2021 ELECTRIC ROAD RACING ASSOCIATION TECHNICAL REGULATIONS

Public Pre-Release 1

ERRA Technical Committee

Published 3rd March 2021

Contents

Preface

These regulations were created to provide a framework for electric motorcycle racing to take place safely and sustainably while safeguarding the interests of riders, teams, event organisers, track owners and all other interested parties.

Material and best practice was gathered from UN type approval documents, international technical standards and regulations published by other electric racing series. The practical experience of the technical committee and invited experts was incorporated, as well as lessons learned from previous electric motorcycle racing series.

The guiding principle for the whole document has been safety equivalence: such that electric motorcycle racing, on track, in the paddock, during charging and transportation should be as safe or safer than the internal-combustion equivalent. These regulations primarily relate to electric motorcycle-specific risks and hazards and how they can be controlled and mitigated.

A well-designed electric-motorcycle can have an excellent safety record and have world-beating performance but equally, poor design decisions or manufacturing can pose major fire and shock hazards to competitors, marshals and the general public. These regulations are about ensuring all electric motorcycles are designed and constructed to an acceptable standard to ensure these hazards are mitigated and controlled.

As the technical committee we hope that the whole electric-racing community will foster a culture of openness around best practice for electric motorcycle design. We are open to suggestions to improve, clarify or simplify the regulations. We encourage anyone considering building modifying or otherwise racing an electric motorcycle to discuss your plans with ERRA in the first instance; we want you to succeed and can point you in the right direction, no matter what level of expertise or background you have.

To get in touch please email regulations@erra.bike.

For the remainder of the documents, references to “you” refer to constructors, competitors, teams and any other party wishing to race or build an electric motorcycle for competition use at events applying these rules. “Us” and “we” refer to the Electric Road Racing Association and its technical committee.

Article 1 Scope

1.1 All electric motorcycles wishing to enter events sanctioned by us, or events where organisers have adopted these rules unilaterally, must comply with these regulations in full. The term "motorcycle" is used within this document to refer to any vehicle that falls within the scope of these regulations, primarily electric solo-competition motorcycles.

1.2 Any reference to high voltage (HV) shall be interpreted as per ISO 6469-1:2019 [5], namely voltages greater than 30 V_{ac} and less than or equal to 1000 V_{ac} or greater than 60 V_{dc} and less than or equal to 1500 V_{dc}.

1.3 Low voltage (LV) shall be interpreted as per ISO 6469-1:2019 [5], namely voltages lower than 60 V_{dc} and less than or equal to 30 V_{ac}.

1.4 Motorcycles may utilise propulsion systems operating at high voltage, low voltage or both.

1.5 Technical innovation is encouraged, so if in doubt please seek guidance from of us before committing to any tuning, modification, technology, upgrade or similar. We can provide clarification on any aspects to help you compete effectively.

1.6 While every effort has been made to ensure these rules are complete, we may make changes to these regulations on grounds of safety, enforceable immediately without notice, at any time. This document is concerned with electric motorcycle specific regulations, primarily power train, electrical safety, battery safety and charging. Regulations which would be common to all competition motorcycles regardless of propulsion method are out of scope. For example, these regulations do not cover elements such as suspension or mechanical braking. National regulations, such as those from the ACU should be followed in these cases.

1.7 In the unlikely event, where national technical rules are written in such a way that they are impossible to comply with for electric motorcycle, please contact us.

Article 2 Glossary

2.1 Original equipment manufacturer (OEM): a type approved vehicle manufacturer, not necessarily of just motorcycles.

2.2 FCEV: Fuel Cell Electric Vehicle, likely incorporating hydrogen and a small battery pack.

2.3 Sporting regulations: also referred to as a sporting code, the event or class specific rules for competitors, motorcycles etc. and how championships points or race formats will operate.

2.4 Electric Motorcycle Passport (EMP): a document issued by us (ERRA) which allows electric motorcycles to enter and compete at events.

2.5 Motor: an electric machine, primarily used for propelling the motorcycle.

2.6 Motor controller: a device that controls the motor speed and torque based on rider input.

2.7 Dielectric fluids: fluids, primarily liquids, with a very low electrical conductivity, primarily designed for use as coolant in live or potentially live equipment.

2.8 MSDS: Material Safety Data Sheet, alternatively referred to as an SDS or Safety Data Sheet. Provides the chemical composition and any hazards associated with a given chemical or substance.

2.9 Toxicity report: a document relating specifically to the toxicity of a substance or chemical, usually included within an MSDS.

2.10 Spill kit: the equipment and consumables required to expediently clean up and clear away spillages of a particular substance or fluid.

2.11 Capacitor: a charge storage device.

2.12 Contactors: like a relay (electronic switch) but for higher currents.

2.13 Manually operated service switch: often referred to as a manual service disconnect. Isolates the battery pack during service or maintenance operations.

2.14 BMS: Battery Management System, a system that monitors battery parameters and makes decisions to ensure the battery remains within the manufacturer's specifications.

2.15 Vehicle Control Unit (VCU): frequently referred to as an ECU. A vehicle computer that manages various vehicles systems and functions.

2.16 High Voltage Interlock Loop (HVIL): An auxiliary circuit that, when closed, indicates that all high voltage connectors are securely mated.

2.17 Isolation monitoring system: a system that continuously monitors the isolation resistance between the high voltage system and the low voltage system ensuring they are never connected.

Article 3 Electric Motorcycle Types

3.1 A standard motorcycle is defined as "as-built" by the original equipment manufacturer (OEM): specifically any electric motorcycle produced in series production to be road-legal by its original manufacturer is acceptable. Modifications allowed by national body regulations, such as the ACU, in order to prepare a motorcycle for competition are allowed and required. ONLY prescribed electric motorcycle-specific modifications to comply with these rules, on safety grounds are allowed.

3.2 A prototype motorcycle is an electric motorcycle that does not meet the definition of standard motorcycle.

3.3 Hydrogen fuel cell electric motorcycles are permitted. However, competitors are required to prove that the system is safe for operation by way of additional documentation, research and evidence of testing. Competitors wishing to compete with such a vehicle are required to contact us in the first instance so that FCEV-specific safety and testing requirements can be discussed.

3.4 These technical regulations cover all motorcycles, but not every regulation shall apply to every motorcycle. For example, regulations regarding high voltage do not apply to motorcycles with only low voltage systems.

3.5 These technical-regulations, in most cases, will be supplemented and augmented by discipline-specific sporting regulations. For guidance purposes, categories may be broadly related to indicative lap times and may not be tied to any one particular metric, such as power, energy or mass.

3.6 All motorcycles, including standard motorcycles must undergo and pass a formal inspection to be granted an Electric Motorcycle Passport (EMP).

3.7 Competitors must be in possession of a valid EMP in order to compete irrespective of discipline or category. For prototype motorcycles this involves a detailed technical inspection of the entire motorcycle including any electrical systems. For standard motorcycles the inspection will focus on ensuring that the motorcycle remains standard and that there are no unauthorised modifications. Electric Motorcycle Passports are issued and certified exclusively by us.

3.8 See Article 9 for further explanation of the inspection process.

Article 4 Motors and Motor Controllers

4.1 Any number of motors and motor controllers is allowed in any configuration for any purpose.

4.2 Motorcycles may be driven by any wheel or combination of wheels.

4.3 Motorcycles where torque is directly or indirectly delivered to all wheels or only to a front wheel must provide evidence of safe operation, by way of sufficient testing, simulations and/or calculations. This evidence will need to be presented to us as laid out in Appendix A.

4.4 Front to rear torque vectoring is allowed.

4.5 Hub and in-wheel motors are allowed.

4.6 Only motors and motor controllers built to a recognised safety standard are permitted. Custom-built or modified motors and inverters may be allowed but documentation of good engineering practice must be provided to us as laid out in Appendix A prior to inspection demonstrating safety at a system and/or vehicle level.

4.7 Repurposing of OEM motors and motor controllers is allowed.

4.8 Brushed DC motors are permitted but motors with exposed commutators must be fitted with a commutator shield.

4.9 If the motor or motor controller is liquid cooled, its coolant must be specified to us as laid out in Appendix A prior to inspection. The use of conventional oils and dielectric fluids is permitted, subject to specific approval by us. In these cases, additional evidence must be submitted prior to inspection, as laid out in Appendix A including, an MSDS, toxicity report, spill kit requirements, engineering and safety statement from the competitor and any testing undertaken by the competitor, manufacturer or reliable third-party.

4.10 If the motor is air-cooled, all ventilation holes must be small enough to prevent the passage of a 12.5 mm diameter spherical test object through all holes, equivalent to IP2X[2]. Some level of particulate ingress protection should be employed and must be justified at time of EMP inspection.

4.11 All motor and motor controller connections that use bolted HV terminals must be fitted with terminal covers that are sealed to satisfy the requirements of IP44 ingress protection rating or higher[2].

4.12 Under normal conditions, the motorcycle must be able to freewheel in forward and reverse directions when turned off and de-energised. The tractive system should not apply excessive resistance to the rotation of the wheels.

Article 5 Battery Pack

5.1 Normally the battery pack is expected to be of the electrochemical battery type but other technologies may be used in any combination within a single cohesive battery pack. Only a single traction battery pack may be installed in a motorcycle. Any battery pack type approved for a standard motorcycle is considered a single battery pack, regardless of physical configuration, for the purposes of these regulations.

5.2 Capacitor energy storage is permitted but it must be integral to the battery pack.

5.3 Flywheel energy storage systems may be allowed, exceptionally. Contact us before committing to using this technology.

5.4 Capacitors whose primary role is not for energy storage are allowed outside of the battery pack, for example in motor controllers for decoupling or filtering.

5.5 The maximum power output and energy storage capacity are unlimited by these regulations but additional requirements may exist in any sporting regulations for particular classes or events.

5.6 On standard motorcycles, the battery pack, motor, motor controller and the interconnections themselves cannot be modified to increase power or to allow the battery pack to operate at unsafe temperatures. This includes software changes to motor controllers or similar changes expressly aimed at increasing maximum power draw from the battery pack. External cooling modification to the battery pack, for example additional ducting, may be allowed with prior approval by us as laid out in Appendix A.

5.7 For prototype motorcycles, the maximum voltage present anywhere on the vehicle must not exceed 1500 V_{dc} or 1000 V_{ac}[5]. For standard motorcycles the maximum voltage is as intended by the OEM.

5.8 The battery pack must be appropriately fused to prevent over-current in the event of short circuit. This must be located inside the battery pack enclosure(s).

5.9 Each HV Circuit must be appropriately fused for the current rating of the cable used. It is acceptable to use the main battery fuse for any circuit that has appropriately sized cable.

5.10 Any Prototype motorcycle with an HV battery pack must be capable of being isolated from the rest of the tractive system by at least two independent systems, for example contactors on both the positive and negative poles of the battery pack, and a manually operated service switch or removable link. There must be at least one manually operated system and one automatic system under control of the BMS, Vehicle Control Unit or similar. For prototype motorcycles with only an LV tractive system, only one battery isolation system is required. Regulations for a manually operated service switch or removable link is recommended for 2021 and mandatory from 2022.

5.11 The battery pack must be installed within, or integral to, the main structure of the motorcycle. The battery pack does not have to be fully enclosed by a frame or similar, but care must be taken to ensure the battery pack will not directly impact the ground if the bike is dropped. This could be achieved, for instance, by the use of a frame member, crash bobbins or careful positioning of the pack.

5.12 The battery pack enclosure must satisfy the requirements of IP44 ingress protection rating or higher[2]. The body of the vehicle may form part or all of the enclosure.

5.13 Battery pack modules must be suitably mechanically secured inside an enclosure fit-for-purpose, typically of metallic or composite construction. Evidence of this must be provided to us as laid out in Appendix A. Any covers or access panels must be sealed and secured requiring tools to remove.

5.14 Enclosures must be designed to retain all cells and modules in the event of a reasonably foreseeable crash by following good engineering practice. Evidence of this must be provided to us as laid out in Appendix A

5.15 The battery pack must be designed to prevent short circuit of the conductive parts.

5.16 All external HV connections to the battery pack must be made using either proprietary HV connectors with High Voltage Interlock Loop (HVIL) or cable glands. If cable glands are used, they must be of suitable size and rating to match the cable and voltage while preserving the ingress protection rating intended of the enclosure. The design of the cable connections must be such to enable the cables to be safely disconnected and extracted from the battery pack under all conditions.

5.17 The enclosure containing the cells, must also contain the BMS voltage and temperature sensing elements associated with the cells, manual service disconnect, fuses and contactors or similar safety and control equipment.

5.18 Commercially available cells or modules must be used. Custom cells may be allowed subject to approval by us and evidence of good engineering practice being followed in their design and manufacture presented to us as laid out in Appendix A

5.19 It is prohibited to modify individual cells, off-the-shelf modules or repurposed OEM battery modules except for the fitment of an approved BMS or additional temperature sensors. Exceptions will be made for OEM cells that the competitor can produce the UN83.3 and MSDS for.

5.20 You must supply documents from the cell or module producer specifying safety relevant data, including manufacturers' data sheet, UN38.3 report and Material Safety Data Sheet (MSDS. This must include a battery characteristic diagram showing the battery limits of voltage, power and temperature wherever possible. These documents must be provided to us as laid out in Appendix A

5.21 Any type of commercially available cell chemistry is allowed subject to prior agreement with us. Full details of the chemistry and safety handling must be provided to us as laid out in Appendix A.

5.22 A Battery Management System (BMS) must be either pre-approved or must implement the essential features laid out in these regulations as laid out in Appendix B.

5.23 For standard motorcycles the architecture and functionality of the BMS must not be changed from standard but the addition of enhanced safety features is allowed and required if the OEM BMS does not implement essential features as laid out in Appendix B. Discretion may be applied to certain features on standard motorcycles at our discretion.

5.24 A battery pack may use any cooling strategy including air, liquid, oil or dielectric fluid cooling provided appropriate engineering practices are followed and evidence can be provided to justify that the battery pack is robust. Documentation must be provided as per Appendix A.

Article 6 Electrical Equipment

6.1 These regulations are based on concepts and principles set out in UN ECE Reg 100[7] Part I and II and UN ECE Reg 136[8] Part I and II are indispensable in complying with them and their intent.

6.2 When the battery pack is isolated the potential of all other HV electrical equipment must fall below 60 V_{dc} or 30 V_{ac} within 1 second.

6.3 If the motorcycle has an HV tractive system, High Voltage warning symbols must be displayed on or near the protective covers of all electrical equipment that may operate at high voltage. The symbol background must be yellow, and the bordering and the arrow must be black, in accordance with ISO 7010[4]; see Figure 1 in Appendix C). Each side of the triangle should measure at least 12 cm but may be reduced to fit onto small components.

6.4 No HV potential should be exposed anywhere on the vehicle during normal operation.

6.5 The design of the system must be such to ensure that a single point of failure cannot cause an electric shock that is hazardous to life and, in addition, that the components used cannot cause injury under any circumstances whether during normal operation or fault conditions.

6.6 HV Electrical cables and electrical equipment must be protected against any risk of mechanical damage such as from stones, corrosion, mechanical failure, etc. as well as any risk of fire and electrical shock.

6.7 HV components and wiring must comply with the applicable sections of IEC 60664[3] on clearance distances, creepage distances given in section 3.4.2 and solid insulation, or meet the withstand voltage capability according to the withstand voltage test given in ISO 6469-3[6]. If you intend to race at high altitudes, it is essential you apply the appropriate creepage and clearance requirements for the maximum circuit altitude.

6.8 Each cable and associated connectors, if any, must ONLY be able to mate with their corresponding socket.

6.9 All parts of the electrical equipment must have protection that satisfies the requirements of IP44 ingress protection rating or higher[2], on all HV components.

6.10 The HV traction system must be electrically isolated from all other parts of the motorcycle .

6.11 All HV cables must be orange and mechanically shielded, either internally or by conduit. They must be securely fixed to the motorcycle using insulated fixings. Tie wraps are not acceptable.

6.12 Conductors must be appropriately sized to suit the application.

6.13 All HV cable terminals in the primary current path must be crimped, laser welded or assembled using a similar or superior process. Soldering is not appropriate.

6.14 All HV cable runs must be a single continuous piece between connectors or terminals. Any cable joins or splices must be achieved using bolted terminals which are securely fixed in an enclosure with glands and/or strain relief on the cable entry points and satisfy the requirements of IP44 ingress protection rating or higher[2]. Any covers or access panels must be sealed and secured requiring tools to remove.

6.15 Any HV ancillary equipment including contactors, relays, fuses, current shunts etc. not located in the battery enclosure must be securely located with glands or strain relief on the cable entry points and satisfy the requirements of IP44 ingress protection rating or higher[2]. Any covers or access panels must be sealed and secured requiring tools to remove.

6.16 All HV connectors must only allow the contacts on either the plug or the receptacle to become live when they are correctly mated. An automatic HVIL system must be present in every HV connector and detect if a tractive system connector is de-mated. If the connector was live when de-mated, the high voltage must be switched off immediately and any residual voltage on the contacts of both the plug and the receptacle discharged to less than 60 V_{dc} or less than 30 V_{ac} within 1 second. Re-mating of the connector must not re-energise the circuit automatically.

6.17 All HV cables must be positively retained.

6.18 All major conductive parts of the body must be connected to obtain equipotential bonding as per UN ECE Reg 136[8] bonding requirements. Every part of the electrical equipment must have a minimum insulation resistance between all live components and the motorcycle main structure and low voltage ground of 500 $\Omega\,V^{-1}$. The measurement of the insulation resistance must be carried out using a dc voltage of at least 100 V.

6.19 Unless the function is already provided by the BMS, a proprietary isolation monitoring system must be used to continuously monitor the status of the isolation barrier between the HV system and the chassis while the HV system is energised. For standard motorcycles this is highly encouraged for 2021 but will not become mandatory until a subsequent season.

6.20 If not part of the BMS, the proprietary isolation monitor system must be located within the battery enclosure.

6.21 You must provide a detailed "Emergency Services Guide" documenting all aspects of the HV system including component locations and details of the standard and emergency HV isolation procedures. This document should be structured in the same way and have similar content to the guides provided by OEMs for production vehicles and must be provided to us as laid out in Appendix A prior to the vehicle inspection.

6.22 See Figure 2 in Appendix C for an example of the electric motorcycle system schematic showing all components and connections. The vehicle specific information must be provided to us as laid out in Appendix A prior to the vehicle inspection.

6.23 You may choose to utilise an LV alternator or DC-DC converter in conjunction with an auxiliary battery to provide auxiliary power. Alternatively, a suitably sized auxiliary battery may be used on its own which is not recharged while competing.

6.24 The auxiliary battery must never be used to recharge the traction battery.

Article 7 Safety Equipment

7.1 All motorcycles must be equipped with at least 1 emergency stop switch. One must be located on the tail accessible to marshals in the event of a crash.

7.2 In addition, all motorcycles must be equipped with a lanyard switch, located on the handlebars. The lanyard must be attached to the rider's leathers while the motorcycle is in motion. If the rider becomes separated from the motorcycle the lanyard switch must open triggering an emergency stop event.

7.3 When an emergency stop event triggered by an emergency stop switch or lanyard, the torque demand to all traction motors must be set to zero immediately and the traction battery pack isolated within 1 second.

7.4 When the battery pack is isolated, within 1 second there must be no HV present outside of the battery pack.

7.5 Any auxiliary low voltage (12 V) battery and auxiliary loads must be appropriately fused in line with the manufacturer's recommendations.

7.6 There must be a switch to isolate the auxiliary low voltage battery.

7.7 See Figure 2 in Appendix C for an example of the functional switching diagram. Your motorcycle specific version must be provided as laid out in Appendix A.

7.8 All motorcycles must be fitted with a Vehicle Status Indicator Light (VSIL).

7.9 A VSIL must have switchable red, green and white channels.

7.10 The VSIL must be in working order at all times during a race event, including after a crash, and must stay on for at least 15 minutes after all other LV systems are isolated or an emergency stop event occurs.

7.11 The VSIL must be fitted in a location in which is likely to withstand a severe motorcycle crash and continue to function as anticipated while also being clearly visible to marshals and other personnel from a reasonable distance. The tail of the motorcycle close to the emergency stop switch would would be a good location.

7.12 If the red indicator is triggered it must latch and remain powered for at least 15 minutes.

7.13 The red indicator reset mechanism must be disclosed at time of vehicle inspection.

7.14 There must be repeater indicator lights within the rider's reasonable field of vision that replicate the states of the main VSIL. These do not have to meet any of the other VSIL requirements.

7.15 See Appendix C Table 2 for the VSIL states.

7.16 All prototype motorcycles must be equipped with a throttle plausibility system such that the throttle is fail-safe

Article 8 Charging

8.1 Standard motorcycles must use the unmodified on-board charger, charge port and charging cables supplied with the vehicle or approved for use by the vehicle manufacturer.

8.2 Prototype motorcycles must use a charging system compliant with a recognized charging standard and be able to use charging equipment supplied by us. The standard protocols for connecting and disconnecting the charge connector and initiating/stopping the charging process must be followed and cannot be deviated from.

8.3 Off-board chargers must be commercially available and meet all local electrical safety requirements. Details must be supplied as laid out in Appendix A.

8.4 Charging of the battery pack must be done with the battery pack in-situ. In exceptional circumstance discretionary exceptions may be made for vehicles designed with easily removable battery pack systems where you can demonstrate and prove the safety of their system.

8.5 All motorcycles must use a commercially available charging equipment.

8.6 It is prohibited for any work to be carried out on the motorcycle whilst any traction battery is charging or charging equipment is connected to the vehicle.

8.7 Any charging installation, with the exception of explicitly designed mobile charging equipment, must be installed and connected to the mains supply by a trained competent person following the Code of practice for Electric Vehicle Charging Equipment Installation, latest edition and meet all the requirements of BS7671 (the wiring regulations)[1], with particular attention paid to earthing. For competitions outside the United Kingdom, an equivalent national standard should be applied. In any case it is your responsibility to ensure you are complying with all local electrical installation regulations.

8.8 The charging system must be automatic and must ensure that the battery cannot be overcharged or damaged if left permanently connected to the charger.

8.9 The use of fossil-fuel generators to provide the energy to charge motorcycles is strongly discouraged. We are working to ensure the provision of sustainable charging facilities.

8.10 UN ECE Reg 100 paragraph 5.3[7] must be complied with regarding the mutual exclusivity or charge and drive modes.

8.11 Motorcycles must be in full compliance with Article 6, specifically regarding VSIL charging indicator requirements.

Article 9 Electric Motorcycle Passport

9.1 All motorcycles must undergo and pass an Electric Motorcycle Passport (EMP) inspection prior to competing.

9.2 All motorcycles must be in possession of a valid EMP to compete irrespective of discipline or category.

9.3 For standard motorcycles, an inspection to ensure OEM specification has not been deviated from, allowing for exception laid out in the rules.

9.4 For prototype motorcycles, a detailed technical inspection of the entire motorcycle will be required.

9.5 EMP will be issued once the motorcycle has passed the inspection.

9.6 See Appendix C Table 4 for EMP requirements.

9.7 Electric motorcycle inspections can be arranged by appointment with us and will be carried out by us or a competent third party we appoint on our behalf.

9.8 You must provide all data and evidence as laid out in Appendix A, as a minimum.

9.9 Please see Appendix E for details of what you will be required during an electric motorcycle inspection.

9.10 The motorcycle will be examined at a location mutually agreed between you and us. The venue must have a mains power supply suitable for your charging equipment, if applicable.

9.11 We may provide multiple inspectors for impartiality, training and HV safety purposes.

9.12 You will bear all fees arising from and the costs incurred by the inspection, including reasonable travel expenses where appropriate.

9.13 Anyone considering building a motorcycle for competition use is encouraged to share their ideas with us prior to starting construction. On-going dialogue between you and us throughout the build process should minimise the risk of non-compliance with these regulations.

9.14 You are responsible for ensuring that the motorcycle complies with these refulations and is presented for inspection in a finished and competition-ready condition.

9.15 All items on the Inspection Checklist in Appendix E must be clearly visible to us without using instruments such as endoscopes or mirrors. Visible access may be provided by removing body panels or via removable access panels. Covers on the traction battery must only be removed by your nominated HV qualified person if requested by the technical inspector.

9.16 Demonstration of the correct function of the indication and safety systems as well as the charging system and charging equipment forms part of the inspection. Correct response to a simulated crash event must also be demonstrated by the HV safety system, as per Appendix E.

9.17 The inspection of prototype motorcycles will examine all items included on the Inspection Checklist (in Appendix E plus any other items we may wish to examine. The exact procedures and instruments employed for inspection and testing are entirely at our discretion.

9.18 The inspection of standard motorcycles will focus on ensuring that the installation of the safety items has not damaged or disturbed any part of the motorcycle system except where explicitly allowed. It is prohibited to reposition any part of the standard motorcycle system.

9.19 If any part of the motorcycle system does not comply with the requirements or is deemed to be a concern, you must correct the problem and re-present the motorcycle for inspection. Minor faults may be rectified immediately, major issues will require a new inspection to be arranged and paid for.

9.20 If any inspector feels there are siginifcant safety concerns, relating to HV fire safety or otherwise, which you do not address promptly they reserve the right to terminate the inspection immediately.

9.21 Our decision concerning compliance with these regulations is final.

9.22 While signing-on to an ERRA sanctioned event, you will be obliged to sign a statement confirming your motorcycle has not been modified, in the sense considered in these rules, to be substantially different to what was presented at the time of the EMP inspection.

9.23 If you cannot sign this statement due to modifications made, it is your responsibility to contact ERRA to ensure your EMP is up to date and valid. This may require a re-inspection, at your cost.

9.24 If you are found to have knowingly falsely signed the aforementioned statement, you can expect your EMP to be withdrawn without notice by ERRA, in addition to any other disciplinary action taken by other organisations for dishonest or unsafe conduct.

Article 10 Scrutineering

10.1 Scrutineering will take place at each race meeting prior to you being allowed on track.

10.2 Only IMI Level 2 HV qualified Scrutineers will perform safety scrutineering on motorcycles.

10.3 A valid EMP must be provided at scrutineering.

10.4 HV motorcycle scrutineering procedures will include but not be limited visual inspection of the electrical system and demonstration of the correct function of the safety and indication systems, as well as the other items listed in Appendix F.

10.5 Your HV qualified person must be present at scrutineering (equipped with their own set of HV safety equipment and tools as required) and be prepared to safely isolate the HV system and remove any HV components for more detailed inspection at the request of the scrutineer.

10.6 The motorcycle specific Emergency Response Guide must be provided as per Appendix A for the benefit of the circuit/venue emergency services team, before the motorcycle is allowed to compete.

10.7 We can require the motorcycle to be re-inspected at any time during an event.

10.8 We reserve the right to request access to any set-up information or data from the motorcycle ECU(s) and other electrical devices at any time during an event.

10.9 It is your responsibility to prove that the motorcycle has not exceeded any control parameter limits during an event (e.g. maximum power, maximum voltage etc.).

10.10 We reserve the right to request that the vehicle be fitted with a data logger as expplained in Appendix F.

10.11 Anti-tamper sealing requirements for HV system components may be applied as explained in Appendix F.

Appendix A Document Submission Schedule

Document	Deadline prior to date of inspection
Initial application of interest · Name of Team · Team Manager · Address · Email address · Telephone number or video calling equivalent · Classes to be entered · Number of entries · Riders' names	tbc
Battery Information · UN 38.3 and MSDS/SDS for battery cell · Cell chemistry details if not mentioned elsewhere · Evidence of battery system construction, CAD etc. · BMS cell temperature sensor placement details · Isolation monitoring mystem details	tbc
Non-recommended isolation monitor supporting document · Manufactures Part Number · User manual · Installation schematic · Test data	tbc
Mechanical · Evidence of battery mounting · Evidence of motor mounting · Evidence of compliance with National Regulations	tbc
Electrical · Electrical propulsion system safety diagram · High Voltage (HV) Schematic · Isolation monitoring system details · Crash HV Isolation FMEA · Details of throttle plausibility system	tbc
Charging · Motorcycle charger details · Charging equipment details	tbc
Motorcycle specific emergency services guide	tbc

Appendix B Battery Management System Requirements

Minimum Requirements:

- The BMS must be capable of monitoring every serial cell for voltage.
- The BMS must have sufficient temperature sensors to cover at least one cell in every group of parallel cells; full temperature coverage of every cell is preferred and, in all cases, coverage should not mask the cells which are likely to be the hottest. Full details of the temperature monitoring must be provided to us as laid out in Appendix A with justification of sensor placements. This requirement must be met when using repurposed OEM battery modules.
- The BMS mustvia a communications protocol, such as CAN, or by analogue signal, be able to communicate a fault state such that actions can be taken to prevent the battery from exceeding the cell manufacturers specification for voltage, current and temperature.
- The BMS must, in the event that any cell exceeds the manufacturers stated limitations for voltage and/or temperature, warn the rider and then within 2 seconds, reduce power to less than 5 kW in order to leave the course or automatically isolate the battery if it is not safe to reduce power.
- The BMS must communicate and be functional during charging.
- If the BMS includes an isolation monitoring device, it must operate in compliance with the isolation monitoring requirements detailed below.

Isolation Monitor Requirements

- It must continuously or near-continuously measure the resistance value between the motorcycle chassis and both positive and negative traction battery terminals in real-time.
- It must have a threshold value of at least $50\ \Omega\,\mathrm{V}^{-1}$ multiplied by the maximum battery pack voltage.
- It must have an output to allow the VCU or other control system to know about and action a response to a fault.

Recommended Isolation Monitors

- Bender IR-55
- Bender iso165C-1
- If you wish to use a non-recommended isolation monitor you must provide full technical details, theory of operation, validation testing etc. as per Appendix A. It must be of an equivalent or superior technical standard as the recommend isolation monitors.

Appendix C Tables and Figures

The VSIL is a mandatory device which allows everybody to know the state of the motorcycle for safety purposes. It will contain 3 lights which show the state of a motorcycle from a distance. These states and the corresponding light output are detailed in the table below

VSIL State	**Vehicle State**	**Interpretation**
Green ON	Battery is good and White is ON or White is Flashing	Isolation check is within range
Red ON	Danger	Isolation fault Battery Over Temperature If a fault is present the light will latch on for 15minutes after motorcycle is turned off
White ON	HV system energised- vehicle ready to move	Used show that the motorcycle is 'live' and the throttle will respond to input
White FLASHING	Charging enabled	Drive is disabled. The battery pack is being charged with a charge cable connected
White OFF	HV system de-energised	Motorcycle has been turned off, the motorcycle cannot be driven, the throttle will not respond to inputs
Green OFF	HV system de-energised	Motorcycle has been turned off, the motorcycle cannot be driven, the throttle will not respond to inputs
Red OFF	HV system de-energised and fault latch timer has elapsed	Red light should remain off unless a fault is present. If a fault is present the light will latch on for 15 minutes after motorcycle is turned off

If the light is OFF or any other colour than Green or Red, the system must be considered unsafe.

Motorcycles without an HV battery pack are encouraged to use a further red flashing state to indicate an impending thermal runaway. Please note, a further red flashing state to indicate impending thermal runaway is encouraged for all vehicles and will be mandatory in the coming years to be agreed by the technical committee.

Figure 1: High Voltage warning sysmbol

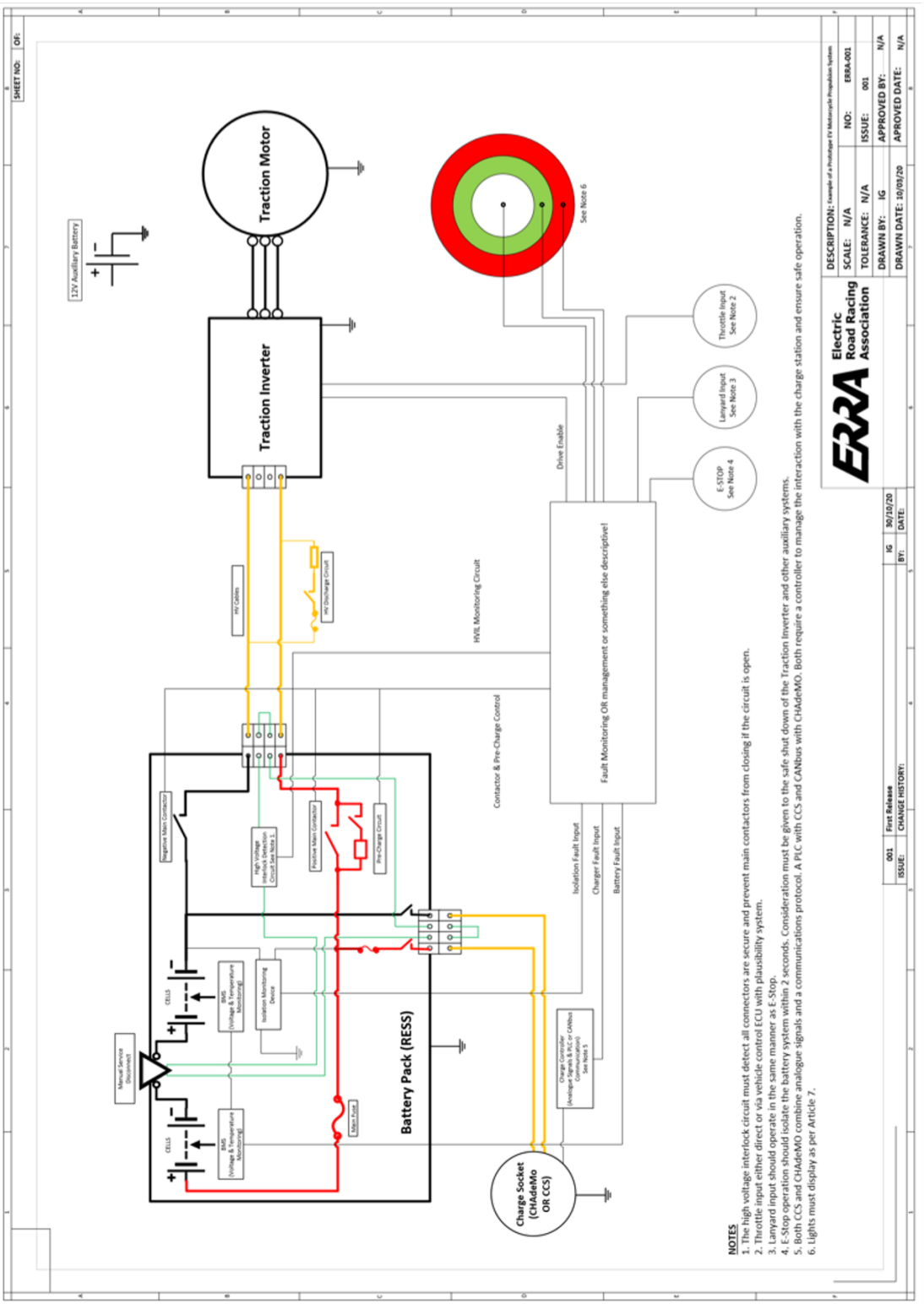

Figure 2: Functional Switching Diagram example

Appendix D Safety Qualifications

Any person with an active role in the race team, including any support personnel.

Total personnel	Minimum HV qualified Level 2 or above	Recommended HV qualified level 2 or above	Recommended HV Qualified level 1
1-5	1	2	All others
6-10	2	3	All others
11-15	3	4	All others
16+	4	At least 25%	All others

Recognised HV Qualifications (preliminary):

UK: The IMI award in electric/hybrid vehicle system repair and replacement NL: Training to NEN 9140 (Dutch EV Safety Standard) Level 2

Appendix E Electric Motorcycle Passport Details

Under development.

Appendix F Scrutineering Check

Under development.

References

[1] *BS 7671:2018/A1:2020 Requirements for Electrical Installations. IET Wiring Regulations.* BS 7671:2018/A1:2020.

[2] *BS EN 60529:1992+A2:2013 Degrees of Protection Provided by Enclosures (IP Code).* BS EN 60529-1992+A2-2013.

[3] *BS EN IEC 60664-1:2020 Insulation Coordination for Equipment within Low-Voltage Supply Systems. Principles, Requirements and Tests.* BS EN IEC 60664-1:2020.

[4] *BS EN ISO 7010 Graphical Symbols. Safety Colours and Safety Signs. Registered Safety Signs.* BS EN ISO 7010.

[5] *BS ISO 6469 - Electrically Propelled Road Vehicles. Safety Specifications: Part 1 Electrically Propelled Road Vehicles. Safety Specifications. On-Board Rechargeable Energy Storage System (RESS).* BS ISO 6469-1:2019.

[6] *BS ISO 6469-3:2018+A1:2020 - Electrically Propelled Road Vehicles. Safety Specifications: Part 3 Electrical Safety.* BS ISO 6469-3:2018+A1:2020.

[7] UNECE. *Regulation No. 100 Uniform Provisions Concerning the Approval of Vehicles with Regard to Specific Requirements for the Electric Power Train.* 12th Aug. 2013.

[8] UNECE. *Regulation No. 136 Uniform Provisions Concerning the Approval of Vehicles of Category L with Regard to Specific Requirements for the Electric Power Train.* 5th Feb. 2016.