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INSTITUT AUTOMOTIF ROBOTIK DAN IoT MALAYSIA
MALAYSIA AUTOMOTIVE ROBOTICS AND IoT INSTITUTE

NORTHPORT
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ELECTRIC VEHICLE AND BATTERY MANAGEMENT (EVBM) GUIDELINES

(INDUSTRY SELF-REGULATION)

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Productivity in EV and Battery Management

Productivity plays a crucial role in driving growth within the EV industry. It is essential for ensuring that electric vehicles (EVs) and their batteries (EVBs) are managed safely, efficiently, and sustainably. By adopting industry self-regulation, promoting standardization, and encouraging innovation in areas like battery recycling, disposal, and safety protocols, the industry can achieve significant productivity improvements. This results in smoother operations, better performance of EVs, and a reduced environmental footprint, all of which contribute to the continued expansion and competitiveness of the EV sector.

Disclaimer Statement

The Electric Vehicle and Battery Management Guidelines (EVBM Guidelines) provide recommendations and best practices for the handling, management and disposing of electric vehicles and their batteries. These Guidelines are advisory in nature and are intended to provide a framework for industry stakeholders to ensure safety, environmental responsibility and operational efficiency. They are in no means intended as a substitute for legal or regulatory advice. The EVBM Guidelines were developed in collaboration with industry experts and a project team of Government representatives and regulators and are industry-led. The Guidelines will be regularly updated to reflect technological advances. The EVBM Guidelines will be continuously reviewed by the industry and focus group discussions every six months to maintain the status of EVBM Guidelines as a "living document." For detailed information or clarification, users should contact the relevant authorities or organisations responsible for the particular functions or transactions of interest. The EVBM Guidelines are based on industry information available at the time of writing. Due to the dynamic nature of functions, systems and processes, updates may be made from time to time to align with new policies, strategies and best practises. Whilst every effort has been made to ensure the accuracy of information at the time of writing, the publisher and technical editors accept no legal responsibility for its accuracy or completeness as the information is subject to change.

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Preface by

YAB Dato' Sri Haji Fadillah bin Haji Yusof

Deputy Prime Minister and Minister of Energy Transition and Water Transformation

I would like to express my sincere gratitude to the industry leaders, regulators, and Government agencies whose invaluable contributions have made the development of the Electric Vehicle and Battery Management (EVBM) Guidelines possible through a collaborative Industry Self-Regulation framework.

The electric vehicle (EV) market is rapidly advancing, propelled by a global shift toward cleaner and more sustainable mobility solutions. Malaysia is fully committed to embracing this transformation, as outlined in the National Energy Transition Roadmap (NETR), with an ambitious goal of achieving 80% EV adoption and 90% local manufacturing by 2050. As our automotive sector adapts to these changes, robust Battery Management Systems (BMS) will be critical to ensuring the safe, efficient, and sustainable management of EV batteries throughout their lifecycle.

The EVBM Guidelines represent a major milestone in our journey toward industry-led self-regulation, positioning Malaysia as a rising global player in the EV landscape. These comprehensive Guidelines cover the entire battery lifecycle - from acquisition to disposal, addressing key areas such as safety, environmental sustainability, and responsible end-of-life management.

However, this is only the beginning. As the EV industry continues to innovate, these Guidelines will remain a dynamic and evolving document, incorporating new technologies and best practices to ensure Malaysia remains at the forefront of the global EV market, both competitively and sustainably.

Moving forward, I am confident that the EVBM Guidelines will not only drive innovation and productivity but will also serve as a catalyst for the long-term growth and success of Malaysia's EV industry on the world stage.

Foreword by

YB Senator Datuk Seri Utama Tengku Zafrul bin Tengku Abdul Aziz

Minister of Investment, Trade and Industry

I am pleased to share the "Electric Vehicle and Battery Management (EVBM) Guidelines (Industry Self-Regulation), a significant initiative aimed at empowering the EV industry to lead its own regulatory efforts. These Guidelines encourage industry players to adopt best practices, ensure compliance, as well as support sustainability and productivity within the growing electric vehicle (EV) ecosystem. They are also a clear reflection of our stakeholders' commitment to the whole-of-nation approach to Malaysia's industrial reforms and Net Zero target, making such commitment an important bridge between our transformative goals and accomplishments.

Given the EV market's rapid evolution, Malaysia is well-positioned to capture a significant share of the ASEAN EV market, projected to grow to US$2.7 billion by 2027. With a comprehensive EV ecosystem - as envisaged in our National Automotive Policy, with further impetus provided by the New Industrial Master Plan 2030 – Malaysia is well-equipped to attract high-value investments in vehicle assembly, manufacturing, and charging infrastructure to become a regional EV manufacturing hub.

To further accelerate EV adoption, the Government has introduced supportive policies, including tax exemptions for EV imports, incentives for local production, and a new road tax structure for EVs starting in 2026, offering lower rates compared to internal combustion engine (ICE) vehicles. These measures aim to promote EV adoption to reach at least 20% of Total Industry Volume (TIV) by 2030, 50% by 2040 and 80% by 2050, in alignment with the National Energy Transition Roadmap (NETR).

Developed in collaboration with industry stakeholders, the EVBM Guidelines ensure the safe, efficient, and sustainable management of EV batteries, underscoring industry leadership in driving productivity and sustainability while positioning Malaysia as a competitive player in the global EV market.

I am confident that the EVBM Guidelines will spur the development of the EV ecosystem and further drive EV adoption, while increasing investors' confidence to invest in the Malaysian EV sector.

Message by

YBhg Dato' Azman Shah Mohd Yusof
Chief Executive Officer
Northport (Malaysia) Bhd

In line with Malaysia's rapid advancement in electric mobility and the Government's efforts to position Malaysia as the regional manufacturing and distribution hub of Electric Vehicles, it is with great enthusiasm that we present the Electric Vehicle and Battery Management Guidelines, an initiative born out of collaboration between industry leaders, Government agencies, and relevant authorities. The development of these Guidelines under the auspices of the National EV Steering Committee, is a pivotal step in ensuring the safe and sustainable management of electric vehicles (EVs) and their batteries throughout their entire lifecycle - from manufacturing, transporting, storing, purchasing, utilizing to eventual disposal.

At Northport (Malaysia) Bhd, we have experienced significant growth in the handling of EV vehicles. This growth is not without its operational safety risks, and these risks are not just limited to the port but extends across the entire ecosystem. This highlights the critical need for safety guidelines based on industry best practices for managing EVs and their batteries.

As a comprehensive reference point for industry, these Guidelines provide practical standards for ensuring safety and environmental sustainability across the EV sector. They cover both front-end processes, such as customer engagement, safety education, and battery care, as well as back-end processes, including responsible manufacturing, transporting, storage, maintenance, and eventual disposal of EV batteries. This approach ensures that all stages of the EV and battery lifecycle are managed effectively, promoting safety, extending battery life, and minimizing environmental impact.

To ensure the robustness of these Guidelines, a workshop with industry players, a focus group discussion with regulators, a public consultation, and a concluding session on the Guidelines were conducted. These sessions provided valuable insights and collaboration, ensuring the Guidelines are comprehensive and effective as a key aspect of this framework is the industry self-regulation, empowering all stakeholders to take responsibility in shaping and adhering to best practices. Furthermore, these Guidelines are designed to be a living document that will be continuously improved and updated as needed to reflect industry advancements and new insights.

In closing, we would like to express our sincere appreciation to the Ministry of Investment, Trade and Industry (MITI), the Malaysia Productivity Corporation (MPC), and the Malaysia Automotive Robotics and IoT Institute (MARii) for their invaluable support and guidance, especially in our collaboration in the development of the Guidelines and for co-organizing the workshop and discussion sessions. The collaboration has been essential in developing this important agile policy development framework, and it is hoped that the ongoing partnership will continue to play a key role in driving the growth of electric vehicles in Malaysia while ensuring a safe and sustainable ecosystem.

MANDATE

The National EV Steering Committee (NEVSC) held its first meeting (No. 1/2024) on 14th February 2024 under the chairmanship of the Deputy Prime Minister, YAB. Dato' Sri Haji Fadillah bin Haji Yusof. In this meeting, the committee approved Northport (Malaysia) Bhd's proposal to establish self-regulated guidelines for the handling of lithium-ion batteries used in electric vehicles. This initiative aims to mitigate the risks associated with fires and the release of hazardous substances and to ensure public safety, health and environmental protection with regard to the use of EVs.

This initiative will be implemented in collaboration with the Ministry of Investment, Trade and Industry (MITI), Malaysia Productivity Corporation (MPC) and Malaysia Automotive Robotics and IoT Institute (MARii), who will act as facilitators.

The Guidelines (acronym: EVBM) were developed with the participation of industry representatives involved in the EV battery management process.

The industry representatives involved are as follows:
(in alphabetical order)

1. Allied Warehouses (M) Sdn Bhd
2. Amtel Cellular Sdn Bhd
3. Association of Malaysian Hauliers (AMH)
4. Automotive Productivity Nexus (APN/MPC)
5. Bermaz Auto Bhd
6. Chartered Institute of Logistics and Transport (CILT) (Selangor Section)
7. Chemical Productivity Nexus (CPN/MPC)
8. EV Charging Industry Association (PIPEV)
9. Federation of Automobile Workshop Owners' Association of Malaysia
10. Federation of Malaysia Electric Vehicle Association (FOMEVA)
11. Federation of Malaysian Manufacturers (FMM)
12. Hicom Diecasting Sdn Bhd
13. Hicom Engineering Sdn Bhd
14. KPX Sdn Bhd
15. Logistics Productivity Nexus (LPN/MPC)
16. Malaysia Zero Emission Vehicle Association (MyZEVA)
17. Malaysian Automotive Association
18. Motorcycle and Scooter Assemblers and Distributors Association of Malaysia (MASAAM)
19. Motordata Research Consortium Sdn Bhd
20. NanoMalaysia Berhad (NanoMalaysia)
21. Northport (Malaysia) Bhd
22. Perusahaan Otomobil Kedua Sdn Bhd (PERODUA)
23. Perusahaan Otomobil Nasional Sdn Bhd (PROTON)
24. PKT Logistics Sdn Bhd
25. Prima Merdu Sdn Bhd
26. Reactive Energy Sdn Bhd
27. Samsung SDI Energy Malaysia Sdn Bhd
28. SIRIM QAS International Sdn Bhd
29. Suzuki Malaysia Sdn Bhd
30. Tesla Malaysia
31. Vertex Mission Sdn Bhd
32. VSD Automation Sdn Bhd
33. Yinson Green Technologies

In addition to input from the industry representatives, a special Focus Discussion Group was initiated involving relevant regulators and Government agencies. This Group was tasked with reviewing the draft Guidelines, providing feedback and suggesting improvements to enhance the Guidelines.

Participating regulators and Government agencies in this Focus Discussion Group includes:
(in alphabetical order)

1. Department of Environment (DOE)
2. Department of Safety and Health (DOSH)
3. Department of Standards Malaysia (JSM)
4. Fire and Rescue Department of Malaysia (BOMBA)
5. Land Public Transport Agency (APAD)
6. Local Government Department (JKT)
7. Majlis Bandaraya Diraja Klang (MBDK)
8. Malaysia Automative Robotics and IoT Institute (MARii)
9. Malaysia Marine Department (JLM)
10. Malaysia Productivity Corporation (MPC)
11. Malaysian Green Technology And Climate Change Corporation (MGTC)
12. Ministry of Transport Malaysia (MOT)
13. Northport (Malaysia) Bhd
14. Port Klang Authority (LPK)
15. Road Transport Department (JPJ)

GLOSSARY

The following glossary of terms used in the EV industry are essentially factual but not complete in its full context. For terminology which is not fully understood, we would suggest you to refer your query to your EV vendor or their adviser. Alternatively, you may want to consult the enquiry desk of Malaysia Productivity Corporation (MPC) or Malaysia Automative, Robotics and IoT Institute (MARii).

ADR	ADR: The Agreement concerning the International Carriage of Dangerous Goods by Road (ADR), a United Nations document which regulates the transport of hazardous goods by road. Adherence to ADR rules is mandatory for transportation of lithium-ion batteries. The specific requirements for this type of battery can be found under Article 2.2.9.1.7 of this Rule.
Battery Pack	An assembly of cells that are connected in series and/or parallel. Each battery pack contains only one type of cell. Connecting cells in parallel increases the pack capacity (ampere hour, Ah), whereas connecting cells in series increases the pack's voltage. For example, if there are y cells connected in series, the pack's voltage would be y times 3.6V.
BEM	Board of Engineers Malaysia: BEM is responsible for regulating the engineering profession in Malaysia. Its key roles include the registration of professional engineers, setting and enforcing ethical and professional standards, issuing licenses to engineering forms and promoting professional development. It also advises the Government on engineering-related matters and collaborates with other institutions to foster knowledge sharing and industry standards.
BEV	Battery EV: A type of vehicle that is powered entirely by an EVB and does not have a gasoline engine.
BMS	Battery Management System: The BMS is crucial for the safe operation of lithium-ion battery packs. The BMS protects against: (a) over-charging, (b) under-charging, and (c) excessive currents and temperatures It prevents the battery pack from exceeding upper and lower voltage and temperature limits. Additionally, it adjusts the current based on temperature, reducing charging rates below 0^{o}C and preventing charging below -20^{o}C. The BMS also estimates the SoC and available power, communicating this information to the device controller of the vehicle. It may also maintain cell balancing within the battery pack.
Drive unit	The combination of an EV motor and its reducer in an EV.
EV	Electric Vehicle: A generic term that includes the following types of EV: (1) BEV - Battery electric vehicle, (2) HEV - Hybrid electric vehicle, (3) PHEV - Plug-in Hybrid electric vehicle and (4) FCEV - Fuel Cell electric vehicle.
EVB	Electric Vehicle Battery: Batteries used in EVs. The battery is the energy centre of the EV and is recharged by plugging the EV into an electrical outlet or charging station.
EVCB	Electrical Vehicle Charging Bay: A designated parking space (bay) equipped with an EV charging station where EV can park and charge their batteries. Such space (bay) is specially marked to indicate that they are reserved for charging of EVs.
EVCS	Electric Vehicle Charging Station: A facility that supplies electric energy to recharge the batteries of EVs. It includes the charging equipment, such as connectors and cables.

EVCP	Electric Vehicle Charging Point: A specific location or device where an EV can be plugged in to recharge its battery. It typically consists of an electrical outlet or connector that interfaces with the EV's charging port. A charging point can be a part of a larger EV charging station or installed independently in homes, businesses or public spaces.
EV Powertrain	The electric vehicle powertrain refers to the complete system that produces and delivers power to an EV. Unlike traditional internal combustion engine vehicles, which have a complex powertrain involving multiple mechanical components (such as the engine, transmission and exhaust system), an EV's powertrain is typically simpler and consists of the key elements: electric motor, battery pack, inverter and cooling system.
Fast Charging	A type of charging that can significantly reduce the time it takes to recharge an EV battery, typically using DC power.
FCEV	Fuel Cell Electric Vehicle: A vehicle that relies on hydrogen fuel cells to charge the vehicle's battery.
HEV	Hybrid Electrical Vehicle: A vehicle that uses both an electric motor and a gasoline engine to improve fuel efficiency.
High-Voltage Battery	Refers to batteries that operate at a voltage level significantly higher than the standard 60 voltage range. These batteries are commonly used in applications where higher energy output and efficiency are required, including EVs, hybrids, industrial applications and energy storage systems. Such batteries typically employ lithium-ion chemistry due to its advantages in energy density, efficiency and weight. Due to high power output, careful management and safety considerations must be observed to prevent overheating, overcharging and other potential hazards.
ICCB	In-Cable Control Box: A device used in EV charging systems. It is typically integrated into the charging cable and plays a crucial role in controlling the charging process between the EV and the charging station.
ICE	Internal Combustion Engine: A vehicle which is powered by fuel in the form of diesel or gasoline. Internal combustion engines are the standard for vehicles for more than a century.
IMO	International Maritime Organisation: A specialised agency of the United Nations responsible for regulating shipping. Headquartered in London, the IMO's primary purpose is to ensure the safety, security, and efficiency of shipping and to protect the marine environment from pollution by ships. IMO plays a critical role in the development of maritime law and the ongoing dialogue between governments, industry and the global community regarding shipping practices and regulations.
ISO 17840-1:2022 IDT	ISO 17840-1:2022 IDT refers to the International Organization for Standardization (ISO) standard 17840-1:2022, which has been adopted as an International Direct Text (IDT) standard in Malaysia. This standard is part of a series that specifies requirements for the design and testing of equipment used for the transportation of goods, particularly focusing on the transport of vehicles and their components.
JPK (DSD)	Jabatan Pembangunan Kemahiran or Department of Skills Development (DSD): DSD is under the Ministry of Human Resources and is tasked with promoting and improving the skills of the workforce to meet the demands of the labour market. It formulates guidelines for vocational training, develops the National Occupational Skills Standards (NOSS) to define the skills required for various occupations, and oversees the implementation and certification of training programs. DSD promotes continuous professional development, works with stakeholders, including

	industry partners and educational institutions, to facilitate workforce initiatives, and conducts research to identify trends and skills gaps in the labour force. In summary, DSD plays a crucial role in developing a skilled and competitive labour force, promoting economic growth and meeting the needs of the various industries in Malaysia.
JPJ (RTD)	Jabatan Pengangkutan Jalan Malaysia or Department of Road Transport Malaysia: JPJ is responsible for the regulation and administration of road transportation in Malaysia. Its duties include enforcing vehicle registration and licensing, ensuring compliance with traffic laws and safety regulations and promoting road safety initiatives through education and awareness campaigns. JPJ manages the issuance of driving licenses and plays a key role in developing and implementing of road safety measures. JPJ endeavours to increase the efficiency and safety of road transport in Malaysia, thereby contributing to improvement of the country's transport system.
kW	Kilowatt: The basic measurement of an EV's power that is generated by its batteries. 1 kilowatt (kW) equals 1,000 watts.
kWh	Kilowatt-Hour: The basic measurement of an EV's energy, how much power (kilowatts) it can supply over a period of time (hours).
Level 1 Charging	The baseline charging level for EV. It is what is available from a standard household outlet, providing a charge of up to 120V and between 8A and 20A. Level 1 charging typically takes a full 24 hours to top up an empty EV. Level 1 charging is typically done with a portable charging cord.
Level 2 Charging	The charging level at most dedicated charging points. They charge EV at a quicker rate with 240V output up to 80A. A full charge at a Level 2 point takes about 4 hours.
LFP	Lithium Iron Phosphate: LFP refers to a type of lithium-ion battery chemistry that uses lithium iron phosphate (LiFePO4) as the cathode material. This chemistry is known for its unique set of characteristics that makes it more suitable for various applications, especially in EV and renewable energy storage systems.
Lithium-Ion	A lithium-ion battery is a type of rechargeable battery in which lithium-ions move from the negative electrode to the positive electrode during discharge and back when charging.
Lithium-ion Polymer cells	Similar chemistry as lithium-ion cells but the electrolyte is made as a gel with a polymer host which reduces flammability and prevents leakage of liquid electrolyte from a damaged cell.
LMFP	Lithium Manganese Iron Phosphate: LMFP refers to a type of lithium-ion battery chemistry that features lithium manganese iron phosphate (LiMnFePO4) as the cathode material. This battery chemistry combines aspects of both lithium iron phosphate (LFP) and lithium manganese oxide (LMO), aiming to balance energy density, safety and thermal stability.
Low-Voltage Battery	Refers to a battery that operates at a relatively low voltage, typically below 60 volts and are commonly used in applications, including portable devices, like smartphones, tablets, laptops, some EVs and hybrid vehicles for low voltage systems for auxiliary functions, such as powering lights, infotainment systems and cordless power tools where the low voltage batteries providing mobility and convenience.

MARii	Malaysia Automotive, Robotics and IoT Institute: MARii plays a significant role in driving the development of the automotive, robotics and Internet of Things (IoT) industries, where several key areas were focused. Among them, the promotion of EVs and the fostering of innovation, facilitating industry growth and enhancing skill training and development in Malaysia's automotive and technology sectors.
MS ISO 17840:2022	MS ISO 17840:2022 is the Malaysian Standards (MS) version of the international standard ISO 17840, which relates to the requirements for the design and testing of devices that facilitate the safe and efficient transportation of goods, particularly in the automotive sector. It provides a framework that ensures the safety, efficiency and reliability of transportation devices for goods, supporting the overall improvement of automotive and logistics operations in Malaysia.
NMC	Nickel Manganese Cobalt: NMC refers to a type of lithium-ion battery chemistry that includes nickel, manganese and cobalt as its primary cathode materials. This combination of metals is utilised in the production of batteries for EVs, portable electronics and energy storage systems.
NMIM	National Metrology Institute of Malaysia: NMIM plays a crucial role in ensuring the accuracy and consistency of measurements in various industries across Malaysia. Under the purview of Ministry of Investment, Trade and Industry (MITI), NMIM's key functions include : Metrology Standards, Calibration Services, Quality Assurance, Research and Development, Training and Capacity Building, National and International Collaboration. NMIM is integral to ensuring the reliability and accuracy of measurements that underpin quality and safety across industries.
NIOSH	National Institute for Occupational Safety and Health: NIOSH Malaysia is a statutory body dedicated to promoting and ensuring occupational safety and health (OSH) across the country. Primary roles include conducting research to improve workplace conditions, providing training and education to employers and employees on OSH practices, and offering consultancy services for the implementation of safety measures and compliance with regulations. Two core legislations: Occupational Safety and Health Act (1994) and the Factory and Machineries Act (FMA) are under the purview of NIOSH and it plays a vital role in fostering a culture of safety and enhancing the health and safety standards in Malaysian workplaces.
PHEV	Plug-in Hybrid Electric Vehicle: A vehicle that combines a conventional internal combustion engine with an electric motor, allowing it to run on electricity for shorter trips and gasoline for longer journeys.
Range	The total distance an EV can travel on one full charge before the battery needs to be recharged.
Regenerative Braking	A mechanism that recovers energy typically lost during braking and converts it back into stored energy in the battery.
Road Car Carrier	Road car carriers are specialised road vehicles designed for transporting multiple cars simultaneously over land. These carriers typically come in the form of truck trailers and are equipped with ramps and multiple levels to maximise load capacity while ensuring safe transportation of vehicles. Road car carriers play a crucial role in the automotive industry, facilitating the distribution of new and used vehicles from manufacturers to dealerships or directly to consumers.
RORO	Roll-on and Roll-off: Refers to specialised cargo ships designed for the efficient transport of wheeled cargo, such as cars, trucks, and trailers. Equipped with built-in ramps at the stern or sides, these ships allow vehicles to be driven directly on and off, simplifying the loading and unloading process. RORO vessels typically feature multiple vehicle decks to maximise cargo capacity and can accommodate large and heavy equipment that may be difficult to load. They are essential

	in global logistics for the seamless movement of vehicles and heavy machineries across seas and oceans.
SoC	State of Charge: An EV's State of Charge (SoC) is akin to the fuel gauge on an ICE vehicle. Measured between 0 and 100 per cent, the SoC refers to remaining charge in a battery pack and is crucial information for EV drivers both on the road and at charging station. SoC is displayed clearly in sight on an EV's dashboard.
SoH	State of Health: SoH indicates the health status of the battery of an EV. Measured between 0 and 100 per cent, the SoH refers to remaining capacity in a battery pack. Since lithium-ion batteries degrade over time, this measurement indicates how much driving range an EV is capable of, compared to when it was new. It is important to find this out when buying a second-hand EV, although data shows EVB lasts longer than most people think.
Type 2 plug	A connector that charges up to 250kW. It is a seven-pin, triple-phase plug often used in Europe and other countries.
VCU	Vehicle Control Unit: The processing centre of a vehicle, which coordinates power control, motor control, regenerative braking, power supply and load management.
VTA	Vehicle Technical Approval: VTA is a process that ensures that vehicles, including their components and systems, comply with specific safety, environmental, and technical standards before they can be registered for use on public roads. This process is critical for ensuring that vehicles meet national and international regulations and can operate safely. VTA is under the responsibility of Automotive Engineering Division of the Road Transport Department (JPJ) in collaboration with various related agencies, who chairs the National Committee for Type Approval and Homologation.

1.0 INTRODUCTION

With the rapid increase in the use of EV, Malaysia finds itself in a crucial situation. In recent years, the adoption of EV has increased significantly. In 2022, 3,017 vehicles were sold, rising to 13,144 vehicles in 2023 and a total of 22,793 vehicles in the last five years. In 2024, the total EV sold in the first seven months of the year reached 12,547 vehicles. This increase emphasises the urgent need for robust management practices of EV and EVB to ensure safety of the stakeholders and at the same time, protect the environment.

The trend is clear: Malaysia is entering the era of electric mobility. In the midst of this transformation, an urgent call to action has been made from the industry to the Government: How can we manage the impending influx of EV and EVB and ensure that they are safe, last longer and are disposed of in an environmentally friendly manner?

Recognising this need, key stakeholders, including manufacturers, importers, distributors, logisticians, regulators and the public, have been invited to contribute their insights and expertise during the formulation of the Guidelines which are designed to enable the effective management of EV and EVB. The aim of these Guidelines is to develop a set of pragmatic, comprehensive standards aimed at managing EV and EVB throughout their life cycle - from purchase, through the years of active use, to their disposal or recycling.

The Government, including the industry stakeholders, has recognised that a flexible and adaptable approach is crucial in the face of rapid technological advancement. It is therefore vital that these Guidelines encompass both the front-end processes, such as customer acquisition and integration, and the back-end processes, including logistics, disposal and recycling, to create a holistic management system.

At the heart of the plan is self-regulation and industry leadership. By encouraging local businesses to adopt self-regulated practices and lead the way in introducing best practices, the initiative aims to facilitate a smooth entry into this new era. Responsibility must be shared in order to foster a sense of collective ownership for the safety and environmental integrity of EV and EVB.

In other emerging markets, we have seen significant progress in the productivity of the EV industry, mainly due to advancements in battery technology, efficient manufacturing processes and a growing demand for sustainable transport solutions. The EV industry in Malaysia is catching up fast and needs a dynamic framework to accelerate its growth. The development of industry-led guidelines could enhance the sector's productivity and competitiveness and firmly position Malaysia as a leading player regionally and globally. These Guidelines would provide strategic direction and identify best practices to help the industry achieve greater efficiency and sustainability, while fostering innovation and collaboration among industry players. Creating an EV ecosystem that is not only dynamic and adaptable but also safe and environmentally friendly, would boost the confidence of customers and foreign EV manufacturers.

2.0 OBJECTIVES OF THE GUIDELINES

The Guidelines for the management of EV and EVB have been developed with several key objectives to ensure that they serve as a comprehensive resource for the industry:

Reference Point for Industry

The Guidelines provide a functional reference for companies involved in the development, management, promotion and provision of products and services related to EV and EVB. This is important for maintaining industry-wide consistency and best practices.

Ensuring Safety

By promoting safe practices for the operation of EV under various conditions, the Guidelines aim to prevent accidents such as fires and explosions. They include established protocols for dealing with emergencies and battery failures, improving overall safety.

Environmental Sustainability

The Guidelines advocate environmentally sound practices in the use of recycling and disposal of batteries for EV. They promote the use of sustainable materials and manufacturing processes to minimise the environmental impact of these batteries.

Standardisation

By creating uniform standards for the management of EVB from different manufacturers and models, the Guidelines ensure compatibility and interoperability. This standardisation facilitates regulatory compliance and harmonisation of battery usage standards across the industry.

Education and Awareness

The Guidelines focus on educating users on best practices for the care and management of EVB to optimise performance and safety. They also emphasise the impact of EVB on the environment and the importance of proper disposal and recycling.

Risk Assessment and Technical Framework

They provide a valuable reference for the industry and assist in the development of future technical frameworks, including risk assessment and technical requirements. This will ensure that the Guidelines remain relevant and can be adapted to the evolving industry and regulatory landscape.

Productive and Competitive

Higher productivity is an essential prerequisite for success and enable companies to produce goods more efficiently, reduce costs and maximise output. Efficiency enhances competitiveness by offering products at competitive prices. Promoting innovation and continuous improvement boosts productivity and adaptability, which are crucial to remaining competitive in dynamic markets.

The Guidelines are designed to provide a functional reference as a recommendation to the industry. They may be superseded by existing or future legal standards or manufacturer-specific OEM (Original Equipment Manufacturer) requirements. The Guidelines will be reviewed on a half-yearly basis to include future technology enhancements and recommendations for further improvements by the industry stakeholders, Government agencies and regulators.

3.0 SCOPE OF THE GUIDELINES

The Guidelines cover a comprehensive range of areas that are critical to ensuring quality, safety and sustainability throughout the life cycle of EV and EVB.

Completely Built-Up (CBU) EV

This aspect of the Guidelines refers to EV that are fully assembled and ready for sale or use. They ensure that these complete units meet strict manufacturing and quality control standards and that each vehicle from the assembly line to the consumer adheres to safety protocols and operational benchmarks. This helps maintain high safety and performance standards as these vehicles enter the market place.

Powertrain Components - Lithium Batteries

Given their critical role in the EV powertrain, lithium batteries are a key focus within the Guidelines. They cover the entire life cycle of EVB and emphasise the importance of high quality manufacturing processes and the establishment of performance benchmarks. Safety protocols are described in detail to prevent accidents and ensure reliability. In addition, the Guidelines address life cycle management, including procedures for recycling and disposal, promoting sustainability and reducing environmental impact.

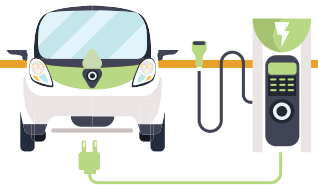
Entire Supply Chain Process for EV and Powertrain Components

Front-End Processes	Back-End Processes
This covers processes from the moment a customer first comes in contact with an EV to the end of the vehicle's life. The Guidelines aim to ensure safety and promote environmental sustainability in theearly stages of these processes. This includes facilitating informed customer interaction, addressing initial safety concerns and early compliance with established standards to protect consumers and the environment.	These processes include the production and distribution phases as well as post-sales considerations. The Guidelines include recommendations for efficient production methods and logistics management to ensure that EV and their components are delivered to showrooms safely and sustainably. They also address after-sales services, focussing on the importance of customer care and maintenance. Finally, the responsible disposal or recycling of EV components, particularly lithium batteries, is also addressed to facilitate end-of-life compliance and minimise environmental impact.

Overall, these Guidelines which are based on recommended industry best practices, are intended to provide a comprehensive framework for all stakeholders at every stage of the EV life cycle. They integrate essential elements such as quality assurance, safety, sustainability and regulatory compliance and ensure that the EV industry evolves responsibly and remains in line with current and future standards. The Guidelines serve as a reference tool to create a seamless and efficient supply chain that strengthens the reputation of the EV industry and supports its longterm success.

4.0 KEY ISSUES TO BE ADDRESSED

The Guidelines cover important topics to ensure effective management of EV and EVB and address the issues of safety, environmental impact and standardisation:



Safety Protocols

The Guidelines take an in depth look at safety protocols, particularly thermal management. They provide clear instructions for maintaining optimal battery temperatures to avoid overheating and thermal runaway, both of which are critical to battery safety and longevity. They also describe comprehensive emergency procedures to follow in the event of battery failure, fire or accident to ensure fast and effective responses to minimise risk. The Guidelines also include electrical safety measures to avoid hazards such as short circuits, overcharging and other electrical problems that could compromise safety.

Environmental Impact

Environmental aspects are an important part of the Guidelines. Procedures are established for the proper recycling and disposal of EVB to minimise the impact on the environment. These procedures ensure that waste is disposed of responsibly and sustainably – to minimise the environmental footprint of the EV industry. The Guidelines also encourage innovation through the research and development of secondary uses for used EVB, such as use in battery storage solutions. This promotes a circular economy and maximises the value extracted from each EVB.

Standardisation and Compatibility

The Guidelines emphasise the importance of standardisation and compatibility across the industry. They ensure that management practices comply with both international and local regulations and standards. This harmonisation promotes consistency in the management of EVB across different regions and manufacturers and facilitates the compatibility and interoperability of products and systems. This focus on harmonised standards helps streamline operations and strengthens the global competitiveness of the industry.

Together, these Guidelines provide a solid framework that supports the sustainable, safe and efficient management of EV and its batteries. They have been developed not only to meet the current challenges of the industry, but also to prepare for future advances and requirements. This proactive approach ensures the long-term viability and success of the EV industry in Malaysia by fostering innovation, improving infrastructure and promoting sustainability. By anticipating market needs and technological changes, these Guidelines aim to help create a robust ecosystem that supports EV growth, encourages investment and contributes to environmental goals to ultimately secure Malaysia's position in the global EV landscape.

5.0 EV AND BATTERY MANAGEMENT: GUIDELINES

Effective management of EV and EVB requires a comprehensive understanding of several critical phases of the product lifecycle, from acquisition to disposal. Proper handling of EVB is crucial to optimise their lifespan, ensure user safety and minimise environmental impact.

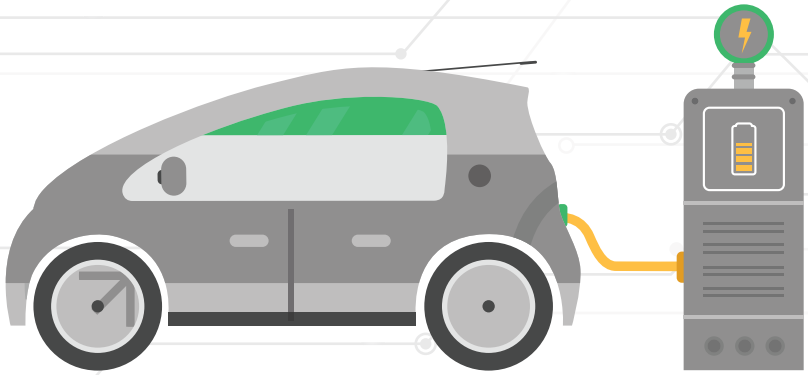
These Guidelines address at the key processes involved in handling EV and EVB, starting with customer interaction, which includes educating buyers about battery care and performance. As the battery life progresses, regular maintenance and monitoring is essential to ensure efficiency and safety. Finally, at the end of the life cycle, responsible disposal or recycling procedures need to be put in place to reduce environmental impact and recover valuable materials, contributing to a more sustainable future for the EV sector.

The EV market is developing rapidly and is mainly focused on lithium-ion chemistry. However, there is a growing interest in alternative battery technologies such as sodium-ion batteries, which are increasingly available, especially in China. This development raises the important question of whether the existing guidelines for lithium-ion batteries for EV can also be applied to these emerging alternatives. To ensure relevance, the Guidelines should in due course extend their scope to different battery chemistries and describe in detail the different characteristics, challenges and safety aspects of lithium-ion batteries such as nickel-manganese-cobalt (NMC), lithium-iron-phosphate (LFP) and lithium-manganese-iron-phosphate (LMFP).

In addition, it would be beneficial to address risk identification for these battery types and highlight indicators such as white smoke and colourless flames that may indicate potential hazards. It is important for users' safety that the challenges of extinguishing battery fires are emphasised and strategies for containing the spread of fire are highlighted. By providing practical resources, such as references to fire safety protocols and safety documents, user readiness can be improved and a culture of safety can be promoted in the increasingly complex electric mobility ecosystem.

Although the Guidelines clearly specify the types and classifications of EV it addresses, the application of the Guidelines may include categories such as motorcycles, passenger vehicles, buses and trucks, as well as powertrain types such as battery electric and hybrid vehicles, including plug-in type and fuel-cells EV.

In addition, the Guidelines should be tailored to classify EV according to their propulsion technology, e.g. by distinguishing between battery of EV, which run solely on electricity, and hybrid vehicles, which combine internal combustion engines with electric propulsion. By including these specifications, the Guidelines will better address the different needs and characteristics of each vehicle type and classification, ensuring more effective guidance and implementation.



GUIDELINES

The Guidelines are divided into clear and structured sections to facilitate understanding. Under each section, the Guidelines begin, followed by a narrative text describing the specific intention or task of that Guidelines. Key points are highlighted to aid understanding and examples of good practice and scenarios are provided to ensure users fully understand the guidance. This systematic approach enables efficient learning and application of the Guidelines in different contexts, as described below:

A) FRONT - END PROCESSES			
1.1	Customer Receiving EV - Lithium Battery	1.2	Customer Using/Charging EV - Lithium Battery
	a) Education and Training b) Initial Battery Health Check c) Warranty and Support d) Competent Sales Executive / Advisor e) Vehicle Manuals f) Special Registration (License) Plate g) EV Module in Driving School h) Emergency Contact Number		a) Charging Practices b) Monitoring and Alerts c) Temperature Management d) Driving Habits e) Government Infrastructure Support f) Standardised Charging Methods g) Safety Awareness h) Home Charging Solutions i) Regulatory Compliance j) In-Cable Control Box (ICCB)

1.3	Customer Receiving EV - Lithium Battery	1.4	Customer Disposing of EV Lithium Battery
	a) Certified Workshop by Authority b) Safe Working Procedures c) Competent Personnel d) Dedicated Areas in Workshop e) Response Equipment f) Workshop Charging Station Compliance g) Storage Areas for Old/Replaced Batteries h) Pre-Disposal Storage for Discarded Batteries i) State of Charge (SoC) Management j) Software Updates k) Battery Passport		a) Direct Disposal Arrangements with Manufacturer b) Battery Recycling Programmes c) Authorised Disposal Centres d) Safe Handling Instructions e) Repurposing and Second-Life Use

B) BACK – END PROCESSES			
2.1	EV Manufacturing Process	2.2	Transporting EV
	a) Certified Manufacturer by Authority b) Compliance with Battery Passport Requirements c) Goods Declaration Form d) State of Charge (SoC) e) Dedicated Storage Areas f) Safe Working Procedures g) Competent Personnel h) Recovery Policy i) End-of-Life Policy Compliance		a) Cargo Declaration b) Dedicated Road Car Carriers c) Certified Road Car Carriers d) Competent Operators e) Competent Drivers f) Firefighting Equipment g) Safety Compliance

2.3	Shipping and Logistics Process	2.4	Storage of EV / Loose Batteries
	a) Local and International Standards Requirements b) Safe Loading c) State of Charge (SoC) Requirement d) Vessel Firefighting Equipment e) Vessel Fire Safety f) Cargo Declaration g) Dedicated RORO Vessel h) Competent Operators i) RORO Vessel Firefighting Equipment j) RORO Vessel Safety Compliance k) Safety Measures l) Trained Personnel m) Vehicle Checklist n) Competent Drivers o) Traffic Controller Deployment p) Safety Protocols q) Hazard-Free Areas r) Handing Over EV at Storage Areas		a) Storage Requirements b) Regular Inspection c) Flood Prevention d) Access Control e) Dwell Time Compliance

2.5	Delivery to Showroom	2.6	In the Showroom
	a) Customs Approval b) Battery Issues c) Safe Transport		a) Adoption of MS 2725:2021 b) Requirements for Showroom c) Employees in Showroom

5.1 EV AND BATTERY MANAGEMENT AREA OF CONCERNS: FRONT-END PROCESS AND SPECIFIC REQUIREMENTS

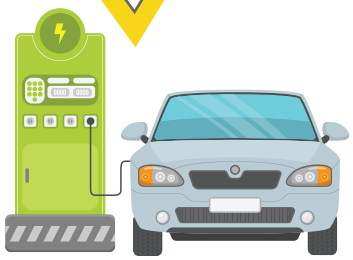
FRONT-END PROCESS OVERVIEW

Customer Receiving
EV - Lithium Battery

1

2

Customer Using/Charging
EV - Lithium Battery

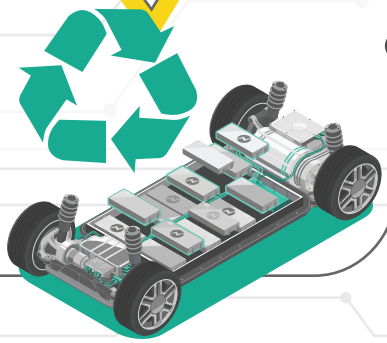


Customer Maintaining
EV - Lithium Battery

3

4

Customer Disposing
EV - Lithium Battery



5.1.1 Customer Receiving EV – Lithium Battery [1]

When a customer receives an EV equipped with a lithium-ion battery, it is essential that they are provided with comprehensive information and resources to ensure the safe and optimal use for the longevity of the battery. This stage involves:

a) Education and Training [2]

- **Customers must be educated about the basic functioning of lithium-ion batteries, including their charging and discharging cycles, and the importance of maintaining optimal temperature conditions. The briefing should include specific details about the lithium-ion battery, its operation and best practices for maintenance and safety.**
- **Rescue Sheet - EV cars are encouraged to have Rescue Sheet as mentioned in MS ISO 17840:2022 – Information for First and Second Responders - Part 1: Rescue Sheet for Passenger Cars and Light Commercial Vehicles (ISO 17840-1:2022, IDT).**
- **IMPORTANT: Users' awareness not to touch or mishandle any of the high-voltage cables in the EV. Such cables are usually orange in colour.**

Narrative

In recent years, lithium-ion batteries have become an important part of how EVs work. Therefore, it is important to educate new EV owners about lithium-ion batteries to ensure safety and optimal performance. New EV owners (customers) should be educated on the basic functions of these batteries, including charging and discharging cycles and the importance of maintaining ideal temperature conditions to prolong battery life and maximise efficiency. This education should include specific details on battery operation as well as best practices for maintenance and safety to avoid potential hazards. In addition, EV should be equipped with a Rescue Sheet that complies with the MS ISO 17840:2024 standard and contains important information for first and second responders in the event of an emergency. This comprehensive approach to education and preparedness helps to promote the safe and effective use of lithium-ion batteries in the EV. Another important awareness is to ensure that Users must not touch or mishandle any of the orange-coloured cables in the EV, as these cables are high-voltage.

b) Initial Battery Health Check

Conducting a health check of the battery at pre-delivery inspection of vehicle to ensure it meets all safety and performance standards.

Narrative

Before an EV with a lithium-ion battery is delivered, an initial health check of the battery is a crucial step to ensure its safety and performance. This thorough examination checks the capacity, charge retention and overall condition of the battery to ensure it meets all safety and performance standards. Using specialised diagnostic tools, technicians can assess aspects such as internal resistance and the ability to hold a charge for an extended period of time, which indicate the health of the battery. Through these tests, manufacturers can identify and rectify potential problems, ensuring that the battery will function efficiently and safely when delivered to the customer. Each vehicle manufacturer may apply different method or in-house standard to verify the EV battery at pre-delivery inspection. This proactive approach not only helps to maintain high safety standards, but also increases customer satisfaction by ensuring the delivery of a reliable and high performing product.

c) Warranty and Support

Informing customers about the battery warranty, including coverage details and the process for claiming warranty services.

Narrative

Understanding the warranty and support details of your lithium-ion battery is crucial for safety and support when problems arise. When purchasing an EV, the customer should fully understand the details of the battery warranty, including how long the warranty lasts and what aspects are covered by the battery's performance and defects. Typically, warranties cover issues such as manufacturing defects or a significant drop in capacity within a certain period of time. Customers should also be informed of the straightforward warranty claims process, which often involves contacting customer service, providing proof of purchase and, if necessary, sending the battery in for assessment. By clearly communicating these details, manufacturers can build trust and reassure customers that they stand behind their products so that they feel supported throughout the life of their EV battery.

d) Competent Sales Executive/Advisor

Ensuring that a knowledgeable and competent sales executive or advisor handles the handover process. This professional should be well-versed in the specifics of the EV, including its battery system, and be able to address any questions the customer might have.

Narrative

The handover of an EV is a crucial moment in gaining the customer's trust and satisfaction, and the presence of a knowledgeable salesperson or advisor is essential. This competent professional should be familiar with the intricacies of the EV and its battery system and effectively guide the new owner through the purchase. They must be able to clearly explain the key features, benefits and maintenance tips to ensure the customer fully understands the capabilities of the vehicle. They should be prepared to answer any questions, from technical details about the battery management system to day-to-day operational issues. By providing clear and comprehensive information, this knowledgeable advisor not only improves the customer's understanding and comfort level, but also promotes confidence and long-term satisfaction with the EV.

e) Vehicle Manuals

Handing over detailed vehicle manuals that cover all aspects of the EV, particularly the battery system. These manuals should include information on charging, maintenance, safety protocols and troubleshooting.

Narrative

It is important that customers are provided with a detailed manual when they take delivery of an EV so that they have access to comprehensive information to help them use their vehicles. These manuals are an invaluable resource covering all aspects of the EV, with a particular focus on the battery system. They provide detailed guidelines on charging procedures, recommended maintenance practices, important safety protocols and effective troubleshooting techniques. By providing these materials, customers are empowered to maximise the performance and lifespan of their EV and understand how to perform routine maintenance and troubleshoot potential issues themselves. This proactive approach not only enhances the user experience by promoting safe and efficient operation, but also complements the support of knowledgeable sales advisors to ultimately ensure a smooth and safe transition to electric mobility.

f) Special Registration (License) Plate

Introducing a special registration plate to distinguish EVs from traditional vehicles. This can help in identifying EVs and the type of assistance needed in case of emergency.

Narrative

The introduction of a special license plate for EV offers a clear advantage both in everyday recognition and in emergency situations. These unique license plates serve as a unique identifier that distinguishes EV from conventional combustion engine vehicles, which can lead to increased awareness and understanding among other drivers and pedestrians. In emergencies, first responders and emergency services can quickly identify the vehicle type based on the license plate. This allows them to adapt their approach and measures to the special needs of EV, e.g. in the event of problems with the battery or the safe handling of high-voltage systems. This easily recognisable distinction not only promotes the visibility of EV on the road and strengthens the sense of community among EV owners, but also ensures that these vehicles receive the necessary attention and care in critical situations, contributing to overall road safety and efficient emergency response.

g) EV Module in Driving School

Implementing an EV module under the driving school curriculum to educate new drivers on the unique aspects of driving and maintaining an EV. This includes understanding battery management safe handling of EV, defensive and efficient driving techniques, and proper use of charging infrastructure.

Narrative

Implementing an EV module into the driving school curriculum is a forward-thinking initiative aimed at educating new drivers on the unique aspects of operating and maintaining EV. This comprehensive programme would cover critical topics such as battery management, including the specifics of charging protocols and the importance of maintaining an optimal battery condition. Safe handling of EV and the special features that differentiate them from conventional vehicles, such as regenerative braking and instant torque, will also be covered. Students will also learn defensive and efficient driving techniques tailored to electric mobility, which will not only improve their driving skills but also promote energy savings and environmental awareness. In addition, the module will educate students about the growing charging infrastructure and help them find and effectively use charging stations. By introducing this electromobility-focused curriculum, driving schools can equip new drivers with the knowledge and skills they need to succeed in an increasingly electric future and fostering a generation of responsible and informed electromobility users.

h) Emergency Contact Number

Equipping customers with an emergency contact number for quick assistance in case of any issues related to the EV or its battery. This contact number should connect to a support team knowledgeable in EV-specific concerns.

Narrative

Providing a dedicated emergency number for rapid assistance in the event of problems with the EV or its battery is an important part of responsible EV ownership. This support hotline should connect users to a knowledgeable team specifically trained in EV issues so they can get expert help in stressful situations. Imagine, for example, a driver who suddenly has a power cut on a busy highway. Immediate access to an emergency number gives them peace of mind and quick access to expert advice on whether it is safe to attempt a reset, find the nearest charging station and/or seek roadside assistance. Such support can alleviate anxiety and potentially prevent further complications, such as damage to the vehicle or safety hazards on the road. In addition, the emergency team could offer solutions for dealing with battery malfunctions, charging issues or software updates and make customers feel supported. This proactive approach not only increases customer satisfaction, but also boost confidence in electric mobility and allows drivers to enjoy their EV experiences to the fullest extent.

5.1.2 Customer Using / Charging EV – Lithium Battery

The usage and charging phase are critical for the safe, sustainable (longevity) and performance of the lithium-ion battery. Key aspects include:

a) Charging Practices

- **Educating customers about optimal charging practices such as avoiding frequent deep discharges, not charging to 100% too often and using slow charging over fast charging when possible.**
- **Prior at usage of public charging stations, the customer should be able to identify whether the public charging station is licensed under the Energy Commission (ST).**

Narrative

Optimal charging practices play a crucial role in prolonging the life of EVB and ensuring efficient utilisation. For example, customers should avoid frequent deep discharging, as this can significantly degrade the condition of the battery. Instead, they should charge their EV when it has reached a level of 20%. Charging to 100% should only be done if a long trip is planned, as regularly charging of the battery can lead to a reduction in capacity over time. In addition, slow charging at home or at public stations is preferable to fast charging as it generates less heat and protects the battery. Imagine a customer planning a weekend getaway and opting for a slow charge during the day instead of charging at full capacity overnight while running errands, effectively extending the life of the battery. Before plugging into a public charging station, make sure the station is licensed by the Energy Commission (ST). This way, the EV owner can be sure of using an approved infrastructure that complies with safety and performance regulations.

b) Monitoring and Alerts

Utilising the vehicle's battery management system (BMS) to monitor battery health and provide alerts for any safety / operational-related irregularities such as overheating, overcharging, or significant capacity loss.

Narrative

Modern EV are equipped with sophisticated battery management systems (BMS) that actively monitor the condition of the battery and issue critical warnings to ensure safe operation. For example, if the BMS detects a temperature rise above the safe threshold, it can trigger a warning on the driver's smartphone and advise them to park the vehicle in a cooler environment to avoid overheating and potential damage. Similarly, if BMS can automatically limit the charging current and inform the driver of the situation via the dashboard or the vehicle's app if the system detects an overcharge – perhaps due to a fault at a charging station. If the BMS detects a significant loss of capacity over time, it can also send maintenance reminders and prompt the driver to consult a technician before the battery's performance deteriorates further. Imagine a scenario where a driver receives a notification while at work that their EV's battery is exhibiting erratic charging behaviour. This proactive alert not only allows them to take immediate action, but also prevents potential safety risks, ultimately leading to a safer and more reliable driving experience.

c) Temperature Management

Customers to park and charge their EV in environments with moderate temperatures, as extreme heat can negatively impact battery performance and lifespan.

Narrative

Proper temperature management is critical to the performance and longevity of EVB. Customers should park and charge their vehicles in environments with moderate temperatures. For example, parking EV in a shaded area on hot sunny days can prevent battery overheating that can occur when the vehicle is left in direct sunlight for long periods of time. This heat can accelerate the degradation of the battery and lead to a shorter life. Conversely, charging in extremely cold temperatures can also be a challenge as it may slow down the charging process and affect the efficiency of the battery. Imagine a scenario where a customer regularly parks the EV in a garage that stays cool on hot, sunny days; the health and performance of the battery is more likely to be maintained over a longer period of time. By investing in a sunshade or utilising charging stations with cooling systems, the customer can protect the battery from extreme thermal conditions and ensure the vehicle remains efficient and ready for use. By being mindful of where and how they charge, customers can play an important role in maximising the life of their EVB.

d) Driving Habits

Encouraging driving habits that conserve battery life, such as gentle acceleration and deceleration, and using regenerative braking effectively.

Narrative

Energy-efficient driving habits are critical to EVB life, and customers can significantly increase their vehicle's range by being intentional behind the wheel. For example, smooth acceleration instead of a quick one can help preserve battery life. Drivers who gradually increase their speed can cover greater distances before needing to recharge. Gentle braking is equally important. Taking your foot off the accelerator pedal when you come to a stop, rather than applying the brakes fully, allows the vehicle to utilise regenerative braking effectively and convert the kinetic energy back into stored energy in the battery. Imagine a driver using these practices on their daily commute to work, opting for a steady pace in city traffic instead of frequent hard acceleration and heavy braking. Not only will this maximise the battery range, but also lead to a more comfortable ride. By planning routes that avoid heavy traffic and hilly terrain that require more energy, drivers can increase battery efficiency even further. By developing these mindful driving habits, customers can get the out of each charge, ultimately increasing driving range and enhancing the experience of owning an EV.

e) Government Infrastructure Support [3]

Ensuring that the Government builds public charging stations according to the vehicle population size ratio. This ensures that the charging infrastructure grows in parallel with the increasing number of EV.

Narrative

Government support for infrastructure is crucial for the fostering of EV adoption growth. An important aspect of this is the building of public charging stations in relation to the number of vehicles. For example, in urban areas where the number of EV is growing rapidly, the Government can implement a strategic plan to build more charging stations to meet demand and ensure that drivers have convenient access to the charging facilities. Imagine a scenario in a busy city where the number of registered EV has skyrocketed. If the Government responds by multiplying the number of public charging stations in car parks, shopping centres and along busy roads, this will ease the range anxiety of EV owners and encourage more drivers to switch from ICE to EV. In addition, targeted investments in charging stations in rural areas, where uptake is slower, can create a favourable environment for potential EV buyers and give them peace of mind that they will have access to charging stations when they needed them. By aligning infrastructure development with the growth of the EV market, the Government is not only improving convenience for current EV drivers, but also fostering an environment that promotes sustainable transport, reduces carbon emission and supports a cleaner environment.

f) Standardised Charging Methods

Implementing standardised and harmonised charging methods by kWh to provide transparency and fairness to customers. This helps customers predict costs and make informed decisions about where to charge.

Narrative

The introduction and harmonisation of kilowatt-hour (kWh) billing method is changing the EV landscape by making it easier for consumers to predict charging costs and select charging stations. Taking the case of an EV user who is planning a long journey across different states. In current practise, charging stations uses a variety of billing models - some charge by time duration used, others by flat fee and still others combine multiple methods, making it difficult to predict the cost of each charging stop. With standardised kWh-based billing, the cost per kWh is clearly displayed at each charging station, allowing EV users to easily estimate the total cost of their trip based on the efficiency of their vehicle and its battery capacity. Although kWh rates may vary from station to station, EV users only need to consider this one, standardised pricing model. This transparency not only boosts consumer confidence and allows the EV users to choose the charging stations that fit their budget, but also stimulate competition between charging service providers who offer better rates and services, ultimately improving the overall EV charging experience.

g) Safety Awareness

Setting up safety awareness programs in rest areas to educate the public about the safe use of charging stations and handling of EV and EVB.

Narrative

The establishment of safety programmes at rest areas, including Rest & Recreation (R&R) stops along the highways, plays a crucial role in educating the public about the safe use of charging stations and the proper handling of EV. For example, these programmes could include informative signage and interactive panels at popular rest areas and stops, where motorists can learn how to best use charging stations, such as how to pay attention to proper grounding and certification labels to ensure safety standards are met. Imagine a family stopping at a charging station during a road journey and experiencing a safety demonstration on EV charging. Through engaging presentations, they learn not only how to avoid common hazards such as overcharging, but also how to respond effectively in the event of an emergency related to battery issues. In addition, informational pamphlets can be distributed explaining important topics such as recognising warning signs of battery damage, securing charging cables and following manufacturer guidelines. By increasing safety awareness in these community spaces, the initiatives empower EV owners and non- EV owners alike to approach EV technology with confidence, contributing to safer charging environment and promote a culture of responsibility around electric mobility.

h) Home Charging Solutions [4]

Advising customers on home charging options, such as AC chargers or wall-box units with Type-2 connectors. These should be selected based on whether the power connection is single-phase or three-phase.

Narrative

When it comes to home charging solutions for EV, advising customers on the right options - such as AC chargers or wall-box units with Type-2 connectors - can significantly improve the charging experience and efficiency. Homeowners with singlephase power connection, for example, can benefit from a 3.7 kW or 7.4 kW AC charger, which allows for convenient overnight charging and ensures their EV is fully charged for the next day. On the other hand, those with three-phase power connection can opt for higher capacity wall-box units, such as 11 kW or 22 kW chargers, which can significantly reduce charging time - perfect for busy individuals who need to make the most of their time on the road. Imagine a scenario where a busy businessman decides to install a three-phase wall-box charger after being educated about the benefits. This allows him to charge his vehicle in just a few hours instead of overnight and gives him the flexibility to use his EV for spontaneous trips. By educating our customers on the importance of choosing the right charging solution according to the power capacity of their home, they can avoid potential problems such as overloading circuits or inefficient charging speeds. This thoughtful approach to home charging not only ensures that EV owners have a reliable and convenient way to This thoughtful approach to home charging not only ensures that EV owners have a reliable and convenient way to power their vehicles, but also promotes a smoother transition to electric mobility.

i) Regulatory Compliance [5,6]

- **Ensuring that all home chargers are approved by regulatory and/or commission bodies which are subject to relevant acts of enforcement associated with the installation of EV chargers installed and by certified installers. This ensures the safety and reliability of the home charging setup.**
- **This approval is currently under the Energy Commission (ST) and a Technical Committee comprising of SIRIM, National Metrology Institute of Malaysia (NMIM) and Malaysia Automotive Robotics and IoT Institute (MARii) and chaired by ST.**

Narrative

Compliance with home charger regulations is critical to the safety and reliability of EV chargers. It is important that all chargers used are approved by relevant regulatory bodies, such as the Energy Commission (ST). In addition, these chargers should be installed by certified technicians to meet the stringent safety standards and legal requirements for EV charger installation. For example, a homeowner who wishes to install a charging station is advised to choose products that are approved by authoritative bodies such as the Energy Commission (ST), SIRIM, National Metrology Institute of Malaysia (NMIM) or the Malaysia Automotive Robotics and IoT Institute (MARii), which together forms a Technical Committee overseeing compliance. Imagine a scenario where a homeowner hires a certified installer to ensure that the charger they choose not only fulfils the safety guidelines but also complies with local regulations. This diligence not only mitigates risks associated with faulty installations, such as electrical fires or equipment malfunction, but also provides peace of mind that the home charging station will operate reliably and efficiently. By creating an environment where legal requirements are met, customers can gain the knowledge and assurance that their investment in electric mobility is safe, fostering a trustworthy ecosystem for electric mobility in the community.

j) In-Cable Control Box (ICCB) [6]

Informing customers that the ICCB should not be connected to any unauthorised cable. Proper usage of the ICCB is essential to avoid electrical hazards and ensure efficient charging.

Narrative

Informing customers about the proper usage of the In-Cable Control Box (ICCB) is crucial for safe and efficient EV charging, as connecting the ICCB to unauthorised cables can lead to significant electrical hazards. Therefore, users should be discouraged from using makeshift or non-certified cables that might not meet safety standards, as this can lead to risks such as overheating, short circuits or even fires during the charging process. Imagine a scenario where a new EV owner who wants to charge his vehicle tries to connect his ICCB with a generic cable from another brand that they found on the internet thinking it will work just as well. This decision could not only jeopardise the safety of the vehicle, but also pose a danger to the home electrical system. By educating customers on the importance of using only approved cables specifically designed for their ICCB and how to recognise certified products, these risks can be minimised to ensure a reliable charging experience. Understanding these protocols not only increases the safety of EV charging, but also promotes confidence in the use of smart charging technology and creates a culture of responsibility among EV users.

5.1.3 Customer Maintaining EV Lithium Battery

Regular maintenance is vital for ensuring the safety, longevity and efficiency of an EV's lithium battery. This involves the following key actions:

a) Certified Workshop by Authority

Ensuring that maintenance is performed at workshops certified by the relevant authorities. These workshops should adhere to established standards and best practices.

Narrative

EV to be sent for repair or maintenance at workshops certified by the relevant authorities to maintain the integrity and performance of the lithium battery. Certified workshops are equipped with the latest tools and technology required to service EV and have technicians who are trained and knowledgeable about the specific requirements of EV. For example, these workshops adhere to established safety and quality standards, which means they can efficiently diagnose and fix battery issues that a non-certified workshop might miss. When an EV has a sudden drop in driving range, a certified technician can use advanced diagnostic tools to quickly determine whether the problem lies in the battery management system or is due to external factors such as tyre pressure. In addition, certified workshops often have direct access to manufacturer resources and updates and can ensure that the vehicle's software is up-to-date, which can improve battery performance and longevity. Overall, choosing a certified workshop ensures that the EV receives high-quality maintenance that meets industry standards. This will give peace of mind and extend the life of the vehicle's battery.

b) Safe Working Procedures

Establishing safe working procedures in workshops to maintain EV. This includes the use of appropriate personal protective equipment (PPE) and adherence to safety protocols.

Narrative

In workshops involved in the maintenance of EV, the establishment of safe working procedures is essential to ensure the safety of technicians and vehicles. This includes the careful use of appropriate personal protective equipment (PPE) such as insulated gloves, safety goggles and grounded tools to prevent electrocution when working with high-voltage components. For example, before starting maintenance work, technicians carry out a safety protocol that includes disconnecting the battery and checking the absence of voltage to prevent accidental electrical discharge. When a technician replaces a damaged battery module, he must work in a designated safety zone equipped with insulated mats and follow strict guidelines for the disposal of potentially hazardous materials. These procedures not only protect the workers, but also ensure that the integrity of the vehicle is maintained during repair or maintenance, avoiding costly damage or dangerous situations. Implementing these stringent safety protocols ensures the wellbeing of workshop staff and compliance with the high standards required for EV.

c) Competent Personnel

Ensuring that the workshop staff are trained and certified to maintain and manage EV. Competent personnel are crucial for the safe and effective maintenance of EVB.

Narrative

In the field of EV maintenance, the competence of workshop personnel is crucial for the successful and safe handling of EVB. This requires that all employees undergo rigorous training and receive certification specific to EV technologies, equipping them with the necessary skills and knowledge. This means a certified technician can not only perform routine maintenance tasks such as checking battery health and updating software systems, but also tackle complex issues such as recalibrating battery management systems to optimise performance. When a customer brings in an EV with faulty charging behaviour, a well-trained technician can efficiently diagnose the problem using specialised diagnostics tools and implement a precise solution that reduces vehicle downtime and ensuring safety. In addition, competent personnel can educate customers on best practices for battery maintenance, increasing customer confidence and satisfaction. Trained and certified personnel are therefore crucial that EV are maintained to the highest standard and that their performance and longevity is guaranteed.

d) Dedicated Areas in Workshop

Establishing dedicated areas within the workshop for EV and Internal Combustion Engine (ICE) vehicles, with clear demarcation. This helps in maintaining safety and efficiency.

Narrative

Creating dedicated areas within a workshop for the maintenance of EV and other types of vehicles, such as Internal Combustion Engine (ICE) vehicles, is critical for both safety and operational efficiency. By clearly delineating the areas, workshops can tailor each area to the specific needs and safety protocols required for the different vehicle types. For example, an EV service area would be equipped with insulated floors, highvoltage signage and dedicated charging stations, while the ICE area could include exhaust ventilation systems and additional lifting equipment for engines. In a busy workshop where both EV and ICE vehicles arrive for maintenance, designated areas prevents cross-contamination of tools and ensure that specialised equipment is available at each station. This separation also minimises the risk of accidentally coming into contact with high-voltage components when working on different types of vehicles, creating a safer environment for technicians. Through such strategic planning, workshops can improve their service quality while ensuring the highest safety standards are maintained for the various vehicle technologies.

e) Response Equipment

Equipping workshops with relevant response equipment to handle any emergencies or incidents related to EVB.

Narrative

Equipping workshops with the appropriate equipment is essential for the effective management of emergencies or incidents involving EVB. This includes specialised fire extinguishers designed for lithium-ion battery fires, spill containment equipment for electrolyte leaks and personal protective equipment (PPE) to protect technicians in the event of an accident. For example, if a technician accidentally punctures a battery cell during maintenance, they can use a readily available lithium battery fire extinguisher to quickly fight an unexpected fire, minimising damage and ensuring safety. Workshops should also have emergency disconnect kits that can be used to immediately disconnect the battery from the vehicle's electrical system to prevent further electrical hazards. In addition, routine drills can prepare employees to respond quickly and effectively to incidents, whether it is a fire or an electrolyte leak, reinforcing a culture of safety and preparedness. By implementing these proactive measures, workshops can significantly reduce risks and ensure a safe working environment while maintaining high standards of service for EV.

f) Workshop Charging Station Compliance [4]

Adhering to charging station requirements set by PLANMalaysia (Dept of Town and Country Planning) and BOMBA (Fire and Rescue Dept of Malaysia) relevant standards and legislation. This ensures that charging facilities within the workshop are safe and compliant with related regulations. For public EV Charging Station (EVCS), the workshop shall obtain EVCS license from the Energy Commission (ST).

Narrative

Ensuring that charging stations in workshop comply with relevant standards and legislation is crucial for safety and legal compliance, especially when servicing EV. Workshops must adhere to guidelines of the authorities, e.g. those of the Energy Commission (ST). This includes obtaining the required license for EV charging stations (EVCS). For example, a workshop wishing to install an EV charging station will need to consider factors such as appropriate electrical load management, suitable signage, accessibility for people with disabilities and compliance with local building regulations. Imagine a scenario where a customer comes into the workshop with a hybrid EV that needs a quick charge before a road trip. If the charging station is set up in accordance with regulations, the driver can just plug in the vehicle knowing that it is safe and compliant. Conversely, failing to meet these standards not only poses a safety risk, such as electrical faults, but can also lead to fines or shutdowns by regulatory authorities. By ensuring compliance when setting up their charging stations, workshops can provide a safe, efficient and user-friendly experience for all EV owners while protecting the reputation and operational integrity of their business.

g) Storage Areas for Old/Replaced Batteries

Establishing dedicated storage areas for loose EVB, adhering to storage requirements set by Uniform Building by-Laws 1984 (UBBL) and BOMBA (Fire and Rescue Dept) approval, NFPA 855 (Standard for the Installation of Stationary Energy Storage Systems) and relevant standards. Proper storage is essential for safety and environmental compliance.

Narrative

Setting up dedicated storage areas for old or replaced EVB is crucial for safety and environmental sustainability in a workshop. These designated storage spaces must comply with the relevant standards which typically include UBBL and approval from BOMBA and in compliance with NFPA 855 standards. For example, a workshop where several EVBs are replaced in a single day should have a well-ventilated area with fireproof cabinets specifically designed for battery storage, as well as easily accessible collection bins nearby. In a scenario where a technician needs to safely store several used lithium-ion batteries until they can be disposed of or recycled, a clearly labelled and compliant storage area can minimise the risk of accidents, such as leaks that could release hazardous substances into the environment. In addition, proper management of these storage areas not only protects workers and the community, but also ensures that the workshop complies with environmental regulations to avoid potential fines and emphasise its commitment to sustainability. By prioritising the proper storage of old EVB, workshops can increase safety, comply with environmental standards and promote responsible recycling initiatives.

h) Pre-Disposal Storage for Discarded Batteries

Setting up a dedicated storage area for EVB prior to disposal. This ensures that EVBs are stored safely until they can be recycled or disposed of properly.

Narrative

The establishment of a dedicated storage area for discarded EVB prior to disposal is essential to ensure that these potentially hazardous materials are handled safely and responsibly. This storage area should be designed to meet legal requirements, including appropriate containment systems to prevent leaks and adequate ventilation to prevent the buildup of harmful gases. For example, in a workshop where old EVBs are routinely replaced, a designated storage area prior to disposal, equipped with leak-proof containers and clearly labelled signage, not only increases safety but also facilitates the efficient tracking and management of batteries for disposal. In a scenario where a technician realises that several EVBs are nearing the end of their life cycle, they can safely store these batteries in the predisposal area while awaiting for an arranged pickup by a certified recycling company. By implementing such protocols, the workshop can minimise environmental risks and ensure compliance with hazardous waste legislation. Ultimately, setting up a secure storage space for EVB demonstrates the workshop's commitment to environmental protection and safety and promotes a culture of responsibility in dealing with electronic waste.

i) State of Charge (SOC) Management

Customers to maintain the SOC within a range of 20-80% for optimal battery health, avoiding prolonged periods at very high or very low charge levels.

Narrative

Effective SOC management is critical to maintain the health and longevity of EVB. It is recommended that customers keep the state of charge of their batteries between 20% and 80%, as this range is optimal for battery performance and helps to prevent degradation over time. For example, if a customer allows the state of charge of their EVB to constantly drop to very low levels (e.g. 10%), or if they frequently charge it to full capacity (100%), this can lead to a shortened overall battery life and reduced driving range. In a real-world scenario, a customer who regularly takes long road trips and fully charges his vehicle before each journey may seem comfortable, but frequent charging can lead to increased stress on the battery. By keeping the SOC within the recommended range, for example by charging the vehicles to 80% before a travelling and ensuring it does not drop below 20% during the journey travel, the customer is maintaining the health of their EVB. This practice not only improves the driving experience by ensuring a reliable range, but also contributes to more sustainable use of the battery, ultimately leading to fewer replacements and a lower environmental impact. By educating customers on SOC management, workshops can make an important contribution to extending the life and performance of EVB.

j) Software Updates

Keeping the vehicle software up-to-date to benefit from the latest improvements in battery management and performance optimization.

Narrative

Keeping the vehicle software up-to-date is essential for optimising battery management and overall performance in EV. Manufacturers regularly release software updates that include improvements to battery performance, charging algorithms and energy management systems that can significantly improve the vehicle functionality. For example, in a scenario where a customer realises that the EV is not holding a charge as efficiently as it used to, a simple software update could introduce a new battery management algorithm that optimises charging patterns and extends battery life. The updates could also include features to improve regenerative braking, allowing the vehicle to recover more energy when slowing down, increasing driving range. A technician at a workshop could easily check for available software updates during routine maintenance, ensuring that the vehicle benefits from the latest innovations. By emphasising the importance of regular software updates, workshops not only improve EV performance and efficiency, but also promote customer satisfaction through proactive vehicle maintenance, which ultimately extends battery life and improves the driving experience.

k) Battery Passport

An EVB shall have a Battery Passport which contains information about its history, performance and health, and a label with QR code, for easy access and verification.

Narrative

The introduction of a Battery Passport for EVB is an innovative step that improves transparency and accountability regarding the history, performance and condition of batteries. This passport contains important information, such as the battery's date of manufacture, previous owners, charge cycles and maintenance records, all of which should contribute to a better understanding and management of battery life. For example, if a customer decides to sell his used EV, potential buyers can use the Battery Passport to quickly scan a QR code on the label to gain detailed insights into the battery's history and current condition, allaying concerns about performance and longevity. This ensures that both seller and buyer know and can trust the condition of the battery. In addition, workshops can use Battery Passport during maintenance work, allowing technicians to track any performance issues or prioritise specific areas for maintenance based on historical data. Overall, the Battery Passport concept strengthens trust and transparency in the EV market. It provides customers with easy access to important information while promoting responsible battery management throughout the entire life cycle.

5.1.4 Customer Disposing of EV Lithium Battery

The end-of-life management of lithium-ion batteries is crucial for ensuring environmental sustainability and safety. The disposal phase covers several important areas of activity:

a) Direct Disposal Arrangements with Manufacturer

Customers to ensure disposal arrangement with manufacturer is made in advance to ensure proper disposal of EVB. This ensures that the batteries are handled and recycled according to the manufacturer's guidelines and standards.

Narrative

Agreeing direct disposal arrangements with the manufacturer is a crucial step for customers to ensure the proper handling and recycling of their EVB. Many manufacturers offer special programmes for the safe disposal and recycling of lithium-ion batteries, ensuring that the batteries are processed according to established guidelines and industry standards. For example, if a customer wants to replace their old EVB, they should proactively contact the manufacturer to organise the return of the old battery. This could include organising a collection or finding a return point that meets the manufacturer's disposal criteria. In a scenario where a customer is unsure what to do with their dead battery, if he already has an agreement with the manufacturer, potential pitfalls such as illegal waste disposal or improper disposal methods can be avoided. This step also helps customers contribute to the circular economy, as manufacturers often recycle materials to make new batteries, reducing the environmental impact. By taking these precautions in advance, EVB will be disposed of responsibly and sustainably.

b) Battery Recycling Programmes

Customers shall be equipped with information on recycling programs and facilities where customers can dispose of their used EVB responsibly. Manufacturer Take-Back Initiatives could be introduced where the manufacturer collects and recycles the battery.

Narrative

Customers should be well informed about battery recycling programmes and facilities that enable the responsible disposal of used EVB. Many manufacturers have set up take-back initiatives that encourage customers to return their old batteries for safe recycling. For example, a customer can find out about their manufacturer's take-back programme via a dedicated website or at the point of sale, which outlines the steps for returning an EVB, including collection points and the associated benefits, such as discounts on future purchases. In a practical scenario, a customer replacing his EVB can seamlessly participate in this initiative by simply returning the old battery to the dealership or a participating facility and ensuring it is processed in an environmentally friendly manner. In addition, workshops and dealers can provide their customers with brochures or digital resources listing local recycling facilities to make it easier to find eco-friendly options. By promoting awareness of these recycling programmes and manufacturers' take-back initiatives, customers are not only contributing to environmental sustainability, but also encouraging a culture of recycling and responsible consumer behaviour in the EV industry.

c) Authorised Disposal Centres [7]

Information on authorised disposal centres by the Department of Environment (DOE) shall be make known to customers.

Narrative

It is important that customers are aware of the Department of Environment (DOE) approved disposal centres for EVB. These centres are equipped to handle hazardous materials safely and ensure that the disposal of batteries complies with environmental regulations. For example, a workshop can provide its customers with a list of nearby approved disposal centres with contact information and operational hours so that they can dispose of their used batteries conveniently and responsibly. In the case of a customer who has recently replaced his EVB, instead of disposing of the old battery unsafely, he can use the information provided to find an authorized disposal centre where he can drop off the battery. This not only ensures that the battery is disposed of in accordance with the latest safety and environmental protocols, but also promotes a culture of environmental responsibility among EV owners. By making their customers aware of authorised disposal options, workshops and manufacturers are empowering them to take proactive steps to protect the environment and ensure the safe disposal of battery waste.

d) Safe Handling Instructions

Customers to be informed on the safe handling and transportation of used EVB to avoid any accidents or environmental hazards.

Narrative

Customers must be informed about the safe handling and transport of used EVB in order to avoid accidents and minimise environmental hazards. This includes instructions on how to use the correct personal protective equipment (PPE), such as gloves and safety goggles, to protect against possible battery leakage or contact with harmful materials. For example, when transporting a used battery, it should be placed in a suitable container that is padded and leak-proof to prevent damage during transit.The battery should be secured to prevent movement that could lead to punctures, short circuits or leaks. In a scenario where a customer decides to take his old battery to an authorised disposal centre, by following safe handling instructions, including avoiding contact with metal objects and ensuring that the battery terminals are covered, the battery can be transported without risk of personal injury or environmental contamination. Providing clear and concise information on safe handling procedures not only empowers customers to act responsibly, but also reinforces the culture of safety and environmental protection in the EV community.

e) Repurposing and Second-Life Use

Relevant Government agencies to explore option for repurposing EVB for secondary applications such as energy storage systems, thereby extending the useful life of the battery.

Narrative

Relevant Government agencies are asked to explore options for reusing EVB for secondary applications, such as energy storage systems, to extend their useful life and enhance sustainability. When EVB reach the end of their life-cycle their remaining capacity can still be significant, making them ideal for use in energy storage systems for homes or businesses. For example, a Government could encourage partnerships with renewable energy companies to develop programmes where used EVBs are refurbished and integrated into solar energy systems so that homeowners can store the excess energy generated during the day and use it at peak times or at night. In a scenario where a family has a solar panel installation but no efficient energy storage system, by utilising reused EVB, they can significantly reduce their reliance on the national grid while supporting a greener energy solution. This approach not only benefits consumers looking for sustainable energy options, but also mitigates the environmental impact of battery waste by encouraging recycling and reusability. By actively researching and implementing EVB reuse strategies, Government agencies can play a critical role in fostering innovation, environmental responsibility and the transition to a circular economy.

CONCLUSION
for the Front-End Process and Specific Requirements

Effective management of EVB throughout their lifecycle, from purchase to disposal, is critical to ensuring safety, maximising battery longevity and promoting environmental protection and sustainability.

Consumer Education on Battery Use

When purchasing an EV, it is important to provide customers with comprehensive information on battery care and use. This includes advice on optimal charging, understanding battery performance under different conditions and the importance of temperature management. Giving customers this knowledge will enable them to make informed decisions that will extend the life of the battery and improve the overall performance of EV.

Robust Customer Support

In addition to education, solid support is also important. This can include access to customer service channels for battery status enquiries, troubleshooting and routine maintenance support. Regular checks and notifications of potential recalls or maintenance can also ensure that batteries are kept in optimum condition.

Sustainable Disposal Practices

In addition, the introduction of sustainable disposal practises is essential for environmental protection. As EVB reach the end of their life cycle, it is important to put systems in place for proper recycling and disposal. This includes working with certified e-waste recycling facilities that can safely process lithium-ion batteries, recover valuable materials and prevent toxic substances from polluting the environment. By prioritising education, support and sustainable disposal practises, the full potential of lithium-ion batteries in EV can be realised. This holistic approach contributes to a greener and safer future by reducing waste, maximising resource recovery and ensuring that EV remain a viable and environmentally friendly option for transportation. Ultimately, a commitment to the responsible use of EVB not only benefits customers and the environment, but also supports the overarching goal of promoting sustainable practises in the automotive industry.

Workplace Safety and Risk Management

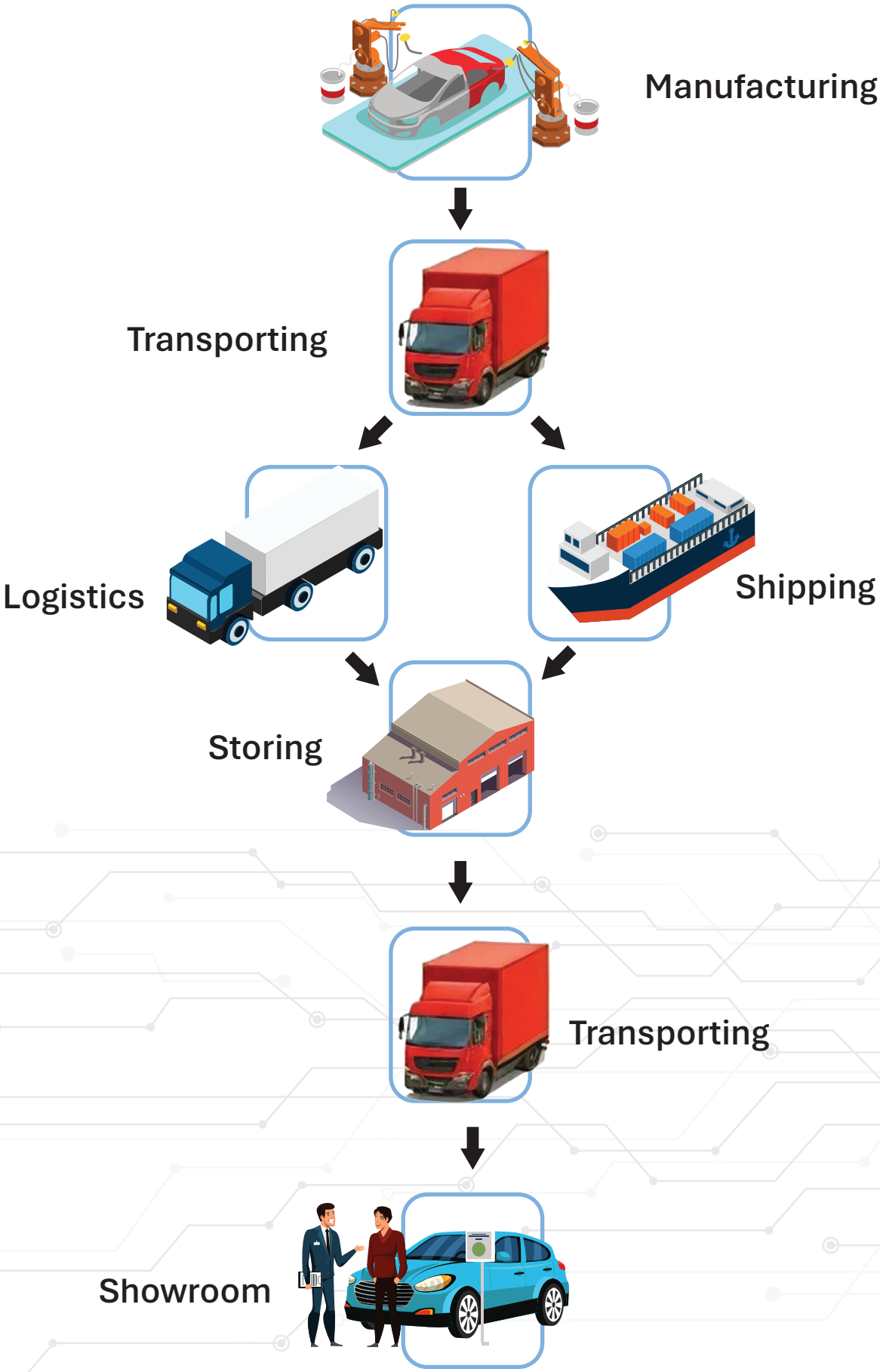
Overall, all commercial organisations involved in front-end processes must ensure that a risk assessment is carried out in their workplace in accordance with the Occupational Safety and Health Act ,1994 (Act 514), to which specific reference is made:

- Obligation to Assess Risk: Every employer, self-employed person or principal must conduct a risk assessment to evaluate the safety and health risks posed to any person affected by their activities in the workplace.
- Implementation of Risk Controls: Where the risk assessment indicates that control measures are required to eliminate or reduce safety and health risks, these measures must be implemented by the employer, self-employed person, or principal.
- Definition of Risk Assessment: The term “risk assessment” refers to evaluation hazards at work and the identification of appropriate risk control measures.

For a comprehensive approach to battery technology, it is advisable to consider broader terms such as “low voltage battery” or “high voltage battery” rather than exclusively focusing on lithium-ion batteries due to potential future developments in battery types.

Additionally, the use of the Guidelines for users of battery swap systems are essential. The Malaysian Standards Authority is actively creating standards for battery swap systems tailored for light EV, including motorcycles. These measures will enhance safety and adaptability in the evolving landscape of battery technology.

5.2 EV AND BATTERY MANAGEMENT AREA OF CONCERNS: BACK-END PROCESS AND SPECIFIC REQUIREMENTS



5.2.1 EV Manufacturing Process

The manufacturing process of EV, especially the production of lithium-ion batteries, requires strict compliance with various standards to ensure high quality and safety. These include the sourcing and testing of raw materials for compliance with exact specifications, adherence to precision processes under clean room conditions and compliance with established design and safety standards through the integration of features such as thermal management systems. There are a number of standards that must be met, and this is not limited to the relevant ISO standards. In general, the requirement for EV manufacturing process include, but are not limited to, the following points:

a) Certified Manufacturer by Authority

- **Ensuring the manufacturer is certified by relevant authorities.**
- **Ensuring to repeat Vehicle Type Approval (VTA) of the EV whenever there are changes to the battery, critical High-Voltage (HV) components or Tier 1 and Tier 2 vendors.**

Narrative

Certification by competent authorities is crucial for maintaining product integrity and safety, especially in the field of electromobility. A certified manufacturer must meet strict automotive and environmental standards to ensure safety, performance and sustainability. For example, if an EV manufacturer sources batteries from a supplier that is certified by the International Automotive Task Force (IATF) and fulfils ISO 9001, it guarantees the quality and reliability of the vehicles. The certification includes regular audits to identify and rectify problems at an early stage, minimising risks such as battery failures. When significant changes are made to components, such as the introduction of a new battery or the modification of high-voltage components, the renewal of the Vehicle Type Approval (VTA) is essential to maintain conformity and performance standards. For example, if new regulations require better thermal management for batteries, certified manufacturers will adopt these standards to ensure compliance and competitiveness. This certification strengthens consumer confidence and opens up new market opportunities through consistent compliance.

b) Compliance with Battery Passport Requirements [8]

Adhering to the Battery Passport requirements to be implemented by the Malaysia Automotive Robotics and IoT Institute (MARii).

Narrative

Compliance with the MARii's requirements for Battery Passports is critical for manufacturers looking to ensure traceability, sustainability and compliance in the EV industry. These Battery Passports provide a digital record of each battery's lifecycle, from raw material sourcing to recycling or disposal, ensuring transparency and accountability at every step. For example, a battery producer in Malaysia could use MARii's Battery Passport system to track the environmental impact and origin of lithium components, assuring automotive companies and customers that their products comply with sustainable practices. In scenarios where regulators require proof of ethical sourcing and environmental impact reduction, manufacturers with a comprehensive Battery Passport can quickly demonstrate compliance and easily adapt to new requirements. Meeting these requirements not only helps manufacturers comply with regional regulations, but also strengthens their brand reputation as a leader in sustainable and ethical production and helps them to compete in a competitive global marketplace.

c) Goods Declaration Form [9]

Establishing a Goods Declaration Form (packaging list and specification) before transportation.

Narrative

The creation of a Goods Declaration Form prior to transport is an important step in ensuring smooth and efficient logistics operations. This form serves as a comprehensive packaging list and specification document, listing all the items to be shipped, the exact quantities, descriptions and any other relevant specifications, especially meeting MS 2687:2017. For example, for a company that is exporting electronic equipment overseas, the Goods Declaration Form would include details such as the number of units to be shipped, detailed descriptions of each model, their serial numbers and important handling instructions or safety guidelines which comply with UN Model Regulations 38.3. Such thorough documentation helps prevent shipping errors, facilitates smooth customs clearance and ensures that all parties involved have accurate information about the shipment, reducing the risk of misunderstandings or delays. In another example, a manufacturer shipping temperature-sensitive goods could include information about the necessary temperature controls or special packaging requirements to ensure the integrity of the goods during transit. Such goods include EVB, their components or electronic sensors, which are in high demand by all EV manufacturers. Overall, the movement document is an important tool for transparency and accountability in the supply chain.

d) State of Charge (SOC) [10]

Ensuring the battery SOC is between 30% - 40% before transportation.

Narrative

Ensuring that the State of Charge (SOC) of a battery is between 30% and 40% before transport is crucial to maximising battery life and ensuring safety. When transporting EVB, for example, a SOC in this range prevents stress on the cells during transport, which could otherwise lead to degradation or even dangerous situations such as thermal runaway. In a scenario where a logistics company is responsible for the transport of batteries for solar energy storage systems, if these batteries are shipped fully charged, the risk of accidental short-circuit or overheating during transport increases significantly, which could lead to catastrophic failures. On the other hand, too low a SOC value could cause irreversible damage and affect performance upon arrival. Monitoring and documenting the SOC value therefore not only ensures compliance with safety regulations, but also increases the reliability of the batteries when they reach their destination, be it a dealer point or a production facility, and ensures that they are ready for immediate use or installation. It is crucial to adhere to specific manufacturer guidelines and consider standards such as those from the United Nations for lithium battery transport.

e) Dedicated Storage Areas

- **Establishing dedicated storage areas for loose EVB and EV, adhering to relevant standard requirements.**
- **The storage and logistics management of components of EVB should be segregated from that of the ready EVB.**

Narrative

The creation of dedicated storage areas for EVB and complete EV is crucial for meeting safety standards and improving logistical efficiency. In accordance with relevant regulations, these dedicated areas should be designed to minimise risks such as short circuits, battery leaks and fire hazards. For example, a facility that manages both the manufacture of EV and the distribution of battery could set up separate zones, with one area specifically for loose EVB being tested or awaiting installation and another for fully assembled, ready-to-ship EV. The loose batteries would be stored in fireproof racks and equipped with appropriate signage and safety equipment, while the finished vehicles could be parked in another area where environmental conditions are optimised. This separation not only ensures compliance with safety standards, but also increases operational efficiency. For example, if a battery recall occurs, the logistics team can quickly access the dedicated storage area for loose batteries without interrupting the workflow of the finished vehicles. In addition, this organised system facilitates tracking and inventory management, ultimately resulting in a safer and more productive environment for everyone involved in the supply chain.

f) Safe Working Procedures

Implementing safe working procedures for handling by focusing on Passive Safety, Active Safety and Cognitive Safety. This includes special precautions for workers with medical devices such as pacemakers or insulin pumps.

Narrative

To ensure the safety and well-being of all personnel, it is important to implement comprehensive safe work procedures for handling EV that focus on passive, active and cognitive safety measures. Passive Safety is about creating environments and protocols that minimise risk without the need for active intervention, such as clearly demarcating high-voltage areas and ensuring that electrical equipment is properly insulated. Active Safety refers to emergency shutdown systems and the availability of personal protective equipment (PPE) and that employees are trained to react quickly to potential hazards. Cognitive Safety is about ensuring that employees are aware of potential risks and fully understand safety protocols. Special precautions need to be taken for employees fitted with electronic medical devices such as pacemakers or insulin pumps, as electromagnetic fields and high-voltage devices can affect their operation. This could mean that such employees are assigned to tasks where they do not have direct contact with high-voltage components or that their medical devices are shielded accordingly. For example, when servicing EVB, employees with pacemakers could work on documenting procedures instead of handling the batteries, ensuring both safety and productivity.

g) Competent Personnel

Ensuring that personnel managing EV are competent and adequately trained.

Narrative

To maintain operational safety and efficiency in the rapidly evolving EV industry, it is necessary to ensure that personnel responsible for the management of EV are competent and adequately trained. This competence can be achieved through comprehensive training programmes that cover essential aspects such as understanding high-voltage systems, battery management and emergency protocols. In addition, such training programmes should be certified by relevant agencies such BEM, NIOSH, JPK, JPJ which include first aid protocols for High-Voltage (HV) shock injury as well as EVB handling procedures. For example, in a scenario where a logistics company manages a fleet of electric delivery vans to minimise risks associated with maintaining these vehicles, the company should invest in training its technicians in the specific intricacies of EV maintenance, including how to handle batteries and troubleshoot electrical systems. In addition, drivers are trained in safe operating procedures, such as the correct use of regenerative braking and charging protocols. Special precautions need to be taken for employees fitted with electronic medical devices such as pacemakers or insulin pumps, as electromagnetic fields and high-voltage devices can affect their operation. By ensuring that all employees are equipped with the necessary knowledge and skills, the logistics company not only increases safety in the workplace, but also improves the longevity and performance of the EV fleet. Regular skills assessments and refresher courses can also be introduced to keep staff up to date with the latest technology and safety practices, promoting a culture of continuous learning and professionalism in the use of EV.

h) Recovery Policy

Establishing a policy on how to recover lithium batteries from abandoned EV.

Narrative

The introduction of a sensible take-back policy for lithium batteries from EV is essential for environmental protection and effective resource management. This policy ensures that the take-back of EV prioritises the safe removal and recycling of lithium batteries and minimising the potential environmental hazards associated with improper disposal. For example, in a scenario where a local town council discovers several abandoned EV in a public parking lot, under the implemented take-back policy, trained personnel would be dispatched to supervise the retrieval of the abandoned vehicles where they ensure that safety protocols for working with high-voltage systems are followed. This would include ensuring that the battery is safely disconnected and transported to a designated recovery facility where it can be reconditioned or recycled in accordance with the relevant regulations. In addition, the policy could provide for partnerships with certified recycling companies specialising in the processing of lithium battery to ensure that the batteries are handled in an environmentally sound manner. By introducing such recovery policy, municipals and town councils not only mitigate the risks posed by abandoned EV, but also promote sustainability by recycling materials and thus contributing to a circular economy in the EV industry.

i) End-of-Life Policy Compliance [11]

Complying with the Vehicle End-of-Life Policy as amended by the Government, by establishing Authorised Automotive Treatment Facility (AATF) and Recycle Centre to process the End-of-Life Vehicles (ELV).

Narrative

Complying with the Government's amended End-of-Life Vehicles (ELV) Policy is vital to ensure that EVs are disposed of in an environmentally friendly manner and in accordance with industry regulations. The presence of Authorised Automotive Treatment Facilities (AATFs) and recycling centres plays a crucial role in this process, as they are equipped to effectively and safely handle End-of-Life vehicles (ELVs) and their components, including lithium batteries. In a scenario where a fleet of obsolete electric taxis is taken out of service to make way for newer models, under the ELV policy, the company coordinates with a certified AATF to ensure that each vehicle is dismantled according to regulatory requirements so that hazardous materials can be safely removed and reusable parts recycled. The AATF would then recondition the vehicle's lithium battery and send it to a specialised facility for responsible recycling, thereby minimising environmental impact. By aligning the operations with the ELV policy, companies are not only fulfilling legal obligations, but also promotes sustainable practices that contribute to a greener future and demonstrate the commitment to corporate social responsibility and environmental protection in the EV industry.

5.2.2 Transporting EV

The safe transport of EV from production sites to distribution points requires careful consideration of several critical stages to ensure both the integrity of the batteries and the safety of the vehicles. The process begins with a pre-transport inspection, where each vehicle is thoroughly checked to ensure that all components, especially the battery, are safe and in good condition. This phase lays the foundation by documenting the condition of the vehicle to track any changes during transport.

Special transport equipment is essential for EVs and it is important for drivers and the transport crew to be skilled in maintaining optimum conditions. This includes keeping the batteries at the recommended SoC, usually not exceeding 30%, to maintain the health of the battery and avoid potential problems.

Specially designed straps and padding are used to stabilise the EVs on the transport carriers and minimise the risk of physical damage from movement or impact. Monitoring and tracking systems are crucial as they provide real-time information about the vehicle's location and the environmental conditions on the transport vehicle so that any irregularities can be quickly rectified.

The delivery of EVs to showrooms is a carefully coordinated process. Each vehicle is carefully loaded onto the road car carriers using specialised equipment to prevent movement and damage. Trained transport staff adhere to strict emergency protocols to ensure safe handling, especially concerning battery safety. Upon arrival at the showroom, vehicles undergo a thorough inspection to ensure they are ready for display and sale. This ensures high standards are maintained from despatch to delivery to the showroom.

Finally, comprehensive emergency protocols must be in place and all transport staff must be well-trained in dealing with potential problems, such as battery fires or mechanical breakdowns. This entire phase involving transportation cover the following stages:

a) Cargo Declaration [12]

Forwarding or Transport agents must declare the cargo (EV) as per the manufacturer's declaration.

Narrative

Cargo declaration is an important step in the transport of EV, ensuring compliance with safety regulations and facilitating efficient logistics processes. Freight forwarders or carriers must declare the cargo according to the manufacturer's specifications, providing important information such as vehicle type, weight and the presence of high-voltage batteries. Take, for example, a logistics company that needs to transport a batch of newly produced electric SUVs to various dealerships. The carrier must accurately complete the cargo declaration documents, including the manufacturer's declaration that the vehicles are classified as hazardous due to their lithium-ion batteries. This declaration is important to ensure that the vehicles are handled correctly during transport, as it alerts transport personnel and Customs officials to take the necessary precautions to reduce the risks associated with the batteries. Should an unexpected inspection occur during transport, a clear cargo declaration will also help to streamline the process and avoid delays and potential fines. Overall, thorough and accurate cargo declarations are critical to maintaining safety standards, complying with regulations and facilitating the smooth transport of EV.

b) Dedicated Road Car Carriers

EV should be loaded onto dedicated road car carriers approved by relevant authorities.

Narrative

Loading EV onto special car transporters approved by the relevant authorities is essential for the safe transport of these specialised vehicles. Specialised road car carriers (transporters) are designed to meet the specific requirements of EV stowage. This includes features that protect the high-voltage battery systems and prevent potential damage during transport. In a scenario in which a fleet of electric SUV is to be transported from a production facility to various regional dealerships, the logistics company need to use a special road car carrier (transporter) equipped with ramps and fastening systems specifically designed for EV. This ensures that the vehicles are safely loaded and stabilised so that they do not move during the transport. In addition, before loading, the transport company's employees must check that the road car carrier (transporter) fulfils the safety standards set by the transport authorities, which include fireproof materials and adequate ventilation. This not only increases the safety of the EVs, but also complies with the regulations for the transport of dangerous goods in connection with lithium-ion batteries. By using specialised road car carriers (transporters), the companies minimise the risk of accidents, increase the safety of the EVs and ensure dealers that their EVs arrive at their delivery points in optimal condition and ready for sale.

c) Certified Road Car Carriers [13]

Road car carriers should be certified and approved by relevant authorities.

Narrative

Certified road car carriers (transporters) are crucial for the safe and efficient delivery of vehicles from manufacturers to regional dealers. Their certification by the relevant authorities ensures compliance with strict safety, quality and operational standards and minimises potential risks during transport. For example, a certified road car carrier operator adheres to the standards established by the Road Transport Department (JPJ) and undergoes regular inspections by PUSPAKOM. This ensures that all drivers and transport assistants are properly trained in safety and emergency procedures, and that the transport vehicles are maintained to the highest standards and in compliance with regulatory requirements. When an EV master dealer needs to transport a fleet of high-end EVs from a distribution centre to their showrooms across the country, hires a certified road car carrier (transporter), the dealer is assured that the EVs are loaded safely with specialised equipment and benefitting from proper insurance coverage benefits that protects against potential damage during transport. Such certification not only gives the dealer peace of mind but also emphasises the professionalism and reliability expected of a road car transporter company.

d) Competent Operators [14]

Deploying competent road car carrier operators with trained personnel, minimum trained under the Malaysian Skills Certificate (SKM) Lev el 3 based on National Occupational Skill Standards (NOSS).

Narrative

The use of competent car transporters with trained personnel, especially those who hold a Malaysian Skills Certificate (SKM) Level 3 based on National Occupational Skill Standards (NOSS), is essential for the safe and efficient transport of EV. In practice, this means that a logistics company tasked with transporting a fleet of newly manufactured EV to various dealerships will ensure that all drivers and ground crew have received rigorous training that meets these standards. For example, these trained personnel will be able to properly secure the vehicles, understand the special requirements of EV and effectively manage loading and unloading operations to prevent damage to the high-voltage battery systems. Furthermore, in the event of unexpected weather conditions such as heavy rain or strong winds, a knowledgeable employee can make informed decisions to ensure the safety and integrity of EV during transport, for example by adjusting loading techniques or taking alternative routes. By prioritising the recruitment and deployment of competent, NOSS-certified staff, logistics companies not only increase their operational efficiency, but also significantly reduce the risk of accidents and damage and ensure that the EVs arrive at their destinations safely and in optimal condition.

e) Competent Drivers

While transporting EV from manufacturers to dealers, competent drivers shall be deployed, adhernce to all traffic and relevant road safety requirements.

Narrative

As a responsible road car carrier, the use of competent drivers should not be underestimated. These drivers play a crucial role in ensuring that the EVs arrive at dealerships safely and on time, which has a positive impact on the manufacturer's reputation. When an EV manufacturer sends a fleet of newly released models from its production facility to its dealerships in different states. The drivers selected for this task must be professionally trained in handling EVs and know the intricacies of transport, such as how to distribute the weight of the vehicle and securing the stowage, to ensure the safety of each EV's batteries. On their journey, they diligently adhere to all traffic rules, speed limits and rest periods to ensure safety and efficiency. For example, on a long journey on the highways, a competent driver should anticipate heavy traffic and adjust their route using real-time navigation devices to avoid an impeding traffic slow- down or jam and ensure on-time delivery. In addition, these drivers carry out regular vehicle checks during planned stops to monitor the condition of the EVs being transported and promptly rectify any problems. Their comprehensive approach exemplifies the mix of expertise and care required for the specialised task of transporting EVs, ultimately ensuring that every EV reaches its destination in pristine condition, ready for the eager customers who awaits it in the dealer's showroom.

f) Firefighting Equipment

Ensuring suitable and adequate firefighting equipment as per JPJ requirements and portable fire extinguisher is available on the car carrier.

Narrative

It is an important safety measure to ensure that transport companies transporting EV have suitable and sufficient fire extinguishing equipment to protect personnel, cargo and the environment from the potential fire hazards posed by lithium-ion batteries. For example, if a logistics company uses car transporters to transport a batch of EV, each transporter will be equipped with special fire extinguishers. These include type D fire extinguishers, which are specifically designed for metal fires, and automated fire extinguishing systems that can respond quickly to signs of overheating or smoke from the batteries. If an operator notices unusual behaviour in one of the vehicles during transport, they can immediately access the fire extinguishers to minimise the risks in the event of a fire. In addition, regular safety drills and training sessions are carried out to ensure that all transporters understand the correct use of the equipment and are prepared to react quickly in emergency situations. By having constant access to appropriate firefighting equipment, transporters are improving safety protocols for transporting EV, protecting lives and property while emphasising their commitment to safety and compliance with industry regulations.

g) Safety Compliance

Car carrier operators must observe and adhere to all traffic and relevant road safety requirements. When carrying dangerous goods, the car carrier must display a vehicle identification in accordance with MS ISO 17840:2024 – Road Vehicles Essential Information for First and Second Responders.

Narrative

Compliance with safety regulations is of paramount importance for car transport operators, especially when transporting EV with high-voltage battery systems, which are classified as Dangerous Goods. Operators must observe and comply with all traffic regulations and relevant road safety requirements to ensure the safe transport of their cargo. For example, if a car transport operator is transporting a fleet of EV, the operator is responsible for following safe driving practises, such as adhering to speed limits and proper loading to prevent shifting during transport. In accordance with the MS ISO 17840:2024 standard, the car transport operator must carry appropriate vehicle labelling placard that clearly alerts both first responders and other road users to the presence of potentially hazardous substances. If, for example, an unforeseen incident such as a minor collision occurs during transport, the visible labelling placard enables the emergency services to quickly assess the situation and take the necessary precautions to respond to the incident. By consistently adhering to these safety measures, car transport operators not only contribute to public safety, but also protect their cargo and increase overall operational safety, boosting the confidence of manufacturers and dealers in the EV supply chain.

5.2.3 Shipping and Logistics EV/EVB Process

Shipping EV and EVB for international distribution requires careful planning to ensure their safe and efficient transport. The logistics process includes coordinating the transport of EV and EVB from the production sites to various distribution centres and navigating through loading and discharging ports. This stage involves the following areas of activity:

a) Local and International Standards Requirements

Shipping EV/EVB shall adhere to relevant local and international standards[15] and guidelines not limited only to IMO[16], to ensure the safe and efficient movement of EV/EVB.

Narrative

When transporting EV and EVB, it is important to comply with both local and international standards to ensure safe and efficient transport. For example, the International Maritime Organization (IMO) provides guidelines for the safe handling of dangerous goods at sea, which also apply to the transport of lithium-ion batteries as they are flammable in nature. In addition, local regulations may prescribe special packaging and labelling protocols to minimise risks during transport. In the European Union, for example, shippers must comply with ADR (European Agreement Concerning the International Carriage of Dangerous Goods by Road) standards when transporting EVB across borders. A scenario in which these standards come into play could involve a manufacturer in Germany shipping large battery packs to a dealer in Malaysia. In this case, strict compliance with the IMDG Code (International Maritime Dangerous Goods Code) would be crucial to ensure that the batteries are correctly classified, packaged and documented for safe sea transport. This prevents accidents and ensures compliance at both ends of the journey.

b) Safe Loading [17]

Ensuring EVs/EVBs are safely loaded onto the vessel according to an approved stowage plan.

Narrative

The safe loading of EV and EVB onto a vessel is a critical step in the shipping process that requires adherence to an approved stowage plan to avoid accidents and ensure stability during sea transport. For example, if a shipping company is transporting several hundred EVs from a port in China to several distribution centres in Malaysia, it must follow a pre-approved stowage plan that takes into account factors such as the weight distribution of the vehicles, potential hazards associated with their batteries and the overall cargo capacity of the vessel. This may include strategically placing lighter vehicles on the upper decks and securing heavier units in the lower decks. Equally important are appropriate securing methods, such as the use of non-conductive strapping materials to avoid electrical hazards and the secure covering and insulation of the EVB terminals. A scenario that illustrates this could be a situation where an unexpected storms may occur. The crew may the need to review the securing mechanisms and reposition certain vehicles to maintain the balance of the vessel and ensure that the EV and EVB remain safe throughout the voyage, minimising the risk of damage or accidents during the voyage.

c) State of Charge (SOC) Requirement [18]

Vessel to ensure EVB SOC is not more than 30% prior to voyage.

Narrative

Before embarking on a voyage, it is essential to ensure that the SOC of EVB does not exceed 30%. This requirement is crucial to minimise the risk of battery fires and ensure safe transport. For example, in a scenario where a shipping company is preparing to transport a fleet of electric buses from a manufacturing facility in China to a major transit hub in Port Klang as part of the safety protocol, the crew must check the SOC of each bus before loading. If a vehicle with SOC more than 30% is found to be loaded, the SOC must either be discharged to the appropriate safe level or removed from the load. Failure to comply with this requirement could have catastrophic consequences, especially if there is a sudden movement or accident during the stage of transport that may cause a short circuit or thermal runaway in an overcharged battery. This procedure not only protects the cargo, but also the crew and the ship itself. It demonstrates that the industry is stricly committed to safety protocols for the transport of EV.

d) Vessel Firefighting Equipment [18]

Ensuring suitable and adequate firefighting equipment is available and compliant with IMO international standards.

Narrative

To comply with Marine Pollution (MARPOL) regulations and international safety standards, it is necessary to ensure that a ship carrying EV and EVB has suitable and adequate firefighting equipment. For example, a cargo ship designed to carry EV must be equipped with specialised firefighting equipment such as portable fire extinguishers for electrical fires, high performance water mist systems and foam extinguishing systems that are effective against lithium-ion battery fires. In a situation where there is a possible thermal runaway during the crossing of the ocean, special fire extinguishers at strategic locations on the ship allow the crew to respond quickly and effectively. In this scenario, if a smoke alarm signals a hazard in the cargo deck, trained personnel can immediately access the necessary firefighting equipment to contain the situation before it escalates. In addition, compliance with international maritime safety regulations requires regular inspection and maintenance of this equipment to ensure not only that it is in working order when required, but also that crew members are adequately trained in its use. Such preparation is essential to protect lives, the ship and the environment from the risks associated with the transport of EV and EVB.

e) Vessel Fire Safety

Prohibiting open fire activities, such as hot work and welding, within 10 meters of the EV storage area.

Narrative

Implementing strict fire safety protocols on-board ships carrying EV and EVB is crucial, especially by prohibiting activities involving open flames, such as hot work and welding, within 10 meters of the EV storage area. For example, in a marine operation where EVs are being loaded into the cargo hold while crew members are performing maintenance work in an adjacent area, if welding work is allowed too close to the storage zone, these sparks could accidently ignite combustible materials, including the exhaust fumes from the batteries that could accumulate nearby. To minimise this risk, the master and ship's safety officer must enforce a strict welding ban, clearly marked to ensure compliance. If the vessel is in port and a repair needs to be carried out, the crew must either move the work to a safe distance or postpone it until the EV loading process is completed to ensure a safe environment. These precautions emphasise the maritime industry's commitment to preventing fire hazards, ensuring crew safety and protecting valuable cargo during transport to ensure that the transportation of EV and their components is incident-free.

f) Cargo Declaration [7,8,9]

Forwarding/shipping agents must declare the cargo (EV) as per the manufacturer's declaration and in compliance with IMDG Code and UN Model Regulations.[19]

Narrative

The precise declaration of the load is a crucial element for the safe transport of EV and their batteries. Carriers and shippers must prepare documentation in accordance with the manufacturer's specifications, the IMDG Code and UN Model Regulations. For example, if a carrier wants to export a batch of EV from the China to Europe, it must ensure that declaration of each vehicle contains detailed information about the type of battery used, its weight and its associated hazards. This information is important not only for regulatory compliance, but also for the safety of the vessel, crew and other cargo onboard. If a carrier fails to properly declare the hazardous nature of lithium-ion batteries, this can have serious consequences, such as inadequate emergency preparedness in the event of a battery-related incident during transport. In addition, Customs authorities at the port of destination rely on accurate cargo declarations to assess duties, and for the port operators, to ensure compliance with local regulations and take necessary safetymeasures upon arrival. Therefore, strict adherence to the declaration process protects all parties involved and promotes the smooth handling of EV shipments in international waters.

g) Dedicated RORO Vessel [20]

EV should be loaded onto dedicated RORO vessels.

Narrative

Loading EV onto special RORO vessel is essential for their safe transport, as these specialised RORO vessels are designed specifically for the requirements of car transport. For example, if a Chinese car manufacturer wants to transport a new line of electric SUVs to dealerships in Malaysia, the use of a specialised RORO vessel enables precise stowage that protects the vehicles from potential damage. These specialised carriers are equipped with ramps and adjustable loading platforms that allows for efficient loading and unloading while providing enough space to properly secure each vehicle and reduce the risk of movement during sea-transport. In a scenario where the specialised RORO vessel is faced with unexpected rough seas, the design of the specialised carrier, along with the careful securing of the EV, minimises the likelihood of damage and preserves the integrity of the battery systems and the vehicles as a whole. In addition, specialised RORO vessels are often equipped with climate control systems that protect the EVB from extreme temperature fluctuations and ensure that the vehicles arrive at their destination in optimal condition. This approach not only increases safety, but also emphasises the manufacturers' commitment to delivering high-quality and reliable products to consumers worldwide.

h) Competent Operators [21,22]

Deploying competent RORO vessel operators.

Narrative

To ensure the safe and efficient transport of EV and EVB, the use of competent RORO vessel operators is essential. Employing competent drivers have the necessary skills, training and experience to deal with driving the vehicles for the loading and unloading operations poses a challenge to handling this type of freight. For example, if a car carrier operator plans to transport a load of EV from a manufacturer in Germany to distribution centres in ASEAN, the presence of trained personnel is crucial to carefully monitor the loading and discharging processes, where correct weight distribution and securing techniques are critical to prevent damage during the sea-transport. In a scenario where the inexperienced drivers accidently overload one side of the vessel or fail to properly secure the vehicles, the risk of the load shifting or even movements during the voyage may increase the risk to damaging the EVB systems and hence, the presence of experienced drivers contribute to smooth operations. This ultimately reflects the logistics company's commitment to safety, reliability and the successful use of latest technology.

i) RORO Vessel Firefighting Equipment [18]

Ensuring suitable and adequate firefighting equipment is available on the RORO vessel.

Narrative

When transporting EV and EVB, which pose a particular fire risk due to their lithium-ion technology, it is essential that suitable and sufficient fire extinguishing equipment are available on a RORO vessel operator. For example, if a RORO vessel operator is transporting a load of new EVs across the Atlantic from Europe to the United States, the crew must ensure that fire suppression systems such as high-pressure water mist systems, foam extinguishers and portable fire extinguishers are strategically placed throughout the vessel storage area. In a scenario where a battery thermal runaway occurs during transport due to a manufacturing defect, the crew can respond immediately with specialised firefighting equipment to contain and extinguish any flames that may break out. Without appropriate firefighting measures, a minor incident could escalate into a catastrophic situation, endangering the vessel, crew and the other EVs onboard. Regular drills and maintenance checks of firefighting equipment increase readiness and ensure that the crew is well prepared to act quickly and effectively in an emergency. When shipping companies prioritise the availability and functionality of firefighting equipment, they not only protect their valuable cargo, but also meet industry safety standards and increase overall safety at sea.

j) RORO Vessel Safety Compliance [22]

RORO vessel operators must observe and adhere to traffic and relevant road safety requirements, whilst in port operations.

Narrative

Compliance with safety regulations for RORO vessel operator during port activities is critical to maintaining a smooth and risk-free environment when loading and unloading vehicles. It is vital that car carrier operators hire drivers who strictly adhere to port procedures and road safety standards to avoid accidents and injuries. For example, drivers must strictly adhere to speed limits and designated routes when maneuvering vehicles within the port area. RORO vessel operators should also ensure that loading ramps are securely fastened and properly aligned to prevent vehicles from tipping over or rolling off. In challenging weather conditions, such as heavy rain or high winds, drivers should take extra care and reduce speed to maintain control. Thorough safety briefings and the use of high-visibility waistcoats for drivers and traffic supervisors help to minimise the risks in challenging weather conditions, at night or in busy port areas. Real-life incidents, such as vehicles being misrouted on RORO carriers and causing an unbalanced load, emphasise the importance of strict compliance. These measures are crucial for the protection of personnel, equipment and vehicles during loading and unloading operations.

k) Safety Measures

Cordon off areas used for receiving EVs from RORO vessels, ensure suitable and adequate fire extinguishers are available and prohibit smoking/open fire/hot work activities in adjacent areas.

Narrative

Robust safety measures in areas dedicated to EV are essential to prevent fire hazards and ensure the well-being of crew members and cargo. For example, in the handling a load of EVs at a port facility, it is important to cordon off the designated loading and unloading areas to prevent unauthorised access and minimise the risk of accidents. Clearly labelling these areas with safety signage improves visibility and awareness for all employees. There is a need to ensure that suitable and sufficient fire extinguishers are strategically placed in and around these zones to provide immediate access in the event of an emergency involving flammable battery materials. In addition, the prohibition of smoking, open flames and hot work in adjacent areas creates an important buffer zone that further reduces the potential for ignition sources near sensitive cargo. In a hypothetical scenario where a crew memberaccidentally ignites a spark while welding near the EV storage area, the risk of a battery fire could quickly escalate. However, if these safety measures are effectively enforced, such a risk can be significantly mitigated. By prioritising these comprehensive safety precautions, shipping companies are demonstrating their commitment to maintaining a safe environment during the transportation of high-tech automotive products, protecting both personnel and valuable cargo.

l) Trained Personnel [12]

- **Ensure resources are well-trained in risk awareness, health and safety protocols with safe work practices. Resources are recommended to be minimum trained under the Malaysian Skills Certificate (SKM) Level 3 based on National Occupational Skill Standards (NOSS).**
- **Appropriate PPE to be provided and safety shoes without steel-based materials are required to be worn.**

Narrative

To ensure a safe working environment, it is necessary to ensure that personnel involved in the handling and transport of EV are well trained in risk awareness, health and safety protocols and safe working practises. For example, according to the Malaysian National Occupational Skill Standards (NOSS), it is recommended for employees working in this field to obtain at least the Malaysian Skills Certificate (SKM) Level 3, which includes comprehensive training on the potential hazards associated with EV and their batteries, as well as emergency response procedures. In a scenario where a worker is tasked with loading EV onto a transporter, their training must prepare them to recognise risks such as battery leakage or fire hazards so that they are able to take appropriate action to mitigate these threats. In addition, the provision of appropriate personal protective equipment (PPE) is mandatory. This includes gloves, safety goggles and safety shoes without steelcontaining materials to reduce the risk of electrical hazards and injuries from falling objects. For example, if a worker wearing standard steel-toed boots accidentally steps on a liquid battery part, the steel toe cap could conduct electrical energy and pose a significant safety risk. When companies provide trained employees with appropriate protective equipment and ensure they have the necessary qualifications, they not only meet industry safety standards, but also promote a safety culture that minimises workplace incidents and improves overall operational efficiency.

m) Vehicle Checklist

Port personnel to use approved tally sheets (vehicle checklists) to accept EV from RORO vessels and carry out inspection accordingly.

Narrative

The use of approved inspection sheets or vehicle checklists is essential for port personnel when receiving EV from ships to ensure a systematic and thorough inspection process. For example, when a cargo of EV arrives at the port, personnel must use the checklist to verify that each vehicle matches the shipping documents, has no visible damage, and that all safety equipment such as battery casings and charging ports are intact and functional. If port personnel discover discrepancies, such as a vehicle showing signs of damage that were not reported during loading, they can use the checklist to document the problem immediately, facilitating communication with the shipping company and ensuring accountability. In addition, the checklist can include specific sections noting the state of charge (SOC) of the batteries as well as compliance with safety protocols to ensure that all critical elements related to the safe handling of EV are assessed. By adhering to this structured approach, port personnel can minimise the risks associated with accepting these technologically advanced vehicles and promote a culture of care and thoroughness that ensures cargo integrity and operational safety. This thorough inspection process not only protects the investment in these high-quality vehicles, but also increases the overall efficiency of the logistics chain.

n) Competent Drivers

While transporting EV from wharf to dedicated storage area, competent drivers shall be deployed, adherence to port speed limit is compulsory.

Narrative

The use of competent drivers to transport EV from the quayside to specific storage locations is crucial for the safety of both the cargo and the personnel involved in the logistics process. For example, when a cargo of high-value EV arrives at a port, the responsibility lies with trained and qualified drivers who understand the intricacies of handling such high-value and technologically advanced vehicles. These drivers must adhere to the port's speed limit, which is designed to protect workers and equipment as well as maintain a safe environment in busy loading zones. If a driver exceeds the speed limit while travelling through a busy area, the risk of collisions with employees or other vehicles increases significantly, which can lead to costly damage and injury. Conversely, a competent driver who adheres to the speed limit and drives defensively can navigate more safely in confined spaces, minimising the risk of accidents while ensuring that EV remain safe and undamaged during transport. In addition, adhering to established protocols and speed limits demonstrates a commitment to maintaining a safe operating environment, promotes confidence among stakeholders and increases the overall efficiency of the logistics chain. Competent drivers are key to the successful and safe transport of EV in port facilities.

o) Traffic Controller Deployment

To ensure safe transportation of EV from wharf to dedicated area, traffic controller from port personnel shall be deployed.

Narrative

To ensure the safe transport of EV from the quayside to dedicated storage areas within a port, the use of a traffic controller, who is a port staff is essential to manage vehicle movements and minimise potential hazards. In a busy port environment where multiple vessels are loading and unloading cargo simultaneously, the traffic controller acts as an important coordination point, directing drivers to designated routes and ensuring that heavy equipment and pedestrians do not get in the way of EV. In a scenario where a load of EV is being transported on a particularly busy day, the traffic controller can communicate effectively with drivers via hand signals or radio to prevent accidents by ensuring that drivers stick to safe speeds and follow designated routes. Should an unexpected situation arise, such as a broken down vehicle blocking a major access road, the traffic controller can quickly implement an alternative plan and re-route traffic to minimise delays while ensuring safety. By monitoring traffic flow and providing clear instructions, the deployed traffic controller improves operational efficiency and safety and enables the seamless transfer of EV within the port. At the same time, it protects both vehicles and personnel from potential risks associated with the high volume of traffic and activity.

p) Safety Protocols

Prohibit smoking, horseplay and handphone use while driving EV, deploy signalmen/traffic controllers, follow traffic regulations and ensure parking standards are met.

Narrative

Establishing robust safety protocols for the movement of EV in port facilities is critical to minimise risk and ensure the welfare of personnel and equipment. To create a safe working environment, protocols should prohibit smoking, loitering and the use of mobile phones while driving EV. For example, if a driver is distracted a phone call or a passenger, the likelihood of accidents and mishaps increases significantly, especially in a busy port area where awareness of surroundings is paramount. The use of signalling systems or traffic controllers to regulate the flow of traffic further increases safety as they provide clear instructions to drivers, avoiding confusion and potential collisions. During rush hour, for example, traffic controllers can help guide drivers safely through congested areas and ensure that they adhere to the applicable traffic rules and maintain a safe speed. In addition, enforcing strict parking regulations is crucial. Proper parking protocols ensure that EVs are parked in designated areas without obstructing pathways or emergency exits, which is especially important in emergency situations when immediate access is required. By consistently following these safety protocols, ports create a safer operating environment that protects valuable cargo and promotes the safety of everyone involved in the transport of EV.

q) Hazard-Free Areas

Ensure parking standard requirement of 1.5 ft radius between car is adhered to.

Narrative

Compliance with parking standards that require a minimum 1.5 - foot radius between EV is critical to creating hazard-free areas in port facilities. This spacing requirement helps to minimise the risk of accidental contact between vehicles that could result in damage or, in the case of EV, potential hazards to the batteries. For example, when a load of electric off-road vehicles arrives at the port, maintaining the prescribed distance between each vehicle ensures sufficient air circulation and reduces the risk of overheating, which is an important consideration given the sensitivity of lithium-ion batteries. In a scenario where vehicles are parked too close together, a slight shift or movement could result in one vehicle coming into contact with another and causing dents, scratches or worse - jeopardising the integrity of the battery systems. However, by maintaining a 1.5 foot radius, port personnel can safely manoeuvre around vehicles, carry out inspections or prepare them for transport without the risk of collision. By adhering to this parking standard, port facilities actively contribute to a safer working environment by protecting vehicles while promoting efficient operations that protect both personnel and valuable cargo.

r) Handing Over EV at Storage Areas

Before exiting the EV car, driver to ensure engine completely switched off and hand brake applied completely.

Narrative

Establishing a thorough protocol for the handover of EV before leaving the vehicle is crucial to ensure safety and avoid potential hazards. Before leaving the vehicle, it is imperative that the driver ensures that the electric motor is fully switched off and the handbrake is applied. For example, if a driver is delivering a new batch of EV to a storage yard in the port area, failure to properly switch off the vehicle could result in unintended acceleration if a malfunction occurs while the vehicle is unattended. Furthermore, if the handbrake is not fully applied, the EV could roll away, especially when parked on an incline, posing a hazard to other vehicles, people and property in the vicinity. In a scenario where a driver forgets to apply the hand-brake, they could leave the vehicle momentarily to assist the charging team and on their return find that the electric car has rolled into another vehicle or facility, causing damage and potentially injury. By implementing a clear and consistent process, which includes checking that the engine is switched off and the handbrake is applied, companies not only increase the safety of their operations, but also instil a sense of responsibility in drivers and promote a culture of care and accident prevention when handling EV.

5.2.4 Storage of EV/Loose EV Batteries (EVB)

Storage of EV and loose EVB at port of loading and discharge, distribution centres or dealerships necessitates specific conditions to ensure the batteries remain in optimal and safe condition. This process involves:

a) Storage Requirement

Ensure EV storage areas are clear from hazards (10 meters away from combustible materials/ hot work activities).

Safety and Emergency Preparedness:

- Ensure proper electrical safety measures (e.g., surge protection), ventilation/exhaust systems to manage gas emissions and real-time monitoring systems for temperature, humidity and hazard ous gases with alerts for anomalies.
- Develop and regularly update an emergency response plan.
- Conduct regular risk assessments and implement mitigation measures.
- Establish protocols for the safe storage, handling, disposal or recycling of damaged or end-of-life batteries.

For loose EVB, requirements below shall be adhered but not limited to:

- Provide specialised training for personnel handling and managing EVB.
- Ensure clear labelling[23] of batteries and maintain detailed documentation for inventory management.
- Ensure compatibility of stored batteries to prevent adverse reactions.
- Storage condition in accordance with OEM requirements
- Compartmentalised zones with temperature and humidity regulated controls, monitoring of charge and vibration level, based on manufacturers' recommended standards and requirements.
- Racking for EVB should be insulated.
- Safety Features
    - Corrosive Gas Geotechnical
    - Atmospheric pressure 86 KPa - 106 KPa
    - Special tools to check physically on battery condition
    - Components of the EVB should be segregated from that of ready-made EVB
- Building Codes
    - UBBL 1984
    - Malaysian Standards
    - Other relevant international standards

Narrative

Establishing comprehensive requirements for the storage of EV and loose EVB is critical to ensuring safety and optimal condition. For example, storage areas for EV must be at least 10 metres away from flammable materials and hot work processes to minimise the risk of fire. This also includes installing surge protection for electrical systems, maintaining adequate ventilation to control gas emissions and installing real-time monitoring systems for temperature, humidity and hazardous gases, including alerts for anomalies. An emergency plan should be developed and regularly updated. Conducting risk assessments helps to identify potential hazards and enables effective remedial action to be implemented. A practical scenario is a distribution centre where loose EVBs are stored. Employees need to be specifically trained in the correct handling of these batteries and clear labelling along with detailed inventory documentation is essential for effective management. To avoid further undesirable reactions, the compatibility of the stored batteries should be ensured and the storage conditions must comply with the manufacturer's OEM (Original Equipment Manufacturer) guidelines. For example, the racking systems for electric car batteries should be insulated and the storage rooms should have regulated temperature and humidity control as well as state of charge and

Narrative

vibration monitoring. Building regulations, such as UBBL 1984 and other relevant standards, must also be adhered to, including a fire suppression system and corrosive gas controls. If a warehouse is equipped with specialised tools to check the condition of the batteries, potential problems can be detected at an early stage. Storing EVB components and finished EVB separately increases safety and compliance. By following these thorough guidelines, facilities can ensure the safe and efficient storage of and their batteries, protecting both employees and valuable assets.

b) Regular Inspections

Conduct regular inspections on EV to ensure their condition matches the arrival tally sheet.

Narrative

Regular inspections of EV to ensure their condition matches the arrival list are essential for maintaining quality control and safety standards in storage facilities and car dealerships. For example, in a scenario where a shipment of electric cars arrives at a distribution centre, port personnel rely on an arrival list that details the expected condition and specifications of each vehicle. During a routine inspection, a technician might find that one of the vehicles shows signs of damage that was not documented upon arrival, such as dents or scratches. This discrepancy could indicate mishandling during transport and require further investigation into shipping practises to prevent future incidents. By systematically checking each EV against the tally sheet, personnel can ensure that any discrepancies are documented and addressed promptly to avoid potentially dangerous situations such as battery malfunction that could result from damage in transit. Regular inspections also allow operations to maintain accurate inventory records and adhere to manufacturer standards, which promotes customer confidence and satisfaction as they receive vehicles that meet the expected quality. Therefore, establishing a consistent inspection routine is not only crucial for operational efficiency, but also for protecting the integrity of EV throughout their lifecycle in storage and distribution.

c) Flood Prevention

Ensure storage areas are free from flooding or water ponding.

Narrative

For both the protection of the vehicles and the safety of employees, it is important that the storage areas for EV and their components are free from flooding or water ponding. For example, if it rains heavily, water can accumulate in a poorly designed storage area without adequate drainage systems, which can lead to flooding. This situation can lead to serious electrical hazards, especially for EV and their lithium-ion batteries, which are sensitive to moisture. If a fleet of newly arrived electric SUVs are stored in such a flooded area, the water could penetrate the battery compartments, compromising their integrity and bringing with it the risk of a short circuit or even a fire. To minimise these risks, facilities should be regularly checked and maintain their drainage systems, ensure that storage floors are raised and properly sloped, and take preventive measures such as installing sump pumps. During the rainy season, implementing a contingency plan to relocate vehicles away from vulnerable areas can further increase safety. By proactively managing water exposure in warehouse or parking areas, organisations not only protect their valuable assets, but also promote a safer working environment by ensuring compliance with safety regulations and increasing confidence in their operations.

d) Access Control

Prevent unauthorised access and record all in/out movements.

Narrative

Implementing strict access control measures to prevent unauthorised entry and meticulously recording all entry and exit of EV is essential to maintaining security and accountability in warehouse facilities and car dealerships. For example, in a scenario where an assembly line worker without proper credentials attempts to enter an area where high-value EV are stored, without effective access control, such as security gates, identity checks and access card systems, this could lead to theft, vandalism or unsafe handling of the vehicles. By setting up a secure entrance where all employees must sign in and out and monitoring the area with CCTV cameras, facilities can track who comes in and out and when, deterring unauthorised persons and increasing overall security. In addition, recording movements in and out of the storage area allows for better inventory management. If a vehicle is lost or reported damaged, the facility team can quickly review access logs to identify possible points of entry and individuals involved. This system promotes a culture of safety and accountability, ensuring that only authorised personnel handle the sensitive EV and that any incidents can be promptly and thoroughly investigated. Ultimately, effective access control not only protects valuable assets, but also improves operational efficiency and compliance.

e) Dwell Time Compliance

Ensure EV dwell time aligns with the EV declaration.

Narrative

It is important that the dwell time of EV complies with the EV declaration in order to optimise logistics processes and comply with legal regulations. For example, in a scenario where a shipment of EV arrives at a port and is declared for a maximum dwell time of 72 hours before being forwarded to distribution centres, if the vehicles remain in port for longer than this prescribed time without justification, this could lead to increased storage costs and logistical inefficiencies, as well as potential import compliance issues. In addition, too long a dwell time can lead to vehicles being exposed to environmental factors such as humidity or temperature fluctuations, which can have a negative impact on sensitive battery systems. By closely monitoring the dwell time and actively managing the logistics plan in accordance with the EV declaration, port staff can minimise unnecessary delays. For example, if port operators notice that a particular cargo is approaching its dwell time limit, they can speed up the unloading process or arrange for immediate transport to the next location. This proactive approach not only ensures compliance, but also improves operational efficiency, fosters positive relationships with manufacturers and dealers, and ultimately ensures that customers receive their vehicles in optimal condition and on time. Setting up automatic alerts for dwell time thresholds can further increase efficiency and allow for quick decisions and actions when needed.

5.2.5 Delivery to Showroom

The final stage involves the transportation of EV from storage facilities to showrooms, where they will be made available to customers. This stage encompasses:

a) Customs Approval

Obtain approval from Customs/OGA for the EVs to move out from the port.

Narrative

Obtaining authorisation from the relevant authorities, such as Customs or Other Government Agencies (OGA), is a crucial step before EVs can be transported out of the port. For example, when a shipment of new EV arrives at a port facility, port operators must ensure that all required documentation, including import licences, invoices and certificates of conformity, are presented to customs for inspection. If discrepancies or missing paperwork are found during Customs inspection, the approval process can be delayed, resulting in costly fees and charges, and disrupting the planned showroom delivery schedule. Conversely, a well-prepared logistics team that anticipates customs requirements and ensures that all documentation is correct can expedite the approval process so that EVs can be quickly released for transport. For example, a logistics manager performs a pre-shipment inspection and finds that certain documents are missing. This proactive approach not only minimises delays, but also strengthens compliance with import regulations so that EVs can be seamlessly moved from the port to the showroom, where they are ready for customers to view and purchase.

b) Battery Issues

Prohibit jump-starts and inform supervisors/PIC if the battery is flat to determine the next course of action.

Narrative

To ensure the safety and proper handling of EV, it is important to prohibit jump starts and inform supervisors or the person in charge (PIC) when a battery is dead. For example, if a delivery driver at a car dealership attempts to jump-start an EV with a dead battery, this can pose significant risks, such as damaging the vehicle's complicated electrical systems or triggering safety mechanisms in the battery management system. Instead, if the driver immediately informs the supervisor of the situation, the team can consider the best course of action. This could include plugging the EV into a designated charging station to properly charge the battery or, if necessary, having a qualified technician assess the condition of the battery. By creating a protocol that emphasises communication and proper procedures for dealing with dead batteries, companies can prevent potential damage to vehicles and maintain operational efficiency. Such proactive measures not only protect the integrity of EV, but also ensure compliance with safety standards and ultimately lead to greater customer satisfaction as vehicles are delivered ready for use without unexpected issues.

c) Safe Transport

Ensure EV are transported safely to showrooms by using approved Road Car Carrier with competent operators.

Narrative

To ensure the safe transport of EVs to showrooms, it is important to use authorised road car carriers operated by competent personnel. For example, if a load of EVs is to be delivered from a port to various car showrooms, choosing a road car carrier that meets industry standards and has been tested for safety is crucial. Competent personnel who are trained in handling high-value vehicles and understand the special requirements of transporting EV plays an important role in minimising risks during transport. In a scenario where the road car carrier is faced with unexpected weather conditions, an experienced driver can effectively navigate the route while adhering to safety protocols to keep the vehicles safe and undamaged. Using appropriate securing techniques and equipment, such as non-conductive belts to avoid electrical hazards, will significantly reduce the risk of damage during transport. By prioritising safe transport practices through the use of approved carriers and thoroughly trained staff, companies can ensure that EV arrive at showrooms in pristine condition and ready for customers, while reinforcing their commitment to quality and safety throughout the logistics process.

5.2.6 In the Showroom

After the final stage of the back-end processes, in which the EVs are delivered to the showroom, the intermediate stage of handing over the vehicles to the front-end processes is the temporary staging of the vehicles before they are sold to consumers. The requirements for this staging in the showroom are:

a) Adoption of MS 2725:2021

- The adoption of MS 2725:2021 on the requirements for the Sales of Motor Vehicle covers the responsibilities related to the requirements for the management system, which includes the 4M framework - Man, Machine, Material and Method. This framework applies to the sale of motor vehicles of categories L, M, and N in accordance to MS 1822.

b) Requirements for Showroom

- The layout and requirements of the showroom should include the following:
  - The PPE area must be designed and equipped with safety shoes/boots, safety glasses, gloves (safety or disposable), protective clothing, such as apron/overalls and high-visibility vest to ensure the safety and comfort of employees when handling customers and vehicles.
  - Depending on the size of the showroom, charging stations for EV can be provided – preferably with at least 1 charging station and must comply with ST legal requirements.
  - Emergency Responder Plan (ERP) equipped with fire blanket, sprinkle system, fire extinguisher etc.
  - An SOP procedure for the management of EV in the showroom (e.g. records of EV – chassis number and battery), including delivery and handover of EV to customer, preferably with a formal checklist (in conjunction with Guideline No. 5.1.1)

c) Employees in Showroom

- Employees in showroom:
  - Sales Manager
  - Sales Advisor
  - Product Specialists
  - Customer Relationship Executives (CRE)
  - First Safety Responder (dedicated person)

  All such employees in the showroom should be competency trained in risk awareness, health and safety protocols with safe work practices. Resources is recommended to be minimum trained under the Malaysian Skills Certificate (SKM) Level 3 based on National Occupational Skill Standards (NOSS).

Narrative

In the final stages of preparing EV for showroom sales, it is important to establish a comprehensive temporary staging area that fulfils the requirements of MS 2725:2021. This includes incorporating the 4M framework - man, machine, material and method - to ensure an efficient and safe sales process for L, M and N category vehicles. For example, the showroom must have a well-designed PPE area equipped with safety shoes, gloves and high-visibility waistcoats so that employees such as the sales manager, sales advisors and product specialists can interact with customers and handle the vehicles safely. Let us say a customer visits the showroom to enquire about their options. The staff, who are trained in health and safety protocols, would certainly help him by using the right PPE and explaining the benefits of EV. In addition, at least one EV charging point should be installed so that customers can experience the convenience of charging, while the Emergency Response Plan (ERP) ensures that safety equipment such as fire extinguishers and fire blankets are easily accessible for emergencies. In addition, a standard operating procedure (SOP) for managing EV in the showroom, with a formal checklist for the delivery and handover process, ensures that all important information such as chassis numbers and battery details are carefully recorded and verified. The First Safety Responder, a dedicated employee trained to Malaysian Skills Certificate (SKM) Level 3, oversees these safety measures and ensures that the entire process through to sale is seamless and safe for the team and customers.

CONCLUSION
for the Back-End Process and Specific Requirements

Effective management of EVB across all back-end processes is critical to the safety, performance and longevity of EV. This encompasses several key areas, including manufacturing, transport, shipping, logistics, storage and delivery.

In the manufacturing phase, strict quality control measures ensure that each battery fulfils the highest safety standards and specifications. This includes the use of highquality materials and adherence to safety guidelines to avoid defects that could affect performance or safety.

During transport and shipping, it is important to follow best practise, such as using approved RORO vessels or Road Car Carriers and ensuring that all staff involved are trained in the safe handling of EVB. This will minimise the risk of damage or malfunction that can occur due to improper handling or unfavourable conditions.

Logistics and storage also play an important role. Ensuring that EVBs are stored in a controlled environment with regulated temperature and humidity can prevent damage and maintain optimal battery performance. Regular inspections and strict adherence to safety protocols will help identify potential problems before they escalate and ensure batteries remain in good condition.

Finally, it is important to ensure that EV arrive at their destination safely and efficiently upon delivery. This includes thorough inspections and proper documentation to ensure that the vehicles are in optimal condition before they are handed over to customers.

By applying best practises in all these processes, manufacturers and dealers can guarantee the safe delivery of EV to their customers. This commitment not only increases customer satisfaction and trust in the brand, but also promotes the overall growth and acceptance of the EV market.

To promote inclusiveness and adaptability in the evolving landscape of battery technology, it is advisable to use more general terms such as “low-voltage battery” or “high-voltage battery” rather than focusing exclusively on the term, lithium-ion batteries. This approach recognises the existence of different battery types in the market, all of which have the potential for significant growth and innovation in the future.

6.0 ACKNOWLEDGEMENT

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Special thanks go to the industry players, experts and associations involved in the discussions for the development of the Guidelines. Their analysis and recommendations have ensured that the Guidelines are comprehensive, relevant and future-focused. Their invaluable feedback has helped to adapt the Guidelines to industry best practices in order to meet consumer expectations. Their diverse perspectives have enabled us to address a wide range of topics with depth and nuance.

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7.0 END-NOTES AND REFERENCES

[1] Low-voltage and high-voltage batteries serve different purposes in EV and other applications due to their distinct characteristics.
Low-Voltage Battery: Typically, a low-voltage battery in an EV is a 12-volt battery, similar to those found in traditional internal combustion engine vehicles. It powers the vehicle's auxiliary systems, such as lights, infotainment, air conditioning controls, and other electronic systems. Its primary role is to start the systems and provide backup power for safety features and essential electronics when the vehicle is off.
High-Voltage Battery: A high-voltage battery is central to the operation of an EV, as it provides power to the EV. These batteries typically operate at several hundred volts, depending on the vehicle, and are responsible for driving the vehicle. High-voltage batteries allow for the regenerative braking process, which helps recharge the battery during braking. Their large capacity and higher voltage enable them to deliver the substantial energy needed for propulsion efficiently.
The combination of both low and high-voltage systems ensures that EV have the necessary power and efficiency to support both driving needs and everyday electrical functionalities. The term lithium battery is used as a general term to cover all kinds of lithium-based batteries, including all the different types of polymers.

[2] New EV owners should be provided basic knowledge on how to handle the EV, including additional knowledge on fundamental understanding on the ownership of an EV. Download the additional handbook available at: http://www.geotab.com/CMS-GeneralFiles-production/UK/Resources/Whitepapers/EV_Drivers_Handbook-Feb2022.pdf

[3] The Planning Guidelines for EV Charging Bay (EVCB) issued by Department of Town and Country Planning (PLANMalaysia), under Ministry of Housing and Local Government (KPKT) prepares the State Authorities (PBN) and Local Authorities (PBT) in the planning and design guidance for the development and approval of EVCB in the respective localities.

[4] For details of the home charging solutions, please refer to the Guide on EV Charging System (EVCS) under Section 5.1 Modes of Charging). This Guide was issued by Suruhanjaya Tenaga (Energy Commission) Malaysia.

[5] Should also refer to the Guide on EV Charging System (EVCS) issued by Suruhanjaya Tenaga (Energy Commission) Malaysia which prescribes minimum standards and specifications in the design, installation, inspection, testing, supervision, operation and maintenance for EV charging systems. It also highlights the international (IEC) and national standards (MS). It is important to note that this guide stated that in the absence of any MS standard, the relevant IEC standard shall prevail. The Planning Guidelines for EV Charging Bay (EVCB) issued by PLANMalaysia (Department of Town and Country Planning) under Ministry of Housing and Local Government (KPKT) which provides for the EVCB planning and design guidelines andEVCB development application and approval procedures. Another important guideline is the Fire Safety Guidelines issued by Fire and Rescue Department of Malaysia (BOMBA).

[6] The scope of each agency is as follows:
a. At the moment, The Energy Commission requires all old and new EV Charging station to obtain EV Charging license from the Energy Commission.
b. The standard requirement applicable to connecting cable, socket, inverter of the EV Charging Station has been established where SIRIM QAS is the appointed agency in carrying out the testing. However, the Energy Commission has yet to gazette a Rule that requires component in the EV Charging Station to be mandatorily tested and to comply with certain IEC standard. As such, the testing of components of the EV Charging Station has yet be mandatory at the moment.
c. The role of the National Metrology Institute of Malaysia (NMIM) is to provide services to calibrate all measurement equipment used in service or trading service. For example: petrol pump, lubricant filling machine or transmission fluid filling machine where calibration is mandatory. As such, it is also applicable to EV Charging Station.

[7] Discarded Lithium-ion battery is regarded as e-Waste and is under the preview of the Department of Environment (DOE). Classification of discarded Lithium-based batteries is SW103 and SW104. Currently, the collection centres approved by DOE only collect all e-Waste other than discarded lithium-based batteries. However, the AATF launched by DOE in March 2021 are designed and licensed for authorized facilities to carry out disposal of EV batteries.

[8] Battery Passport is the initiative by The Global Battery Alliance (GBA) which published a report: "Battery 2030: Resilient, sustainable and circular". GBA has conceptualized the Battery Passport as a framework to increase transparency across the battery value chain.

[9] Entry of EVB packs into Malaysia must meet Malaysian Standard MS 2687:2017, which provides for the safety of lithium-ion batteries used in EV and adhering to International Standard IEC 62660 and complying to UN Model Regulations 38.3 which specifically addresses the transportation of lithium batteries.

[10] Many manufacturers recommend that EVB be charged to a State of Charge of about 30% before transportation. This range is often considered optimal for reasons, such as Minimizing Risk of Thermal Runaway Batteries that are too full (close to 100% SoC) may be at higher risk of thermal runaway during transportation due to potential overheating. Lower SoC reduces this risk and Avoiding Deep Discharge: Batteries kept at a very low charge (close to 0%) can enter a deep discharge state, which may lead to permanent capacity loss or damage. Keeping the battery at an SoC of around 30% helps to avoid this.

[11] For details of AATF and the licensing requirements, visit:
https://marii.my/authorised-automotive-treatment-facility-aatf-application/

[12] Under Protocol 9 of the ASEAN Framework Agreement for the Facilitation of Goods in Transit (AFAFGIT) which provides the standards for ASEAN Transportation of Dangerous Goods (DG), including Malaysia, stipulate that drivers carrying DG should be competently trained and certified.

[13] Under the International Convention for Carriage of DG by Road 2023 (ADR 2023), drivers must be trained and certified under the ADR 8.2.1.2 to carry DG, including EV and EV batteries.

[14] NOSS SKM Level 3 refers to the National Occupational Skills Standard (NOSS) for a specific industry or sector in Malaysia. SKM stands for "Sijil Kemahiran Malaysia" meaning "Malaysian Skills Certificate". Level 3 indicates a higher level of competency and skill within a particular field, typically in more specialised tasks and responsibilities. For more details on NOSS SKM Level 3, visit website: https://www.dsd.gov.my/en/service/malaysian-skills-certificate-skm

[15] The United Nations has classified lithium batteries as hazardous materials under the UN Model Regulations. Specifically, lithium batteries are listed under UN3480 for lithium-ion batteries (not contained in or packed with equipment) and UN3481 for lithium-ion batteries contained in or packed with equipment. These classifications dictate how batteries should be packaged, marked, and handled.

[16] The International Maritime Organisation (IMO) has established guidelines for the transport of dangerous goods, including lithium-ion batteries, under the International Maritime Dangerous Goods (IMDG) Code. This code provides detailed requirements for the packaging, labelling, documentation, and stowage of lithium-ion batteries on ships.

[17] Shipping EV and EVB in containers is classified under Dangerous Goods (DG) regulations due to the hazardous nature of lithium-ion batteries, typically under Class 9 with additional classification for the lithium-ion batteries under UN3480 (if packed separately) and UN3481 (if contained within the EV). It is important to note that shipping EV in RORO vessels are not classified under DG regulations.

[18] IMDG Code Special Provision 188 provides that lithium-ion batteries should be transported at a SOC of no more than 30% of their capacity, to minimize the risk of thermal runaway or fire during transport.

[19] The UN Model Regulations 38.3 provides for the safety risk management and global compliance of handling and shipping of lithium batteries, particularly the regulations outlining specific packaging and labelling requirements, including use of non-conducive materials, inner packaging that prevent short-circuits, strong outer packaging to protect against damages and proper labelling indicating lithium battery (UN3480 or UN3841)

[20] The UK Marine Guidance Note No 653 (M) Amendment 1 provides the shipping industry with best practice guidance to facilitate safe carriage and potential charging of, EV onboard roll-on and roll-off (RORO) ferries. This amendment includes a section on the carriage of light such as e-bikes and e-scooters.

[21] The document entitled "Guidelines for the Safe Transportation of Electrical Vehicles" issued by ClassNK. This document is available for download at: https://www.classnk.or.jp/hp/pdf/activities/statutory/ev_carriage_safety/gl_ev_carriage_safety_e202308.pdf

[22] Car carriers are usually the Ro-Ro type and must follow SOLAS II-2/Re. 10 (Firefighting) and SOLAS II-2/Reg.

[23] Labelling should be marked clearly in either English or Malay.