulation for more information about requirements relating to toxic process gases (TPGs) — including anhydrous ammonia — in the workplace.

| Requirement | OHS Regulation |
| --- | --- |
| [Workplace Hazardous Materials Information System (WHMIS)](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-05-chemical-and-biological-substances#SectionNumber:5.3)  | 5.3 to 5.18 |
| [Exposure control plan](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-05-chemical-and-biological-substances#SectionNumber:5.54) | 5.54 |
| [Emergency washing facilities](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-05-chemical-and-biological-substances#SectionNumber:5.85)  | 5.85 to 5.96 |
| [Emergency plan](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-05-chemical-and-biological-substances#SectionNumber:5.97) (including written elements covered by sections 5.98 to 5.102, and requiring an annual review) | 5.97 |
| [Inventory identifying all hazardous substances](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-05-chemical-and-biological-substances#SectionNumber:5.98)  | 5.98 |
| [Assessment of the risks posed by hazardous substances from accidental release, fire, or other such emergency](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-05-chemical-and-biological-substances#SectionNumber:5.99) | 5.99 |
| [Written procedures to evacuate workers and, as appropriate, notify emergency responders, adjacent workplaces, residences that might be affected, and provincial and municipal agencies](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-05-chemical-and-biological-substances#SectionNumber:5.100) | 5.100 |
| [Spill cleanup and re-entry procedures](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-05-chemical-and-biological-substances#SectionNumber:5.101)  | 5.101 |
| [Emergency procedure training](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-05-chemical-and-biological-substances#SectionNumber:5.102)  | 5.102(a) |
| [Emergency procedure drills](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-05-chemical-and-biological-substances#SectionNumber:5.102)  | 5.102(b) |
| [Risk assessment for toxic process gases (TPGs)](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-06-substance-specific-requirements#SectionNumber:6.118) (can be done in conjunction with section 5.99) | 6.118 |
| [Exposure control plan must meet the requirements of section 5.54](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-06-substance-specific-requirements#SectionNumber:6.119) | 6.119 |
| [Written work procedures regarding safe handling of TPGs](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-06-substance-specific-requirements#SectionNumber:6.120) | 6.120(1) |
| [Emergency procedures for safe evacuation and rescue of workers established and tested on a regular basis](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-06-substance-specific-requirements#SectionNumber:6.120) | 6.120(2) |
| [Written work and emergency procedures are readily available](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-06-substance-specific-requirements#SectionNumber:6.120)  | 6.120(3) |
| [Training: Workers are capable of safely operating equipment and machinery](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-06-substance-specific-requirements#SectionNumber:6.121) | 6.121 |
| [Where practicable, separate enclosure for TPG handling](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-06-substance-specific-requirements#SectionNumber:6.122) | 6.122 |
| [Safe testing for enclosure(s) before entry by authorized workers](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-06-substance-specific-requirements#SectionNumber:6.123) | 6.123 |
| [TPGs vented outdoors safely](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-06-substance-specific-requirements#SectionNumber:6.124) | 6.124(a) |
| [Emergency ventilation for containment and control](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-06-substance-specific-requirements#SectionNumber:6.125) | 6.125 |
| [Shutdown device for emergency or accidental release](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-06-substance-specific-requirements#SectionNumber:6.126) | 6.126 |
| [Appropriate personal protective equipment available and used by workers](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-06-substance-specific-requirements#SectionNumber:6.127) | 6.127 |
| [Fixed gas monitors connected to alarms at designated sites](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-06-substance-specific-requirements#SectionNumber:6.128) | 6.128(1), (2) |
| [Fixed gas monitors tested monthly and calibrated annually](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-06-substance-specific-requirements#SectionNumber:6.128) | 6.128(3) |
| [Pressure relief valves or similar devices safely direct gas outdoors](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-06-substance-specific-requirements#SectionNumber:6.129) | 6.129(1) |
| [Pressure relief alarm or other reporting system engaged if pressure relief valve engages or malfunctions](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-06-substance-specific-requirements#SectionNumber:6.129) | 6.129(2) |
| [Controls involving TPGs all clearly identified with the control function described](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-06-substance-specific-requirements#SectionNumber:6.130) | 6.130 |
| [Piping system appropriately constructed, tested, and equipped with systems to safely purge lines](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-06-substance-specific-requirements#SectionNumber:6.131) | 6.131 |
| [Appropriate servicing and maintenance of equipment and machinery](https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-06-substance-specific-requirements#SectionNumber:6.132) | 6.132 |