Low Volume Vehicle Technical Association Incorporated

Low Volume Vehicle Standard
75-00(00)
(Electric and Hybrid Vehicles)

This Low Volume Vehicle standard corresponds with Land Transport Rule: Vehicle Standards Compliance 2002, and Land Transport Rule: Light Vehicle Brakes 2002

The picture is of the SIM-Drive concept electric Eliica car that can do 0-100 in 4 seconds, 370km/h top speed

(DRAFT # 6) Original version - effective from: 1 Dec 2011

Signed in accordance with clause 1.5 of the Low Volume Vehicle Code, on……………………………………………………………by	
on behalf of the New Zealand Transport Agency: ………………………………………………………………………………………………	*on behalf on the Low Volume Vehicle Technical Association (Inc):* ………………………………………………………………………………………………

LVV Standard 75-00 Amendment Record:

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2				
3				
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Changes from Draft 5 are denoted by yellow highlight. Deletions are also denoted by use of strikethrough. Blue text boxes are for information.

Overview

Background

The Low Volume Vehicle Technical Association Incorporated (LVVTA) represents ten hobbyist and specialist groups who are dedicated to ensuring that their members' vehicles, when scratch-built or modified, meet the highest practicable safety standards. The information in these standards has stemmed from work undertaken by LVVTA founding member groups that commenced prior to 1990 and has been progressively developed as an integral part of NZ Government safety rules and regulations by agreement and in consultation with the New Zealand Transport Agency. As a result, the considerable experience in applied safety engineering built up by LVVTA over the past twenty years is available to members of the NZ public and the modification industry who may also wish to build or modify light motor vehicles.

Availability of low volume vehicle standards

Low volume vehicle standards are developed by the LVVTA, in consultation with the New Zealand Transport Agency, and are printed and distributed by the LVVTA. Low volume vehicle standards are available to the public free of charge. The standards, together with any information associated with the low volume vehicle standards, may be obtained from the LVVTA website; www.lvvta.org.nz

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Contents

Electric and Hybrid Vehicles (75-00[00])

Purpose of this standard

The purpose of this low volume vehicle standard is to specify requirements for light motor vehicles that are converted to electric or hybrid propulsion, or that are scratch-built using electric or hybrid propulsion, which must be met, in order to ensure that the vehicles are safe during all normal driving conditions, in relation to their electrical systems, and also in relation to any inter-related effects that the electric or hybrid systems might have on other safety-related systems within the vehicle, particularly those governing directional and braking control.

Section 1 Scope and application of this standard

1.1 Scope of this standard

1.1(1) This low volume vehicle standard applies to all light vehicles other than those specified in *1.1(2)*, that are:

(a) converted to electric or hybrid power on or after 1 January 1992; or

(b) scratch-built using electric or hybrid power on or after 1 January 1992; or

(c) have modifications to electric/hybrid systems on or after 1 January 1992.

NOTE 1: The requirement for LVV certification in the case of electric or hybrid systems was triggered by the introduction of the Transport (Vehicle Standards) Regulations which, for low volume vehicles, took effect on 1 January 1992. Because electric or hybrid power may have an effect on the performance of a vehicle's braking system, and *Transport (Vehicle Standards) Regulation 1990: (13) Brakes* took effect on 1 January 1992, this date becomes the application date of this low volume vehicle standard.

NOTE 2: Item (c) includes addition of a plug-in charging system, additional batteries and changes to battery chemistry or an on-board charging system.

NOTE 3: Where a light vehicle is required to be certified to the *Low Volume Vehicle Code*, but the modification or construction date precedes the application date specified in *1.1(1)* of this standard, an LVV Certifier must ensure that the vehicle meets the general safety requirements contained in *2.1* of this standard, and should use the applicable technical requirements of *section 2* of this standard as a guideline upon which to base his judgements on the safety of the vehicle.

In the case of a vehicle built or modified between 1 January 1992 and the introduction date of this standard, an LVV Certifier must ensure that the requirements of the *LVVTA Electric Vehicle Guideline of 1997* are met.

1.1(2) This low volume vehicle standard does not apply to:

(a) powered bicycles of Class AB; or

(b) mopeds of Class LA, LB; or

(c) light trailers of Class TA or TB; or

(d) those vehicles specified in *section 4*.

1.1(3) An electrically or hybrid-powered low volume vehicle certified to this low volume vehicle standard may incorporate ~~within its drive train~~:

(a) single or multiple electric traction motors; and/or

(b) an alternative non-electric drive-line power unit; and/or

(c) a charging generator; and/or

(d) storage batteries; and/or

(e) other electric power sources such as solar cells; and/or~~. or a hydrogen powered fuel cell.~~

(f) an on-board mains charger.

NOTE: Technically advanced systems such as fuel cells can have wider implications to safety and are outside of the scope of this standard. Refer to LVVTA for individual advice on certification of fuel cells and other similarly complex systems.

1.2 Application of this standard

1.2(1) A light vehicle that is modified or scratch-built as in *1.1(1)*, becomes a low volume vehicle, and must:

(a) be certified in accordance with the procedures specified in *chapter 2* of the *Low Volume Vehicle Code*; and

(b) unless *section 3* applies, comply with all applicable technical requirements contained in *section 2* of this standard.

NOTE: ~~Where a light vehicle is required to be certified to the *Low Volume Vehicle Code*, but the modification or construction date precedes the application date specified in *1.1(1)* of this standard, an LVV Certifier must ensure that the vehicle meets the general safety requirements contained in *2.1* of this standard, and should use the applicable technical requirements of *section 2* of this standard as a guideline upon which to base his judgements on the safety of the vehicle.~~

~~In the case of a vehicle built or modified between 1 January 1992 and the introduction date of this standard, an LVV Certifier must ensure that the requirements of the *LVVTA Electric Vehicle Guideline of 1997* are met.~~ NOTE MOVED TO SECTION 1.1

1.2(2) A reference within this standard to an electrically-powered low volume vehicle, includes a low volume vehicle which is propelled by either electric or hybrid power.

Section 2 Technical requirements of this standard

2.1 <u>General safety requirements</u>

General operational safety

2.1(1) A low volume vehicle must:

(a) be designed and constructed using materials and components that are fit for their purpose; and

(b) be safe to be operated on the road.

NOTE: The requirements specified in *2.1(1)* are selected from *2.3* of *Part 2* of the *Low Volume Vehicle Code*, reproduced here in the interest of convenience, and are over-riding requirements which make it clear that, regardless of what technical requirements are or are not in place within this low volume vehicle standard, every vehicle certified to the *Low Volume Vehicle Code* must be fit for its purpose, and must be safe.

Tradesman-like manner

2.1(2) Any electrical, mechanical, engineering, or fabrication work associated with a modification or construction feature in a low volume vehicle must:

(a) be carried out in a thorough, tidy, and tradesman-like manner; and

(b) follow sound electrical and automotive engineering principles.

NOTE 1: *2.1(2)(a)* specifies that it is an expectation of the LVV certification system that modification work is not only compliant and safe, but is carried out to a reasonable standard. Engineering work that - whilst compliant and safe - has been executed in a manner that makes the job rough or crude in appearance, can bring the LVV certification system into disrepute through observers' perception (rightly or wrongly) of any such work. This in turn can lead to complaint investigations being raised, which can consume time unnecessarily.

NOTE 2: 'Automotive engineering principles' referred to in *2.1(2)(b)* is intended to mean those top-end quality engineering principles employed throughout the light passenger vehicle manufacturing industry, and not low-technology industrial equipment such as some fork-lifts.

2.2 Electrical systems

NOTE: Inspecting and maintaining an electric vehicle can be extremely hazardous due to the high voltages present. High voltage is defined as exceeding 60V DC or 25V AC. All work should be carried out with a high regard for personal safety, using appropriate tools and all available safeguards.

General system requirements

2.2(1) The electrical system within an electrically-powered low volume vehicle must incorporate:

(a) design features that, in the event of a common malfunction, provide a fail-safe outcome; and

(b) ~~adequate~~ fail-safe measures such as fuses, circuit breakers or fusible links that offer adequate protection in case of a short-circuit, which must be appropriate for the voltage and have a current carrying capacity less than that of the wiring, main contactors and switches (notes 2, 3 and 4); and

(c) a master isolation switch within reach of the driver in the normal seated position that isolates ~~both~~ all poles of the motor power supply from the motor controller circuitry, either mechanically or electro-mechanically (note 1); and

(d) if situated within the battery compartments, flameproof electrical switches and relays; and

(e) a separate battery or electrical supply management system that provides priority to the power supply needs of the vehicle's safety equipment, such as lighting equipment, brakes, and windscreen wipers; and

(f) a suitable mechanical maintenance isolation switch, operated without the need for tools, close to each separate group of batteries, to isolate all poles of the batteries, ~~during maintenance~~ such that safe access is provided for maintenance within two minutes of power disconnection.

(g) components that able to operate effectively while subject to typical vehicle conditions, such as vibration, dust and moisture ingress, without leading to fatigue and premature failure.

(h) Clearly visible labels warning of electric shock hazard on the covers of all compartments which contain high voltage connections. Refer to section 2.6(1) for label requirements.

NOTE 1: In addition to *2.2(1)(c)*, a mechanical disconnect between the motor and the drive-train, such as a clutch, is permissible.

NOTE 2: Fuses, switches, contactors, and wire insulation as referred to in *2.2(1)(b)* must be appropriate for the voltages and current type present in the system. For example:

- use of an automotive blade fuse on a high-voltage circuit will result in a fire if the fuse ever opens
- Cylindrical glass fuses commonly available are mostly rated for 240v AC. This is quite different from a DC rating and may explode or fail to clear the fault if used with high voltage DC
- Fuses with appropriate ratings are usually ceramic or fibreglass bodied with a sand filling
- DC contactors often have 'blow out' magnets which blow the arc out of the contactor, improving their ability to clear a high voltage current. Such contactors must not be installed backwards, as the magnets will blow the arc into the contactor and reduce their voltage rating
- Power circuitry should be employed, using relays with two separate contacts for both traction battery polarities. A single relay is not recommended.

NOTE 3: All connections to the high-voltage system as referred to in *2.2(1)(b)* should be fused as closely as practical to the battery. This includes small wires such as the sensor-wires on a current shunt or a volt-meter.

2.2(2) The electrical system within an electrically-powered low volume vehicle must be designed to, or incorporate cooling to, maintain ~~ambient~~ operating temperatures during prolonged operation in all typical ambient temperatures that are within the manufacturers' guidelines for all components and systems used within the vehicle's electric power systems.

NOTE: Typical New Zealand ambient operating temperatures ~~within an electric engine and related components and systems~~ referred to in *2.2(2)* range from minus 10 degrees C to plus 40 degrees C.

Wiring requirements

2.2(3) The high voltage (exceeding 60V DC or 25V AC) electrical wiring within an electrically-powered low volume vehicle must:

~~(a) be of a fail-safe design~~ not incorporate sharp bends; and

(b) be adequately insulated, taking into consideration the system's operating voltage and temperature range; and

(c) not be electrically connected to the vehicle's chassis or body; and

(d) be effectively sealed or otherwise resistant to the intrusion of dust and moisture; and

(e) be contained within a sealed, rigid protective housing where the wiring passes through the passenger compartment or load space (note 2); and

(f) be sized to make allowance for high peak currents in the case of stall or high acceleration of at least 1.5 times the continuous current rating of the motor or controller; and

(g) be adequately supported and secured to the chassis or other structural section at intervals of less than 350 mm; and

(h) be positioned against the chassis or other structural section in such a way that it is protected from accidental damage as a result of jacking or road debris; and

(i) have electrical connections with large voltage differences and high current capabilities positioned apart, so as to minimise the likelihood of short-circuits; and

(j) have protective covers over any live connections; and

(k) not be positioned within the roof, body pillars or outer sills (note 3) ; and

(l) allow for movement under high load.

NOTE 1: 'High voltage', as referred to in *2.2(3)*, is defined as exceeding 60V DC or 25V AC.

NOTE 2: The requirement for sealing of cable housing in 2.2(3)(e) is necessary to prevent noxious gases from entering the passenger compartment following a wire short, arc and overheat situation.

NOTE 3: The requirement for prohibited cable positioning in 2.2(3)(k) is to prevent installation of high voltage cables in areas that emergency services commonly cut open to effect a rescue.

2.2(4) The electrical wiring within an electrically-powered low volume vehicle that carries high current loads and/or high voltage, must be orange in colour, and where the wiring is concealed in conduit, the conduit must be orange in colour.

NOTE: Where high voltage cables need to be marked with polarity or other designations, this should be done with a tracer colour along the orange cable length, or with coloured bands at the ends of the orange cable.

Overload protection

2.2(5) The electrical systems within an electrically-powered low volume vehicle must have an over-current protection device system that:

(a) is an appropriate selection for the design of the electrical system; and

(b) is mounted as closely as possible to the power sources, but not within a compartment containing venting batteries unless the over-current device will not overheat if deployed; and

(c) is designed to protect the wiring and electrical components of the electrical drive ~~from over-current and damage, with at least 20% overload capacity~~ from over-heating following an over-current situation; and

(d) has ~~no more over-load capacity than is necessary~~, between 20% and 40% overload capacity, in order to protect the electrical wiring and components of the electrical drive from damage; and

(e) is DC rated for the maximum battery voltage and capable of interrupting the maximum short circuit battery current; and

(f) protects all connections to the high voltage traction battery and motor wiring, which must include ammeter shunt wiring, volt meter wiring, battery management systems, chargers, and heaters.

(g) In the event of deployment, is not likely to cause itself or any surrounding components to ignite.

NOTE: LVVTA recommends that:

(a) a battery disconnection device, such as an inertia switch, be fitted to automatically switch off in the event of a vehicle crash; and

(b) current-sensitive overload relays or controllers be used in place of simple wire or cartridge-type fuses, in order to ensure that a total loss of control to the traction motor cannot occur; and

(c) cable sizing takes into account any enclosed runs which may limit effective cooling; and

(d) fuses or circuit breakers should be mounted as near as practical to the electrical middle of the battery pack so that the battery voltage is split into 2 lower voltage sections.

External charging circuits

2.2(6) The ~~external~~ electrical charging system of an electrically-powered low volume vehicle, that takes power from an external source, must:

(a) be fitted with an interlock which immobilises the vehicle when the charging cable is connected, regardless of the presence of a charging voltage; and

(b) if 230 volt domestic power or 3-phase supply is directly connected, a Certificate of Compliance must be provided by a registered electrician to confirm that the wiring complies with the *Australia/New Zealand Wiring Standard AS/NZS ~~3000:2007~~ 3001:2008 - Electrical installations – Transportable structures and vehicles including their site supplies; and*

(c) not be installed inside a compartment with venting type batteries

NOTE 1: The battery charging process has a high safety risk from a malfunction. Modern non-venting batteries can still overheat, emit noxious gases and catch fire.

NOTE 2: Common household wiring is rated at 15 Amps, but standard plugs are only rated at 10 Amps. Follow EECA/MED guidance for charging needs over 10 Amps.

2.3 Batteries

NOTE: Though lead-acid type venting batteries have well-known safety risks, such as acid spillage and venting noxious gases, there are also safety risks with other battery types, including thermal runaway. Care should be taken with the specification of battery and the appropriate installation and control.

Battery restraint

2.3(1) Batteries used to power an electrically-powered low volume vehicle must be securely fixed in position by a support or restraint system constructed of durable materials that:

(a) for batteries located rearward of, inside, or under the passenger compartment, is able to withstand:

(i) in the forward longitudinal direction, 20 times the combined weight of the battery and restraint system; and

(ii) in all other directions, 2.5 times the combined weight of the battery and restraint system;

and

(b) for batteries located forward of the passenger compartment, is able to withstand in all directions, 2.5 times the combined weight of the battery and restraint system.

NOTE 1: The loadings in *2.3(1)* are specified in order to ensure that the very high battery weights are adequately restrained in the event of a crash.

NOTE 2: The strength of a bulkhead that is inter-positioned between any batteries and the passenger compartment may be taken into consideration when assessing the strength of a battery restraint system.

NOTE 3: Where lead-acid batteries or other devices are used that have the potential of releasing corrosive by-products, the selection of materials used in the battery restraint system should take into account the need for the restraint system to be resistant to degradation in the presence of the corrosive materials.

Battery compartments and venting

2.3(2) Batteries that are used to power an electrically-powered low volume vehicle and which have the potential to emit a hazardous liquid or gas, must be effectively sealed off from the passenger compartment so that liquid spillage or gas leakage cannot occur, by either:

(a) individually sealing the batteries, and externally venting each battery; or

(b) fully enclosing the batteries within one or more sealed battery compartments, and externally-venting the compartments.

(c) positioning the batteries outside of, and away from the passenger compartment, such as in a ute tray.

2.3(3) Battery compartments used to isolate the passenger compartment of an electrically-powered low volume vehicle from hazardous liquid or gas, must:

(a) incorporate compartment seals made of non-porous material which are resistant to corrosion; and

(b) be designed so that transmission of flames between battery compartments cannot occur; and

(c) incorporate trays to catch fluids expelled from the batteries by either:

(i) an absorbent neutralising mat in the tray; or

(ii) a drip tube that directs fluid away from the vehicle to prevent corrosion;

and

(d) have, affixed to each compartment, a warning label stating the type of battery and the potential dangers associated with the battery; and

(e) be resistant to degradation in the presence of corrosive materials.

> NOTE: The warning notice positioned on the outside of each battery compartment, as required by *2.3(3)(d)* can be achieved by moving or copying a battery manufacturer's warning label from one of the batteries to the outside of the compartment.

2.3(4) If venting-type batteries are used, the design of the batteries or battery compartment must provide for venting directly to the atmosphere of all gases given off by normal battery operation.

> NOTE: It is critically important to vent the battery compartment as noted in *2.3(4)*. During recharging of venting type batteries, hydrogen can be given off in quantities sufficient to create an explosion. Hydrogen is lighter than air so will rise in a battery box, so the vent out should be high up, and the air inlet low down.

2.3(5) The battery installation must provide access, in under a minute, for power disconnection of both poles of the system and for maintenance, such as electrolyte top-up, and battery cleaning.

Gas venting and cooling split into 2 sections for clarity

Battery compartment forced ventilation

2.3(6) An electrically-powered low volume vehicle that uses batteries which have the potential to emit a hazardous gas during normal operations, must be fitted with a forced ventilation system that:

(a) is constructed of materials that are corrosion-resistant to any gas present; and

(b) is designed in such a way that it will not ignite any gas present; and

(c) will operate automatically whenever a hazardous gas could be produced; and

(d) ~~operates automatically for three minutes after the batteries are taken off charge in order to remove any hazardous gases, if present~~ continues to operate for three minutes after any period of automatic operation; and

(e) operates by extracting gas from the battery compartments, and not by blowing in air which could leak out of the compartment; and

(f) is adequately protected from mechanical damage; and

(g) has an inlet low down and an outlet high up that are located at opposite ends of the battery compartment; and

(h) ~~has a method to~~ prevents reverse-flow of any hazardous gases into the vehicle's interior; and

(i) has an air flow rate that is sufficiently in excess of any gas evolution of the batteries; and

(j) has an inlet opening external to the ~~vehicle~~ passenger compartment.

NOTE 1: The inlet opening referred to in *2.3(6)(j)* should not be placed in the vicinity of the ventilation system's outlet, and with the vehicle in motion it should preferably be in an area where the local air pressure is likely to be higher than static atmosphere pressure.

NOTE 2: Where any doubt exists about the adequacy of the ventilation, relevant documentation must be provided from the battery manufacturer confirming that the designed airflow is adequate for the gas evolution conditions specified in *2.3(6)*.

NOTE 3: Examples of the types of designs referred to in *2.3(6)(b)* include a sparkless/brushless type fan motor.

NOTE 4: Consideration needs to be given to filtering the air brought into the battery compartment, and venting potentially explosive gases away from any ignition sources and components susceptible to corrosion.

2.3(7) An electrically-powered low volume vehicle that uses batteries which require cooling during operation, must be fitted with a forced ventilation system that:

(a) will operate automatically whenever cooling is required; and

(b) continues to operate for three minutes after any period of automatic operation; and

(c) is adequately protected from mechanical damage; and

(d) ~~has a method to~~ prevents reverse-flow of any hazardous gases into the vehicle's interior; and

(e) has an air flow rate that is sufficient to cool the batteries while under charge and drive cycles; and

(f) has an inlet opening external to the ~~vehicle~~ passenger compartment.

NOTE 1: The inlet opening referred to in *2.3(7)(f)* should not be placed in the vicinity of the ventilation system's outlet, and with the vehicle in motion it should preferably be in an area where the local air pressure is likely to be higher than static atmosphere pressure.

NOTE 2: Where any doubt exists about the adequacy of the ventilation, relevant documentation must be provided from the battery manufacturer confirming that the designed airflow is adequate for the heat evolution conditions specified in *2.3(7)*.

NOTE 3: Consideration needs to be given to filtering the air brought into the battery compartment.

2.4 Vehicle operation

Instrumentation

2.4(1) The instrumentation of an electrically-powered low volume vehicle must provide to the driver, a clear visual indication of:

(a) when the traction motor circuit is live; and

(b) the state of charge of the batteries (note 2); and

(c) when the handbrake is on (note 5); and

(d) in the case of a vehicle fitted with ~~an electric vacuum pump,~~ power assisted brakes, such as vacuum fed, a loss of ~~vacuum~~ power assistance that may result in a loss or reduction of braking performance (notes 1 and 5); and

(e) in the case of a vehicle fitted with a forced ventilation system for the battery compartments, the failure of the ~~fan motor~~ ventilation supply; and

(f) Where the components are suitable, the occurrence of a ground fault (isolation failure), accompanied by an audible warning. (note 3)

NOTE 1: The brake failure warning light specified in *2.4(1)(d)* must be able to be tested by turning the ignition switch to 'start' or 'test' position.

~~NOTE 2: Because electric vehicles can be very quiet, LVVTA recommends that a reversing alarm which will be audible to nearby pedestrians is fitted.~~

NOTE 2: This requirement is necessary to provide an indication of remaining range

NOTE 3: A ground fault detection system may not be compatible with some components. Brushed DC systems will always have some earth leakage due to conductive dust from the motor brushes, and flooded batteries will also inevitably cause some earth leakage due to conductive mist vented during charging. A ground fault detection system as specified in *2.4(1)(f)* should take account of the motor and battery type. The aim is to detect a ground between any potential within the battery and the vehicle structure or body (if made of conductive material). To test as part of the certification, connect a suitable resistor between several electrical positions within the battery, (for example at the most negative battery, the most positive battery somewhere in the middle of the battery) and several places on the vehicle structure/body (including structure near the battery) and check that the leakage detector detects it. This should be done between the structure/body. ~~This should be done in several places on the vehicle.~~

NOTE 4: Despite the requirement for an interlock device in *2.2(6)(a),* LVVTA recommends that a warning light also indicates that an external battery charging system is connected.

NOTE 5: The handbrake and brake vacuum warning lights specified in *2.4(1)(c)* and *(d)* are critical to show that the braking system is performing properly, as there is no back-up engine braking that would be available with an internal combustion engine.

Accelerator

2.4(2) An electrically-powered low volume vehicle must have an accelerator pedal (note 2), and an associated control mechanism for the control of the electrical motor and circuitry, incorporating a fail-safe design (note 1).

NOTE 1: ~~A single potentiometer type mechanism is not acceptable as a means of compliance with *2.4(2)*.~~ A single sliding contact type potentiometer alone is not failsafe. A hall effect sensor or wire-wound potentiometer is acceptable but must have secondary safety features such as a throttle-shut microswitch, brake-on microswitch and double throttle return springs.

NOTE 2: A motorcycle may use an alternative control instead of a pedal, as appropriate.

Transmission

2.4(3) The transmission of an electrically-powered low volume vehicle with an electric reversing switch fitted, must incorporate an operative inhibitor switch that will ~~in the case of an electric reversing switch being fitted,~~ prevent the electric reverse switch from being inadvertently engaged during forward motion.

NOTE: Slow moving electric vehicles can be very quiet; LVVTA recommends that a reversing alarm which will be audible to nearby pedestrians is fitted. A wide angle rear-view camera may also reduce the risk to safety.

Braking system

2.4(4) Where power assisted brakes, such as vacuum or air-boosted hydraulic brakes, are fitted to an electrically-powered low volume vehicle, and the ~~vacuum or air~~ power assisting supply ~~is no longer available~~ fails during electric drive operation:

(a) an alternative ~~vacuum or air~~ supply must be provided in order to maintain safe braking performance for a minimum of two stops; and

(b) a brake failure warning light must notify the driver of the situation, as noted in *2.4(1)(d)*.

2.4(5) During a brake-performance test, carried out as part of the low volume vehicle certification inspection process, any system, supplementary to the type noted in 2.4(4), that may aid the braking process, such as electric motor regenerative braking, must be disengaged for the duration of that test, unless disengagement of the system is not possible. (note 1)

NOTE 1: *2.4(2)* of *LVV Standard 35-00 (Braking Systems)* requires that a low volume vehicle is able to meet the specified brake performance requirements without the deliberate aid of engine compression. Therefore, any electrical equivalents must not be used to achieve the same effect.

NOTE 2: When any electric engine conversion (and associated batteries etc) results in a significant increase in mass, particular attention should be paid to the condition and durability of all braking components, including the rotors, calipers, pads, drums and shoes, along with wheel hubs and bearings.

2.5 Manufacturer's GVM and MAR

2.5(1) An electrically-powered low volume vehicle must not exceed the vehicle manufacturer's gross vehicle mass or either of the vehicle manufacturer's axle ratings, for that make and model of vehicle.

2.5(2) In the case of an electrically-powered low volume vehicle which, due to the addition of heavy components such as batteries, has an increased tare (unladen) weight, or a change in axle load distribution:

(a) the spring rates and shock absorber damping capability must be suitable for the increased unladen vehicle mass or axle load, and enable the vehicle to maintain similar handing characteristics and comfort levels to that of its unmodified condition; and

(b) the vehicle's wheel-stud number and size must be suitable for the increased unladen vehicle mass or axle load; and

(c) the vehicle's increased unladen vehicle mass or axle load has not caused the load-rating of the tyres to be exceeded; and

(d) the vehicle's steering characteristics are as good as would be expected from the vehicle despite its increased unladen vehicle mass or axle load; and

(e) the vehicle's braking performance, both in one-off emergency braking and cyclic fade resistance brake-testing, is sufficient for the increased unladen vehicle mass or axle load; and

(f) the amount of deflection throughout the vehicle's structure, both in bending and twisting, does not exceed, despite the increased unladen vehicle mass or axle load, that of the same make and model of vehicle in an unmodified form.

NOTE 1: The manufacturer's gross vehicle mass cannot exceed the sum of the manufacturer's axle ratings for the front and rear axles.

NOTE 2: When weighing a vehicle to determine that the manufacturer's GVM has not been exceeded, a simulated occupant weight of 80 Kg must be applied to each seating position, and any equipment must be in its maximum weight state, such as full water storage tanks.

2.6 Other requirements

Warning labels

2.6(1) An LVVTA-approved warning label warning of electric shock hazard must be fitted on the covers of all compartments which contain high voltage connections. The warning label must incorporate the symbol of a triangle containing a lightning bolt, and the words 'high voltage', as shown in *diagram 1.1*.

~~2.6(1) An LVVTA-approved battery logo warning label, as shown in *diagram 1.1*, must be fitted to an electrically powered low volume vehicle to indicate the presence of high voltage electric power, and must:~~

~~(a) be fitted to:~~

~~(i) the front and rear bumpers of the vehicle; and~~

~~(ii) on batteries, covers or compartments containing high voltage batteries; (see *diagram 1.1*)~~

~~and~~

~~(b) be of a total width of not less than 100 mm.~~

NOTE 1: 'High voltage', as referred to in *2.6(1)*, is defined as exceeding 60V DC or 25V AC.

~~NOTE 1: The warning label must incorporate the symbol of a triangle containing a lightning bolt, and the words 'high voltage', as shown in *diagram 1.1*.~~

NOTE 2: It is intended that the labels make the presence of an electrical hazard obvious, however it is not intended that every component of the electrical system be individually labelled.

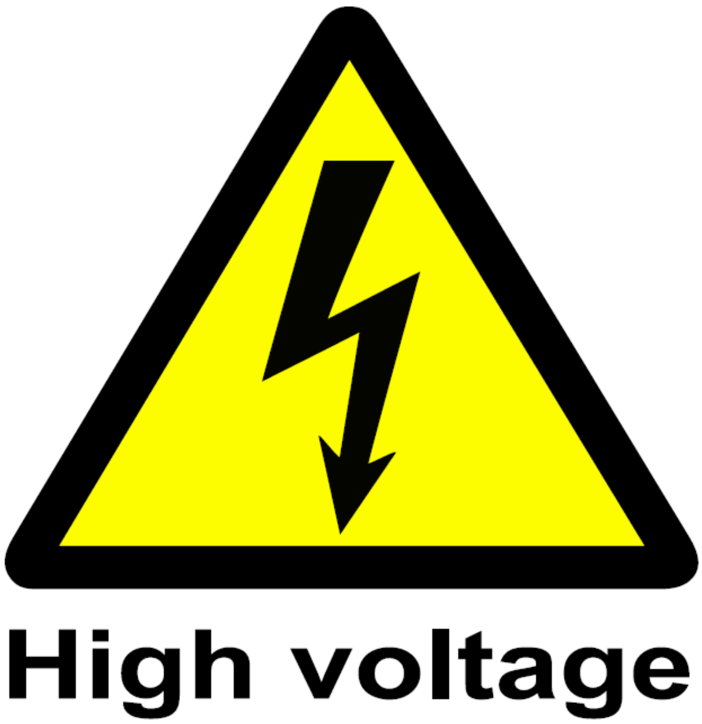

Diagram 1.1 High Voltage warning label

Compliance with other technical requirements

2.6(2) An electrically-powered low volume vehicle must also meet any applicable technical requirements specified in:

(a) *Low Volume Vehicle Standard 85-40 (Engine and Drive-train Conversions)*; and

(b) *Low Volume Vehicle Standard 195-00 (Suspension Systems)*; and

(c) *Low Volume Vehicle Standard 155-30 (Frontal Impact)*; and

(d) *Low Volume Vehicle Standard 155-40 (Interior Impact)*; and

(e) *Chapter 5 (Chassis Modification and Construction)* of the *New Zealand Hobby Car Technical Manual*; and

(f) *Chapter 18 (Attachment Systems)* of the *New Zealand Hobby Car Technical Manual.*

NOTE 1: All electrically-powered low volume vehicles, including those production vehicles with relatively straight-forward electric engine conversions, will potentially affect compliance with some parts of the LVV standards and NZ Hobby Car Technical Manual chapters listed in *2.6(2)(a)* to *(f)*, and therefore must be assessed against those standards and chapters in every case.

NOTE 2: Due to the high torque of electric motors, motor and transmission mounts may need to be stronger than original equipment types.

Extensively modified and scratch-built LVVs

2.6(3) All electrically-powered low volume vehicles which are either scratch-built, or are modified to such an extent that they are beyond the scope of the applicable requirements referred to in *2.6(2)(a)* to *(f)*, must comply with any relevant design and construction requirements specified in the applicable chapter of the *New Zealand Hobby Car Technical Manual*.

Section 3 Exclusions to this standard

No exclusions apply to this low volume vehicle standard.

Section 4 Vehicles that are not required to be certified to this standard

4.1 Vehicles not covered by this standard

4.1(1) A light vehicle is not required to be certified to this low volume vehicle standard, if the vehicle is modified for use for law enforcement or the provision of emergency services.

4.2 Vehicles that pre-date legal requirements

4.2(1) A light vehicle is not required to be certified to this low volume vehicle standard, if the vehicle was:

(a) converted to electric or hybrid power before 1 January 1992; or

(b) scratch-built using electric or hybrid power before 1 January 1992.

Section 5 Terms and definitions within this standard

Ampere (Amp or A) means the unit of electric current; one ampere is the current passed by one volt through one ohm of resistance.

~~**Chassis**~~ ~~means the supporting frame or platform of a motor vehicle to which the major mechanical components and body attach.~~

Charging means the method of forcing electric current in the reverse direction into a storage battery, inducing a chemical change that stores the energy.

Contactor means an electrically controlled switch used for switching a power circuit, the higher current rating version of a relay

~~**Differential**~~ ~~means the mechanical assembly used for transferring the engine and gearbox power output to the driving wheels.~~

~~**Drive-shaft**~~ ~~means the assembly which transfers the power output from the gearbox to the differential.~~

~~**Drive-shaft universal**~~ ~~means the devices positioned at each end of the drive-shaft to enable the power transfer to take place from the rigidly mounted gearbox to the differential operating on an upward and downward plane whilst the suspension operates throughout its range of travel.~~

~~**Engine mounts**~~ ~~means the devices that fasten the engine onto the chassis or sub-frame section.~~

Fail-safe means to default to the safest mode in the event of a common failure such as a broken connection in the switch wiring. Fail-safe design always starts with an assumption as to the most likely kind of wiring or component failure, and then tries to configure things so that such a failure will cause the circuit to act in the safest way, this being determined by the physical characteristics of the system.

Fuel cell means a device that generates electricity from a chemical reaction, such as the interaction of hydrogen and oxygen through a catalytic membrane.

Fuse, fusible link means a device that interrupts the electricity circuit if an overload occurs.

~~**Gearbox**~~ ~~means the mechanical assembly used to convert engine speed to road speed through the use of a number of different gear ratios.~~

Gross vehicle mass (GVM) means the combination of the tare (the un-laden weight of the vehicle), plus the amount of load that the manufacturer certifies that the vehicle can carry.

Ground fault means a device that detects a connection between the battery and the body of

detector the vehicle. Such a connection will allow a current to flow through the body of a person who is simultaneously touches the body of the vehicle and part of the battery during maintenance. A second connection between the body and different part of the battery will allow current to flow through the body, potentially causing a fire or damaging the battery.

~~means a device that detects that the electric current is not balanced between the energized conductor and the return neutral conductor. Such an imbalance can be caused by current leakage through the body of a person who is grounded and accidentally touching the energized part of the circuit.~~

~~GVM~~ ~~means an abbreviation for gross vehicle mass.~~

High voltage means ~~where battery~~ any situation where voltage exceeds 25 volts AC or 60 volts DC, as designated by UN/ECE regulations.

Hybrid means a vehicle powered by two or more power sources, for example electric and petrol.

Isolation switch means a switch that cuts the power. The master isolation switch allows the driver to cut power to the motor. The maintenance isolation switch disconnects the high voltage battery pack to enable access and maintenance.

~~KiloNewton (kN)~~ ~~means the measure of force equal to gravity multiplied by mass (1000 Kilograms at sea level exerts a downward force of 9.81kN).~~

Manufacturer's axle rating (MAR) means the maximum load that the vehicle manufacturer certifies that the axle can carry.

~~MAR~~ ~~means an abbreviation for manufacturer's axle rating.~~

~~mm~~ ~~means an abbreviation for millimetres.~~

Original Equipment (OE) means as originally fitted by the vehicle manufacturer to that specific vehicle.

Over-current trip means a device which automatically interrupts the electrical current in a circuit if the level of this current exceeds a defined limit value. Fuses and circuit breakers (but never the motor circuit breaker) count as over-current trips. Extra fast electronic circuit fuses and fast fuses are appropriate.

Regenerative braking means a braking effort due to the electric traction motor acting as a generator and returning energy to the traction batteries.

Short circuit means an abnormal low-resistance connection in an electrical circuit. This results in an excessive electric current and potentially causes circuit damage, overheating, fire or explosion.

Solar cell means a device that converts sunlight to electricity.

Thermal Runaway means generation of heat in a battery to a dangerous level. If batteries are charged too fast, heat is generated which in turn creates Hydrogen (known as gassing). As the battery heats up, more hydrogen is created and the risk of explosion increases. The danger posed by high Hydrogen concentrations is one of the reasons that batteries must be installed in well-ventilated areas.

~~**Torque**~~ ~~means rotating effort produced by applying a force to a lever arm about a pivot.~~

Volt (V) means the unit of electrical pressure, or electromotive force.

NOTE: The terms and definitions found in section 5 are limited to those terms and definitions that are unique to this low volume vehicle standard, and are not necessarily contained within the terms and definitions section of the Low Volume Vehicle Code.