TEST REPORT
UL 2849
STANDARD FOR SAFETY
Electrical Systems for eBikes

Report Number .....:	HK2312041806-SR
Date of issue.....:	2023-12-08
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Testing Laboratory.....:	Shenzhen HUAK Testing Technology Co., Ltd.
Address .....:	1-2/F., Building B2, Junfeng Zhongcheng Zhizao Innovation Park, Heping, Fuhai Street, Bao'an District, Shenzhen, Guangdong, China
Applicant's name.....:	Jiangsu Zhongxing Motorcycle Co., Ltd.
Address .....:	Xihulukou, Zhaqiao, Anzhen Town, Xishan District, Wuxi City, Jiangsu Province, China
Test specification:	
Standard .....:	UL 2849:2020
Test procedure .....:	UL test report
Non-standard test method……..:	N/A
Test Report Form No……..:	UL 2849_A
TRF originated by……:	HUAK
General disclaimer: The test results presented in this report relate only to the object tested.	
Test item description .....:	Electric Bicycle
Trade Mark .....:	Luckeep
Manufacturer.....:	Jiangsu Zhongxing Motorcycle Co., Ltd.
Address .....:	Xihulukou, Zhaqiao, Anzhen Town, Xishan District, Wuxi City, Jiangsu Province, China
Model/Type reference.....:	X2
Ratings .....:	54.6VDC, 3.0A

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Responsible Testing Laboratory (as applicable), testing procedure and testing location(s):			
☒	**Testing Laboratory:**	Shenzhen HUAK Testing Technology Co., Ltd.	
Testing location/ address .....:		1-2/F., Building B2, Junfeng Zhongcheng Zhizao Innovation Park, Heping, Fuhai Street, Bao'an District, Shenzhen, Guangdong, China	
☒	**Associated Testing Laboratory:**		
Testing location/ address .....:			
Tested by (name, function, signature).....:		Kevin Yao	
Approved by (name, function, signature) ..:		Dendi Wei	
☐	**Testing procedure: TMP/CTF Stage 1:**		
Testing location/ address .....:			
Tested by (name, function, signature).....:			
Approved by (name, function, signature) ..:			
☐	**Testing procedure: WMT/CTF Stage 2:**		
Testing location/ address .....:			
Tested by (name + signature).....:			
Witnessed by (name, function, signature) .:			
Approved by (name, function, signature) ..:			
☐	**Testing procedure: SMT/CTF Stage 3 or 4:**		
Testing location/ address .....:			
Tested by (name, function, signature).....:			
Witnessed by (name, function, signature) .:			
Approved by (name, function, signature) ..:			
Supervised by (name, function, signature) :			

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Copy of marking plate:

Luckeep
Electric Bicycle
Model: X2
Input: 54.6VDC, 3.0A
Jiangsu Zhongxing Motorcycle Co., Ltd.
Made in China

Possible test case verdicts:

- test case does not apply to the test object..... : N/A (or N)
- test object does meet the requirement..... : P (Pass)
- test object does not meet the requirement ..... : F (Fail)
- test date..... : From Dec. 04, 2023 to Dec. 08, 2023

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UL 2849			
Clause	Requirement – Test	Result – Remark	Verdict
7	General		P
7.1	The information provided in Sections 7 through 10 is essential for the proper evaluation of the products covered by this Standard. The concepts in these Sections will outline and define the evaluation path based on what is provided in the electrical system.		P
7.2	The concepts in Sections 7 through 10 are general in nature and could result in different methods of evaluation for each different product type dependent upon its overall design.		P
7.3	EBikes consist of both EPAC and non-EPAC types, but in all cases functional pedals shall be provided. For EPACs, motors shall disengage their assist function when the rider stops pedaling, when a maximum predetermined speed as specified by the manufacturer is reached, or when the user applies the brakes (if the brakes are provided with cutoff functions). For non-EPAC versions of the eBike, motors are not required to disengage when the user stops pedaling. A non-EPAC type eBike may be provided with an EPAC mode.		P
7.4	The electrical system located on the eBike, those subassemblies or components shall comply with all the requirements in this Standard at a maximum altitude of 2000 m (6562 feet) and over an ambient temperature range of 0°C to 40°C (32°F to 104°F) and be subjected to ingress protection tests. Equipment may be used at ambient temperature extremes for operation and battery charging that exceed the default limits above (e. g., -10 ° C or +50 ° C) when specified by the manufacturer and the equipment shall be provided with instructions in accordance with 46.3 (j) and (k), and 48.3.		P
8	Power Levels		P
8.1	General		P
8.1.1	For all products covered by this Standard, a specific power level will be associated with the eBike.This will require rated voltage and current levels to be assigned, but can also include voltages or currents that are available within the eBike being evaluated. Different approaches can be used based on the potential hazards associated with a given power level.		P

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8.12	For the purposes of this Standard, different designations will be used. This includes hazardous voltage and/or hazardous current resulting in hazardous energy, and in all cases these designations indicate a voltage, current or energy level that is potentially dangerous to the user and means of protection are required. Additional designations cover Low Voltage, Limited Energy (LVLE) which indicates voltage		N/A
8.2	Hazardous Voltage and Hazardous Energy		N/A
8.2.1	Any accessible circuit or accessible part, as determined by the articulate probe in Figure 18.1, that is operating at a voltage above 42.4 volts peak or 60 V dc is considered to be operating at a hazardous voltage. In these cases, the user must be protected against contact with the part or circuit by the use of an enclosure or proper insulation. The requirements for both enclosures and insulation are included in this Standard and shall be applied as appropriate in all cases where hazardous voltages exist.		N/A
8.2.2	Hazardous energy exists in any circuit or part that is operating with a stored energy level of 20 J or more, or has an available continuous power level of 240 VA or more, at a potential of 2 volts or more. In these cases, the user shall be protected against contact with the part or circuit by the use of an enclosure or proper insulation. The requirements for both enclosures and insulation are included in this Standard and shall be applied as appropriate in all cases where hazardous energy exist.	<240VA	N/A
8.3	Low Voltage Limited Energy Circuits		P
8.3.1	A Low-Voltage Limited Energy Circuit (LVLE) shall comply with the limits in Table 8.1.		P
8.3.2	The power limitations in Table 8.1 may be obtained by the use of any of the following configurations:		P
	a) An inherently-limited transformer;		P
	b) A non-inherently-limited transformer coupled with an overcurrent protective device in the output circuit;		N/A
	c) A combination transformer and fixed impedance; or		N/A
	d) An arrangement determined to be equivalent to (a), (b), or (c).		N/A
8.3.3	A part or device, other than the battery pack, located in or supplied by an LVLE circuit need not be investigated. The secondary winding of the transformer, the fuse or circuit protective device, or the regulating network, and all wiring up to the point at which the current and voltage are limited shall be judged under the applicable requirements in this Standard.		N/A

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8.3.4	The maximum load current is to be drawn under any condition of loading, including short circuit, using a resistor. The current is to be measured 60 seconds after the application of the load. The resistor is to be continuously readjusted during this 1 minute period to maintain maximum load current. The measured load current shall not exceed the value listed in Table 8.1.		P
8.3.5	With reference to the voltage limit specified in Table 8.1, measurement is to be made with the product connected to the intended source of supply and with all loading circuits disconnected.		P
8.3.6	The over-current protective device provided in the LVLE circuit used to limit the current shall be rated or set at not more than the values specified in Table 8.1. The device shall not be of the automatically reset type.		N/A
8.3.7	If a regulating network is used to limit the output under any conditions, the LVLE current limitation in Table 8.1 shall not be affected by malfunction of a single component, excluding resistors. The network shall comply with the value in Table 8.1 when the current is measured after 5 seconds.		N/A
9	Combination of Battery, Battery Management System, and Charger		P
9.1	The battery management system (BMS) is used to control battery charging and discharging. For battery packs that are provided with an integral BMS, that BMS shall be evaluated as part of the battery pack in accordance with Battery Packs, Section 11. If the BMS, or a portion of the BMS, resides in components or circuits external to the battery pack, then the combination of the external components and the battery pack is critical to safety and shall be evaluated together in accordance with 9.2.		P
9.2	All testing of the system shall be performed with the actual battery/BMS and charger that is recommended by the manufacturer. Any protection circuits, or other external components or systems, can remain in place provided those circuits or systems are proven to be reliable in accordance with Sections 12 and 19.		P
10	User Protection While Charging		P
10.1	General		P

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10.1.1	Charging of the battery may occur while the battery is installed on the eBike, with the battery removed from the eBike, or both options may apply based on user preference. If the battery is only intended to be charged when it is removed from the eBike, then an inherent means shall be provided to insure that this option is the only option for charging the battery. If no inherent means are provided, and it is possible to charge the battery while on the eBike, the battery shall be considered to be charged both on board and off board the eBike.		P
10.1.2	If the battery is intended to be charged while on the eBike, whether by inherent construction or user preference, then the requirements in 10.2 apply. If the battery is only intended to be charged when removed from the eBike, then the requirements in 10.2 do not apply.		P
10.1.3	The requirements in 10.1.1 and 10.1.2 are to be used in conjunction with the requirements in Section 8. If energy levels are such that no hazard exists, then protection means may be reduced.		P
10.2	Charging batteries that are on the eBike		P
10.2.1	Charging of the battery on an eBike where voltage or energy levels exceed the lower limits for shock hazards or electric energy hazards will require that the exposed conductive surfaces of the eBike are protected and monitored during charging to prevent a shock hazard due to the charging energy supplied to the eBike. The personnel protection system supplied shall be as indicated in 10.2.2.		P
10.2.2	For equipment where the specifics of the installation of the on board electrical system is part of the evaluation, the eBike shall be provided with a system of protection that is considered suitable to protect the user. This may include suitable means such as double insulation systems onboard the eBike. The suitability of the protection system shall be judged based on the requirements in this Standard.		P
10.2.3	With reference to 10.2.2, products utilizing a system of protection based on protective grounding shall comply with the requirements in 10.2.4 and products utilizing a system of protection based on double insulation shall comply with the requirements in 10.2.5.		P
10.2.4	Protection systems relying on protective grounding for user protection shall comply with the applicable requirements for grounding and bonding in Section 22. The requirements shall be applied to all points where protective grounding is used as a means to protect the user.		P

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10.2.5	A system of double insulation provided to protect the user shall be in accordance with the requirements in UL 2097.		N/A
10.2.6	The eBike shall have charger connect-interlock so that the motor cannot be activated when the charger is plugged in. If there is no interlock, there shall be a secondary means of preventing inadvertent motor activation.		P
11	Battery Packs		P
11.1	Battery packs that provide power to the motor shall be provided with an appropriate Battery Management System (BMS) either integral to the pack or as part of a system that includes components and circuits external to the pack. The BMS shall be designed to safely withstand normal and foreseeable misuse conditions for the eBike involved. For a BMS that includes components or circuits external to the battery pack, the BMS shall comply with Safety Circuits and Safety Analysis, Section 12, as applicable. A battery pack used in eBikes covered by this Standard shall comply with one of the following:		P
11.2	A battery pack in accordance with 11.1 (c) and (d) is additionally required to comply with the requirements in Overcharging Test, Section 32.2; Short Circuit Test, Section 32.7; Imbalanced Charging Test, Section 32.8; Shock Test, Section 32.9; Vibration Test (battery method), Section 38.2; and Thermal Cycling Test, Section 32.10.		N/A
11.3	For rechargeable batteries providing power to other than the motor and part of the eBike electrical system, the battery shall comply with UL 62133 or UL 2054.		P
12	Safety Circuits and Safety Analysis		P
12.1	The protective circuits of the electrical system shall undergo a safety analysis as specified in 12.4 to verify that potential hazards associated with the design are addressed in this evaluation. A circuit is defined as a protective circuit if it contains a circuit or a component that is considered critical for mitigating a fire, shock, or explosion hazard in accordance with this Standard.		P
12.2	For battery management systems, the protective circuit shall maintain the cells within their normal operating region for charging and discharging; and, if normal limits are exceeded, the protective circuit shall limit or shut down the charging or discharging to prevent excursions beyond normal operating limits. Compliance is determined through a review of the battery system data including the safety analysis of 12.4 and through the tests in this Standard.		P

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12.3	Protection circuits used to monitor operational parameters, such as maximum assist speed, cutoff assistance due to braking, and the like, shall also be evaluated based on the requirements in this Section as applicable. Compliance is determined through a review of the design and overall system, including the safety analysis of 12.4 and through the tests in this Standard.		N/A
12.4	An analysis of potential hazards shall be conducted on the electrical system of the eBike, including the charger and other safety circuits as applicable, to determine that events that could lead to a hazardous condition have been identified and addressed through design or other means. Documents that can be used as guidance for the safety analysis include:		N/A
12.5	The analysis in 12.4 is utilized to identify anticipated faults or conditions in the system which could lead to a hazardous condition and the types and levels of protection provided to mitigate the potential hazards. The manufacturer shall provide the analysis of 12.4 for review as part of the evaluation of the system. The manufacturer shall indicate potential risks associated with the system and document the level of risk associated with each potential risk. During the review of the analysis during this evaluation, the results associated with the analysis may change or may be modified as deemed appropriate. The analysis shall consider single fault conditions in the protection circuit/scheme as part of the anticipated faults; and faults that occur as a result of those single faults are to be included.		N/A
12.6	When conducting the analysis of 12.4, active devices shall not be relied upon for critical safety unless:		P
12.7	Devices relied upon for safety as noted in 12.4 shall be tested for functionality and reliability in the relevant configuration and environment, in accordance with appropriate functional safety requirements unless already evaluated through the other tests of this Standard. Functional safety criteria can be found in one of the following standards as appropriate to the design of the electronic and software protection scheme:		P
12.8	Any product containing hazardous voltage shall have a manual disconnect to prevent inadvertent access to hazardous voltage parts during servicing. The manual disconnect shall:		P
12.9	If a hazardous voltage automatic disconnect device is provided to isolate accessible conductive parts from the hazardous voltage circuit of the battery system, it shall:		P
13	Enclosing and Insulating Hazardous Parts		P

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13.1	General		N/A
13.1.1	An eBike shall be provided with one or more enclosures that house all live parts that are considered hazardous. The parts of the enclosure that are required to be in place to comply with the requirements for risk of fire, electric shock, injury to persons, and electrical energy – high current levels shall comply with the applicable enclosure requirements specified in this Standard.		N/A
13.1.2	An enclosure shall have the strength and rigidity required to resist the possible physical abuses that it will be exposed to during its intended use, in order to reduce the risk of fire or injury to persons.		N/A
13.2	Materials		P
13.2.1	Nonmetallic materials		P
13.2.1.1	The materials employed for enclosures shall comply with the applicable enclosure requirements outlined in UL 746C and CSA C22.2 No. 0.17, except as modified by this Standard.		P
13.2.1.2	Polymeric materials employed for enclosures shall have a minimum flame rating of V-1 in accordance with Flammability, Section 17, or the enclosure may alternatively be evaluated to the 20 mm end product flame test in accordance with UL 746C and CSA C22.2 No. 0.17.		P
13.2.1.3	The following factors in (a) – (e) shall be taken into consideration when an enclosure employing nonmetallic materials is being evaluated. For a nonmetallic enclosure all of these factors shall be considered with respect to thermal aging. Dimensional stability of a polymeric enclosure is addressed by compliance to the mold stress relief test. Suitability to factors (a) – (e) below may be determined by the tests of this Standard.		P
13.2.1.4	The polymeric materials employed for enclosures and insulation shall be suitable for anticipated temperatures encountered in the intended application. Enclosures shall have a Relative Thermal Index (RTI) with impact suitable for temperatures encountered in the application but no less than 80°C (176°F), as determined in accordance with UL 746B and CSA C22.2 No. 0.17.		P

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13.2.1.5	Materials employed as electrical insulation in the assembly shall be resistant to deterioration that would result in a risk of electrical shock, fire or other safety hazard. Compliance is determined by the tests of this Standard. Materials employed for direct support of live parts at hazardous voltage, shall additionally meet the direct support insulation criteria outlined in UL 746C and CSA C22.2 No. 0.17, unless employed as part of a component that has been evaluated to a suitable component standard. Insulated wiring is subjected to the requirements outlined in Section 18, Internal Wiring and Terminals.		P
13..2.1.6	Gaskets and seals relied upon for safety, shall be determined suitable for the environmental conditions and chemical substances they are anticipated to be exposed to in their end use.		P
13.2.1.7	Enclosure materials intended to be directly exposed to sunlight in the end use application shall comply with the UV Resistance test in accordance with UL 746C and CSA C22.2 No. 0.17.		P
13.2.2	Metallic materials		P
13.2.2.1	Metal enclosures shall be corrosion resistant. A suitable plating or coating process can achieve corrosion resistance. Additional guidance on methods to achieve corrosion protection can be found in UL50E/CSA		P
13.2.2.2	Metal enclosures may be provided with an insulating liner to prevent shorting of live parts to the enclosure. If using an insulating liner for this purpose, the insulating liner shall consist of non-moisture absorbent materials that have a temperature rating suitable for temperatures during operation including charging.		
13.2.2.3	Conductive parts in contact at terminals and connections shall not be subject to corrosion due to electrochemical action.		P
13.3	Strength of Enclosures		P
13.3.1	The enclosure shall be subjected to the Impact Test, Section 33.		P
13.4	Sharp Edges		P
13.4.1	An enclosure, a frame, a guard, a handle, or similar device shall not have sharp edges that constitute a risk of injury to persons in normal maintenance and use.		P
13.5	Ingress Protection		P

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13.5.1	Openings in the enclosure shall be designed to inhibit inadvertent access to hazardous parts. Compliance is determined by the Tests for Protection Against Access to Hazardous Parts Indicated by the First Characteristic Numeral, of IEC 60529, for a minimum IP rating of IP3X. Evaluation per IEC 60529,consists of the use of the Test Rod 2.5 mm, 100 mm long, shown in UL/ULC 2271, applied with a force of 10 N ±10 percent.		P
13.5.2	Openings in an enclosure shall be designed to prevent ingress of water as installed in the intended application in accordance with intended use and IP rating in accordance with IEC 60529, with a minimum rating of IPX4. Compliance is determined by the Ingress Protection Tests in Section 36.		P
14	Mounting		P
14.1	Components mounted on the eBike shall be subjected to the Vibration Test, Section 38.		P
15	Printed Wiring Boards		P
15.1	A printed-circuit board shall comply with the requirements in UL 796, and shall have a flammability rating as indicated in Section 17.		P
15.2	A resistor, capacitor, inductor, or other part that is mounted on a printed-circuit board to form a printed-circuit assembly shall be secured so that it does not become displaced and cause a risk of electric shock or fire by a force that is capable of being exerted on it during assembly, intended operation, or servicing of the power supply.		N/A
16	Spacings and Separation of Circuits		P
16.1	Electrical circuits within the electrical system shall be provided with reliable physical spacing to prevent inadvertent short circuits (i.e., electrical spacings on printed wiring boards, physical securing of uninsulated leads and parts). Insulation suitable for the anticipated temperatures and voltages shall be used where spacings cannot be controlled by reliable physical separation.		P
16.2	Electrical spacings in circus shall have the following minimum over surface and through arspacings as outlined in one of the following		P
16.3	As an alternative to the spacing requirements in 16.2, the spacing requirements in UL 840 and CSAC22.2 No. 0.2, may be used. For determination of clearances, the overvoltage category is considered Overvoltage Category II; and the pollution degree would be Pollution Degree 3 unless reduced by design in accordance with UL 840 and CSA C22.2 No. 0.2.		P

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16.4	As an alternative to the clearance values outlined in UL 60950-1/CSA C22.2 No. 60950-1 in Clearances, Creepage Distances and Distances Through Insulation, the alternative method for determining minimum clearances in the Annex for Alternative Method for Determining Minimum Clearances, Annex G, of the UL 60950-1/CSA C22.2 No. 60950-1 may be applied.		P
16.5	There are no minimum spacings applicable to parts where insulating compound completely fills the casing of a component or subassembly, if the distance through the insulation at voltages above 60 Vdc or above 30 Vrms is a minimum of 0.4 mm (0.02 inch) thick for supplementary or reinforced insulation, and the eBike passes the Dielectric Strength Test, Section 30, and the Isolation Resistance Test, Section 29. There is no minimum insulation thickness requirement for insulation of circuits at or below 60 Vdc or for basic or functional insulation. Some examples include potting, encapsulation, and vacuum impregnation.		P
16.6	Conductors of circuits operating at different voltages shall be reliably separated from each other through the use of mechanical securements such as barriers or wire ties to maintain spacing requirements unless they are each provided with insulation acceptable for the highest voltage involved. An insulated conductor shall be reliably retained so that it cannot contact an uninsulated live part of a circuit operating at a different voltage.		P
17	Flammability		P
17.1	As an alternative, finished enclosures may be tested in accordance with the 20 mm end-product flame test in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, and Evaluation of Properties of Polymeric Materials, CAN/CSA C22.2 No. 0.17. Metallic materials used for enclosures are considered to comply without further evaluation.		P
17.2	Nonmetallic materials used for internal parts within the overall enclosure shall be rated V-2 minimum.		P
17.3	Internal parts of components shall comply with the flammability requirements of the component standard in accordance with Components, Section 2.		P
17.4	Small parts, and gaskets, that are not located near live parts, and are located in a manner such that they cannot propagate flame from one area to another within the equipment, are not required to have a specific flame rating.		P

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17.5	Nonmetallic materials located outside the enclosure, and not used to complete the enclosure, are considered decorative parts. These parts do not have a specified flame rating.		P
17.6	Printed wiring board materials used for circuits or components at hazardous voltage or hazardous energy levels shall be rated V-1 minimum.		P
17.7	For the requirements outlined in 17.2 – 17.6, the flammability rating of the material shall be provided as part of the material rating or the flammability rating may be determined in accordance with UL 94 and CAN/CSA C22.2 No. 0.17.		N/A
18	Internal Wiring and Terminals		P
18.1	Wiring shall be insulated and acceptable for the purpose, when considered with respect to temperature, voltage, and the conditions of service to which the wiring is likely to be subjected within the equipment.		P
18.2	Wiring internal to an enclosure shall be routed, supported, clamped or secured in a manner that reduces the likelihood of excessive strain on wire and on terminal connections; loosening of terminal connections; and damage of conductor insulation. In safety critical circuits, for soldered terminations, the conductor shall be positioned or fixed so that reliance is not placed upon the soldering alone to maintain the conductor in position.		P
18.3	An external terminal shall be designed to prevent inadvertent shorting. An external terminal shall be designed to prevent inadvertent misalignment or disconnection when the eBike is in use.		N/A
18.4	An external terminal for charging shall be designed to prevent an inadvertent shorting and misalignment and a reverse polarity connection when connected to the charger.		N/A
18.5	Any other external terminals with hazardous voltage shall be designed to prevent access by the user. Any external terminals with hazardous energy level as determined in accordance with 8.2.2 shall not be bridged by a metallic object. Compliance is determined by use of the articulate probe shown in Figure 18.1.		N/A
18.6	A hole by which insulated wires pass through a metal wall shall be provided with a smoothly rounded bushing or shall have smooth surfaces, free of burrs, fins, sharp edges, and the like, upon which the wires may bear, to prevent abrasion of the insulation.		P

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18.7	Wiring for hazardous voltage on board the eBike shall be enclosed in junction boxes with hazardous voltage warning labels such as ISO 7010, No. W012 (i. e. lightning bolt within triangle), or shall be protected by suitable enclosures that are not accessible to the user.		P
18.8	Wires that are subjected to flexing during normal operation or due to user accessibility shall be subjected to the Flexing Test, Section 35.		P
19	Overcurrent Protection		P
19.1	Power, control and auxiliary circuits shall have overcurrent protection that is sized to prevent overheating of the smallest size conductor.		P
19.2	The need for overcurrent protection in the power circuit to motors, whether one protective device for each motor or one device for multiple motors, is to be determined on the basis of the locked rotor and running overload tests described in Section 32.		P
19.3	Overcurrent devices in the control and power circuit shall be physically located the shortest distance possible from the power supply or battery		N/A
19.4	The need for overcurrent protection in the LVLE circuits is to be determined on the basis of theequirements described in Low-voltage Limited Energy Circuit 8 .3		N/A
19.5	The overcurrent protective device specified in 19.4 shall be a circuit breaker, fuse or positive temperature coefficient device.		P
19.6	A fuse or circuit breaker shall be either:		N/A
19.7	A positive temperature coefficient device shall comply with Manufacturing Deviation and Drift; Endurance; and Requirements for Controls Using Thermistors, in UL 60730-1/CSA C22.2 E60730-1. The positive temperature coefficient device shall be tested and determined to comply in the actual battery configuration and environment.		N/A
19.8	Fuses shall be acceptable for the current and voltage of the circuit they are protecting and shall comply with 19.9 and 19.10. Fuses shall be tested and determined to comply in the actual battery configuration and environment.		N/A
19.9	Fuses provided for protection of circuits or outputs shall comply with CSA C22.2 No.248.1/UL 248-1 and the applicable parts of the series. Fuseholders used with these fuses shall comply with CSA C22.2 No. 4248.1/UL 4248-1 and the applicable parts of the series.		N/A

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19.10	For user replaceable fuses, a fuse replacement marking in accordance with 44.3 shall be located adjacent to each fuse or fuse holder, or on the fuse holder, or in another location provided that it is obvious to which fuse the marking applies. Where user replaceable fuses with special fusing characteristics such as time delay or breaking capacity are necessary, the type shall also be indicated. Information on proper fuse replacement of user replaceable fuses shall also be included in the instructions. See Section 47.		N/A
20	Motors and Motor Controllers		P
20.1	A traction motor used in a eBike shall not be hazardous under locked rotor and overload conditions. Compliance is determined by the tests of this standard unless previously evaluated as part of a motor and motor protector combination evaluation.		P
20.2	Motors shall be capable of carrying the maximum normal anticipated load without exceeding temperatures on insulation and windings as determined during the temperature test.		P
20.3	Motors located in hazardous voltage circuits shall comply with the requirements of UL 1004-1 and CSA-C22.2 No. 100. Motors located in low voltage circuits shall comply with either UL 1004-1 or CSA C22.2 No. 100 or the requirements of this Standard.		P
20.4	Sensors and controls associated with the motor control, either as a stand-alone component or system, provided to perform a safety function shall comply with the applicable requirements in the appropriate controls standard in accordance with 2.1. For eBikes and EPACs provided with a startup assistance function, the control for providing startup assistance shall require a voluntary and continuous action by the user to allow startup assistance, such as the use of a dead man switch.		N/A
20.5	In addition to the testing associated with the control of the motors in this Standard, hazards associated with the motor control shall be included in the analysis required in Safety Circuits and Safety Analysis, Section 12.		N/A
21	Operator Interface		N/A
21.1	The operator interface shall be constructed such that the user will not have access to hazardous parts. If hazardous parts exist in the operator interface, then the operator interface shall comply with the requirements for enclosing hazardous parts in Section 13. Also, the interface shall comply with 21.2.		N/A

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21.2	An operator interface with internal battery circuits and/or a touchscreen with high voltage backlights shall be evaluated as Limited Current Circuits in accordance with UL 60950-1/CSA C22.2 60950-1 or UL 62368-1/CSA C22.2 No. 62368-1.		P
22	Grounding and Bonding		N/A
22.1	General		N/A
22.1.1	For eBikes that are using a grounded system of protection to mitigate hazards associated with electric shock or electrical energy while charging, a means of extending the ground to the eBike through a bonding conductor shall be provided.		N/A
22.1.2	The requirement in 22.1.1 applies for both on board chargers and off board chargers.		N/A
22.2	Bonding connections		N/A
22.2.1	For grounded systems, there shall be provision for bonding all dead metal parts of an eBike to the main ground connection. This requirement applies to all dead metal parts that are exposed or that possess a risk of being contacted by a person during intended operation or adjustment and that are capable of becoming energized as a result of electrical malfunction.		N/A
22.2.2	The bonding shall be by a positive means, such as by clamps, rivets, bolted or screwed connections, or by welding, soldering, or brazing with materials having a softening or melting point greater than 455°C (850°F). The bonding connection shall penetrate nonconductive coatings, such as paint or vitreous enamel. Bonding around a resilient mount shall not depend on the clamping action of rubber or similar material.		N/A
22.2.3	An equipment-bonding terminal, or lead-bonding point, shall be connected to the frame or enclosure by a positive means, such as by a bolted or screwed connection. To reduce the risk of inadvertent loosening, the head of the screw or bolt shall not be accessible from outside of the enclosure.		N/A
22.2.4	An equipment-bonding connection shall penetrate a nonconductive coating, such as paint or vitreous enamel.		N/A
22.2.5	An equipment-bonding point shall be located so that the risk of inadvertently removing the bonding means during servicing is reduced.		N/A
22.2.6	An equipment-bonding lead shall be the same size as the grounding lead associated with the AC power source. The surface of the insulation shall be green.		N/A

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22.2.7	For eBikes that are connected to NEMA 5-20R receptacles directly, the equipment-grounding conductor of a power-supply cord shall be connected to dead metal parts within the frame or enclosure by means of a screw, or stud and nut combination, or other equivalent means, not to be removed during ordinary servicing not involving the power-supply cord. T		N/A
22.2.8	An equipment-grounding conductor or equipment-bonding conductor shall not be spliced, nor shall it involve a trace on a printed wiring board.		N/A
22.2.9	A soldering lug, a connection means that depends on solder only, a screwless (push-in) connector, a quick-connect, or other friction-fit connector shall not be used for equipment-grounding or equipment-bonding.		N/A
22.2.10	The equipment-grounding terminal or equipment-bonding terminal shall be capable of securing a conductor of a size intended for the application.		N/A
22.2.11	A terminal intended for the connection of an equipment-bonding conductor shall be identified by:		N/A
23	Chargers		P
23.1	The charger used to recharge the battery shall comply with one of the following:		P
23.2	For chargers that comply with 23.1 (b), no hazard exists at the output of the charger and requirements to mitigate a shock hazard or an energy hazard may be reduced as described in 8.3.		P
23.3	Chargers that comply with 23.1 (a), (c), or (d) are not necessarily limited at the output and the requirements for hazard mitigation for electrical systems connected to the output of the charger apply. Personnel protection in accordance with Section 10 shall be provided.		N/A
23.4	Chargers for lithium-ion battery systems shall have voltage, current, and temperature monitoring of the cells in the battery pack. This monitoring may be part of the battery management system integral to the battery pack. In this case, compliance with Section 11 is sufficient. If the monitoring is part of circuits or components located outside the battery pack, then those circuits or components shall be evaluated as part of the overall battery management system and shall be subjected to the risk assessment of Section 12.		P
24	Electrical Cables and Connectors Between the eBike and the Equipment		N/A

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24.1	Cables that are used to connect the off board equipment to the eBike shall be permanently connected to the charger or connected to the charger with a connector that complies with 24.2. The cable shall comply with UL 62/CSA C22.2 No. 49, and shall be suitably rated for the voltage and temperature it will be subjected to in the end use application and shall be sufficiently sized to conduct the anticipated current.		N/A
24.2	Connectors used to connect the off board equipment to the eBike or EPAC shall comply with UL2251/CSA C22.2 No. 282, or UL 1977 and CSA C22.2 No. 182.3. The connectors shall be suitably rated for the application.		N/A
25	Supply Connections		P
25.1	For all equipment located off board the eBike and transferring power to the eBike, the connection to the supply source will be in accordance with the applicable standard for that equipment. See Chargers, Section 23.		P
26	General		P
26.1	The performance tests are to be conducted on representative electrical systems of eBikes as appropriate.		P
26.2	Testing is to be conducted at any ambient temperature between 5°C (41°F) and 35°C (95°F).		P
26.3	Unless indicated otherwise, batteries are to be fully charged to the maximum operating state of charge in accordance with the manufacturer's specifications. After charging and prior to testing, the batteries are to be allowed to rest for a maximum period of 8 hours at room ambient.		P
26.4	Tests may be conducted on a test track, a bench or a test stand, which keeps the driven wheel free of the ground.		P
26.5	If conducted on a test track, the test track is to be level and the wind speed is to not exceed 3 m/s (6.7 mph).		N/A
26.6	In all cases, worst case conditions to simulate maximum normal load are to be selected.		N/A
26.7	The test area is to be well ventilated to protect personnel from possible harmful fumes or gases. As an additional precaution, the temperatures on surface of at least one cell/module within the device are to be monitored during the test for safety and information purposes. All personnel involved in the testing are to be instructed to never approach the test unit until temperatures are falling and have returned to within ambient temperatures.		P
26.8	Unless noted otherwise in the individual test methods, the tests shall be followed by a 1-h observation time prior to concluding the test and temperatures are to be monitored.		P

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26.9	Products that are operational after tests associated with the battery shall be subjected to a minimum of one cycle of charging and discharging in accordance with the manufacturer's specifications to determine that there is no fire, explosion, rupture, electrolyte leakage, or shock hazard associated with the stressed battery.		N/A
27	Input Test		P
27.1	The input current to a product is to be measured with the unit operating while charging a fully discharged battery. The current input of the product shall not be more than 110 percent of the rated current value for the eBike as assigned by the manufacturer and if an external charger is used, the measured input current shall not exceed the rated output current of the external charger.		P
28	Temperature Test		P
28.1	The Temperature test shall be conducted to determine whether or not the temperature sensitive safety critical components and temperature sensitive materials in the eBike components are being maintained within their temperature ratings and that temperatures on accessible surfaces, which may be contacted by the user, are within acceptable limits. Additionally, this test is conducted to determine whether or not the component cells are being maintained within their specified operating limits during maximum charge and discharge conditions of the eBike.		P
28.2	The test is to be performed using two methods. The battery charging circuit and battery are tested in accordance with 28.3 – 28.7, and the eBike system is tested in accordance with 28.8 – 28.9.		P
28.3	First, a fully discharged battery pack is to be conditioned within a chamber set to the upper limit charging temperature specifications of the eBike manufacturer. After thermal stabilization in the chamber,the battery pack is to be connected to a charging circuit input representative of anticipated maximum charging parameters provided by the specified charger. The battery pack shall then be subjected to maximum normal charging while monitoring voltages and currents on cells until it reaches the manufacturer's specified fully charged condition. Temperatures shall be monitored on temperature sensitive components including cells, enclosure, and all parts within the charging circuit that are temperature sensitive, including any user accessible surfaces.		N/A

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28.4	While still in the conditioning chamber, and after allowing temperatures to stabilize, the fully charged battery pack shall then be discharged in accordance with the manufacturer's specifications representative of maximum weight and operating conditions for loading down to the manufacturer's specified end of discharge condition while monitoring voltage and current on cells until the battery pack reaches its specified end of discharge voltage (EODV). Temperatures shall be monitored on temperature sensitive safety critical components including cells, enclosure, and all parts within the charging circuit that are temperature sensitive, including any user accessible surfaces.		N/A
28.5	The charge and discharge cycles are then repeated for a total of 2 complete cycles of charge and discharge. The test is then repeated with the representative unit in a chamber set to the eBike system manufacturer's lowest specified operating ambient for 2 complete cycles of charge and discharge. If the battery pack will not operate at the lowest ambient rating, then a temperature as close as possible to the lower ambient rating which allows the battery pack to operate shall be used.		P
28.6	During the temperature test, the voltage and current during discharge and charging of the component cells is monitored to determine that they are not outside of the specified cell manufacturer's operating region.		P
28.7	The manufacturer's specified limits (voltage, current and temperatures measured) shall not be exceeded during the charging and discharging cycles. Temperatures measured on components shall not exceed their specifications. See Table 28.1 and Table 28.2 for surface and component temperature limits.		P
28.8	The eBike shall be powered from a power source used to represent a battery pack. The eBike system is then operated at the maximum load on motors continuously until thermal stabilization. See 28.10.		N/A
28.9	Temperatures shall be monitored on all temperature sensitive components, enclosures, and user accessible surfaces. Temperatures measured on components shall not exceed their specifications. See Table 28.1 and Table 28.2 for surface and component temperature limits.		N/A
28.10	A temperature is determined to be stabilized when three successive readings taken at intervals of 10 percent of the previously elapsed duration of the test, but not less than 15 minutes, indicate no increase greater than 2°C (4°F).		N/A

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28.11	At the conclusion of this test, the battery pack tested under the battery method is placed back into the eBike system. Any hazardous voltage circuits shall be subjected to an Isolation Resistance Test,Section 29, (without humidity conditioning) or a Dielectric Strength Test, Section 30.		N/A
28.12	As a result of this test, in addition to temperatures remaining below the limits, there shall be no indication of fire, explosion, rupture, electrolyte leakage or electric shock.		N/A
29	Isolation Resistance Test		N/A
29.1	This test is intended to determine that insulation of the equipment provides adequate isolation of hazardous voltage circuits from accessible conductive parts and that the insulation is non-hygroscopic. The measured insulation resistance between the positive terminals and accessible parts of the equipment shall be at least 50,000 Ω.		N/A
29.2	Equipment with accessible parts shall be subjected to an insulation resistance test between the positive terminal and accessible dead metal parts. If the accessible parts are covered with insulating material that may become live in the event of an insulation fault, then the test voltages are applied between each of the live parts and metal foil in contact with the accessible parts as shown in 30.4 and Figure 30.1.		N/A
29.3	The insulation resistance shall be measured after a 60-s application with a high resistance voltmeter using a 500 V dc potential applied for at least 1 minute to the locations under test.		N/A
29.4	The test shall be repeated on a representative unit subjected to humidity conditioning in accordance with Section 31. Measurements shall be made with the unit still in the chamber.		N/A
30	Dielectric Strength Test		P
30.1	This test is an evaluation of the electrical spacings and insulation at hazardous voltage circuits within the equipment. There shall be no evidence of a dielectric breakdown (breakdown of insulation resulting in a short through insulation/arcing over electrical spacings) as evidenced by an appropriate signal from the dielectric withstand test equipment as a result of the applied test voltage. Corona discharge or a single momentary discharge is not regarded as a dielectric breakdown (i.e., insulation breakdown).		P

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30.2	Circuits at 60 Vdc or higher shall be subjected to a dielectric withstand voltage consisting of a dc potential of twice the rated dc voltage or twice the rated ac voltage times 1.414. Semiconductors or similar electronic components liable to be damaged by application of the test voltage may be bypassed or disconnected.		P
30.3	The test voltage is to be applied between the hazardous voltage circuits and non-current carrying conductive parts that may be accessible.		P
30.4	If the accessible parts of the equipment are covered with insulating material that may become live in the event of an insulation fault, then the test voltages are applied between each of the live parts and metal foil in contact with the accessible parts. The metal foil shall be wrapped tightly around and in intimate contact with the accessible part.		N/A
30.5	The test voltages shall be applied for a minimum of 1 minute with the cells/modules disconnected to prevent charging during application of the voltage.		N/A
30.6	The test equipment shall consist of a 500 VA or larger capacity transformer, the output voltage, which is variable and which is essentially sinusoidal if using an ac test method and dc output if using a dc test method. There is no trip current setting for the test equipment since the test is checking for insulation breakdown, which results in a large increase of current. Setting a trip current may result in a false failure of this test, as it may not be indicative of insulation breakdown.		N/A
31	Humidity Conditioning		P
31.1	A product shall comply with the requirements for the Dielectric Strength Test, Section 30, and the Isolation Resistance Test, Section 29, following exposure to air having a relative humidity of 88 ±2 percent at a temperature of 32 ±2°C (90 ±4°F).		P
31.2	To determine whether a unit complies with the requirement in 31.1, a representative unit is to be heated to a temperature just above 34°C (93°F) to reduce the risk of condensation of moisture during conditioning. The heated unit is to be placed in the humidity chamber and is to remain for 48 hours under the conditions specified in 31.1. Immediately following the conditioning, the unit is to be removed from the humidity chamber and tested as described in 31.1.		P
32	Abnormal Operations Tests		P
32.1	General		P

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32.1.1	A unit shall not emit flame or molten metal or become a risk of fire, electric shock, or injury to persons when subjected to the tests specified in 32.2 – 32.10. Separate representative units are to be used for conducting these tests, unless requested otherwise by the manufacturer.		P
32.1.2	Following each test, any hazardous voltage circuits shall be subjected to an Isolation Resistance Test, Section 29, (without humidity conditioning) or a Dielectric Strength Test, Section 30.		P
32.1.3	A risk of fire, electric shock, or injury to persons exists when:		P
32.1.4	During these tests the unit is to be placed on a softwood surface covered with a white tissue paper and a single layer of cheesecloth is to be draped loosely over the entire enclosure. The cheesecloth is to be untreated cotton cloth running 14 – 15 yards per pound (26 – 28 m2 /kg), and having, for any square inch, a count of 32 threads in one direction and 28 in the other direction.		P
32.1.5	The supply circuit is to have branch circuit overcurrent protection, the size of which equals 125percent of the input current rating (20-ampere minimum), except where this value does not correspond with the standard rating of a fuse or circuit breaker, the next higher standard device rating shall be used. The test voltage and frequency are to be adjusted to the rated values.		P
32.1.6	A unit with a conductive enclosure shall have the enclosure of the unit connected directly to ground.		N/A
32.1.7	Each test is to be continued until further change as a result of the test condition is reduced significantly. When an automatically reset protector functions during a test, the test is to be continued for 7 hours. When a manual reset protector functions during a test, the test is to be continued until the protector is operated for 10 cycles using the minimum resetting time, and not faster than 10 cycles of operation per minute. The following are examples of test terminations:		N/A
32.1.8	When the manually reset protector is a circuit breaker that complies with CSA C22.2 No. 5 / UL489, it is to be operated for 3 cycles using the minimum resetting time and not faster than 10 cycles of operation per minute.		P
32.1.9	A manual reset protector that becomes inoperative in the open condition shall be operated between 10 cycles and 3 cycles.		P
32.1.10	With reference to 32.1.7(b), when the branch circuit overcurrent protection device terminates the test, the instruction manual shall contain the information specified in 46.3(i).		P
32.2	Overcharging test		P

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32.2.1	This test is intended to evaluate the ability of the electrical system of the eBike to withstand an overcharge condition under a single fault in the charging control circuitry that could result in an overcharge condition. One representative system is to be tested for each fault condition applied. The same system can be used for more than one test if it remains functional after the fault is removed. For battery packs in accordance with 11.1(a) or 11.1(b), this test is not required.		P
32.2.2	A fully charged battery is to be discharged at a constant discharge rate of 0.2 times the manufacturer's rated capacity of the battery, or a higher discharge rate permitted by the manufacturer to the manufacturer's specified end-of-discharge voltage. The first representative system is then subjected to a constant current charging at the manufacturer's specified charging rate (i.e. based upon the maximum intended charger output current rate) under a single fault condition in the charging protection circuitry that could lead to an overcharge condition. Protective devices that have been determined reliable may remain in the circuit. For information purposes, temperatures are to be monitored on the cell/module where temperatures may be highest. The output control circuitry of external chargers with standardized output connectors that may result in the use of unspecified chargers shall not be considered as a reliable control to prevent an overcharging condition.		P
32.2.3	The test is to be continued until the voltage has reached 110 percent of the maximum specified voltage limit and/or monitored temperatures return to ambient or steady state conditions and an additional 2 hours has elapsed, or explosion/fire occurs. If the system is operational after the test, it shall be subjected to a minimum of one charge/discharge cycle at the manufacturer's maximum specified values. The test shall be followed by a 1-hour observation time prior to concluding the test and temperatures are to be monitored.		P
32.2.4	At the conclusion of the observation period, systems that contain hazardous operating voltages shall be subjected to a Dielectric Voltage Withstand Test, Section 30, or an Isolation Resistance Test, Section 29, (without humidity conditioning).		P
32.2.5	If a protective device in the circuit operates, the test is repeated at 90 percent of the trip point of the protection device or at some percentage of the trip point that allows charging for at least 10 minutes. Temperatures shall be measured on the cell/module where temperatures may be highest for monitoring purposes.		N/A

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32.2.6	As a result of the overcharge test, there shall be no indication of any noncompliant results as outlined in 32.1.		N/A
32.3	Component fault tests		P
32.3.1	A component, such as a capacitor diode, solid state desimilar device		P
32.4	Forced ventilation/blocked ventilation		P
32.4.1	A unit having forced ventilation is to be operated with the rotor of a blower motor or fan locked. For a unit having more than one blower motor or fan, the test is to be conducted with the rotor of each blower motor or fan locked, one at a time, unless agreeable to all for which all blower motors or fans shall be locked at the same time.		P
32.4.2	A unit having filters over ventilation openings is to be operated with the openings blocked to represent clogged filters. The test is to be conducted initially with the ventilation openings blocked 50 percent, then to be repeated under fully blocked condition.		P
32.5	Locked rotor motor test		P
32.5.1	This test is intended to evaluate a motor's ability to safely withstand a locked rotor condition, which may occur in the end use application. This test is waived if the motor and its locked rotor protection has already been evaluated as part of a motor and motor protector combination evaluation, in accordance with UL 1004-3 and CSA C22.2 No. 77, or UL 1004-7 and CSA C22.2 No. 77, or if relying on impedance protection in accordance with UL 1004-2 and CSA C22.2 No. 77, as applicable.		P
32.5.2	The motor is operated at the voltage used in the eBike application and with its rotor locked for 7 h or until steady conditions are established. The motor is to be tested while on the eBike and temperatures on windings are to be monitored. As an alternative, the motor can be tested outside of the eBike.		P
32.5.3	If the design or size of the motor prevents the measuring of temperatures on the windings, the test may be conducted with the motor removed from the eBike and instead of monitoring temperatures, the motor is to be supported on a surface covered with a single layer of tissue paper with the motor covered with a single layer of cheesecloth.		N/A
32.5.4	If the motor contains a hazardous voltage circuit, the motor shall be subjected to a Dielectric Voltage Withstand Test, Section 30, or Isolation Resistance Test, Section 29, (without humidity conditioning).		N/A

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32.5.5	If monitoring temperatures on windings during the locked rotor test, the temperatures on the windings shall not exceed the values noted in Table 32.1. If not monitoring temperatures on windings during the test, there shall be no sign of ignition of the tissue or cheesecloth at the conclusion of the test.		N/A
32.6	Running overload test		N/A
32.6.1	This test is intended to evaluate a motor's ability to safely withstand an overload condition, which may occur in the end use application. This test is waived if the motor and its overload protection has already been evaluated as part of a motor and motor protector combination evaluation in accordance with UL 1004-3 and CSA C22.2 No. 77, or UL 1004-7 and CSA C22.2 No. 77, as applicable to the method of thermal protection.		N/A
32.6.2	The motor is to be tested while in the eBike and temperatures on windings are to be monitored. As an alternative, the motor can be tested outside the eBike.		N/A
32.6.3	The motor is first operated under maximum normal load conditions. The load is then increased so that the current is increased in appropriate gradual steps with the motor supply voltage being maintained at its original value. When steady state temperature conditions are established the load is again increased. The load is thus progressively increased in appropriate steps until either the overload protection device operates or the motor winding becomes an open circuit.		N/A
32.6.4	The motor winding temperatures are determined during each steady period and the maximum temperature recorded shall not exceed the value in Table 32.2.		N/A
32.6.5	If the design or size of the motor prevents the measuring of temperature windings, the test may be conducted with the motor removed from the eBike and instead of monitoring temperatures, the motor is to be supported on a surface covered with a single layer of tissue paper with the motor is covered with a single layer of cheesecloth.		N/A
32.6.6	If the motor contains a hazardous voltage circuit, the motor shall be subjected to a Dielectric Voltage Withstand Test, Section 30, or Isolation Resistance Test, Section 29, (without humidity conditioning).		N/A
32.6.7	If monitoring temperatures on windings during the overload test, the temperatures on the windings shall not exceed the values noted in Table 32.2. If not monitoring temperatures on windings during the test, there shall be no sign of ignition of the tissue or cheesecloth at the conclusion of the test.		N/A
32.7	Short circuit test		P

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32.7.1	This test evaluates the ability of the battery pack to withstand a short circuit condition under a single fault in the charging control circuitry. For battery packs in accordance with 11.1(a) or 11.1(b), this test is not required.		P
32.7.2	A fully charged representative battery pack is to be short-circuited by connecting the positive and negative terminals of the battery pack with a circuit load having a total resistance of less than or equal to 20 mohms.		P
32.7.3	Representative battery packs are to be subjected to a single fault across any protective device in the charging control circuit. Protective devices that have been determined reliable may remain in the circuit.		P
32.7.4	The representative battery pack shall be discharged until the battery pack has returned to ambient temperature or fire or explosion occurs. Temperatures shall be measured on the cell/module where temperatures may be highest for monitoring purposes.		N/A
32.7.5	If the electrical system of the eBike is operational after the test, it shall be subjected to a minimum of one charge/discharge cycle at the manufacturer's maximum specified values. The test shall be followed by a 1-hour observation time prior to concluding the test and temperatures are to be monitored.		N/A
32.7.6	If a protective device in the circuit operates, the test is repeated at 90 percent of the trip point of the protection device or at some percentage of the trip point that allows discharging for at least 10 min.		N/A
32.7.7	At the conclusion of the test and after cooling to near ambient, representative battery packs that contain a hazardous operating voltage shall be subjected to a Dielectric Voltage Withstand Test, Section 30, or an Isolation Resistance Test, Section 29, (without humidity conditioning).		N/A
32.7.8	As a result of the Short Circuit Test, there shall be no indication of any noncompliant results as outlined in 32.1.		N/A
32.8	Imbalanced charging test		P
32.8.1	This test is to determine whether or not the battery pack, with series connected cells, can maintain the cells within their specified operating parameters if it becomes imbalanced. For battery packs in compliance with 11.1(a) or 11.1(b), this test is not required.		P
32.8.2	A fully charged battery pack of an eBike shall have all of its cells with the exception of one cell/cell block discharged to its specified fully discharged condition. The undischarged cells shall be discharged to approximately 50 percent of its specified state of charge (SOC) to create an imbalanced condition prior to charging.		P

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32.8.3	If the battery pack is operational after the test, it shall be subjected to a minimum of one charge/discharge cycle at the manufacturer's maximum specified values. The test shall be followed by a 1-hour observation time prior to concluding the test and temperatures are to be monitored.		N/A
32.8.4	At the conclusion of the observation period, battery packs that contain hazardous operating voltages shall be subjected to a Dielectric Voltage Withstand Test, Section 30, or an Isolation Resistance Test, Section 29 (without humidity conditioning).		N/A
32.8.5	As a result of the test, there shall be no indication of any noncompliant results as outlined in 32.1.		N/A
32.9	Shock test		N/A
32.9.1	This test is intended to determine whether or not the battery pack can withstand a mechanical shock that may occur when in use. For battery packs in compliance with 11.1(a) or 11.1(b), this test is not required.		N/A
32.9.2	The fully charged battery pack is to be secured to the testing machine by means of a rigid mount,which supports all mounting surfaces of the sample. Temperatures on the center cell are monitored for information purposes.		N/A
32.9.3	The battery pack is to be subjected to mechanical shock testing with parameters as shown in Table 32.3. The shocks are to be applied in all 6 spatial directions.		N/A
32.9.4	If the electrical system of the device is operational after the test, it shall be subjected to a minimum of one charge/discharge cycle at the manufacturer's maximum specified values. The test shall be followed by a 1-hour observation time prior to concluding the test and temperatures are to be monitored.		N/A
32.9.5	At the conclusion of the observation period, devices that contain hazardous operating voltages shall be subjected to a Dielectric Voltage Withstand Test, Section 30, or an Isolation Resistance Test, Section 29 (without humidity conditioning).		N/A
32.9.6	As a result of the test, there shall be no indication of any noncompliant results as outlined in 32.1.		N/A
32.10	Thermal cycling		N/A
32.10.1	This test determines the ability of the battery pack of the eBike to withstand exposure to rapidly changing environments such as when the eBike is entering or exiting a heated storage facility after being in a cold environment, changing temperatures during transport or storage outdoors, and the like, without evidence of damage that could lead to a hazardous event.		N/A

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32.10.2	A fully charged battey shall be subjected to the thermal cycing in accordance with 32.10.3		N/A
32.10.3	For the test, the battery or battery system shall be placed in a chamber with ambient air cycling at the temperature extremes of the manufacturer's recommended ambient range. The transition period between exposure temperatures is to be 15 minutes or less. This swing of temperature variations may be performed either through the use of a fast-response chamber, or by moving the battery or battery system between two chambers at the two test temperatures. The battery or battery system shall remain at each temperature extreme for as long as required for the battery or battery system to reach a uniform temperature (±5°C) of the chamber temperature but no less than 6 hours. A total of five cycles (at the high and low temperature extremes) are to be performed.		N/A
32.10.4	If the battery pack is operational after the test, it shall be allowed to return to room ambient and then subjected to a minimum of one charge/discharge cycle at the manufacturer's maximum specified values. The test shall be followed by a 1-hour observation time prior to concluding the test and temperatures are to be monitored.		N/A
32.10.5	At the conclusion of the observation period, battery or battery systems that contain hazardous operating voltages shall be subjected to a Dielectric Voltage Withstand Test, Section 30, or an Isolation Resistance Test, Section 29 (without humidity conditioning).		N/A
32.10.6	As a result of this test, there shall be no indication of any noncompliant results as outlined in 32.1.		N/A
33	Impact Test		P
33.1	unit acting as an enclosure shall be subjected to this test. The enclosure is to be subjected to an impact of 6.8 J (5 foot-pounds) on any surface that is exposed to a blow during normal use. This impact is to be produced by dropping a steel sphere, 50.8 mm (2 inches) in diameter and weighing 535 g (1.18pounds), from a height of 1.29 m (51 inches) to produce the 6.8 J (5 foot-pound) impact. For surfaces other than the top, the steel sphere is to be suspended by a cord and swung as a pendulum, dropping through a vertical distance of 1.29 m (51 inches) to strike the surface.		P
33.2	A unit is to be subjected to the impact test described in 33.1 with or without any attachment specified by the manufacturer so as to result in the most severe test.		P

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33.3	When the part under test is made of polymeric material, the impact test is to be first conducted on a representative unit or units in the as-received condition. The test is then to be repeated on a different unit or units that have been cooled to room temperature after being conditioned for 7 hours in an air oven operating at 10°C (18°F) higher than the maximum operating temperature of the material, and not less than 70°C (158°F). While being conditioned, a part is to be supported in the same manner in which it is supported on the unit.		P
33.4	Upon being removed from the oven mentioned in 33.3 and before being subjected to the impact test, no units shall show signs of cracking or other deleterious effects from the oven conditioning, and no unit shall be distorted so as to result in a risk of injury to persons.		N/A
33.5	After the impact test, any openings resulting from the test shall be evaluated for access to hazardous live parts using the articulate probe shown in Figure 18.1.		N/A
34	Mold Stress		P
34.1	This test is intended to evaluate whether any shrinkage or distortion exists on a molded or formed thermoplastic enclosure due to release of internal stresses caused by the molding or forming operation and result in the exposure of hazardous parts or reduction of electrical spacings.		P
34.2	The representative units are to be placed in a full-draft circulating-air oven maintained at a uniform temperature of 70°C (158°F) or 10°C (18°F) higher than the maximum temperature observed on the part during the Temperature Test, Section 28, whichever is higher. The units are to remain in the oven for 7hours.		P
34.3	To inhibit hazards from overheating energized cells, units shall be fully discharged prior to conditioning.		P
34.4	After careful removal from the oven, the units shall be allowed to cool to room temperature and then examined. After the examination, the units shall be subjected to a Dielectric Strength Test, Section 30, or sIsolation Resistance Test, Section 29, (without humidity conditioning).		N/A
34.5	There shall be no damage of the eBike system enclosure that would allow hazardous voltage parts to be accessed by use of the test rod 2.5 mm diameter, 100 mm long, shown in UL/ULC 2271, and the articulate probe shown in Figure 18.1.		N/A
35	Flexing Test		P

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35.1	After wiring has been subjected to flexing as described in 35.2, the unit shall be subjected to the Dielectric Voltage-Withstand Test in Section 30 and the wiring is to be examined for damage to determine where any conductors are broken or where individual strands have penetrated the insulation.		P
35.2	Wiring that is subjected to movement at times other than installation and servicing is to be tested by cycling the moving part through the maximum travel intended for the construction. The duration of the test is to be 500 cycles.		P
36	Ingress Protection Tests		N/A
36.1	This test is intended to evaluate the ability of the eBike to withstand potential water exposure in its sintended use and is conducted in accordance with the test method outlined in 36.2.		N/A
36.2	The enclosure shall be subjected to a water exposure test in accordance with the Standard for Degrees of Protection Provided by Enclosures (IP Code), IEC 60529, Tests for Protection Against Water Indicated by the Second Characteristic Numeral 4 (IPX4), unless the equipment is provided with a higher IP Code rating by the manufacturer, in which case the equipment shall be tested in accordance with its rating. During this test, the enclosure is to be mounted in the manner intended when installed on the eBike.If multiple mounting orientations are allowed, then each one is to be tested individually		N/A
36.3	If the equipment is operational after the test, it shall be subjected to a minimum of one charge/discharge cycle at the manufacturer's maximum specified values. The test shall be followed by an observation period in accordance with 26.8.		N/A
36.4	At the conclusion of the observation period, the units shall be subjected to a Dielectric Strength Test, Section 30, or an Isolation Resistance Test, Section 29, (without humidity conditioning).		N/A
36.5	As a result of the test, there shall be no indication of fire, explosion, rupture, electrolyte leakage, or shock hazard.		N/A
37	Permanence of Marking		P
37.1	The purpose of this test is to evaluate the permanence of an adhesive label that has not been subjected to a previous evaluation program		P
37.2	An adhesive label secured to a surface representative of the end use application and is subjected to the following conditioning. The label is rubbed by hand for 15 s with a piece of cloth soaked with water. This is then repeated using petroleum spirit.		P

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37.3	The petroleum spirit to be used for the test is an aliphatic solvent hexane having:		P
37.4	After the conditioning outlined in 37.2, the unit is to be examined for signs of damage including curing and to determine if the marking is still legible. The unit is also examined to determine if it can be removed easily by hand from the adhered surface.		P
37.5	As a result of the conditioning, the representative label shall remain legible, show no evidence of damage including curling and shall not be able to be easily removed by hand from the adhered surface.		P
38	Vibration Test		P
38.1	Complete device		P
38.1.1	An eBike system, or parts of the system, intended to be permanently mounted on an eBike shall be subjected to a vibration test. After the unit is subjected to the vibration test described in 38.1.2:		P
38.1.2	The vibration test shall consist of vibration for one hour at a frequency of 10 to 55 Hz and back to 10 Hz, with a linear sweep having a sweep time of two minutes per sweep cycle. The amplitude shall be 1.0 +0.1, - 0 mm (0.040 +0.004, - 0 inch) p-p displacement limit in a vertical plane.		P
38.1.3	After this test, the representative unit shall be subjected to a minimum of one charge/discharge cycle at the manufacturer's maximum specified values. After this charge/discharge cycle, the unit shall be subjected to an observation period per 26.8.		P
38.1.4	At the conclusion of the observation period, units that contain hazardous operating voltages shall be subjected to a Dielectric Strength Test, Section 30, or an Isolation Resistance Test, Section 29, (without humidity conditioning).		P
38.1.5	As a result of the test, there shall be no indication of fire, explosion, rupture, electrolyte leakage, or shock hazard.		P
38.2	Batteries/battery packs		P
38.2.1	This test evaluates the ability of the battery pack of the eBike to withstand vibration. The test shall be performed in accordance with IEC 60068-2-64, as specified in UL/ULC 2271. For battery packs in compliance with 11.1(a) or 11.1(b), this test is not required.		P

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38.2.2	The battery pack is to be securely mounted to a vibration test platform in a manner similar to how it is oriented during use. The representative battery pack is to be subjected to a random vibration along three perpendicular axes in space in a sequence starting with the vertical axes (Z) and ending with the longitudinal axis (X).		P
38.2.3	The representative battery pack shall be subjected to the vibration in each axis for 21 h. For each axis the frequency shall be varied from 5 Hz to 200 Hz with power spectral density (PSD) for the vertical (Z) axis, the longitudinal (X) axis, and the transverse (Y) axis as outlined in ISO 12405-1.		N/A
38.2.4	If the battery pack is operational after the test, it shall be subjected to a minimum of one charge/discharge cycle at the manufacturer's maximum specified values.		N/A
38.2.5	The test shall be followed by an observation period in accordance with 26.8.		N/A
38.2.6	At the conclusion of the observation period, representative battery packs containing hazardous operating voltages shall be subjected to a Dielectric Voltage Withstand Test, Section 30, or an Isolation Resistance Test, Section 29 (without humidity conditioning).		N/A
38.2.7	As a result of the test, there shall be no indication of any noncompliant results as outlined in 38.1.1.		N/A
39	Strain Relief		P
39.1	General		P
39.1.1	The tests in 39.2 and 39.3 apply to interconnecting cables of a hazardous voltage circuit.		P
39.1.2	Both the Strain Relief – Pull Test and the Strain Relief – Push Back Test are required for each interconnecting cable as specified in 39.1.1.		P
39.1.3	All of the tests can be performed on one representative system, but each test is to be performed individually		P
39.1.4	The internal connections are to be disconnected or cut prior to the tests in 39.2 and 39.3.		P
39.2	Strain relief – pull test		P
39.2.1	The strain relief means provided for each interconnecting cable as specified in 39.1.1 shall withstand a direct pull of 156 N (35 pounds) applied to the cord for one minute without displacement. The strain relief does not comply when at the point of disconnection of the conductors, there is such movement as to indicate that stress on the connections results		P
39.2.2	The weight is to be suspednde from the cable and supported by the unit so that the strain relief means is stressed from andy angle of the unit		P

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39.3	Strain relief – push back test		P
39.3.1	The interconnecting cable as specified in 39.1.1 shall be prevented from being pushed into the product through the cord entry hole where such displacement is likely to:		P
39.3.2	The cable is to be held 25.4 mm (1 inch) from the point where the cable emerges from the unit and is then to be pushed back into the unit. The cable is to be pushed back into the unit in 25.4 mm (1 inch) increments until the cable buckles or the force to push the cable into the unit exceeds 26.7 N (6pounds force). The cable, within the unit, is to be manipulated to the worst case position during the test to determine compliance with 39.3.1.		P
40	Startup Assistance Mode Test		N/A
40.1	EBikes or EPACs provided with a startup assistance mode are to be tested. The startup assistance mode shall have a maximum speed of 6 kph (3.7 mph) and the assistance shall stop when the activation control is released.		N/A
40.2	The representative eBike or EPAC shall be provided with a fully charged battery for this test. The test can be performed on a test track or on a test bench that keeps the assisted wheel free of the ground during the test.		N/A
40.3	Motor current is to be monitored throughout the test. Prior to any start of pedaling (stand by condition), the motor current is measured and recorded. This is considered the no-load current point. During the test, the current to the motor will increase due to motor assist. The test is terminated when the motor returns to this no-load current point.		N/A
40.4	The unit is to be operated for 5 minutes at a speed equal to 80 percent of its marked maximum assistance speed and then the representative eBike or EPAC is stopped. The startup assistance mode is activated and run for 1 minute. At the end of the 1 minute, the maximum speed is recorded.		N/A
40.5	At the end of the 1 minute duration in 40.4, the activation control is released and the motor current is observed. When the motor current returns to the no-load current point, the test is ended.		N/A
41	Motor Assistance Control		P
41.1	General		P
41.1.1	The tests in 41.2, 41.3, and 41.5, are required for all EPACs and all eBikes with an EPAC mode. For eBikes without EPAC mode, the tests in 41.2 and 41.3 do not apply. The test in 41.4 is only required on eBikes and EPACs that are provided with a cutoff feature when braking.		P

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41.1.2	For all tests in Section 41, the term “sample” is considered to apply to the on board electrical system or the complete eBike with the on board electrical system installed. The term refers to all EPACs and to any eBike that is provided with an EPAC function		N/A
41.1.3	When testing at the electrical system level , the distance traveled or speed can be determined inthe test bench by calculation using the number of rotations of a given wheel sizeom UL		N/A
41.2	Reverse Pedaling Test		N/A
41.2.1	The motor assistance shall not be activated when the pedals are operated in reverse. The motor current shall not increase above the no-load current point when tested in accordance with 41.2.2 – 41.2.4.		N/A
41.2.2	The sample shall be provided with a fully charged battery for this test. The test can be performed on a test track or on a test bench that keeps the assisted wheel free of the ground during the test.		N/A
41.2.3	Motor current is to be monitored throughout the test. Prior to any start of pedaling (stand by condition), the motor current is measured and recorded. This is considered the no-load current point.During the test, the current to the motor will increase due to motor assist. The test is terminated when the motor returns to this No-load current point.		N/A
41.2.4	The pedals are operated in reverse and the motor current value is observed. The motor current value is recorded during this operation and shall not exceed the non-assist current value.		N/A
41.3	Pedal Cessation Test for EPACs		N/A
41.3.1	The motor assistance of an EPAC shall cutoff within 2 meters (6.6 feet) of travel distance when the user stops pedaling. The motor current shall decrease to or below the no-load current point within sthose 2 meters.		N/A
41.3.2	The sample shall be provided with a fully charged battery for this test. The test can be performed son a test track or on a test bench that keeps the assisted wheel free of the ground during the test.		N/A
41.3.3	Motor current is to be monitored throughout the test. Prior to any start of pedaling (stand by condition), the motor current is measured and recorded. This is considered the no-load current point.During the test, the current to the motor will increase due to motor assist. The test is terminated when the motor returns to this no-load current point.		N/A

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41.3.4	The sample is operated at 90 percent of the marked maximum assistance speed and then pedaling is ceased. The distance traveled is measured from the time pedaling ceases to the time the motor current is at or below the no-load current point. No braking shall occur during this test.		N/A
41.3.5	With reference to 41.3.4, the distance traveled can be determined in the test bench by calculation using the number of rotations of a given wheel size.		N/A
41.4	Cutoff When Braking Test		P
41.4.1	The motor assistance shall cutoff when the brake device is actuated.		P
41.4.2	The sample shall be provided with a fully charged battery for this test. The test can be performed on a test track or on a test bench that keeps the assisted wheel free of the ground during the test.		P
41.4.3	Motor current is to be monitored throughout the test. Prior to any start of pedaling (stand by condition), the motor current is measured and recorded. This is considered the no-load current point. During the test, the current to the motor will increase due to motor assist. The test is terminated when the motor returns to this no-load current point.		P
41.4.4	The sample is operated at any actuated and the motor current shall be p enient speed for IS decrease . This test is repeated for each41.4.4 The sample isWhile pedaling		P
41.5	Cutoff at Maximum Speed Test		N/A
41.5.1	The motor assistance shall be cutoff on or before the sample obtains the marked maximum assistance speed when tested as indicated in 41.5.2 – 41.5.4.		N/A
41.5.2	The sample shall be provided with a fully charged battery for this test. The test can be performed on a test track or on a test bench that keeps the assisted wheel free of the ground during the test.		N/A
41.5.3	Motor current is to be monitored throughout the test. Prior to any start of pedaling (stand by condition), the motor current is measured and recorded. This is considered the no-load current point. During the test, the current to the motor will increase due to motor assist. The test is terminated when the motor returns to this no-load current point.		N/A

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41.5.4	The sample is to be operated for 5 minutes at a speed equal to 80 percent of its marked maximum assistance speed. After this duration, the speed is increased to the maximum speed the motor will allow but not more than 125 percent of the marked maximum assistance speed. The motor current shall be reduced to the no-load current point when, or before, the maximum speed of the sample reaches the marked maximum assistance speed.		N/A
42	General		P
42.1	The markings required for compliance to this Standard shall be legible and permanent such as etched, adhesive labels, etc. An adhesive-backed label shall comply with UL 969 and CSA C22.2 No.0.15, for the intended exposure conditions and surface adhered to. Alternatively, the label shall be subjected to the Permanence of Marking Test, Section 37.		P
43	Nameplate and Identification		P
43.1	Products shall be marked with the manufacturer's name, trade name, trademark or other descriptive marking which may identify the organization responsible for the product, part number or model number,and electrical ratings.		P
43.2	Products shall be marked with the date of manufacture, which may be in the form of a code that does not repeat within 10 years.		P
43.3	Products that are provided with a battery pack that has its battery management system residing in components or circuits outside the battery pack shall be marked with the charger that is specified for use. An example of such markings would be the following or equivalent "Use Only Charger (_____)." The blank would be filled in with identifying information for the charger.		P
43.4	All external terminals and connections intended to be made in the field, including the battery terminals if the battery pack is not keyed, shall be provided with identification and if applicable, polarity markings.		P
43.5	If a manufacturer produces or assembles eBike systems at more than one factory location, the equipment shall have a distinctive marking – which may be in code – to identify it as the product of a particular factory.		P
44	Cautionary Markings		P
44.1	The words, "CAUTION", "WARNING", OR "DANGER" in a cautionary marking shall be in letters not less than 3.2 mm (1/8 inch) high. The remaining letters in a cautionary marking shall not be less than 1.6mm (1/16 inch) high. The words, "WARNING" or "DANGER" are alternatives for the word, "CAUTION".		P

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44.2	A cautionary marking shall be located on a part that is not removable; or if removable, on a part that impairs the operation of the unit when removed. The marking shall also be visible and legible to the operator during normal operation of the unit.		P
44.3	A cautionary marking shall be located on a part that is not removable; or if removable, on a part that impairs the operation of the unit when removed. The marking shall also be visible and legible to the operator during normal operation of the unit.		P
45	General		P
45.1	A product shall be provided with legible installation instructions, operation instructions, and instructions pertaining to a risk of fire, electric shock, or injury to persons associated with the use of the product. Also, user maintenance instructions and moving and storage instructions associated with the use of the product by the end user shall be included.		P
45.2	The instructions mentioned in 45.1 shall be in separate manuals or shall be combined in one or more manuals when the instructions pertaining to a risk of fire, electrical shock, or injury to persons are separated in format and emphasized to distinguish them from the rest of the text.		P
45.3	An illustration is allowed with a required instruction to clarify the intent but shall not replace the written instruction.		P
45.4	The following items shall be entirely in upper case letters or shall be emphasized to distinguish them from the rest of the text:		P
45.5	Unless otherwise indicated, the text of all instructions shall be in the words specified or words that are equivalent, clear, and understandable. Substitution of the signal word "DANGER" for "WARNING " is allowed, when the risk associated with the eBike is such that a situation exists which		P
46	Instructions Pertaining to a Risk of Fire or Electric Shock		P
46.1	Instructions pertaining to a risk of fire or electric shock shall warn the user of reasonably foreseeable risks and state the precautions to be taken to reduce such risks. Such instructions shall be preceded by the heading, “INSTRUCTIONS PERTAINING TO RISK OF FIRE or ELECTRIC SHOCK” or the equivalent.		P
46.2	Numbering of the items in the list in 46.3 and including other instructions pertaining to a risk of fire, selectric shock, or injury to persons that the manufacturer determines to be necessary and that do not sconflict with the intent of the instructions are acceptable.		N/A

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46.3	The instructions pertaining to a risk of fire, electric shock, or injury to persons shall include those items in the following list that are applicable to the product. The statement “IMPORTANT SAFETY INSTRUCTIONS” or the equivalent shall precede the list, and the statement “SAVE THESE sINSTRUCTIONS” or the equivalent shall either precede or follow the list. The word “WARNING” shall be entirely in upper case letters or shall be emphasized to distinguish it from the rest of the text.		N/A
46.4	The instructions pertaining to a risk of fire, electric shock, or injury to persons, or the installation instructions shall include the following items if applicable. If the following instructions are included in the installation instructions, a reference to these instructions shall be included in the list mentioned in 46.3 as a separate item. The headings and the word “WARNING” shall be entirely in upper case letters or shall be emphasized to distinguish it from the rest of the text.		N/A
47	Installation Instructions		P
47.1	Installation instructions shall contain all the information needed to install the product for use as sintended, and shall be preceded by the heading, “INSTALLATION INSTRUCTIONS” or the equivalent.		P
48	Operating Instructions		P
48.1	Operating instructions shall contain all the information needed to operate the product as intended, and shall be preceded by the heading “OPERATING INSTRUCTIONS” or the equivalent.		P
48.2	Instructions in relation to operating that appear in the instructions pertaining to a risk of fire, electric shock, or injury to persons, are not required to be repeated here; but a reference to those instructions shall be included here.		P
48.3	The instruction manual shall contain the following information:		P
48.4	Instructions shall indicate that charging of the eBike shall only be performed with the manufacturer's recommended charger		P
49	User Maintenance Instructions		P
49.1	Instructions for user maintenance shall include explicit instructions for all cleaning and servicing that are intended to be performed by the user, and shall be preceded by the heading, “USER MAINTENANCE sINSTRUCTIONS” or the equivalent.		P
49.2	For units with user replaceable fuses, the user maintenance instructions shall contain statements concerning fuse replacement instructions and reference to the correct fuse ratings that are to be used.		P

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50	Moving and Storage Instructions		P
50.1	If moving or storage of the product is able to result in damage to the product that could result in a risk of fire, electric shock, or injury to persons during subsequent use, the instructions shall describe the proper moving and storage procedure, and shall be preceded by the heading, “MOVING AND STORAGE INSTRUCTIONS” or the equivalent.		P

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	TABLE: List of critical components				P
Object/part No.	Manufacturer/ trademark	Type/model	Technical data	Standard (Edition / year)	Mark(s) of conformity[1])
Plastic enclosure	LG CHEM LTD	LUMID GP2251BFH	V-0, 130°C	UL 94	UL E67171
Internal wire	Xin Sheng Terminal Mfg Ltd	1007	80 °C, 300V~, 20AWG	UL758	UL E328303
PCB	MeiZhou ChaoJie Electronic technology Co.,Ltd.	CJ-D	V-0, 130ºC	UL 796	UL E313924
Battery	Jiangsu Zhongxing Motorcycle Co., Ltd.	Samsung Battery-48V15Ah	48VDC, 15Ah	UL 1642	UL
Li-ion Battery Charger	Shenzhen Atnen Technology Co., Ltd.	LBC015480301	Input: 100-240V~, 50-60Hz, 2.5A Max. Output: 54.6VDC, 3.0A	UL 1310	UL

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	Input Test						P
U (V)	I (A)	Irated (A)	P (W)	Fuse #	Ifuse (A)	Condition/status	
54.6VDC	2.91	3.0	158.9	--	--	Normal Condition	

	TABLE: Thermal requirements			P
	test voltage (V)	charger	discharger	—
	t1 (°C)	23.3	23.4	—
Maximum temperature T of part/at:		T (°C)		allowed T_{max} (°C)
Internal wire		28.9	30.6	80
PCB		32.1	35.2	130
Enclosure		28.5	29.9	70
Motor Winding		25.0	58.9	125
Battery surface		42.7	40.0	Ref.
Supplementary information: The temperatures were measured under worst case normal mode defined in 1.2.2.1 and as described in sub-clause 1.6.2 and at voltages as described above. With a rated maximum ambient temperature of 25°C. For the components temperatures limit, please refer to table 1.5.1.				

	TABLE: High Voltage		P
Measured between:	Measured VA	Comments/conditions	
Adapter to Electric Bicycle	500	No breakon	
supplementary information:			

	TABLE: touch current measurement			P
Measured between:	Measured (mA)	Limit (mA)	Comments/conditions	
Adapter to Electric Bicycle	0.05	0.25	--	
supplementary information:				

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	TABLE: Fault condition tests					P
	Ambient temperature (°C) .....:				25°C unless otherwise specified	—
	Power source for EUT: Manufacturer, model/type, output rating .....:				See below	—
Component No.	Fault	Supply voltage (V)	Test time	Fuse #	Fuse current (A)	Observation
U1 pin1-pin6	SC	54.6VDC	10min	--	--	Unit shut down immediately, no damage, no hazards.
Motor	Locked	54.6VDC	7hours	--	--	No damage,no hazards.
Battery	SC	54.6VDC	10min	--	--	Unit shut down immediately, no damage, no hazards.
Battery	Overcharge	54.6VDC	7hours	--	--	No damage,no hazards.
Battery	discharge	--	2hours	--	--	No damage,no hazards.
Supplementary information: 1. SC: short-circuit; OC: open-circuit; OL: overload; 2. The Hi-pot tests were successfully conducted after the completion of fault condition.						

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Appendix 1: Photo document

Photo 1: Overall view

Photo 2: Overall view

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Photo 3: Overall view

Photo 4: Overall view

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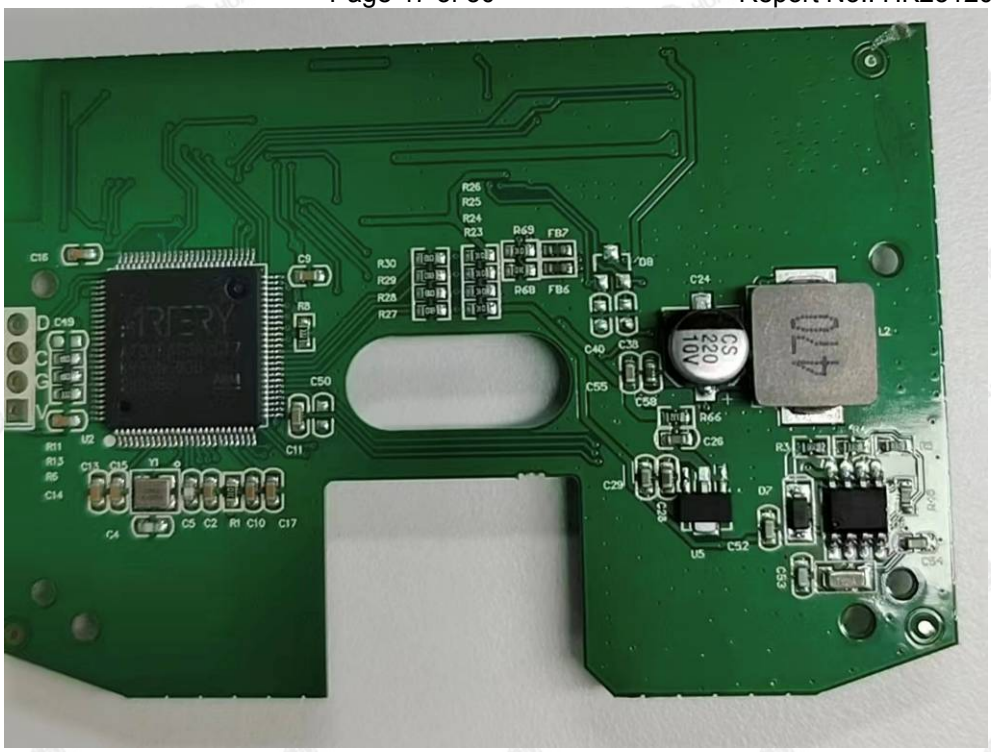

Photo 5: PCB view

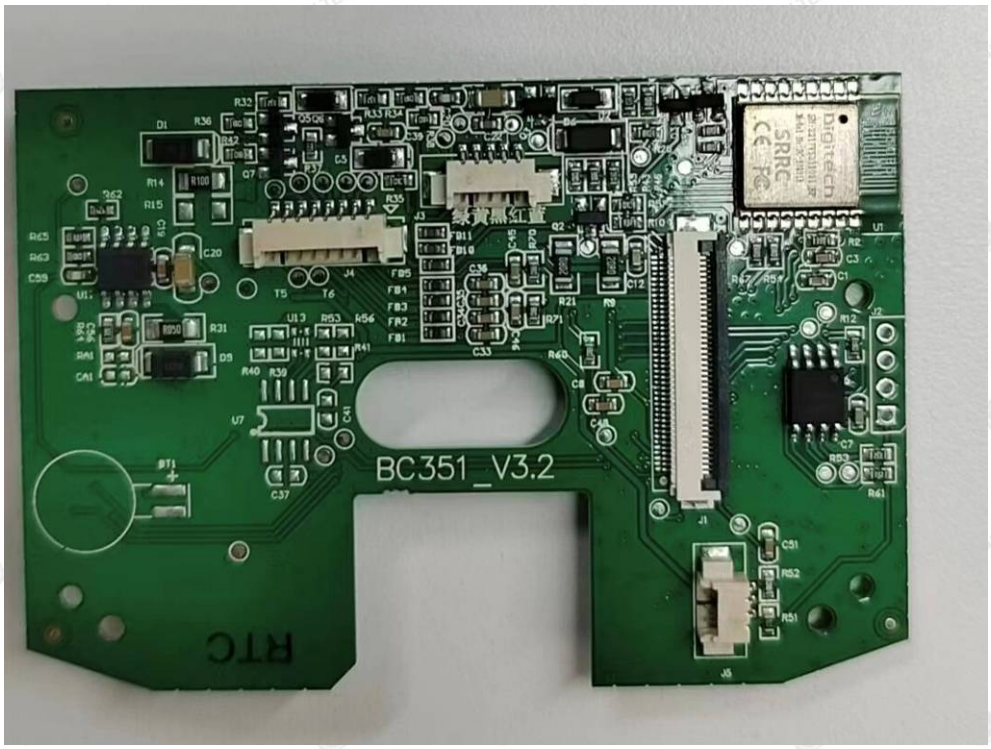

Photo 6: PCB view

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Photo 7: Battery view

Photo 8: Adapter View

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Photo 9: Overall view

Photo 10: Overall view

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Photo 11: Overall view

Photo 12: Overall view

----------End of report----------

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