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AUSTRALIAN HUMAN POWERED VEHICLE RACING DESIGN & CONSTRUCTION SPECIFICATIONS

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CONTENTS

1.0	OVERVIEW.....	2
1.1	Introduction	2
1.2	Vehicle Type.....	2
1.3	Decisions and Interpretation	2
1.4	Specification Compliance.....	2
2.0	SAFETY	2
2.1	General Safety	2
2.2	Vehicle Safety	3
2.3	Rider Safety	3
2.4	Rider Vision	3
3.0	DIMENSIONS.....	4
3.1	Wheels, Track and Wheelbase	4
3.2	Vehicle External Dimensions.....	4
4.0	RIDER PROTECTION	4
4.1	Guarding of Moving Parts	4
4.2	Floor Protection	4
4.3	Side Impact Protection	4
4.4	Rear Impact Protection.....	4
4.5	Forward Protection	5
4.6	General Vehicle Design Principles.....	5
4.7	Rider Rollover Protection Structure Requirements	5
4.8	Open Cockpit Vehicle Rider Rollover Protection Structures.....	5
4.9	Closed Canopy Vehicle Rider Rollover Protection Structures.....	5
4.10	Cockpit Overhead Protection Requirements.....	6
5.0	SEAT BELTS	8
5.1	Seat Belt types.....	8
5.2	Seat Belt Mounting	8
6.0	VEHICLE CONTROL	8
6.1	Steering.....	8
6.2	Braking Systems Configuration	9
6.3	Braking Systems Conditions and Integrity	9
6.4	Mirrors	9
7.0	VEHICLE ELECTRONICS	9
7.1	Lighting	9
7.2	Warning Device.....	9
7.3	Speedometer	9
8.0	DEFINITIONS	10

1.0 OVERVIEW

1.1 Introduction

The vehicle specifications contained within this document are for vehicles entering in Human Powered Vehicle events in Australia conducted by approved bodies who have been verified to comprehensively and concisely implement them and conduct an in-depth standardised Scrutineering process.

Currently approved organising bodies are:

- Australian International Pedal Prix Inc.
- Victorian Human Powered Grand Prix Series

1.2 Vehicle Type

Vehicles must be single seat, recumbent, have three or more load bearing wheels and be solely Human Powered, activating one or more of the wheels. No alternative propulsion systems are allowed. Motorised fans are not permitted.

1.3 Decisions and Interpretation

The organising body will make any decision which is not covered by these specifications (**refer 1.1**).

All changes made to these specifications will be distributed by the approved bodies and published on their websites.

Approved bodies will attempt to notify all relevant persons via their nominated Team contact details.

1.4 Specification Compliance

- 1.4.1 No vehicle will be allowed to take part in an event until it has passed **Scrutineering (Definition 1)**. Vehicles must maintain compliance throughout each event. Vehicles may be inspected at any point throughout and after an event for post-race scrutineering.
- 1.4.2 Team managers have a responsibility and duty of care to their riders. During construction and use of their vehicle, the Team Manager is required to monitor and assume responsibility for the following:
 - a) Rider protection structures are strong enough to meet their purpose (**Section 4**).
 - b) No aspect of the vehicle compromises rider safety at any time.
 - c) The Team's riders each fit safely within the vehicle, especially head clearances.
- 1.4.3 Team Managers and constructors are encouraged to seek early prior clarification from the Approved Body, for any specification needing interpretation, or if seeking a ruling on their vehicle's compliance (**refer 1.1**).
- 1.4.4 Vehicle exterior bodywork must provide room rearward of the front wheels for attaching Vehicle Number Panels (300mm high and 400mm wide) and also allow room for Event sponsorship stickers. [Details in Event Manuals]
- 1.4.5 Replacement large body sections, e.g. Tops specifically for night-time, low visibility periods, or improved ventilation use, must be presented at Scrutineering with the vehicle they will be used on.

2.0 SAFETY

2.1 General Safety

- 2.1.1 All vehicles are ridden at the riders' own risk.
- 2.1.2 The Scrutineering process is to determine if the vehicle complies with the current specifications.
- 2.1.3 No warranty whether expressed or implied is made in relation to safety or roadworthiness through the Scrutineering process.
- 2.1.4 Constructors using composite materials must comply with Safe Work requirements, particularly in regards to unbound fibres and complete curing of materials. Such materials must be of suitably rigid design and construction to meet HPV Event requirements.

2.2 Vehicle Safety

These specifications carry an intention to support subtle, progressive, innovative, evidence based design and construction. Desirable design directions to enhance rider safety may include:

- a) flexibility designed into structures where appropriate.
- b) deformation allowed for in suitable structural elements.
- c) chassis/roll cage/bodywork sections that are intentionally replaceable.

In general engineering principles, these are preferable to entirely inflexible rigidity. Deformation [permanent or transitory] is not a sign of failure but evidence of crash force attenuation. Total rigidity is more prone to unanticipated complete failure and damage to other structures.

- 2.2.1 The vehicle design must provide substantial protection for riders during any incident. Vehicles must:
 - a) Contain the rider in a strong and tough enclosure, hard shell or soft shell.
 - b) Prevent contact between rider, the road, other vehicles and obstacles.
 - c) Be formed from metal bar work, composite, metal panels or combinations of materials.
 - d) Have no internal items that could injure the rider.
- 2.2.2 The exterior of the vehicle must not have protrusions capable of causing interference, injury or damage to personnel, vehicles or infrastructure. These include but are not limited to body or door handles, fins or roll bars. Closed Canopy vehicles are not to have external roll bars.
- 2.2.3 Exposed axle ends must be recessed or flush in the hub, covered by bodywork, bar work, dome nuts or be shielded by annulus capping.
- 2.2.4 All batteries must be mounted securely so that they do not come loose. Liquid lead acid type batteries are not to be used.
- 2.2.5 Vehicles are to have a white or very light-coloured underside.
- 2.2.6 Teams are to place the **supplied** reflective material externally on the roof above the rider's head. A 50mm X 250mm space needs to be left for this.
- 2.2.7 Seats, including adjustable seats, must be prevented from moving during riding. Seat belts or rider weight cannot be part of the seat position retention system.
- 2.2.8 Bodywork and canopies must be **inherently safe**, and maintained in a safe condition.

2.3 Rider Safety

- 2.3.1 Canopies must be able to be opened independently from the inside by the rider, and, from the outside without rider help.
- 2.3.2 Location of closure devices for canopies must be marked externally with an equilateral triangle with sides of 50mm in a colour that contrasts with the vehicle colour.
- 2.3.3 The cockpit must be free of hazards that could injure the rider or pit crew. For example:
 - a) Zip tie ends need to be cut flush, filed round, taped over or rotated away.
 - b) Brake and gear cable ends should be covered with cable caps.
 - c) No bare edge, rigid material should be within 250mm of the rider's face.
- 2.3.4 Riders observed to have their helmet compressing the Specified Foam will not be allowed to continue riding (**Definitions 3 and 4**)
- 2.3.5 Helmet mounted cameras (or other devices) are not allowed.
- 2.3.6 Airflow for rider ventilation and provision to mitigate internal fogging must be evident.

2.4 Rider Vision

- 2.4.1 Windows that riders need to look out of must not be tinted or obscured
- 2.4.2 Rider vision must not be impaired by bodywork.
- 2.4.3 Riders seated in the normal riding position must be able to sight an object on the road surface 5 metres straight ahead of the vehicle.

3.0 DIMENSIONS

3.1 Wheels, Track and Wheelbase

- 3.1.1 Vehicles must have a minimum of three load bearing wheels.
- 3.1.2 Three wheeled vehicles track must be a minimum of 600mm.
- 3.1.3 Four wheeled vehicles are to have one axle's track of 500mm minimum and the sum of both axle's tracks is to be 900mm minimum.
- 3.1.4 Wheelbase must be a minimum of 1000mm

3.2 Vehicle External Dimensions

- 3.2.1 Maximum length 2700mm
- 3.2.2 Maximum width 1100mm
- 3.2.3 Maximum height 1200mm

4.0 RIDER PROTECTION

4.1 Guarding of Moving Parts

- 4.1.1 Where a rider's hands are at risk of contacting spokes or tyres, guarding must be provided.
- 4.1.2 Riders must be protected from hair and clothing entanglement.
- 4.1.3 Chain ring teeth must be covered on both sides using chain ring discs (**figure 1**).
- 4.1.4 The drive system leading to the chain ring must be covered from under the seat to the chain ring with channel or tube. This channel or tube must extend between or past the chain ring discs, or be mounted with skimming clearance of 3mm max (**figure 1**).
- 4.1.5 Any exposed pinch point on the return side of the chain must be guarded.

4.2 Floor Protection

- 4.2.1 The vehicle must protect the rider from impact through the floor. A "cruciform" chassis has a large diameter tube running from the bottom bracket through to the rear wheel which protects the rider. A peripheral chassis uses tubes each side of the rider from the main axle/cross tube to the rear wheel. In this case, cross tubes, flooring and seat structures must combine to protect the rider from impacts through the floor
- 4.2.2 A floor pan must be fitted to all vehicles. The whole underside must be enclosed with the floor only being penetrated by cut-outs for wheels. The floor pan must prevent the rider's feet, legs or hands coming into contact with the road surface when seated

4.3 Side Impact Protection

Side impact protection must be afforded to the rider's body, from shoulders to hips to knees, **capable of protecting** the rider from entry by another vehicle during a "T-bone" style of collision and must protect riders in all seat positions. It should consist of:

- 4.3.1 Tubing and/or rigid panelling on each side forming an enclosed cockpit.
- 4.3.2 The wheels may form part of this protection.
- 4.3.3 Side impact protection structures must be anchored not to move sideways.

4.4 Rear Impact Protection

Rear impact protection must offer the rider protection in the case of a rear impact and ensure the riders shoulders, neck and head are protected.

- 4.4.1 The vehicle must have some form of head restraint that prevents over-extension of the rider's head backward to prevent whiplash.
- 4.4.2 Shoulder and Neck rest/supports can act as head restraints when properly positioned and designed. Care must be taken to ensure that the top, or the edge in contact with the neck/head, will not lead to further injury.

4.5 Forward Protection

Vehicles must incorporate forward protection for the rider integral to the design.

- 4.5.1 At 100mm from the front, the vehicle must be bigger than 200mm cross-sectionally.
- 4.5.2 Constructors must ensure that forward projecting struts will not become a hazard if surrounding bodywork is no longer intact [eg.by use of end plates or lateral tubing].

4.6 General Vehicle Design Principles

- 4.6.1 **All vehicles must include Rider Rollover Protection Structures (RRPS)** which are vehicle structures, including roll-bars, providing protection to the rider during a rollover or other track incident.
- 4.6.2 **All vehicles must include Cockpit Overhead Protection (COP)** which is a structure above the rider that will protect them from oncoming traffic when their vehicle is stationary and on its side, with the rider towards approaching vehicles.
- 4.6.3 Vehicles are of two styles.
 - a) Open Cockpit
 - b) Closed Canopy
- 4.6.4 Vehicles may be built of framework incorporating bodywork that is hard shell [composites or metal] or soft-shell materials.
- 4.6.5 Hard shell bodywork may incorporate **RRPS** and/or **COP** in monocoque style construction to provide the same level of bracing as framework, without replicating bar work.

4.7 Rider Rollover Protection Structure Requirements

- 4.7.1 Be structurally integrated with the chassis/frame/monocoque shell and be constructed to meet their purpose.
- 4.7.2 RRPS including bracing, can be formed from metal tubing, composite materials or other suitable materials.
- 4.7.3 Must entirely encompass the rider viewed from all directions. [front, rear and sides]
- 4.7.4 The structures and bracing may be removable, providing that appropriate attachment methods are used [multiple bolts – minimum M5 Grade 8.8 (Unbrako, Wurth) bolts with sleeving or flanges. Not pins or clips.]
- 4.7.5 The rider's legs, knees and feet must be protected from injury by the vehicle's structures/panels when the vehicle is upside down or on its side.
- 4.7.6 Opening parts of the **RRPS** must be secured to not open involuntarily. Large components, such as clam shell or semi-clam shell styles, must have a closure system shutting with an audible click. Supplementary systems of locating pins, tabs, or lips may be needed to ensure that body sections align correctly.

4.8 Open Cockpit Vehicle Rider Rollover Protection Structures

- 4.8.1 Must be a minimum of 500mm wide at the riders' shoulders and an integral part of the side impact protection.
- 4.8.2 At the rider's head the structure must:
 - a) Be at least 300mm wide, 150mm down from its highest point (**figure 2**)
 - b) Be 100mm minimum above every rider's helmet.
 - c) Be braced longitudinally from its highest point to a substantial chassis/body member see (**figure 3**) or be sufficiently braced within the structure's functional region requiring two braces.
 - d) Form a minimum angle of 10 degrees to the brace and this angle must include the vertical line through the highest point (**figure 4**).
- 4.8.3 Front structures must be stabilized from their highest point by bar bracing (**figures 3 & 4**) OR through sufficient attachment of canopy/bodywork material of enough integrity to prevent it collapsing

4.9 Closed Canopy Vehicle Rider Rollover Protection Structures

- 4.9.1 The body system must be robust enough to protect the rider, acting as roll bars and COP and be capable of meeting its purpose.
- 4.9.2 **Specified Foam** must be installed above all riders' "head positions" (**Definition 4**).
- 4.9.3 There must be sufficient room for all riders to be able to move their head easily from resting on the head restraint, forwards so that their chin is on their chest and turn their head 90° right, through to 90° left as per the Roller Test (**Definition 3**).

4.10 Cockpit Overhead Protection Requirements

- 4.10.1 COP must be capable of deflecting an oncoming vehicle.
- 4.10.2 The minimum for an **Open Cockpit** vehicle is two longitudinal bars with a maximum separation of 200mm. These bars must be straight or upwardly arched and suitably cross-braced.
- 4.10.3 The total width of the COP structure actually required depends upon the vehicle's shape and structure and should be checked when it is lying on its side.
- 4.10.4 **Open Cockpit** vehicles must have a minimum clearance between COP and rider's helmet of 100mm.
- 4.10.5 For **Closed Canopy** vehicles, the COP must incorporate a rigid panel, of composite material or metal, having a minimum width of 200mm (measured around the outside of the structure) and a minimum length of 600mm.
- 4.10.6 All COP structures must have locating fixtures able to keep the COP in place during track incidents and to cope with any flexing.
- 4.10.7 A moveable door/roof/COP panel must have 20mm minimum overlapping at its margins to maintain its integrity. If constructed of a material with inherent flexibility, greater overlap is required.
- 4.10.8 Movable COP structures **must not** be hinged from the rear and **must** be secured using a locking mechanism, to be proven at Scrutineering, that will maintain the required protection during track incidents. The locking mechanism must comply with the following:
 - a) Velcro is not sufficient by itself.
 - b) If elastic loops are used.
 - i. A minimum of two must be provided, under tension, with fixed hooks or large flanged buttons.
 - ii. They need to be a **minimum** of 300 mm apart
 - iii. Must be fixed to structural members/bars/composites
 - iv. Elastic cord must be a minimum diameter of 5 mm

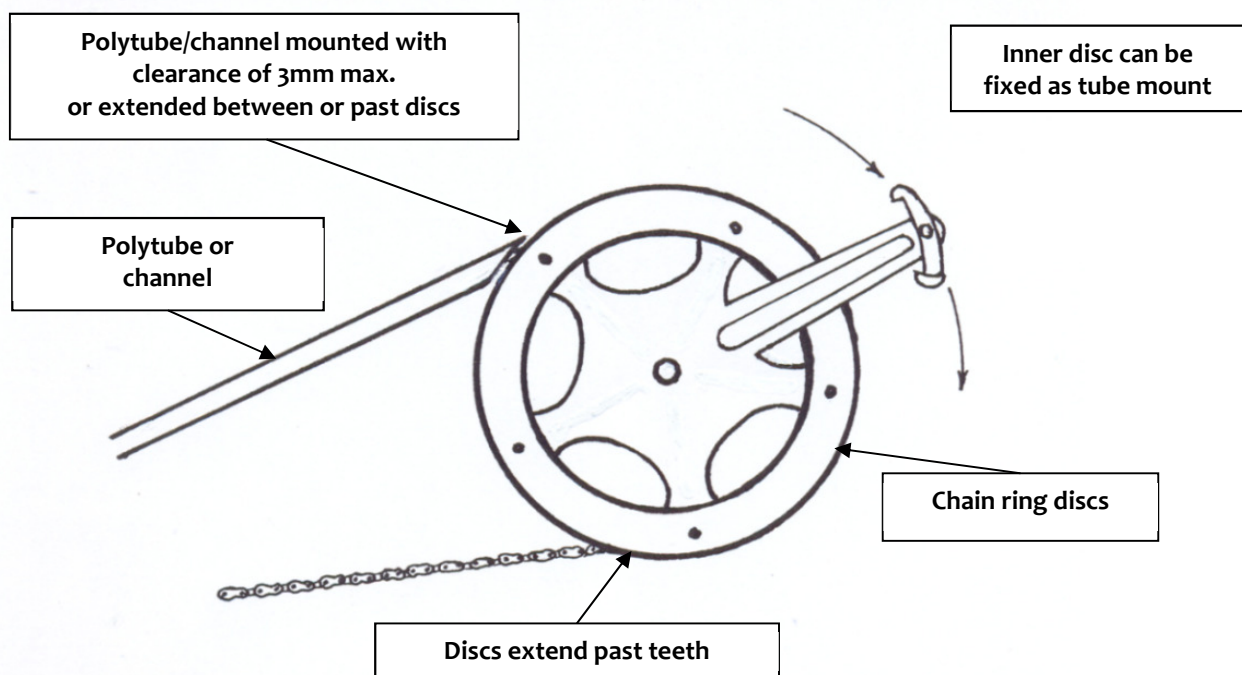


Figure 1, Guarding of chain drive system as per 4.1.3 & 4.1.4

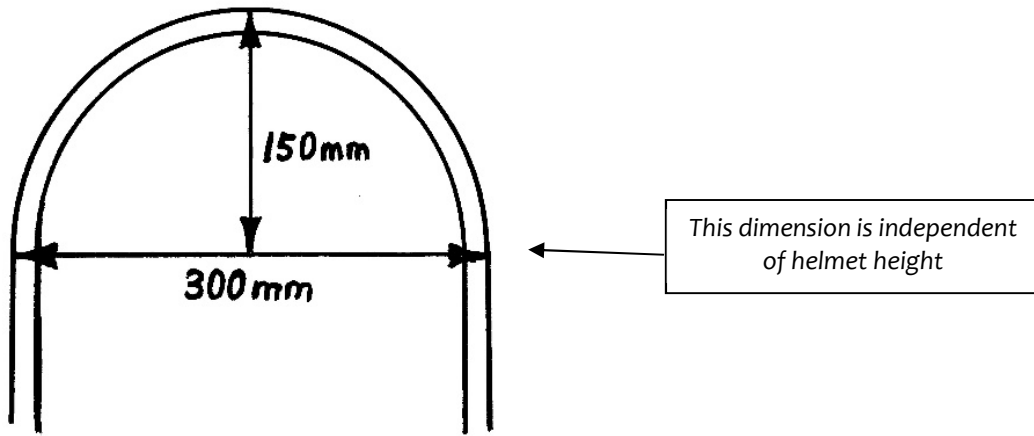


Figure 2, Rider rollover protection structure at the rider's head per 4.8.2a showing required shape

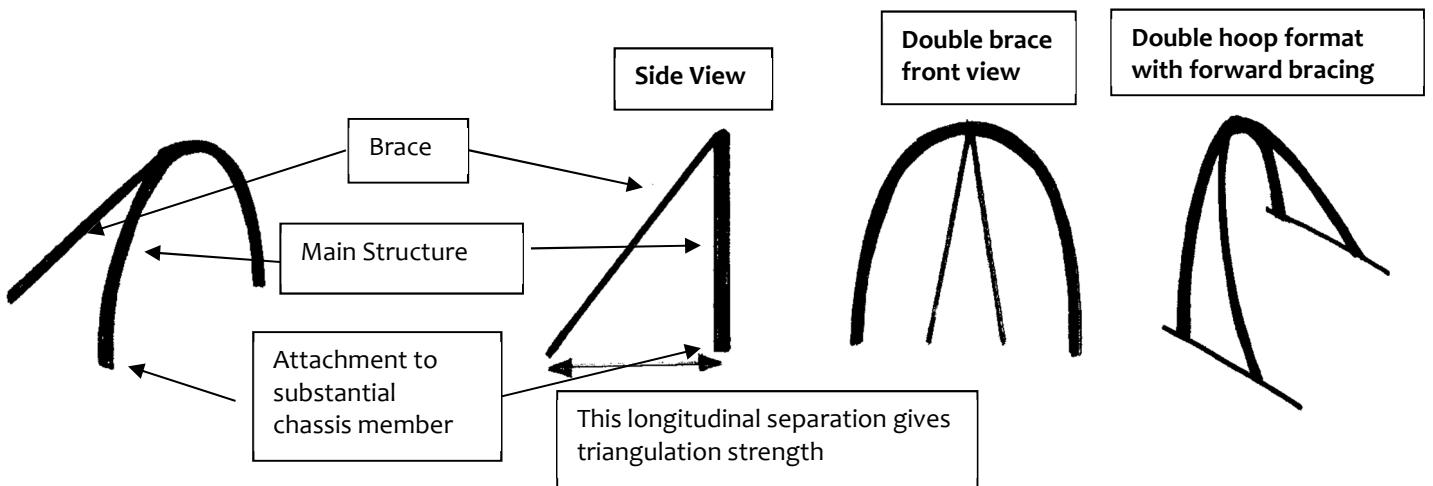


Figure 3, Rider rollover protection structure bracing as per 4.8.2c

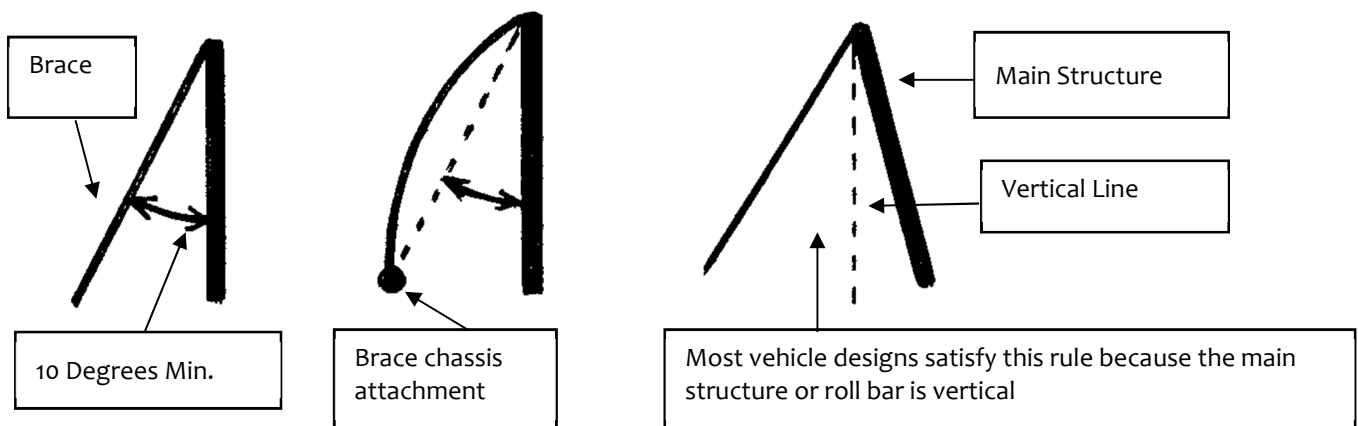


Figure 4, Rider rollover protection structure bracing as per 4.8.2d

5.0 SEAT BELTS

5.1 Seat Belt types

The vehicle must be fitted with an “**Approved and Certified**” 4-strap seat belt which must comply with the following:

- 5.1.1 The seat belt must have the manufacturer’s certification label attached.
- 5.1.2 Belts must be in good condition and not frayed, cut or restitched.
- 5.1.3 Seat belts must be worn correctly and in accordance with manufactures specification.
- 5.1.4 No modifications are allowed to the seatbelt assembly as manufactured.

Suggested supplier: HEMCO INDUSTRIES, VICTORIA, www.hemco.com.au.
PO Box 444 BALLARAT VIC 3353. Phone:1300 065 057
Wayne Fitzgerald: wayne@hemco.com.au

5.2 Seat Belt Mounting

Mounting of the seat belt should be considered at the beginning of the chassis design process to provide secure mounting points. The seat belt must be mounted to comply with the following:

- 5.2.1 Mounted securely to major vehicle structural members in the manner intended by the belt manufacturer (e.g. the HEMCO four-point Pedal Prix Harness is to be mounted using four bolts **OR** two bolts for the waist strap with a three-bar slide for each shoulder strap).
- 5.2.2 The correct bolts/fittings must be used as supplied by the harness manufacturer **OR** $\frac{5}{16}$ [8mm] minimum diameter and Grade 5 minimum strength. Bolts to be installed with 2 to 3 threads showing through either a nut with spring washer or a nylock nut.
- 5.2.3 Mounting bolts must be put through frame tags or fully welded sleeves through frame tubes.
- 5.2.4 Removable sub-frames or brackets carrying mounting bolts must be attached to major vehicle structural members with strength equivalent to the mounting bolts.
- 5.2.5 Use of three bar slides as a mounting system for the shoulder straps is allowed, provided the slide supplied is used and correct threading procedure is followed.
- 5.2.6 Mounting points for shoulder straps must:
 - a) Be level or higher than the rider’s shoulders. Where mounting points cannot be raised, guiding brackets at shoulder height can ensure the belt is effectively acting from shoulder height.
 - b) A maximum of 200 mm apart.
- 5.2.7 The seat must be shaped to prevent the rider sliding under the seatbelt.
- 5.2.8 The seat belt may be mounted to an adjustable seat frame provided the strength of the seat belt anchorages is carried through to where the seat is connected to the structural frame member(s). For example: If the seat belt is anchored by 4 x 8mm bolts, the seat should be secured to the frame with a minimum equivalent cross section of material of equivalent strength.
- 5.2.9 Where seat belts run through slots in metal or composite seats (or over seat edges), substantial protection is required to prevent damage to the seat belt (eg. fraying and cutting). **Tape alone is not sufficient.**

6.0 VEHICLE CONTROL

6.1 Steering

The vehicle must steer in a smooth and controlled manner while adhering to the following:

- 6.1.1 The steering design must allow the wheels to be moved from full left lock to full right lock in an uninterrupted movement.
- 6.1.2 Must satisfy and pass the requirements of the Steering Slalom Test (see **Definition 5**).
- 6.1.3 Steering systems must have a maximum lock limitation that prevents jamming, linkage damage, over centre travel
- 6.1.4 Tyre or wheel must not come in contact with the vehicle or rider
- 6.1.5 Steering controls must be designed and constructed so that they **will not injure** the rider in the event of an incident.
- 6.1.6 Steering controls which project towards the rider: (i) must not be closer than 250 mm to the rider’s face: (ii) require rounded edges and suitable padding.
- 6.1.7 Rope, cable, tilt steer, lean steer, flexible column and rear only steer systems **are not permitted.**

6.2 Braking Systems Configuration

- 6.2.1 Minimum of two independently operated systems must be evident and operational.
- 6.2.2 A separate lever for each front brake where there are two front wheels meets this requirement.
- 6.2.3 A rear wheel brake is not required when there are two front wheels with separately operated brakes.

6.3 Braking Systems Conditions and Integrity

- 6.3.1 Brake controls must be away from any moving parts and the road surface, to avoid injury to the rider or compromising the braking system of the vehicle.
- 6.3.2 Brake systems must not apply friction contact to the tyres.
- 6.3.3 A dynamic brake test will be incorporated in the Scrutineering process.

6.4 Mirrors

- 6.4.1 At least two effective rear-view mirrors of minimum area 18 cm² must be fitted, one on each side of the vehicle.
- 6.4.2 Mirrors may be of the mildly convex type, but both must have same the size image and enable riders to clearly identify overtaking vehicles.
- 6.4.3 Each mirror must be positioned within arm's reach of the rider.

7.0 VEHICLE ELECTRONICS

7.1 Lighting

Vehicles must have a front white light and a rear red light.

- 7.1.1 Head lights must operate continuously throughout any “declared lights on period”.
- 7.1.2 **Front lighting** must:
 - a) be at least one white light, securely fitted between 250mm and 600 mm above road level, at the front of the vehicle (forward of the rider's feet).
 - b) be of sufficient size and capacity to effectively illuminate the pathway of the vehicle, and to illuminate other vehicles being approached.
 - c) Headlights are not to be flashing.
 - d) All white lights must be forward facing.
- 7.1.3 Rear Lighting must be:
 - a) **fitted and turned on** for all Events.
 - b) red LED.
 - c) set to **steady mode ONLY**
 - d) mounted within 150mm of the rear-most part of the vehicle.
 - e) mounted on the vertical centre line of the vehicle.
 - f) visible through 160° rear sweep.
 - g) robustly mounted between 350mm and 600mm above road level.
 - h) strip lighting or string LEDs must be confined or masked to 350mm – 600mm above road level.
 - i) all red lights on the vehicle must be **rear facing** and comply with a – h.
 - j) a minimum of three LEDs
- 7.1.4 Helmet mounted lights are not to be used.
- 7.1.5 Teams may use subsidiary lights anywhere on their vehicle. These lights cannot be flashing.

7.2 Warning Device

A warning device must be fitted to each vehicle. It must comply with the following:

- 7.2.1 Mounted in front of the rider's feet.
- 7.2.2 The warning device must be directed forwards and directly contact the outside airstream.
- 7.2.3 It shall be electric or electronic.
- 7.2.4 The warning device must only be operated by using a momentary switch mounted on a steering handle.
- 7.2.5 The warning device should be waterproofed.

7.3 Speedometer

A speedometer must be fitted to the vehicle in a position where it can be clearly seen by each rider.

8.0 DEFINITIONS

- 1) **Scrutineering:**
Process to ensure vehicles meet specifications, have Team Managers committed to complying with their responsibilities as listed, act to help Teams get their vehicles complying.
- 2) **The Organising Body:**
Is responsible for the running of the event as a whole and the correct and in-depth application of these specifications to all vehicles.
- 3) **Roller Test:**
Vehicle is placed on the roller bench with the rider wearing their helmet and belted in.
They are to pedal through the gear range up to “race pace” cadence, and show that they are operating using an easily held head position with enough room inside the cabin to satisfy the indicators below:
 - a) able to move their head easily from resting on the head restraint, forwards so that their chin is on their chest
 - b) move their head 90° right and through to 90° left
- 4) **Specified Foam:**
The Specified Foam is Ethylene Vinyl Acetate (EVA) foam of density 105kg/cubic metre. 20mm thickness is required with minimum area of 1200 cm², or dimensions of 200mm X 600mm.
- 5) **Steering Slalom Test:**
Slalom is with four traffic cones spaced at 4.2m. This is a swerve and recover test.