CSA M424.4:26 – TSC Update – MDEC 2025
Self-propelled, electrically driven, non- rail-bound mobile machines for use in non-gassy underground mines

Nam (John) Le, P.Eng (CanmetMINING)
Cheryl Allen, P.Eng (Vale)
William Hughes, P.Eng (Rokion)

Oct 6th, 2025
MDEC Conference in Toronto

Safety Share

February 16, 2025 – Delta Air Lines Flights 4819 at Toronto Pearson Airport

Credits Platform X

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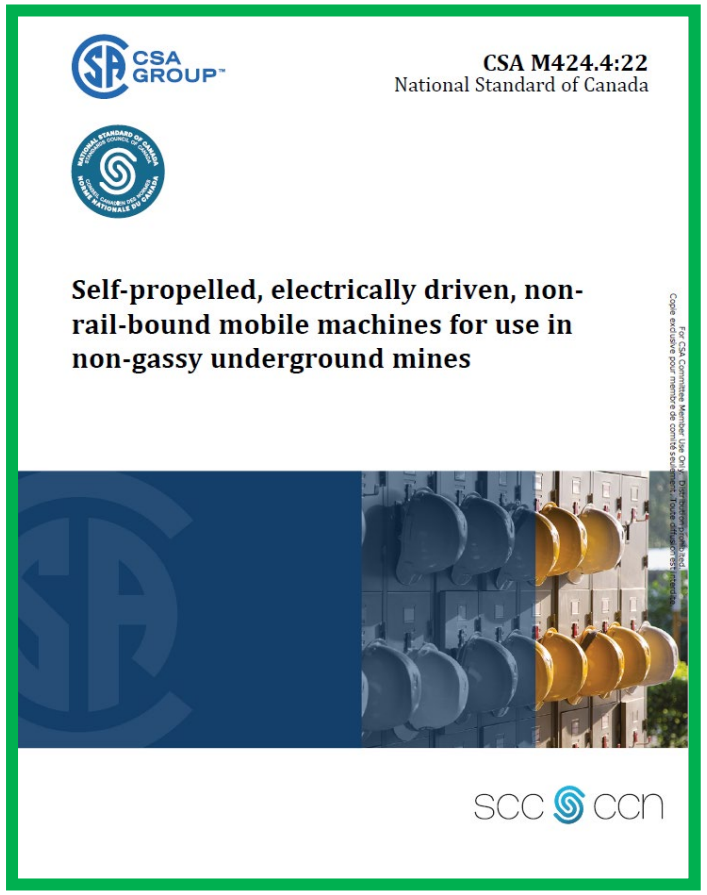
01. Objectives



Update M424.4:22 to create M424.:26

- Include requirements for battery handling, transportation, and storage
- Review, revise, and enhance content where needed
- Relocate Section 6 (Hydrogen fuel cell–electric powered machine) to the new Standard M424.5:25

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2.0 General Approach - Working group structure

Each working group will review, revise, and supplement the technical content, and provide the final version for the M424.4 Standard.

Working Group	Section	Members
WG1	Preface, (1) Scope, (2) Reference, (3) Definitions & Abbreviations	**Leader: David Rezansoff**
WG2	(4) General Requirements: * BEV & hybrid * Risk assessment * Transport and storage batteries	**Leader: William Hughes**
WG3	Review and revise clauses: * (5) Battery electric-power machines	**Leader: Gaurav Mahajan**
WG4	Review and revise clauses: * (6) Diesel-electric powered machines Annex (informative)	**Leader: William Hughes**

2.0 General Approach - Working group structure

TSC Membership

First Name	Last Name	Email	Position	Group	Company
John	Le	john.le@nrcan-rncan.gc.ca	Chair	Government	NRCan - CanmetMINING
Cheryl	Allen	cheryl.allen@vale.com	Co-Chair	Mine Operation	Vale Canada
William	Hughes	whughes@prairiemachine.com	Co-Chair	OEM	Prairie Machine
Vaishnavi	Somasundaram	vaishnavi.somasundaram@csagroup.org	Project Manager	Standard Organization	CSA

Total 26+ Team Members

2.0 General Approach - Working group structure

Section: Preface, (1) Scope, (2) Reference, (3) Definitions & Abbreviations

- *Remove all requirements related to hydrogen*
- *Revise the list of reference standards*
- *Add new definitions & abbreviations*

WG #1 - Membership			
First Name	**Last Name**	**Group**	**Company**
David	***Rezansoff***	*Government*	***Saskatchewan Ministry of Labour***
Blair	Baldwin	Consultant	Baldwin Services
Brent	Rubeli	Government	NRCan - CanmetMINING
Cheryl	Allen	Mine operation	Vale Canada
George	Lobay	Government	NRCan
John	Le	Government	NRCan - CanmetMINING
William	Hughes	OEM	Prairie Machine
Alexander	Lenz	OEM	MacLean Engineering
Craig	Harris	Mine Operation	Glencore
Brailyn	Johnsgaard	Mine Operation	Nutrien

2.0 General Approach - Working group structure

Section: (4) General Requirements: BEV & hybrid, Risk assessment, Transport and storage batteries

- *Review, revise & add any new content applicable to both technologies*
- *Include a risk assessment for battery handling, transport and storage.*

WG #2 - Membership			
First Name	**Last Name**	**Group**	**Company**
William	***Hughes***	***OEM***	***Prairie Machine***
Alexander	Lenz	OEM	MacLean Engineering
Andrew	Hubele	OEM	Epiroc
Brent	Rubeli	Government	NRCan - CanmetMINING
Dave	Schmidt	OEM	Kovatera
Jerry	Davis	OEM	Komatsu
Joe	Benoit	Mine Operation	Hudbay Minerals
Cornelius	Powell		
Joel	Thon	Mine Operation	Nutrien
John	Le	Government	NRCan - CanmetMINING
Scott	Secord	Government	Ontario Ministry of Labour
Shawn	Sauve	Mine Operation	Glencore
Craig	Alair	Mine Operation	Vale Canada
Blair	Baldwin	Consultant	Baldwin Services
Craig	Harris	Mine Operation	Glencore

2.0 General Approach - Working group structure

Section: (5) Battery electric-power machines

- *Review all clauses and references standards*
- *Revise and add requirements applicable to mobile machines in Canadian mines*

WG#3 - Subgroup Members

Name	Organization	Subgroup #
Craig Harris	Glencore	T1
Alex Lenz	MacLean Engineering	T1
Dave Schmidt	Kovatera	T2
Paul Summers	Miller Technology	T2
Andres Hubele	Epiroc	T3
Joel Thon	Nutrien	T3
William Hughes	Rokion	T4
Brailyn Johnsgaard	Nutrien	T4
David Lyon	Zero Nexus	T5
Gaurav Mahajan	***CanmetMINING***	***T5***
Bryson Cochrane	MOL - NT	T6
Brent Rubeli	CanmetMINING	T6
Cheryl Allen	Vale	T7
Cynthia Matikainen	MOL - ON	T7
Fred Pellieter	HJS	T8
John Le	CanmetMINING	T8

2.0 General Approach - Working group structure

Section: (6) Diesel-electric powered machines, Annex (information)

- Review all clauses and reference standards
- Add new technical content specific to diesel-electric powered machines

WG #4 - Membership			
First Name	**Last Name**	**Group**	**Company**
William	**Hughes**	**OEM**	**Prairie Machine**
Fred	Pellietier	Supplier	HJS
John	Le	Government	CanmetMINING
Recruit new member			
Recruit new member			
Recruit new member			
Recruit new member			
Recruit new member			

2.0 General Approach - Working group structure

Standards Procurement

No	M424.4:22 Clause	Reference Standard	Who has/buy	Workspace (July/25/2025)	Comment
91		ISO 16750-2		Yes	Bought 3 months ago
92		ISO 12405-4		Yes	Bought 3 months ago
93		ISO TS 5474-5		Yes	Bought 3 months ago
94		ISO PAS 5474-6		Yes	Bought 3 months ago
95		ISO 11452-1_2015		Yes	Bought 3 months ago
96		ISO 16750-3		Yes	Bought 3 months ago
97		Z107_56-94		Yes	Bought 3 months ago
98		ISO_IEC_DIS_80079-38(E)-_Annex_ZA		Yes	Bought 3 months ago
99		IEC 60034.1.2004		Yes	Bought 3 months ago
100		ISO 8528-5_2022		Yes	Bought 6 months ago
101		ISO 8528-1_18			
102		IEC 62282-2-100-2020			
103		IEC 60479-1_2018			
104		IEC 60034-1_2022			
105		ISO 8528-3_2020			Bought 6 months ago
106		ISO 10263-3_2009	Vaishnavi	Yes	Aug/13/2025, can't download
107		ISO 10570:2004	Vaishnavi	Yes	Aug/13/2025, can't download
108		ISO 10968:2020	Vaishnavi	Yes	Aug/13/2025, can't download
109		ISO 11112:1995	Vaishnavi	Yes	Aug/13/2025, can't download
110		ISO 12509:2004	Vaishnavi	Yes	Aug/13/2025, can't download
111		ISO 13031:2016	Vaishnavi	Yes	Aug/13/2025, can't download
112		ISO 13857:2019	Vaishnavi	Yes	Aug/13/2025, can't download
113		ISO 14401-1:2004	Vaishnavi	Yes	Aug/13/2025, can't download
114		ISO 14401-2:2004	Vaishnavi	Yes	Aug/13/2025, can't download
115		ISO 15817:2012	Vaishnavi	Yes	Aug/13/2025, can't download
116		Z432			**Brailyn Johnsgaard**
117		Z462			**Brailyn Johnsgaard**
118		iec60695-1-20	Gaurav	Yes	Bought August/27/2025
119		iec60695-1-30	Gaurav	Yes	Bought August/27/2025
120		iec61427-1	Gaurav	Yes	Bought August/27/2025
121		iec61558-2-6	Gaurav	Yes	Bought August/27/2025
122		iec60947-5-1	Gaurav	Yes	Bought August/27/2025
123		iec62619{ed2.0.CMV}en	Gaurav	Yes	Bought August/27/2025
124		iec60034-2-1{ed3.0.RLV}en	Gaurav	Yes	Bought August/27/2025

International Electrotechnical Commission

Require over reference 124 Standards

2.0 General Approach - Working group structure

TC Meeting April, 2025: Important decisions

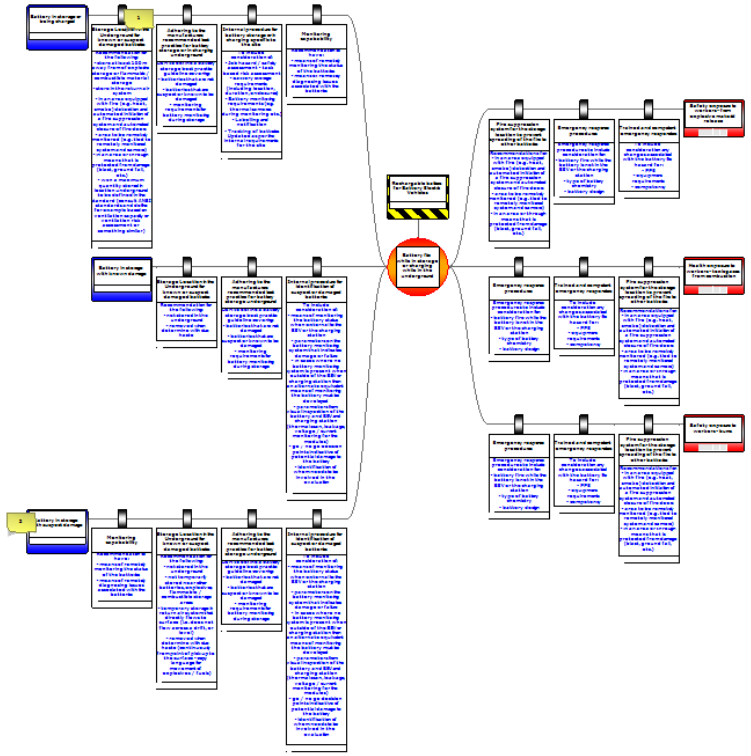
Should safety requirements for handling, transporting, and storing batteries be moved to guideline, new Standard (M424.6) or Annex as not mandatory requirement, so that M424.4 contains only design requirements?

Should we adopt ISO 14990-1:2016 (*Earth-moving machinery — Electrical safety of machines utilizing electric drives and related components and systems — General Requirements*) with Canadian deviations, or develop Canadian content with references to other Standards as needed?

2.0 General Approach - Working group structure

TC Meeting April, 2025: Path Forward

- Move Battery Storage, Handling and Transportation Dangerous Goods to Annex A.9 as an informative reference rather than a mandatory requirement, so that M424.4 contains only design requirements.



2.0 General Approach - Working group structure

TC Meeting April, 2025: Path Forward

Create Canadian Content With reference to other Standards

OR

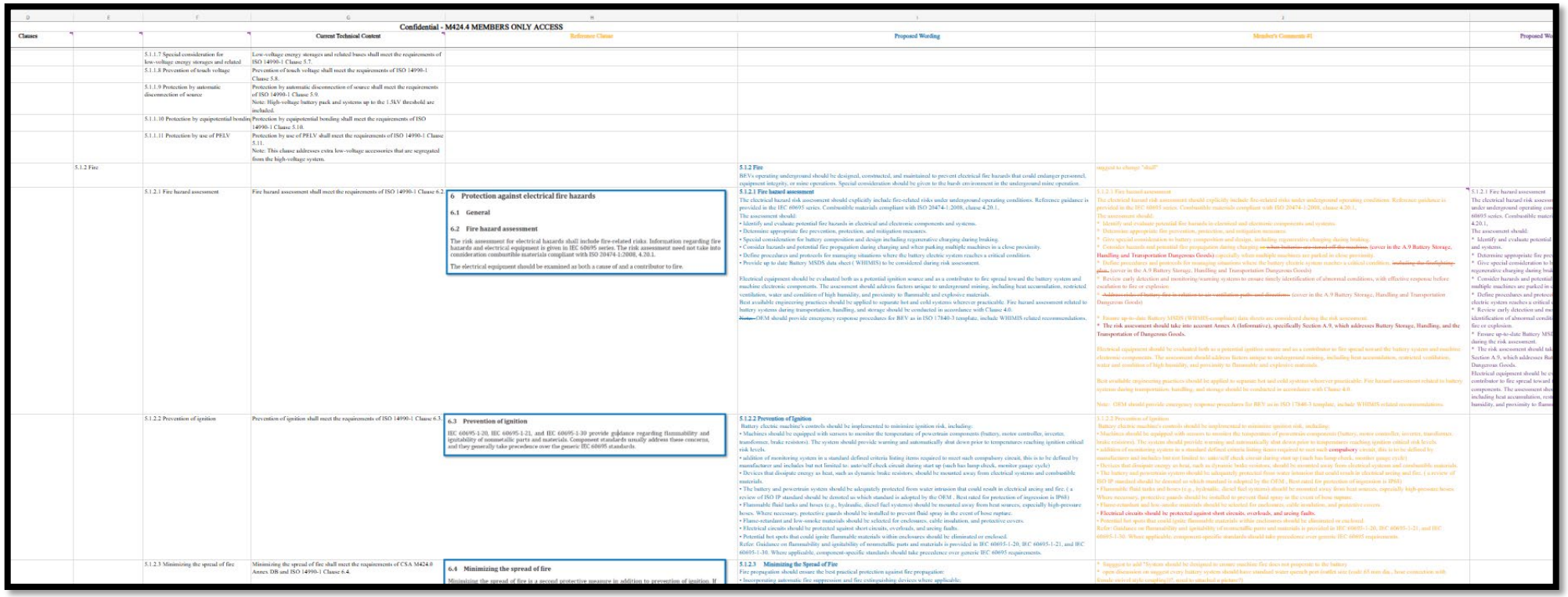
Adopt ISO 14990-1:2016 With Canadian Deviation

Decision

Create Canadian Content With reference to other Standards

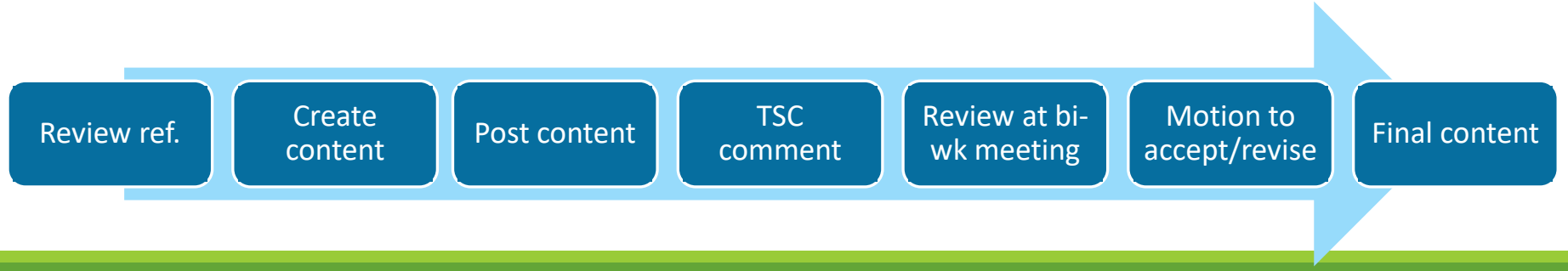
Requirements specific to underground mine mobile machines, with minimal reference to other Standards.

2.0 General Approach - Working group approach



Confidential - M424.4 MEMBERS ONLY ACCESS

Clauses			Current Technical Content	Reference Clause	Proposed Wording	Member's Comments #1	Proposed Wo
		5.1.1.7 Special consideration for low-voltage energy storages and related	Low-voltage energy storages and related buses shall meet the requirements of ISO 14990-1 Clause 5.7.				
		5.1.1.8 Prevention of touch voltage	Prevention of touch voltage shall meet the requirements of ISO 14990-1 Clause 5.8.				
		5.1.1.9 Protection by automatic disconnection of source	Protection by automatic disconnection of source shall meet the requirements of ISO 14990-1 Clause 5.9. Note: High-voltage battery pack and systems up to the 1.5kV threshold are included.				
		5.1.1.10 Protection by equipotential bonding	Protection by equipotential bonding shall meet the requirements of ISO 14990-1 Clause 5.10.				
		5.1.1.11 Protection by use of PELV	Protection by use of PELV shall meet the requirements of ISO 14990-1 Clause 5.11. Note: This clause addresses extra low-voltage accessories that are segregated from the high-voltage system.				
	5.1.2 Fire				5.1.2 Fire BEVs operating underground should be designed, constructed, and maintained to prevent electrical fire hazards that could endanger personnel, equipment integrity, or mine operations. Special consideration should be given to the harsh environment in the underground mine operation.	suggest to change "shall"	
		5.1.2.1 Fire hazard assessment	Fire hazard assessment shall meet the requirements of ISO 14990-1 Clause 6.2	6 Protection against electrical fire hazards 6.1 General 6.2 Fire hazard assessment The risk assessment for electrical hazards shall include fire-related risks. Information regarding fire hazards and electrical equipment is given in IEC 60695 series. The risk assessment need not take into consideration combustible materials compliant with ISO 20474-1:2008, 4.20.1. The electrical equipment should be examined as both a cause of and a contributor to fire.	5.1.2.1 Fire hazard assessment The electrical hazard risk assessment should explicitly include fire-related risks under underground operating conditions. Reference guidance is provided in the IEC 60695 series. Combustible materials compliant with ISO 20474-1:2008, clause 4.20.1. The assessment should: • Identify and evaluate potential fire hazards in electrical and electronic components and systems. • Determine appropriate fire prevention, protection, and mitigation measures. • Special consideration for battery composition and design including regenerative charging during braking. • Consider hazards and potential fire propagation during charging and when parking multiple machines in a close proximity. • Define procedures and protocols for managing situations where the battery electric system reaches a critical condition. • Provide up to date Battery MSDS data sheet (WHMIS) to be considered during risk assessment. Electrical equipment should be evaluated both as a potential ignition source and as a contributor to fire spread toward the battery system and machine electronic components. The assessment should address factors unique to underground mining, including heat accumulation, restricted ventilation, water and condition of high humidity, and proximity to flammable and explosive materials. Best available engineering practices should be applied to separate hot and cold systems wherever practicable. Fire hazard assessment related to battery systems during transportation, handling, and storage should be conducted in accordance with Clause 4.0. ~~Note:~~ OEM should provide emergency response procedures for BEV as in ISO 17840-3 template, include WHIMIS related recommendations.	5.1.2.1 Fire hazard assessment The electrical hazard risk assessment should explicitly include fire-related risks under underground operating conditions. Reference guidance is provided in the IEC 60695 series. Combustible materials compliant with ISO 20474-1:2008, clause 4.20.1. The assessment should: * Identify and evaluate potential fire hazards in electrical and electronic components and systems. * Determine appropriate fire prevention, protection, and mitigation measures. * Give special consideration to battery composition and design, including regenerative charging during braking. * Consider hazards and potential fire propagation during charging, ~~or when parking multiple machines in a close proximity.~~ (cover in the A.9 Battery Storage, Handling and Transportation Dangerous Goods) * Define procedures and protocols for managing situations where the battery electric system reaches a critical condition. ~~including the firefighting plan.~~ (cover in the A.9 Battery Storage, Handling and Transportation Dangerous Goods) * Review early detection and monitoring/warning systems to ensure timely identification of abnormal conditions, with effective response before escalation to fire or explosion. * ~~Address risks of battery fire in relation to air ventilation paths and durations~~ (cover in the A.9 Battery Storage, Handling and Transportation Dangerous Goods) * Ensure up-to-date Battery MSDS (WHMIS-compliant) data sheets are considered during the risk assessments. * The risk assessment should take into account Annex A (Informative), specifically Section A.9, which addresses Battery Storage, Handling, and the Transportation of Dangerous Goods. Electrical equipment should be evaluated both as a potential ignition source and as a contributor to fire spread toward the battery system and machine electronic components. The assessment should address factors unique to underground mining, including heat accumulation, restricted ventilation, water and condition of high humidity, and proximity to flammable and explosive materials. Best available engineering practices should be applied to separate hot and cold systems wherever practicable. Fire hazard assessment related to battery systems during transportation, handling, and storage should be conducted in accordance with Clause 4.0. Note: OEM should provide emergency response procedures for BEV as in ISO 17840-3 template, include WHIMIS related recommendations.	5.1.2.1 Fire hazard assessment The electrical hazard risk assessm under underground operating con 60695 series. Combustible mater 4.20.1. The assessment should: * Identify and evaluate potential and systems. * Determine appropriate fire pre * Give special consideration to b regenerative charging during brak * Consider hazards and potential multiple machines are parked in c * Define procedures and protocol electric system reaches a critical * Review early detection and mo identification of abnormal condit fire or explosion. * Ensure up-to-date Battery MSI during the risk assessment. * The risk assessment should tak Section A.9, which addresses Bat Dangerous Goods. Electrical equipment should be e contributor to fire spread toward components. The assessment shou including heat accumulation, rest humidity, and proximity to flamm
		5.1.2.2 Prevention of ignition	Prevention of ignition shall meet the requirements of ISO 14990-1 Clause 6.3.	6.3 Prevention of ignition IEC 60695-1-20, IEC 60695-1-21, and IEC 60695-1-30 provide guidance regarding flammability and ignitability of nonmetallic parts and materials. Component standards usually address these concerns, and they generally take precedence over the generic IEC 60695 standards.	5.1.2.2 Prevention of Ignition Battery electric machine's controls should be implemented to minimize ignition risk, including: • Machines should be equipped with sensors to monitor the temperature of powertrain components (battery, motor controller, inverter, transformer, brake resistors). The system should provide warning and automatically shut down prior to temperatures reaching ignition critical risk levels. • addition of monitoring system in a standard defined criteria listing items required to meet such compulsory circuit, this is to be defined by manufacturer and includes but not limited to: auto/self check circuit during start up (such has lamp check, monitor gauge cycle) • Devices that dissipate energy as heat, such as dynamic brake resistors, should be mounted away from electrical systems and combustible materials. • The battery and powertrain system should be adequately protected from water intrusion that could result in electrical arcing and fire. (a review of ISO IP standard should be denoted as which standard is adopted by the OEM , Best rated for protection of ingression is IP68) • Flammable fluid tanks and hoses (e.g., hydraulic, diesel fuel systems) should be mounted away from heat sources, especially high-pressure hoses. Where necessary, protective guards should be installed to prevent fluid spray in the event of hose rupture. • Flame-retardant and low-smoke materials should be selected for enclosures, cable insulation, and protective covers. • Electrical circuits should be protected against short circuits, overloads, and arcing faults. • Potential hot spots that could ignite flammable materials within enclosures should be eliminated or enclosed. Refer Guidance on flammability and ignitability of nonmetallic parts and materials is provided in IEC 60695-1-20, IEC 60695-1-21, and IEC 60695-1-30. Where applicable, component-specific standards should take precedence over generic IEC 60695 requirements.	5.1.2.2 Prevention of Ignition Battery electric machine's controls should be implemented to minimize ignition risk, including: • Machines should be equipped with sensors to monitor the temperature of powertrain components (battery, motor controller, inverter, transformer, brake resistors). The system should provide warning and automatically shut down prior to temperatures reaching ignition critical risk levels. • addition of monitoring system in a standard defined criteria listing items required to meet such compulsory circuit, this is to be defined by manufacturer and includes but not limited to: auto/self check circuit during start up (such has lamp check, monitor gauge cycle) • Devices that dissipate energy as heat, such as dynamic brake resistors, should be mounted away from electrical systems and combustible materials. • The battery and powertrain system should be adequately protected from water intrusion that could result in electrical arcing and fire. (a review of ISO IP standard should be denoted as which standard is adopted by the OEM , Best rated for protection of ingression is IP68) • Flammable fluid tanks and hoses (e.g., hydraulic, diesel fuel systems) should be mounted away from heat sources, especially high-pressure hoses. Where necessary, protective guards should be installed to prevent fluid spray in the event of hose rupture. • Flame-retardant and low-smoke materials should be selected for enclosures, cable insulation, and protective covers. - Electrical circuits should be protected against short circuits, overloads, and arcing faults. • Potential hot spots that could ignite flammable materials within enclosures should be eliminated or enclosed. Refer Guidance on flammability and ignitability of nonmetallic parts and materials is provided in IEC 60695-1-20, IEC 60695-1-21, and IEC 60695-1-30. Where applicable, component-specific standards should take precedence over generic IEC 60695 requirements.	
		5.1.2.3 Minimizing the spread of fire	Minimizing the spread of fire shall meet the requirements of CSA M424.0 Annex DB and ISO 14990-1 Clause 6.4.	6.4 Minimizing the spread of fire Minimizing the spread of fire in a second protective measure in addition to prevention of ignition. If	5.1.2.3 Minimizing the Spread of Fire Fire propagation should ensure the best practical protection against fire propagation: • Incorporating automatic fire suppression and fire extinguishing devices where applicable;	* Suggest to add "Systems should be designed to ensure reactions fire does not propagate to the battery * open discussion on suggest every battery system should have standard water quench port (outlet size (scale 65 mm dia., hose connection with female swivel style coupling(?), must be attached or permanent))	



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3.0 Completion Status – Summary Deliverables

Sections	Estimated Completion (%)	Comments
1. Scope	98	Add 1.5 scope
2. Reference Publications	80	Add/remove reference standards upon request
3. Definitions and Abbreviations	90	Add/remove definitions and abbreviations upon request
4. General requirements	98	• Revised the entire section • Added battery handling and transportation of dangerous goods
5. Battery electric-powered machines	20	• Previously, too many reference standards were required, but most are now available. • Review the lengthy chain of reference clauses • Develop Canadian content and reference other standards as needed
6. Diesel electric powered machines	0	• New working group requires additional team members to review reference Standards and revise the content
Annex A (Informative)	80	• Added sample bow tie risk assessment • Add/remove content upon request

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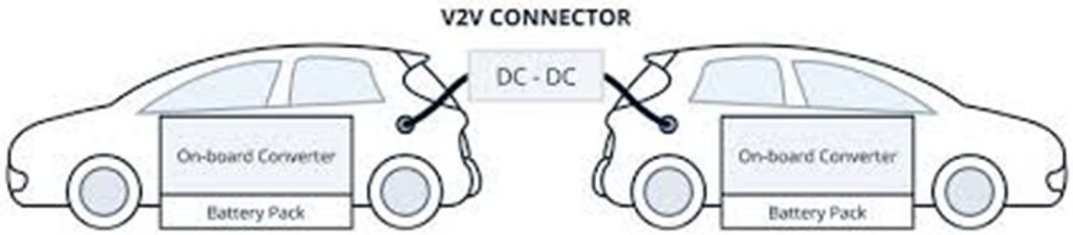
4.0 Next steps

- TSC conducts bi-weekly meeting
- Increase efforts to review and develop content for Section 5.0 (WG#3)
- Form WG#4 to work on Section 6.0
- Continue securing additional reference Standards

4.0 Next steps – Further Discussions

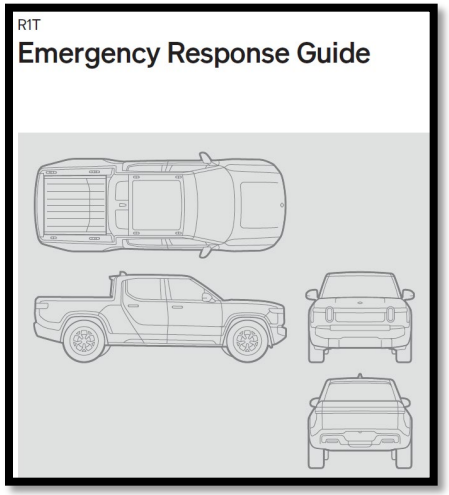
A. Battery water quench port connection



B. Charge machine to machine

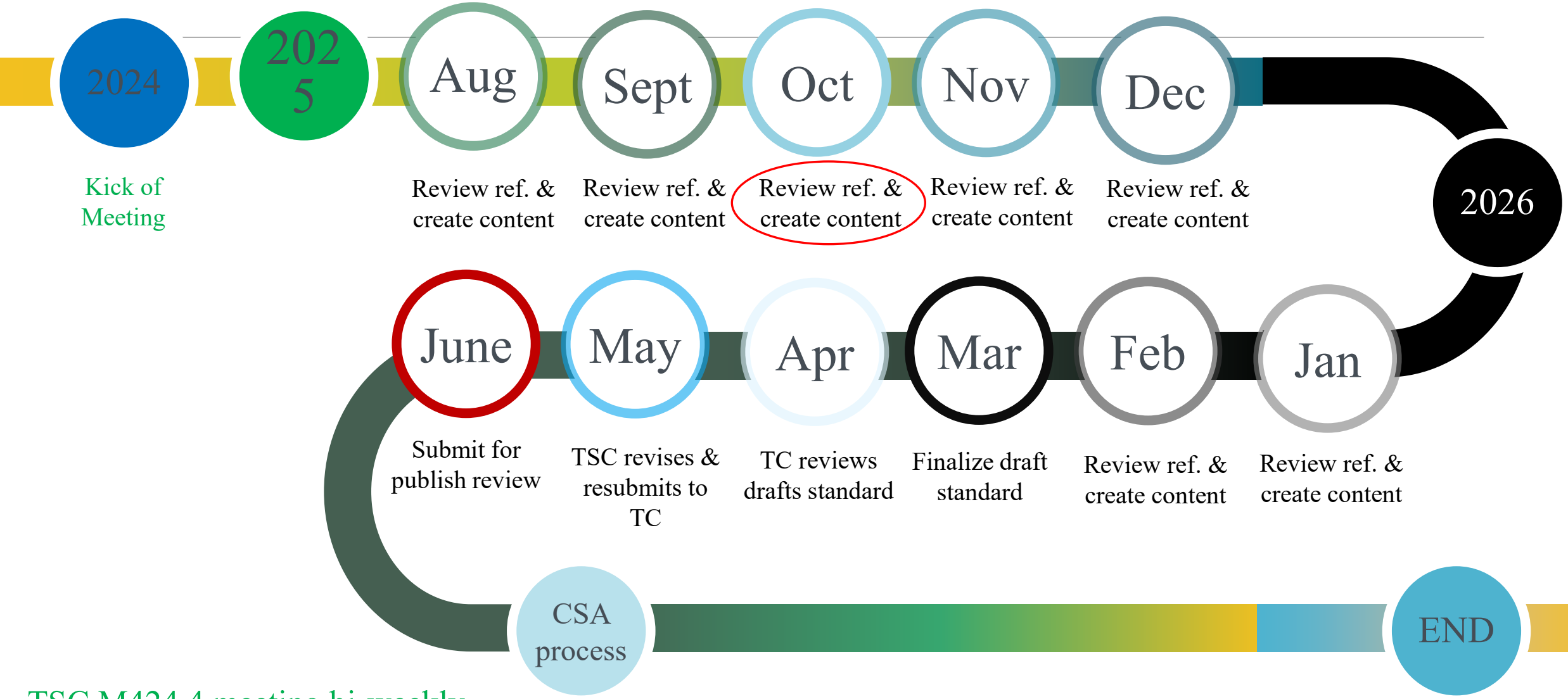
GM #__, BEM#__, __#B

C. Battery machine name plate convention



D. Emergency response guide template ISO 17840-3-2019

4.0 Next steps: M424.4 Plan



TSC M424.4 meeting bi-weekly

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