BC GUIDANCE DOCUMENT

April 2024

Health, Safety and Reclamation Code for Mines in British Columbia

Emerging Technology Implementation

BRITISH COLUMBIA
Ministry of Energy, Mines and Low Carbon Innovation

Contents

Purpose of Guidance Document

This Guidance document is intended to provide further information on the changes to the 2024 version of the Code regarding the introduction and use of mining equipment with technologies that haven't been included in previous versions of the Code. Compared with its previous version, the 2024 Code expands the types of new technologies covered by its previous version which focused only on Autonomous and Semi-Autonomous Machine Systems. This expansion also impacted other sections of the Code which required new sections or adjustments to existing ones, such as sections 1.6.9 and 4.7.1.

It focuses on the implementation and use of the following mining equipment at mine sites:

- Autonomous and semi-autonomous machine systems (ASAMS)
- Battery electric vehicles (BEVs)
- Hydrogen powered vehicles.
- Trolley-assisted technology

The requirements of the Code related to emerging technologies do not apply to other emerging technologies that may be introduced onto mine sites, including:

- Data management systems,
- Communication systems,
- Water treatment systems, components, or facilities.
- Remote operations centres
- Unmanned aerial vehicles (UAVs)
- Remote controlled systems, but components could be relevant to mobile tele-remote systems if they incorporate additional functionality that takes autonomous control of machines.
- Autonomous functionality of a process or machine that moves on
- Fixed infrastructure such as rail (e.g. trains, stackers, reclaimers)
- A fixed base (e.g. laboratory robots)

Definitions

"Autonomous" means designed to perform the full job cycle without operator interaction or direct control by a person. This is related to autonomous mining equipment used at mine sites to drill, load, haul, or transport people without a person operating or directly controlling the machine.

"Emerging technology" means a technological innovation to mining equipment and related infrastructure that has an inherent risk to health and safety including:

- autonomous and semi-autonomous machine systems;
- battery electric vehicles;
- hybrid vehicles;
- hydrogen powered vehicles; and
- trolley-assisted technology.

As described in the definition, the requirements of the Code related to emerging technologies is focused only on mining equipment and related infrastructure.

Several other areas of the mining industry have been provided with the opportunity to opt for upgraded and modern technologies as well but are out of the scope for the changes described in this document. For example, new technologies related to data management, automation of ore processing, and water treatment components, systems, or facilities are not regarded as part of the definition of emerging technology in this Code.

"Semi-autonomous" means designed to perform a subset of tasks within the full job cycle without operator interaction or direct control by a person.

This is related to semi-autonomous mining equipment used at mine sites to drill, load, haul, or transport people in which a person may not be needed to operate or control the machine through its full cycle of operation.

Project Management Plan

Requirements

6.18.3 (1) Prior to the use of an emerging technology, the manager must submit to the chief inspector a project management plan respecting the emerging technology prepared by a qualified professional.

Guidance:

Section 6.18.3 of the Code requires that a company proposing the use of emerging technology as defined in the Code at a new or existing mine must submit a Project Management Plan (PMP) to the Chief Inspector of Mines prior to its implementation.

Submission of the Project Management Plan (PMP) for the use of emerging technology should be seen not only as a regulatory requirement, but an opportunity to demonstrate an understanding of the risks associated with implementing that technology. The PMP is a critical tool in the development of a site-specific occupational health and safety management system to address specific issues not directly addressed by Code requirements.

The introduction of mining equipment with emerging technologies to a mining operation, whether surface or underground, new or existing, can improve health, and safety; However, there may be new hazards beyond those associated with conventional equipment that require detailed consideration and a full risk assessment to ensure controls are in place to support their safe implementation.

Both the Code and the PMP are used jointly as references to ensure that occupational health and safety items are being followed and comply with the regulations.

Project Management Plan Content

The PMP must contain the information required in section 6.18.3 of the Code. The following headings cover the PMP content for the use of mining equipment with emerging technology at mine sites. The plan should set out clear objectives, stating what will be done, how it will be done, and the proposed schedule for doing it.

The type of technology, implementation, and level of complexity will determine the information and level of detail required in the following sections. The PMP is scalable with the size and complexity of the project.

The requirements for a PMP are set out in section 6.18.3 of the Code as follows:

A. Requirement to submit a Project Management Plan:

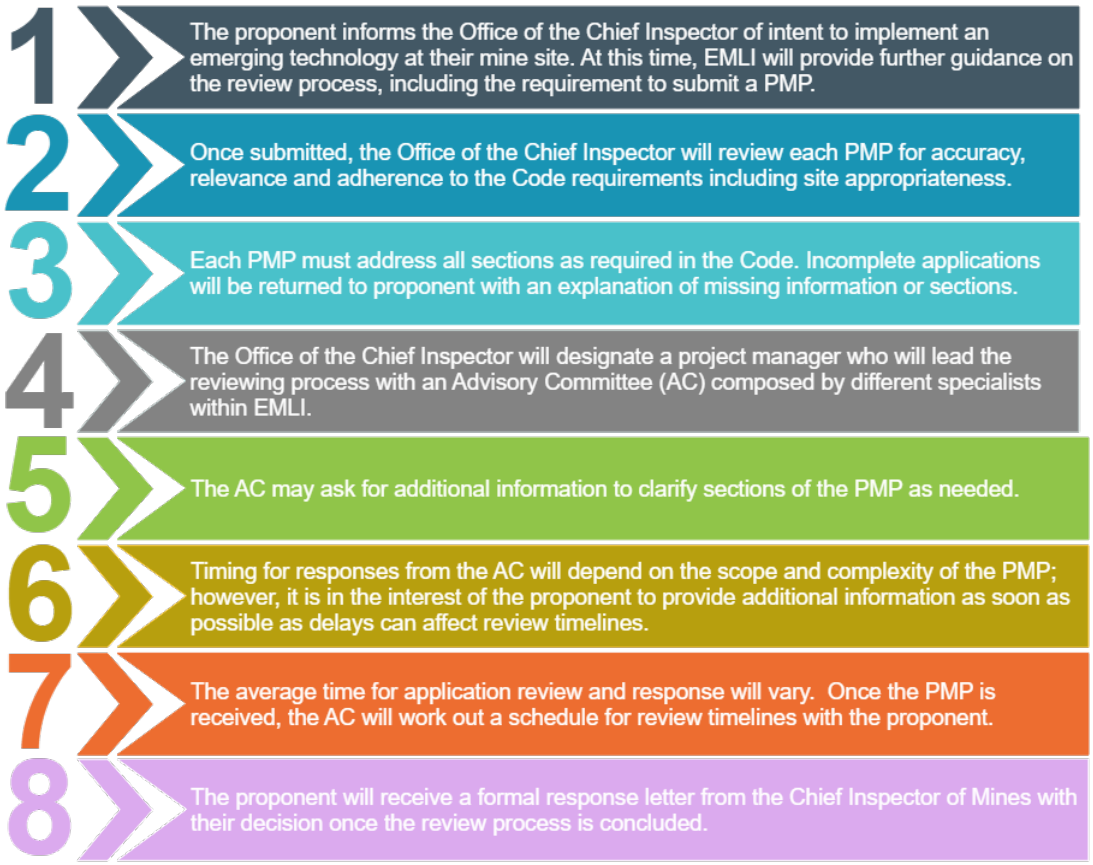
This requirement allows the Ministry of Energy, Mines and Low Carbon Innovation (EMLI), through the Office of the Chief Inspector of Mines, to be aware and review the plans associated with the introduction of emerging technologies at mine sites. The intent of the review is to ensure all parts of the Code have been considered in the development of the PMP, including the assessment of potential gaps related to a specific technology. A mine site will be out of compliance if mining equipment with emerging technology as defined in the Code are used at mine sites without the Chief Inspector of Mines' formal recognition that an acceptable PMP is in place.

To facilitate the review process and avoid delays, it is recommended that mine managers contact the Office of the Chief Inspector of Mines as soon as they plan to introduce mining equipment with emerging technology at their sites.

B. Ministry PMP Review Process:

The Office of the Chief Inspector is the lead for the review and consideration for the implementation of PMPs on mines in British Columbia. Proponents must provide the information as required under section 6.18.3 of the Code.

The process for review and confirmation of the PMP is as follows:



6.18.3 (2) The project management plan must contain the following elements:
(a) a detailed risk assessment for the purpose of identifying, assessing and managing hazards;

Guidance

This requirement emphasises the importance of how risks associated with the introduction of emerging technologies at mine sites are accessed and managed. It is expected that PMPs will describe the mine's risk management strategy approach, including but not limited to:

Hazard identification	Description of tools and methods used to identify existing and potential hazards related to the implementation of the new technology.
Risk assessment	Description of the process to rank each hazard associated with implementation of the new technology according to the likelihood of occurrence as well as the likely consequence and severity if it occurs. Development of a safety management plan specific to the technology to be introduced. Description of core safety management principles and approach at the mine site applied to the implementation of the new technology.
Risk management approach	Description of how risks associated with implementation of the new technology will be controlled throughout the different stages of the introduction and operation of the new technology.
Risk management responses	Description of actions to be taken to address the identified risks according to their rank of magnitude.
Risk registers	List of identified risks associated with implementation of the new technology their ratings (risk ranking), affected areas, and identified accountabilities to mitigate them with a summary of controls being implemented in response to the risk.

(b) a summary of the safe working procedures in the Mine Health and Safety Program required under section 1.6.9 (1) (c.1);

Guidance

Description of safe working procedures to be followed by persons involved in each relevant tasks that may be affected by the introduction of the new technology.

(c) a summary of the project management plan, including project milestones and scope;

Guidance

The intent of this section is to include an overview of the project scope and information for implementation and key milestones, including construction, commissioning, and production stages. If applicable, include information on planned and staged project expansions.

(d) details on location, access, infrastructure, and equipment;

Guidance

The intent of this section is to include an overview of the proposed location of the emerging technology and related infrastructure, operating areas, access and access control, and what infrastructure and equipment is involved.

This includes a description of where the mining equipment will be used and accessibility to those areas, details of the equipment with the emerging technology being introduced to the site, a list of equipment that may also be impacted by the introduction of the emerging technology (i.e., manually operated shovels interacting with Autonomous Haul Trucks) and details of the infrastructure required for the implementation and operation of equipment with emerging technology.

(e) a summary of key roles and responsibilities associated with the project;

Guidance

The intent of this section is to include information on the reporting structure for the project, including commissioning and production stages, and responsibilities and qualifications of personnel in key roles. This will often include operators, supervisors, and maintenance subject matter experts.

This includes a description of key roles and their responsibilities throughout the development of the project and all phases of the implementation of the technology at the site including the PMP review process, commissioning, operation, and maintenance

(f) a summary of system functionality, redundancy, limitations and safety features;

Guidance

The intent of this section is to include information on the emerging technology, such as the descriptions of hardware and functionality for essential systems, redundancies built into the design (e.g., backup power sources), system limitations, and safety features.

This includes details of components of the technology that are considered proprietary information are not expected to be part of the PMP.

(g) a commissioning plan;

Guidance

The intent of this section is to include information on the commissioning process, including implementation stages if applicable, testing requirements (installation checklists and user acceptance tests for construction and live commissioning), and critical controls for hazards specific to commissioning.

(h) a maintenance and inspection plan;

Guidance

The intent of this section is to include a plan for maintenance and inspection of the emerging technology equipment and related infrastructure. Maintenance and inspection plans must comply with the Code and should consider manufacturer recommendations. If applicable, the plan may include information on continuous machine health monitoring which informs the maintenance and inspection strategy.

(i) an operational plan;

Guidance

The intent of this section is to include an overview of how the project will be integrated into conventional mining operations. This includes transitioning from a pilot phase to full implementation, if applicable.

(j) a description of the training program and competence assessment for working with and around the emerging technology as required in section 1.11.1 and 1.11.2 of this code;

Guidance

The intent of this section is to include information on the training program and competence assessment for the emerging technology. This includes roles and responsibilities, program components, hours of instruction and field time, competency assessment process, and training delivery methods.

(k) the process for investigating failures;

Guidance

The intent of this section is to include information on the mine's process for investigating failures of the emerging technology and related infrastructure.

(l) a summary of the updates to the Mine Emergency Response Plan relating to the emerging technology as required under section 3.7.1 of this code;

Guidance

The intent of this section is not to reproduce the MERP in its entirety, but to update the MERP and provide a summary of how emergencies and emergency response will be managed if they involve an emerging technology or related infrastructure or if an emergency occurs within the area of the mine where it is located.

(m) a gap assessment of this code to identify any non-conformances and plans and timelines to address the non-conformances prior to implementation of the project management plan;

Guidance

The intent of this section is for the proponent to examine the Code and identify any gaps or areas where the project may not conform to the Code requirements. If this is the case, the PMP must include how the proposed project will account for these gaps/non-conformances and timelines to address them.

(n) a summary of critical controls as identified in the risk assessment referred to in paragraph (a);

Guidance

The intent of this section is to include a summary list of critical controls identified in the risk assessment, including engineering and administrative controls and PPE.

(o) if autonomous and semi-autonomous machines are operated on the mine site, an interaction plan for human operated equipment and personnel;

Guidance

This element of the PMP is only required if autonomous or semi-autonomous machines systems will be used on the mine site. The intent of this section is to include information on interaction strategies and management of interactions, including ground personnel, conventional vehicles, and mining and support activities (drill and blast, mine services, maintenance, survey, geology, etc.).

(p) if battery or hybrid vehicles are operated on the mine site, a battery management plan;

Guidance

This element of the PMP is only required if battery electric or hybrid vehicles will be used on the mine site. The intent of this section is to include a plan for how vehicle batteries will be handled, including disposal methods. This may include a plan to return leased batteries to the manufacturer once they are no longer usable.

(q) if hydrogen powered vehicles are operated on the mine site, a hydrogen management plan.

Guidance

This element of the PMP is only required if hydrogen powered vehicles will be used on the mine site. The intent of this section is to include a plan for how hydrogen will be handled at the mine site, including components involved in the refueling process and/or storage of hydrogen and hydrogen fuel cells as applicable.

6.18.3 (3) The manager must ensure the OHSC is provided with an opportunity to review and provide comments respecting the provisions of the project management plan that relate to the emerging technology and worker health and safety, as well as associated updates as required under subsection (5), prior to submission to the chief inspector.

Guidance

The Occupational Health and Safety Committee (OHSC) must be given the opportunity to review the PMP, or PMP updates, prior to submission to the Chief Inspector. Some portions of the PMP may be considered proprietary, but the OHSC must be given the opportunity to review and comment on the sections of the PMP that are specific to the worker's health and safety.

It is expected that the submission of the PMP or any amendment clearly indicates the participation of the OHSC in the process. This does not mean the OHSC endorses the emerging technology, it means they must have had the opportunity to review and raise concerns related to worker's health and safety.

Potential health and safety concerns or gaps related to Code provisions raised by any party involved in the review process of the PMP will be discussed and addressed during meetings coordinated by EMLI's Advisory Committee. It is expected that proponents will include representation from the OHSC in those PMP review meetings.

6.18.3 (4) The manager must implement and adhere to the project management plan once the chief inspector confirms that it meets the requirements of this code and is appropriate for the mine site.

Guidance

The Code and the PMP must be used in conjunction by all parties involved, including inspectors of mines, as references for the proper implementation, operation, and maintenance of the equipment and infrastructure related to the emerging technology being introduced at the mine site. It is critical that people involved in all those stages are familiar with, are kept updated with potential major or minor adjustments, and follow the elements of the PMP.

6.18.3 (5) If a material change is proposed to the operational use of an emerging technology, the manager must
- (a) ensure that a qualified professional updates the project management plan,
- (b) submit the updated plan to the chief inspector, and
- (c) not make operational changes until the chief inspector confirms that the updated project management plan meets the requirements of this code.

Guidance

If there are to be material changes to the use of an emerging technology on a mine site, the PMP must be updated and re-submitted to the Chief Inspector. This triggers another review by the OHSC prior to submission.

A change is considered as material if it introduces new hazards that are not addressed in the original risk registry and critical control list.

Changes that are considered material include but are not limited to:

- Addition of new autonomous and/or semi-autonomous equipment and technologies, such as adding autonomous drilling to a site that already has autonomous haulage.
- Change of system builder or system
- Changing from a segregated autonomous operating area to co-mingling autonomous and manually operated operations.
- Adding a battery electric scoop tram to a site that already has battery electrical haulage trucks.
- Adding a battery electric haul truck equipped with pantographs to connect on an existing trolley assisted haulage system.

Other changes, such as expansion of fleet size and operating area may not trigger an update, if the associated hazards, risks, and controls are addressed in the original submission.

Health and Safety Program

1.6.9 (1) The manager shall develop a Mine Health and Safety Program which includes the following sections
(c) safe working procedures on a departmental basis,
(c.1) if emerging technology is in use at the mine, safe working procedures for the equipment,

Section 1.6.9 of the Code requires the mine to have a Health and Safety Program. If an emerging technology is used at the mine site, the program must include safe working procedures for the emerging technology.

The safe working procedures required will depend on the individual mine site and the type of emerging technology in use. Examples of such procedures include but are not limited to the following:

- Access to autonomous operating areas
- Procedures for working within an autonomous operating area
- Clearing of autonomous operating areas, and restarting autonomous operations
- Switching mobile equipment between autonomous and manual mode
- Recovering a failed/stopped mobile equipment in areas impacted using emerging technology.
- Introduction of BEV into shops or tire bays designed for non-BEV maintenance.
- Performing maintenance in BEVs or related infrastructure where exposure to electrical hazards may be a risk.
- Procedures to swap or recharge batteries, including potential ergonomic issues.
- Mine personnel attending a haul truck that it has stopped under the powerlines of a trolley assisted system.

Mobile Equipment Standards and Certifications

Section 6.18.4 and Part 4 of the Code refer to standards that all mobile equipment used on mine sites must meet, including those with emerging technology and related infrastructure (e.g., battery charging and refueling stations).

6.18.4 The manager must ensure that emerging technology has been certified by an organization, which is accredited by the Standards Council of Canada, as meeting the requirements of

(a) an applicable CSA Standard;

(b) an applicable standard recognized by the Standards Council of Canada, if a standard referred to in paragraph (a) does not exist, or

(c) an applicable standard acceptable to the chief inspector, if neither standard referred to in paragraphs (a) and (b) exist.

Guidance

This section of the Code is intended to ensure that mining equipment with emerging technology that is introduced at mines in BC is designed accordingly and based on an acceptable standard to ensure it meets proper health and safety requirements.

The three options that have been made available provide opportunities to the entire industry to acquire mining equipment with emerging technology from other jurisdictions within and outside Canada as long as they are certified and meet the requirements of acceptable Standards as described in 6.18.4 (a), (b), and (c).

4.6.2 General Requirements

(1) The manager must ensure that all underground mining mobile equipment introduced into service in an underground mine on or after the date this section comes into force complies with CSA Standard M424.0-2022 Underground mining mobile equipment – General requirements.

(2) The manager must ensure that underground mining mobile equipment introduced into service in an underground mine before the date this section comes into force, complies with

(a) CSA Standard M424.0-2022 Underground mining mobile equipment – General requirements, or

(b) in the case of the equipment operating in

(i) an underground coal mine, with the general vehicle and machine requirements set out in CSA Standard CAN/CSA-M424.1-88, "Flame-Proof Non-Rail Bound Diesel-Powered Machine for Use in Gassy Underground Coal Mines", or

(ii) an underground mine, other than a coal mine, with the general vehicle and machine requirements set out in CSA Standard CAN/CSA-M424.2-90, "Non-Rail Bound Diesel-Powered Machines for use in Non-Gassy Underground Mines".

Guidance

Sub-section 4.6.2(1) requires that, underground mobile equipment introduced to mines after the publication of the 2024 version of the Code, must comply with a new standard that is now part of the CSA M424 series of Standards for underground mining mobile equipment.

Previous versions of the Code referred to three (3) Standards: M424.1-88, M424.2-90 and M424.3-90. The CSA Technical Committee on Underground Mining Mobile Equipment decided to restructure the whole set of stand-alone standards in the CSA M424 series and transform it into a new set of standards composed of general requirements documents and specific requirements documents.

The M424.0-2022 standard contains the basic safety and essential performance requirements that are generally applicable to a variety of underground mining mobile equipment. This standard shall be read and applied in conjunction with the relevant specific requirements standards for braking (CSA M424.3) and the specific type of power train concerned (CSA M424.1, CSA M424.2, and CSA M424.4).

Subsection 4.6.2(2) addresses underground mining mobile equipment that were introduced to mine sites prior to the date of the publication of this section. This subsection clarifies that equipment currently being operated at mine sites continue to be compliant if they satisfied the requirements of CSA M424.0 or version 2022 of the Code when they were introduced to the site.

4.7.1 (1) The manager must ensure that trackless diesel-powered equipment for use in
(a) underground coal mines complies with CSA Standard M424.1-2022 Flameproof non-rail-bound diesel-powered machines for use in gassy underground coal mines, and

Guidance

This Standard describes construction and test requirements for new non-rail-bound diesel-powered, self-propelled machines for use in gassy underground coal mines. It contains requirements that are supplementary to and must be used in conjunction with CSA M424.0-2022 and CSA M424.3-2022 as applicable.

(b) underground mines, other than coal, comply with CSA Standard M424.2-2022 Diesel-powered machines for use in non-gassy underground mines.

Guidance

This Standard describes the technical requirements and procedures necessary for the design, performance, and testing of new or unused diesel engines for use in non-gassy underground mines. It replaces the obsolete version of the M424.2 that was part of previous versions of the Code.

(2) Subsection (1) (a) does not apply to trackless diesel-powered equipment, made for use in underground coal mines, if
(a) the equipment is not used for cutting, digging and loading coal and

Guidance

In previous versions of the Code, this exception was included in the description of section 4.7.1(1). The new subsection 4.7.1(2) maintains that exception.

(b) The manager, prior to the use of the equipment,
i. makes health and safety procedures relating to the equipment,

Guidance

This section requires the development and implementation of health and safety procedures related to each type of equipment that may be regarded as exempt from CSA M424.1-2022. Any item of the equipment that doesn't comply with that standard needs to be properly assessed and addressed by qualified professionals to ensure that an equal or better level of protection is in place before the equipment is put in operation. Procedures must include but are not limited to a description of the activities, training required for a person to operate the equipment, locations where the equipment will be used, and the conditions of the area or workplace where the equipment will be operated including the expected air quality in the areas the machine will potentially be exposed to.

ii. updates the Mine Health and Safety Program, as set out in section 1.6.9 (c), in relation to the health and safety procedures, and

Guidance

This section requires that the procedures developed under 4.7.1(2)(b)(i) are included and updated as necessary in the Mine Health and Safety program.

iii. submits a copy of the health and safety procedures to the chief inspector.

Guidance

This section requires that a copy of the health and safety procedures related to this exemption is formally submitted to the chief inspector.

4.7.2 The manager must ensure that rubber tired, self-propelled underground vehicles used in underground mines comply with CSA Standard M424.3-2022 Braking performance – Rubber-tired, self-propelled underground mining machines.

Guidance

Part 4.7.2 applies to all rubber-tired, self-propelled underground mining machines, independently of the type of mine – coal or non-coal - its power source or technology.

The CSA M424.3-2022 Standard describes minimum performance and test criteria for the service braking system, secondary braking system, and parking system for rubber-tired, self-propelled underground mining machines.

4.7.3 The manager must ensure that self-propelled, electrically driven, non-rail-bound mobile machines used in underground mines, other than coal, comply with CSA Standard M424.4-2022 Self-propelled, electrically driven, non-rail-bound mobile machines for use in non-gassy underground mines.

Guidance

This Standard applies to self-propelled, electrically driven, non-rail-bound mobile machines for use in non-gassy underground mines. It provides requirements for such machines and is intended to be used in conjunction with CSA M424.0-2022, CSA M424.1-2022, CSA M424.2-2022, and CSA M424.3-2022, each as applicable. An example of application of this section of the Code is underground battery electric vehicles.