2016 SPECIFICATIONS

HUMAN POWERED VEHICLES

RACV ENERGY BREAKTHROUGH

17-20 NOVEMBER 2016 | MARYBOROUGH, VICTORIA

POWERED BY IMAGINATION

THE PREMIER SCIENCE, TECHNOLOGY, ENGINEERING AND MATHS, ACTIVE LEARNING PROGRAM

A PARTNERSHIP BETWEEN

cep SHARE PARTICIPATE COLLABORATE

CENTRAL GOLDFIELDS SHIRE COUNCIL

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Energy Breakthrough
Vehicle Specifications

Please note these Vehicle Specifications also cover the EEV and Try-athlon category.

EEV teams should refer to the EEV Supplement at the end of these specifications.

The format and structure of these specifications has changed since last year. Any significant specification changes have been highlighted in blue.

If changes are made to these specifications, the event committee will notify all team managers who have entered via their e-mail contact and changes will be published on the website.

All enquiries regarding Rules and Specifications should be emailed to:
Ernest Litera, Greg Hill and/or Blake Harris of the RACV:

ernest_litera@racv.com.au, greg_hill@racv.com.au and/or blake_harris@racv.com.au

1. Scope & Configuration

1.1 Intent

The Energy Breakthrough is intended as an experiment in personal mobility. The objective is to build an efficient and stable machine powered either entirely by human effort (Human Powered Vehicle) or a combination of power sources (Energy Efficient Vehicle).

Entrants must:

- **Participate in the design and construction of the vehicle whether it is from a clean sheet or the modification of an existing vehicle**
- **Understand the fundamental design and construction elements of the vehicle.**
- **Liaise with local industry or community groups to design and build a machine.**

Students will be judged on these aspects during the Design and Construction assessment.

The RACV Scrutineers have the final authority to decide if any vehicle or team participates in the event, based on safety and their interpretation of the following rules.

Clarification of rules and specifications sought from Ernest Litera, Greg Hill or Blake Harris of the RACV must be submitted by e-mail and a copy of responses presented at scrutineering. Please see the contact details on page 2.

1.2 Seating Capacity, Wheels

- The vehicle shall carry a rider alone, and shall have three or more load bearing wheels arranged in a stable configuration.

1.3 Riding Position

- The riding position shall not compromise machine controllability or safety, nor shall the riding position place the rider in a potentially hazardous position in the event of a collision.
- For these reasons a riding position (body angle) of less than 20 degrees from the horizontal is not allowed. *(See Section 4.2.1)*
- It is not advisable for the 'bottom bracket' or pedal crank to be higher than the rider's chest.

1.4 Power Source

- HPV - Motive power shall be entirely supplied by the rider.
- EEV – See EEV Supplement

1.5 Potential Maximum Speed

- The maximum speed of vehicles shall be 60 kph. The trial is a test of endurance and efficiency and therefore vehicles should not just be designed with achieving high speeds in mind.

2. Design and Materials

2.1 Inherent Safety

- The design shall provide protection for the rider in the event of a collision or rollover. *(See Sections 2.3 and 4.0).*
- The design must be free of protrusions or other features capable of causing interference or injury to fellow competitors or spectators.
- Vehicle control and stability shall not be jeopardised by inappropriate design and construction methods.
- The onsite repairing, securing or joining of steering, brake or any other safety related components with glue or epoxy resins during the event is strictly forbidden.
- It is advisable for teams to carry spares of any critical components that may not be repairable during the race.
- Any electrical connections for lights or warning devices must be of an automotive or industrial standard with fully insulated connectors.

2.2 Exclusions

Choice of design and construction materials is free, except that:

- Designers and constructors are permitted to freely use any bicycle component except for complete frame sections.
- The use of Go-Kart frames or motorbike frames is not permitted.
- Maximum overall tyre width is 70mm.
- Rope or cable steering systems, tilt steering and flexible steering columns are prohibited.
- Our experience has shown Rear Wheel Steer (RWS) vehicles to be highly unstable. For this reason, RWS vehicles will not be accepted at the RACV event.

2.3 Bodywork

- There are three bodywork configurations, which impact the structure of the vehicle.
    - **Open bodywork (**or 'head out') vehicles requiring full roll bar protection
    - **Aerodynamically enclosed** vehicles with a soft shell or corflute panels requiring full roll bar protection
    - **Fully enclosed hard shell** bodywork built from a stiff composite material (carbon fibre / kevlar / fibreglass / etc.)
- The test for whether a vehicle will be accepted as a fully enclosed hard shell is if the tallest rider can stand on the roof between where the riders head would be located and their knees. If the roof is unable to support the rider it will be deemed 'aerodynamically enclosed' and must meet all roll bar requirements.
- If teams prepare multiple bodywork configurations for use, then all configurations must comply with all specifications and must be presented for approval during scrutineering.
- *Try-athlon competitors* – Bodywork must not be removed if doing so compromises occupant safety ie. The roof in hard shell vehicles.

2.3.1 Clearances and Access for Enclosed Bodywork Vehicles

- There must be a forward clearance of at least 300 mm between the rider's face and the steering wheel or any bodywork.
- The rider shall be able to open and/or remove bodywork and exit the vehicle without external assistance.
- Bodywork shall be capable of being easily opened and or removed from outside the vehicle independently of the rider by someone who is unfamiliar with the vehicle. In an emergency marshals must be able to open the vehicle without explanation.
- The location of closure devices for opening body sections must be marked outside with a triangle of contrasting colour to the body making it clear for anyone unfamiliar with the vehicle.

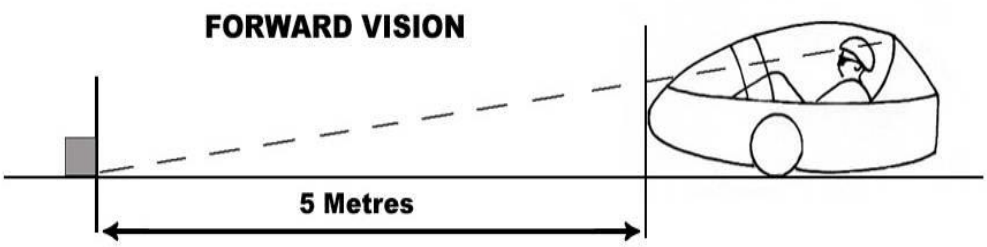
2.4 Vision and Ventilation

- Rider and vehicle safety shall not be impaired by restricted ventilation or visibility.
- Provision for rain and fogging must be demonstrated.
- Rider vision must not be impaired by excessively enclosed and restricting bodywork.
- Windows must not be tinted or covered with coloured stickers, regardless of if they are intended to be see-through.

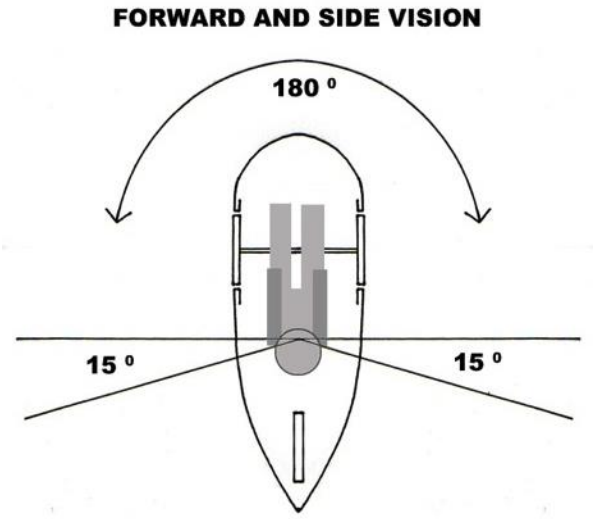
Vision Tests

- Riders seated in the normal riding position are required to pass the following vision tests during scrutineering:

1. Sight an object on the road 5 metres in front of the vehicle.



2. Sight 180 degrees ahead of the rider, and be able to turn their head sufficiently to see 15 degrees behind the rider on each side of the vehicle. The intent of this clause is that a rider is able to turn their head to visually check for other vehicles before changing their position on the road.



3. Riders must be able to demonstrate that the vehicles mirrors provide effective rear vision.

3. Vehicle Dimensions

Length
2700 mm maximum

Width
1100 mm maximum

Height
1200 mm maximum

Wheelbase
1000 mm minimum wheelbase between the most forward and most rearward axles.

Track
600 mm minimum (width between centres of outermost tyre ground contact points)

Turning circle
10 metre maximum diameter (left and right).

Note: Due to the hairpins in Try-athlon Time Trial and Obstacle courses, Try-athlon teams are **strongly encouraged** to set up their vehicle with a **maximum** turning circle of 8 metres.

3.1 Vehicle Weight

HPV

50kg maximum

EEV

Single Power Source – 60kg maximum

Hybrid 1 – 60kg maximum

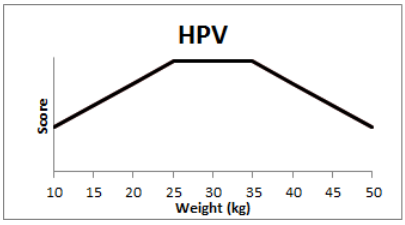
Hybrid 2 – 80kg maximum

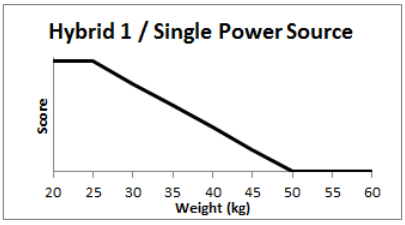
The specified maximum weight includes batteries however EEV's will be scored on their weight without batteries.

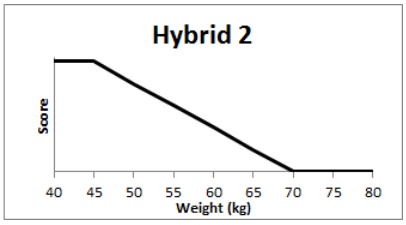
Note: EEV teams should strive to make their vehicles as lightweight as possible **without compromising safety**.

3.1.1 Scoring of vehicle weight

All vehicles will be weighed and this will contribute to D&C score. Scores will be allocated according to the following charts:







Please Note: This is different to the scoring method in 2015.

4. Occupant Protection

4.1 Protection Bars for Open and Aerodynamically Enclosed vehicles

Vehicles must have four sets of protection bars:

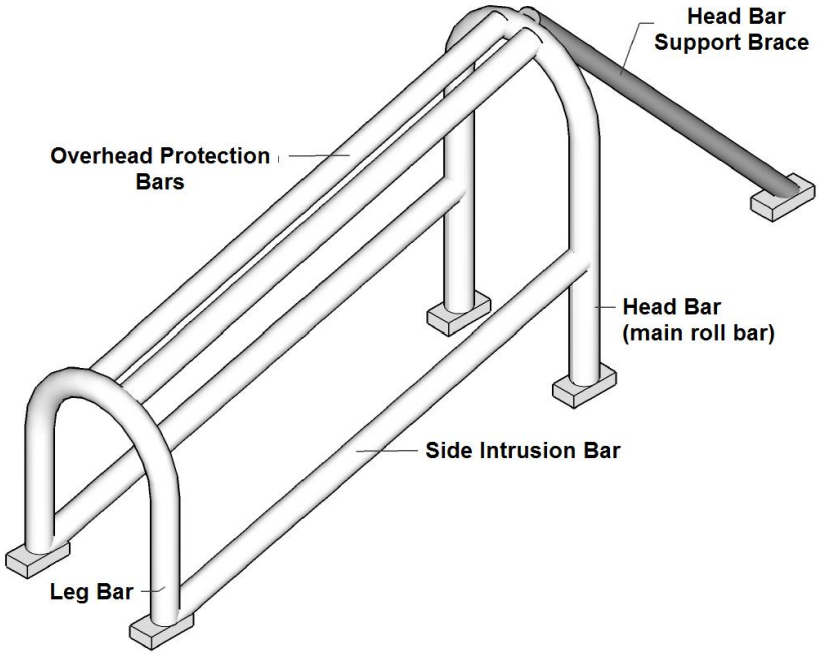
- "Head bar" (main bar) including brace,
- "forward leg bar" including brace,
- "side intrusion bars", and
- "overhead protection".

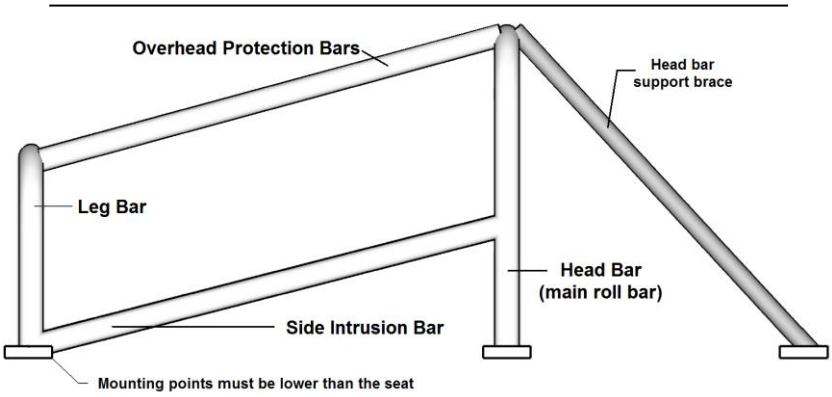
4.1.1 Construction

All protection bars, including bracing must be constructed from metal meeting the minimum outside diameter (O.D) specifications in the following table. All bars except the overhead protection bar must be joined either by welding or plate method(refer 4.1.4). The overhead protection bar may be hinged and locked to enable easier access for riders.

	HPV	EEV
Steel or Chromoly tubing	12.7mm O.D	16.0mm O.D
Aluminium tubing	16.0mm O.D	19.0mm O.D

Positioning of Roll Bars





(Please note: Drawings are not to scale)

4.1.2 Head Bar

The main head bar and brace together with the side intrusion bars must be one continuous welded frame, constructed according to the diagram above and must be solidly attached to the vehicle frame. (See Section 4.3: Plate Joints)

The “head bar” hoop must be braced from its highest point with one bar, preferably two, to a major structural member to form a tripod.

Note: The diagrams above show secure mounting plates; teams can use other mounting approaches but it must be solid, and able to support the weight of the vehicle and rider in a rollover.

4.1.3 Leg Bar

The “leg bar” (forward bar) must protect the riders legs, knees and feet from contacting the ground in a rollover or side slide situation and must be mounted across the vehicle above the riders knee area.

The “leg bar” must be braced to prevent the bar from folding over in a rollover or sliding situation.

The protection bars (head bar & leg bar) must be able to support the weight of the vehicle and rider in a rollover (a 40km/h impact is equivalent to dropping the vehicle on its roof from a first floor landing).

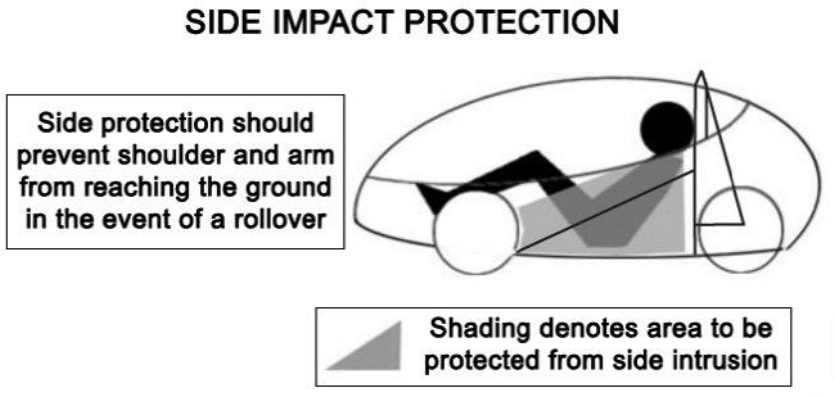
4.1.3 Side Protection

The vehicle must have side intrusion bars typically in line with the rider’s body (as described and illustrated in 4.1.1) that are an integral part of the continuous “head bar”.

In addition to the side intrusion bars, side protection bodywork or shielding is required to protect the area between the rider’s hip and shoulder from making contact with another vehicle and to prevent the rider’s shoulders and arms from reaching the ground in the event of a rollover.

This side protection bodywork should be constructed from suitably strong materials that will withstand sliding contact with the road.

No part of the rider is allowed to protrude outside the side protection during normal operation and there must be a clearance of 50mm between any part of the rider and the shielding.



4.1.4 Overhead Protection

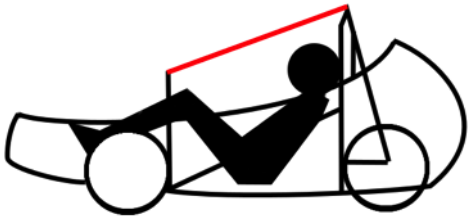
The structure over the head of the rider must provide enough strength to prevent the rider’s head from being struck by another vehicle when on its side after a roll over.

Open top and aerodynamically enclosed vehicles must have two longitudinal bars connecting the main head bar to the knee bar.

Bars must be symmetrical around the vehicle centreline and there must be 100mm to 200mm of separation between the bars.

These bars may be detachable or hinged to enable easier access for riders, but must lock in place and be strong enough to ensure the structure remains attached during a rollover.

In 2015 vehicles were allowed to compete with one overhead protection bar, this will not be allowed in 2016.



4.1.5 Rider Protection Bar Clearances

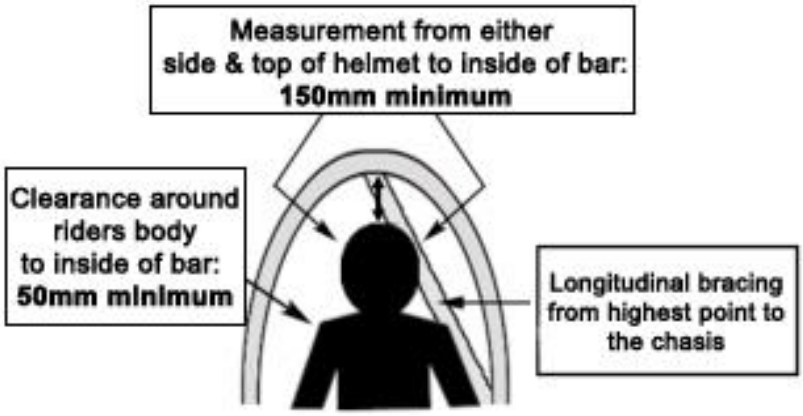
With the tallest of the competing riders in the normal riding position, the "head bar" must be fully visible outside the rider silhouette when viewed from the front or rear.

The overhead protection bars must have at least 50mm clearance above any part of the rider when viewed from the side.

The head bar must conform to the following dimensions:

- Measurement from helmet to inside of bar: 150mm minimum
- Measurement from either side of helmet to inside of bar: 150mm minimum
- Clearance around riders body to inside of bar: 50mm minimum
- Location forward or rearward of helmet: No more than 150mm

Diagram below: Open top or aerodynamically enclosed vehicles



4.2 Rider protection for fully enclosed hard shell vehicles

Fully enclosed bodies made from composites such as Carbon-Fibre, Fibreglass or Kevlar do not require metal protection bars provided they comply with the following requirements for strength and build quality tests.

- The body must have strengthened ribs moulded into the composite that are of at least equal strength to a metal roll bar. (eg: The roll bar area should not be able to flex when pressed by hand)
- All composite roll bar and side intrusion bar ribs must follow the same positioning as the metal protection bars outlined in section 4.1.
- All composite constructions must have finished edges. That is no protruding fibres or frayed edges.

- Metal roll bars can be used with composite bodies.
- Any joins must follow the plate mounting method as described in 4.3 Plate Joints.
- All teams constructing new hard shell composite vehicles with integral protection bars must send photos to the RACV technical contacts for review by the end of October.
- The onus is on schools to ensure that their vehicle is compliant with the required safety standards. The RACV Energy Breakthrough website includes some advice on composite construction in the *'Downloads'* section.

The test for whether a vehicle will be accepted as a fully enclosed hard shell is if the tallest rider can stand on the roof between where the riders head would be located and their knees. If the roof is unable to support the rider it will be deemed 'aerodynamically enclosed' and must meet all roll bar requirements.

4.2.1 Rider Protection Clearances for fully enclosed enclosed hard shell vehicles

With the tallest of the competing riders in the normal riding position, the following clearance must be met:

- Measurement from helmet to inside of shell: 50 mm minimum
- Measurement from either side of helmet to inside of shell: 50mm minimum
- Clearance around riders body to inside of shell: 50mm minimum

4.3 Plate Joints

- Where metal protection bars are to be joined without welding or attached to a composite body, plates should be used to distribute the loads into the body.
- These plates must be welded onto the metal protection bar and be no less than 60mm x 60 mm square in size and at least 3mm thick.
- A matching plate should be used on either side of the composite body and spacers must be used to prevent crushing of the composite structure.
- The plates must be joined using at least two 6 mm bolts with locking nuts (eg. Nylock Nuts).
- Corners and edges should be rounded and smoothed off.

4.4 Forward Protection & Nose Cone

All vehicles must have adequate forward protection to reduce the chance of injury in the event that the vehicle collides with a person or another vehicle.

The front of the vehicle must have a curved nose to prevent easy penetration of another vehicle. At 100mm from the front, the vehicle must have a cross section greater than 200mm.

4.5 Seats

4.5.1 Position

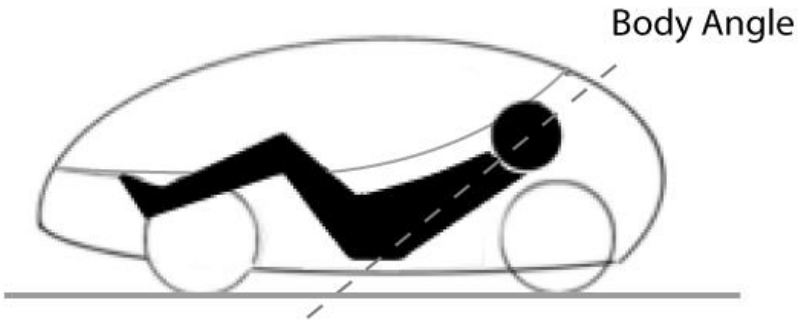
The seat shall be fitted to ensure that the riding position does not compromise machine controllability or safety, nor shall the riding position place the rider at risk of neck or back injury in the event of a collision.

For these reasons a riding position (body angle) of less than 20 degrees from the horizontal is not allowed.

This riding position is measured from the hip and shoulder joints, in relation to the road.

The seat must be shaped and positioned to prevent the rider sliding under the seat belt.

In vehicles with movable seats, riders must remain fully protected by the side intrusion bars in all seat positions.



4.5.2 Locking of Seat Position

- The seat must be secured and locked into position.
- Adjustable seats must lock securely into position for each rider and must not move forwards or backwards.
- Seat belts cannot be used as part of the seat lock system.

4.5.3 Extra Padding

- Any temporary or removable padding used for riders MUST be fixed into place using a positive attachment to a fixed part of the vehicle.
- Teams could use strap and buckle, velco straps, dog clips, canvas zips, etc.

4.5.4 Head Restraint

- The vehicle should have a padded head restraint behind the rider's head that reduces the chance of over extension of the riders head backwards.

4.6 Seat Belt

4.6.1 Type

- The vehicle must be fitted with an Approved and Certified adult Four (4) point (minimum) seat belt for all riders.
- Seat belts must have certification label attached.
- The seat belt must be in good condition and completely standard, including buckle, stitching and mounting plates.

Teams will be required to demonstrate adjustment of the seatbelt to suit each rider.

Suggested supplier:
Hemco Industries - http://www.hemco.com.au/ or Ph: 1300 065 057
APV Safety Products: 4 point, 2 inch webbing available through most automotive parts stores.

4.6.2 Mounting

The seat belt must be mounted to a major, non-moving, structural member of the vehicle or can be mounted to the seat provided it is suitably secured. (See Section 4.5.2)

Upper belts mounted behind the rider's shoulders are required to be no more than 40 degrees from horizontal and mounted so as not to allow the seat belt webbing to fall from the shoulders when riding.

4.6.3 Positioning

The positioning of buckles and belts on the rider's body shall conform strictly to the belt wearing requirements of Australian Design Rules (ADRs) for motor vehicles.

The relevant section of the ADR 4/01 is reproduced below:
'Seat belts are designed to bear upon the bony structure of the body, and should be worn across the chest, shoulders and low across the front of the pelvis; wearing the lap section of the belt across the abdominal area should be avoided. Seat belts should be adjusted as firmly as possible, consistent with comfort, to provide the protection for which they have been designed. A slack belt will greatly reduce the protection afforded to the wearer'.

This means seat belts must:

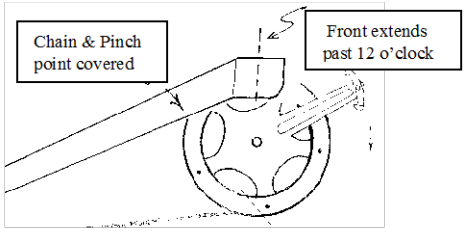
- be worn across the chest, shoulders and low across the front of the pelvis
- be adjusted to be as firm as possible on **each** rider and fitted to ensure that the seat belt remains properly adjusted on each rider, at all times.

The lap belts should be tightened before the shoulder belts so that the lap belts remain in the correct position.

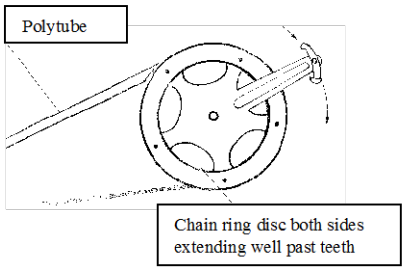
4.7 Shielding

4.7.1 Rider Protection

Rigid Chain Guard



Chain Tube and Sprocket Rings



- Chains, sprockets and gear wheels MUST be fully shielded to prevent accidental hazardous contact with rider or clothing.
- Chain ring teeth must be covered both sides using chain ring discs.
- Shielding or a clearance of 100mm is required between the occupant and any rotating part, such as wheels and controls, during vehicle operation.
- A hair shield must be used to prevent long hair from falling anywhere near the rear wheel, chain or gear components.

4.7.2 Protection of other Vehicles

- Chains, gear wheels and sprockets shall be suitably shielded to prevent their contact with other vehicles.
- Exposed axle ends have to be recessed or flush in the hub, covered by bodywork, bar work, dome nuts or hub caps.

4.7.3 Shielding from Road Surface

- Vehicles must be fitted with an under-tray or floor panel which prevents the rider's feet from contacting the ground when seated in the riding position.
- Pedal toe clips, elastic straps or pedal-to-shoe locking devices do not fulfil the requirements of this clause.

5. Steering:

5.1 Type

The type of steering mechanism is free, except for:

- Tilt steering, flexible steering columns and rear wheel steer are prohibited.
- A minimum clearance of 300mm is required between the riders face and the steering wheel.
- The rider must have continuous positive control without the need for regular adjustment.

5.2 Freedom from Binding and Fouling

Steering linkages shall operate freely from full left to full right lock without binding or fouling.

5.3 Lock Stops

To prevent the rotating road wheels from coming into contact with any part of the vehicle or rider, there must be positive steering lock stops.

The steering mechanism or any solid component that moves with the steering mechanism must come up against a solid bracket or non-flexible part of the body or frame on full lock in either direction and stop any further steering travel.

In addition, at full lock there must be shielding or a clearance of 100mm between the occupant and any rotating part (such as wheels and controls) and in all steering positions there must be at least 50mm clearance between the hand controls (including brake levers) and the frame or solid bodywork.

6. Brakes

6.1 Independent Systems

The vehicle shall be fitted with a minimum of two (2) separate effective and independent braking systems.

Two (2) separate brake levers must be used.

All wheels in contact with the road must have a braking capability.

6.2 Type

The front axle braking system shall operate directly on the wheel hubs or axles (i.e. not acting on the wheel rims) and may be either drum or disc type.

6.3 Directional Stability

Brakes on the same axle line (e.g. both front wheels) must operate via a single lever, so that independent operation of any braking system shall not have the potential to affect directional stability of the vehicle. That is, the braking power of each and every braking system shall be symmetrical about the vehicles longitudinal centre line.

6.4 Simultaneous Operation

The two braking systems shall be able to be operated by the rider simultaneously.

In a Hybrid 2 or single power source EEV a single lever may be used to operate both braking systems provided it is foot operated only.

6.5 Steering Control

Full steering control shall be maintained while braking systems are being operated.

6.6 Contact to the tyres

Brake systems must not apply friction contact to the tyres.

7. Ancillary Devices

7.1 Lighting
The vehicle shall be fitted with the following as a minimum requirement.

7.1.1 Headlight
Front lighting must be at least one white light, securely mounted between 250mm and 600mm above road level, at the front of the vehicle (forward of the rider's feet).

Lighting must be adequate to provide good visibility for the rider to see the track in the dark.

Additional lighting to improve the rider's vision is encouraged provided at least one light meets the designated requirement.

Headlights are not to be flashing.

Please note: Sections of the track are in darkness at night and sufficient lighting to see the road will be required.

7.1.2 Tail Light
Rear lighting must be at least one red bicycle type LED taillight. A steady, non-flashing light is required.

The light must be sercurely mounted:

- between 350mm and 600mm above road level
- within 150mm of the rear-most part of the vehicle, and
- on the vertical centre line of the vehicle.

7.1.3 Outline Lighting
The use of reflective material or strip lighting to indicate machine width and height (especially from the rear) is encouraged.

A light coloured under floor to make it more visible in a rollover is encouraged.

7.1.4 Mounting
All lights are required to be securely mounted for the duration of the event to maintain correct aim.

7.1.5 Helmet Mounted Lights
Helmet mounted lights are not to be used.

7.1.6 Batteries
Wet cell batteries must be housed in a sealed box (e.g. plastic) that will prevent spillage if the battery is inverted or damaged.

All connections must be of an appropriate industry standard as per section 2.1

7.2 Mirrors
At least two effective rear view mirrors must be fitted, one on each side of the vehicle, and having similar reflection (i.e. same size image) in order to clearly identify overtaking traffic and meet the rear vision test in 2.3.2.

Mirrors may be of the mildly convex type.

Mirrors shall be rigidly mounted to non-moving chassis or body members and steps should be taken to reduce vibration.

The smallest rider must be able to reach each mirror from the normal riding position, regardless of if they are adjustable.

7.3 Warning Device
An electric audible warning device shall be fitted (e.g. smoke alarm siren) and operate from the normal riding position.

The device must not run continuously and operate via a momentary switch.

The horn must emit a distinctly audible sound. This will be checked at scrutineering.

7.4 Other Devices
Any other equipment, e.g. drink bottle, shall be securely mounted and shall not impair rider control in its mounting or use.

The use of MP3's or similar music /entertainment devices by riders is NOT permitted.

Small video cameras (eg. GoPro) are allowed as long as they are not attached to the rider's helmet and are positioned so that they cannot pose any safety risk. Cameras should not be mounted outside the silhouette of the vehicle when viewed from the front.

7.5 Speedometer
All vehicles shall be equipped with a simple electronic speedometer (e.g. Cat-eye) to monitor speed during the event (pit area speed limit of 15 kph, track speed limit of 60kph).

7.6 Transponder
Vehicle design should allow for a lap counting transponder to be mounted inside the vehicle, positioned within 200mm of the road surface, not above carbon fibre or metal; and not within 500mm of any RF source.

Transponders will be issued to Team Managers upon Check-in at the Administration Centre at the event.

8. Markings

8.1 School Name
Each vehicle shall have their school name visibly displayed on either side of their vehicle.

8.2 Identification Panels
At registration, each vehicle will be provided with two adhesive identification panels (250mm x 300mm) with their competition number on it.

These identification panels must be attached to each side of the tail of the vehicle and as close to the rear as possible.