

# 2023 FORMULA 1 TECHNICAL REGULATIONS

PUBLISHED ON 22 FEBRARY 2023

Issue 5

## Convention:

Black Text: Text of 2023 F1 Technical Regulations Issue 4 as approved by WMSC on 26/06/22, 16/0822, 19/10/22, and 07/12/22

Pink text: Changes approved by the WMSC on 22 February 2023

## CONTENTS:

	Page
<b>ARTICLE 1: GENERAL PRINCIPLES</b>	<b>6</b>
1.1 Formula One World Championship	
1.2 Regulatory Framework	
1.3 Dangerous construction	
1.4 Compliance with the regulations	
1.5 New systems or technologies	
1.6 Duty of Competitor	
<b>ARTICLE 2: DEFINITIONS</b>	<b>8</b>
2.1 Formula One Car	
2.2 Competition	
2.3 Component classification categories	
2.4 Car mass	
2.5 Sprung mass	
2.6 Unsprung mass	
2.7 Power unit	
2.8 Power train	
2.9 Geometrical planes	
2.10 Reference Volumes and Surfaces	
2.11 Coordinate system and references	
2.12 Precision of Numerical Values	
<b>ARTICLE 3: AERODYNAMIC COMPONENTS</b>	<b>11</b>
3.1 Definitions	
3.2 General Principles and Legality Checking	
3.3 Component Definition	
3.4 Overall Dimensions	
3.5 Floor	
3.6 Front Bodywork	
3.7 Rear Bodywork	
3.8 Tail and Exhaust Tailpipe	
3.9 Front Wing (FW)	

3.10	Rear Wing	
3.11	Final Assembly	
3.12	Bodywork not defined in Articles 3.5 to 3.11	
3.13	Wheel bodywork	
3.14	Suspension Fairings	
3.15	Aerodynamic Component Flexibility	
3.16	Aerodynamic Component construction	
<b>ARTICLE 4:</b>	<b>MASS</b>	<b>45</b>
4.1	Minimum mass	
4.2	Mass distribution	
4.3	Mass of tyres	
4.4	Ballast	
4.5	Adding during the race or sprint session	
4.6	Mass of the driver	
<b>ARTICLE 5:</b>	<b>POWER UNIT</b>	<b>46</b>
5.1	Definitions	
5.2	Engine specification	
5.3	Other means of propulsion and energy recovery	
5.4	Power unit dimensions	
5.5	Mass and centre of gravity	
5.6	Power unit torque demand	
5.7	Power unit control	
5.8	Engine high rev limits	
5.9	Exhaust fluids	
5.10	Variable geometry systems	
5.11	Fuel systems	
5.12	Ignition systems	
5.13	Energy Recovery System (ERS)	
5.14	Engine ancillaries	
5.15	Engine intake air	
5.16	Materials and Construction – Definitions	
5.17	Materials and construction – General	
5.18	Materials and construction – Components	
5.19	Materials and construction – Pressure charging and exhaust systems	
5.20	Materials and construction – Energy recovery, storage systems and electronic systems	
5.21	Starting the engine	
5.22	Stall prevention systems	
5.23	Replacing power unit parts	
5.24	Oil and coolant systems and charge air cooling	
5.25	General electrical safety	
5.26	ES design and installation	
<b>ARTICLE 6:</b>	<b>FUEL SYSTEM</b>	<b>64</b>
6.1	Fuel tanks	
6.2	Fittings and piping	

6.3	Fuel tank fillers	
6.4	Refuelling	
6.5	Fuel draining and sampling	
6.6	Fuel System Hydraulic Layout	
<b>ARTICLE 7:</b>	<b>OIL AND COOLANT SYSTEMS AND CHARGE AIR COOLING</b>	<b>68</b>
7.1	Location of lubricating oil tanks	
7.2	Location of lubricating oil system	
7.3	Oil and coolant lines	
7.4	Heat exchangers	
<b>ARTICLE 8:</b>	<b>ELECTRICAL SYSTEMS</b>	<b>70</b>
8.1	Definitions	
8.2	Software and electronics inspection	
8.3	Control electronics	
8.4	Start systems	
8.5	Data acquisition	
8.6	Telemetry	
8.7	Driver inputs and information	
8.8	Master switch	
8.9	Driver radio	
8.10	Accident analysis	
8.11	Accident data	
8.12	FIA Marshalling system	
8.13	Track signal information display	
8.14	Medical warning system	
8.15	Installation of electrical systems or components	
8.16	Timing transponders	
8.17	Cameras and camera housings	
8.18	Wheels display panel	
8.19	Electromagnetic radiation	
8.20	Vehicle dynamics analysis	
8.21	Sensor signals	
<b>ARTICLE 9:</b>	<b>TRANSMISSION SYSTEM</b>	<b>79</b>
9.1	Definitions	
9.2	Fundamental provisions	
9.3	Clutch control	
9.4	Clutch disengagement	
9.5	Homologated Gearbox and Component Classification	
9.6	Gearbox Dimensions	
9.7	Gear ratios	
9.8	Reverse gear	
9.9	Gear changing	
9.10	Torque transfer systems	
9.11	Driveshafts	
<b>ARTICLE 10:</b>	<b>SUSPENSION, STEERING SYSTEMS, WHEELS AND TYRES</b>	<b>85</b>

10.1	Definitions	
10.2	Sprung suspension	
10.3	Outboard suspension	
10.4	Inboard suspension	
10.5	Steering	
10.6	Suspension Uprights	
10.7	Wheel rims	
10.8	Tyres	
10.9	Wheel attachment and retention	
10.10	Dimensions	
	<b>ARTICLE 11: BRAKE SYSTEM</b>	<b>93</b>
11.1	Brake circuits and pressure distribution	
11.2	Brake calipers	
11.3	Brake discs and pads	
11.4	Brake pressure modulation	
11.5	Liquid cooling	
11.6	Rear brake control system	
11.7	Supply of Brake Friction and Brake System Hydraulic components	
	<b>ARTICLE 12: CAR CONSTRUCTION AND SURVIVAL CELL (CHASSIS)</b>	<b>95</b>
12.1	Definitions and General Requirements	
12.2	Survival cell specifications	
12.3	Intrusion Protection	
12.4	Roll Structures	
12.5	Cockpit Specification	
12.6	Cockpit Padding	
12.7	Seat fixing and removal	
12.8	Driver Fit Information	
	<b>ARTICLE 13: SAFETY STRUCTURES AND HOMOLOGATION</b>	<b>104</b>
13.1	General Principles	
13.2	Survival Cell Frontal Impact Test	
13.3	Roll Structure Testing	
13.4	Survival Cell Load Tests	
13.5	Side Impact Structure	
13.6	Front Impact Structure	
13.7	Rear Impact Structure	
13.8	Steering Column Impact Test	
13.9	Headrest Load Test	
	<b>ARTICLE 14: SAFETY EQUIPMENT</b>	<b>118</b>
14.1	Fire Extinguishers	
14.2	Rear view mirrors	
14.3	Rear lights	
14.4	Safety Tethers	
14.5	Safety Harnesses	
	<b>ARTICLE 15: MATERIALS</b>	<b>121</b>

15.1	Definitions	
15.2	General Principles	
15.3	Permitted Materials	
15.4	Specific Prohibitions	
15.5	Specific Exceptions	
15.6	Prescribed Laminates	
<b>ARTICLE 16: FUEL AND ENGINE OIL</b>		<b>126</b>
16.1	Basic principles	
16.2	Fuel definitions	
16.3	Fuel properties	
16.4	Composition of the fuel	
16.5	Fuel approval	
16.6	Fuel sampling and testing at a Competition	
16.7	Engine oil definitions	
16.8	Engine oil properties	
16.9	Composition of the engine oil	
16.10	Engine oil approval	
16.11	Sampling and testing at a Competition	
<b>ARTICLE 17: COMPONENTS' CLASSIFICATION</b>		<b>131</b>
17.1	Definitions	
17.2	General Principles	
17.3	Listed Team Components (LTC)	
17.4	Standard Supply Components (SSC)	
17.5	Transferable Components (TRC)	
17.6	Open Source Components (OSC)	
17.7	List of LTC, SSC, TRC and OSC	
<b>APPENDIX 1: REGULATION VOLUMES</b>		<b>138</b>
<b>APPENDIX 2: DRAWINGS</b>		<b>156</b>
<b>APPENDIX 3: POWER UNIT SYSTEMS, FUNCTIONS, COMPONENTS AND SUPPLY PERIMETER</b>		<b>158</b>
<b>APPENDIX 4: 2022-2025 POWER UNIT, FUEL AND ENGINE OIL HOMOLOGATION</b>		<b>163</b>
<b>APPENDIX 5: COMPONENTS' CLASSIFICATION AND PERIMETER</b>		<b>168</b>
<b>APPENDIX 6: APPROVED CHANGES FOR SUBSEQUENT YEARS</b>		<b>176</b>

## ARTICLE 1: GENERAL PRINCIPLES

### 1.1 Formula One World Championship

- 1.1.1 The FIA will organise the FIA Formula One World Championship (the "Championship") which is the property of the FIA and comprises two titles of World Champion, one for drivers and one for constructors. It consists of the Formula One Grand Prix races which are included in the Formula One calendar and in respect of which the ASNs and organisers have signed organisation agreements with the FIA. All the participating parties (FIA, ASNs, organisers, competitors and circuits) undertake to apply as well as observe the rules governing the Championship and must hold FIA Super Licences which are issued to drivers, competitors, officials, organisers and circuits.
- 1.1.2 The Championship and each of its Competitions are governed by the FIA in accordance with the Regulations.
- 1.1.3 In the sense of the Regulations, terms referring to natural persons are applicable to any gender.

### 1.2 Regulatory Framework

- 1.2.1 The Regulations applicable to the Championship are the International Sporting Code (the "Code"), the Formula One Technical Regulations (the "Technical Regulations"), the Formula One Sporting Regulations (the "Sporting Regulations"), and the Formula One Financial Regulations (the "Financial Regulations"), together referred to as the "Regulations".
- 1.2.2 These Regulations are issued by the FIA and apply to the whole calendar year referred to in the title and to the Championship taking place within that calendar year. Any changes made by the FIA for safety reasons may come into effect without notice or delay.
- 1.2.3 The definitive text of the Technical Regulations shall be the English version which will be used should any dispute arise as to their interpretation. Headings in this document are for ease of reference only and do not affect the meaning of the Technical Regulations.

### 1.3 Dangerous construction

The stewards may prohibit the participation of a vehicle whose construction is deemed to be dangerous. Should the relevant information become apparent during a session, such a decision may apply with immediate effect.

### 1.4 Compliance with the regulations

Formula 1 Cars must comply with these regulations in their entirety at all times during a Competition.

Should a Competitor introduce a new design or system or feel that any aspect of these regulations is unclear, clarification may be sought from the FIA Formula One Technical Department. If clarification relates to any new design or system, correspondence must include:

- a. A full description of the design or system.
- b. Drawings or schematics where appropriate.
- c. The Competitor's opinion concerning the immediate implications on other parts of the car of any proposed new design.
- d. The Competitor's opinion concerning any possible long term consequences or new developments which may come from using any such new designs or systems.
- e. The precise way or ways in which the Competitor feels the new design or system will enhance the performance of the car.

## **1.5 New systems or technologies**

Any new system, procedure or technology not specifically covered by these regulations, but which is deemed permissible by the FIA Formula One Technical Department, will only be admitted until the end of the Championship during which it is introduced. Following this the Formula One Commission will be asked to review the technology concerned and, if they feel it adds no value to Formula One in general, it may be specifically prohibited by the FIA.

Any team whose technology is prohibited in this way will then be required to publish full technical details of the relevant system or procedure.

## **1.6 Duty of Competitor**

It is the duty of each Competitor to satisfy the FIA technical delegate and the stewards that his Formula 1 Car complies with these regulations in their entirety at all times during a Competition.

The design of the car, its components and systems shall, with the exception of safety features, demonstrate their compliance with these regulations by means of physical inspection of hardware or materials. Unless explicitly requested by an Article, no mechanical design may rely upon software inspection as a means of ensuring its compliance.

Due to their nature, the compliance of electronic systems may be assessed by means of inspection of hardware, software and data.

CAD models may be requested by the FIA in order to check compliance with the Regulations. Such models should be supplied in a format and by a method specified by the FIA. In such cases, scanning technology will be used by the FIA to check that the physical car is the same as the inspected CAD models.

Each competitor must ensure that all relevant personnel (whether employee, consultant, contractor, secondee or any other type of permanent or temporary personnel) associated with its participation in the Championship are appropriately informed with respect to the ways in which their areas of responsibility may impact the competitor's compliance with the Regulations.

Each competitor must ensure that the FIA ethics and compliance hotline with respect to the Regulations is clearly communicated to all these individuals.

## ARTICLE 2: DEFINITIONS

### 2.1 Formula One Car

An automobile (the car) designed solely for speed races on circuits or closed courses that is propelled by its own means, moving by constantly taking real support on the ground, of which the propulsion and steering are under the direct control of a driver aboard the vehicle. It runs on four non-aligned complete wheels, with wheel centres that are arranged symmetrically about the car centre plane, when in the straight-ahead position, to form the front and rear axles.

### 2.2 Competition

As defined in Article 2.2 of the Sporting Regulations

### 2.3 Component classification categories

The terms LTC, SSC, TRC and OSC defined in Articles 17.3 to 17.6 and used throughout the Regulations, refer to the classification of the car's components in terms of their Design, Intellectual Property, Manufacture and Supply.

### 2.4 Car mass

Is the mass of the car with the driver, wearing his complete racing apparel, at all times during the Competition.

### 2.5 Sprung mass

All parts of the car that are entirely supported by the sprung suspension.

### 2.6 Unsprung mass

All parts of the car composing the sprung suspension external to the sprung mass and/or not entirely supported by the sprung suspension. For the purpose of this definition the boundary between sprung and unsprung mass will be at the suspension members' inboard attachments.

### 2.7 Power unit

As defined in Article 5.1.2

### 2.8 Power train

As defined in Article 5.1.1

### 2.9 Geometrical planes

2.9.1 **Reference plane:** a nominally horizontal plane sitting at the bottom of the sprung part of the car, with the exception of the plank assembly defined in Article 3.5.9.

2.9.2 **Centre plane:** a vertical plane, which is perpendicular to the reference plane and aligned with the direction of motion of the car. The centre plane is the nominal plane of symmetry of the car.

2.9.3 **Plane A-A** (also referred to as "A-A"): a plane which is perpendicular to both the reference and centre planes, which lies on the front bulkhead of the survival cell that is defined in Article 12, or up to 100mm behind it.

2.9.4 **Plane C-C** (also referred to as "C-C"): a plane which is parallel to A-A, whose position is defined in Article 12.1.4.



## 2.10 Reference Volumes and Surfaces

“Reference Volumes” and “Reference Surfaces” and their position in space are defined in Appendix 1 using the car’s coordinate system, and are used throughout the Technical Regulations for geometrical constraints. For convenience, Reference Volumes are preceded by the prefix “RV-” and Reference Surfaces by the prefix “RS-”.

## 2.11 Coordinate system and references

2.11.1 A right-handed Cartesian (X, Y, Z) coordinate system will be used in these regulations, defined in the following way:

- a. The X axis is in the rearwards longitudinal direction, and is parallel to the reference and car centre planes. Depending on the regulation in question, the local origin can vary, and the following convention is used:
  - i.  $X_A=0\text{mm}$  is defined to be on plane A-A
  - ii.  $X_B=0\text{mm}$  is defined to be on plane B-B
  - iii.  $X_C=0\text{mm}$  is defined to be on plane C-C
  - iv. The planes  $X_F=0$  and  $X_R=0$  are defined as the planes which respectively pass through the origin of the two front or two rear wheels’ coordinate systems, as defined in Article 2.11.3, with the wheels in the straight ahead position and the car at the Legality Ride Height, as defined in Article 10.1.4.
  - v.  $X_{DIF}=0\text{mm}$  is defined as the output axis of the final drive as defined in Article 9.6.1.
  - vi.  $X_{PU}=0\text{mm}$  is defined to pass through the forward most mounting face of the studs connecting the power unit to the survival cell, as defined in Article 5.4.8.
- b. The Y axis is normal to the X axis, parallel to the reference plane, and pointing to the right hand side of the car.  $Y=0\text{mm}$  is defined to be on the car centre plane.
- c. The Z axis is normal to the reference plane and points upwards.  $Z=0\text{mm}$  is defined to be on the reference plane

2.11.2 Further conventions:

- a. If no units are specified, it is implicit the unit will be in millimetres
- b. The suffix “L” may be used for local coordinates in specific rules, i.e.  $X_L$ ,  $Y_L$ ,  $Z_L$ , where these local axes are defined within a specific Article for local use.
- c. Planes will be referred to as the axis to which they are normal to (e.g. X-plane or  $X_A=300$  plane).
- d. Unless otherwise specified, the positive side of the Y axis is used in the various articles and it is implicit that a symmetrical rule applies for the other side of the car. The terms “inboard” or “outboard”, when used in reference to the Y coordinate, respectively refer to closer to or further away from the car centre plane.
- e. Unless otherwise specified any measurements and references will be with the wheels in the straight ahead position (the wheel rotation axis lying within an X plane).
- f. Unless otherwise specified, when a viewing direction is stated, “front” and “rear” are parallel to the X axis, “side” is parallel to the Y axis (in the direction towards the car centre plane) and “above”, “below” and “plan” are parallel to the Z axis.
- g. Unless otherwise specified, directions of angles, slopes and incidences are taken in context of the right-handed Cartesian coordinate system defined in 2.11.1. For example, a positive slope within a Y-Plane would be characterised by positively increasing X and Z components.

- 2.11.3** A Cartesian ( $X_w$ ,  $Y_w$ ,  $Z_w$ ) coordinate system will be used for each wheel, defined in the following way:
- a. The  $X_w$  axis lies on the inboard plane of the wheel rim, passes through its rotational axis and points in the rearward longitudinal direction.  $X_w=0$ mm is defined to be on the wheel rotational axis. The  $X_w$  axis is parallel to the car centre plane and to the reference plane, with the wheel in the straight-ahead position and the car at its legality ride height, as defined in Article 10.1.4.
  - b. The  $Y_w$  axis is normal to the inboard plane of the wheel rim and points towards the car centre plane.  $Y_w=0$ mm is defined to be on the inboard plane of the wheel rim. Referring to this coordinate, the terms “inboard” or “outboard” respectively refer to closer to or further away from the car centre plane.
  - c. The  $Z_w$  axis is normal to both the  $X_w$  and  $Y_w$  axes and points upwards.  $Z_w=0$  is defined to be on the wheel rotational axis.
  - d. Once the wheel axis system is defined as above, then it maintains a fixed orientation relative to the suspension upright at all other suspension articulation points.

## **2.12 Precision of Numerical Values**

Any numerical values specified in these Regulations as limits (maxima or minima), will be considered to be the limits regardless of the decimals quoted.

## ARTICLE 3: AERODYNAMIC COMPONENTS

### 3.1 Definitions

#### 3.1.1 Aerodynamic Components or Bodywork

All parts of the car in contact with the external air stream.

- a. The following components are considered to be bodywork:
  - i. all components described in Article 3;
  - ii. inlet or outlet ducts for the purpose of cooling, up to the component they are intended to provide cooling for;
  - iii. inlet ducts for the power unit (air boxes) up to the air filter;
  - iv. primary heat exchangers, as defined in Article 7.4.1 (b).
- b. The following components are not considered to be bodywork:
  - i. cameras and camera housings, as defined in Article 8.17;
  - ii. rear view mirrors as defined in Article 14.2;
  - iii. the ERS status light;
  - iv. parts definitely associated with the mechanical functioning of the power train, transmission of power to the wheels, and the steering system providing, in any case, none are of a design contrived to achieve an aerodynamic effect;
  - v. the wheel rims and tyres;
  - vi. the brake disc assemblies, calipers and pads.

#### 3.1.2 Frame of Reference

The geometry, component or group of components with respect to which certain bodywork must remain immobile.

#### 3.1.3 External air stream

The flow of air around the car which has a primary impact on its aerodynamic performance.

#### 3.1.4 Concave and convex curvature

References made in this Article on curvature of aerodynamic surfaces refer to the part of the aerodynamic surface which is in contact with the external air stream.

When references are made to the curvature of a surface, without specifying an intersection with a particular plane, the local curvature at any point will be defined as the curvature of the intersection of the surface in question with a plane passing through a line normal to the surface at that point. The concave radius of curvature of the surface at that point will be defined as the minimum concave radius of curvature obtained when the intersecting plane is swept through 180 degrees around the normal line. The convex radius of curvature of that surface at that point will be defined as the minimum convex radius of curvature obtained when the intersecting plane is swept through 180 degrees around the normal line.

As an example, and for the sake of clarity, the aerodynamic surface of a solid sphere would be the surface where this sphere makes contact with the external airstream, and would be considered to be a convex surface.

#### 3.1.5 Normal to an aerodynamic surface or curve

The normal applied to an aerodynamic surface at a given point is a vector which is perpendicular to the surface at that point and points towards the local external air stream.

The normal to a curve at a given point will be considered to be the normal to the surface containing the curve at the same point.

### **3.1.6 Tangency Continuity**

Tangency Continuity at a given point of a curve or at a given point of a surface, is satisfied if the value of the tangent is continuous.

Tangency Continuity at intersections between two curves or two surfaces, is satisfied if the two curves or two surfaces at the intersection are tangent to one another and also have their normal coincident with each other.

Where two adjacent surfaces are not tangent continuous but could be made so by applying a fillet radius of no more than 1mm along their boundary, these surfaces will be considered tangent continuous at this boundary whether or not the fillet radius is applied, as long as such a fillet radius is permitted according to the relevant article.

### **3.1.7 Curvature Continuity**

Curvature Continuity between two curves, at a given point of a curve, between two surfaces or within a surface is satisfied if the value of the curvature is continuous and in the same direction.

### **3.1.8 Open and closed sections**

Within the prescribed limitations of the relevant regulation, a section through the bodywork when intersected with a defined plane will be considered closed if it forms a complete boundary by itself otherwise it will be considered open.

### **3.1.9 Fillet Radius**

An arc with radius of curvature respecting the limit(s) specified, connecting two fully defined surfaces tangentially with no inflection and perpendicular to the intersection between them. Unless otherwise specified, fillet radii may change in magnitude around the periphery of the boundary around which they are defined, but such changes must be continuous.

If there exists a discontinuity in tangency at the trailing edge of the intersection between the parts to be joined by the fillet, then a closed aerodynamic fairing may be added immediately behind the trailing edge. This fairing must be no larger in cross section than the preceding fillet and any trailing edge immediately adjacent to the fillet and no longer than three times the maximum fillet arc radius at this point.

### **3.1.10 Aerodynamic seal**

The function by which the flow between two regions of different pressure is kept to the minimum feasible magnitude.

### **3.1.11 Gurney**

A component fitted to the trailing edge of a profile in order to adjust its aerodynamic performance. In any plane normal to the trailing edge of the profile, the Gurney must contain a flat section no more than 1mm thick, and of a given height (defined as the size of the Gurney), and a bonding flange onto the surface of the wing which may be no more than 20mm long and 1mm thick. No part of the Gurney may protrude behind a line that is normal to the surface on which the Gurney is applied at the point of the trailing edge of the profile.

## **3.2 General Principles and Legality Checking**

### **3.2.1 Objective of Article 3**

An important objective of the Regulations in Article 3 is to enable cars to race closely, by ensuring that the aerodynamic performance loss of a car following another car is kept to a minimum. In order to verify whether this objective has been achieved, Competitors may be required on request to supply the FIA with any relevant information.

In any case the Intellectual Property of this information, will remain the property of the Competitor, will be protected and not divulged to any third party.

### 3.2.2 Aerodynamic Influence

With the exception of the driver adjustable bodywork described in Article 3.10.10 (in addition to minimal parts solely associated with its actuation) and the flexible seals specifically permitted by Articles 3.13 and 3.14.4, all aerodynamic components or bodywork influencing the car's aerodynamic performance must be rigidly secured and immobile with respect to their frame of reference defined in Article 3.3. Furthermore, these components must produce a uniform, solid, hard, continuous, impervious surface under all circumstances.

Any device or construction that is designed to bridge the gap between the sprung part of the car and the ground is prohibited under all circumstances.

With the exception of the parts necessary for the adjustment described in Article 3.10.10, or any incidental movement due to the steering system, any car system, device or procedure which uses driver movement as a means of altering the aerodynamic characteristics of the car is prohibited.

The Aerodynamic influence of any component of the car not considered to be bodywork must be incidental to its main function. Any design which aims to maximise such an aerodynamic influence is prohibited.

### 3.2.3 Symmetry

All bodywork must be nominally symmetrical with respect to  $Y=0$ . Consequently, and unless otherwise specified, any regulation in Article 3 concerning one side of the car will be assumed to be valid for the other side of the car and references to maximum permissible numbers of components in Article 3 will also refer to the one side of the car.

Minimal exceptions to the requirement of symmetry of this Article will be accepted for the installation of non-symmetrical mechanical components of the car, for asymmetrical cooling requirements or for asymmetrical angle adjustment of the front flap defined in Article 3.9.7.

Bodywork on the unsprung mass must respect this Article when the suspension position of each wheel is virtually re-orientated so that its wheel coordinate system axes (described in Article 2.11.3) are parallel to their respective axis of the car coordinate system (described in Article 2.11.1).

### 3.2.4 Digital legality checking

The assessment of the car's compliance with the Aerodynamic Regulations will be carried out digitally using CAD models provided by the teams. In these models:

- a. Components may only be designed to the edge of a Reference Volume or with a precise geometrical feature, or to the limit of a geometrical criterion (save for the normal round-off discrepancies of the CAD system), when the regulations specifically require an aspect of the bodywork to be designed to this limit, or it can be demonstrated that the design does not rely on lying exactly on this limit to conform to the regulations, such that it is possible for the physical bodywork to comply.
- b. Components which must follow a precise shape, surface or plane must be designed without any tolerance, save for the normal round-off discrepancies of the CAD system.

### 3.2.5 Physical legality checking

The cars may be measured during a Competition in order to check their conformance to the CAD models discussed in Article 3.2.4 and to ensure they remain inside the Reference Volumes.

- a. Unless otherwise specified, a tolerance of  $\pm 3\text{mm}$  will be accepted for manufacturing purposes only with respect to the CAD surfaces. Where measured surfaces lie outside of this tolerance but remain within the Reference Volumes, a Competitor may be required to provide additional information (e.g. revised CAD geometry) to demonstrate compliance with the regulations. Any discrepancies contrived to create a special aerodynamic effect or surface finish will not be permitted.
- b. Irrespective of a), geometrical discrepancies at the limits of the Reference Volumes must be such that the measured component remains inside the Reference Volume.

- c. A positional tolerance of +/- 2mm will be accepted for the Front Wing Bodywork, Rear Wing Bodywork, Exhaust Tailpipe, Floor Bodywork behind  $X_R=0$ , and Tail. This will be assessed by realigning each of the groups of Reference Volumes and Reference Surfaces that define the assemblies, by up to 2mm from their original position, to best fit the measured geometry.
- d. Irrespective of b), a tolerance of  $Z=\pm 2\text{mm}$  will be accepted for parts of the car lying on the  $Z=0$  plane, with  $-375 \leq Y \leq 375$  and ahead of  $X_R=0$ .
- e. Minimal discrepancies from the CAD surfaces will also be accepted in the following cases:
  - i. Minimal repairs carried out on aerodynamic components and approved by the FIA
  - ii. Tape, provided it does not achieve an aerodynamic effect otherwise not permitted by Article 3
  - iii. Junctions between bodywork panels
  - iv. Local bodywork fixing details

### 3.2.6 Datum Points

All cars must be equipped with mountings for optical targets that enable the car's datum to be determined for scrutineering in the following locations:

- i. One on the forward part of the top of the survival cell.
- ii. Two positioned symmetrically about  $Y=0$  on the top of the survival cell close to  $X_B=0$ .
- iii. Two positioned symmetrically about  $Y=0$  on the side of the survival cell close to  $X_B=0$ .
- iv. Two positioned symmetrically about  $Y=0$  on the side of the survival cell close to the rear mounts of the secondary roll structure.
- v. Two positioned symmetrically about  $Y=0$  within an axis-aligned cuboid with an interior diagonal defined by points  $[X_C=0, 175, 970]$  and  $[X_C=150, -175, 870]$ .
- vi. One probed point on the RIS or gearbox case.

In all cases, a file with required datum points must be supplied for each survival cell.

For deflection testing, all cars must be provided with a means of mounting a reference artefact to the RIS. This mounting may be temporary, but must be rigid with respect to the underlying car structure.

Full details of the requirements are given in the Appendix the Technical and Sporting Regulations.

**3.2.7** Section titles and Article titles within this article have no regulatory value.

**3.2.8** Static pressure tappings are permitted in surfaces, provided that they;

- i. Have an internal diameter of no more than 2mm.
- ii. They are flush with the underlying geometry.
- iii. Are only connected to pressure sensors, or are blanked, without leakage.

## 3.3 Component Definition

The permitted bodywork and the relevant frame of reference (as defined in Article 3.1.2, and used to establish compliance with Article 3.2.2) for each group is defined in the following Articles 3.3.1, 3.3.2 and 3.3.3.

### 3.3.1 Bodywork which is part of the sprung mass of the car

The only sprung mass bodywork permitted is that defined under Articles 3.5 to 3.12 and under Articles 3.1.1.a.ii to iv. The frame of reference for every part of the car classified as Sprung Mass Bodywork is the coordinate system defined in Article 2.11.1.

Any bodywork that is trimmed or filleted in Article 3.11 must first be declared as belonging to one of the groups defined in Articles 3.5 to 3.10.

Unless otherwise stated, the compliance of an individual bodywork group to Article 3 will be assessed independently and prior to any trimming, filleting and assembly operation referred to in Article 3.11, and the FIA may request to see any discarded geometry after final assembly. Once the final assembly is completed, any bodywork surfaces no longer exposed to an external airstream or internal duct may be modified, providing they remain unexposed.

### 3.3.2 Wheel Bodywork

The only wheel bodywork permitted is that defined under Article 3.13. With the exception of wheel covers, as defined in Article 3.13.7, the frame of reference for every part of the car classified as Wheel Bodywork is the corresponding upright structure and the corresponding coordinate system defined in Article 2.11.3.

The frame of reference for any wheel cover, as defined in Article 3.13.7 is the corresponding wheel rim.

### 3.3.3 Suspension Fairings

The only suspension fairings permitted are those defined under Article 3.14. In order to assess compliance with Article 3.2.2, the frame of reference of any suspension fairing is the structural suspension member that it is attached to.

## 3.4 Overall Dimensions

### 3.4.1 Width

With the exception of the tyres, the wheel rims defined in Article 10.7.2, and the wheel covers defined in Article 3.13.7, no part of the car may lie outboard of  $Y=1000$ .

### 3.4.2 Wheelbase

The distance between the planes  $X_F=0$  and  $X_R=0$  must not exceed 3600mm.

### 3.4.3 Front Wheel Position

The plane  $X_F=0$  must not be behind  $X_A=100$ .

## 3.5 Floor

### 3.5.1 Floor Body

Bodywork declared as "Floor Body" must:

- a. Lie within RV-FLOOR-BODY.
- b. Entirely obscure RS-FLOOR-PLAN, and RS-CASSETTE, when viewed from below.
- c. Entirely obscure RS-FLOOR-REAR, when viewed from the side.
- d. Lie on the reference plane if both visible from below and within the boundaries of RS-FLOOR-MID when viewed from below.

Furthermore:

- e. Its complete surface, when intersected with any X-plane must produce only a single section that is continuous, closed and with all parts of the section visible from either above or below.
- f. Its complete surface, when intersected with any Y-plane must produce only a single section that is continuous, closed and with all parts of the section visible from either above or below. Two such sections will be permitted outboard of  $Y=595$ , provided:
  - i. these two sections are not closer than 50mm to each other on any Y-plane, except for a transition between one and two sections that is contained within two Y-planes up to 10mm apart.
  - ii. the rearward-most point of the forward-most section is aft of  $X_F=1700$ .

- g. Its complete surface must be tangent continuous, and any concave radius of curvature must be greater than 25mm. This is with the exception of regions of its surface that are within 60mm of the point  $[X_R, Y, Z] = [-350, 495, 5]$  and visible from above.
- h. Its complete surface must be tangent continuous, and any convex radius of curvature must be greater than 25mm. This is with the exception of regions of its surface that are:
  - i. Within 60mm of the point  $[X_R, Y, Z] = [-350, 495, 5]$  and visible from below.
  - ii. In plan view, within 5mm of the boundary of the Floor Body. In the region  $-345 < X_R < 440$  this exception only applies below  $Z = 65$ .
  - iii. Visible from above, and within 10mm of the load application points defined in Article 3.15.7.c. Such features must be the minimal required for applying the loads required by that article.
- i. All regions of its surface that are visible from above, outboard of  $Y=500$  and forward of  $X_F=1700$ , must be visible from the side.

Once the surfaces defined as Floor Body have been defined in accordance to the provisions of parts (a) to (i), it is permitted to attach additional bodywork to the surface of the Floor Body for the purpose of aiding local flow attachment. These items, which need not comply with parts (a) to (i), will nevertheless be considered part of the Floor Body and must:

- j. Be entirely within 10mm of the surface of the Floor Body that is visible from below.
- k. Be entirely within 100mm of the car centre plane and rearward of  $X_R = -550$ .
- l. Collectively lie in a region no greater than 50mm when measured in the X-direction.

The requirements of parts (e), (g) and (h) must be satisfied when considering both sides of the car.

### 3.5.2 Floor Fences

Bodywork declared as "Floor Fences" must lie within **RV-FLOOR-FENCE**. Furthermore:

- a. For each Floor Fence, a virtual surface must first be defined, which must:
  - i. Be a single surface with no apertures. Any straight line aligned with the Y-axis must intersect the virtual surface no more than once.
  - ii. Produce no more than one curve when intersected with any Z-plane. At no point along this curve may the line tangent to it subtend an angle greater than  $50^\circ$  to the X-axis. For the virtual surface whose associated Floor Fence is subsequently used to obscure **RS-FLOOR-FENCE**, the same angle must be no greater than  $40^\circ$ .
  - iii. Produce no more than one curve when intersected with any X-plane. At no point along this curve may the line tangent to it subtend an angle greater than  $25^\circ$  to the Z-axis. This curve must not intersect the surface of the Floor Body that is visible from above. If this curve is rearward of  $X_F=960$ , it must intersect the Floor Body exactly once and any part of the curve above this intersection must be internal to the Floor Body.
  - iv. Not be closer than 10mm at any point to any other Floor Fence virtual surface.
- b. Once the virtual surface has been defined, the associated Floor Fence must:
  - i. Fully enclose the entire virtual surface.
  - ii. Be no more than 4mm distant from the virtual surface at any point.
- c. There may be no more than four Floor Fences on each side of the car centre plane, one of which must fully obscure **RS-FLOOR-FENCE** when viewed from the side. The curve produced by intersection of the virtual surface associated with this fence and the Floor Body, must be fully within 5mm of the boundary of the Floor Body when viewed from above.



- d. Once each Floor Fence has been fully defined it is permitted to apply a Fillet at the boundary between it and the Floor Body, having radius of curvature no greater than 50mm. Such a Fillet would then be considered part of the associated Floor Fence.
- e. Once the Floor Body, each Floor Fence and each associated Fillet have been fully defined, the boundary of the assembled bodywork between  $X_F=1290$  and  $X_R=-700$ , when viewed from below, must be below  $Z=35$ .

### 3.5.3 Floor Edge Wing

Bodywork declared as “Floor Edge Wing” must:

- a. Lie within RV-FLOOR-EDGE.
- b. Be a single volume with no apertures.
- c. Its complete surface, when intersected with any X-plane must produce only a single section that is continuous and closed, having cross-sectional area no greater than  $2000\text{mm}^2$ . This section must be between 5mm and 20mm distant from the curve produced by intersection of the Floor Body with the same X-plane, at its closest point.
- d. Its complete surface, when intersected with any Z-plane must produce only a single section that is continuous and closed.
- e. Its complete surface must be tangent continuous and any concave radius of curvature must be greater than 25mm.

For the sole purpose of providing a structural connection between the Floor Edge Wing and the Floor Body, it is permitted to add up to six support brackets per side of the car. These brackets, which need not comply with parts (a) to (e), will nevertheless be considered part of the Floor Edge Wing and must:

- f. Be in their entirety within 40mm of the Floor Body and 30mm of the Floor Edge Wing.
- g. Be no more than 5mm thick. A fillet radius no greater than 4mm will be permitted where these brackets join to the components they connect.
- h. Be no larger than 40mm in the X-direction and have no dimension that exceeds 60mm.
- i. Not be closer than 50mm at any point to any other such support bracket.
- j. Not be visible from below.

### 3.5.4 Bib

Bodywork declared as “Bib” must:

- a. Lie within **RV-BIB**.
- b. Be a single volume with no apertures.

Furthermore, when considering both sides of the car, its complete surface must:

- c. When intersected with any X plane produce only a single section that is continuous, closed and with all parts of the section visible from either above or below.
- d. Be tangent continuous with no concave radius of curvature when viewed from below and any concave radius of curvature when viewed from above must be greater than 15mm.
- e. Not contain any convex radius of curvature less than 15mm. This is with the exception of regions of its surface below  $Z=5$  that are within 5mm of any point that, when viewed from above, lies on the boundary of the Bib.

### 3.5.5 Bib to Floor Body Assembly

Once the Bib and Floor Body are fully defined, the Bib and the Floor Body must be trimmed to each other, to create one unified volume with no remaining overlapping surfaces. A fillet radius, no greater than 50mm, may be applied along the intersection between these surfaces. This fillet, which need not comply with Article 3.5.4, will nevertheless be considered part of the Bib.

Furthermore, in the area of the fillet, minimum flexibility is permitted in order to allow compliance of the Front Floor Structure when the front of the car comes into contact with the ground. After the fillet has been applied, the external surfaces at the boundaries between adjacent sections of Bib and Floor Body must maintain both continuity and tangency in any X, Y, or Z plane.

### 3.5.6 Floor Bodywork Group

Once the components defined in Articles 3.5.1 to 3.5.5 have been constructed in accordance to the provisions of those Articles, and any subsequent operation of sub-assembly described within Article 3.5 has been applied, the resulting union of these components is defined as "Floor Bodywork".

### 3.5.7 Floor Auxiliary Components

Once all parts of Floor Bodywork have been fully defined, the following may be used:

- a. A single stay per side to act as a rigid support between the Floor Bodywork and the Rear Impact Structure described in Article 13.7. If fitted, this stay must:
  - i. Have its inboard attachment point between  $X_{DIF}=150$  and  $X_{DIF}=325$  on the Rear Impact Structure.
  - ii. Be of a circular cross section with a diameter of no more than 5mm, with the exception of minimal details at its inboard and outboard attachment points, or for adjustment purposes.
- b. A single device between the Front Floor Structure and the Survival Cell. If fitted, all parts of this device in contact with the external airstream must:
  - i. Be fully within **RV-BIB-STAY** and be symmetrically arranged about  $Y=0$ .
  - ii. In any Z-plane contain only one closed section.
- c. A single stay per side to act as a support between the Floor Bodywork ahead of  $X_R=0$ . This stay may be designed to only take load in tension. If fitted, this stay must:
  - i. Be entirely between  $X_R=-850$  and  $X_R=0$
  - ii. Have its outboard attachment on the Floor Bodywork.
  - iii. Have its inboard attachment on the entirely sprung part of the car.
  - iv. Be of a circular cross section with a diameter of no more than 5mm, with the exception of minimal details at its inboard and outboard attachment points, or for adjustment purposes.

Any parts of these components exposed to the external airstream will be considered part of the Floor Bodywork Group.

### 3.5.8 Apertures

Once all parts of Floor Bodywork have been fully defined, the following apertures may be added:

- a. For the sole purpose of cooling auxiliary components, (such as Electrical Components, etc.) in the region forward of  $X_F=650$  and above  $Z=100$ . The total area of such apertures must not exceed  $500\text{mm}^2$  per side of the car.

All areas mentioned in this Article will be measured on the untrimmed Floor Bodywork surface.

### 3.5.9 Plank Assembly

Below the central surfaces of the Floor Body, the plank assembly must be fitted: consisting of the plank, the skids, and the mountings. The requirements of this article must be satisfied when considering both sides of the car.

The following provisions apply to the plank assembly:

- a. The upper surface of the plank assembly must lie at  $Z=0$ , so that no air can pass between it and the Floor Body or Bib lower surfaces.
- b. The plank assembly must be symmetrically arranged about  $Y=0$ .
- c. The forward edge of the plank assembly must lie at  $X_F=430$
- d. The rearmost edge of the plank assembly must lie at  $X_R= -600$ .
- e. The thickness of the plank assembly measured normal to the lower surface must be  $10\text{mm} \pm 0.2\text{mm}$  and must be uniform when new. A minimum thickness of 9mm will be accepted due to wear, and conformity to this provision will be checked at the peripheries of the designated holes.
- f. The plank assembly must have four precisely placed holes the positions of which are given by **RV-PLANK**. To establish the conformity of the plank assembly after use, its thickness will only be measured at these holes, regardless of whether plank or skid material is present.

Four additional 10mm diameter holes are permitted provided their sole purpose is to allow access to the bolts which secure the Accident Data Recorder to the survival cell.

The following provisions apply to the plank:

- g. The geometry of the plank must conform to **RV-PLANK** with a general manufacturing tolerance of  $\pm 0.5\text{mm}$  and a tolerance on thickness given in (e) above
- h. The material of the plank is free, but it must be homogeneous with a specific gravity between 1.3 and 1.45, or if pocketed be made from a bonded assembly the upper 0.5mm of which must have a specific gravity of between 1.3 and 1.65 and the remainder, excluding pockets, be made from an homogeneous material with a specific gravity of between 1.3 and 1.45.
- i. The plank may comprise no more than three pieces, the forward one of which may not be any less than 900mm in length.
- j. In the areas between  $X_F=630$  and  $X_C=-800$  and behind  $X_C=-400$ , pocketing of the lower 9.5mm of the plank from above is permitted. The pocket depth may not reduce the remaining plank material thickness to less than 2mm from either the lowest surface below the reference plane when new or the lower surface of any recesses necessary to fit the skids permitted by items k) to r) of this article. Furthermore, the periphery of any pocket, in any horizontal plane parallel to the reference plane, must be not less than 10mm from either the edges of the plank or any holes or recesses in the plank. In vertical cross section the internal pocket fillet radii must be at least 3mm and in horizontal cross section 10mm. Pockets may only be filled with a material having a specific gravity of less than 0.25.

The following provisions apply to the skids. The lower surface of the plank may be fitted with flush mounted metal skids which:

- k. May only be fitted in place of plank material.
- l. Have a total area no greater than  $24000\text{mm}^2$  when viewed from below.
- m. Are no greater than  $4000\text{mm}^2$  in area individually when viewed from below.
- n. Are fitted in order that their entire lower surfaces are visible from below.
- o. Must have a minimum cross sectional thickness of 15mm across its external boundaries in plan view.  
The minimum wall thickness between an internal fixing hole and the external boundaries of the skid must be no less than 7.5mm.
- p. Must have an upper surface no more than 3mm below the reference plane.
- q. Must be designed such that they are secured to the car using the fasteners described in items t) to w) of this article and that, when viewed from below, no part of the skid is more than 50mm from the centre line of a fastener which passes through that skid.

- r. Must be made from Titanium alloy (according to AMS4928 or AMS4911 in annealed condition). Furthermore, they may only be machined from solid and no processes (such as forging, rolling, welding, heat treatment or coating) may be carried out either before or after machining.
- s. If positioned entirely inboard of  $Y=120$  and between  $X_F= 425$  and  $X_F= 625$ , must be fastened directly to the forward floor structure with zero degrees of freedom:

The following provisions apply to the plank and skid mountings. The plank and skids must be fixed to the car using fasteners which:

- t. Are no smaller than M6 and are made from grade 12.9 or 10.9 steel.
- u. If used to attach a skid to the car, must employ at least 1 fastener per  $1,000\text{mm}^2$  of skid area.
- v. If used to attach a skid to the car, the team must be able to show by calculation that the shanks of the fasteners (which may be no less than 6mm diameter) are the weakest point in the attachment of the skids to the car.
- w. May use a load spreading washer if required.

The total area of the fasteners and any load spreading washers employed with them when viewed from below must be less than  $7,500\text{mm}^2$ . The area of any single fastener plus its load-spreading washer may not exceed  $500\text{mm}^2$ .

No part of any fastener or load-spreading washer may be more than 8mm below the reference plane. For the avoidance of doubt, the skids referred to in items k) to s) of this article will not be treated as load spreading washers.

## 3.6 Front Bodywork

### 3.6.1 Nose

Bodywork declared as “Nose” must:

- a. Lie within RV-CH-NOSE.
- b. In any X plane, contain no more than a single closed section which must have no external concave radius of curvature. Between  $X_F= -950$  and  $X_A=0$ , the part of this section which is visible from above, must:
  - i. be a tangent continuous curve
  - ii. be tangent to the Z-axis at its outermost extremity
  - iii. have no radius of curvature smaller than 45mm at  $X_A=0$  which may reduce to a minimum radius of curvature of 20mm forward of  $X_A=0$

The provisions of this Article must be satisfied when considering both sides of the car.

- c. In any Y plane, contain only a single section which, if inboard of  $Y=150$ , must be open.
- d. Be arranged such that, when viewed from above, no part of **RS-CH-NOSE**, may be visible.

The following will be exempt from the above:

- e. The cameras (position 2) and mounting brackets defined in Article 8.17.7
- f. When considering both sides of the car, a single aperture for the purpose of driver cooling, such an aperture having a maximum surface area of  $1500\text{mm}^2$  when measured on the untrimmed Nose and being situated forward of the section referred to in Article 13.6.1 (a).
- g. Minimal apertures for front suspension members.

### 3.6.2 Forward Chassis

Bodywork declared as “Forward Chassis” must:

- a. Lie within **RV-CH-FRONT** and completely enclose **RV-CH-FRONT-MIN**.
- b. When considering both sides of the car, at any X plane, not contain any convex radius smaller than 25mm or a concave radius smaller than 200mm.

Once these requirements have been met, minimal apertures may be applied for access to, and movement of mechanical components.

### 3.6.3 Mid Chassis

Bodywork declared as “Mid Chassis” must lie within **RV-CH-MID**.

### 3.6.4 Mirror Housing

- a. The bodywork declared as “Mirror Body” must lie within **RV-MIR-HOU**.
- b. The bodywork defined as “Mirror Inner Stay” must connect the Mirror Body to the Mid Chassis and must:
  - i. Lie between two X-Planes, located at the forward and rearward extremities of the inboard face of **RV-MIR-HOU**
  - ii. Not lie above a plane parallel to and offset upwards by 25mm from the lower face of **RV-MIR-HOU** or below  $Z=550$
  - iii. Lie inboard of the inboard face of **RV-MIR-HOU**
  - iv. Form no more than a single section when intersected by any Z-plane or Y-Plane
- c. The Mirror Body may be connected to the Sidepod by bodywork declared as “Mirror Rear Stay”. If present, this bodywork must:
  - i. Lie between  $Y=440$  and  $Y=630$ .
  - ii. Lie behind a plane lying on the forward face of **RV-MIR-HOU**
  - iii. When cut by any X-Plane, form a single section measuring no more than 50mm in Z and no more than 10mm in Y.
  - iv. Lie forward of the plane  $X_f=1300$  and lie between two Z-Planes at  $Z=400$  and  $Z=720$ .
- d. Once the Mirror Inner Stay and Mirror Rear Stay (if present) are fully defined, they must be trimmed to the Mirror Body to produce a single volume. A fillet with radius of no more than 10mm may be applied to the intersections between these volumes. The resulting volume is defined as Mirror Housing.
- e. Once fully defined, the Mirror Housing must be trimmed to all of the following bodywork components it connects to: Mid Chassis, Sidepod and the fillet defined in Article 3.11.1. A fillet with radius of no more than 10mm may be applied to the intersections between the Mirror Housing and these components.

### 3.6.5 Front Bodywork Group

Once the components defined in Articles 3.6.1 to 3.6.4 have been constructed in accordance to the provisions of those Articles, and any subsequent operation of sub-assembly described within those Articles has been applied, the resulting union of these components is defined as “Front Bodywork”.

### 3.6.6 Continuity

Once all parts of the Front Bodywork have been fully defined, the external surfaces at the boundaries between adjacent sections of the Nose, Forward Chassis and Mid Chassis bodywork, must maintain both continuity and tangency in any Y or Z plane.

### 3.7 Rear Bodywork

#### 3.7.1 Sidepod

Bodywork declared as "Sidepod" must:

- a. Lie within **RV-RBW-SPOD**.
- b. Form no more than two curves on its surface when intersected by any X or Y plane, each of which must be tangent continuous and open. Furthermore:
  - i. Assessed on any X plane, any such curve that is wholly or partially visible when viewed from the side of the car, is subject to the following requirements:

Parts of this curve that are visible from the car centre plane (viewed parallel to the Y-axis) and not visible from the side may contain no concave radius of curvature (as defined by Article 3.1.4) smaller than 50mm.

All other parts of this curve may contain no concave radius of curvature smaller than 200mm.
  - ii. Assessed on any Y plane, whenever two such curves are visible when viewed from the front of the car, no part of either curve may have a concave radius of curvature smaller than 200mm.
  - iii. Compliance with (i) and (ii) is not required within a single 50mm diameter sphere defined by the competitor.
- c. In any Z plane, any cross section of bodywork must form a single curve on its surface which must be tangent continuous and open.

#### 3.7.2 Coke Panel

Bodywork declared as "Coke Panel" must:

- a. Lie within RV-RBW-COKE.
- b. At no point be less than 50mm distant to RV-FLOOR-EDGE.
- c. Be arranged such that, when viewed from the side, no part of RS-RBW-EC that lies within RV-RBW-COKE may be visible.

#### 3.7.3 Engine Cover

Bodywork declared as "Engine Cover" must:

- a. Lie within RV-RBW-EC.
- b. Be arranged such that when viewed from the side, no part of RS-RBW-EC that lies within RV-RBW-EC may be visible.

#### 3.7.4 Coke Panel and Engine Cover Shape

On each side of the car, the combined external Coke Panel and Engine Cover surfaces must:

- a. On any X section, form one tangent continuous curve. Furthermore:
  - i. Outboard of Y=25 the radius of curvature of any such section must not be less than 75mm if convex, or 50mm if concave, with the exception of a rectangular region bounded in plan view by (X<sub>c</sub>=20, 125) and (X<sub>c</sub>=150, 375) where the radius of curvature must not be less than 25mm and within a 20mm offset from the lower side impact structure defined in article 13.5.1 where the radius of curvature must not be less than 10mm.
  - ii. Between Y=5 and Y=25 the radius of curvature of any such section must not be less than 25mm.
- b. Not contain any apertures ahead of X<sub>R</sub>= -55, other than those permitted in Article 3.7.6.
- c. Not contain any surface parallel to a X plane ahead of X<sub>R</sub>= -55.

- d. Rearward of  $X_R = -300$ , and below  $Z=350$ , and prior to the addition of any apertures, the X component of any normal to the external surface of bodywork visible from the side must not be negative.

The cameras (position 3) and mounting brackets defined in Article 8.17.8 will be exempt from the restrictions of this Article.

### 3.7.5 Bodywork Blister

Once the Rear Bodywork surfaces are fully defined in accordance with Articles 3.7.1 to 3.7.4, a single Bodywork Blister may be added per side, which must:

- a. Exist entirely between  $X_R = -50$  and  $X_R = -600$ , below  $Z=550$  and inboard of  $Y=250$ .
- b. Lie entirely between the Rear Bodywork surfaces and a 50mm external offset of them.
- c. In side-view, lie entirely within an axis-aligned rectangle which is 350mm long and 120mm high.
- d. Intersect the Rear Bodywork surfaces around its entire periphery.
- e. Only comprise convex curvature, with a minimum radius of 20mm.
- f. At no point on its surface have a normal with a negative X component that subtends an angle greater than 20deg to an X plane.

Once the Bodywork Blister surfaces are fully defined, the Bodywork Blister and Rear Bodywork must be trimmed to each other, such that no overlapping surfaces remain. A fillet radius, no smaller than 20mm, must be applied along the intersection between these surfaces.

### 3.7.6 Apertures

Once the Rear Bodywork surfaces are fully defined in accordance with Articles 3.7.1 to 3.7.5, the following apertures may be added:

- a. For the purpose of allowing suspension members and their fairings and driveshafts to protrude through the bodywork and provided that the result of adding the aperture does not subvert the intention of regulation 3.7.4, a single aperture may be added for each suspension member and driveshaft. No such aperture may have an area greater than 12,000mm<sup>2</sup>. No point on an aperture may be more than 200mm from any other point on the aperture. Individual apertures may adjoin or overlap each other. At the legality ride height defined in Article 10.1.4, the aperture must enclose the suspension member, including its fairing, or driveshaft for parts forward of  $X_R = -55$ .
- b. For the sole purpose of allowing cooling flow exits, apertures may be added provided they lie within **RV-RBW-APERTURE**. The total area (per side of the car) of such apertures may be no greater than 150,000mm<sup>2</sup>. Furthermore, any apertures added must be arranged such that, when viewed from above, no part of **RS-RBW-APERTURE** may be visible through the aperture and any underlying part of the car exposed by application of an aperture must lie no further than 50mm normal to the untrimmed surface. For the avoidance of doubt, no part of the car exposed by application of an aperture may lie external to the untrimmed surface.
- c. For the sole purpose of allowing cooling flow exits, apertures may be added inboard of  $Y= 25$ . The total area of such apertures may not be greater than 30,000mm<sup>2</sup> per side of the car.
- d. For the sole purpose of cooling auxiliary components, (such as Electrical Components, etc.), apertures may be added forward of  $X_F=1300$  or below  $Z=100$ . The total area of such apertures may not exceed 5,000mm<sup>2</sup> per side of the car.

All areas mentioned in this Article will be measured on the untrimmed Rear Bodywork surface.

### 3.7.7 Rear Bodywork Group

Once the components defined in Articles 3.7.1 to 3.7.6 have been constructed in accordance to the provisions of those Articles, and any subsequent operation of sub-assembly described

within those Articles has been applied, the resulting union of these components is defined as “Rear Bodywork”.

### 3.7.8 Continuity

Once the Front and Rear Bodywork are fully defined, the external surfaces at the boundaries between adjacent sections of the Front Bodywork, Sidepod, Coke Panel, Engine Cover, and Bodywork Blister parts, must maintain continuity in any X, Y or Z plane.

Furthermore, the external surfaces at the boundaries between adjacent sections of the Sidepod, Coke Panel, Engine Cover, and Bodywork Blister parts, must also maintain tangency in any X, Y or Z plane.

## 3.8 Tail and Exhaust Tailpipe

### 3.8.1 Tail

Bodywork declared as “Tail” must:

- a. Lie within **RV-TAIL**.
- b. In any X-plane rearwards of  $X_R=440$ , contain only a single closed section, when considering both sides of the car.
- c. Not be visible from below forward of  $X_R=440$  and with the Floor Body present.

### 3.8.2 Exhaust Tailpipe

Bodywork declared as “Exhaust Tailpipe” must:

- a. Lie within the union of **RV-TAIL** and **RV-TAIL-EXH**.

Furthermore, when considering both sides of the car:

- b. Over its last 150mm, the Exhaust Tailpipe must comprise of a single tailpipe and its minimal supports.
- c. Over its last 450mm:
  - i. The turbine tailpipe through which all the turbine exit fluids pass must have a circular internal cross-section of a constant diameter between 100mm and 130mm.
  - ii. Any wastegate tailpipe(s) through which all the wastegate exit fluids pass must have an internal cross section less than  $1500\text{mm}^2$ , and all external surfaces must have minimal aerodynamic effect on the external air stream.
  - iii. The inside of the Exhaust Tailpipe must remain unobstructed and in full compliance with the provisions of this Article after the Final Assembly of all bodywork groups.

Minimal exceptions, solely for the purpose of permitting the wastegate tailpipe(s) to join the turbine tailpipe, are allowed over an axial length of up to 100mm and more than 150mm from the Exhaust Tailpipe exit.

- d. Over its last 150mm, the Exhaust Tailpipe must have an internal surface which is a right circular cylinder, with an axis that lies on  $Y=0$  and forms an angle between  $0\text{deg}$  and  $5\text{deg}$  to the X-axis (tail up).
- e. The Exhaust Tailpipe must have an exit whose entire circumference lies between  $X_R=550$  and  $X_R=565$  and above  $Z=350$ .
- f. The Exhaust Tailpipe must have a thin wall, of constant thickness, with the exception of minimal, external, local reinforcements.



### 3.9 Front Wing (FW)

#### 3.9.1 Front Wing Profiles

Bodywork declared as “Front Wing Profiles” must lie within **RV-FW-PROFILES**.

In any Y plane, the following conditions apply:

- a. There must be no more than four closed sections.
- b. No closed section may contain any concave radius of curvature less than 50mm
- c. The distance between adjacent sections must lie between 5mm and 15mm at their closest position.
- d. The rearmost point of every closed section must be visible when viewed from below.
- e. With the exception of the rearmost closed section, the rearmost point of every closed section must not be visible when viewed from above.
- f. Assessing each closed section independently, the part of any closed section visible when viewed from below may contain no concave radius of curvature.
- g. Within 40mm of the rearward-most point of each closed section a line tangent to any part of the section visible from below must have a positive slope. The slope of this line will be considered in the Y-plane.
- h. Within 40mm of the rearward-most point of each closed section, no part of the section visible from above may be more than 8mm distant from the section visible from below, if outboard of Y=500, or 15mm if inboard of Y=500.
- i. Inboard of Y=300, the forward-most two closed sections, must have a maximum thickness of at least 25mm when measured in the Z direction.

Furthermore, when considering the entire profiles, the following conditions apply:

- j. The normal to any point of the profiles surface must not subtend an angle greater than 25° to a vertical plane that is normal to **RS-FW-SECTION** for the forward most two profiles and 30° for any other profiles.
- k. The rearward most point of every closed section, when projected in Z on to the reference plane, must produce a single tangent continuous curve with no radius of curvature smaller than 200mm.
- l. The Front Wing Profiles must be arranged such that, when viewed from below, no part of **RS-FW-PROFILES** may be visible.

Once the Front Wing Profiles are fully defined Gurneys of up to 10mm may be fitted to the trailing edge of the upper surface of the rearmost section. These Gurneys are considered to be part of the Front Wing Profiles and must satisfy the provisions of this Article with the exception of sections (b) and (h) and, for the inner extremity of the innermost Gurney and outer extremity of the outermost Gurney, section (j).

#### 3.9.2 Front Wing Endplate Body

Bodywork declared as “Front Wing Endplate Body” must lie within **RV-FW-EP** and be constructed by the following process:

- a. A virtual surface must first be defined, which must:
  - i. Produce no more than one curve when intersected with any Z plane. At no point along this curve may a line tangent to it subtend an angle greater than 10° to the X-Axis.
  - ii. Produce no more than one curve when intersected with any X plane. At no point along this curve may a line tangent to it subtend an angle greater than 10° to the Z-Axis.
- b. Once the virtual surface has been defined, the Front Wing Endplate Body must:
  - i. Fully enclose the entire virtual surface.

- ii. Be no more than 10mm distant from the virtual surface at any point. Regions further than 150mm in X from its forward most point on the same Z-plane, must be no more than 6mm distant from the virtual surface at any point.
- c. Once fully defined, the Front Wing Endplate Body must be arranged such that when viewed from the side, no part of **RS-FWEP-BODY** may be visible.
- d. With the exception of regions of the Front Wing Endplate Body surface that are not in contact with the external air stream after the Front Wing Assembly is complete, its complete and final surface must be tangent continuous and any concave radius of curvature must be greater than 100mm.

### 3.9.3 Front Wing Tip

Bodywork declared as “Front Wing Tip” must:

- a. Lie within the RV-FW-TIP.
- b. Be a single volume with no apertures.

Furthermore:

- c. The following must apply to the intersection between regions of the Front Wing Tip below Z=170 and any plane that contains the X-aligned axis [Y,Z] = [900, 170]:
  - i. There must be no more than four closed sections.
  - ii. No closed section may contain any concave radius of curvature less than 20mm.
  - iii. The distance between adjacent sections must be no more than 15mm at their closest position.
  - iv. For any two adjacent sections, the trailing edge of the forward section must be at a greater distance from the X-aligned axis than the leading edge of the rear section.
  - v. When measured in the X-direction, each section must be larger than 50mm and no more than 30mm of this may overlap, in X, any other section in the same plane.
- d. The intersection between the Front Wing Tip and any Z plane between Z=170 and Z=180 must produce no more than four closed sections and above Z=180 must produce no more than one closed section.
- e. For any section described in (c) and (d), the forward-most point and the rearward-most point, measured in X, must each be situated between a pair of planes from a set defined as follows:
  - i. All planes must be vertical and oriented within the angular range defined by the acute angle between an X-plane and RS-FW-SECTION.
  - ii. Each pair must consist of two parallel planes no more than 35mm apart. This is except for the pairs whose intersection with RV-FW-TIP is furthest forward and furthest rearward, which must be no more than 50mm apart.
  - iii. The total number of pairs of planes must be equal to one plus the number of closed sections produced by the intersection of the FW Tip and the plane Y=900.
  - iv. No two planes may be coincident with each other and no part of RV-FW-TIP may lie within more than one of these pairs of planes.
- f. With the exception of regions of the Front Wing Tip surface that are not in contact with the external air stream as a result of assembly with the Front Wing Profiles and Front Wing Endplate, curves produced by the intersection of the Front Wing Tip with any X plane must:
  - i. Be tangent-continuous and not contain any radius less than 20mm.

- ii. Not contain any concave radius less than 1000mm if formed from any surface that is visible from the side or below. This is except for regions of the curve above Z=170, where a minimum concave radius of 200mm will be accepted.
- g. Compliance with (f) is not required in the following regions:
  - i. within 35mm of up to THREE “Junction Points”, which must lie above Z= 160, and not be closer than 50mm to each other. Surfaces exempt from (f) within these regions must lie above Z=150 and inboard of a 3mm external offset of the outboard face of the Front Wing Tip at Z=200 when viewed from above.
  - ii. within 10mm of the forward-most point of each individual closed section described in (c) and (d).
  - iii. within 3mm of the rearward-most point of each individual closed section described in (c) and (d), within 6mm if this section is the rearward-most section, and within 10mm for the rearward-most section if the point is above Z=170.

### 3.9.4 Front Wing Diveplane

Bodywork must be declared as “Front Wing Diveplane”, lie within **RV-FW-DP** and be constructed by the following process:

- a. A virtual surface must first be defined, which must:
  - i. Produce no more than one curve when intersected with any Y plane, the rearward most point of this curve must lie at least 75mm above its forwards most point.
  - ii. Produce no more than one curve when intersected with any X plane, at no point along this curve may a line tangent to it subtend an angle greater than 25° to the Y-Axis.
- b. Once the virtual surface has been defined, the Front Wing Diveplane must:
  - i. Fully enclose the entire virtual surface.
  - ii. Be no more than 6mm distant from the virtual surface at any point.
- c. Once fully defined, the Front Wing Diveplane must be arranged such that when viewed from above, no part of **RS-FW-DP** may be visible.
- d. Its complete and final surface must be tangent continuous and any concave radius of curvature must be greater than 50mm.

### 3.9.5 Front Wing Endplate

Once the Front Wing Diveplane and Front Wing Endplate Body are fully defined, the Front Wing Diveplane must be trimmed to the Front Wing Endplate Body to create one unified volume with no remaining overlapping surfaces. Any Front Wing Diveplane bodywork remaining inboard of the Front Wing Endplate Body must be discarded. A fillet radius, no greater than 10mm, may be applied along the intersection between these volumes. Furthermore, once the trim is complete:

- a. Any section of the unified volume taken through an X plane should contain only one closed section.
- b. When viewed from the car centre-plane, no part of the Front Wing Diveplane may be visible.
- c. In order to prevent tyre damage to other cars, the complete Front Wing Endplate must be at least 10mm thick (being the minimum distance when measured normal to the surface in any direction). When assessing this thickness, adjoining parts of the Front Wing Tip may also be considered. Furthermore, with the exception of parts of the Front Wing Endplate that lie on the shared boundary of RV-FW-EP and RV-FW-TIP a 5mm radius must be applied to all extremities.

### 3.9.6 Front Wing Assembly

Once the Front Wing Endplate, Front Wing Profiles and Front Wing Tip are fully defined, they must be trimmed to each other to create one unified volume with no remaining overlapping

surfaces. Furthermore, the external surfaces at the boundaries between adjacent sections of the Front Wing Endplate, Front Wing Profiles and Front Wing Tip, must maintain both continuity and tangency in any X, Y, or Z plane.

### 3.9.7 Adjustability of Front Wing

Once the Front Wing Assembly has been defined in accordance with Article 3.9.6, a continuous portion of either the rearmost or the two rearmost profiles (including any Gurney rigidly attached to it) may be adjustable for the sole purpose of trimming front wing aerodynamic load. This adjustable part of the Front Wing Profiles will be called the FW Flap.

The axis of rotation of the adjustable part of the wing must:

- a. Pass through points A and B where:
  - i. Point A lies within the volume of the FW Flap, no more than 25mm from its forward most point at this Y and between Y=200 and Y=400.
  - ii. Point B lies within the volume of FW Flap, no more than 25mm from its forward most point at this Y and between Y=825 and Y=850.
- b. Be no more than 70mm from the FW Flap at any point between points A and B.
- c. Once the axis of rotation AB has been defined, two surfaces of revolution must be defined. These surfaces must:
  - i. Have the axis AB as their axis of revolution, and respectively pass through points A (one surface) or B (the other surface).
  - ii. Extend over the complete chord of the FW Flap, thus clearly defining its boundaries in relation to the non-adjustable part of the Front Wing Profiles.
  - iii. Over their intersection with the FW Flap at its original design position (defined in accordance to Article 3.9.1), have a normal which does not subtend an angle greater than 30deg to the Y axis.

Furthermore:

- d. Compared to the original position of these profiles (as defined in accordance with Article 3.9.1), adjustment may only permit an increase of incidence of the slope defined in Article 3.9.1.g, and the maximum deviation for any point of these profiles from its original position must not exceed 40mm.
- e. Minimal exceptions to the geometrical criteria of Article 3.9.1 for the wing profiles may be made in the junction between the adjustable and non-adjustable parts, in order to ensure the necessary level of sealing. Such parts must lie within 3mm from one of the two surfaces of revolution and their maximum size must be the minimum necessary amount required to achieve a 20mm overlap between the adjustable and the non-adjustable parts of the profiles over the whole range of movement. In the case where the trailing edge of the rearmost element is trimmed, any such parts with minimal exceptions can remain untrimmed, provided that the remaining parts extend no more than 20mm behind the trimmed trailing edge.

For the avoidance of doubt, the adjustment permitted under this Article is only allowed when the car is stationary and by the use of a tool, and in accordance with the Sporting Regulations.

Furthermore, any such variation of incidence must maintain compliance with all of the bodywork regulations, with the exception of Article 3.9.1.

### 3.9.8 Front Wing Auxiliary Components

The following components will be permitted in addition to the Front Wing Assembly:

- a. Up to three brackets which define the pivot axis of the FW Flap and allow the necessary movement. Each bracket must:
  - i. be in ~~their~~ its entirety within 40mm of the FW Flap, per side of the car, over the whole range of adjustment.

- ii. be no more than 5mm thick and lie within two parallel planes no more than 10mm apart.
- iii. have no dimension that exceeds 80mm. Furthermore, when projected in X on to an X-plane, the area of each separator must be less than 750 mm<sup>2</sup>.

Once the above requirements have been met, a fillet radius no greater than 4mm will be permitted where these brackets join the two profiles.

- b. Up to eight slot gap separator brackets, per side of the car, which provide a structural connection between consecutive FW Profiles. Each bracket must:
  - i. be in ~~their~~ its entirety within 40mm of both of the two profiles ~~they that it~~ supports in relation to each other.
  - ii. be no more than 6mm thick and lie within two parallel planes no more than 10mm apart.
  - iii. have no dimension that exceeds 70mm. Furthermore, when projected in X on to an X-plane, the area of each separator must be less than 750 mm<sup>2</sup>.

Once the above requirements have been met, a fillet radius no greater than 4mm will be permitted where these brackets join the two profiles.

- c. A mechanism with or without a fairing to contain it for the angle adjustment of part of the FW Flap, as defined in Article 3.9.7. This mechanism and fairing must fit within a cuboid of which is 25mm wide, 60mm long and 65mm high. This cuboid may have a free orientation in space, but must intersect both the stationary and the adjustable part of the profiles for the entire range of adjustment.
- d. A fairing that contains a single tyre temperature sensor. The entire fairing and sensor must:
  - i. fit in the union between two volumes, a cuboid which is 15mm wide, 60mm long and 50mm high and a circular cylinder which has a base diameter of 30mm and a height of 60mm. The axis of the cylinder must coincide with the major axis of the one of the 15mm x 60mm faces of the cuboid.
  - ii. be symmetrical about a plane which is parallel to the 50mm x 60mm faces of the cuboid, and
  - iii. intersect either the Front Wing Profiles defined in Article 3.9.1 or the Front Wing Endplate Body defined in Article 3.9.2. A fillet radius no greater than 5mm will be permitted along this intersection.

Furthermore, all the components listed above must be arranged such that they are not visible from below and do not lie outboard of the virtual surface defined in 3.9.2.a.

Should there be a requirement for any additional component to be added, the Competitor must write specifically to the FIA with an explanation, design, and calculated aerodynamic effect, in order to get approval. Such a communication will be circulated to rival Competitors if deemed to cover a new aspect that had previously not been considered.

### 3.9.9 Front Wing Bodywork Group

Once the components defined in Articles 3.9.1 to 3.9.8 have been constructed in accordance to the provisions of those Articles, and any subsequent operation of sub-assembly described within those Articles has been applied, the resulting union of these components is defined as “Front Wing Bodywork”.

## 3.10 Rear Wing

### 3.10.1 Rear Wing Profiles

Bodywork declared as “Rear Wing Profiles” must:

- a. Lie within RV-RW-PROFILES.
- b. In any Y plane:

- i. Contain exactly two sections.
- ii. The rearmost section, which will be known as the “RW Flap”, must have a chord smaller than the chord of the adjacent section.
- iii. With the exception of minimal modifications to permit attachment of the actuator system described in 3.10.10 to the RW Flap, the sections may not contain any concave radius of curvature smaller than 100mm
- iv. The distance between the two sections must lie between 10mm and 15mm at their closest position.

Furthermore:

- c. Outboard of Y100, the normal to any point of the profiles surface must not subtend an angle greater than 20° to a Y plane.
- d. Once the RW Flap is fully defined, a Gurney of up to 20mm may be fitted to the trailing edge. This Gurney is considered to be part of the Rear Wing Profiles and must satisfy the provisions of this Article with the exception of sections b (iii) and (c).

### 3.10.2 Pylons

Bodywork declared as “Rear Wing Pylon” must:

- a. Lie within RV-RW-PYLON.
- b. On any Z plane, when considering both sides of the car, only contain no more than two closed symmetrical sections with a maximum total area of 5000mm<sup>2</sup>. This does not apply if the complete section lies within 30mm of the Exhaust Tailpipe defined in Article 3.8.2. For any complete closed section outside of RV-TAIL-EXH, the thickness of each section may not exceed 25mm when measured in the Y direction.

Once the Rear Wing Pylon and Rear Wing Profiles are fully defined the Rear Wing Pylon must be trimmed to the Rear Wing Profiles such that no overlapping surfaces remain. A fillet radius, up to 10mm, may be applied along the intersections between these surfaces.

### 3.10.3 Rear Wing Beam

Bodywork must be declared as “Rear Wing Beam” and must:

- a. Lie within RV-RW-BEAM.
- b. At no point be less than 10mm distant to the Exhaust Tailpipe once fully defined in accordance to Article 3.8.2.
- c. In any Y plane:
  - i. Contain no more than two sections.
  - ii. The section may not contain any concave radius of curvature smaller than 50mm

Furthermore:

- d. The Rear Wing Beam must be arranged such that when viewed from above no more than 80,000mm<sup>2</sup> of RS-RW-BEAM may be visible per side of the car.
- e. Outboard of Y=175, the normal at any point on the profiles’ surface must not subtend an angle greater than 15° to a Y plane. Inboard of Y=175mm, the normal at any point on the profiles surface must not subtend an angle greater than 60° to a Y plane.

Once the profiles have been fully defined:

- f. A Gurney of up to 20mm may be fitted to the trailing edge of the rearward most profile. This Gurney is considered to be part of the Rear Wing Beam and must satisfy the provisions of this Article with the exception of sections c (ii) and (e).
- g. Provided two closed sections are present as specified in (c), up to two slot gap separator brackets, per side of the car, will be permitted. These brackets must:
  - i. Be in their entirety within 30mm of both of the two profiles they support in relation to each other.

- ii. Be no more than 6mm thick. A fillet radius no greater than 2mm will be permitted where these brackets join the two profiles.
- iii. Have no dimension that exceeds 60mm
- iv. Not be visible from below with the Rear Wing Beam Profiles present

#### 3.10.4 Rear Wing Endplate Body

Bodywork declared as “Rear Wing Endplate Body” must:

- a. Lie within RV-RWEP-BODY.
- b. Be a single volume with no apertures.
- c. In any X or Z plane contain only one closed section. Furthermore, any such section, on any X or Z plane, must not contain an external concave radius of curvature smaller than 100mm.

#### 3.10.5 Rear Wing Tip

Bodywork declared as “Rear Wing Tip” must:

- a. Lie within the RV-RW-TIP.
- b. Be a single volume with no apertures.

Furthermore:

- c. The following must apply to the intersection between regions of the Rear Wing Tip above Z=670 and any plane that contains the X-aligned axis  $[Y, Z] = [480, 670]$ 
  - i. There must be no more than two closed sections.
  - ii. The distance between adjacent sections must be no more than 15mm at their closest position.
  - iii. When measured in the X-direction, each individual section must be larger than 100mm and no more than 40mm of the complete intersection may contain more than two points with the same X-coordinate.
- d. The intersection between the Rear Wing Tip and any Z plane between Z=660mm and Z=670mm must produce a single closed section.
- e. Its complete surface must be tangent continuous, and any concave radius of curvature must be greater than 20mm. Furthermore, any surface visible from the side or above must not contain any concave radius of curvature smaller than 50mm.
- f. Curves produced by the intersection of the Rear Wing Tip with any X plane must:
  - i. Be tangent continuous and not contain any radius less than 20mm forwards of  $X_R=550$ .
  - ii. Not contain any concave radius less than 1000mm if formed from any surface that is visible from the side or any surface forwards of  $X_R=550$  that is visible from above.

The sole purpose of the external surfaces of the Rear Wing Tip is to create a smooth transition, with no discontinuities, between the Rear Wing Profiles and the Rear Wing Endplate Body. Provided this purpose is observed, and the following are only used at the leading and trailing edges of the sections used to create this transition:

- g. Compliance with Section (f) of this Article is not required in the following regions of the Rear Wing Tip:
  - i. within 10mm of the forward-most point of each individual closed section described in (c) and (d).
  - ii. within 3mm of the rearward-most point of each individual closed section described in (c) and (d).

- h. Compliance with Sections (e) and (f) of this Article are not required in the following regions of the Rear Wing Tip:
  - i. Regions not in contact with the external air stream after the Rear Wing Assembly is complete.
  - ii. Within 30mm of a single "Junction Point". This Junction Point must lie above Z= 670.

### 3.10.6 Rear Wing Separators

Once the Rear Wing Profiles and the Rear Wing Tip are fully defined, the two closed sections described Articles 3.10.1.b and 3.10.5.c must be bridged by three pairs of rigid impervious supports. One pair of supports must be located at Y=0 with the remaining supports arranged symmetrically about the car centre plane and lying in their entirety between Y=+/-470 and Y=+/-490. These pairs of supports must be designed and arranged such that the two closed sections and the relationship between them can only change whilst the car is in motion in accordance to Article 3.10.10. They must:

- a. With the exception of minimal local changes where the two sections are adjacent to each other and with the rearmost element in the closed position, have an inner profile that is coincident to the section they are fixed to, an outer profile that is an offset of the inner profile of no more than 15mm and may not incorporate any radius smaller than 10mm in sideview ('gurney' type trim tabs may however be fitted between the supports).
- b. Be aligned as a pair so as to provide a bearing across at least 40mm<sup>2</sup> when the distance between the two sections is at its closest position.
- c. Not be recessed into the Rear Wing Profiles or Rear Wing Tip (where a recess is defined as a reduction in section at a rate greater than 45° with respect to the Y-axis).
- d. Be arranged so that any curvature occurs only in a horizontal plane (other than when this bodywork is adjusted in accordance with Article 3.10.10).
- e. Not be visible from below when the Rear Wing Profiles and Rear Wing Tip are present.
- f. Have no dimension that exceeds 150mm when considering the forward most part of the pair.
- g. Have no dimension that exceeds 30mm when considering the rearward most part of the pair.
- h. Be between 2mm and 6mm thick.
- i. Be rigidly fixed to their respective section. Where they are fixed, a fillet radius of no greater than 4mm will be permitted between the support and the Rear Wing Profiles or the Rear Wing Tip.
- j. Be constructed from a material with a modulus greater than 50 GPa.

### 3.10.7 Rear Wing Endplate

Once the Rear Wing Endplate Body and Rear Wing Tip are fully defined they must be joined to create one unified volume with no remaining overlapping surfaces. The resultant volume, known as the Rear Wing Endplate must be arranged such that, when viewed from the side of the car, no part of **RS-RW-RWEP**, may be visible. Furthermore, the external surfaces at the boundaries between adjacent sections of the Rear Wing Endplate Body and Rear Wing Tip must maintain both continuity and tangency in any X, Y or Z plane.

### 3.10.8 Continuity

Once the Rear Wing Endplate is fully defined, the external surfaces at the boundaries between adjacent sections of the Rear Wing Endplate, and Rear Wing Profiles must maintain both continuity and tangency in any X, Y or Z plane.



### 3.10.9 Rear Wing Beam Assembly

Once the Rear Wing Endplate and Rear Wing Beam are fully defined the Rear Wing Beam must be trimmed to the Rear Wing Endplate such that no overlapping surfaces remain. Any Rear Wing Beam bodywork remaining outboard of the Rear Wing Endplate must be discarded. A fillet radius, no greater than 10mm, may be applied along the intersections between these volumes. Furthermore, once the trim is complete, when viewed from the side, no part of the Rear Wing Beam may be visible.

### 3.10.10 Drag Reduction System (DRS)

The entire RW Flap described in Article 3.10.1, including any gurney if fitted, part of the rearward most section from any regions of the Rear Wing Tip described in Article 3.10.5 where there are exactly two sections in an intersection with any plane that contains the X-aligned axis  $[Y,Z]=[480, 670]$ , and the portions of the Rear Wing Separators defined in 3.10.6 that are attached to these components, may be rotated about a fixed axis whilst the car is in motion. All bodywork to be rotated shall be known as “DRS Bodywork”

Furthermore:

- a. No part of the “DRS Bodywork” may lie outboard of  $Y=490$ .
- b. The axis of rotation of the RW Flap must be fixed and located no more than 20mm below the upper extremity and no more than 20mm forward of the rear extremity of **RV-RW-PROFILES** at all times.
- c. There must be no relative movement between the constituent parts of the DRS Bodywork.
- d. Any such variation of incidence maintains compliance with all of the bodywork regulations with the exception of Article 3.10.1 and 3.10.5.
- e. It cannot be used to change the geometry of any duct, either directly or indirectly, other than the change to the distance between adjacent sections permitted by Article 3.10.1 and 3.10.5.
- f. The design is such that failure of the system will result in the uppermost closed section returning to the normal high incidence position.
- g. Any alteration of the incidence of the uppermost closed section may only be commanded by direct driver input and controlled using the control electronics specified in Article 8.3.
- h. At any Y plane, the distance between the two sections of the Rear Wing Profiles at their closest position must lie between 10mm and 85mm.

In order to achieve the above adjustment, the actuator mechanism and any associated minimal fairings must lie inboard of  $Y=25$ , below  $Z=940$  and not extend beyond **RV-RW-PROFILES** in the forward or rearward direction, when viewed from above. Furthermore, any additional minimal bodywork associated with the adjustment of the DRS Bodywork must be located outboard of  $Y= 465$  and in side-view be below the top surface of **RV-RW-PROFILES**, must not be visible from below and must fit within a cuboid which is 30mm wide, 60mm long and 30mm high. This cuboid may have a free orientation in space, but its width must be aligned with the axis of rotation of the RW flap.

### 3.10.11 Rear Wing Bodywork Group

Once the components defined in Articles 3.10.1 to 3.10.10 have been constructed in accordance to the provisions of those Articles, and any subsequent operation of sub-assembly described within those Articles has been applied, the resulting union of these components is defined as “Rear Wing Bodywork”.

## 3.11 Final Assembly

This Article gives additional information on the junction between adjacent bodywork groups defined in Articles 3.5 to 3.10.

### 3.11.1 Front Bodywork to Rear Bodywork

Once both the complete Front Bodywork and the Rear Bodywork are fully defined, the Front Bodywork and the Rear Bodywork must be trimmed to each other, such that no overlapping surfaces remain. A maximum fillet radius, no greater than 50mm, may be applied along the intersections between these surfaces.

### 3.11.2 Front and Rear Bodywork Assembly to Floor Bodywork

Once both the complete Front and Rear Bodywork assembly defined in Article 3.11.1 and the Floor Bodywork are fully defined, the Front and Rear Bodywork assembly and the Floor Bodywork must be trimmed to each other, such that no overlapping surfaces remain. Additionally, before the trimming is applied, any Mid Chassis or Rear Bodywork remaining below the Floor Bodywork must be discarded and the intersection formed by any remaining surfaces and the Floor Bodywork must produce no more than one curve. A maximum fillet radius, no greater than 50mm, may be applied along the intersection between these surfaces. Any such fillet must be at least 1mm distant from **RV-FLOOR-EDGE**. Furthermore, once all surfaces are trimmed and filleted, no part of the Mid Chassis, Rear Bodywork, fillet between the Rear Bodywork and the Floor Bodywork, or fillet between the Mid Chassis and the Floor Bodywork, may be visible from below.

Once the Front and Rear Bodywork has been assembled to the Floor Bodywork, up to two apertures may be added on each side of the car for the sole purpose of giving tyre temperature sensors visibility of the tyres, one for the front tyre and one for the rear tyre. If present, each individual aperture must have an area no greater than 1500mm<sup>2</sup> when measured on the assembled, untrimmed, surface.

### 3.11.3 Tail to Floor and Bodywork Assembly

Once both the complete Tail, and the Floor and Bodywork Assembly created in 3.11.2 are fully defined, the Tail, and the Floor and Bodywork Assembly must be trimmed to each other, such that no overlapping surfaces remain. A maximum fillet radius, no greater than 50mm, may be applied along the intersections between these surfaces.

### 3.11.4 Front Wing Bodywork to Nose

Once both the complete Front Wing Bodywork and the assembly referred to Article 3.11.2 are fully defined, the Front Wing Bodywork and the Nose must be trimmed to each other, such that no overlapping surfaces remain. A fillet radius, up to 25mm, may be applied along the intersections between these surfaces. Once all surfaces are trimmed and filleted, only Nose bodywork and fillet and no part of the Front Wing Bodywork may remain directly above **RS-CH-NOSE**.

### 3.11.5 Rear Wing Bodywork to Tail

Once both the complete Rear Wing Bodywork and the Tail are fully defined, the Rear Wing Bodywork and the Tail Bodywork must be trimmed to each other, such that no overlapping surfaces remain. A fillet radius, up to 10mm, may be applied along the intersections between these surfaces.

## 3.12 Bodywork not defined in Articles 3.5 to 3.11

In addition to the bodywork defined and regulated by Articles 3.5 to 3.11, the following components are permitted:

- 3.12.1 A transparent windscreen may be fixed to the forward face of the cockpit opening and may extend above **RV-CH-MID**.
- 3.12.2 Antennae and pitot tubes may be mounted on the upper surface of the survival cell ahead of the cockpit opening and may extend above **RV-BODY-FRONT**.
- 3.12.3 The following fairings may be attached to the secondary roll structure defined in Article 12.4.2, or the cameras defined in Articles 8.10.3 and 8.17.6:
  - a. A fairing bonded to the secondary roll structure, which:

- i. Must lie entirely within a 20mm offset from the secondary roll structure or high-speed camera, above  $Z=695\text{mm}$  and outside of **RV-COCKPIT-HELMET**.
    - ii. Must not have any part with a convex radius of less than 2mm
  - b. An additional fairing around the secondary roll structure forward mounting and the camera defined in Article 8.17.6, which:
    - i. Must lie in a volume defined by an axis-aligned cuboid, which has one interior diagonal defined by points  $[X_c = -1066, -25, 600]$  and  $[X_c = -835, 25, 705]$ .
    - ii. May be joined to the **Front Bodywork** with a fillet radius of no greater than 10mm.
- 3.12.4 Ducts (as specified in Article 3.1.1) and primary heat exchangers provided they are not visible when viewed from the outside of the car, at any angle perpendicular to the X-axis. This is assessed with the bodywork defined in Articles 3.5 to 3.11 present but prior to the application of apertures permitted in Articles 3.5.8, 3.6.1.f, and 3.7.6.
- 3.12.5 A slip sensor and its minimal fairings may be mounted underneath the Forward Chassis provided it lies entirely within 25mm of the car centre plane, above  $Z=120$  and in the region  $50 < X_f < 450$ . The external surface of the combined slip sensor and fairings must form a single curve when intersected by any Z plane.

### 3.13 Wheel bodywork

#### 3.13.1 General principles

Geometry declared as “Front Wheel Bodywork” and “Rear Wheel Bodywork” must comprise of all the components described in Articles 3.13.2 to 3.13.7.

When referred to individually, these components will have the words “Front” or “Rear” added to the component name.

Any criteria of visibility will assume that the sprung mass, the suspension, the RS-FWH-DRUM assembly, the drum to wheel seals and the complete wheels have been removed, and will be considered in the orthogonal frame of reference of the wheel ( $X_w, Y_w, Z_w$ ).

With the exception of the Wheel Covers and minimal flexible parts for the sole purpose of allowing an aerodynamic seal to be maintained to the suspension members and wheels, the Wheel Bodywork must:

- a. Be rigid and rigidly secured to the suspension uprights (rigidly secured means not having any degree of freedom).
- b. Not be rigidly secured to the suspension members.

#### 3.13.2 Drum

The Front and Rear Drums must be made respectively to the geometry defined by **RS-FWH-DRUM** and **RS-RWH-DRUM**.

For each drum, a circumferential, continuous (around an arc of  $360^\circ$ ), and uniform aerodynamic seal must be fitted in the outboard of the two annotated volumes, in order to prevent any significant aerodynamic or heat transfer flow between the drum and the axle.

An optional aerodynamic seal may be fitted in the inboard of the two annotated volumes between the drum and the wheel rim. If fitted, this seal must be circumferential, continuous (around an arc of  $360^\circ$ ), and uniform.

Notwithstanding this specification, the following modifications will be permitted inboard of  $Y_w = -5$ :

- a. Apertures where suspension members or suspension fairings intersect the surface of the Drum. These apertures must be minimal in size in order to permit the full articulation of the suspension system (and for the front, also the steering system). Furthermore, they must be internally sealed in such way so as to prevent any air flow from another aperture.

- b. Minor fixing details to permit the attachment of the Drum Deflectors described in Articles 3.13.5 and 3.13.6.
- c. An aperture contained within the periphery of the intersection between the Scoop defined in Article 3.13.3 and the Drum.
- d. Minor modifications to the front drum between  $Z_w=155$  and  $Z_w=230$ , providing these are for the sole purpose of permitting the outboard suspension to connect to the upright and do not protrude from the original surface into the external air stream.

### 3.13.3 Scoop

The Front and Rear Scoop must lie within **RV-FWH-SCO** and **RV-RWH-SCO** respectively.

Any part of the Scoop which is in contact with the external air stream must be tangent continuous and be fully visible when viewed parallel to the  $Y_w$  axis from inboard. These criteria will be assessed prior to the addition of apertures detailed in (c), (d) and (g).

Furthermore, with the exception of any Rear Scoop surfaces rearward of  $X_w=0$ , the Scoop must satisfy the following criteria:

- a. For the parts of the Scoop's surfaces that are visible when viewed parallel to the  $Y_w$  axis from inboard, the radius of curvature must be greater than 20mm.
- b. Any intersection with a  $Y_w$  plane must produce only, a single closed section for the Front Scoop, and a single section for the Rear Scoop.

Once the Front and Rear Scoop have been defined, they must be trimmed to RS-FWH-DRUM and RS-RWH-DRUM respectively, and a fillet radius no greater than 20mm may be applied at their boundaries.

Once the Front and Rear Scoops have been trimmed to their respective drums, the following apertures may be added:

- c. A single inlet aperture, with a periphery which:
  - i. Must lie within **RV-FWH-SCO** and **RV-RWH-SCO** respectively and may not be more than 200mm when measured in  $Z_w$ .
  - ii. Has no point more than 50mm from any other point on the periphery of the aperture when measured in  $X_w$  and has no point rearward of  $X_w = -100$ .
- d. A single outlet aperture, with a periphery which:
  - i. Must lie within **RV-FWH-SCO** and **RV-RWH-SCO** respectively be fully visible from the rear and must lie above  $Z_w = -50$ .
  - ii. For the Front Scoop, has no point more than 75mm from any other point on the periphery of the aperture when measured in  $X_w$  and has no point forward of  $X_w=100$ .
  - iii. For the Rear Scoop, has no point on the periphery of the aperture forward of  $X_w=100$

Once the Rear Scoop has been defined, trimmed to its drum, and the apertures permitted in c. and d. applied, the following geometry may be added:

- e. A single Rear Scoop Lip which must lie within **RV-RWH-LIP**. Furthermore:
  - i. Its complete surface must be tangent continuous and contain no more than a single section in any  $X_w$  plane.
  - ii. For the parts of the Rear Scoop Lip surface that are visible when viewed parallel to the  $Y_w$  axis from inboard, the radius of curvature must be greater than 20mm. This is with the exception of regions of its surface that are within 5mm of the boundary of the Rear Scoop Lip when viewed parallel to the  $Y_w$  axis from inboard.
  - iii. Once the Rear Scoop Lip has been fully defined, it must be trimmed to the Rear Scoop and Rear Drum, such that no overlapping surfaces remain, and a fillet radius of no greater than 25mm may be applied at their boundaries. Once the

fillet radius has been applied the external surfaces at the boundaries between adjacent sections of the Rear Scoop Lip and the Rear Scoop and Rear Drum must maintain tangent continuity in any  $X_w$ ,  $Y_w$  or  $Z_w$  plane

- f. Once the requirements of paragraph e) above have been satisfied, additional geometry may be added to the combined rear drum and scoop surfaces, for the sole purpose of protecting the scoop inlet from debris ingestion, providing this geometry satisfies the following criteria:
- i. its entire surface sits within either RV-RWH-LIP or RV-RWH-SCP
  - ii. before the bodies are trimmed to the Rear Scoop, Rear Lip or Rear Drum, the additional geometry must not contain any open sections in any  $X_w$ ,  $Y_w$  and  $Z_w$  planes
  - iii. on any  $Y_w$  plane, any individual closed section must have a cross-sectional area less than  $8\text{mm}^2$ , with the exception of a fillet radius of no larger than 5mm at the boundaries.

Once the Front and Rear Scoop have been defined, trimmed to their respective Drums, had the apertures permitted in c. and d. applied, and in the case of the Rear Wheel Bodywork, the Rear Scoop Lip has been fully defined and trimmed to the Rear Scoop and Rear Drum, the following additional apertures may be added:

- g. Apertures for suspension members or suspension fairings. These apertures must be minimal in size in order to permit the full articulation of the suspension system (and for the front, also the steering system). Furthermore, they must be internally sealed in such way so as to prevent any air flow from another aperture.

With the exception of minimal incidental leakage, all and only air entering the inlet aperture described in point (c), must exit out of the outlet aperture described in point (d). Furthermore, any flow line linking the inlet to the outlet must pass through a  $Y_w$  plane outboard of  $Y_w = -50$ , with the exception of ducts solely for cooling electrical components.

For clarity, apertures as referred to in this Article are considered to be mathematical surfaces that are coincident with the surfaces constructed in accordance with Article 3.13.3 and bound by their peripheries. Any criterion of visibility in this Article will consider these surfaces to be non-transparent.

#### 3.13.4 Internal Cooling Ducts

Any bodywork which is situated within the volume defined by the drum and the scoop will be considered to be part of the internal Cooling Ducts and be classed as LTC.

#### 3.13.5 Front Drum Deflector

The Front Drum Deflector must be made to the geometry defined by **RS-FWH-DEFL**.

In order to adapt the component of the Front Drum Deflector forward of  $X_w = -30$  to the local flow conditions, a  $\pm 6^\circ$  tolerance in its **incidence** will be accepted. Any such rotation must be made about a  $Z_w$ -aligned axis through the point [ $X_w = -260$ ,  $Y_w = -10$ ].

The parts of the permitted component above and below  $Z_w = -110$  may be adjusted as separate rigid bodies, by different amounts. To allow the parts of the resultant Front Drum Deflector to blend smoothly into one another, the angle of adjustment may vary within the regions between  $Z_w = -110$  and  $Z_w = -70$  and between  $Z_w = 110$  and  $Z_w = 150$ . Within each of these two regions, the angle of adjustment must vary monotonically along  $Z_w$ . The final surfaces must maintain both continuity and tangency across all boundaries of these regions. At  $Z_w = 150$  continuity and tangency must be maintained to the Front Drum.

Bodywork may be added to further adapt the Front Drum Deflector components. Any such bodywork must:

- a. Lie within one of the following volumes. Each volume is defined by a four-sided simple polygon with vertices at the following points on  $Y_w = 0$ , extruded along  $Y_w$  to the given value:
  - i. [ $X_w, Z_w$ ] = [-195, -130], [-195, -115], [-155, -115], [-155, -130], extruded to  $Y_w = 50$ .

- ii.  $[X_w, Z_w] = [-85, -182], [-85, -170], [-70, -170], [-70, -182]$ , extruded to  $Y_w=100$ .
- iii.  $[X_w, Z_w] = [27, -176], [41, -136], [81, -167], [77, -179]$ , extruded to  $Y_w=56$ .
- iv.  $[X_w, Z_w] = [79, -144], [88, -100], [135, -126], [132, -139]$ , extruded to  $Y_w=60$ .
- v.  $[X_w, Z_w] = [28, -189], [32, -145], [92, -153], [88, -193]$  extruded to  $Y_w=106$ , with regions outboard of  $Y_w=55$  removed.

Existing regions of the Front Drum Deflector within the volumes defined in (iii), (iv) and (v) may be trimmed away, provided that any new surfaces that result from the trim are not in contact with the external air stream once the added bodywork of this article is applied.

- b. Be solely for the purposes of adding flow aligned leading edges to the rearward component of the Front Drum Deflector, or adding flow aligned stays to the forward component.
- c. Not obscure any part of the Front Drum Deflector when viewed from the car centre plane. This applies only to bodywork within the volumes defined in (a.i) or (a.ii).
- d. In any  $Y_w$  plane:
  - i. Maintain both continuity and tangency to the remaining Front Drum Deflector surfaces. This does not apply to bodywork within the volumes defined in (a.i) and (a.ii).
  - ii. Contain no more than one closed section in each volume defined in (a).
  - iii. Have no part of the section visible from above that is more than 15mm distant from the section visible from below. This does not apply to bodywork within the volume defined in (a.v).
  - iv. Have an  $X_w$ -dimension of at least 30mm in each of the volumes defined in (a.iii), (a.iv) or (a.v), when combined with any remaining Front Deflector Surfaces within the same volume. This does not apply if the original geometry prior to the trimming permitted in (a) is below this minimum dimension.
  - v. Have an  $X_w$ -dimension no greater than 20mm. This applies only to bodywork within the volume defined in (a.i).

Once the added bodywork has been defined in accordance with this article, it is trimmed to RS-FWH-DRUM, the bodywork added in the volumes defined in (a.i) and (a.ii) is trimmed to Front Drum Deflector, and a fillet radius of no greater than 5mm may be added at the intersections between these surfaces. The resultant bodies are considered to be part of the Front Drum Deflector.

### 3.13.6 Rear Drum Deflector

The Rear Drum Deflector must be made to the geometry defined by RS-RWH-DEFL, with the exception of surfaces below the annotated curve "TRIM LINE" in RS-RWH-DEFL which may be trimmed. The part of the resulting trimmed Rear Drum Deflector below the annotated curve "SINGLE SECTION LINE" in RS-RWH-DEFL must produce only a single section when intersected with any  $Z_w$  or  $X_w$  plane.

In order to adapt the Rear Drum Deflector to the local flow conditions, a +/-10mm tolerance in its  $Z_w$  position and a +/-5° tolerance in its incidence about the annotated axis in **RS-RWH-DEFL** will be accepted. Any translation in  $Z_w$  includes the rotation axis and is applied before the rotation.

Once the Drum deflector has been positioned and adjusted in accordance with its specification, it must be trimmed to the Rear Drum and a maximum fillet radius, no greater than 5mm, may be applied along the intersections between these surfaces.

### 3.13.7 Wheel Cover

A single Wheel Cover per wheel, must be rigidly secured to the wheel rim such that it has the same rotational velocity as the wheel it is connected to and forms an aerodynamic seal to the

wheel rim. The outboard surface of the Wheel Cover must be made to the geometry defined by **RS-FWH-COV** for the front wheels and by **RS-RWH-COV** for the rear wheels.

The Wheel Covers are classed as SSC.

### 3.14 Suspension Fairings

**3.14.1** Suspension Fairings must be fitted to all suspension members defined in Article 10.3.6, with the exception of those of circular cross section.

Each suspension fairing must:

- a. Fully cover the suspension member it corresponds to and any other components supported on it, such as hydraulic brake lines, electrical wiring and wheel tethers (all of which must be supported on a suspension member), over the span exposed to the external air stream.
- b. Be rigid and rigidly secured to the suspension member (rigidly secured means not having any degree of freedom).

Minimal deformation will nonetheless be accepted for suspension conforming to Article 10.3.3. In such cases, any shared cover sections may deform or articulate a minimal amount to accommodate nominal misalignment of the relevant suspension members through the suspension travel range.

Furthermore, the surface bounded by the external cross-sections of each suspension fairing, when taken normal to the load line defined in Article 10.3.6 (a), must:

- c. Intersect the load line. With the exception of front suspension elements, locally, for the sole purpose of ensuring minimum clearance with the wheel rim at full steering lock.
- d. Have at least one axis of symmetry, of which the larger one will be called the “major axis”.
- e. Have no dimension which exceeds 100mm, or 150mm only where a single fairing per side is used to shroud the driveshaft in addition to a suspension member, ~~or which is more than 5mm larger than the major axis.~~
- f. Up to two suspension fairings per side may be trimmed to allow the passage of the driveshaft. In such cases, compliance with the remainder of this Article must be demonstrated before the strictly necessary removal of any fairing material related to the passage of the driveshaft.
- g. Have an aspect ratio no greater than 3.5:1, that being defined as the ratio of the major axis to the maximum thickness, measured in the direction normal to the major axis. **Furthermore, no dimension may be more than 5mm larger than the major axis.**
- h. Have an incidence (defined as the angle between the major axis and Z=0 with the car at its legality ride height, as defined in Article 10.1.4.) which lies within the following ranges:
  - i. For the Front Suspension Fairings, between 10° (nose down) and 0°
  - ii. For the Rear Suspension Fairings, between 10° (nose down) and -10° (nose up)

**3.14.2** Fairings of suspension members which share an attachment point will be considered by a virtual dissection into discrete components. Such fairings will be allowed local minimal exceptions to Article 3.14.1 (d), (g) and (h) close to the junction of the suspension members, including minimal cut outs to allow the passage of a suspension member connected inboard to the rockers defined in Article 10.4.1. After application of any such cut out, the resultant fairings must still seal the internal volume of the fairings from the external airstream.

**3.14.3** The angle between the normal to any point of the surface of a suspension fairing and a plane normal to the corresponding suspension member’s load line must not exceed 15deg. Legitimate exceptions to this constraint will be accepted close to the inner and outer

attachment points, or close to the junction between suspension members that share an attachment.

**3.14.4** In order to permit suspension travel while maintaining an aerodynamic seal, minimal flexible components may be fitted between the Suspension Fairings and the following components:

- a. The Front Bodywork defined in Article 3.6.
- b. The Tail Bodywork defined in Article 3.8.
- c. The Wheel Bodywork defined in Article 3.13.
- d. The gearbox case as defined in Article 9.1.7
- e. The suspension fairing covering the suspension member connected inboard to the rockers defined in Article 10.4.1.

With the car at its legality ride height, these flexible components must:

- f. Contain a fillet radius of up to 30mm between the components they are sealing.
- g. Other than the fillet radius described above, conform with the shape restrictions of either of the two components they are sealing to each other. For clarity, parts of these components may be replaced with the flexible component.
- h. Be designed in such way as to maintain their shape integrity with the car in motion, and as much as possible, with the suspension at another position than that of the Legality Ride Height.

Minimal exceptions to (f) and (g) are permitted between the Suspension Fairings and the Front Wheel Bodywork and between the Fairing of the Front Trackrod and the Front Bodywork. These exceptions are for the sole purpose of introducing a pleat into the flexible component to allow steering articulation without compromising the structural integrity of the flexible component. With the suspension at the Legality Ride Height and wheels in the straight-ahead position, these pleats must be internal to the volume bound by the fillet radius referred to in (f) above.

## **3.15 Aerodynamic Component Flexibility**

### **3.15.1 Introduction of load/deflection tests**

In order to ensure that the requirements of Article 3.2.2 are respected, the FIA reserves the right to introduce further load/deflection tests on any part of the bodywork which appears to be (or is suspected of), moving whilst the car is in motion.

### **3.15.2 Load/deflection linearity**

All load deflection tests must have a nominally linear elastic relationship unless otherwise stated.

### **3.15.3 Rear Wing Skins**

The skins of the rear wing elements may deflect no more than 2mm when a 60N force is applied to the skin normal to and away from the element.

The force will be applied using a vacuum cup of 50mm diameter and the deflection will be measured at the outer diameter of the cup.

### **3.15.4 Front Wing Bodywork Flexibility**

The flexibility of **Front Wing Bodywork** will be tested by applying a load of [0, 0, -1000]N at points  $[X_F, Y, Z] = [-800, \pm 800, 250]$  or  $[-1000, \pm 800, 250]$ .

The load will be applied in a downward direction using a 50mm diameter ram on a rectangular adaptor measuring 350mm in the X-direction and 150mm in the Y-direction. This adaptor must be supplied by the team and should:

- a. Have a flat top surface without recesses.



- b. Be fitted to the car so as to apply the full load to the bodywork at the test point and not to increase the rigidity of the parts being tested.
- c. Be placed with the inner face 725mm from  $Y=0$ .
- d. Be placed with its forward face at  $X_F=-1100$ mm.
- e. Be placed with its top face at  $Z=250$
- f. Have a mass of no more than 2kg.

The deflection will be measured relative to the survival cell and along the loading axis.

When the load is applied symmetrically to both sides of the car the vertical deflection must be no more than 15mm.

When the load is applied to only one side of the car the vertical deflection must be no more than 20mm.

### 3.15.5 Front Wing Flap Flexibility

Any part of the trailing edge of any front wing flap may deflect no more than 5mm, when measured along the loading axis, when a 60N point load is applied normal to the flap.

### 3.15.6 Front Floor Flexibility

Bodywork flexibility will be tested by applying a load vertically upwards using a 50mm diameter pad with a gimbed interface to the loadcell. The position of the centre of the pad will be given by the FIA and will be on the underside of the plank within a quadrilateral area, with vertices at points  $[X_F=460, 50]$ ,  $[X_F=610, 65]$ ,  $[X_F=610, -65]$ ,  $[X_F=460, -50]$ . The deflection will be measured along the loading axis.

At all times during the test, the load at a given deflection must exceed the load given by a straight-line graph defined by connecting the following coordinates in order: (0 mm, 0 N) (1 mm, 0 N) (5 mm, 4000N) (25mm, 6000N). This must be the case whether the deflection is increasing, decreasing, or held constant. The test will have no more than a maximum load of 8000N or a maximum deflection of 15mm (whichever is reached first) unless specifically requested by the FIA to investigate behaviour above these limits.

The load deflection relationship must be strictly monotonic with both increasing and decreasing deflection.

### 3.15.7 Outboard Floor Flexibility

- a. Bodywork may deflect no more than 5mm vertically when a  $[0, 0, -500]$ N load is applied to it at a position chosen by the Competitor, between  $X_R=-450$  and  $X_R=-500$ , and  $Y=\pm 450$ . The load will be applied using a 50mm diameter ram and an adaptor of the same size. Teams must supply the latter when such a test is deemed necessary.
- b. Bodywork may deflect no more than 20mm vertically when a  $[0, 0, 500]$ N load is applied to it at points  $[X_R, Y]$   $[-450, \pm 600]$  or  $[-1300, \pm 670]$ . The load will be applied using a 50mm diameter ram and an adaptor of the same size in an upwards or downwards direction. Teams must supply the latter when such a test is deemed necessary.
- c. The outboard edge of the **Floor Bodywork Group** may deflect no more than 8mm in Z at any point between  $X_R = -1260$  and  $X_R = -350$  when a distributed load of  $[0, 0, -600]$ N is applied to each side of the car.

The load will be applied simultaneously at 6 points on each side of the car, nominally at:  $[X_R, Y] = [-480, 652.2]$ ,  $[-635, 686.3]$ ,  $[-790, 714.4]$ ,  $[-945, 736.7]$ ,  $[-1100, 753.3]$ , and  $[-1255, 764.2]$ . A 2mm tolerance on position will be permitted for manufacturing reasons.

When viewed from above, and with the **Floor Bodywork Group** as fully defined in Article 3.5.6 in place, nothing other than the bodywork may be visible within 15mm of any load application point. A load application point that does not meet this requirement may be moved, in X and/or in Y, by the minimum amount necessary to comply. The FIA may require load points to be moved if, in their view, the load location or the floor

shape has been specifically designed to permit greater levels of outboard floor flexibility in untested regions of the floor.

Once the load application positions are fully defined, Teams must provide a suitable means of applying the load to the upper surface of the bodywork. The load will be applied through a rod of diameter 2.3mm. Details of this arrangement are provided in the appendix to the Technical and Sporting Regulations. The contact of any load-spreader with the bodywork must lie within a cylinder of diameter 25mm, coaxial with the load application axis. If the Team's preferred method requires through-holes, these holes must be sealed on either or both of the upper and lower surfaces at all times the car is on the circuit and during any assessment of any visibility from above around load application points.

Loads will be applied to these rods in two stages:

- i.  $[0, 0, -50]$ N to each load application point to give 300N per side.
- ii.  $[0, 0, -100]$ N to each load application point to give 600N per side.

Deflection will be measured by laser scanning of the bodywork at each loading stage.

### 3.15.8 Central Floor Flexibility

- a. Bodywork within RV-PLANK may deflect no more than 2mm at the two holes in the plank at  $X_F=1080$  and no more than 2mm at the rearmost hole, when the car, without driver, is supported at these positions. The car will be supported on 70mm diameter pads, centred on the holes, and only in contact with the underside of the plank assembly. The displacement will be measured at the supports, relative to the reference plane at the centre of each hole.

Furthermore, the stiffness for any deflection exceeding that defined in the previous paragraph must be no less than 15kN/mm.

Competitors will be required to demonstrate the local vertical stiffness and design installation of the skids and plank to the FIA for the regions around the periphery of each of these three holes. Compliance with Article 3.5.9.e. will only be assessed in the regions that are at least 90% as stiff as the stiffest part of the periphery. Any designs intended to protect these regions of the periphery from wear will not be accepted.

Competitors will be required to demonstrate compliance with these provisions by way of a detailed inspection of both the CAD and the physical installation, as well as Finite Element analysis.

- b. Bodywork on the reference plane may deflect no more than 0.2mm when the car, without driver, is supported at the two holes in the plank at  $X_F=1080$  and at the rearmost hole in the plank. The car will be supported on 40mm diameter pads, centred on the holes, and only contacting the bodywork on the reference plane. For the two holes at  $X_F=1080$  the displacement will be measured at the supports, relative to the survival cell datum points detailed in Article 3.2.6. For the rearmost hole the displacement will be measured at the support, relative to the power unit at the uppermost transmission mounting studs detailed in Article 5.4.8.

### 3.15.9 Rear Wing Mainplane Flexibility

- a. Bodywork may not deflect more than 6mm along the loading axis and  $1.0^\circ$  in a Y-plane, when two loads of  $[0, 0, -1000]$ N each, are applied simultaneously to the Rear Wing Profiles. The loads will be applied at  $[X_R=375, \pm 300, 910]$
- b. Bodywork may not deflect more than 6mm along the loading axis and  $1.0^\circ$  in a Y-plane, when two loads of  $[324, 0, -940]$ N each, are applied simultaneously to the Rear Wing Profiles. The loads will be applied at  $[X_R=325, \pm 300, 900]$

The loads in (a) and (b) will be applied through adaptors, supplied by the team, that lie between 250mm and 350mm from  $Y=0$  and between  $X_R=90$  and at least  $X_R=500$ . The upper surface each adaptor must lie at  $Z=910$  and should have a counterbore of 52mm diameter for the application of the load in (b).

The deflection will be measured on the rear wing profiles, at  $[X_R, Y]$   $[350, \pm 150]$ , and  $[350, \pm 450]$  and relative to the Rear Impact Structure. Teams must provide four pads to support tracking targets. Details of the targets is given in the Appendix to the Technical and Sporting Regulations.

The tests defined in this article may be performed with the RW Flap removed. In such cases the permitted deflections will be 25% higher than those defined in (a) and (b).

#### **3.15.10 Rear Wing Flap Flexibility**

The RW Flap may deflect no more than 7mm horizontally when a 500N load is applied horizontally. The load will be applied in the plane  $Z=875$  at one of three separate points which lie within 50mm of the car centre plane and 270mm either side of it. The loads will be applied in a rearward direction using a suitable 25mm wide adaptor which must be supplied by the relevant team.

The deflection will be measured along the loading axis and relative to the forward part of the Rear Wing Mainplane at the same Y-station.

#### **3.15.11 Rear Wing Mainplane Trailing Edge**

The forward-most aerofoil element of Rear Wing Profiles may deflect no more than 3mm along the line of load application, when a 200N load is applied normal to the lower surface. The load will be applied in line with the trailing edge of the element at  $Y=0$ ,  $Y=\pm 125$ , or at  $Y=\pm 375$ .

The deflection will be measured relative to the forward part of the Rear Wing Mainplane at the same Y-station.

The loads will be applied using a suitable adaptor, supplied by the relevant team, which:

- i. May be no more than 50mm wide.
- ii. Which extends no more than 10mm forward of the trailing edge.
- iii. Incorporates an 8mm female thread in the underside.

#### **3.15.12 Beam Wing Flexibility**

No element within RV-RW-BEAM may deflect more than 3mm when a load of 150N is applied to its trailing edge, normal to the lower surface of the element. Two loads of 150N will be applied simultaneously at  $Y=270$  and  $Y=-270$  and 5mm forward (measured along the lower surface) of the local trailing edge.

The deflection will be measured along the line of load application, relative to the Rear Impact Structure.

The loads will be applied using adaptors, no more than 60mm wide, supplied by the relevant team. These adaptors must conform to the specification given in the Appendix to the Technical and Sporting Regulations.

#### **3.15.13 Rear Wing Endplate Flexibility**

The endplates described in article 3.10.4 may deflect no more than 10mm, when measured along the loading axis, when a 50N point load is applied in an inward direction normal to the car centre plane using a spherical 15mm diameter tip at  $[X_R, Z] = [635, 585]$ . For this measurement, the contribution of the rigid-body rotation of the whole wing assembly will be removed.

#### **3.15.14 Front Drum Flexibility**

Bodywork defined by RS-FWH-DRUM may deflect no more than 5mm, vertically, when a 60N load is applied vertically downwards at  $[X_W=0, Y_W=-100, Z_W=425]$ . The load will be applied using an adaptor provided by the FIA.

#### **3.15.15 Rear Wing Slot Gap Deflection**

With the hydraulic system active and the DRS deployed, a spherical gauge must not pass through the gap between the two elements within RV-RW-Profiles. The gauge will have a diameter of 85mm  $+0.00 / -0.05$ mm and a load of 10N will be applied during the test.

### 3.15.16 Additional Diagnostics

To allow the behaviour of the Rear Wing to be monitored using the onboard cameras, contrasting markers must be applied to bodywork within RV-RW-PROFILES and within RV-RW-BEAM. Details of these markers and their positions are given in the Appendix to the Technical and Sporting Regulations.

## 3.16 Aerodynamic Component construction

The components outlined below must be constructed to prescribed laminates. Details of these laminates can be found in Article 15.6.2.

### 3.16.1 Front Wing Endplate

The bodywork declared as **Front Wing Endplate** in Article 3.9.5 must be made to the laminate **PL-ANTI-SPLINTER**.

Fasteners and related inserts, for the purpose of attaching the front wing endplate to the profiles must be positioned at least 30mm rearward of the leading edge of the endplate.

### 3.16.2 Suspension Fairings

Suspension Fairings as defined in Article 3.14 must be made to the laminate **PL-SUS-FAIRING**.

### 3.16.3 The secondary roll structure fairings, defined in Article 3.12.3, must be made to the laminate **PL-HALO**.

## ARTICLE 4: MASS

### 4.1 Minimum mass

The mass of the car, without fuel, must not be less than ~~796kg~~ 798kg at all times during the Competition.

If, when required for checking, a car is not already fitted with dry-weather tyres, its mass will be determined using a set of dry-weather tyres selected by the FIA technical delegate.

### 4.2 Mass distribution

With the car resting on a horizontal plane the mass measured at the front and rear axles must not be less than the mass specified in Article 4.1 factored by ~~0.445~~ 0.446 and ~~0.540~~ 0.539 respectively at all times during the qualifying practice session. Rounding will be to nearest 0.5kg.

If, when required for checking, a car is not already fitted with dry-weather tyres, its mass will be determined using a set of dry-weather tyres selected by the FIA technical delegate.

### 4.3 Mass of tyres

The mass limit specified in Article 4.1 and the factors specified in Article 4.2 will be adjusted up or down according to any differences (rounded to the nearest 1kg for Article 4.1) between the total set and individual axle set mass respectively of the dry-weather tyres used in the Championship taking place in the calendar year referred to in the title and the preceding year's Championship.

### 4.4 Ballast

Ballast can be used provided it is secured in such a way that tools are required for its removal and that it remains immobile with respect to the sprung mass in its entirety. It must be possible to fix seals if deemed necessary by the FIA technical delegate.

Ballast designated for the sole purpose of achieving the driver mass specified in Article 4.6.2 must :

- a. Be entirely located to the car between the front and rear extent of the cockpit entry template.
- b. Be attached securely to the survival cell and sealed by the FIA.
- c. Be clearly identified.
- d. Have a density greater than 8000Kg/m<sup>3</sup>.

A nominal such mass of 10kg should be present for the impact test described in Article 13.2.

### 4.5 Adding during the race or sprint session

With the exception of compressed gases, no substance may be added to the car during the race or sprint session. If it becomes necessary to replace any part of the car during the race or sprint session, the mass of the new part must not be more than that of the original part.

### 4.6 Mass of the driver

4.6.1 The mass of the driver with his seat and driving equipment will be established by the FIA technical delegate at the first Competition of the Championship, this reference mass may be amended at any time during the Championship season if deemed necessary by the FIA technical delegate. This reference mass will be used to establish the minimum mass of the driver and ballast referred to in Article 4.6.2 below.

4.6.2 The reference mass of the driver will be added to the mass of any ballast designated for this purpose and at no time during the Competition, may this be less than 80kg.

## ARTICLE 5: POWER UNIT

### 5.1 Definitions

#### 5.1.1 Power train

The power unit and associated torque transmission systems, up to but not including the drive shafts.

#### 5.1.2 Power unit (PU)

The internal combustion engine and turbocharger, complete with its ancillaries, any energy recovery system and all actuation systems and PU-Control electronics necessary to make them function at all times.

#### 5.1.3 Engine (ICE)

The internal combustion engine including ancillaries and actuator systems necessary for its proper function.

#### 5.1.4 Turbocharger (TC)

The assembly of a compressor used for pressure charging of the engine, a turbine connected to the engine exhaust system used to drive the compressor, the drive system between the compressor and the turbine and their respective housings and bearings.

#### 5.1.5 Energy Recovery System (ERS)

A system that is designed to recover energy from the car, store that energy and make it available to propel the car and, optionally, to drive any ancillaries and actuation systems necessary for its proper function.

#### 5.1.6 Motor Generator Unit - Kinetic (MGU-K)

The Kinetic Motor Generator Unit is the electrical machine mechanically linked to the drive train as part of the ERS.

#### 5.1.7 Motor Generator Unit - Heat (MGU-H)

The Heat Motor Generator Unit is the electrical machine linked to the exhaust turbine of a pressure charging system as part of the ERS.

#### 5.1.8 Energy Store (ES)

The part of ERS that stores energy, including its safety control electronics and a minimal housing.

#### 5.1.9 Engine cubic capacity

The volume swept in the cylinders of the engine by the movement of the pistons. This volume shall be expressed in cubic centimetres. In calculating engine cubic capacity, the number Pi shall be 3.1416.

#### 5.1.10 Combustion chamber

An enclosed space in the engine cylinder controlled by the opening and closing of the poppet valves in which combustion takes place.

#### 5.1.11 In-cylinder pressure sensor

A sensor whose function is to measure the pressure in the combustion chamber.

#### 5.1.12 Fuel injector

Any device or component that delivers fuel into an oxidiser.

#### 5.1.13 High pressure Fuel pump

A mechanical device whose sole function is to pressurise the fuel to the pressure required for the high-pressure injection. It may be electronically controlled.

#### **5.1.14 Fuel Flow meter**

A sensor whose function is to measure the flow of the fuel passing through it.

#### **5.1.15 Ignition Coil**

Assembly including an induction coil that supplies the high voltage to the spark plug.

#### **5.1.16 Ancillaries**

A component whose function is to support the primary activities of a main system to allow it to operate.

#### **5.1.17 Pressure charging**

Increasing the weight of the charge of the fuel/air mixture in the combustion chamber (over the weight induced by normal atmospheric pressure, ram effect and dynamic effects in the intake and/or exhaust system) by any means whatsoever. The injection of fuel under pressure is not considered to be pressure charging.

#### **5.1.18 Compressor inlet**

A component containing a duct of closed cross section through which all air destined for combustion enters any compressor; the duct must extend upstream of any part of any variable geometry device permitted by Article 5.10.

#### **5.1.19 Compressor outlet**

One or more components each of them containing a duct of closed cross section through which all air destined for combustion exits the compressor.

#### **5.1.20 Engine Plenum**

A pressurised vessel upstream of the combustion chamber containing air destined for combustion. This vessel (or vessels) may be comprised of several components. Pipes, as generally understood, conveying air from the compressor to the engine are not part of the engine plenum.

#### **5.1.21 ES cells**

The elementary part of the ES that produces and stores electricity through electro-chemical reactions.

#### **5.1.22 DC-DC Converter**

An electronic circuit or electromechanical device, only capable of consuming energy, that converts a source of direct current (DC) from one voltage level to another for use by the electrical and electronic components of the car and power unit.

#### **5.1.23 Auxiliary Oil Tank (AOT)**

An Auxiliary Oil Tank (AOT) is a singular vessel connected to the engine whose sole function is to hold engine oil for the replenishment of the engine lubrication system.

#### **5.1.24 Power Unit Control Electronics (PU-CE)**

Any component used to control Power Unit sub-systems and containing programmable semiconductors or high power switching devices.

It includes, but is not limited to, MGU-K control unit (CU-K), MGU-H control unit (CU-H), injector control unit, ignition control unit, DC-DC.

It excludes any FIA Standard ECU, FIA sensors and ES safety control electronics.

#### **5.1.25 Engine exhaust system**

Assembly of parts conveying the engine exhaust fluids from the cylinder head up to but not including the turbine and/or wastegate. It does not include the turbine or wastegate exit tail-pipe(s). A set comprises left and right assemblies.

#### **5.1.26 ES main enclosure**

External structure that encloses at least the elements listed in Article 5.13.6 and allows their installation inside of the survival cell. It may be composed of elements rigidly linked to form a continuous closed volume.

#### **5.1.27 Battery management system (BMS)**

The BMS is a set of important safety systems of the ES. It must detect internal faults and must trigger power reduction delivered from/to the battery or shutdown the ERS if the BMS considers that the ES is operating unsafely.

#### **5.1.28 High Voltage**

Classification of an electrical component or circuit whose maximum working voltage is  $> 30$  V AC rms or  $> 60$  V DC.

#### **5.1.29 Hazardous electric shock**

Physiological reaction generated by an electrical current greater than 2mA passing through the human body.

#### **5.1.30 Car main ground**

The electrical reference potential of all conductive parts of the car, typically located on the ICE block.

#### **5.1.31 Exposed conductive part**

Conductive part of the electric equipment, which can be touched by a test finger according to IP2X and which is not normally live, but which may become live under single fault conditions.

#### **5.1.32 Live part**

Conductive part which belongs to a high voltage component or circuit in normal use and which has an insulation resistance lower than  $100\Omega/V_{DC}$  and  $500\Omega/V_{AC}$ .

#### **5.1.33 Basic insulation**

Insulation applied to live parts which provides protection against hazardous electric shock in case of contact.

#### **5.1.34 Supplementary insulation**

Independent insulation applied in addition to basic insulation for protection against hazardous electric shock in the event of a failure.

#### **5.1.35 Double insulation**

Insulation comprising both basic insulation and supplementary insulation. Double insulation is composed of two layers of insulators with two different failure modes. Those two layers can be tested separately.

#### **5.1.36 Reinforced insulation**

Insulation of hazardous-live-parts which provides a degree of protection against electric shock equivalent to double insulation.

#### **5.1.37 Maximum working voltage**

Highest value of AC peak-to-peak voltage or of DC voltage that can occur under any normal operating conditions according to the manufacturer's specifications, disregarding residual variation of the DC voltage shorter than  $100\mu s$ .

#### **5.1.38 Valve Stem**

The valve stem is the part of the component that slides within the valve guide during operation.

#### **5.1.39 Wastegate**

A device used to release exhaust fluids from the complete exhaust system, anywhere downstream of the exhaust valves and upstream of the turbine wheel.



#### 5.1.40 Pop-Off Valve

A device used to release and recirculate air from the engine inlet system, anywhere downstream of the compressor wheel and upstream of the inlet valves.

### 5.2 Engine specification

5.2.1 Only 4-stroke engines with reciprocating pistons are permitted.

5.2.2 Engine cubic capacity must be 1600cc (+0/-10cc).

5.2.3 Fuel mass flow must not exceed 100kg/h.

5.2.4 Below 10500rpm the fuel mass flow must not exceed  $Q \text{ (kg/h)} = 0.009 N(\text{rpm}) + 5.5$ .

5.2.5 At partial load, the fuel mass flow must not exceed the limit curve defined below:

-  $Q \text{ (kg/h)} = 10$  when the engine power is below -50kW

-  $Q \text{ (kg/h)} = 0.257 \times \text{engine power (kW)} + 22.85$  when the engine power is above -50kW

5.2.6 Pressure charging may only be effected by the use of a sole single stage compressor with a single Inlet linked to a sole single stage exhaust turbine by a shaft assembly parallel to the engine crankshaft and inboard of  $Y=25$ . The shaft must be designed so as to ensure that the shaft assembly, the compressor and the turbine always rotate about a common axis and at the same angular velocity, an electrical motor generator (MGU-H) may be directly coupled to it. The shaft may not be mechanically linked to any other device. Only parts approved by the FIA Technical Department may be used. The approval of the FIA Technical Department is conditional upon the PU manufacturer, intending to use such parts during a Championship season undertaking not to conclude any exclusivity agreement for the supply of such parts with the supplier of these parts. The approval request form must be sent by the PU Manufacturer to the FIA before the 1<sup>st</sup> of November of the preceding year.

Shall be treated as an exclusivity agreement, any agreement concluded between the supplier of such parts (including any PU manufacturer) and any PU Manufacturer, which has the purpose and/or the effect of restricting the possibility for such a supplier:

- a. to consider any request from another PU Manufacturer; and/or
- b. to supply, under reasonable commercial conditions, a part meeting the applicant's specifications.

5.2.7 All engines must have six cylinders arranged in a 90° "V" configuration and the normal section of each cylinder must be circular.

All six cylinders must be of equal capacity.

5.2.8 Engines must have two inlet and two exhaust valves per cylinder.

Only reciprocating poppet valves with axial displacement are permitted.

The sealing interface between the moving valve component and the stationary engine component must be circular.

5.2.9 Engine exhaust gases may only exit the cylinder head through outlets outboard of the cylinder bore centre line and not from within the "V" centre.

5.2.10 The crankshaft may only have three connecting rod bearing journals.

5.2.11 An insert within a PU component is a non-dismountable part whose function is solely to locally support a function of this component. The total volume of inserts within the component cannot be more than 10% of the total volume of the component.

5.2.12 All power unit breather fluids may only vent to atmosphere and must pass through a single orifice which is positioned behind  $X_R=0$ , inboard of  $Y=100$  and below  $Z=400$ . No breather fluids may re-enter the power unit.

5.2.13 With the exception of incidental leakage through joints (either into or out of the system) all and only the air entering the compressor inlet must enter the combustion chambers.

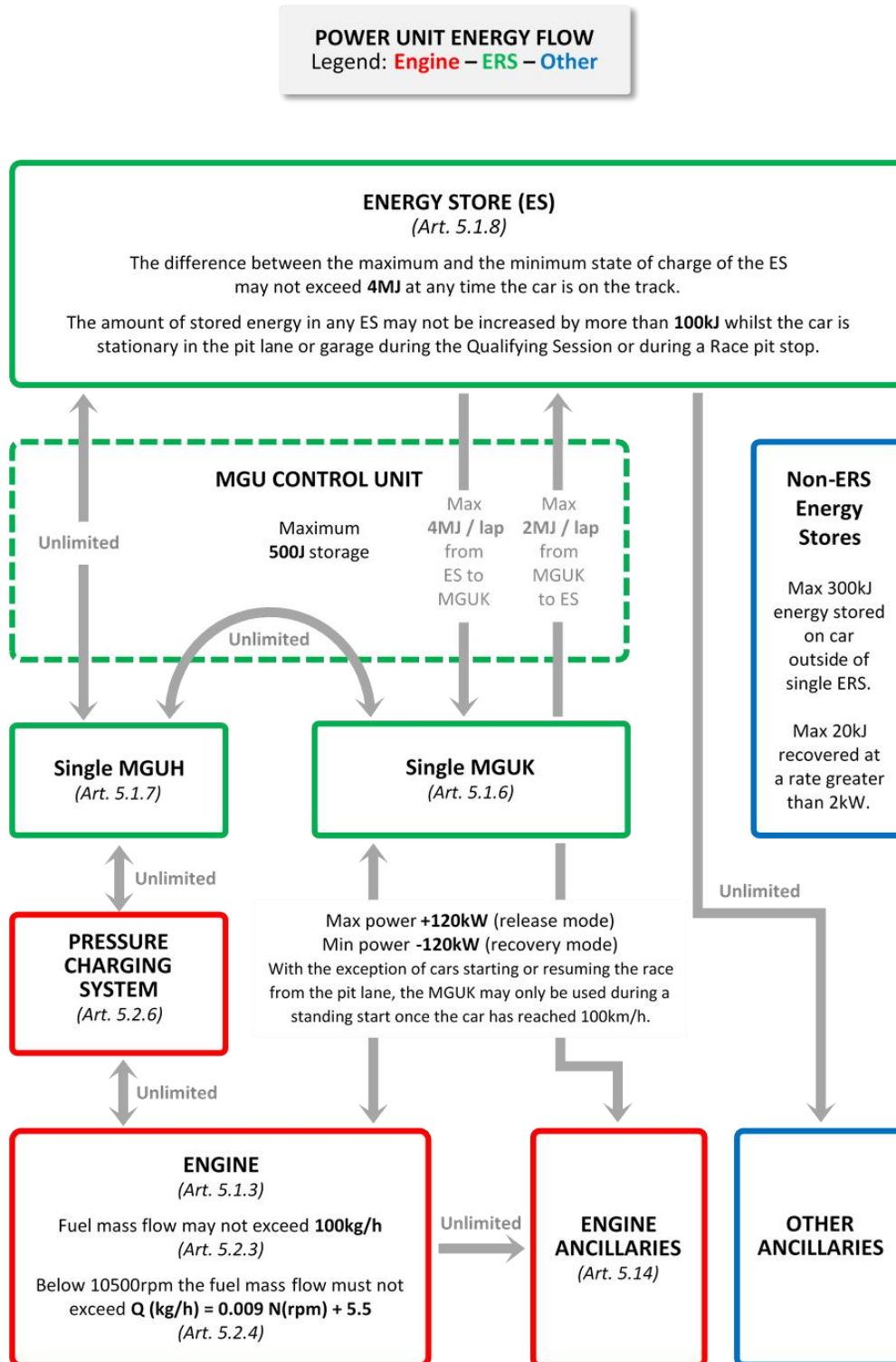
5.2.14 The power unit may be equipped with a maximum of two wastegates and two pop-off valves.

5.2.15 Engine oil consumption must never exceed 0.30l/100km in normal operating conditions.

### 5.3 Other means of propulsion and energy recovery

5.3.1 The use of any device, other than the engine described in 5.2 above, and one MGU-K, to propel the car, is not permitted.

5.3.2 Energy flows, power and ES state of charge limits are defined in the energy flow diagram shown below:



When the car is on the track a lap will be measured on each successive crossing of the timing line, however, when entering the pits the lap will end, and the next one will begin, at the start of the pit lane (as defined in the Sporting Regulations).

In order to verify that the energy and power requirements are being respected, all cars must be fitted with electrical DC sensors which have been manufactured and calibrated by the FIA designated suppliers to specifications determined by the FIA. These sensors may only be installed outside the sealed perimeter of any PU-CE and used as specified below:

- a. One sensor must be connected to the ES negative DC pole to measure all electrical energy into and out of the energy store.  
The voltage sense wire must be connected to the dedicated measurement point on the ES positive DC pole sensor.  
The sensor data will be made available to the Competitor.
- b. One sensor must be connected to the ES positive DC pole.  
The voltage sense wire must be connected to the dedicated measurement point on the ES negative DC pole sensor.  
The sensor data will be available to the FIA only.
- c. One sensor must be connected to the CU-K positive DC pole to measure all electrical energy into and out of the MGU-K  
The voltage sense wire must be connected to the dedicated measurement point on the CU-K negative DC pole sensor.  
The sensor data will be made available to the Competitor.
- d. One sensor must be connected to the CU-K negative DC pole.  
The voltage sense wire must be connected to the dedicated measurement point on the CU-K positive DC pole sensor.  
The sensor data will be available to the FIA only.
- e. For CU-K designs with more than two DC poles, sensors must be connected to each additional DC pole.  
The voltage sense wire must be connected to a dedicated measurement point on the CU-K positive or negative DC pole sensor.  
The sensors data will be available to the FIA only.
- f. One sensor must be connected to the CU-H negative DC pole to measure all electrical energy into and out of the MGU-H.  
The sensor data will be made available to the Competitor.
- g. One sensor must be connected to the DC-DC converter positive DC pole to measure all electrical energy consumed by the DC-DC converter.  
The sensor data will be made available to the Competitor.

Electrical energy may not flow between consumers without being directly measured by one or more of the sensors previously listed. This must be guaranteed by design and verifiable by inspection.

The design of the ERS and the installation of the electrical DC sensors must be approved by the FIA. ~~A preliminary technical dossier must be submitted to the FIA before 31<sup>st</sup> March 2021.~~

A fixed efficiency correction of 0.95 will be used to monitor the maximum MGU-K power.

- 5.3.3** The MGU-K must be solely and permanently mechanically linked to the powertrain before the main clutch. This mechanical link must be of fixed speed ratio to the engine crankshaft. An in-line, passive, dissipative energy torque limitation device may be incorporated in this link which temporarily allows the speed ratio to change for the sole purpose of protecting the

components from dynamic torque overshoots. This device may only act above 220Nm when referred to crankshaft speed.

The rotational speed of the MGU-K may not exceed 50,000rpm.

The mass of the MGU-K (as defined in line 12 of Appendix 3 to these regulations) may not be less than 7kg.

The power of the MGU-K may not exceed 120 kW. The maximum torque of the MGU-K may not exceed 200Nm. The torque will be referenced to the crankshaft speed and the fixed efficiency correction defined in Article 5.3.2 will be used to monitor the maximum MGU-K power and torque.

The laminate thickness of the MGU-K may not be less than 0.05mm.

The MGU-K must be fitted with a torque sensor which has been manufactured and calibrated by a FIA designated supplier to a specification determined by the FIA. The installation of the MGU-K torque sensor must be approved by the FIA.

- 5.3.4 The MGU-H must be solely mechanically linked to the pressure charging system. This mechanical link must be of fixed speed ratio to the exhaust turbine.

The rotational speed of the MGU-H may not exceed 125,000rpm.

The mass of the MGU-H (as defined in line 14 of Appendix 3 to these regulations) may not be less than 4kg.

- 5.3.5 Cars must be fitted with homologated sensors which provide all necessary signals to the FIA data logger in order to verify the requirements above are being respected.

- 5.3.6 Only cells approved by the FIA Technical Department may be used in the ES. The approval of the FIA Technical Department is conditional upon the PU manufacturer, intending to use such parts during a Championship season undertaking not to conclude any exclusivity agreement for the supply of such parts with the supplier of these parts. The approval request form must be sent by the PU Manufacturer to the FIA before the 1st of November of the preceding year.

Shall be treated as an exclusivity agreement, any agreement concluded between the supplier of such parts (including any PU manufacturer) and any PU Manufacturer, which has the purpose and/or the effect of restricting the possibility for such a supplier:

- a. to consider any request from another PU Manufacturer; and/or
- b. to supply, under reasonable commercial conditions, a part meeting the applicant's specifications.

- 5.3.7 Any non-ERS energy storage and components supplied by it will be considered an ancillary and subject to Article 5.14.1.

## 5.4 Power unit dimensions

- 5.4.1 Cylinder bore diameter must be 80mm (+/- 0.1mm).

- 5.4.2 The crankshaft centre line must lie at Y=0 and Z=90 (+/-0.5mm) and be parallel to the X axis. The power unit may only transmit torque to the gearbox by means of a single output shaft that must be co-axial with the crankshaft. The output shaft must rotate clockwise when viewed from the front of the car.

- 5.4.3 Valve stem diameter must not be less than 4.95mm.

- 5.4.4 The crankshaft main bearing journal diameter (measured on the crankshaft) must not be less than 43.95mm.

- 5.4.5 The crankshaft crank pin bearing journal diameter (measured on the crankshaft) must not be less than 37.95mm.

- 5.4.6 No cylinder of the engine may have a geometric compression ratio higher than 18.0.
- 5.4.7 All elements of the power unit specified in the relevant column of the table in Appendix 3 of these regulations must be installed in the union of the two following volumes
- the volume between two X planes at  $X_{PU}=0$  and  $X_{PU}=700$ .
  - the volume between two X planes at  $X_{PU}= -150$  and  $X_{PU}=0$ , inboard of  $Y=125$  and below  $Z=800$ .
- 5.4.8 Power unit mountings may only comprise six M12 studs for connection to the survival cell and either four or six M12 studs for connection to the transmission. These studs may be fitted on the survival cell, power unit or transmission, their installed end must be M12 and their free end may be a different diameter. Every stud must have a tensile strength greater than 100kN.

The six mounting faces of the studs for connection to the survival cell must lie at  $[X_{PU}, Y, Z]=[0, \pm 215, 15]$ ,  $[0, \pm 340, 260]$  and  $[0, \pm 175, 420]$ . All six of these studs must be used.

Four mounting faces of the studs for connection to the transmission must lie at  $[X_{PU}, Y, Z]=[480, \pm 100, 15]$  and  $[480, \pm 255, 345]$ . All four of these studs must be used. Optionally, an additional two studs may be used, provided their coordinates are at  $[X_{PU}, Y, Z]=[480, \pm 150, 140]$

A tolerance of +/- 0.2mm will be permitted on all of the above dimensions, all dimensions refer to the centre of the studs. All dimensions in this Article refer to studs fitted symmetrically about the car centre plane.

Any part which provides an additional load path from the survival cell to the gearbox, with a connection to the power unit, may only do so if this is incidental to its principal purpose.

## 5.5 Mass and centre of gravity

- 5.5.1 The overall mass of the power unit must be a minimum of 151kg.
- 5.5.2 The centre of gravity of the power unit must be above  $Z=200$ .
- 5.5.3 The total mass of the part of the ES that stores energy, i.e. the cells (including any clamping plates) and electrical connections between cells, must be no less than 20kg and must not exceed 25kg.
- 5.5.4 The mass of a piston (with piston-pin, piston-pin retainers and piston rings) may not be less than 300g.
- 5.5.5 The mass of a connecting rod (with fasteners, small and big end bearings) may not be less than 300g.
- 5.5.6 The mass of the complete crankshaft assembly between the mid positions of the front and rear main bearing journals (including balance masses, bolts, bungs, O-rings between the boundaries), may not be less than 5300g. See drawing 1 in Appendix 2.
- 5.5.7 When establishing conformity with Articles 5.5.1, 5.5.2 and Appendix 4 of these Regulations, the homologated power unit perimeter will be defined in accordance with the table shown in Appendix 3 of these regulations.

## 5.6 Power unit torque demand

- 5.6.1 The only means by which the driver may control acceleration torque to the driven wheels is via a single foot (accelerator) pedal mounted inside the survival cell.
- 5.6.2 Designs which allow specific points along the accelerator pedal travel range to be identified by the driver or assist him to hold a position are not permitted.
- 5.6.3 At any given engine speed the driver torque demand map must be monotonically increasing for an increase in accelerator pedal position.
- 5.6.4 At any given accelerator pedal position and above 4,000rpm, the driver torque demand map must not have a gradient of less than – (minus) 0.045Nm/rpm.

## 5.7 Power unit control

- 5.7.1 The maximum delay allowed, computed from the respective signals as recorded by the FIA ADR or FIA Standard ECU, between the accelerator pedal position input signal and the corresponding output demands being achieved is 50ms.
- 5.7.2 Teams may be required to demonstrate the accuracy of the power unit configurations used by the FIA Standard ECU.
- 5.7.3 Power unit control must not be influenced by clutch position, movement or operation.
- 5.7.4 The idle speed control target may not exceed 4,000rpm.
- 5.7.5 A number of power unit protections are available in the FIA Standard ECU.  
A minimum of nine seconds hold time should be configured for the power unit protections enabled during qualifying and race or sprint session. The configuration of the air tray fire detection and throttle failsafe are exceptionally unrestricted in order to allow each team to achieve the best level of safety.
- 5.7.6 The power unit must achieve the torque demanded by the FIA standard software.
- 5.7.7 In order to measure the torque generated by the power unit the following sensors must be fitted:
- Each driveshaft must be fitted with an homologated torque measurement system which has been approved by the FIA.
  - The power unit output shaft must be fitted with a torque sensor which has been manufactured and calibrated by an FIA designated supplier to a specification determined by the FIA.

The installation and the connectivity of each of these torque sensors to the FIA Standard ECU must be approved by the FIA.

- 5.7.8 Engine plenum air temperature must be more than ten degrees centigrade above ambient temperature. When assessing compliance, the temperature of the air will be the lap average recorded, by an FIA approved and sealed sensor located in an FIA approved location situated in the engine plenum, during every lap of the qualifying practice session and the race or sprint session. The first lap of the race or sprint session, laps carried out whilst the safety car is deployed, laps with a time at least 20% greater than the fastest lap of the session, pit in and out laps and any laps that are obvious anomalies (as judged by the technical delegate) will not be used to assess the average temperature. The ambient temperature will be that recorded by the FIA appointed weather service provider. This information will also be displayed on the timing monitors.

## 5.8 Engine high rev limits

Engine high rev limits may vary for differing conditions provided all are contained within a band of 750rpm. However, a lower rev limit may be used when:

- The gearbox is in neutral or in reverse.
- Stall prevention is active.
- The driver clutch request is greater than 95% of the total available travel of the driver clutch actuation device, used only to protect the engine following a driver error.
- An engine protection is active.
- The bite point finder strategy is active.
- The safety car is deployed or during the formation lap.

Except for the above conditions, power unit actuators may not be used to artificially control the power unit speed or alter the power unit response in a rev range more than 750rpm below the final rev limit.

## 5.9 Exhaust fluids

- 5.9.1 With the exception of incidental leakage through joints (either into or out of the system) and power unit breather fluids, all and only the fluids entering the compressor inlet and fuel injectors must exit from the engine exhaust system.
- 5.9.2 All turbine exit and all wastegate exhaust fluids must pass through the “tailpipe” defined in Article 3.8.2.b.
- 5.9.3 The total fluid mass flow passing through the exhaust tailpipe defined in Article 3.8.2.b may only exceed 1000kg/h when the sum of the intake air demand and the quantity of fuel injected exceeds this value, “intake air demand” being the intake air mass flow strictly necessary for the combustion to achieve the torque demand under the specified conditions.

## 5.10 Variable geometry systems

- 5.10.1 With the exception of devices needed for control of pressure charging systems, variable geometry exhaust systems are not permitted. No form of variable geometry turbine (VGT) or variable nozzle turbine (VNT) or any device to adjust the gas throat section at the inlet to the turbine wheel is permitted.
- 5.10.2 Variable valve timing and variable valve lift profile systems are not permitted.

## 5.11 Fuel systems

- 5.11.1 The pressure of the fuel supplied to the fuel injectors may not exceed 500barG.
- 5.11.2 There may only be one fuel injector per cylinder and no fuel injectors are permitted upstream of the intake valves or downstream of the exhaust valves. Only parts approved by the FIA Technical Department may be used. The approval of the FIA Technical Department is conditional upon a fuel injector with the same body being available on a non-exclusive basis and under normal commercial terms to all Competitors. The approval request form must be sent by the injector supplier to the FIA before the 1<sup>st</sup> of November of the preceding year.
- 5.11.3 All cars must be fitted with two fuel flow meters, wholly within the fuel tank, which have been manufactured and calibrated by the FIA designated suppliers to specifications determined by the FIA. These sensors may only be installed and used as specified by the FIA Technical Department. Furthermore, all fuel delivered to the power unit must pass through these homologated sensors, and must all be delivered to the combustion chambers by the fuel injectors described by Article 5.11.2.
- 5.11.4 Homologated sensors which directly measure the pressure and temperature of the fuel supplied to the fuel injectors must also be fitted, these signals must be supplied to the FIA data logger.
- 5.11.5 Any device, system or procedure the purpose and/or effect of which is to increase the flow rate or to store and recycle fuel after the measurement point is prohibited. Additional measurements in each sub-circuit of the fuel system may be requested in order to check compliance. When fuel flow rate is above 90 kg/h, fuel pressures must remain constant in each sub-circuit.
- 5.11.6 All cars must be fitted with a high pressure fuel pump which has been manufactured by the single supplier appointed by the FIA World Motor Sport Council to a specification determined by the FIA Technical Department.
- 5.11.7 A maximum of 0.25 litres of fuel may be kept outside the survival cell, but only that which is necessary for the normal running of the engine.

## 5.12 Ignition systems

- 5.12.1 Ignition is only permitted by means of a single ignition coil and single spark plug per cylinder. No more than five sparks per cylinder per engine cycle are permitted.  
The use of plasma, laser or other high frequency ignition techniques is forbidden.

Only ignition coils approved by the FIA Technical Department may be used. The approval of the FIA Technical Department is conditional upon such ignition coil being available on a non-exclusive basis and under normal commercial terms to all Competitors. The approval request form must be sent by the ignition coil supplier to the FIA before the 1<sup>st</sup> of November of the preceding year.

- 5.12.2** Only conventional spark plugs that function by high tension electrical discharge across an exposed gap are permitted.

Spark plugs are not subject to the materials restrictions described in Articles 5.17 and 5.18.

### **5.13 Energy Recovery System (ERS)**

- 5.13.1** The system will be considered shut down when no high voltage can be present on any external or accessible part of the ERS, or across any capacitor belonging to the MGU control units.

It must be possible to shut down the ERS via the following means :

- a. The switch required by Article 8.8.1.
- b. The switches required by Article 8.8.2.
- c. The switch or button required by Article 9.4.

The shutdown process must take no longer than two seconds from activation and must be started immediately when the electrical circuits to the ignition are cut off by any of the means described in articles 8.8.1 and 8.8.2.

- 5.13.2** The ERS must shut down when the FIA Standard ECU initiates an anti-stall engine shut off.

- 5.13.3** All cars must be fitted with two ERS status lights which:

- a. Have been supplied by an FIA designated manufacturer and fitted to the car in accordance with the instructions in the Appendix to the Technical and Sporting Regulations.
- b. Are in working order throughout the Competition even if the main hydraulic, pneumatic or electrical systems on the car have failed.
- c. Remain powered for at least 15 minutes if the car comes to rest with its engine stopped.
- d. Are marked with a "HIGH VOLTAGE" symbol according to ISO3864 of at least 30mm along the triangle side and no more than 50mm away from the lights.

- 5.13.4** All cars must provide signals regarding the car operating and insulation states to the FIA ADR in order to facilitate control of the ERS status lights.

- 5.13.5** The maximum working voltage on the car must never exceed 1000V.

- 5.13.6** The following elements of the power unit must be installed wholly within the survival cell:

- a. ES elements as defined in lines 16 and 17 of Appendix 3 to these regulations.
- b. Any DC-DC converter connected to ES HV DC bus. Includes active parts, enclosure, brackets and supports.
- c. CU-K. Includes active parts, enclosure, brackets and supports.
- d. CU-H. Includes active parts, enclosure, brackets and supports.
- e. HV DC connections between ES and CU-K/CU-H/DC-DC converter. Includes all conductors, insulation, EMC screening, mechanical and thermal shielding.

The minimum values of volume and mass for these groups of components are 22.0 l and 31.0 kg respectively. The procedure which will be used to determine these values may be found in the Appendix to the Technical and Sporting Regulations.



## 5.14 Engine ancillaries

- 5.14.1 Unless specified otherwise, ancillaries may be mechanically or electrically driven. Any electrically driven ancillary cannot be linked mechanically to any drivetrain, including the Power Unit. Ancillaries cannot be used to propel the car.

With the exception of batteries of less than 100 kJ total capacity used for safety and control purposes during ERS start-up and shut-down operations, which must be prevented from supplying energy under normal ERS operation; electrical energy may not flow from any ancillary in the direction of any DC pole of the ERS high voltage DC bus. This must be guaranteed by design and verifiable by inspection.

A diode must be fitted, in series, at the DC-DC converter positive pole to ensure that electrical energy cannot flow from the DC-DC converter into the ES.

- 5.14.2 All fuel pumps delivering more than 10barG, coolant pumps, oil pumps, scavenge pumps, oil/air separators and hydraulic pumps must be mechanically driven directly from the engine and/or MGU-K with a fixed speed ratio.
- 5.14.3 Any pressure sensor used to measure pressure of any fluid necessary to ensure the power unit functions correctly at all times (including but not limited to coolant, oil, fuel and air) must be manufactured by the single supplier appointed by the FIA World Motor Sport Council to a specification determined by the FIA Technical Department. Cylinder pressure sensors are excluded from this requirement.
- 5.14.4 With the exception of exhaust temperature sensors and temperature sensors embedded in electronic boxes, any temperature sensor used to measure temperature of any fluid necessary to ensure the power unit functions correctly at all times (including but not limited to coolant, oil, fuel and air) must be manufactured by the single supplier appointed by the FIA World Motor Sport Council to a specification determined by the FIA Technical Department.
- 5.14.5 Only cylinder pressure sensors approved by the FIA Technical Department may be used. The approval of the FIA Technical Department is conditional upon such sensor being available on a non-exclusive basis and under normal commercial terms to all Competitors. The approval request form must be sent by the sensor supplier to the FIA before the 1<sup>st</sup> of November of the preceding year.

## 5.15 Engine intake air

- 5.15.1 With the exception of incidental leakage through joints or cooling ducts in the inlet system (either into or out of the system), all air entering the engine must enter the bodywork through a maximum of two inlets which are located on a single X plane between  $X_C = -850$  and  $X_R = -500$  and above  $Z = 200$ .

Furthermore, any such inlets must be visible in their entirety when viewed from the front of the car without the driver seated in the car and with the secondary roll structure and any parts attached to it removed (see Article 12.4.2).

- 5.15.2 The addition of any substance other than fuel, as described in Article 5.11.3, into the air destined for combustion is forbidden. Exhaust gas recirculation is forbidden.

## 5.16 Materials and Construction – Definitions

- 5.16.1 X Based Alloy (e.g. Ni based alloy) – X must be the most abundant element in the alloy on a %w/w basis. The minimum possible weight percent of the element X must always be greater than the maximum possible of each of the other individual elements present in the alloy.
- 5.16.2 X-Y Based Alloy (e.g. Al-Cu based alloy) – X must be the most abundant element as in Article 5.16.1 above. In addition element Y must be the second highest constituent (%w/w), after X in the alloy. The mean content of Y and all other alloying elements must be used to determine the second highest alloying element (Y).
- 5.16.3 Intermetallic Materials (e.g. TiAl, NiAl, FeAl, Cu<sub>3</sub>Au, NiCo) – These are materials where the material is based upon intermetallic phases, i.e. the matrix of the material consists of greater than 50%v/v intermetallic phase(s). An intermetallic phase is a solid solution between two or

more metals exhibiting either partly ionic or covalent, or metallic bonding with a long range order, in a narrow range of composition around the stoichiometric proportion.

- 5.16.4 Composite Materials – These are materials where a matrix material is reinforced by either a continuous or discontinuous phase. The matrix can be metallic, ceramic, polymeric or glass based. The reinforcement can be present as long fibres (fibre length greater than 13mm) or short fibres, whiskers and particles (discontinuous reinforcement). Nanoscale reinforced materials are to be considered as composites. (a reinforcement is considered to be nanoscale if any dimension of the reinforcement is less than 100nm.)
- 5.16.5 Metal Matrix Composites (MMC's) – These are composite materials with a metallic matrix containing a minimum ratio of 0.5% volume/volume of other ceramic, metallic, carbon or intermetallic phase which is not soluble in the liquid phase at 100°C above the melting point of the metallic matrix.
- 5.16.6 Ceramic Materials (e.g. Al<sub>2</sub>O<sub>3</sub>, SiC, B<sub>4</sub>C, Ti<sub>5</sub>Si<sub>3</sub>, SiO<sub>2</sub>, Si<sub>3</sub>N<sub>4</sub>) – These are inorganic, non-metallic solids.
- 5.16.7 Nanomaterials – These are purposely created objects that have one or more dimensions (e.g. length, width, height, diameter) which is less than 100nm. (1nm = 1 x 10<sup>-9</sup> metres.)

## 5.17 Materials and construction – General

- 5.17.1 Unless explicitly permitted for a specific application, the following materials may not be used on the power unit:
  - a. Magnesium based alloys.
  - b. Metal Matrix Composites (MMC's) containing more than 2.0% volume/volume of other ceramic, metallic, carbon or intermetallic phase which is not soluble in the liquid phase at 100°C above the melting point of the metallic matrix.
  - c. Intermetallic materials.
  - d. Alloys containing more than 5% by weight of Platinum, Ruthenium, Iridium or Rhenium.
  - e. Copper based alloys containing more than 2.75% Beryllium.
  - f. Any other alloy class containing more than 0.25% Beryllium.
  - g. Tungsten base alloys.
  - h. Ceramics and ceramic matrix composites.
  - i. Aluminium based alloys containing more than 2.5 weight % Lithium.
  - j. Materials containing nanomaterials.
  - k. Thermal insulation containing unbound nanomaterials.
- 5.17.2 Unless explicitly permitted otherwise for a specific application, only material approved by the FIA Technical Department may be used on the power unit. The approval of the FIA Technical Department is conditional upon the material concerned being available on a non-exclusive basis and under normal commercial terms to all Competitors. This does not apply to materials that have been present on a F1 PU homologated in 2018. The approval request form must be sent by the PU Manufacturer to the FIA before the 1<sup>st</sup> of November of the preceding year.
- 5.17.3 The restrictions in Article 5.17.1 do not apply to coatings provided the total coating thickness does not exceed 25% of the section thickness of the underlying base material in all axes. In all cases, other than under Article 5.17.4(b), the relevant coating must not exceed 0.8mm.  
  
Where the coating is based on Gold, Platinum, Ruthenium, Iridium or Rhenium, the coating thickness must not exceed 0.035mm.
- 5.17.4 The restrictions in Article 5.17.1(h) do not apply to the following applications :
  - a. Any component whose primary purpose is for electrical or thermal insulation.
  - b. Any coating whose primary purpose is for thermal insulation of the outside of the exhaust system.

- 5.17.5 Magnesium based alloys, where permitted, must be available on a non-exclusive basis and under normal commercial terms to all Competitors. Only those alloys covered by ISO16220 or ISO3116 and approved by the FIA may be used.
- 5.17.6 The restrictions in article 5.17.1 b do not apply to TiB<sub>2</sub> grain refinement of aluminium-copper based materials. TiB<sub>2</sub> additions for the purpose of grain refinement are permitted up to a maximum of 5% v/v.

## 5.18 Materials and construction – Components

- 5.18.1 Pistons must respect Article 5.17. Titanium alloys are not permitted.
- 5.18.2 Piston pins must be manufactured from an iron based alloy and must be machined from a single piece of material.
- 5.18.3 Connecting rods must be manufactured from iron or titanium based alloys and must be machined from a single piece of material with no welded or joined assemblies (other than a bolted big end cap or an interfered small end bush).
- 5.18.4 Crankshafts must be manufactured from an iron based alloy.  
No welding is permitted between the front and rear main bearing journals.  
No material with a density exceeding 18,400 kg/m<sup>3</sup> may be assembled to the crankshaft.  
These parts assembled to the crankshaft may be manufactured in a Tungsten based material.
- 5.18.5 Camshafts must be manufactured from an iron based alloy.  
Each camshaft and lobes must be machined from a single piece of material.  
No welding is allowed between the front and rear bearing journals.
- 5.18.6 Valves must be manufactured from intermetallic materials or from alloys based on Iron, Nickel, Cobalt or Titanium. Hollow valves (e.g. sodium, or similar, filled for cooling) are permitted, but the main cavity created must be a cylindrical feature of constant diameter. Machined features to facilitate manufacture and assembly are allowed above and below the main cavity, however such features must not create a volume that extends beyond a virtual plain cylinder positioned on the valve centreline with a diameter which is 1.0 mm greater than that of the main cavity.  
  
In addition, the restrictions detailed in Articles 5.17.3 and 15.1.2 do not apply to valves.
- 5.18.7 Reciprocating and rotating components:
- Reciprocating and rotating components must not be manufactured from graphitic matrix, metal matrix composites or ceramic materials, this restriction does not apply to the clutch and any seals.
  - Rolling elements of rolling element bearings must be manufactured from an iron based alloy or from a ceramic material.
  - All timing gears between the crankshaft and camshafts (including hubs) must be manufactured from an iron based alloy.
  - High pressure fuel pumps elements may be manufactured from a ceramic material.
  - Torsional damper elements may be manufactured in a Tungsten based material.
- 5.18.8 Static components:
- Other than inserts within them, engine crankcases including sump, cylinder heads and cylinder head cam covers must be manufactured from aluminium or iron alloys.  
No composite materials or metal matrix composites are permitted either for the whole component or locally.
  - Other than parts listed in a) above, magnesium based alloys are permitted for static parts which may not be changed without incurring a penalty under Article 5.23.

- c. Any metallic structure whose primary or secondary function is to retain lubricant or coolant within the engine must be manufactured from an iron based alloy, an aluminium alloy or a magnesium based alloy if permitted by Article 5.18.8(b).
- d. All threaded fasteners, other than the two exceptions below, must be manufactured from an alloy based on Cobalt, Iron or Nickel. The exceptions are:
  - i. Fasteners whose primary function requires them to be an electrical insulator may be manufactured from ceramic or polymeric materials.
  - ii. Fasteners that are used in electronic control units may be manufactured from aluminium or copper based alloys or polymeric (plastic) materials.

Composite materials are not permitted.

- e. Valve seat inserts, valve guides and any other bearing component may be manufactured from metallic infiltrated pre-forms with other phases which are not used for reinforcement.
- f. Ballast may be manufactured in a Tungsten based material.
- g. In a cylinder head, a minimum of 1200mm<sup>2</sup> per cylinder of the projected surface of the part directly exposed to combustion must not comprise inserts. The minimum surface area will be assessed with a projection of the fire face along the bore centreline, within an 80mm diameter circle centred on the same axis, and with the valves closed.

## **5.19 Materials and construction – Pressure charging and exhaust systems**

- 5.19.1 All components of the power unit exhaust system, (from the cylinder head up to and including turbine housing or waste-gate exit housing) that are in contact with the main exhaust gas flow must be manufactured from a Cobalt, Iron or Nickel based alloy. Any gaskets or seals are excluded from this restriction.
- 5.19.2 Any rotating and reciprocating component in the compressor (from compressor inlet to compressor outlet(s)) must be manufactured from an aluminium, titanium or iron based alloy.
- 5.19.3 Static components that are neither in the exhaust system nor in the compressor line must be manufactured from iron based alloys, aluminium alloys or titanium alloys.
- 5.19.4 The compressor housing (from compressor inlet to compressor outlet(s)) must be manufactured from aluminium, titanium or magnesium based alloys.
- 5.19.5 Measures must be taken to ensure that in the event of failure of the turbine wheel any resulting significant debris is contained by and within the turbine housing, except in the case of an axial failure where this debris must be contained within the turbine housing and/or tailpipe assembly.

## **5.20 Materials and construction – Energy recovery, storage systems and electronic systems**

- 5.20.1 All metallic casings for the energy recovery and storage systems must be manufactured in iron, aluminium or titanium based alloys and must comply with all aspects of Article 5.17 except for power electronic cooling base plate where metal matrix composite may be used.
- 5.20.2 All metallic casings for electronic systems, with the exception of metallic casings for the energy recovery and storage systems, must be manufactured in iron, aluminium, titanium or magnesium based alloys.
- 5.20.3 Energy storage devices are not subject to Articles 5.17.1a), b), c) and h) nor to 5.17.3.
- 5.20.4 Permanent magnets in electrical machines are not subject to Articles 5.17.1 a), b), c) or h) nor to Article 5.17.3.

- 5.20.5 Electronic components contained inside electronic units are not subject to any material restriction.
- 5.20.6 ES Cells materials are not subject to Article 5.17.1 j).

## 5.21 Starting the engine

A supplementary device temporarily connected to the car may be used to start the engine in the team's designated garage area, in the pit lane and on the grid.

## 5.22 Stall prevention systems

If a car is equipped with a stall prevention system, and in order to avoid the possibility of a car involved in an accident being left with the engine running, all such systems must be configured to stop the engine no more than ten seconds after activation.

The sole purpose of such systems is to prevent the engine stalling when a driver loses control of the car. If the car is in second gear or above when the system is activated multiple gear changes may be made to either first gear or neutral, under all other circumstances the clutch alone may be activated.

Each time such a system is activated the clutch must be fully disengaged and must remain so until the driver de-activates the system by manually operating the clutch with a request greater than 95% of the total available travel of the drivers clutch actuation device.

## 5.23 Replacing power unit parts

Refer to the table in Appendix 3 of these regulations.

The parts listed as "EXC" in the table referred to above may be changed without incurring a penalty under Article 28.3 of the Sporting Regulations. If changing any of these parts involves breaking a seal this may be done but must be carried out under FIA supervision. Any parts changed may only be replaced by parts homologated in accordance with Appendix 4 of these Regulations.

## 5.24 Oil and coolant systems and charge air cooling

- 5.24.1 **Coolant header tanks:** Any header tank used on the car with a water based coolant must be fitted with an FIA approved pressure relief valve which is set to a maximum of 3.75 barG, details of the relief valve may be found in the Appendix to the Technical and Sporting Regulations. If the car is not fitted with a header tank, an alternative position must be approved by the FIA.
- 5.24.2 **Cooling systems:** The cooling systems of the power unit, including that of the air destined for combustion, must not intentionally make use of the latent heat of vaporisation of any fluid with the exception of fuel for the normal purpose of combustion in the engine as described in Article 5.11.3.
- 5.24.3 **Main oil tank level measurement:** The measurement of the oil level in the main oil tank must be supplied to FIA at all times. The main oil tank is the oil tank directly connected to the engine oil feed at the inlet of the oil pressure pump.
- 5.24.4 **Oil injection:** The use of active control valves between any part of the PU and the engine intake air is forbidden.
- 5.24.5 **AOT**
- Only one AOT may be fitted to the car.
  - The total volume of the AOT and its connections to the engine must not be greater than 2.5l. The transfer of oil between the AOT and the engine must be controlled by a solenoid.

## 5.25 General electrical safety

### 5.25.1 Principles

- a. A single point of failure of the electric system or ERS cannot result in a person being exposed to a live part.
- b. The components used cannot cause injury under any circumstances or conditions, whether during normal operation or in reasonably foreseeable cases of malfunction.
- c. If a single fault can predictably generate multiple failures, they must be considered as a single point of failure.

### 5.25.2 Protection of cables, lines, connectors, switches, electrical equipment

The following design practices must be adhered to for all electrical parts external to the ES main enclosure or accessible and which operate at high voltage:

- a. Protection against electrical shock via basic insulation combined with equipotential bonding, double insulation or reinforced insulation;
- b. Protection against risks of mechanical damage;
- c. Parts should be secured with cable guides, enclosures and conduits if exposed to stress (mechanical, vibration, thermal);
- d. Each cable must be rated to the respective circuit current and must be insulated adequately for the environment and operating conditions;
- e. Sections of looms containing high voltage wiring must be coloured orange;
- f. Connectors must be IP2X when not connected and IP65 when mated;
- g. A connector plug must physically only be able to mate with a single correct socket of any sockets within reach;
- h. Comply with creepage and clearance distances according to IEC-60664. Connectors which are opened in the garage must be considered PD2 or higher.

Clearance and creepage requirements can be verified by safety tests proposed in IEC-60664-1 session 6.

5.25.3 The ES main enclosure, MGU-H, MGU-K and high voltage junction boxes must be marked with a "Danger High Voltage" symbol according to ISO 7010.

5.25.4 All ERS high voltage cables outside of the ES main enclosure must be equipped with:

- a. A system to prevent high voltage when cables are not connected or incorrectly mated. In the event of detection of any of those conditions, actions must be immediately taken to ensure safe operation. The list of actions must be pre-defined in a Failure Mode and Effect Analysis provided to the FIA by each competitor. To avoid spurious detections a software debounce of maximum one second may be used.
- b. A system to allow detection of insulation faults or damaged high voltage lines by an isolation monitoring system.

5.25.5 To mitigate the risk failure mode where a high voltage is AC coupled onto the car's low voltage system, bonding is required for any system component to which a wire, cable or harness connects, or passes in close proximity, and which is able to conduct current by means of AC coupling.

The bonding must protect against short circuit currents generated by an insulation failure and low currents generated by capacitive coupling. It can be achieved using wires or conductive parts of an appropriate dimension.

Any components that require equipotential bonding will be connected to the car main ground and the resistance of potential equalization paths must not exceed 5.0  $\Omega$ .

In addition, the resistance measured between any two exposed conductive parts of the high voltage system must not exceed 0.1  $\Omega$ .

- 5.25.6 An insulation monitoring system must be used to measure the insulation resistance between the car main ground and the entire conductively connected high voltage system. It must be connected on the ES side of contactors.

## 5.26 ES design and installation

- 5.26.1 No high voltage must be present or accessible by any reasonable means between the ES main enclosure and any ES off-board charging connector when the off-board charger is not connected.
- 5.26.2 No DC voltage above 60V is permitted outside of the ES main enclosure, except for the sole purpose of injection and ignition or when an off-board charger is connected to charge or discharge the ES.
- 5.26.3 The ES must be equipped with a BMS.
- 5.26.4 The ES must be equipped with a fuse to protect the system in case of a short circuit. The fuse shall be located as close as possible to the cells.

The fuse must be tested and demonstrated to work in realistic load cases.

- 5.26.5 The ES must have at least two contactors, one per positive and negative pole, which will isolate the high voltage parts of the ES once the shutdown process has started.

Contactors must provide a dielectric strength:

- a. between the control circuit and any of the high voltage contacts and;
- b. across high voltage contacts, when the high voltage circuit is open.

For each of (a) and (b) above:

- c. A dielectric withstanding voltage test must be performed with a DC voltage at least equal to the ES maximum DC voltage plus 1200V. The device must withstand the DC voltage for 60 seconds with a leakage current lower than 1mA and without flashover.
- d. The electrical resistance measured by applying a DC voltage of 500VDC when the circuit is open must be higher than 50MΩ.

Once commanded to open, contactors must be able to keep the high voltage circuit open.

The contactors must be tested and demonstrated to work in realistic load cases, as described in the Appendix to the Technical and Sporting Regulations.

## ARTICLE 6: FUEL SYSTEM

### 6.1 Fuel tanks

- 6.1.1 The fuel tank must be a single rubber bladder conforming to or exceeding the specifications of FIA Standard FT5-1999, the fitting of foam within the tank however is not mandatory. A list of approved materials may be found in the Appendix to the Technical and Sporting Regulations.
- 6.1.2 With the exception of the fuel out of the survival cell permitted under Article 5.11.7, all fuel on board the car must be stored within the following limits:
- Ahead of  $X_{PU}=0$ .
  - Rearward of **RS-FWD-FUEL-LIMIT**.
  - Inboard of  $Y=400$ .
- 6.1.3 No fuel bladders shall be used more than 5 years after the date of manufacture.
- 6.1.4 All fuel tanks must be fitted with a pressure relief valve to prevent overpressure, and with a fuel tank pressure sensor as specified in the diagram of Article 6.6.4. The FIA may request Competitors to demonstrate that the specification of all relevant parts of the fuel tank, and the strength of the surrounding structure, are consistent with the pressure that the pressure relief valve is set to.
- 6.1.5 The maximum internal pressure exerted on the fuel bladder must not exceed 1.0 barG.

### 6.2 Fittings and piping

- 6.2.1 The total area of apertures in the fuel bladder must not exceed 35 000mm<sup>2</sup>.
- Circular apertures smaller than 35mm diameter may be closed with a fitting, secured with a single threaded fastener on the full diameter of the opening, provided that this threaded fastener is provided with mechanical secondary locking.
- All other apertures in the fuel bladder must be closed by hatches or fittings which must:
- Be secured to metallic bolt rings bonded to the inside of the bladder.
  - Have bolt hole edges no less than 5mm from the edge of the bolt ring, hatch, or fitting.
  - Attach directly to the fuel bladder and have no part of the survival cell structure included in the closure.
  - Be secured with multiple fasteners in such a way that the absence of any single fastener does not compromise the security of the closure.
- 6.2.2 Where the fuel bladder is attached to the survival cell, fixings must be designed so that if it is pulled away from the survival cell, the attachment will fail without compromising the integrity of the fuel bladder. For this assessment, the pull-out load for any fitting will be calculated from the clamp area between the fitting and the bladder (on one face of the bladder). Between a clamp area of 1650mm<sup>2</sup> and 9 500mm<sup>2</sup>, the load will be a linear interpolation between points (1650mm<sup>2</sup>, 11kN) and (9 500mm<sup>2</sup>, 37.5kN). Below a clamp area of 1650mm<sup>2</sup>, the load will be taken as 11kN. Above a clamp area of 9 500mm<sup>2</sup>, the load will be taken as 37.5kN. No fitting may have a clamp area of less than 600 mm<sup>2</sup>.
- 6.2.3 All fuel lines between the fuel tank and the engine must have a self-sealing breakaway valve. This valve must separate at less than 50% of the load required to break the fuel line fitting or to pull it out of the fuel tank.
- 6.2.4 No lines containing fuel may pass through the cockpit.
- 6.2.5 All lines must be fitted in such a way that any leakage cannot result in the accumulation of fuel in the cockpit.



- 6.2.6 All components containing fuel at a pressure greater than 10barG must be located outside the fuel tank.

### 6.3 Fuel tank fillers

Fuel tank fillers must not protrude beyond the bodywork. Any breather pipe connecting the fuel tank to the atmosphere must be designed to avoid liquid leakage when the car is running and its outlet must not be less than 250mm from the cockpit opening.

All fuel tank fillers and breathers must be designed to ensure an efficient locking action which reduces the risk of an accidental opening following a crash impact or incomplete locking after refuelling.

### 6.4 Refuelling

- 6.4.1 A cover must be fitted over any refuelling connector at all times when the car is running on the track. The cover and its attachments must be sufficiently strong to avoid accidental opening in the event of an accident.

- 6.4.2 The fuel in a car must not be colder than the lowest of: ten degrees centigrade below ambient temperature, or ten degrees centigrade, at any time when the car is running after leaving the Competitor's designated garage area.

When assessing compliance:

- a. The ambient temperature will be that recorded by the FIA appointed weather service provider one hour before any practice session or three hours before the race or sprint session. and will be displayed on the timing monitors.
- b. The temperature of the fuel (TFFMFuel) will be that recorded in the car by the primary Fuel Flow Meter, referred to as the "Team FFM".

- 6.4.3 The use of any device on board the car to decrease the temperature of the fuel is forbidden.

- 6.4.4 Fuel may not be added to nor removed from a car during a race or sprint session.

- 6.4.5 Any refuelling procedure must respect the provisions of Article 36 of the Sporting Regulations.

### 6.5 Fuel draining and sampling

- 6.5.1 Competitors must provide a means of removing all fuel from the car.

- 6.5.2 Competitors must ensure that a 1.0 litre sample of fuel may be taken from the car at any time during the Competition.

After a practice session, sprint session, and race, if a car has not been driven back to the pits under its own power, it will be required to supply the above mentioned sample plus the amount of fuel that would have been consumed to drive back to the pits. The additional amount of fuel will be determined by the FIA.

- 6.5.3 All cars must be fitted with a -2 'Symetrics' male fitting in order to facilitate fuel sampling. If an electric pump on board the car cannot be used to remove the fuel an externally connected one may be used provided it is evident that a representative fuel sample is being taken. If an external pump is used it must be possible to connect the FIA sampling hose to it and any hose between the car and pump must be -3 in diameter and not exceed 2m in length. Details of the fuel sampling hose may be found in the Appendix to the Technical and Sporting Regulations.

- 6.5.4 The sampling procedure must not necessitate starting the engine or the removal of bodywork (other than the nosebox assembly and the cover over any refuelling connector).

## 6.6 Fuel System Hydraulic Layout

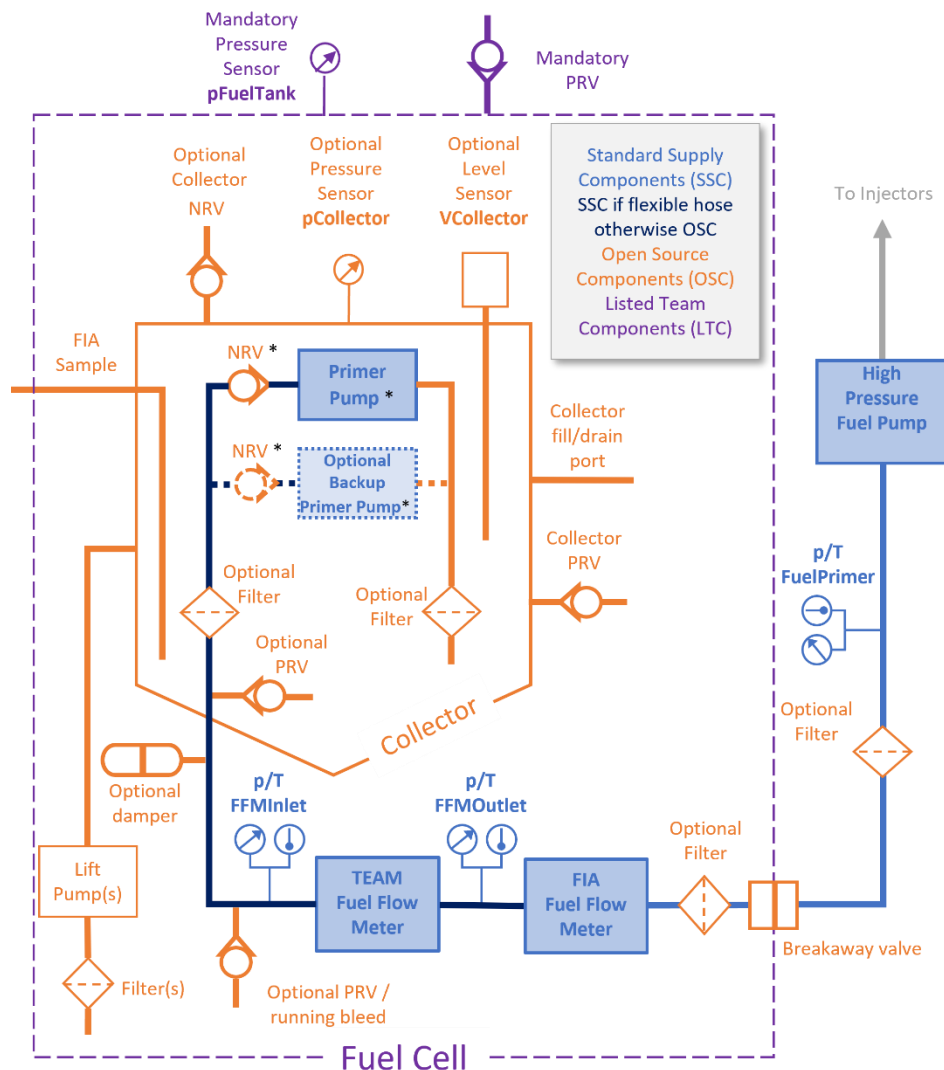
6.6.1 Parts listed in Appendix 5 sections 6A and 6E are classified as OSC.

6.6.2 The primer pump(s), high pressure pump, fuel flow meters and pressure and temperature sensors are SSC, as mandated by the FIA and specified in the Appendix to the Technical and Sporting Regulations.

6.6.3 All flexible pipes and hoses and their fittings between the primer pump(s) and the high-pressure pump are SSC, mandated by the FIA. The specification is given in the Appendix to the Technical and Sporting Regulations. The total length of flexible hose in the system between the primer pump(s) and the Breakaway Valve must not exceed 1000mm. The total length of flexible hose in the system between the Breakaway valve and the High Pressure Fuel Pump must not exceed 500mm. Rigid pipes and manifolds and their fittings may be used instead of flexible pipes and hoses up to the inlet of the FIA fuel Flow Meter.

6.6.4 The hydraulic layout of the fuel system must functionally conform to the schematic given in the drawing below. Additional components (such as collector pressurisation system) are permitted, subject to the approval of the FIA if they are deemed necessary for the proper behaviour of the system.

Furthermore, fuel cell components, such as fuel cell pressurisation system and fill/drain hoses, are permitted provided they do not functionally interfere with the system shown.



- 6.6.5 If a fuel pressure damper is fitted it must be fitted upstream of both Fuel Flow Meters described in article 5.11.3.
- 6.6.6 The pressure of the fuel inside the collector may be increased relative to the pressure in the fuel cell volume by the lift pumps and/or either:
- i. air pressure acting on the free surface of the fuel,
  - ii. or hydraulic oil or air pressure acting on a piston.

In all cases the increase in pressure in the collector must be for the sole purpose of maintaining the primer pump(s) inlet pressure above the cavitation point. And it must be demonstrated to the satisfaction of the FIA that any fluid used for this purpose cannot be used to change to composition of the fuel.

\* The primer pump(s), the NRV(s), the damper, the filter and PRV downstream of the NRV(s) may be installed inside or outside the Collector.

## ARTICLE 7: OIL AND COOLANT SYSTEMS AND CHARGE AIR COOLING

### 7.1 Location of lubricating oil tanks

All oil storage tanks must be situated between  $X_F=0$  and  $X_{DIF}=150$ , and must be no further outboard than the lateral extremities of the survival cell.

### 7.2 Location of lubricating oil system

No other part of the car containing lubricating oil may be situated behind  $X_{DIF} = 150$  or outboard of  $Y=750$ .

### 7.3 Oil and coolant lines

7.3.1 No lines containing coolant or lubricating oil may pass through the cockpit.

7.3.2 All lines must be fitted in such a way that any leakage cannot result in the accumulation of fluid in the cockpit.

7.3.3 No hydraulic fluid lines may have removable connectors inside the cockpit.

### 7.4 Heat exchangers

#### 7.4.1 Definitions

For the content of Articles 7.4 and 17, the following definitions apply:

- a. **Heat Exchanger:** a device for transferring heat between two or more fluids.
- b. **Primary Heat Exchanger:** a heat exchanger that uses the air flowing over or through the car to cool a fluid, which includes all of the core, tubes, header plates, header tanks and fins.
- c. **Secondary Heat Exchanger:** a heat exchanger that uses a fluid other than the air flowing over or through the car to cool another fluid.
- d. **Core:** any part of the heat exchanger where one of the fluids is divided into multiple channels, and in which the primary function of the Heat Exchanger is achieved. If two or more such components lie on the same side of the car and outboard of  $Y=200$  or two or more such components are centred around the  $Y=0$  plane, and have an inlet liquid from the same source, or an outlet liquid that goes to the same destination, these will be considered to be part of the same core. Such components which share neither an inlet liquid from the same source, nor an outlet liquid that goes to the same destination are considered to form separate cores, even if the individual components are integrated to each other for construction purposes.
- e. **Tubes:** the enclosed channels within the core in which one of the fluids flows.
- f. **Header plates:** The face of the header-tank adjacent to the core, through which the tubes pass and to which they are sealed.
- g. **Fins:** devices between the tubes or within the tubes whose function it is to increase the level of heat exchange by convection and/or an increase of contact area.

#### 7.4.2 Primary heat exchanger specification and technology

In order to reduce the cost of primary heat exchangers used on the car, the following restrictions apply:

- a. The core and header tanks must be made from aluminium alloy.
- b. The core must not be produced using additive manufacturing.
- c. Tubes must have a wall thickness of at least 0.18mm.
- d. The internal cross section of any tube must have an area of at least  $10\text{mm}^2$ , without considering structural stiffening ribs and the internal fins described in point (e) below.

- e. Fins fitted inside the tubes must have a thickness of at least 0.06mm. Fins fitted between the tubes must have a minimum thickness of 0.05mm.

In any liquid to air primary heat exchanger, the following additional restrictions apply:

- f. Its core may be divided in to two or more parts, each part must be planar and all parts must be parallel with each other. Tubes must be straight and parallel.
- g. Header plates must be perpendicular to the face of the core when measured in the plane of the tubes and air fins. The angle between the header plate and a tube, at their intersection, must not be less than 60°. Furthermore, with the exception of up to two sharp corners per header plate, the header plate may not have a radius of curvature of less than 50mm, prior to the holes being added for the tubes.

#### **7.4.3 Secondary heat exchanger specification and technology**

Secondary heat exchangers must be constructed from metallic materials with the exception of any sealing or bonding.

#### **7.4.4 New Heat Exchanger Technologies**

Technologies that are currently prohibited by Article 7.4 but which offer improved performance, lower mass or improved component life will be considered for future versions of this regulation, provided that they are not significantly more expensive than the currently permitted technologies. All Competitors will be consulted before such changes are made to this Article 7 to accommodate such technologies.

## ARTICLE 8: ELECTRICAL SYSTEMS

### 8.1 Definitions

#### 8.1.1 Electronically controlled

Any command system or process that utilises semi-conductor or thermionic technology.

#### 8.1.2 Control

A sensor, actuator, wiring loom or unit will be referred to as "Control" if it is used by any on-board strategy other than input handling, input failure detection or functions used for logging only.

It includes for example units, sensors, actuators, wiring looms used in control loops, protections or driver information.

#### 8.1.3 Electronic Control Unit (ECU)

A programmable embedded system that controls one or more car sub-systems.

#### 8.1.4 FIA Standard ECU

An ECU or set of ECUs and their sub-components manufactured by an FIA designated supplier to a specification determined by the FIA.

The FIA Standard ECU comprises at least a master control unit and modules used for driver information and driver input device interfacing.

#### 8.1.5 FIA Accident Data Recorder (FIA ADR)

An ECU manufactured by an FIA designated supplier to a specification determined by the FIA.

The primary purpose of the FIA ADR is to monitor, record or control the following:

- a. Data relevant to an accident or incident.
- b. The management of marshalling and safety systems.

#### 8.1.6 Telemetry

Wireless transmission of data from remote sources.

### 8.2 Software and electronics inspection

8.2.1 Prior to the start of each season the complete electrical and electronic system on the car must be examined and all on board and communications hardware and software must be inspected by the FIA Technical Department.

8.2.2 The FIA must be notified of any changes prior to the Competition at which such changes are intended to be implemented.

8.2.3 All re-programmable devices must have a mechanism that allows the FIA to accurately identify the software version loaded.

Acceptable solutions to verify the programmed software may be found in the Appendix to the Technical and Sporting Regulations.

8.2.4 All electronic units containing a programmable device, and which are intended for use at a Competition, must be presented to the FIA before each Competition in order that they can be identified.

8.2.5 All on-car software versions must be registered with the FIA before use.

8.2.6 The FIA must be able to test the operation of any compulsory electronic safety systems at any time during a Competition.

- 8.2.7** Competitors may only run custom software that has been homologated by the FIA for their control applications hosted inside or outside the ECU described in Article 8.3.1.

Details of the homologation process can be found in the Appendix to the Technical and Sporting Regulations.

- 8.2.8** The number of versions used in any single championship season will be limited as shown in the table below. Figures are given per custom control application.

	2022	2023	2024	2025
ECU Team applications	5	5	5	5
ECU PU applications	5	1	1	1
ERS and PU-CE Applications	5	1	1	1

A version will be deemed to have been used once the car's timing transponder has shown that it has left the pit lane.

Changes made solely for reliability, bug fix, compatibility with standard or other custom applications or changes requested by the FIA will not increase the version counter.

### **8.3 Control electronics**

- 8.3.1** All components of the power unit, fuel system, transmission systems, brake system, tyre pressure monitoring system and DRS, in addition to all associated actuators, must be controlled by the FIA Standard ECU.

The FIA Standard ECU may only be used with FIA approved software and may only be connected to the control system wiring loom, sensors and actuators in a manner specified by the FIA.

Additional information regarding the FIA Standard ECU software versions and setup may be found in the Appendix to the Technical and Sporting Regulations.

- 8.3.2** All ECUs, control sensors, actuators and FIA monitoring sensors will be homologated by the FIA. Details of the homologation process may be found in the Appendix to the Technical and Sporting Regulations.

Each and every component of the control system will be sealed and uniquely identified and their identities tracked through their life cycle.

These components and units may not be disassembled or modified in any way and seals and identifiers must remain intact and legible.

- 8.3.3** The control system wiring loom connectivity must be approved by the FIA.

All wiring looms must be built to ensure that each control sensor and each control actuator is electrically isolated from logging-only sensors.

In general, there must be no active or passive electronic component in the control loom. Exceptions (e.g. termination resistors) must be approved by the FIA before use.

Additional wiring guidelines may be found in the Appendix to the Technical and Sporting Regulations.

- 8.3.4** If sensor faults or errors are detected by the driver or by the on-board software, back-up sensors may be used and different settings may be manually or automatically selected. However, any back-up sensor or new setting chosen in this way must not enhance the performance of the car. Any driver default turned on during the start lockout period may not be turned off before the end of that period.

- 8.3.5 Pneumatic valve pressure may only be controlled via a passive mechanical regulator or from the FIA Standard ECU and its operation will be monitored by the FIA Standard ECU.

## 8.4 Start systems

- 8.4.1 Any system, the purpose and/or effect of which is to detect when a race start signal is given, is not permitted.
- 8.4.2 The FIA Standard ECU will implement a “lockout” period after each race start or pit stop during which a number of power unit and transmission related functions will be frozen or disabled. Details of the strategy may be found in the Appendix to the Technical and Sporting Regulations.

## 8.5 Data acquisition

- 8.5.1 To assist scrutineering, the FIA requires unlimited access to the following FIA Standard ECU information before, during and after any track session:
- Application parameter configurations.
  - Logged data and events.
  - Real-time telemetry data and events.

Throughout the Competition, the logging memory and events buffer may only be cleared by an FIA engineer.

The FIA must have the ability to connect to the FIA Standard ECU via a team-provided standalone equipment using an FIA laptop. The teams should make a jump battery available at all times during the Competition.

The teams should transfer the real-time telemetry data and events on the FIA network as requested by, and in the format defined by, the FIA.

Prior to the race or sprint session, the FIA Standard ECU data logger must be configured in such a way that allows logging of data for at least two hours and fifteen minutes without exceeding the size of the logger memory.

- 8.5.2 Any data acquisition system, telemetry system or associated sensors additional to those provided by the FIA Standard ECU and FIA ADR must be physically separate and electrically isolated from any control electronics with the exception of:
- The primary regulated voltage supply.
  - The car system ground.
  - Communication links to the FIA Standard ECU, telemetry unit and FIA ADR.
  - Power supplies, provided they are not used to power any control electronics, control sensors or actuators.
  - Time synchronisation lines.
  - Power unit synchronisation lines.
  - An umbilical loom whose connector will remain disconnected when the car is moving.

Unless approved by the FIA, no junction box or break-out box may be shared between the FIA Standard ECU system and a team data acquisition system.

The use of any coupling, be it hard wired, magnetic, optical or other such link which allows the transmission of signals will not be considered as adequate isolation in the context of this Article.



## **8.6 Telemetry**

- 8.6.1 All cars must be fitted with a car to team telemetry system which has been manufactured by the FIA designated supplier to a specification determined by the FIA.
- 8.6.2 Telemetry systems must operate at frequencies which have been approved by the FIA.
- 8.6.3 Team to car telemetry is prohibited, with the exception of:
  - a. The FIA Marshalling System defined in Article 8.12;
  - b. Handshaking required by the car to team telemetry system defined in Article 8.6.1.

## **8.7 Driver inputs and information**

- 8.7.1 With the exception of voice radio communication, all signals associated with driver information and driver input devices must be generated by the FIA Standard ECU.
- 8.7.2 Any single input device, including but not limited to switch, button, paddle or pedal, used by the driver must be connected to a single analogue or digital input of the FIA Standard ECU.

Exceptions will be considered to handle the following:

- a. A spare clutch paddle sensor.
- b. A spare accelerator pedal sensor.
- c. A separate "kick-down" sensor which indicates that the accelerator pedal has been deliberately depressed past full travel.
- d. Multiplexed shift signals.
- e. A spare brake pressure and pedal sensor.

Any interface between such driver input devices and the FIA Standard ECU must be approved by the FIA.

- 8.7.3 Any alteration of the driver's inputs may only be commanded by direct, deliberate and primary driver actions.

The logged raw signals from the FIA Standard ECU inputs must provide a true representation of the driver's actions.

## **8.8 Master switch**

- 8.8.1 The driver, when seated normally with the safety belts fastened and the steering wheel in place, must be able to cut off the electrical circuits to the ignition, all fuel pumps and the rear lights by means of a spark proof circuit breaker switch.

This switch must be located on the dashboard and must be clearly marked by a symbol showing a red spark in a white edged blue triangle.

- 8.8.2 There must also be two exterior horizontal handles which are capable of being operated from a distance by a hook. These handles must be situated at the base of the main roll over structure on both sides of the car and have the same function as the switch described in Article 8.8.1.

## **8.9 Driver radio**

- 8.9.1 All cars must be fitted with a voice radio communication system which has been manufactured by the FIA designated supplier to a specification determined by the FIA.
- 8.9.2 Other than authorised connections to the FIA Standard ECU, any voice radio communication system between car and pits must be stand alone and must not transmit or receive other data. All such communications must be open and accessible to both the FIA and broadcasters.

## 8.10 Accident analysis

For the purpose of accident analysis and driver rescue, during each Competition and all tests which are attended by more than one team, each car must be fitted with:

- a. One FIA ADR;
- b. Two external 500g accelerometers;
- c. One high speed camera;

and each driver must wear:

- d. In-ear accelerometers;
- e. A biometric glove.

Teams must use their best endeavours to ensure that all those parts are in working order at all times.

### 8.10.1 FIA ADR

The FIA ADR must be fitted and operated:

- a. In accordance with the instructions of the FIA.
- b. With its centre plane no more than 25mm from  $Y=0$  and with its top facing upwards.
- c. With each of its 12 edges parallel to the coordinate system defined in Article 2.11.1.
- d. Below  $Z=300$ .
- e. In a position within the cockpit which is readily accessible at all times from within the cockpit without the need to remove plank or floor.
- f. In order that the entire unit lies behind RV-COCKPIT-DRIVER and between  $X_C = -450$  and  $X_C = 50$
- g. Via anti-vibration mountings giving a clearance of 5mm to all other objects.
- h. With its connectors facing forwards.
- i. In order that the download connector is easily accessible when the driver is seated normally and without the need to remove bodywork.
- j. within the operating limits specified by the supplier, in particular the maximum temperature limits.

The FIA ADR must be powered from a nominally 12V supply such that its internal battery can be recharged at all times when the car's electronic systems are powered and when the car systems are switched off, but a jump battery or umbilical is connected.

Details of the connections to the FIA ADR may be found in the Appendix to the Technical and Sporting Regulations.

### 8.10.2 External accelerometers

The FIA ADR must be connected to two external 500g accelerometers which have been manufactured by a FIA designated supplier to a specification determined by the FIA.

The accelerometers must be solidly bolted to the survival cell, on the car centre plane, using four 4mm bolts. One must be as close to the nominal car centre of gravity as practical and the other as far forward as possible inside the survival cell. The forward accelerometer may be mounted to the underside of the top surface provided it is solidly bolted to a structural part of the survival cell.

Details of the accelerometers may be found in the Appendix to the Technical and Sporting Regulations.

### 8.10.3 High speed camera

Each car must be fitted with a high speed camera which has been manufactured by the FIA designated supplier to a specification determined by the FIA.

The camera must be fitted in accordance with the instructions of the FIA, details of which may be found in the Appendix to the Technical and Sporting Regulations.

#### **8.10.4 In-ear accelerometers**

Each driver must wear in-ear accelerometers which have been manufactured by the FIA designated supplier to a specification determined by the FIA.

#### **8.10.5 Biometric glove**

For the purpose of aiding driver rescue, each driver must wear a biometric glove which has been manufactured by the FIA designated supplier to a specification determined by the FIA.

### **8.11 Accident data**

At any time following an accident or incident Competitors must make the FIA ADR available and accessible to the FIA. A representative of the team concerned may be present when data relevant to an accident or incident is being uploaded from the recorder. A copy of the data will be made available to the team.

Any conclusions as to the cause of an accident, or any data relevant to an accident, may only be published in the form of a report which has been agreed between the team concerned and the FIA.

### **8.12 FIA Marshalling system**

All cars must be fitted with a marshalling system, comprising a car positioning system and a bidirectional race control to car communication system, which has been manufactured by the FIA designated supplier to a specification determined by the FIA.

No other parts which, in the opinion of the FIA are capable of performing a similar function, may be fitted to any car.

Details of the marshalling system may be found in the Appendix to the Technical and Sporting Regulations.

### **8.13 Track signal information display**

All cars must be fitted with red, blue and yellow cockpit lights, supplied as part of the FIA Standard ECU, the purpose of which are to give drivers information concerning track signals or conditions. The lights must be fitted directly in the driver's normal line of sight.

### **8.14 Medical warning system**

In order to give rescue crews an immediate indication of accident severity each car must be fitted with a warning light which is connected to the FIA ADR.

The light must face upwards and be recessed into the top of the survival cell inboard of  $Y=150$ , rearward of  $X_C=-1150$  and as near to the clutch disengagement system, as described in Article 9.4, as is practical.

Details of the light and its control system may be found in the Appendix to the Technical and Sporting Regulations.

### **8.15 Installation of electrical systems or components**

**8.15.1** Exceptionally, each car may be equipped with a maximum of five test sensor installations, which do not comply with Article 3 of the Technical Regulations, during P1 and P2, provided:

- a. They could not materially affect the outcome any of the impact tests described in Article 13.
- b. They lie entirely within an axis-aligned cuboid with an internal diagonal bounded by points  $[X_F=-1350, -1000, -200]$  and  $[X_{DIF}=1000, 1000, 1100]$ .

- c. No part of any sensor may lie above a triangular surface with vertices at  $[X_C=-200, 0, 655]$ ,  $[X_F=-1350, 1350, 655]$  and  $[X_F=-1350, -1350, 655]$ .
- d. They do not obstruct on-board camera views.

Any such test sensor installations do not need to be homologated.

The FIA technical delegate must be notified of any intended test sensor installations prior to the Competition at which they are first used.

- 8.15.2 Competitors must be notified of any changes to the installation instructions for any FIA specified systems or components before 1 March of the previous season.
- 8.15.3 Notwithstanding the provisions of Article 8.15.1, the use in testing of any system designed to adjust the ride height of the car in a way that is not compliant with Article 10 is prohibited.

## 8.16 Timing transponders

All cars must be fitted with two timing transponders supplied by the officially appointed timekeepers. These transponders must be fitted in strict accordance with the instructions detailed in the Appendix to the Technical and Sporting Regulations. Teams must use their best endeavours to ensure that the transponders are in working order at all times.

## 8.17 Cameras and camera housings

- 8.17.1 All cars must be equipped with seven positions in which cameras or camera housings can be fitted at all times throughout the Competition. Referring to Drawing 2 of Appendix 2, all cars must carry
  - a. a camera in positions 4, and 5.
  - b. a camera or camera housing in positions 1, 2 (both sides) and 3.
  - c. A camera fitted in the driver's helmet and pointing forward.
- 8.17.2 Details concerning the technical specification of all cameras may be found in the Appendix to the Technical and Sporting Regulations.
- 8.17.3 With the exception of the position in the driver's helmet, camera housings, when used, must be fitted in the same location as cameras, and satisfy all the relevant regulations. They must be identical in size, shape, and mass to the camera in lieu of which they are fitted, and must be supplied by the relevant Competitor. Details concerning the shape and mass of all camera housings may be found in the Appendix to the Technical and Sporting Regulations.
 

Any decision as to whether a camera or camera housing is fitted in those positions will be by agreement between the relevant Competitor and the Commercial Rights Holder.

If a Competitor is not required to fit a camera in the helmet of one of its drivers, ballast equivalent in mass to that of the components removed must be securely fitted in the cockpit.
- 8.17.4 Competitors must be notified of any changes to the camera or transponder installation instructions before 30 June of the previous season.
- 8.17.5 Any camera fitted in positions 2, 3 or 4 shown in Drawing 2 of Appendix 2 must be mounted in order that its major axis does not subtend an angle greater than  $1^\circ$  to the reference plane, and its lateral axis is normal to the car centre plane.
- 8.17.6 Any camera fitted in position 1 must be fitted above the survival cell, forward of the cockpit opening, rearwards of the forward attachment of the Secondary Roll Structure described in Article 12.4.2. and symmetrically with respect to the car centre plane, with the camera pointing towards the driver. The electronic conditioning unit for this camera must be positioned within the survival cell and in accordance with the Appendix to the Technical and Sporting Regulations.

**8.17.7** The entire camera in position 2 must lie within RV-CAMERA-2.

Any camera fitted in the left hand position 2 shown in Drawing 2 of Appendix 2 must be mounted in order that its major axis where passing through the centre of the camera lens does not intersect any part of the car lying forward of the camera

Any part provided by the Competitor for the purpose of aligning the camera in position 2 correctly will be considered part of the camera provided it does not exceed 25mm in width and is being fitted for that sole purpose.

**8.17.8** The camera fitted in position 3 must be mounted in order that its forward-most point is situated between  $X_C=0$  and  $X_C=300$  and between  $Z=865$  and  $Z=900$ . The inner face of the camera unit should be between  $Y=120$  and  $Y=150$ .

Any part provided by the Competitor for the purpose of aligning the camera in position 3 must be an extrusion of the camera unit profile. A radius of up to 10mm will be permitted where this component meets the bodywork or survival cell.

**8.17.9** The camera fitted in position 4 must be mounted in order that its forward-most point is forward of  $X_C=80$ .

**8.17.10** The camera fitted in position 5 must be mounted, symmetrically about  $Y=0$ , with the lens centre forward of  $X_C=-1250$  and with its lower surface at an angle no greater than  $6^\circ$  to the plane  $Z=0$ . In order to not impinge on its 360deg image, any shrouding or cut-out should be no higher than "Shoulder X", as defined in the Appendix to the Technical and Sporting Regulations.

## **8.18 Wheels display panel**

Depending on the availability of the necessary technology, and in order to provide visual information to the spectators, the FIA may request each of the four wheel covers described in Article 3.13.7 to be fitted with a rotating LED display panel.

The Wheel Display Panel will be classed as SSC, and details about it and its associated control system may be found in the Appendix to the Technical and Sporting Regulations.

Such a request will only be made following consultation with the competitors, and in any case no later than 6 months before the first introduction of these display panels in a Competition.

An adjustment to the minimum mass of the cars will be made to compensate for the additional mass of these components.

## **8.19 Electromagnetic radiation**

Electromagnetic radiation between 2.0 and 2.7GHz is forbidden save with the written consent of the FIA.

## **8.20 Vehicle dynamics analysis**

For the purpose of vehicle dynamics analysis, all cars must be fitted with an accelerometer that has been manufactured by the FIA designated supplier to a specification determined by the FIA.

The accelerometer outputs must be connected to the FIA Standard ECU in a manner specified by the FIA.

Details of the accelerometer and installation requirements may be found in the Appendix to the Technical and Sporting Regulations.

~~The sensor body must:~~

~~a. Be solidly mounted to the survival cell~~

~~b. Be inside the cockpit, on the cockpit floor~~

~~c. Have each of its 12 edges parallel to the coordinate system defined in Article 2.11.1~~

- ~~d. Lie entirely behind  $X_c = 600$ , and less than 130mm from  $Y=0$~~
- ~~e. Be in a position within the cockpit which is readily accessible at all times from within the cockpit when the seat is removed~~
- ~~f. Be fixed with the 2 x M3 through holes (diagonal)~~

## 8.21 Sensor signals

Any system, device or installation which is contrived or operated in a way to alter the measurement or the signal of a sensor used by the FIA to establish compliance with the Regulations is forbidden.

## ARTICLE 9: TRANSMISSION SYSTEM

### 9.1 Definitions

#### 9.1.1 Gearbox

All the parts in the power train which transfer torque from the power unit output shaft, as described in Article 5.4.2, to the drive shafts (the drive shafts being defined as those components which transfer drive torque from the sprung mass to the unsprung mass). It includes all components whose primary purpose is for the transmission of power or mechanical selection of gears, bearings associated with these components (as described in Articles 9.1.2 to 9.1.4) and the casing in which they are housed (as described in Articles 9.1.5 to 9.1.7).

#### 9.1.2 Driveline components

The rotating components involved in transmitting torque between the gearbox input shaft and the drive shafts. This includes gears, shafts, dog rings, differential and rotating parts of the differential control mechanism. Bearings between these components and the Cassette are included in this definition.

#### 9.1.3 Gear-Change Components

Mechanical components that are involved in selecting the forward gears; barrel(s) and associated bearings, selector forks, selector rail, detent mechanisms and hydraulic actuator(s).

#### 9.1.4 Auxiliary Components

Components that are not included in Driveline or Gear-Change Components but interact directly with these components and are essential for the functioning of the gearbox. This includes oil pressure and scavenge pumps, reverse-gear idler and its actuator, differential actuator, electronic sensors and actuators.

#### 9.1.5 Cassette

The housing that immediately encloses the Driveline Components and Gear-Change Components including all associated covers. This may be integrated into the Gearbox Case or may be a separate housing.

#### 9.1.6 Integrated Cassette

A cassette will be considered integrated if it is predominantly of the same material as the Gearbox Case and is permanently fixed to it. The minimal structure enclosing the Driveline Components and Gear-Change Components will be considered as the Cassette.

#### 9.1.7 Gearbox Case

The structure that supports the Cassette, mounts the rear impact structure, takes suspension loads and aerodynamic loads and transfers them to the power unit through the studs defined in Article 5.4.8.

#### 9.1.8 Parts Not Included for Compliance with Article 29 of the Sporting Regulations

Only in the context of Article 29 of the Sporting Regulations, the following parts are not considered part of the gearbox and may be changed without incurring a penalty under that Article's provisions. If changing any of these parts involves breaking an FIA applied seal this may be done but must be carried out under FIA supervision:

- a. The clutch assembly and the power unit output shaft, provided this is located prior to any mechanical speed reduction from the engine.
- b. The clutch actuator and clutch release bearing(s).
- c. Inboard driveshaft joints and seals but not their housing if that housing is integral with the gearbox output shaft and therefore part of the sprung mass.
- d. The hydraulic system prior to the point at which it produces direct mechanical movement of the gear selection mechanism by means of hydraulic actuator(s).

- e. Oil, oil pumps, oil filters, oil seals, oil coolers and any associated hoses or pipes.
- f. Electrical sensors, actuators, servo valves and wiring.
- g. Any parts associated with the suspension or functioning of the sprung suspension that are attached to the gearbox casing.
- h. The rear impact structure provided it can be separated from any gearbox casing.
- i. Any other component mounted to the casing whose primary purpose is unconnected with the transmission of power or selection of gears.

## 9.2 Fundamental provisions

### 9.2.1 Transmission type

The transmission may only drive the two rear wheels.

### 9.2.2 Traction control

No car may be equipped with a system or device which is capable of preventing the driven wheels from spinning under power or of compensating for excessive torque demand by the driver.

Any device or system which notifies the driver of the onset of wheel spin is not permitted.

## 9.3 Clutch control

The following applies only to the main power train clutch or clutches, any clutch used exclusively as part of an ERS is exempt.

### 9.3.1 Clutch operating devices must be in the form of paddles, which comply with the following principles:

- a. There should be a maximum of two, mounted on the steering wheel for direct access in all circumstances.
- b. They should be of pull-type, opening the clutch when pulling the paddle towards the driver.
- c. Their travel should be in a plane nominally normal to the face of the steering wheel, with a maximum displacement of the driver's contact surfaces of 80mm between end stops.
- d. They should have only a single degree of freedom.
- e. Where two paddles are fitted, they must be a left and right handed pair, identical in function and ergonomics, mounted in a symmetrically opposite manner on either side of the steering wheel centre plane. For the avoidance of doubt, they must have the same mechanical travel characteristics and be mapped identically.

No interaction between them or the associated FIA Standard ECU inputs will be permitted and, furthermore, Competitors must be able to demonstrate beyond any doubt that each of the paddles may only be operated with only one hand.

- f. To ensure that the signals used by the FIA Standard ECU are representative of the driver's actions, each Competitor is required to demonstrate that the paddle percentage calculated by the FIA Standard ECU does not deviated by more than +/-5% from the physical position of the operating device measured as a percentage over its entire usable range.

In that context, the physical position of the paddle will be measured at the location operated by the fingers.

### 9.3.2 Designs which allow specific points along the travel range of the clutch operating device to be identified by the driver or assist him to hold a position are not permitted.

In order to prevent interaction between the clutch paddles and other driver control devices, at least one of the following arrangements must be respected:



- a. When pulled to its maximum travel position, any clutch paddle should not reach further than the driver's contact surfaces of any other paddle, lever or switch in any of their positions.
- b. The outboard 60% portion of any clutch paddle, measured from its mounting point to its outer edge by the driver's contact surface, should be a minimum of 50mm away over its entire travel range from any other paddle, lever or switch.
- c. A clutch paddle should be separated from any adjacent paddle, lever or switch by a physical stop preventing any practical interaction between them by the driver. Such stop should be sized and shaped so that it cannot be used as a reference point during paddle operation.

In addition, other parts of the steering wheel or chassis should not be practically usable as reference points for the driver to identify or hold a specific position.

- 9.3.3 The minimum and maximum travel positions of the clutch operating device must correspond to the clutch fully engaged normal rest position and fully disengaged (incapable of transmitting any useable torque) positions respectively.
- 9.3.4 Designs or systems which in addition to typical inherent hydraulic and mechanical properties are designed to, or have the effect of, adjusting or otherwise influencing the amount, or rate, of engagement being demanded by the FIA Standard ECU, are not permitted.
- 9.3.5 The amount by which the clutch is engaged must be controlled solely and directly by the driver with the exception of :
  - a. Stall prevention.
  - b. Gearshifts.
  - c. Bite point finder where brake pressure, wheel speed and driver clutch demand safeguards are used.
  - d. De-clutch protections.
  - e. Power train protection on the track outside of any start lockout period or immediately following stall prevention activation only.
  - f. Test signals enabled only when the car is connected to the garage system.

When commanded by the driver, the amount of clutch engagement will be expressed in the FIA Standard ECU as torque at the rear axle by applying a gain of 5200Nm / 90% to the clutch paddle position between 5% and 95%.

In that case the clutch torque controller implemented in the FIA Standard ECU must be used. Except for the first 70ms following the initial step in clutch torque demand during a launch, the control error, calculated using the power unit output shaft torque sensor, must be contained in a band of +/-150Nm when converted at the rear axle.

- 9.3.6 When the clutch operating device is released from its maximum travel position it must return to its resting position within 50ms.  
The maximum delay allowed, computed from the respective signals as recorded by the FIA ADR or FIA Standard ECU, between the clutch driver control input signal and the corresponding output demand being achieved is 50ms.
- 9.3.7 Any device or system which notifies the driver of the amount of clutch slip or engagement is not permitted.

## 9.4 Clutch disengagement

All cars must be fitted with a means of disengaging the clutch for a minimum of fifteen minutes in the event of the car coming to rest with the engine stopped. This system must be in working order throughout the Competition even if the main hydraulic, pneumatic or electrical systems on the car have failed. This system must also disconnect any ERS system fitted to the car.

In order that the driver or a marshal may activate the system in less than five seconds, the switch or button which operates it must :

- a. Face upwards and be recessed into the top of the survival cell and be inboard of  $Y=150$  and behind  $X_c = -1150$ .
- b. Be designed in order that a marshal is unable to accidentally re-engage the clutch.
- c. Be marked with a letter "N" in red at least 40mm tall, with a line thickness of at least 4mm, inside a white circle of at least 50mm diameter with a red edge with a line thickness of at least 2mm.

## 9.5 Homologated Gearbox and Component Classification

The design of the Cassette, Driveline Components (with the exception of the gear ratios, for which the provisions of Article 9.7.2 apply), Gear-Change components and Auxiliary Components must be homologated by each gearbox supplier before the start of the 2022 season and must not be modified, except in exceptional circumstances, throughout the 2022, 2023, 2024 and 2025 seasons. A single upgrade to the gearbox specification will be permitted during this four-year period, such change only being permitted between two consecutive Championship Seasons. This will be the only gearbox design that can be used in the Championship by the supplying competitor. This upgrade must be made available to customer competitors, who may opt to continue with the original specification and upgrade in a subsequent year.

Modifications may be made to the homologated gearbox in the following cases:

- a. To resolve reliability problems.
- b. For cost saving, at the start of each season.
- c. In the case of materials, processes or proprietary parts becoming unavailable or having their use restricted for health and safety reasons.

In all cases; clear documentation justifying the change must be provided, prior approval must be obtained from the FIA, and the modification must not give any performance advantage. A summary of the modification will be circulated to all teams by the FIA.

With reference to Article 40.3 of the Sporting Regulations, if a Gearbox part is subsequently replaced after a qualifying practice session by another which differs only by one or more modifications permitted by this article 9.5, the replacement Gearbox part will be considered the same in design and similar in mass, inertia and function.

Modifications may be made for cost saving, at the start of each season, after approval has been granted by the FIA. The cost saving must be clearly documented and the modification must not give any performance advantage. A summary of the modification will be circulated to all teams.

If a team uses a Gearbox Case with an Integrated Cassette, the Gearbox Case may be modified before the start of each new season provided that:

- d. The layout of the Driveline Components, Gear-Change components and Auxiliary Components is unchanged, except for a translation, as a group, in X.
- e. The part of the case considered as Cassette remains unchanged, except for a translation in X.

Approval of the modification must be granted by the FIA.

The Gearbox, as defined in Article 9.1.1, is classified as **TRC**.

## 9.6 Gearbox Dimensions

### 9.6.1 Layout

The primary (lay) shaft must be concentric with the PU crankshaft centreline and must be driven at the same speed.

The secondary (main) shaft must lie on  $Y=0$ , above the Primary Shaft and be parallel to it. The axes of the primary and secondary shafts must be between 90mm and 100mm apart.

The axis of any gear-change barrel must be above the axis of the secondary shaft.

The distance between the front lateral gear-tooth face of the forward-most forward gear ratio pair and the rear lateral gear-tooth face of the rearward-most forward gear ratio pair must be at least 175mm. The minimum distance must be respected by both the gears on the primary (lay) shaft and the gears on the secondary (main) shaft.

The axis of the final drive (at  $X_{DIF}=0$ ) must be between  $X_R = -60$  and  $X_R = 60$ , between  $Z=250$  and  $Z=260$ , and be between 415mm and 450mm behind the front lateral gear-tooth faces of both gears of the forward-most forward gear ratio pair.

The tip diameter of the final drive gear must be at least 205mm.

#### 9.6.2 Mass

The combined mass of driveline and gear-change components must be at least 22kg.

#### 9.6.3 Gearbox Case

The Gearbox Case must fully enclose **RV-CASSETTE**. There must be no suspension components inside **RV-CASSETTE** in any condition.

### 9.7 Gear ratios

9.7.1 The number of forward gear ratios must be 8. Continuously variable transmission systems are not permitted.

9.7.2 Each Competitor must nominate the forward gear ratios (calculated from engine crankshaft to drive shafts) to be employed within their gearbox. These nominations must be declared to the FIA technical delegate at or before the first Competition of the Championship.

In the event the Competitor obtains the Gearbox from another Competitor as a TRC, the gear ratios used must be the same between those two Competitors.

For the avoidance of doubt, changes to the forward gear ratios under the provisions of this Article may involve changes to either the gear ratio pairs defined in Article 9.7.3, or to the final drive.

9.7.3 No forward gear ratio pair may be:

- a. Less than 12mm wide when measured across the gear tooth at the root diameter or any point 1mm above or below the root diameter. Above this area each side of the gear teeth may be chamfered by a maximum of  $10^\circ$ . In addition, a chamfer or radius not exceeding 2.0mm may be applied to the sides and the tip of the teeth.
- b. Less than 600g in mass (excluding any integral shaft or collar). If an integral shaft or collar is to be excluded the mass of this may be shown by calculation assuming the gear to be 12mm wide and the shaft geometry to be the same as that where slide on gears are used.

9.7.4 Gear ratio pairs must be made from steel.

### 9.8 Reverse gear

All cars must be able to be driven in reverse by the driver at any time during the Competition.

### 9.9 Gear changing

9.9.1 Automatic gear changes are considered a driver aid and are therefore not permitted.

For the purposes of gear changing, the clutch and power unit torque need not be under the control of the driver.

**9.9.2** Gear changing is restricted during the following periods:

One gear change is permitted after the race or sprint session has started and before the car speed has reached 80km/h, provided every gear fitted to the car is capable of achieving at least 80km/h at 15,000rpm.

**9.9.3** The minimum possible gear the driver is able to select must remain fixed whilst the car is moving.

Each individual gear change must be separately initiated by the driver and, within the mechanical constraints of the gearbox; the requested gear must be engaged immediately unless over-rev protection is used to reject the gear shift request. Once a gear change request has been accepted no further requests may be accepted until the first gear change has been completed.

Multiple gear changes may only be made under Article 5.22 or when a shift to gearbox neutral is made following a request from the driver.

If an over-rev protection strategy is used this may only prevent engagement of the target gear, it must not induce a delay greater than 50ms. If a gear change is refused in this way, engagement may only follow a new and separate request made by the driver.

Any de-bounce time used to condition driver gear change requests must be fixed.

**9.9.4** The maximum permitted duration for down changes and up changes is 300ms and 200ms respectively. The maximum permitted delay for the latter is 80ms from the time of the driver request to the original gear being disengaged.

The duration of a gear change is defined as the time from the request being made to the point at which all gear change processes are terminated. If for any reason the gear change cannot be completed in that time the car must be left in neutral or the original gear.

**9.9.5** Distance channel or track position is not considered an acceptable input to gearbox control.

## **9.10 Torque transfer systems**

**9.10.1** Any system or device the effect of which is capable of transferring or diverting torque from a slower to a faster rotating wheel is not permitted.

**9.10.2** Any device which is capable of transferring torque between the principal axes of rotation of the two front wheels is prohibited.

## **9.11 Driveshafts**

Driveshafts must be made from steel. The bore, more than 150mm from the ends, must be of constant diameter. At one of the ends, the internal diameter of the final 150mm must be equal to or greater than the diameter of the bore of the constant diameter section.

## ARTICLE 10: SUSPENSION, STEERING SYSTEMS, WHEELS AND TYRES

### 10.1 Definitions

#### 10.1.1 Sprung suspension

The means whereby all complete wheels are suspended from the sprung mass by a spring medium.

#### 10.1.2 Complete wheel

Wheel, inflated tyre, wheel rim covers and also the items permitted by Article 10.7.3. The complete wheel is considered part of the suspension.

#### 10.1.3 Wheel or wheel rim

Rim (including lips and barrel), spokes and centre hub.

#### 10.1.4 Legality ride height

The attitude of the unsprung mass, in relation to the sprung mass, for the assessment of its compliance to the Technical Regulations.

At the legality ride height, and with the wheels in the straight-ahead position, the origin of the wheels' coordinate system must lie between  $Z=310$  and  $Z=340$  for the front wheels, and between  $Z=200$  and  $Z=300$  for the rear wheels.

#### 10.1.5 Mass damper

A mass or system that has a degree of freedom relative to the sprung mass, which either performs no other function, or while performing another legitimate function has a compliance beyond what is necessary for its safe and reliable operation.

### 10.2 Sprung suspension

10.2.1 Cars must be fitted with sprung suspension.

10.2.2 The suspension system of each axle (front and rear) must be independent from the other axle and so arranged that its response results only from changes in load applied to the wheels of that axle.

10.2.3 The suspension system comprises of:

- a. Outboard suspension: the suspension members connecting the uprights to the sprung mass, the upright and attachments, the wheel axles and bearings, wheel fasteners and the complete wheels.
- b. Inboard suspension: the mechanical arrangement of the components that provide the vertical suspension travel response of the suspension system to the changes in load applied to the wheels.

The inboard suspension is considered to be part of the sprung mass, whereas the outboard suspension is considered to be part of the unsprung mass.

10.2.4 Any powered device which is capable of altering the configuration or affecting the performance of any part of any suspension system is forbidden.

10.2.5 No adjustment may be made to any suspension system while the car is in motion.

10.2.6 On each axle, the state of its suspension system must be uniquely defined by the angular position, and angular velocity of its two rockers. Inertial and hysteresis effects are acceptable provided they are incidental.

In addition, the following systems or configurations are not permitted:

- a. Any response of the suspension elements to body accelerations and/or angular acceleration of the rockers (e.g. any inerters, mass dampers, acceleration-sensitive valves in the dampers).

- b. Any coupling of the suspension systems to the braking or steering systems. Furthermore, any variation of ride height caused by the suspension geometry's kinematics must not exceed 2mm over the range of  $\pm 12^\circ$ , measured between the principal axis of rotation of the front wheel and an X-plane. Compliance must be demonstrated using CAD with the vehicle at the legality ride height, using a rigid set-up wheel of spherical outer surface and diameter 710 mm with its centre point at  $[X_w=0, Y_w=-178, Z_w=0]$ .

For the avoidance of doubt, fixed suspension kinematic geometries which affect the reaction of contact patch forces such as "anti-dive", "anti-squat", "anti-lift" are permissible.

- c. Any form of ride height control or alteration via self-levelling systems or feedback loops.
- d. Any change of suspension characteristics resulting from track events acting as triggers with the exception of passive damping conforming to Article 10.4.3(b).
- e. Any storing of energy via any means for delayed deployment and/or any suspension system that would result in a non-incidentally asymmetry (e.g. hysteresis, time dependency, etc.) in the response to changes in load applied to the wheels.
- f. Coupling between suspension elements, such that the state of an element(s) is used to alter the response of another element(s).
- g. Any system such as spool valves, switches, ratchets, etc. intended to change the suspension elements' characteristics between different states. Valves within a suspension damper element are acceptable as long as the only function is to provide a passive change in the damper force response whilst conforming to Article 10.4.3(b).
- h. Mass dampers, as defined in Article 10.1.5.

### 10.3 Outboard suspension

- 10.3.1 With the steering wheel rotation fixed, the position of each wheel centre and the orientation of its rotation axis must be completely and uniquely defined by a function of its principally vertical suspension travel, save only for the effects of reasonable compliance which does not intentionally provide further degrees of freedom.

Additionally, once the wheel axis system defined in Article 2.11.3 is applied, in side view the angle subtended between the  $Z_w$  axis and the Z axis may not exceed 5 deg. of variation over the range of suspension vertical travel, with the steering wheel rotation fixed. Compliance must be demonstrated using CAD.

- 10.3.2 There must be six suspension members connecting each suspension upright to the sprung mass.

Redundant suspension members are not permitted.

On the front axle, one suspension member per wheel must be connected to the steering system.

- 10.3.3 Suspension members having shared attachment points will be considered by a virtual dissection into discrete members.

- 10.3.4 The outboard attachment points of each suspension member (defined as the kinematic centre of rotation of the joint that allows relative rotation between a suspension member and its adjoining upright) must lie:

- a. outboard of  $Y_w=0$ .
- b. Above  $Z_w= -40$ .
- c. Inside the Drum defined in Article 3.13.2.

Exceptionally, the outboard attachment point of a suspension member connected inboard, to the rockers defined in Article 10.4.1 and outboard, directly to another suspension member, may not satisfy the provisions of this Article, but must in any case:

- a. lie outboard of  $Y_w=50$
  - b. no more than 25mm from the load line of the suspension member it is attaching to
  - c. together with the inboard attachment point of the same suspension member, lie on the same side of the suspension member it is attaching to when viewed from the front
- 10.3.5** On the front axle only, considering the six suspension members connected to an upright, but excluding the members connected inboard to the steering system or the rockers defined in Article 10.4.1, they must form 2 independent pairs of members each with their inboard attachment points separated in X by no less than 300mm and above  $Z=250$ mm. Furthermore to form a pair, each suspension member must also be accompanied by the suspension member with the closest outboard attachment point in  $Z_w$ .
- 10.3.6** The structural part of each suspension member must:
- a. In any normal cross section relative to its load line (defined as a straight line between the inner and outer attachment point centres of the member) have two orthogonal axes of symmetry. Over the whole length of the member, the cross section must have a constant size, shape, and incidence to the reference plane when assessed at the legality ride height.  
  
Furthermore, the centroid may not be more than 5mm from the load line with the exception of front suspension elements locally for the sole purpose of ensuring minimum clearance with the wheel rim at full steering lock.  
  
In the case of the suspension member connecting the front upright to the steering system this dimension may be up to 10mm.  
  
Minimal exceptions will be permitted for the following:
    - i. static ride height, camber, or toe adjustment components
    - ii. the passage of hydraulic brake lines, electrical looms, or wheel tethers.
    - iii. the attachment of flexures, rod ends or bearings.
    - iv. along the interface between members that are structurally connected to each other
    - v. Cut-outs to allow the passage of a suspension member connected at the inboard end to the rocker (Art 10.4.1)
    - vi. installation of strain gauge systems
  - b. Not be in contact with the external air stream, unless it is of a circular cross section when measured normal to the load line.
  - c. Not vary the angle subtended by the major axis of the cross section in (a) and the reference plane by more than  $\pm 5$ deg over the range of suspension vertical movement and by more than  $\pm 1$ deg over the range of steering movement.
  - d. One of the six rear suspension members per side may be exempt from part a) above.
- 10.3.7** It must be possible to achieve a minimum angle of  $+23^\circ/-21^\circ$  (positive angles mean toe in) between the principal axis of rotation of the front wheel and an X-plane. If necessary, the steering system may be disconnected from the suspension members or the steering arm may be changed to verify this requirement. The achievement of the minimum angles is intended at legality ride height and the bodywork defined in Articles 3.13.3, 3.13.4 and 3.13.5 may be removed.
- 10.3.8** In order to help prevent a wheel becoming separated in the event of all suspension members connecting it to the car failing, flexible tethers as specified in Article 14.4.1 must be fitted. The sole purpose of the tethers is to prevent a wheel becoming separated from the car, they should perform no other function.
- 10.3.9** Where any Suspension Member attaches to the survival cell behind  $X_A=250$ , teams should provide calculations showing that there would be no damage to the survival cell if a load of

1.25 times the compressive failure load of the leg is applied to the mounting, along the axis of the leg.

## 10.4 Inboard suspension

**10.4.1** The inboard suspensions of the front and rear axles must only be actuated via a single rocker per wheel, with only a single outboard suspension connection to each rocker.

A rocker is a mechanical device that is rigidly supported on the sprung mass and rotates about a fixed axis on the sprung mass with no other relative degree of freedom.

**10.4.2** Suspension elements can only connect to the rockers or sprung mass, where any such connection is classified as a node, subject to the following restrictions :

- a. They only permit relative rotation at their nodes.
- b. They must be so arranged that any suspension element functions only in parallel to any other, even if multiple elements are physically combined into a single component and/or share physically coincident nodes.
- c. There is only one degree of relative freedom between each element's end nodes. No functional connection may be used to any other part of the element in order to obtain, for example, a feedback signal for other parts of the suspension system.
- d. With the exception of sensors whose sole purpose is to provide data, no other device(s) may connect to a node or act on the rocker.

**10.4.3** The only permitted suspension elements are :

- a. Springs - the primary purpose of which is to absorb and release energy in a monotonically increasing load relationship with relative deflection between its nodes (or increasing torque with twist). Multiple springs may be combined in series or parallel to generate a single spring element entity between its nodes providing the result, as measured at the nodes, conforms to the monotonic requirement above and no part of the design has the purpose and/or effect of altering this relationship. Spring elements using a fluid medium are not permitted.
- b. Dampers – the primary purpose of which is to dissipate energy by generating an opposing force to the direction of motion as a function of the relative velocity between its nodes. Utilisation of heavily asymmetric damping forces for the purpose and/or effect of contravening Article 10.2.6 is not permitted. A gas spring as part of the functionality of a damper element, for the purposes of anti-cavitation, is acceptable as long as the spring rate, as measured between the nodes does not exceed 10N/mm.

Hysteresis is acceptable in an element providing it is at an incidental level and no attempt is made to utilise any inherent hysteresis to alter the response of the element relative to its primary purpose.

Links may be used to actuate the suspension elements that are mounted remotely from the rockers but cannot be used to circumvent or subvert the requirement of Article 10.2.6. Such links must be rigid and of minimal mass and design so as to achieve the linking mechanism. Links using a fluid medium are not permitted.

## 10.5 Steering

**10.5.1** The steering system is the mechanical system, on and part of the sprung mass, that converts the steering column demand into the outboard suspension position control for the re-alignment of only the two front wheels (the steered wheels).

**10.5.2** The re-alignment of the steered wheels must be uniquely defined by a monotonic function of the rotation of a single steering wheel about a single axis. Furthermore, the inboard



attachment points of the suspensions members connected to the steering system must remain a fixed distance from each other and can only translate in Y.

- 10.5.3 Power assisted steering systems may not be electronically controlled or electrically powered. No such system may carry out any function other than reduce the physical effort required to steer the car.
- 10.5.4 No part of the steering wheel or column, nor any part fitted to them, may be closer to the driver than a plane formed by the entire rear edge of the steering wheel rim. All parts fixed to the steering wheel must be fitted in such a way as to minimise the risk of injury in the event of a driver's head making contact with any part of the wheel assembly.
- 10.5.5 The steering wheel, steering column and steering rack assembly must pass an impact test, details of the test procedure may be found in Article 13.8.

## 10.6 Suspension Uprights

- 10.6.1 The upright is the structural component, in the outboard suspension, which provides the physical mounting, kinematic restraint and load path connections of the wheel axle to the suspension member outboard attachments as well as the reaction of the brake caliper loads into the suspension.

There can only be one suspension upright per complete wheel.

- 10.6.2 The loads from the suspension members and wheel bearings must individually and entirely be carried by the suspension upright. Exceptionally up to three suspension members may be connected together by titanium, aluminium alloy or steel components before their load is passed into the upright. Any such components are in any case considered to be part of the upright assembly.
- 10.6.3 No part of the upright assembly may be inboard of  $Y_w=0$  except for parts solely for the attachment and fixing of a suspension member outboard attachment point, conforming to Article 10.3.4 (a) to (c), to the upright which may encroach no more inboard than a sphere of radius 25mm about the attachment point.
- 10.6.4 The suspension uprights may only be made from UNS A92014, UNS A92618, UNS A97075 or EN/AA 7022 aluminium alloys.

## 10.7 Wheel rims

### 10.7.1 Wheel rim material

With the exception of surface treatments for appearance and protection, wheel rims must be made from AZ70 or AZ80 magnesium alloy.

### 10.7.2 Wheel rim dimensions

The front wheel rim key dimensions are:

Tyre mounting width = 335.3mm +/-0.5mm.

Outer lip diameter = 490,6mm +/-1mm.

The rear wheel rim key dimensions are:

Tyre mounting width = 429.3mm +/-0.5mm.

Outer lip diameter = 490,6mm +/-1mm.

### 10.7.3 Parts attached to the wheel rim

The only parts which may be physically attached to the wheel in addition to the tyre are surface treatments for appearance and protection, valves for filling and discharging the tyre, wheel fasteners, balance weights, drive pegs, standard supply tyre pressure and temperature monitoring sensors, wheel covers described in Article 3.13.7 and spacers on the inboard mounting face of identical specification on all wheels for the same axle.

All cars must be fitted with tyre pressure and temperature monitoring sensors which have been manufactured by an FIA designated supplier to a specification determined by the FIA.

Wheel rims and tyre pressure and temperature sensors should be marked according to the corner colouring and labelling scheme defined in the Appendix to the Technical and Sporting Regulations.

#### **10.7.4 Supply of wheel rims**

In accordance with the provisions of Article 17.4, the FIA will appoint a standard supplier for wheel rims and the Competitors will be required to use these rims.

### **10.8 Tyres**

#### **10.8.1 Tyre dimensions**

- a. Tyre width and diameter will be measured parallel to and in a plane perpendicular to respectively the wheel rotation axis with new tyres fitted and inflated to 1.4 bar.
- b. Tyre width must lie between 345mm and 375mm when fitted to the front of the car and between 440mm and 470mm when fitted to the rear.
- c. Tyre diameter must not exceed 725mm when for dry-weather tyres or 735mm for wet weather tyres.

#### **10.8.2 Tyre supply**

- a. All tyres must be used as supplied by the manufacturer, any modification or treatment such as cutting, grooving, the application of solvents or softeners is prohibited. This applies to dry, intermediate and wet-weather tyres.
- b. If, in the opinion of the appointed tyre supplier and FIA technical delegate, the nominated tyre specification proves to be technically unsuitable, the stewards may authorise the use of additional tyres to a different specification.
- c. If, in the interests of maintaining current levels of circuit safety, the FIA deems it necessary to reduce tyre grip, it shall introduce such rules as the tyre supplier may advise or, in the absence of advice which achieves the FIA's objectives, specify the maximum permissible contact areas for front and rear tyres.

#### **10.8.3 Tyre specification**

Tyre specifications will be determined by the tyre supplier, in agreement with the FIA, no later than 1 September of the previous season for the construction and 15 December for the range of compounds to be used during the Championship season. Once determined in this way, the specification of the tyres will not be changed without the agreement of the Formula One Commission.

Notwithstanding the above, the FIA may decide to change the specification during the Championship season for safety reasons without notice or delay.

#### **10.8.4 Treatment of tyres**

- a. Tyres may only be inflated with air or nitrogen.
- b. Any process the intent of which is to reduce the amount of moisture in the tyre and/or in its inflation gas is forbidden.
- c. A complete wheel must contain a single fixed internal gas volume. No valves, bleeds or permeable membranes are permitted other than to inflate or deflate the tyre whilst the car is stationary.
- d. The only permitted type of tyre heating devices are blankets that comply with the design prescriptions listed in Article 10.8.5.

Any other device, system or procedure (except for driving of the car) the purpose and/or effect of which is to heat the wheels, hubs or brakes above the ambient air temperature, or to maintain their temperature if they are already warm, is prohibited.

### 10.8.5 Tyre heating systems design prescriptions

- a. Tyre heating systems may only use resistive heating elements and act upon the outer tyre surface.
- b. No more than three temperature controllable zones may be present on a single tyre blanket.
- c. A temperature controllable zone is at most composed of one heating element (the actuator) and one or more temperature sensor(s) solidly mounted on the blanket.
- d. The blanket temperature sensors may be used to control the delivered power of the actuator using a single-input single-output (SISO) feedback control strategy approved by the FIA. There should be no other sensors involved in the temperature control strategy.

If a temperature controllable zone contains more than one temperature sensor, the signals must be arbitrated by software prior to being used in the SISO feedback control loop. Additional software design guidelines may be found in the Appendix to the Technical and Sporting Regulations.

- e. At any time during a Competition, the heating system must provide mechanisms to:
  - i. Log and download an accurate record of the last 96 hours of operations,
  - ii. Accurately display in real-time the calibration, inputs and outputs of all control and arbitration strategies,
  - iii. Enable the FIA to test the operation of any tyre heating systems.
- f. All software, hardware and wiring must:
  - i. Be approved and homologated by the FIA prior to being used at a Competition,
  - ii. Provide a unique and unambiguous identification that enables the FIA to identify and compare the versions being used to the version presented in the homologation dossier at any time during a Competition.

Additional details may be found in the Appendix to the Technical and Sporting Regulations.

## 10.9 Wheel attachment and retention

**10.9.1** The wheel must be attached to the car with a single fastener. The outer diameter of the fastener must not exceed 105mm and the axial length must not exceed 75mm. The wheel fastener may not attach or mount any part to the car except the wheel assembly described in Article 10.7.

**10.9.2** With the exception of manual torque wrenches, devices which are used to fit or remove wheel fasteners during a pit stop during the qualifying practice session, sprint session or race may only be powered by compressed air or nitrogen.

Any sensor systems may only act passively

**10.9.3** All cars, whilst under their own power, must be fitted with dual stage devices which will retain the wheel fastener in the event of it coming loose from both its full fitted position and from any angular position before the fastener begins to engage on the axle thread.

**10.9.4** Each team must provide test results which demonstrate that all dual stage devices must be able to :

- a. Withstand 20kN of axial tensile force exerted on the wheel nut in a direction away from the car centre line whilst the wheel nut is fully disengaged from the thread.
- b. Withstand 300Nm of torque exerted on the wheel nut in the unwinding direction whilst the wheel nut is partially engaged on the thread.

**10.9.5** Furthermore, the dual stage retaining systems must incorporate a means of allowing the wheel operator/fitter to visually identify an incorrectly fitted fastener.

## **10.10 Dimensions**

### **10.10.1 Suspension Width**

The origin of the front wheel axis system may not lie outboard of  $Y=635$  when the car is presented for scrutineering.

The origin of the rear wheel axis system may not lie outboard of  $Y=548$  when the car is presented for scrutineering.

## ARTICLE 11: BRAKE SYSTEM

### 11.1 Brake circuits and pressure distribution

11.1.1 With the exception of a power unit, all cars must be equipped with only one brake system. This system must consist of one pedal which operates two master cylinders. On the outlet side of the master cylinders the system must comprise of two hydraulic circuits, one circuit from one master cylinder to operate the two front wheels, the other circuit from the other master cylinder to operate the two rear wheels. The rear brake control system described in Article 11.6 will be regarded as part of circuit that operates the rear wheels. This system must be designed so that if a failure occurs in one circuit the pedal will still operate the brakes in the other.

The diameters of the master cylinders acting on the two rear wheels and the two front wheels must be within 2mm of each other and have the same available travel. The same principle must be applied in multi-stage master cylinder designs.

11.1.2 The brake system must be designed so that within each circuit, the forces applied to the brake pads are the same magnitude and act as opposing pairs on a given brake disc.

11.1.3 Any powered device, other than the system referred to in Article 11.6, which is capable of altering the configuration or affecting the performance of any part of the brake system is forbidden.

11.1.4 Any change to, or modulation of, the brake system, whilst the car is on the track must be made by the driver's direct physical input or by the system referred to in Article 11.6, and may not be pre-set.

### 11.2 Brake calipers

11.2.1 Brake calipers are defined as the parts of the braking system outside the survival cell, other than brake discs, brake pads, caliper pistons, components directly associated with the system referred to in Article 11.6, brake hoses and fittings, which are stressed when subjected to the braking pressure. Bolts or studs which are used for attachment are not considered to be part of the brake calipers.

11.2.2 All brake calipers must be made from aluminium materials with a modulus of elasticity no greater than 80Gpa.

11.2.3 No more than two attachments may be used to secure each brake caliper to the car.

11.2.4 No more than one caliper, with a maximum of six pistons, is permitted on each wheel.

11.2.5 The section of each caliper piston must be circular.

### 11.3 Brake discs and pads

11.3.1 No more than one brake disc is permitted on each wheel which must have the same rotational velocity as the wheel it is connected to.

11.3.2 All discs must have a maximum thickness of 32mm

11.3.3 The diameters of the discs are between 325mm and 330mm for the front and between 275mm and 280mm for the rear.

11.3.4 The minimum diameter of cooling holes in the discs is 3mm.

11.3.5 No more than two brake pads are permitted on each wheel. Cooling holes are not permitted in the pads.

### 11.4 Brake pressure modulation

11.4.1 No braking system may be designed to prevent wheels from locking when the driver applies pressure to the brake pedal.

**11.4.2** No braking system may be designed to increase the pressure in the brake calipers above that achieved by the driver applied force to the pedal under all conditions.

### **11.5 Liquid cooling**

Liquid cooling of the brakes is forbidden.

### **11.6 Rear brake control system**

The pressure in the rear braking circuit may be provided by a powered control system provided that :

- a. The driver brake pedal is connected to a hydraulic master cylinder that generates a pressure source that can be applied to the rear braking circuit if the powered system is disabled.
- b. The powered system is controlled by the control electronics described in Article 8.3.

### **11.7 Supply of Brake Friction and Brake System Hydraulic components**

The Brake Disks and Pads described in Article 11.3, the Brake Caliper described in Article 11.2, the Master Cylinder described in Article 11.1 and Rear brake control system described in Article 11.6 are classified as OSC, in accordance with the provisions of Article 17.6.

## ARTICLE 12: CAR CONSTRUCTION AND SURVIVAL CELL (CHASSIS)

### 12.1 Definitions and General Requirements

#### 12.1.1 Cockpit

The volume that accommodates the driver.

#### 12.1.2 Survival cell

The continuous closed structure containing the fuel tank, the cockpit and the parts of the Energy Store listed in Article 5.3.6.

The lower plate of the Energy Store assembly is considered to be part of the Survival cell.

#### 12.1.3 Cockpit padding

Non-structural parts placed within the cockpit for the sole purpose of improving driver comfort and safety. All such material must be quickly removable.

#### 12.1.4 Standard planes

- a. A-A: the plane  $X_A=0$
- b. C-C: a plane, defined by the Competitor, at  $X_A \geq 1830$
- c. B-B: the plane  $X_C = -875$

#### 12.1.5 Homologation

The survival cell must be homologated in accordance to the provisions of Article 13.

#### 12.1.6 Demonstration by Calculation

Where the regulations require a team to demonstrate the strength of a component or structure by calculation, a reserve factor of 1.0 at ultimate failure should be used for metallic components and first-ply failure for composites.

The FIA may request teams to submit models and material properties used in these calculations for inspection.

### 12.2 Survival cell specifications

#### 12.2.1 Cockpit Opening

In order to ensure that the opening giving the driver access to the cockpit is of adequate size; with the exception of the steering wheel, steering column, chassis mounted PCU8 display unit, seat and all padding required by Article 12.6.1 (including the forward most fixings), no part of the survival cell or bodywork may lie within **RV-COCKPIT-ENTRY**.

With the secondary roll structure removed, **RV-COCKPIT-ENTRY** must be entirely visible from directly above.

The shape of the survival cell must be such that no part of this volume is visible when viewed from either side of the car.

The parts of the survival cell which are situated each side of the driver's head must be no more than 550mm apart.

#### 12.2.2 Survival Cell Dimensions

Before the openings and recesses allowed in Articles 12.2.1, 12.2.4 and 12.2.5 are created, a single volume, which is symmetrical about  $Y=0$ , continuous, and has no apertures must be defined in accordance with the conditions laid out in (a)-(d), below. For this purpose, the panels specified in 12.3.2 and 12.3.3 are considered part of the survival cell.

- a. The minimum dimensions of the survival cell between  $X_A=0$  and  $X_C=0$  are defined by the union of **RV-CH-FRONT-MIN** and **RV-CH-MID-MIN**.

- b. The maximum dimensions of the survival cell between  $X_A=0$  and  $X_B=0$  are defined by the union of **RV-CH-FRONT** and the portion of **RV-FLOOR-BODY** that lies forward of  $X_B=0$  and inboard of  $Y=210$ .
- c. Material may be removed from the upper front part of the volume defined in (a) and (b) above. In order to do so, a Z-plane must be defined such that the remaining part of **RV-CH-FRONT-MIN** below it is at least 250mm high in every X-plane ahead of  $X_C=-1600$ . Material may only be removed above this Z-plane and ahead of  $X_C=-1600$ , in two stages:
  - i. After the first stage of material removal, the external surface of the survival cell forward of  $X_C=-1590$ , including parts of the survival cell ahead of  $X_A=0$ , must enclose all mechanical components and associated brackets of the inboard front suspension at Legality Ride Height. Furthermore, any normal to this external surface must not subtend an angle greater than  $25^\circ$  to an X-plane, with the exception of the areas covered by the structural part of the front impact structure.
  - ii. In the second stage, further material may be removed down to the Z-plane defined above. In every X-plane, a cumulative total width of 150mm must remain from the surfaces created in the first stage of material removal.

Structure that lies above the Z-plane and ahead of  $X_C=-1600$  may be removable provided that the fastenings can resist a load of [50, 0, -30] kN, to be demonstrated by calculation.

- d. With the exception of any minimal apertures for front suspension members, and a recess for the timing transponder, the external surfaces of the survival cell and the external surfaces of the structural part of the front impact structure must coincide over the entire periphery of the survival cell at its front bulkhead.

### 12.2.3 Identification Transponders

Every survival cell must incorporate three FIA supplied transponders for identification purposes. These transponders must be a permanent part of the survival cell, be positioned in accordance with Drawing 2 and must be accessible for verification at any time.

### 12.2.4 Openings in the Survival Cell

The survival cell must have an opening for the driver, the dimensions of which are given in Article 12.2.1. Any other ducts, or openings in the survival cell must only:

- a. Be of the minimum size, and for the sole purpose of, allowing access to mechanical components. In front view, these openings, may not increase the exposed part of any mechanical components of the front suspension, at Legality Ride Height, by more than  $2000\text{mm}^2$ . Openings covered by the structural part of the front impact structure will not be considered for this assessment.
- b. Be for the sole purpose of cooling the driver or mechanical or electrical components, the area of any such duct or opening may not exceed  $3000\text{mm}^2$ .
- c. Be for the sole purpose of routing wiring looms, cables or fluid lines, the total combined area of any such openings must not exceed  $7000\text{mm}^2$ .

### 12.2.5 Recesses in the Survival Cell Minimum Volume

Recesses are permitted in the Survival Cell minimum volume, defined in Article 12.2.2, for the following:

- a. For the sole purpose of, allowing the side impact structures and their mountings to be installed in accordance with Article 13.5.1. The area of each such recess for each side impact structure must not exceed  $8\,000\text{mm}^2$  when projected onto a Y-plane.
- b. For the sole purpose of allowing the secondary roll structure front fixing and fairings to be installed in accordance with Articles 12.4.2 and 3.12.3 (b). The total area of any such recess must not exceed  $50\,000\text{mm}^2$ .



- c. Minimal Recesses for the sole purpose of mounting mandatory components. Including but not limited to; timing transponder, PDM-F1 unit, F1MS Antenna, position 5 camera, medical light, datum-target seats, ERS Status Light, and clutch disengagement button.
- d. Minimal Recesses for the sole purpose of mounting team specified components. Including but not limited to; suspension brackets, suspension fairings, slip-angle sensor, bib stay mounting, and antennae.

Furthermore:

- e. The step surfaces of recesses no more than 3mm deep are not required to comply with the angle constraints of 12.2.2.c.i.
- f. Any recesses in areas covered by Article 12.3.1 - Anti Intrusion Laminate, must comply with that article's requirements for maintaining equivalent intrusion strength.

#### 12.2.6 Structure behind the driver

The parts of the survival cell immediately behind the driver which separate the cockpit from the car's fuel tank, must lie outside **RV-COCKPIT-DRIVER**.

No head and neck support worn by the driver may be less than 25mm from any structural part of the car when he is seated in his normal driving position.

#### 12.2.7 Front Floor Structure

Below the survival cell, a structure, called "Front Floor Structure" must be fitted.

The Front Floor Structure:

- a. Must lie within **RV-BIB** and be fully enclosed by the Floor Bodywork as specified in Article 3.5.6 such that no part of the structure is in contact with the external air flow.
- b. Must be rigidly mounted to the Survival Cell using at least 4 fasteners.
- c. Must only deform in the event of an impact with the ground.

Furthermore, the Front Floor Structure and Floor Auxiliary Component described in Article 3.5.7 b:

- a. Must not incorporate any component, mechanism or structure whose characteristics vary with time, velocity, acceleration or temperature. Including, but not limited to viscous damping, hysteretic damping and hydraulic systems.
- b. Must not incorporate any parts which may systematically or routinely exhibit permanent deformation.
- c. Must not be designed in such a way, or incorporate any component, mechanism or structure that can cause it to exhibit anything other than the same load deflection relationship measured during the test described in Article 3.15.6 whilst on the circuit (other than minor incidental effects such as those caused by inertia).

#### 12.2.8 Chassis Datum Points

For aligning the car for scrutineering, the survival cell should have the necessary precisely machined details to allow for the relevant legality datum points defined in Article 3.2.6 to accurately positioned.

### 12.3 Intrusion Protection

In order to protect the driver and the fuel cell in case of an impact, the sides and lower surfaces of the survival cell must comply with the following requirements.

#### 12.3.1 Anti-Intrusion Laminate

The sides and lower surfaces of the survival cell should be constructed to the laminate **PL-CHASSIS-SIDE** as specified in Article 15.6.

Additional plies may be added to this laminate. The core thickness or density may be increased or the core may be replaced with solid inserts.

Between  $X_B=-100$  and 100mm behind the rear of **RV-CH-MID-STRUCT**, the core may be supplemented or replaced by an alternative reinforcing method.

In all cases, the FIA technical delegate must be satisfied that the overall strength of the structure has been improved by doing so and that its ability to pass the test given by "Side Intrusion Test Procedure 02/05", as defined in the Appendix to the Technical and Sporting Regulations is maintained.

This laminate should extend in a longitudinal sense from A-A to the rear of the survival cell.

The laminate should cover:

- a. From A-A to B-B, all surfaces which lie on or outside **RV-CH-FRONT-MIN** and which in side view are more than 50mm below the top curve of this volume. Any panel covering the Timing Transponder required by Article 8.16 is excluded from this requirement.
- b. From BB to the rear of the survival cell, all surfaces below  $Z=550$  and above  $Z=100$ .

### 12.3.2 6.2mm Zylon Panel

Two panels, no less than 6.2mm thick, constructed from 16 plies of Zylon and two plies of carbon (precise lay-up instructions may be found in the Appendix to the Technical and Sporting Regulations) must be permanently attached to each side of the underlying survival cell structure with an appropriate adhesive which has been applied over their entire surface.

These panels must cover all surfaces more than 140mm from  $Y=0$ , which in side view, lie between B-B, two lines at  $Z=100$ mm and  $Z=570$ mm and a curve that is offset 50mm rearward and normal to the rearmost intersection of **RV-COCKPIT-DRIVER** with  $Y=0$  between the two horizontal lines. Furthermore, when viewed from the side, the panel must cover **RV-COCKPIT-ENTRY**.

A 50mm linear taper may be included at the forward and rearward boundaries of the panel, and a 20mm linear taper may be included at the upper boundary of the panel behind  $X_C=-375$ . The taper dimensions are measured normal to the boundaries.

Cut-outs in these panels totalling 50 000mm<sup>2</sup> per side will be permitted for fitting around side impact structures, the survival cell openings described in article 12.2.4, datum-target seats, and essential fixings.

Recesses in the panel, permitted under Article 12.2.5, are limited to the outer four Zylon plies only and may have a total area of no more than 75 000mm<sup>2</sup> per side of the car.

### 12.3.3 3mm Zylon Panel

One further panel, which may be made in a maximum of four parts but which is no less than 3.0mm thick, constructed from seven plies of Zylon and two plies of carbon (precise lay-up instructions may be found in the Appendix to the Technical and Sporting Regulations), must then be permanently attached to the underlying survival cell structure with an appropriate adhesive which has been applied over its entire surface including all overlapping joints.

This panel must cover the outer skin of the underlying survival cell structure lying:

- a. Between  $X_A=300$  and B-B, all surfaces which in side view are more than 50mm below the top curve of **RV-CH-FRONT-MIN**.
- b. Between B-B and  $X_C=-350$ , the sides and under-surfaces of the survival cell below  $Z=200$  and are not covered by the panel defined by Article 12.3.2.

A 25mm horizontal linear taper may be included at the forward and rearward boundaries of the panel.

This panel must overlap the panel defined by Article 12.3.2 along all joining edges by a minimum of 25mm. If made in more than one part, all adjacent panels must overlap by a minimum of 25mm. All overlaps may include linear tapers in the thickness of both overlapping parts.

Cut-outs in this panel totalling 30 000mm<sup>2</sup> per side will be permitted for fitting around the survival cell openings described in article 12.2.4, datum-target seats, and essential fixings.

Recesses in the panel, permitted under Article 12.2.5, are limited to the outer three Zylon plies only and may have a total area of no more than 75 000mm<sup>2</sup> per side of the car.

#### 12.3.4 Frontal Intrusion

It must be demonstrated by calculation that during a collision, the rear impact structure of a car ahead could not enter the survival cell through the front bulkhead if the Front Impact Structure were not present. For this calculation, a load of [220, 0, 0] kN should be applied through a pad of the same dimensions as the prescribed rear impact structure, anywhere on the front bulkhead of the survival cell. The pad should not intrude into the survival cell more than 50mm behind AA. All components normally attached to the survival cell, except for the Front Impact Structure, must be considered in this evaluation.

#### 12.3.5 Cockpit Side Structure

The survival cell visible from the side that covers **RV-CH-MID-MIN** must be designed to resist the force of an impacting Front Impact Structure, at up to 350kN. This should be demonstrated by the tests and calculations defined in Article 13.4.8

The volume **RV-CH-MID-STRUCT** may only contain

- i. Survival cell structure
- ii. Wiring looms or cables, excluding connectors, electrical boxes, or other electrical components
- iii. Electrical components that require direct driver input
- iv. Fluid lines and their fittings
- v. Fire extinguisher nozzles, tubes and brackets
- vi. Padding for driver comfort
- vii. Ducts for the sole purpose of cooling the driver and/or mechanical and/or electrical components

### 12.4 Roll Structures

All cars must have two roll structures that are designed to help prevent injury to the driver in the event of the car becoming inverted.

#### 12.4.1 Principal Roll Structure

The principal roll structure must:

- a. Have structure at Z=968 at X<sub>c</sub>=55.
- b. Have a minimum enclosed structural cross section of 6000mm<sup>2</sup>, in vertical projection, across a horizontal plane at Z=950. The cross-sectional area may not be less than 6000mm<sup>2</sup> below this plane.
- c. Above Z=935, have the external surface that is tangent continuous, and does not contain any concave radius of curvature. Any convex radius of curvature must be no smaller than 20mm.

Compliance will be assessed without considering an opening in the structure to allow aerodynamic ducts to pass through. Any such opening must be below Z=955

Minimal local deviations from this surface are permitted where the load pad described in Article 13.3.1 contacts the structure, at the intersection of the external surface and openings for an internal duct, and for the mounting of Camera 4.

- d. Have a minimum enclosed structural cross section of 10000mm<sup>2</sup>, in vertical projection, across a horizontal plane at Z=910. The area thus established must not exceed 200mm in length or width and may not be less than 10000mm<sup>2</sup> below this point.

When evaluating the above, only parts that genuinely contribute to the strength of the principal roll structure will be considered and no fairings may be included. Parts of the

structure above Z=935 must be designed to support the car in a 15g vertical impact with the ground and be made from an abrasion resistant material.

In order that a car may be lifted quickly in the event of it stopping on the circuit, the principal rollover structure must incorporate an unobstructed opening, whose section measures 60mm x 30mm with internal radii of no more than R15mm, clearly visible in side view, to permit a strap to pass through it.

It must be shown by calculation that this opening is capable of resisting a load of 20kN applied by a strap in an upwards direction, on the ZX plane between +45° and -45° to the Z-axis. In designs where the strap could be threaded in different ways, calculations must be provided for all possibilities.

#### **12.4.2 Secondary Roll Structure (Halo)**

The secondary roll structure, which is not considered part of the survival cell, must be positioned symmetrically about the car centre plane with its front fixing axis at  $X_C = -975$  and  $Z = 660$ . The mounting faces for the rearward fixings must lie on the plane  $Z = 695$ .

The secondary roll structure must be made to standard FIA8869-2018 and supplied by an FIA designated manufacturer. Details of the structure and its mountings may be found in the Appendix to the Technical and Sporting Regulations.

The FIA will take the appropriate measures to ensure that secondary roll structures supplied by different FIA designated manufacturers are of similar mass.

### **12.5 Cockpit Specification**

#### **12.5.1 Entry and Exit**

The driver must be able to enter and get out of the cockpit without it being necessary to open a door or remove any part of the car other than the steering wheel or the headrest as defined in Article 12.6.1.

From his normal seating position, with all seat belts fastened and whilst wearing his usual driving equipment, the driver must be able to remove the steering wheel and get out of the car within 7 seconds and then replace the steering wheel in a total of 12 seconds.

For this test, the position of the steered wheels will be determined by the FIA technical delegate and after the steering wheel has been replaced steering control must be maintained.

#### **12.5.2 Helmet Position**

When seated normally, the driver must be facing forwards and the rearmost part of his crash helmet must be between  $X_C = -50$  and  $X_C = -125$ .

The driver's helmet must lie below a line drawn between the front fixing axis of the secondary roll structure and a point 75mm vertically below the highest point of the principal roll structure.

#### **12.5.3 Steering Wheel**

The steering wheel, at any rotation, must lie below a line drawn between the front fixing axis of the secondary roll structure and a point 75mm vertically below the highest point of the principal roll structure.

The steering wheel must be at least 50mm behind the front edge of the cockpit opening.

The steering wheel must be fitted with a quick release mechanism operated by pulling a concentric flange installed on the steering column behind the wheel.

The steering wheel must be positioned so as it intersects RV-COCKPIT-HELMET at all angular positions.

#### **12.5.4 Internal cockpit volumes**

- a. With the exception of the steering wheel, pedal assembly, driver's seat, and any padding that is required by Article 12.6.2, no part of the car may lie within a volume

created by sweeping the outer vertical section shown in Drawing 3 of Appendix 2 between  $X_{C=}$  -850 and  $X_{C=}$  -1415.

- b. With the exception of the steering wheel, steering column, driver's seat, and pedal assembly, no part of the car may lie within a volume created by sweeping the inner vertical section shown in Drawing 3 of Appendix 2 between  $X_{C=}$  -850 and  $X_{C=}$  -1515.
- c. No part of the car may lie within the volume defined in **RV-COCKPIT-DRIVER** with the exception of:
  - i. Items required for driver comfort or restraint e.g., the seat and its mountings, seatbelts and their mountings, drinks system, padding required by Article 12.6.1.
  - ii. Items required for the driver to control the car e.g. steering wheel, steering column, dash display, switch panels, associated looms, driver microphone & earpiece.
  - iii. Items that need to be accessed whilst the driver is seated in the car e.g. SDR download connector, connector for driver radio, associated looms, ES dousing connector.
  - iv. Driver ballast.
  - v. wiring looms or cables, excluding connectors, electrical boxes, or other electrical components.
  - vi. Fire extinguisher nozzles, tubes, and brackets.
  - vii. Fluid lines and their fittings
  - viii. The accelerometer close to the centre of gravity, required by Article 8.10.2.
  - ix. The accelerometer required by Article 8.20.
- d. The driver, seated normally with his seat belts fastened and with the steering wheel removed must be able to raise both legs together so that his knees are past the plane of the steering wheel in the rearward direction. This action must not be prevented by any part of the car.

#### 12.5.5 Position of the Pedals

The face of the foremost pedal, when in the inoperative position, must be situated behind  $X_{C=}$  -1515.

It must be possible to mount the pedals with the face of the brake pedal as far forward as  $X_{C=}$  -1515. When mounted in this position, the brake pedal, through the full pedal sweep, must maintain at least 10mm longitudinal clearance from any structure or component that could limit further movement.

## 12.6 Cockpit Padding

### 12.6.1 Headrest

All cars must be equipped with three areas of padding for the driver's head which:

- a. Are so arranged that they can be removed from the car as a single part.
- b. Are made from a material which is suitable for the relevant ambient air temperature, details of approved materials and the temperature bands in which they should be used may be found in the Appendix to the Technical and Sporting Regulations.
- c. Are covered, in all areas where the driver's head is likely to make contact, with laminate **PL-HEADREST**.
- d. Are positioned to be the first point of contact for the driver's helmet in the event of an impact projecting his head towards them during an accident.
- e. Must have a cover and internal structure which have no features that obstruct the padding's freedom to compress to 5% of its uncompressed thickness.

- f. Must be so installed that if movement of the driver's head, in any expected trajectory during an accident, were to compress the padding fully at any point, his helmet would not make contact with any structural part of the car.
- g. Do not obscure sight of any part of the driver's helmet when he is seated normally and viewed from directly above the car.

#### Rear Padding

The first area of padding for the driver's head must be positioned behind him, be between 260mm and 380mm wide and be between 75mm and 90mm thick over an area of at least 40000mm<sup>2</sup>. If necessary, and only for driver comfort, an additional piece of padding no greater than 10mm thick may be attached to this headrest provided it is made from the same material.

#### Side Padding

Two areas of padding must be positioned either side of the driver's head. These areas must:

- h. Be symmetrically positioned about Y=0.
- i. Be positioned with their upper surfaces at least as high as the survival cell over their entire length.
- j. Have a radius on their upper inboard edge no greater than 10mm.
- k. Be positioned in order that, forward of X<sub>C</sub>=-150, the distance between the two is no less than 320mm.
- l. Be as high as practicable within the constraints of driver comfort.
- m. Extend as far forward as the forward face of **RV-COCKPIT-HELMET**.

Between X<sub>C</sub>= -75 and X<sub>C</sub>= -400 and above Z=545, the padding must be at least 95mm thick over an area greater than 35750mm<sup>2</sup> when viewed from the side of the car. This minimum thickness must be maintained to the upper edges of the survival cell and over their entire length. The minimum thickness will be assessed perpendicular to the car centre plane and prior to the application of the radius required by (j).

Furthermore, any void between these areas of padding and the rear part described above must also be completely filled with the same padding material.

If necessary, and only for driver comfort, an additional piece of padding no greater than 20mm thick may be attached to these headrests provided they are made from the same material which incorporates a low friction surface.

Forward of X<sub>C</sub>= -400, further padding must be provided on each side of the cockpit rim. The purpose of the additional padding is to afford protection to the driver's head in the event of an oblique frontal impact and must therefore be made from the same material as the other three areas of padding with the same cover material.

#### Fixings

The Headrest should be fixed in a way that is clearly indicated and should be easily removable without tools. Fixings should consist of:

- n. Two cylindrical longitudinal pegs with a diameter of at least 6mm and with an engagement of at least 12mm into the rear of the cockpit opening
- o. A keyhole fixing at X<sub>C</sub>= -250 ±50mm and Z=610 ±25mm on each side of the car. These fixings must comply with 12.6.1 (e) and the receptacle mounted on the survival cell must be flush with the survival cell structure. These fixings must prevent the headrest from moving laterally or vertically with up to 12mm of forward movement of the headrest. They may not be inside RV-COCKPIT-HELMET and should be designed to minimize the risk of injury should the driver come in contact with them during an accident.

- p. A quick release fixing which is clearly indicated at the front corner on each side of the car. No tape or similar material may be used to cover the forward fixings of the headrest.

#### **12.6.2 Leg Padding**

In order to minimise the risk of leg injury during an accident, additional areas of padding must be fitted each side of, and above, the driver's legs.

These areas of padding must:

- a. Be made from a material described in the Appendix to the Technical and Sporting Regulations.
- b. Be no less than 25mm thick over their entire area.
- c. Cover the area situated between the plane B-B and 100mm behind the face of the rearmost pedal when in the inoperative position.
- d. Cover the area 50mm above the lower surface of the volume defined in Article 12.5.4.a, over its entire length, as defined in (c) above.

#### **12.7 Seat fixing and removal**

In order that an injured driver may be removed from the car in his seat following an accident, all cars must be fitted with a seat which, if it is secured, must be done so with no more than two bolts. If bolts are used they must be:

- a. Clearly indicated and easily accessible to rescue crews.
- b. Fitted vertically.
- c. Removable with the same tool for all teams and which is issued to all rescue crews.

The seat must be equipped with receptacles which permit the fitting of belts to secure the driver and one which will permit the fitting of a head stabilisation device.

The seat must be removable without the need to cut or remove any of the seat belts.

Details of the tool referred to above, the belt receptacles and the head stabilisation device may be found in the Appendix to the Technical and Sporting Regulations.

#### **12.8 Driver Fit Information**

Driver-fit information may be transferred between teams. Such information may include CAD geometries and measurements directly relating to driver-fit but must not include construction details.

Information that can be transferred includes: seat geometry, helmet position, steering wheel position, seatbelt installation, elbow and knee clearance, pedal position, pedal-pad geometry, and heel-rest geometry.

In all cases, the content of the information to be transferred must be approved by the FIA before it is exchanged.

## ARTICLE 13: SAFETY STRUCTURES AND HOMOLOGATION

### 13.1 General Principles

- 13.1.1 The purpose of this Article is to define the safety structures of the car and all the homologation processes necessary to guarantee that each car that is eligible to race satisfies all the relevant requirements.
- 13.1.2 Should a fundamental weakness or sub-optimal level of safety become evident in either the definition of the structures or the homologation procedures, the FIA retains the right to modify the relevant regulations without observing the deadlines otherwise dictated by the prevailing governance regulations. In any case, such actions will be discussed in the Technical Advisory Committee.
- 13.1.3 All impact tests must be carried out in accordance with FIA Test Procedure 01/00, in the presence of an FIA technical delegate and by using measuring equipment which has been calibrated to the satisfaction of the FIA technical delegate. A copy of the test procedure may be found in the Appendix to the Technical and Sporting Regulations.
- 13.1.4 Any significant modification introduced into any of the structures tested shall require that part to pass a further test.
- 13.1.5 With the exception of tests described by Article 13.3.2, all static and dynamic load tests must be performed with the secondary roll structure (whether dummy or otherwise) removed.
- 13.1.6 All homologation tests on the survival cell will be carried out before the Zylon panels described in 12.3.2 and 12.3.3 have been fitted.

### 13.2 Survival Cell Frontal Impact Test

A 50mm (+/-1mm) thick aluminium plate should be attached to the front bulkhead of the survival cell through the mounting points of the frontal impact absorbing structure. The plate should:

- a. Measure 430mm (+/-1mm) wide x 430mm (+/-1mm) high.
- b. Be fitted symmetrically about the car centre plane.
- c. Be fitted in a vertical sense in order to ensure force distribution is similar to that with the nose fitted.
- d. Have seven M10 x 30mm holes in the outer face arranged in a grid pattern as shown in the diagram below. The test laboratory will then fit a 5mm thick 430mm x 430mm steel plate to these holes using a 5mm washer stack.

All parts which could materially affect the outcome of the test must be fitted to the test structure which must be solidly fixed to the trolley through its engine mounting points but not in such a way as to increase its impact resistance.

The fuel tank must be fitted and must be full of water.

A dummy weighing at least 75kg must be fitted with safety belts described in Article 12.5.6 fastened. However, with the safety belts unfastened, the dummy must be able to move forwards freely in the cockpit. The dummy shall be equipped with a helmet to FIA8860 or FIA8859 and an FHR to FIA8858 (the mass of the helmet and FHR should be recorded, but should not be included in the 75kg). The safety belts shall be fastened to represent in-race conditions.

The fire extinguishers, as described in Article 14.1 must also be fitted.

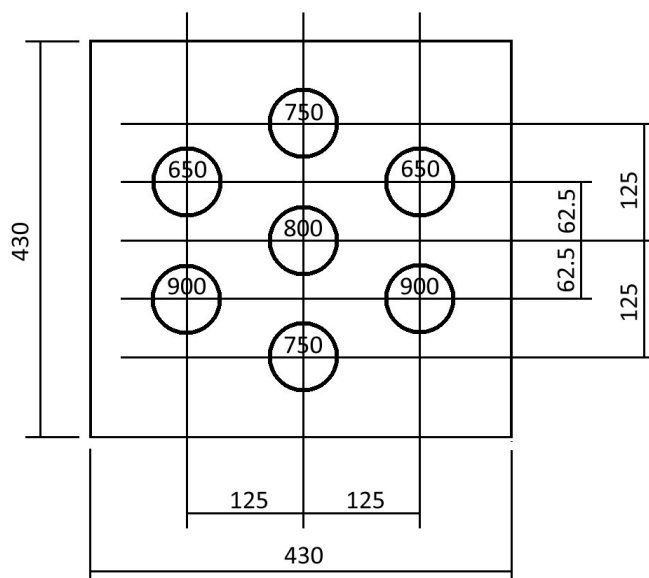
For the purposes of this test, the total mass of the trolley and test structure shall be between 900kg and 925kg and the velocity of impact not less than 15 metres/second.

The impact wall must be fitted with seven carbon composite crush tubes which develop a combined 500kN nominal load as follows:



- a. 2 x tubes, 900mm long, from T-zero to T-end, directed into the lower left and right M10 attachment points.
- b. 1 x tube, 800mm long, from T-100mm to T-end, directed into the central M10 attachment point.
- c. 2 x tubes, 750mm long, from T-150mm to T-end, directed into the central upper and lower M10 attachment points
- d. 2 x tubes, 650mm long, from T-250mm to T-end, directed into the upper left and right M10 attachment points.

The specification of the tubes and details of how they should be mounted is given in the Appendix to the Technical and Sporting Regulations.



The resistance of the test structure must be such that following the impact there is no damage to the survival cell or to the mountings of the safety belts or fire extinguishers.

The maximum deceleration in the chest of the dummy for a cumulative 3ms shall be reported, this being the resultant of data from the three orthogonal axes.

This test may be carried out on any survival cell provided it has been successfully subjected to the tests described in Articles 13.3.1, 13.3.2 and 13.4. The test must however be carried out on the survival cell which was subjected to the test described in Article 13.4.9.

The minimum chassis acceleration from T=30ms is 52g.

The maximum chassis displacement from T=Zero is 425mm.

### 13.3 Roll Structure Testing

13.3.1 The principal roll structure must be subjected to the following static tests:

- a. A load equivalent to 60kN laterally, 70kN longitudinally in a rearward direction and 105kN vertically downwards, must be applied to the top of the structure through a rigid flat pad which is 200mm in diameter and perpendicular to the loading axis.
- b. A load equivalent to 42kN laterally, 49kN longitudinally in a forward direction and 73.5kN vertically downwards, must be applied to the top of the structure through a rigid flat pad which is 200mm in diameter and perpendicular to the loading axis.

For each test:

- i. Initially, the pad must not contact the roll structure below Z=935.
- ii. At any time during the test, the pad must not contact the structure below Z=900.
- iii. Rubber 3mm thick may be used between the load pads and the roll structure.

- iv. The peak load must be applied in less than three minutes and be maintained for 10 seconds.
- v. Under the load, deformation must be less than 25mm when measured along the loading axis and any structural failure limited to 100mm below the top of the roll structure when measured vertically.
- vi. During the test, the roll structure must be attached to the survival cell which is supported on its underside on a flat plate, fixed to it through its engine mounting points and wedged laterally by any of the static load test pads described in Article 13.4.2.

Before performing the physical tests specified above, the Competitor must submit detailed calculations to show that the principle roll structure and survival cell are able to sustain the following loads:

- c. The test described in (b) with a load equivalent to 60kN laterally, 70kN longitudinally in a forward direction and 105kN vertically downwards.

The methodology for the calculations shall be authenticated by comparing data from the physical test (b).

- d. A load of 140kN vertically downwards, applied to the centre of the top of the structure through a rigid flat pad which is 200mm in diameter and perpendicular to the loading axis.
- e. A load of 50kN applied normal to the surface through a 10mm diameter pad, anywhere on the structure above Z=935.

**13.3.2** The secondary roll structure attachments must be subjected to the following two static tests. For each test:

- a. Rubber 3mm thick may be used between the load pads and the roll structure.
- b. A secondary roll structure as prescribed by 12.4.2 must be fitted.
- c. The loads shall be applied using a 150mm diameter flat, rigid pad whose centre lies in the specified loading position. The pad shall have only one translational degree of freedom, this being along the axis of load application.
- d. For each test, peak loads must be applied in less than three minutes and be maintained for five seconds.
- e. After five seconds of application, there must be no failure of any part of the survival cell or of any attachment between the structure and the survival cell.

#### Centreline Test

A load equivalent 130.1kN vertically downward and 51.6kN longitudinally rearward must be applied at a position  $[X_c -785, 0, 830]$ . in one of the following two ways:

- a. A physical test to 100% of the test load (140kN); or
- b. A physical test to 57% of the test load (80kN) plus detailed calculations to show that the attachments are able to sustain more than 120% of the test load (168kN) when fitted with the secondary structure as specified in Article 12.4.2 and with the deformation simulated as elastic.

The methodology for the calculations shall be authenticated with data from the physical test prescribed above for the load range from 0kN to 80kN. The load and displacement shall be recorded along the axis of load application together with the vertical displacement of the three attachments.

During the test, the structure must be attached to the survival cell which is supported on its underside on a flat plate, fixed to it through its engine mounting points and, optionally, through the front bulkhead and/or the mountings of the lower side impact structures.

## Lateral Test

A load equivalent to 104.5kN laterally inward and 93.2kN longitudinally rearward must be applied to the outer surface of the structure at a position [ $X_c$  -590, 233.5, 810]. in one of following two ways:

- a. A physical test to 100% of the test load (140kN); or
- b. A physical test to 71% of the test load (100kN) plus detailed calculations to show that the attachments are able to sustain more than 120% of the test load (168kN) when fitted with the secondary structure as specified in Article 12.4.2 and with the deformation simulated as elastic.

The methodology for the calculations shall be authenticated with data from the physical test prescribed above for the load range from 0kN to 50kN. The load and displacement shall be recorded along the axis of load application together with the lateral displacement of the three attachments.

During the test, the survival cell should be fixed at its rear bulkhead via its engine mounts to a strongwall and supported along its lower face by a surface plate.

The survival cell may be restrained laterally and vertically at its front end by a cradle that wraps around all four sides of the survival cell. This cradle may extend as far forward as the plane A-A, but may not extend further rearwards than  $X_A=600$ .

The side of the survival cell that is opposite to the application point of the Halo test load may be restrained laterally by supports that conform to the sides of the survival cell. These lateral supports may not extend further forward than  $X_C=-1075$  or above  $Z=545$ .

A drawing of the method of support is given in the Appendix to the Technical and Sporting Regulations

**13.3.3** In addition to the static load tests described above, each team must supply detailed calculations which clearly show that:

- a. The survival cell will sustain a load of 75kN vertically upward on each rear attachment of the Secondary Roll Structure.
- b. The survival cell and bracket will sustain a load equivalent to 99kN vertically upward and 99kN longitudinally rearward on the axis of the front attachment of the Secondary Roll Structure.

## 13.4 Survival Cell Load Tests

### 13.4.1 Conditions applicable to all static load tests

- a. The tests described in Articles 13.4.2 to 13.4.7 must be carried out on every survival cell intended for use. During these tests (on deflections greater than 3.0mm), the deflection across the inner surfaces must not exceed 120% of the deflection obtained on the survival cell used for the tests described in Articles 13.3.1 and 13.3.2.
- b. The tests described in Articles 13.4.8 13.4.9 and 13.4.11 must be carried out on the survival cell used for the tests described in Articles 13.3.1 and 13.3.2.
- c. Deflections and deformations will be measured at the centre of area of the load pad unless otherwise stated.
- d. All peak loads must be applied in less than three minutes, through a ball jointed junction at the centre of area of the pad and maintained for 30 seconds.
- e. All tests must be carried out by using measuring equipment which has been calibrated to the satisfaction of the FIA technical delegate.
- f. A radius of 3mm is permissible on the edges of all load pads and rubber 3mm thick may be placed between them and the test structure.
- g. For the tests described in Articles 13.4, the survival cells must always be produced in an identical condition in order that their mass may be compared. If the mass differs by

more than 5% from the one subjected to the impact test described in Article 13.2 further frontal and side impact tests and roll structure tests must be carried out.

- h. Any significant modification introduced into any of the structures tested shall require that part to pass a further test.
- i. The Survival cell may be mounted in any orientation provided that the mounting arrangement does not increase the strength or stiffness of the survival cell being tested.

#### **13.4.2 Survival cell fuel tank side test**

Pads of diameter 200mm, which conform to the shape of the survival cell, must be placed against the outermost sides of the survival cell with the centre of the pad 150mm above the lowest part of the survival cell at that section. The centre of these pads will coincide, in the longitudinal direction, with an X-plane passing through the centroid of the fuel tank. The technical delegate may select however to alter the longitudinal position for this test if he considers the above criterion to not correspond to the weakest position of the survival cell side in the area of the fuel tank.

A constant transverse horizontal load of 50kN will be applied and, under the load, there must be no structural failure of the inner or outer surfaces of the survival cell.

Deflections and deformations will be measured at the centre of the pad.

Permanent deformation must be less than 1.0mm after the load has been released for 1 minute.

#### **13.4.3 Survival cell wheel contact side test**

Pads 200mm in diameter which conform to the shape of the survival cell, must be placed against the outermost sides of the survival cell. The centre of these pads must lie:

- a. In the X- direction, on an X-plane passing through the rearmost point at which the outer end of the forward-most front wheel tether would make contact with the survival cell when swung about the inner attachment.
- b. In the Z-direction, at the mid-point of the height of the structure at that section.

A constant transverse horizontal load of 40kN will be applied to the pads and, under the load, there must be no structural failure of the inner or outer surfaces of the survival cell and the total deflection must not exceed 15mm.

Permanent deformation must be less than 1.0mm after the load has been released for 1 minute.

#### **13.4.4 Survival cell floor test**

A pad of 200mm diameter must be placed on the survival cell floor, in a position determined by the FIA technical delegate, and corresponding to the fuel tank. A vertical upwards load of 25kN will be applied.

Under the load, there must be no structural failure of the inner or outer surfaces of the survival cell.

Permanent deformation must be less than 0.5mm after the load has been released for 1 minute.

#### **13.4.5 Cockpit floor test**

A pad of 200mm diameter must be placed beneath the survival cell, at  $[X_c, Y] = [-600, 0]$ , and a vertical upwards load of 30kN applied.

Under the load, there must be no structural failure of the inner or outer surfaces of the survival cell.

Permanent deformation must be less than 0.5mm after the load has been released for 1 minute.

#### 13.4.6 Cockpit rim tests

Two pads, each of which is 50mm in diameter, must be placed on both sides of the cockpit rim with their upper edges at the same height as the top of the cockpit side with their centres at  $X_C = -250$ .

A constant transverse horizontal load of 50kN will then be applied at 90° to the car centre plane and, under the load, deformation must be less than 10mm when measured along the loading axis and there must be no structural failure of the inner or outer surfaces of the survival cell.

Permanent deformation must be less than 1.0mm after the load has been released for 1 minute.

#### 13.4.7 Cockpit Side Test 1

A 225mm diameter pad which conforms to the shape of the survival cell at the load application point, must be placed against the outermost sides of the survival cell, centred at  $[X_C, Z] = [-520, 400]$ .

At the Competitor's discretion, a load of either  $[0, 200, 0]$ kN or  $[48.6, 194, 0]$ kN shall be applied through a ball joint and, under the load, there must be no structural failure of the inner or outer surfaces of the survival cell and the total deflection must not exceed 15mm. The load and displacement shall be recorded along the axis of load application.

Permanent deformation must be less than 5mm after the load has been released for 1 minute.

The chassis support conditions shall be the same as those for the lateral test in Article 13.3.2., but the chassis may be mounted in any orientation, provided that the supports do not increase the strength of the survival cell in this load case, beyond the Article 13.3.2 arrangement.

A temporary spacer constructed to the same specification as the panels described in Article 12.3.2 with a maximum diameter of 325mm may be placed between the pad and the survival cell.

#### 13.4.8 Cockpit Side Test 2

A 225mm diameter pad which conforms to the shape of the survival cell at the load application point, must be placed against the outermost sides of the survival cell, centred at  $[X_C, Z] = [-520, 400]$ .

At the Competitor's discretion, a load of either  $[0, 300, 0]$ kN or  $[72.9, 291, 0]$ kN shall be applied through a ball joint and, under the load, there must be no structural failure of the inner or outer surfaces of the survival cell and the total deflection must not exceed 30mm. The load and displacement shall be recorded along the axis of load application.

After 5 seconds of application, there must be no failure of the survival cell.

The chassis support conditions shall be the same as those for the lateral test in Article 13.3.2., but the chassis may be mounted in any orientation, provided that the supports do not increase the strength of the survival cell in this load case, beyond the Article 13.3.2 arrangement.

A temporary spacer constructed to the same specification as the panel described in Article 12.3.2 and with a maximum diameter of 325mm may be placed between the pad and the survival cell.

In addition to the physical test, the team shall provide detailed calculations to show that the cockpit side is able to sustain a lateral load of 380kN applied at the following 6 positions.  $[X_C, Z]$ ;  $[-320, 490]$ ,  $[-690, 490]$ ,  $[-690, 320]$ ,  $[-520, 400]$ ,  $[-585, 150]$ , and  $[-450, 320]$ .

The methodology for the calculations shall be authenticated by comparing data from the physical test for the load range from 0kN to 275kN and the calculated case.

#### 13.4.9 Nose Push-off Test

During this test, the survival cell must be resting on a flat plate and secured to it solidly but not in a way that could increase the strength of the attachments being tested.

A dummy front impact structure may be used for this test. The 250mm of the dummy structure closest to the survival cell should be identical in design and construction to the structure used in 13.6.2. The dummy structure should not in any way increase the strength of the survival cell or of the attachment between the survival cell and the impact structure.

A constant transversal horizontal load of 66.7kN must be applied to one side of the impact structure at  $X_A = -750$  and at the mid-point of the height of the structure used in 13.6.2. All loads must be applied through a ball-jointed junction at the centre of area of the pad.

After 30 seconds of application, there must be no failure of the survival cell or of any attachment between the structure and the survival cell.

Additionally, teams must supply calculations that show that there would be no failure of the survival cell or of any attachment between the structure and the survival cell if a load of 83kN were applied  $X_A = -750$  through the dummy structure.

#### 13.4.10 Engine Separation

It must be demonstrated by calculation that in the case of an accident that causes the engine to become separated from the survival cell, significant structural failure of the survival cell does not occur.

The survival cell should be restrained ahead of the seatback bulkhead. A load of  $[F_x, F_y, M_z] = K \cdot [-1N, 5N, 3Nm]$ , acting through and about  $[X_{PU} = 0, 0, 210]$ , should be applied to the survival cell through the engine mounts using a representative engine. K should be increased up to the first engine mount failure. The analysis should be repeated, disconnecting the failed fixing until only two engine fixings remain. In all cases, the failure should remain local to the engine mounts and there should be no significant exposure of the fuel cell.

#### 13.4.11 Forward Survival Cell Test

A rigid pad measuring 200mm in X and 320mm in Y which has a single degree of freedom along the direction of loading, must be placed against the outer surface of the survival cell. The pad should conform to the shape of the parts of the survival cell that either lie on or outside **RV-CH-FRONT-MIN** or that comply with 12.2.2.c.i. The load axis must lie:

- On the  $Y=0$  plane
- In a position between the front of the survival cell and  $X_C = -1600$ , determined by the technical delegate and communicated to the team two weeks before the homologation.
- Normal to the surface of the survival cell.

A constant load of 30kN will be applied and, under the load, there must be no structural failure of the inner or outer surfaces of the survival cell and the deflection must be less than 5mm.

A cradle may be used on the opposite side of the survival cell to react the load.

### 13.5 Side Impact Structure

#### 13.5.1 Side Impact Structure Specification

Two impact absorbing structures must be fitted on each side of the survival cell and must be solidly attached to it. The purpose of these structures is to protect the driver in the event of a lateral impact and, in order to ensure this is the case, strength tests of the mountings must be carried out successfully. Details of the test procedure may be found in Articles 13.5.3 and 13.5.4.

The impact absorbing structures must be manufactured and mounted to the survival cell in accordance with the following specifications:

- a. The construction and geometry of the structures may be found in the Appendix to the Technical and Sporting Regulations.
- b. The structures must be mounted with the principal axes of their prismatic mounting sections perpendicular to the longitudinal and vertical centre plane of the car, and with an incidence (defined as the angle between the major axis and  $Z=0$ ) of  $0^\circ$  for the upper structure and within the range of  $0^\circ$  and  $-10^\circ$  (nose up) for the lower structure.

The centres of area of their outermost longitudinal vertical cross sections must be positioned:

- i. Longitudinally: between  $X_c = -525$  and  $X_c = -475$  for the upper structure and between  $X_c = -525$  and  $X_c = -375$  for the lower structure.
- ii. Vertically: between  $Z=460$  and  $Z=550$  for the upper structure and between  $Z=100$  and  $Z=240$  for the lower structure.
- iii. Laterally: Within 15mm of each other.

Refer to the drawings which may be found in the Appendix to the Technical and Sporting Regulations.

The two side impact structures must be fully enclosed by bodywork, and hence no part of them should be exposed to the external air stream.

- c. Mountings must be permanently bonded to the structures to enable them to be attached to the survival cell, each of them must :
  - i. Incorporate a closed end and internal abutment to the impact structure that must be capable of withstanding the lateral load described in Article 13.5.4 without a structural contribution from the bonded interface.
  - ii. Lie entirely inboard of a plane which lies 292mm inboard of the outermost longitudinal vertical cross section of the impact structure.
  - iii. Be arranged in order that the outermost surface created by an interface between the mounting and structure lies on a vertical surface that is located between the plane defined in c.ii) and a vertical plane which intersects the leading and trailing edges of the structure no more than 357mm and 332mm inboard of the outermost longitudinal vertical cross section of the impact structure respectively.
  - iv. Be arranged in order that the innermost extent of the bonded interface between the mounting and structure is offset inboard by a minimum of 44mm from the vertical surface defined in (iii) above.
  - v. Be arranged in order that the bonded interface covers the entire external area of the structure between the innermost and outermost extents defined in iii) and iv) above.
- d. To allow for debris compaction, the internal volumes of the structures must be empty outboard of vertical planes which:
  - i. For the upper structure, intersects the leading, and trailing edges of the structure at least 342mm inboard of the outermost longitudinal vertical cross section of the impact structure. Furthermore, the projected area of the structure onto a Z-Plane, between this plane and the plane defined in c.ii) must be greater than  $7440\text{mm}^2$ .
  - ii. For the lower structure, intersects the leading, and trailing edges of the structure at least 357mm inboard of the outermost longitudinal vertical cross section of the impact structure. Furthermore, the projected area of the structure onto a Z-Plane, between this plane and the plane defined in c.ii) must be greater than  $9225\text{mm}^2$ .

No parts which, in the opinion of the FIA technical delegate, would prevent proper function of the impact structures in the event of a lateral impact may be present in the volume lying between  $X_c = -700$  and  $X_c = -300$ , and between  $Z=50$  and  $Z=600$ , and outboard of a plane 280mm inboard of the outermost longitudinal vertical cross section of the impact structures.

The following components may be placed in this volume;

- i. Bodywork
- ii. Components of the oil and coolant systems and charge air cooling (excluding any secondary heat exchangers)
- iii. Electrical systems (excluding electrical pumps and filters)
- iv. Pneumatic pressure vessels (excluding regulators operating at over 5 barG inlet pressure)
- v. Brake system, hydraulic system and pneumatic system hoses

Provided that;

- i. The construction of any of the components is such that they would not, in the opinion of the FIA technical delegate, cause significant damage to the survival cell in the event of a lateral impact,
- ii. Components of the oil and coolant systems and charge air cooling, electrical units and pneumatic pressure vessels are no closer than 20mm at any point to the closest impact structure,
- iii. Electrical units and pneumatic vessels;
  - have a total volume that does not exceed 2 litres on each side of the survival cell,
  - have an individual assembly density of no more than 1500 kg/m<sup>3</sup>,
  - are orientated such that corners or edges are not likely to cause significant damage to the survival cell in the event of a lateral impact.

#### 13.5.2 Side impact structure push-off calculations

Each team must supply detailed calculations which clearly show that the mountings of the upper and lower side impact structures are capable of withstanding:

- a. Horizontal loads of 40kN and 60kN applied simultaneously to the upper and lower structures respectively in a rearward direction through ball-jointed pads, which may conform to the shape of the structures, measuring 100mm high x 100mm wide and whose centre of area lies 100mm inboard of the centre of the outermost longitudinal vertical cross-section of the impact structure.
- b. Horizontal loads of 40kN and 60kN applied simultaneously to the upper and lower structures respectively in a forward direction through ball-jointed pads, which may conform to the shape of the structures, measuring 100mm high x 100mm wide and whose centre of area lies 100mm inboard of the centre of the outermost longitudinal vertical cross-section of the impact structure.
- c. A vertical load of 35kN applied in an upward direction to the lower impact structure through a ball-jointed pad, which may conform to the shape of the structure, measuring 200mm long x 100mm wide whose centre of area lies 100mm inboard of the centre of the outermost longitudinal vertical cross section of the impact structure.
- d. A vertical load of 27kN applied in a downward direction to the upper impact structure through a ball-jointed pad, which may conform to the shape of the structure, measuring 200mm long x 100mm wide whose centre of area lies 100mm inboard of the centre of the outermost longitudinal vertical cross section of the impact structure.

In all cases, the calculations should show that there will be no structural failure of the parts. It should be assumed that ball-jointed pads are used, the joint lying at the centre of area of the pad.

#### 13.5.3 Side impact structure push-off tests

These tests may be carried out on any survival cell provided it has been successfully subjected to the tests described in Articles 13.3 and 13.4. The tests may be performed on either side of the survival cell.



During the push off tests the survival cell must be resting on a flat plate and secured to it solidly but not in a way that could increase the strength of the attachments being tested.

Temporary spacers representing part sections of the panels described in Article 12.3.2 and 12.3.3 may be incorporated within the assembly of the impact structures to the survival cell. These spacers may not in any way increase the strength of the survival cell being tested.

Dummy test parts may be used in place of the impact structure provided the test part incorporates identical mounting details to those described in Article 13.5.1 and does not in any way increase the strength of the attachments being tested.

During the first test rearward horizontal loads of 40kN and 60kN must be applied simultaneously to the upper and lower structures respectively through ball joints or ball-jointed pads whose centre of area lies 100mm inboard of the centre of the outermost cross-section of the dummy impact structures.

During the second test an upward vertical load of 35kN must then be applied to the lower impact absorbing structure using a ball joint or a ball-jointed pad whose centre of area lies 100mm inboard of the centre of the outermost cross section of the dummy lower impact structure.

After five seconds of application there must be no failure of any structures or of any attachment between the structure and the survival cell.

#### **13.5.4 Side impact structure squeeze tests**

This test may be carried out on any survival cell which has been subjected to the tests described in Articles 13.3 and 13.4. The test may be performed on either side of the survival cell.

During the test, the survival cell may be supported in any way provided this does not increase the strength of the attachments being tested.

Temporary spacers representing part sections of the panels described in Article 12.3.2 and 12.3.3 may be incorporated within the assembly of the impact structures to the survival cell. These spacers cannot in any way increase the strength of the survival cell being tested.

Dummy test parts may be used in place of the impact structure provided the test parts incorporate identical mounting details to those described in Article 13.5.1 and do not in any way increase the strength of the attachments being tested.

Loads of 100kN and 150kN must be applied simultaneously to the dummy upper and lower structures respectively in a lateral direction using a hemispherical pad or ball joint, loading through the centre cross section, 292mm from the outermost longitudinal vertical cross-section of both impact structures.

After five seconds of application, there must be no failure of the survival cell or the attachments between the structures and the survival cell.

Each team must supply detailed calculations which clearly show that the mountings of the upper and lower side impact structures satisfy the requirement of 13.5.1.(c).(i).

### **13.6 Front Impact Structure**

#### **13.6.1 Front Impact Structure Specification**

An impact absorbing structure must be fitted in front of the survival cell. This structure need not be an integral part of the survival cell but must be solidly attached to it and be arranged symmetrically about the car centre plane.

The impact absorbing structure must affix to the survival cell using a minimum of four attachments having the same nominal strength.

Its forward-most point must be forward of  $X_F = -1150$ . The X-planes D-D and E-E are defined as respectively 50mm and 150mm behind this forward-most point.

This structure, excluding fairings or removable wing, must have:

- a. A single external vertical cross-section at the plane D-D. The area of the part of this section that lies less than 100mm from  $Y=0$  must exceed  $9000\text{mm}^2$ .
- b. A single external vertical cross-section whose area exceeds  $20000\text{mm}^2$  at the plane E-E.
- c. Ahead of the plane D-D, no part above  $Z=235$
- d. Behind the plane D-D, no part above a plane normal to  $Y=0$  and containing points  $[Y, Z]$   $[0, 235]$  in plane D-D and  $[0, 305]$  in plane E-E.
- e. Each external X-plane cross-section between E-E and  $X_A = -100$ , must be a single section with an area which exceeds a value given by a linear taper from  $20000\text{mm}^2$  to  $60000\text{mm}^2$  respectively.
- f. Behind an X-plane 100mm behind E-E, with the exception of bodywork joggles, any normal to the external surface of the Impact structure must not subtend an angle greater than  $25^\circ$  to an X-plane.
- g. All lines drawn normally and externally to a cross-section taken at  $X_A = -100$  must not cross the car centre plane.

Once the requirements of a-g have been met, minimal apertures may be applied for mechanical components or sensors.

Any bodywork ahead of the plane defined in d), and above  $Z=235$ , and less than 166mm from the centre plane must be constructed of laminate **PL-LWT-FAIRING**.

### 13.6.2 Front Impact Structure Push-Off Tests

During these tests, the nose must be mounted to the same fixture that is used for the test described in Article 13.6.3.

#### a. Lateral Push-off test

A constant transversal horizontal load of 66.7kN must then be applied to one side of the impact absorbing structure, using a pad 200mm long and 300mm high, at  $X_A = -750$ .

All loads must be applied through a ball-jointed junction at the centre of area of the pad.

The stiffness of the pad may be chosen by the team.

Rubber or foam may be used between the pad and the test structure.

The centre of area of the pad must pass through the plane mentioned above and the mid-point of the height of the structure at the relevant section. After 30 seconds of application, there must be no failure of the structure or of any attachment between the structure and the fixture.

#### b. Wing Section Push-off Test

Two equal loads, each equivalent to 3.2kN vertically downward and 2.2kN longitudinally rearward, must be applied simultaneously to the wing section at  $Y=\pm 250\text{mm}$ . The load vector should intersect the top surface of the wing section between 75mm and 200mm behind the leading edge of the forward wing element, measured in the X-direction.

The loads shall be applied through a ball joint, using rectangular pads measuring no more than 100mm in Y and no more than 200 mm in X and with the lower surface shaped to match the wing section. 3mm rubber or foam may be used between the pad and the test structure. The pads must lie entirely between 200mm and 300mm from the plane  $Y=0$ .

After 30 seconds of application, there must be no failure of the impact structure or of any attachment between the impact structure and the wing section.

### 13.6.3 Front Impact Structure Dynamic Test

To simulate in-car conditions, all parts that could materially affect the outcome of the test must be fitted to the test structure. The test structure must be solidly fixed, either to the

trolley or to the impact wall, through the mounting points of the nose structure, but not in such a way as to increase its impact resistance.

If the test facility includes a system to manage excess residual energy (in the event that the nose structure fails to absorb all the test energy), such a system must not in any way modify the results during a successful test.

For the purposes of this test, the total mass of the trolley and test structure shall be 900kg (+1%/-0) and the velocity of impact not less than 17 ms<sup>-1</sup>.

The resistance of the test structure must be such that during the impact:

- a. The deceleration profile measured in g from the first deformation of the complete assembly to 0.354m forward of AA does not exceed the limit curve defined by 14.16/X, where X = the longitudinal distance from AA calculated by the test laboratory in metres.
- b. Exceptionally, when filtered with a CFC60 filter (ISO 6487), the limit curve may be exceeded for a maximum cumulative period of 15ms and an absolute ceiling of 20g.
- c. The average deceleration over the first 150mm of deformation of the impact absorbing structure defined article in 13.6.1 exceeds 2.5 g.
- d. The peak deceleration does not exceed 40g.
- e. After the impact, the remaining length of the impact absorbing structure must be greater than 100mm. This will be measured between the furthest point that the trolley reaches and the most forward of:
  - i. Any significant change in the construction of the impact structure such as inserts, or openings.or
  - ii. Any mechanical components mounted to the survival cell ahead of the front bulkhead.

Furthermore, there must be no damage to the mountings of the nose.

This test must be carried out on the frontal impact absorbing structure which was subjected to the test described in Article 13.6.2.

## 13.7 Rear Impact Structure

### 13.7.1 Rear Impact Structure Definition

An impact absorbing structure must be fitted behind the gearbox in accordance with the following specifications:

- a. Between  $X_{DIF}=325$  and  $X_{DIF}=750$ , the external geometry of the Rear Impact Structure must conform to **RV-TAIL-RIS** with a manufacturing tolerance of  $\pm 0.5$ mm.
- b. The rearmost face of the structure must be positioned at  $X_{DIF}=750$ . The upper surface of the structure on  $Y=0$  must lie at  $Z=372.5$ . A tolerance of  $\pm 2$ mm will be accepted for manufacturing reasons only.
- c. To minimise the likelihood of the structure penetrating a survival cell, it must be designed so that the majority of its material lies evenly around its perimeter. The perimeter of any X-plane between points 50mm forward of its rear face and 200mm forward of its rear face must be of a uniform construction and have a minimum thickness of 1.6mm. Material with a specific gravity of less than 1 will not be considered when calculating these thicknesses and, furthermore, any internal structure must not be thicker than any part of the perimeter at that section.

Only those parts of the structure which genuinely contribute to its performance during the impact test, and which are designed and fitted for that sole purpose, will be considered when assessing compliance with any of the above.

- d. No parts which, in the opinion of the FIA technical delegate, would prevent proper function of the impact structure in the event of a rear impact may be present behind  $X_{DIF}=325$ .

The Rear Impact structure is classed as TRC.

### 13.7.2 Rear impact Structure Static Load Tests

To verify the strength of the gearbox and the attachment of the rear impact structure to the gearbox, the gearbox and impact structure must pass three static load tests.

During the tests, the gearbox should be solidly fixed to ground but not in a way that could increase the strength of the joint being tested.

The gearbox and crash structure will be subjected to the following separate tests:

- a. A lateral load of 40kN applied at the mid-height of the structure at  $X_{DIF}=500$  applied using a pad measuring 100mm in X and at least 150mm in Z.
- b. A load of 40kN vertically upwards applied on the car centre plane at  $X_{DIF}=500$  applied using a pad measuring 100mm in X and at least 100mm in Y.
- c. A load of 40kN vertically downwards applied on the car centre plane at  $X_{DIF}=500$  applied using a pad measuring 100mm in X and at least 100mm in Y.

These pads should conform to the shape of the rear impact structure and their centres of area must pass through the plane mentioned above and the mid-point of the height/width of the structure at the relevant section.

A radius of 3mm is permissible on the edges of all load pads and rubber 3mm thick may be placed between them and the test structure.

In each case, the load should be applied through a ball-joint and after 30 seconds of application, there must be no failure of the impact structure, of the gearbox, or of the attachment between the impact structure and the gearbox.

### 13.7.3 Rear impact Structure Dynamic Test

All parts which will be fitted behind the rear face of the engine and which could materially affect the outcome of the test must be fitted to the test structure. If suspension members are to be mounted on the structure they must be fitted for the test. The structure and the gearbox must be solidly fixed to the ground and a solid object, having a mass of 900kg (+1%/-0) and travelling at a velocity of not less than 11 metres/second, will be projected into it.

The object used for this test must be flat, measure 450mm (+/-3mm) wide by 550mm (+/-3mm) high and may have a 10mm radius on all edges. Its lower edge must be at the same level as the car reference plane (+/-3mm) and must be so arranged to strike the structure vertically and parallel to the plane C-C.

During the test, the striking object may not pivot in any axis and the crash structure may be supported in any way provided this does not increase the impact resistance of the parts being tested.

The resistance of the test structure must be such that during the impact:

- a. The deceleration profile measured in g does not exceed the limit curve defined by  $15 + 26.5 X$ , where X = the longitudinal distance from the start of the impact, calculated by the test laboratory in metres.
- b. The maximum deceleration does not exceed 25g.
- c. For  $X > 0.225m$ , the maximum deceleration does not exceed the limits defined in (a) and (b) for more than a cumulative 15ms.

Furthermore, all structural damage must be contained within the area behind  $X_R=0$ .

This test must be carried out on the rear impact absorbing structure which was subjected to the test described in Article 13.7.2.

### 13.8 Steering Column Impact Test

The parts referred to in Article 10.5.5 must be fitted to a representative test structure; any other parts which could materially affect the outcome of the test must also be fitted. The test structure must be solidly fixed to the ground and a solid object, having a mass of 8kg (+1%/-0) and travelling at a velocity of not less than 7metres/second, will be projected into it.

The object used for this test must be hemispherical with a diameter of 165mm (+/-1mm).

For the test, the centre of the hemisphere must strike the structure at the centre of the steering wheel along the same axis as the main part of the steering column.

During the test the striking object may not pivot in any axis and the test structure may be supported in any way provided this does not increase the impact resistance of the parts being tested.

The resistance of the test structure must be such that during the impact the peak deceleration of the object does not exceed 80g for more than a cumulative 3ms, this being measured only in the direction of impact.

After the test, all substantial deformation must be within the steering column and the steering wheel quick release mechanism must still function normally.

### 13.9 Headrest Load Test

The headrest must pass a load test. The load applied will be  $P = (700 \times m_{HR})N$ , where  $m_{HR}$  is the mass of the complete headrest in kg fitted with 'pink' Confor foam. The load may be applied either:

- a. With the headrest mounted in a dummy cockpit surround, a force of  $[-P/2, 0, 0]$  will be applied simultaneously to each of two positions on the back of the headrest, at  $Z=630\text{mm}$  and  $Y=\pm 130\text{mm}$ .

or

- b. With the headrest mounted in the car, a force of  $[-P, 0, 0]$  will be applied, evenly shared between two pull rods, to the back of the headrest, at  $Z=630\text{mm}$  and  $Y=\pm 130\text{mm}$ . The pull rods should pass through holes in the headrest of no greater than 2.5mm diameter. The force should be reacted against the secondary roll structure forward mount.

At the test load, the pegs at the rear of the headrest must remain engaged in the holes in the chassis or dummy chassis, and there must be no failure of the headrest backing structure or the quick release mountings.

Load spreader plates may be used to apply the load to the back of the headrest provided that each load spreader is more than 80mm and less than 180mm from the car centre-plane.

## ARTICLE 14: SAFETY EQUIPMENT

### 14.1 Fire Extinguishers

All cars must be fitted with a fire extinguishing system which will discharge into the cockpit and into the engine compartment. The fire extinguishing system must be approved according to the "FIA Standard for Plumbed-in Fire Extinguisher Systems in Competition Cars".

Any extinguishant listed in the Appendix to the Technical and Sporting Regulations is permitted.

The quantity of extinguishant may vary according to the type of extinguishant used, a list of quantities may be found in the Appendix to the Technical and Sporting Regulations.

When operated, the fire extinguishing system must discharge 95% of its contents at a constant pressure in no less than 10 seconds and no more than 30 seconds.

If more than one container with extinguishant is fitted, they must be released simultaneously.

In the case of a pressurized system, each pressure vessel must be equipped with a means of checking whether the extinguisher is in an operable condition. Operable conditions are defined by the extinguisher manufacturer.

The following information must be visible on each container with extinguishant:

- a. Type of extinguishant.
- b. Mass or volume of the extinguishant.
- c. Date the container must be checked which must be no more than two years after the date of filling.

All parts of the extinguishing system must be situated within the survival cell and all extinguishing equipment must withstand fire.

Any triggering system having its own source of energy is permitted, provided it is possible to operate all extinguishers should the main electrical circuits of the car fail.

The driver must be able to trigger the extinguishing system manually when seated normally with his safety belts fastened and the steering wheel in place.

Furthermore, a means of triggering from the outside must be combined with the circuit breaker switches described in Article 8.7. They must be marked with a letter "E" in red at least 80mm tall, with a line thickness of at least 8mm, inside a white circle of at least 100mm diameter with a red edge with a line thickness of at least 4mm.

The system must work in any position, even when the car is inverted.

All extinguisher nozzles must be suitable for the extinguishant, included in the homologation of the fire extinguishing system, and be installed in such a way that at least one nozzle and is aimed at the driver's midriff.

### 14.2 Rear view mirrors

14.2.1 All cars must have two mirrors positioned symmetrically about the car's centre plane and mounted so that the driver has visibility to the rear and both sides of the car.

14.2.2 The reflective surface of each mirror must satisfy the following conditions:

- a. It must be contained within **RV-MIR-HOU** and not be obstructed by the Mirror Housing, as defined in Article 3.6.4 either towards the driver or in the rearward direction.
- b. Its four edges must project orthogonally onto the edges of a vertical rectangle which is 200mm wide and 50mm high (+2mm/-0mm for both dimensions), with a radius of up to 10mm applied to each corner.
- c. Over its whole area it must:
  - i. not contain any concave parts

- ii. be tangency continuous
- iii. not have any normal radius of curvature less than 400mm.
- d. When cut by any Z-Plane and before any radius is applied to the corners:
  - i. the normal to the curve at its inboard end must subtend an angle of between 24deg and 28deg to the X axis, pointing towards the Y=0 plane.
  - ii. the angle between normals to the curve at its inboard and outboard ends must be greater than 8 degrees.

For the avoidance of doubt, any non-reflective parts of the mirror must be contained within the Mirror Body.

**14.2.3** Teams will be required on request to supply the FIA with CAD data with regard to the visibility of their mirror arrangement, and the FIA will retain the right to modify the position of the volume defined in Article 3.6.4 (a) should it become apparent that the mirror position does not meet the safety requirements.

### 14.3 Rear lights

**14.3.1** All cars must have three rear lights in working order throughout the Competition which:

- a. Have been supplied by FIA designated manufacturers.
- b. Are clearly visible from the rear.
- c. Can be switched on by the driver when seated normally in the car.

**14.3.2** The first such light must have:

- a. Its rear face on an X-Plane and at least 750mm behind  $X_{DIF}=0$ .
- b. The centre of its rear face on  $Y=0$ .
- c. The centre of its rear face between  $Z=295$  and  $Z=305$ .

**14.3.3** Two further lights must be fitted, one on each side of the car, within the bodywork defined in Article 3.10.7. Each such light must:

- a. Be positioned in full compliance with Article 3.10.7.
- b. May be curved in the plane of the lens of the LED elements with a radius of not less than 200mm.
- c. The normal to the plane of the lens of the LED elements must be no more than 5° from the X-axis.
- d. Lie in its entirety between  $Z=500$  and  $Z=870$ .
- e. Respect the directionality of the lens of the LED elements, which should point in a nominally horizontal direction towards the rear of the car.
- f. Be fitted in accordance with the instructions detailed in the Appendix to the Technical and Sporting Regulations.

**14.3.4** Both types of rear light are classed as **SSC**, and all the relevant details can be found in the Appendix to the Technical and Sporting Regulations.

### 14.4 Safety Tethers

#### 14.4.1 Wheel Tethers

Each wheel must be fitted with three tethers, each with a cross sectional area greater than 110mm<sup>2</sup> and each of which comply with FIA standard 8864-2013 and each of which has a minimum energy absorption of 7kJ. No suspension member may contain more than two tethers.

Each tether must have its own separate attachments at both ends, which:

- a. Are able to withstand a tensile force of 70kN in any direction within a cone of 45° (included angle) measured from the load line of the relevant suspension member.
- b. Are able to accommodate tether end fittings with a minimum inside diameter of 15mm.
- c. Do not share a common fastener and are designed such that the failure of one attachment point will not lead to the direct failure of an adjacent attachment point.
- d. Furthermore, at least two of the three tethers must have attachment points which:
  - i. On the survival cell are separated from each other by at least 300mm in the X-direction, measured between their centres.
  - ii. On the gearbox are separated from each other by at least 250mm in the X-direction, measured between their centres.
  - iii. On each wheel/upright assembly are separated by at least 90° radially with respect to the rotational axis of the wheel and 100mm measured between the centres of the two attachment points.

Each tether must exceed 450mm in length and must utilise end fittings which result in a tether bend radius greater than 7.5mm.

Each team must supply detailed geometries which clearly show that all of the three tethers will independently prevent a wheel from making contact with a driver's head during an accident, with the secondary roll structure fitted, assuming 40% elongation in each tether.

#### 14.4.2 Rear Wing Tethers

The rear wing assembly must be fitted with two tethers. Each tether should have a cross sectional area of at least 7mm<sup>2</sup> and a minimum breaking strength of 5kN.

The outer end of each tether should be attached to opposite sides of the rear wing assembly between 500mm and 600mm from the plane Y=0, between X<sub>R</sub>=150 and X<sub>R</sub>=400, and above Z=675. Each attachment must be able to withstand 5kN and the minimum bend-radius of the tether at the attachment is 3mm.

The inboard end of each tether should be attached ahead of X<sub>DIF</sub>=300 and below Z=610. The attachments must be able to withstand 7.5kN if independent or 15kN if common. The minimum bend-radius of the tether at the attachment is 3mm.

Alternatively, the two tethers may be joined to a single tether with a cross sectional area of at least 14mm<sup>2</sup> and a minimum breaking strength of 10kN using a fitting able to withstand 15kN and with a minimum bend radius of the tethers of 3mm. The inboard end of this tether should be attached ahead of X<sub>DIF</sub>=300, and below Z=610, with attachments able to withstand 15kN and with a minimum bend radius of the tether of 3mm.

Teams must provide calculations demonstrating that the inboard attachment point would remain connected if the wing assembly becomes detached.

#### 14.4.3 Rear Impact Structure Tether

The rear impact structure should be attached to the gearbox case with a tether with a cross sectional area of at least 20mm<sup>2</sup>, a minimum breaking strength of 24kN and a length of at least 600mm. The attachment to the gearbox case should be ahead of X<sub>DIF</sub>=300, should be able to accommodate the tether with a minimum bend radius of 6mm. This fixing should withstand a load of 20kN in a rearward direction at up to 22.5° from the X-axis. The attachment to the RIS should be behind X<sub>DIF</sub>=650, should be able to accommodate the tether with a minimum bend radius of 6mm. This fixing should withstand a load of 20kN in a forward direction.

### 14.5 Safety Harnesses

It is mandatory to wear a safety harness that has been homologated to FIA Standard 8853-2016. The safety harness must be used in accordance with the safety harness manufacturer's instructions and must be securely fixed to the car. Approved harnesses are listed in Technical List n°57.



## ARTICLE 15: MATERIALS

### 15.1 Definitions

#### 15.1.1 Commercially Available material

A material that:

- a. Is available on a non-exclusive basis and under normal commercial terms to all Competitors.
- b. Is not supplied to a specification tighter than the standards listed in Section 15.3 (where applicable) with a primary aim of improving the baseline mechanical properties. Additional specifications concerned with process control and/or quality control are permissible.
- c. Has no restrictions or agreements in place that prevents the supplier from openly marketing it.

#### 15.1.2 Material definitions in Article 5

The following materials are defined in Article 5.16, however their definition is applicable to any part of the car:

- a. X-Based Alloy (e.g. Ni Based Alloy) – See 5.16.1
- b. X-Y Based Alloy (e.g. Al-Cu based alloy) – See 5.16.2
- c. Intermetallic Material – See 5.16.3
- d. Metal Matrix Composite – See 5.16.5
- e. Ceramic Material – See 5.16.6

#### 15.1.3 Shape Memory Material

A material that is configured to move reversibly between two (or more) different shapes when it is subjected only to a non-mechanical uniform stimulus (thermal, electrical, magnetic, optical, etc.), or exhibits a reversible phase change when subject to an applied stress. For clarity, this does not include consequential geometric changes that result solely from the effects of thermal expansion.

#### 15.1.4 Foil Metallurgy

A process by which a material or component is made by the consolidation of metallic foils (by co-forging, welding etc.) which increases the mechanical properties of the material with respect to those of a bulk material. For this definition, a foil is considered a material with a thickness of less than 1mm.

#### 15.1.5 Metallic Materials Used for Additive Manufacture

A group of materials in powder form used for manufacturing near-net shape components from a digital model processed in separate layers and joined by either selective melting, bonding, or sintering.

### 15.2 General Principles

- 15.2.1 Materials used in the construction of the Formula One car – excluding the power unit - are limited to those defined in article 15.3 and to the specific exceptions in article 15.5.
- 15.2.2 Materials used in the power unit are defined in Article 5.
- 15.2.3 All materials used must be commercially available.
- 15.2.4 No parts of the car may be made from metallic materials that have a specific modulus of elasticity greater than 40GPa / (g/cm<sup>3</sup>). Tests to establish conformity will be carried out in

accordance with FIA Test Procedure 03/03, a copy of which may be found in the Appendix to the Technical and Sporting Regulations.

- 15.2.5 A team may submit a proposal to the FIA to add or to remove a material from this article. The proposal should include mechanical characteristic, cost, and supply considerations. The proposal will be considered by the TAC after the teams have reviewed the proposal.
- 15.2.6 Materials that are a direct equivalent to permitted materials may be added by presenting justification to the FIA, who may at its absolute discretion ask more information or tests to be carried out to support the claim.
- 15.2.7 Teams are required to make submissions of the materials that they will use on the car by the end of January of the year of the championship. These shall be listed at the same level of detail as presented in Section 15.3. This information will be compiled, anonymised and circulated to all teams by the end of March of the same year.

### 15.3 Permitted Materials

With the exception of materials specifically permitted for certain components, as listed in Article 15.5, only the following materials may be used:

#### 15.3.1 Metallic Materials – Not Used for Additive Manufacture

- a. Iron Alloys: any
- b. Aluminium Alloys:
  - i. Aluminium based alloys from the 1xxx, 2xxx, 3xxx, 4xxx, 5xxx, 6xxx and 7xxx series containing less than 1% Lithium.
  - ii. In addition, the specific alloys 2099, 2199, 2050 and 2055 are permitted.
- c. Ni or Co based Superalloys:
  - i. UNS N06625; W.Nr.2.4856 Inconel 625
  - ii. UNS N07718; W.Nr.2.4668 Inconel 718
  - iii. UNS N07001; W.Nr.2.4654 Waspaloy
  - iv. UNS R30035; W.Nr.2.4999 MP35N
  - v. UNS R30159 MP159
- d. Titanium Alloys:
  - i. Low-alloy titanium alloys containing at least 97.5% Ti and less than 1% of any other element.
  - ii. Grade 9 Ti3Al2.5V
  - iii. Grade 5; grade 23 TiAl6V4, Ti64
  - iv. UNS R54620, Ti6242, Ti6242Si
  - v. UNS R56260 Ti6246
  - vi. UNS R56410 Ti10-2-3
  - vii. UNS R58153 Ti15-3-3-3
  - viii. UNS R58640 Allvac 38-644
  - ix. Ti-5Al-5Mo-5V-3Cr Ti5553
  - x. Ti-15Mo-3Nb-3Al-0.2Si Timetal Ti-21S
  - xi. Timetal Ti1100
  - xii. Ti 6Cr-5Mo-5V-4Al
- e. Copper Alloys containing less than 2.5% Beryllium
- f. Tungsten Alloys: any

### 15.3.2 Metallic Materials Used for Additive Manufacture

Components produced by additive manufacture can be made from materials in the following list. A full list of applicable standards and criteria for acceptance of metals under the provisions of Article 15.2.5 in this list is given in the Appendix to the Technical and Sporting Regulations.

- a. Aluminium Alloys; AlSi10Mg, AlSi7MG, Al Cl-30AL, P339 AM, EOS Aluminium 2139 AM
- b. Aluminium Alloys with particulate reinforcing, A20X, 2024-RAM2, 6061-RAM2
- c. Aluminium-Magnesium Alloys; Scalmalloy
- d. Titanium Alloys; Grade 1, Grade 2, Ti6Al4V, Ti6AL4V ELI, Ti 5553, Ti 6242.
- e. Steel Alloys; 316, 304, MS1, 15-5PH, 17-4PH, 300M, 4140.
- f. Copper Alloys not containing Beryllium.
- g. Superalloys; Inconel 625, Inconel 718, Cobalt-Chrome.

Furthermore, the finished mass of a component made by additive manufacture should be no less than 60% of the mass of the printed component, excluding support structures.

### 15.3.3 Permitted Polymer Composite Materials

**Matrix Systems:** the matrix system utilised in all polymer composite materials must be based on one of the following:

- a. Epoxy
- b. cyanate ester
- c. bismaleimide
- d. phenolic
- e. polyurethane
- f. polyester
- g. Thermoset resins not derived from petrochemicals – subject to approval.

**Reinforcing:** unidirectional or planar reinforcing is permitted using the following materials:

- a. Carbon fibres manufactured from polyacrylonitrile (PAN) precursor, which have:
  - A nominal tensile modulus  $\leq 550$  GPa
  - A nominal tensile strength  $\leq 7100$  MPa (i.e. up to and including that of Toray T1100 or Mitsubishi MR70).
  - A density  $\leq 1.92$  g/cm<sup>3</sup>
- b. Aramid fibres.
- c. Poly(p-phenylene benzobisoxazole) fibres (e.g. "Zylon").
- d. Polyethylene fibres.
- e. Polypropylene fibres.
- f. Glass fibres.
- g. Natural Fibres (i.e. flax, hemp, linen, cotton, bamboo)

Core Materials:

- a. Aluminium Honeycomb
- b. Meta-Aramid Honeycomb (e.g. Nomex or equivalent)
- c. Polymer foams
- d. Polymer syntactic foams

- e. Balsa wood

#### 15.3.4 Permitted Polymer Materials

- a. Thermoplastics - monolithic, particulate filled or short fibre reinforced with fibre length less than 13mm
- b. Thermosets - monolithic, particulate filled or short fibre reinforced with fibre length less than 13mm

### 15.4 Specific Prohibitions

15.4.1 Notwithstanding the list of permitted materials in Article 15.3, the following materials or processes are forbidden:

- a. Metal Matrix Composites, except where allowed under article 15.3.2
- b. Shape Memory Materials except for piezoelectric materials used in electrical sensors.
- c. Titanium alloys may not be used for fasteners with a male thread less than 15mm diameter.
- d. Additive manufactured materials containing Beryllium.
- e. Three-dimensional fibre reinforcement of Polymer Composite Materials.

15.4.2 Notwithstanding the list of permitted materials in Article 15.3, the following materials or processes are forbidden unless listed in Article 15.5:

- a. Alloys where the combined weight of Platinum, Ruthenium, Iridium, Rhenium and Gold is more than 5%
- b. Components produced by foil metallurgy.
- c. Intermetallic alloys.

### 15.5 Specific Exceptions

The following materials, components or processes do not have to comply with articles 15.2 or 15.3 but may be subject to restrictions elsewhere in these regulations:

- a. Monolithic Ceramic Materials may be used for; rolling elements of rolling-element bearings, high-pressure fuel pumps elements, electrical components, thermal insulation, clutch friction materials and spherical bearings.
- b. Ceramic Matrix Composites may be used for; friction materials, seals and thermal insulation.
- c. Carbon-carbon composites may be used for friction materials.
- d. Materials used in any electrical component (e.g. control boxes, wiring looms, sensors).
- e. All seals and rubbers (e.g. rubber boots, o-rings, gaskets, any fluid seals, bump rubbers).
- f. Fluids (e.g. water, oils).
- g. Tyres.
- h. Coatings and platings (e.g. DLC, chroming) whose primary purpose is not thermal or electrical insulation and provided the total coating thickness does not exceed 25% of the section thickness of the underlying base material in all axes. In all cases, the relevant coating must not exceed 0.8mm.
- i. Paint.
- j. Adhesives.
- k. Thermal insulation (e.g. felts, reflective foils or heat shields).
- l. Any currently regulated materials (e.g. fuel bladder, headrest, extinguishant, padding or plank).

- m. Materials used in any component that is supplied to an FIA Single Supply Contract.
- n. Z-pinning is allowed in composite components.
- o. Magnesium alloys may be used for inserts in composite components
- p. Nano particles are permitted when part of a commercially available polymer or polymer resin.
- q. UNS R30006 (Stellite 6 - Cast), UNS R30106 (Stellite 6 - Sintered), UNS R30016 (Stellite 6 - Wrought) and UNSR30012 (Stellite 12) may be used on or above Z=0 (i.e. not in RV-PLANK)

## 15.6 Prescribed Laminates

The following are the prescribed laminates referred to in other articles of these regulations.

15.6.1 The materials referred to in Article 15.6.2 are defined below:

- a. CC200 – Woven carbon cloth, fibre weight 200gsm, epoxy prepreg.
- b. CC100 – Woven carbon cloth, fibre weight between 50gsm and 150 gsm, epoxy prepreg
- c. KC60 – Woven aramid cloth, fibre weight 60gsm, epoxy prepreg
- d. KC170 - Woven aramid cloth, fibre weight 170gsm
- e. R135 – 135gsm elastomeric material
- f. R350 – 350gsm elastomeric material
- g. CC280UHS - Woven carbon cloth, fibre weight 280gsm,  $F_{tu} > 6500\text{MPa}$ , epoxy prepreg

15.6.2 The prescribed laminates in use throughout the Technical Regulations are listed below:

- a. **PL-HALO:** [KC60, CC100, KC60] stacking sequence is free.
- b. **PL-ANTI-SPLINTER** may be one of the three specifications listed below:
  - i. Laminate Type **A** – a laminate where more than 50% by weight of the reinforcing is: aramid, poly(p-phenylene benzobisoxazole) (e.g. “Zylon”), polyethylene, polypropylene or natural fibres. In this case, no additional precautions are required.
  - ii. Laminate Type **B** – Laminates not covered by **A** and with areal weight of reinforcing up to 1000gsm: [**B**/2, R135, **B**/2] where **B**/2 is half the laminate  $\pm 1$  ply.
  - iii. Laminate Type **C** – Laminates not covered by **A** and with areal weight of reinforcing is greater than 1000gsm: [**C**/2, R350, **C**/2] where **C**/2 is half the laminate  $\pm 1$  ply.
- c. **PL-SUS-FAIRING:** [CC100, KC170, CC100] or [CC100, KC60, KC60, KC60, CC100]
- d. **PL-HEADREST:** [KC60, KC60]
- e. **PL-CHASSIS-SIDE:** A laminate homologated to “Side Intrusion Test Procedure 02/05” defined in the Appendix to the Sporting and Technical Regulations with one additional ply per skin (two total) of CC280UHS cloth using the same resin system as the homologated laminate. The orientation of the additional ply in each skin should be the same as the least numerous ply-orientation in that skin.
- f. **PL-LWT-FAIRING** [CC200, (Optional Aramid core), CC200]  
The edge of the laminate may be reinforced with a further 2 plies of CC200 (1 either side of the core, if applicable) which may extend no further than 20mm in from the perimeter of the fairing.

## ARTICLE 16: FUEL AND ENGINE OIL

### 16.1 Basic principles

- 16.1.1 The purpose of this Article is to ensure that the fuel and engine oil used in Formula One correspond to what these terms are generally understood to mean.
- 16.1.2 With regard to fuel, the detailed requirements of this Article are intended to ensure the use of fuels that are composed of compounds normally found in commercial fuels and to prohibit the use of specific power-boosting chemical compounds. Acceptable compounds and compound classes are defined in 16.2 and 16.4.3. In addition, to cover the presence of low level impurities, the sum of components lying outside the 16.2 and 16.4.3 definitions are limited to 1% max m/m of the total fuel.
- 16.1.3 Only approved fuel (Article 16.5) may be released into the engine combustion chamber by the fuel injector (5.1.12).
- 16.1.4 Only ambient air may be mixed with the fuel as an oxidant.
- 16.1.5 The function of an engine oil is to lubricate moving parts, to improve the overall efficiency of the engine by reducing friction and to reduce wear. It also cleans, inhibits corrosion, improves sealing, and cools the engine by carrying heat away from moving parts. Engine oils should not enhance the properties of the fuel nor energize the combustion. The presence of any component that cannot be rationally associated with the defined functions of the engine oil will be deemed unacceptable.
- 16.1.6 Any fuel or engine oil, which appears to have been formulated in order to subvert the purpose of this regulation, will be deemed to be outside it.
- 16.1.7 All Competitors must be in possession of a Material Safety Data Sheet for each type of fuel or engine oil used. This sheet must be made out in accordance with EC Directive 93/112/EEC and all information contained therein strictly adhered to.

### 16.2 Fuel definitions

Paraffins	Straight chain and branched alkanes.
Olefins	Straight chain and branched mono-olefins and di-olefins. Monocyclic mono-olefins (with five or more carbon atoms in the ring) with or without paraffinic side chains.
Di-olefins	Straight chain or branched or monocyclic hydrocarbons (with five or more carbon atoms in any ring) with or without paraffinic side chains, containing two double bonds per molecule.
Naphthenes	Monocyclic alkanes (with five or more carbon atoms in the ring) with or without paraffinic side chains.
Aromatics	Monocyclic and bicyclic aromatic rings with or without paraffinic side chains.
Oxygenates	Organic compounds containing oxygen.
Advanced Sustainable component	An advanced sustainable component is either a second generation bio component or a component produced from non-bio carbon capture and re-use. Capture and re-use process must be approved by FIA. For the purposes of quantification, the advanced sustainable component contribution of a given molecule is defined as the carbon, hydrogen and oxygen atoms from an advanced sustainable origin as a percent of the total molecule, on a mass/mass basis.

Second generation bio components	Second generation bio components are components manufactured from various types of non-food biomass, including lignocellulosic biomass, algae, agricultural residues or waste and dedicated non-food energy crops grown on marginal land unsuitable for food production. Biocomponents from food crops can be regarded as second generation only if they have already fulfilled their food purpose (e.g. waste vegetable oil because it has already been used and is no longer fit for human consumption). It includes all biocomponents falling into the RED II definition <sup>1</sup> .
Metals	Metals are defined as alkali metals, alkaline earth metals, transition metals, actinides, lanthanides, post-transition metals and metalloids.
Alkali Metals	Group 1 elements, excluding hydrogen.

<sup>1</sup> ANNEX IX - Part A. of Directive(EU) 2018/2001

### 16.3 Fuel properties

The only fuel permitted is petrol having the following characteristics :

Property	Units	Min	Max	Test Method
(RON+MON)/2		87		ASTM D 2699/D 2700
Oxygen	wt%	3.45		Elemental Analysis
Nitrogen	mg/kg		500	ASTM D 5762
Benzene	wt%		1	GC-MS
DVPE	kPa	45	68	EN13016-1
Lead	mg/l		5	ASTM D 3237 or ICP-OES
Manganese	mg/l		2	ASTM D 3831 or ICP-OES
Metals (excluding alkali metals)	mg/l		5	ICP-OES
Oxidation Stability	minutes	360		ASTM D 525
Sulphur	mg/kg		10	EN ISO 20846
Electrical conductivity	pS/m	200		ASTM D 2624
Final Boiling Point	°C		210	ISO 3405
Distillation Residue	%v/v		2	ISO 3405

The fuel will be accepted or rejected according to ASTM D 3244 with a confidence limit of 95%.

### 16.4 Composition of the fuel

16.4.1 The composition of the petrol must comply with the specifications detailed below :

Component	Units	Min	Max	Test Method
Aromatics	wt%		40	GCMS
Olefins	wt%		17	GCMS
Total di-olefins	wt%		0.1	GCMS
Total styrene and alkyl derivatives	wt%		0.1	GCMS

In addition, the fuel must contain no substance which is capable of exothermic reaction in the absence of external oxygen.

- 16.4.2 The total of individual hydrocarbon components present at concentrations of less than 5% m/m of the total fuel must be at least 30% m/m of the hydrocarbon component of the fuel.
- 16.4.3 The only oxygenates permitted are paraffinic mono-alcohols and paraffinic mono-ethers with a final boiling point below 210°C.
- 16.4.4 A minimum of 10% (m/m) of the fuel must comprise advanced sustainable Ethanol.

## 16.5 Fuel approval

- 16.5.1 Before any fuel may be used in the Formula One Championship:
- The supplier must comply with the requirements set in Appendix 4, Paragraph 1.2 of the Technical Regulations.
  - Two separate five litre samples, in suitable containers, must be submitted to the FIA for analysis and approval.
  - The fuel must be shown to be compatible with the fuel bladder and seal materials used by all teams that will be using the fuel by passing the tests specified in The Appendix to the Technical and Sporting Regulations.
- 16.5.2 No fuel may be used in a Competition without the prior written approval of the FIA.

## 16.6 Fuel sampling and testing at a Competition

- 16.6.1 All samples will be taken in accordance with the FIA Formula One fuel sampling procedure, a copy of which may be found in the Appendix to the Technical and Sporting Regulations.
- 16.6.2 Fuel density will also be checked and must be within 0.15% of the figure noted during pre-approval analysis.
- 16.6.3 Fuel samples taken during a Competition will be checked for conformity by using a gas chromatographic technique, which will compare the sample taken with an approved fuel. Samples which differ from the approved fuel in a manner consistent with evaporative loss, will be considered to conform. However, the FIA retains the right to subject the fuel sample to further testing at an FIA approved laboratory.
- 16.6.4 GC peak areas of the sample will be compared with those obtained from the reference fuel. Variations in any given peak area (relative to its adjacent peak areas) which are greater than 12%, or an absolute amount greater than 0.10% for compounds present at concentrations below 0.8%, will be deemed not to comply.

If a peak is detected in a fuel sample that was absent in the corresponding reference fuel, and its peak area represents more than 0.10% of the summed peak areas of the fuel, the fuel will be deemed not to comply.

If the deviations observed (above) by GC indicate that they are due to mixing with another Formula One fuel, which has been approved by the FIA for use by the team, the fuel sample will be deemed to comply, provided that the adulterant fuel is present at no more than 10% in the sample. Any systematic abuse of mixed fuels will be deemed not to comply.

## 16.7 Engine oil definitions

Engine oil (serving the purpose stated in Article 16.1.5) must comprise base oils and additives as defined below.

Base Oil General:

- A base oil is a base stock or blend of base stocks.
- A base stock is a lubricant component that is produced by a single manufacturer. Base stocks may be manufactured using a variety of different processes including but not limited to distillation, solvent refining, hydrogen processing, oligomerization, esterification, and re-refining.

All base stocks are divided into five general categories :



- a. Group I base stocks contain less than 90 percent saturates and/or greater than 0.03 percent sulphur and have a viscosity index greater than or equal to 80 and less than 120 using the test methods specified in the table below.
- b. Group II base stocks contain greater than or equal to 90 percent saturates and less than or equal to 0.03 percent sulphur and have a viscosity index greater than or equal to 80 and less than 120 using the test methods specified in the table below.
- c. Group III base stocks contain greater than or equal to 90 percent saturates and less than or equal to 0.03 percent sulphur and have a viscosity index greater than or equal to 120 using the test methods specified in the table below.
- d. Group IV base stocks are polyalphaolefins (PAO).
- e. Group V base stocks include all other base stocks not included in Group I, II, III, or IV.

The Analytical Methods for Base Stock are defined below:

Property	Test Method
Saturates	ASTM D2007
Viscosity index	ASTM D2270
Sulfur (use one listed method)	ASTM D1552 ASTM D2622 ASTM D3120 ASTM D4294 ASTM D4927

Additives are defined as the chemical compounds added to the base oil in small concentrations in order to improve the performance characteristics of the engine oil.

## 16.8 Engine oil properties

The engine oil must comply with the following characteristics :

Property	Units	Min	Max	Test Method
Kinematic Viscosity (100°C)	cSt	2.8		ASTM D445
HTHS Viscosity at 150°C and Shear Rate of $10^6 \text{ s}^{-1}$	mPa.s	1.4		ASTM D4741
Initial Boiling Point	°C	210		ASTM D7500
Flashpoint	°C	93		ASTM D3828

The oil will be accepted or rejected according to ASTM D 3244 with a confidence limit of 95%.

## 16.9 Composition of the engine oil

- 16.9.1 In the event that the initial boiling point test (ASTM D7500) suggests the presence of compounds with a boiling point of less than 210°C the sample will be further analysed by

GCMS. The total of any components with boiling points less than 210°C must not exceed 0.5% m/m.

- 16.9.2 The engine oil must not contain any organo-metallic petrol additives or other octane boosting petrol additives.

## **16.10 Engine oil approval**

- 16.10.1 Before any engine oil may be used in the Formula One Championship:
- a. The supplier must comply with the requirements set in Appendix 4, Paragraph 1.2 of the Technical Regulations.
  - b. Two separate one-litre samples, in suitable containers, must be submitted to the FIA for analysis and approval.
- 16.10.2 No engine oil may be used in a Competition without the prior written approval of the FIA.
- 16.10.3 In addition to the engine oils approved for use in a Competition, one type of dyno engine oil may be approved by the FIA.

## **16.11 Sampling and testing at a Competition**

- 16.11.1 Each Competitor must declare, prior to every Competition, which oil will be used in each of their engines during the Competition.
- 16.11.2 For reference purposes, before any oil may be used at a Competition, a sample must be submitted to the FIA together with the oil reference number.
- 16.11.3 Engine oil samples taken during a Competition will be checked for conformity by using a Fourier transform infrared (FTIR) technique, which will compare the sample taken with that submitted at the start of the Competition. Samples which differ from the reference engine oil in a manner consistent with fuel dilution, engine fluids contamination and oil ageing as a result of normal engine operation, will be considered to conform. Samples which differ from the reference engine oil in a manner consistent with the mixing with other engine oils, which have been approved by the FIA for use by the team at a Competition, will be deemed to comply, provided that the adulterant oils are in total present at no more than 10% in the sample. This tolerance will also be applicable for the mixing with the approved dyno engine oil but only for a new engine during the competition at which it is first used. However, the FIA retains the right to subject the oil sample to further testing at an FIA approved laboratory.

## ARTICLE 17: COMPONENTS' CLASSIFICATION

### 17.1 Definitions

In this Article 17:

**“Associate”** means, with respect to a Competitor in the Championship (and any entity representing that Competitor):

- a. any other person or entity (including any corporate or unincorporated body) that (directly or indirectly):
  - i. owns share capital or business assets of the Competitor; or
  - ii. has the power to exercise voting rights in relation to the Competitor; or
  - iii. has the power to appoint members of the supervisory board, board of directors or bodies legally representing the Competitor; or
  - iv. has the power to conduct the affairs of the Competitor by constitutional documents or agreement or otherwise; and
- b. any other person or entity in the same legal group structure as the Competitor from time to time; and
- c. any agent, contractor (or sub-contractor) or other person or entity (including any corporate or unincorporated body) that is set up or used by a Competitor to circumvent the requirements of this Article 17.

**“Outsourcing”** means procuring goods or services by contract with an external supplier.

**“Design Specification”** means, in respect of a component all design (including three-dimensional geometry, tolerances, materials, surface finishes and design standards), manufacturing, installation and operational information related to that component.

And for the purposes of these Technical Regulations, including in this Article 17:

"Intellectual Property" means:

- a. patents, rights to inventions, designs, copyright and related rights, database rights, trade marks and trade names, rights in get-up and related goodwill and the right to sue for passing off or unfair competition (in each case whether registered, registerable or unregistered);
- b. proprietary rights in domain names;
- c. rights to use, and protect the confidentiality of, trade secrets, know-how and confidential information;
- d. applications, and rights to apply for and be granted registrations, including extensions and renewals of, such rights; and
- e. all other rights of a similar nature or having an equivalent effect anywhere in the world.

### 17.2 General Principles

#### 17.2.1 Classification:

- a. Subject to Article 17.2.1 (d), all components used in Formula One cars (other than the secondary roll structure referred to in Article 12.4.2 and the side impact structures defined in article 13.5.1) and all equipment used to support a Competitor's operations during a Championship shall be classified as a Listed Team Component (LTC), or a Standard Supply Component (SSC), or a Transferable Component (TRC), or an Open Source Component (OSC), each as defined in Article 17.3-17.6 (inclusive).
- b. Unless otherwise specified, such components/equipment will be classified as LTC.
- c. All Aerodynamic Components described in Article 3 of these Technical Regulations are LTC, unless specifically defined as SSC or OSC.

- d. Power Unit components shown as “INC” in the column “Definitions – Article 5.1.2” of the table in Appendix 3 of the Technical Regulations do not fall under any of the four categories set out in this Articles 17.
  - e. In cases of doubt, the FIA should be consulted and shall determine the classification of a particular component or piece of equipment, should that differ from the default classification mentioned in Article 17.2.1(b) above.
- 17.2.2** For the purposes of the remaining provisions of this Article 17, any reference to any Competitor shall include (a) any Associate of such Competitor; and (b) any external entity (i) working on behalf of a Competitor or (ii) working for its own purposes and subsequently providing the results of its work to a Competitor.
- 17.2.3** For the purposes of the remaining provisions of this Article 17, any reference to a “component” may also refer to complete assemblies.
- 17.2.4** No Competitor may use movement of personnel (whether employee, consultant, contractor, secondee or any other type of permanent or temporary personnel) with another Competitor, either directly or via an external entity, for the purpose of circumventing the requirements of this Article 17.
- 17.2.5** From time to time the FIA may request that a competitor shares certain information in connection with this Article 17 with the FIA (a) so that the FIA may share with the other competitors for safety reasons only, or (b) to assist the FIA in considering future amendments to the Technical Regulations, subject in each case to receiving the appropriate undertaking of confidentiality from the FIA.
- 17.2.6** Except as otherwise expressly permitted by these Technical Regulations or by the FIA, no competitor may directly or indirectly disclose or transfer any Intellectual Property to another competitor that is reasonably likely to impact upon the performance of the receiving competitor, and no competitor may directly or indirectly obtain (by any means) the same from another competitor.
- 17.2.7** Where a Competitor is made responsible under these Technical Regulations for raising any issues of safety, incompatibility and/or reliability of a component that it uses on its car, it shall not make any claim against any other party that is inconsistent with that responsibility.
- 17.2.8** Competitors may make available to other Competitors test facilities and equipment such as (but not limited to) wind tunnels or dynamometers. The Intellectual Property involved in the operation of such shared facilities may be used by and/or disclosed to the sharing party but the results of any experimental or test work carried out on such facilities may only be used by the originator of the work. Where facilities are shared, robust processes must be put in place to ensure there is no transfer of Intellectual Property through common personnel and that all data can only be accessed by the originator of the work. Any such sharing of facilities must be declared to the FIA with a full description of the work that will be carried out, and also of the processes that will be put in place in order to avoid an exchange of information that could lead to the transfer of knowledge leading to the performance enhancement of an LTC (as required by Article 17.3.4), or a TRC (as required by Article 17.5.8) or an OSC (as required by Article 17.6.11).

### **17.3 Listed Team Components (LTC)**

- 17.3.1** “Listed Team Components” (LTC) are components whose design, manufacture and Intellectual Property is owned and/or controlled by a single Competitor or its agents on an exclusive basis (including, without limitation, the components identified as such in Appendix 5).
- 17.3.2** A Competitor may only use LTC in its Formula One cars that it has designed (including, for the avoidance of doubt, its three-dimensional shape and the evolution history leading to it, any preliminary designs, simulations, wind tunnel tests, and analysis) and manufactured itself. However, this does not prevent the Competitor Outsourcing any R&D, engineering and/or

CAD design and/or the manufacture of any LTC to a third party (including, for the avoidance of doubt, an Associate of such Competitor) provided that:

- a. the Competitor retains the exclusive right to use the LTC in Formula One for so long as it competes in Formula One;
- b. the third party to whom manufacture of the LTC is Outsourced may not be another Competitor or an Associate to another Competitor; and
- c. the third party to whom design of the LTC is Outsourced may not be another Competitor, an Associate to another Competitor, or a party that directly or indirectly designs LTCs or TRCs for any other Competitor.

**17.3.3** Although it is permissible to be influenced by the design or concept of a Competitor's LTC using information that must potentially be available to all Competitors, this information may only be obtained at Competitions or Tests (as defined respectively in Articles 5 and 10.1 3 of the Sporting Regulations), and no Competitor may design its LTCs based on “reverse engineering” of another Competitor's LTC. For the purpose of this Article, “reverse engineering” shall mean:

- a. The use of photographs or images, combined with software that converts them to point clouds, curves, surfaces, or allows CAD geometry to be overlaid onto or extracted from the photograph or image
- b. The use of stereophotogrammetry, 3D cameras or any 3D stereoscopic techniques
- c. Any form of contact or non-contact surface scanning
- d. Any technique that projects points or curves on a surface so as to facilitate the reverse-engineering process

In cases where isolated features of a Competitor's LTC(s) may closely resemble the features of another Competitor's LTC(s), it will be the role of the FIA to determine whether this resemblance is the result of reverse engineering or of legitimate independent work. The following further provisions apply:

- e. All Competitors must provide to the FIA, upon request, any data or other information that is required to demonstrate compliance with this Article.
- f. For all LTCs used during the Championship, the restrictions described in this Article apply to their entire design process, including actions carried out before the calendar year of the Championship.
- g. The FIA may issue guidance from time to time to define more specifically the requirements and constraints of this Article.

**17.3.4** No Competitor may, either directly or via a third party:

- a. pass on any information in respect of its LTC (including but not limited to data, designs, drawings, or any other Intellectual Property) to another Competitor or receive any information from another Competitor in respect of that Competitor's LTC; or
- b. receive consultancy or any other kind of services from another Competitor in relation to LTC, or supply any such services to another Competitor; or
- c. pass any methodology which can be used to enhance the performance of LTC (including but not limited to simulation software, analysis tools, etc.) to another Competitor, or receive any such methodology from another Competitor.

Notwithstanding the provision of this Article, Supplying Power Unit Manufacturers or Supplying Competitors of TRCs may carry out the assembly of the components they supply with adjacent LTC components of the Customer Competitor. In such cases, the Customer Competitor may provide the minimal assembly information of the LTCs they need to assemble to the supplying Competitor or Power Unit Manufacturer. The FIA must approve such a transaction to its absolute discretion and must be satisfied that it is not used as a means to circumvent the provisions of Article 17.3.

- 17.3.5** A Competitor (or its agents) must have exclusive ownership of (or the Competitor must have the exclusive right to use in the Championship) any and all rights, information or data of any nature (including but not limited to all aspects of the design, manufacturing, know-how, operating procedures, properties and calibrations) in respect of the LTC in its Formula One cars. However, notwithstanding the foregoing:
- a. the use of specialist Intellectual Property or technology of third parties is permitted in respect of LTC, provided that this Intellectual Property or technology is commercially available to all Competitors. The principal parameters of such components must in any case be determined by the Competitor and not be available to other Competitors;
  - b. Similarly, it is permitted to use commercially available sub-components or sub-assemblies in respect of LTC, provided these are commercially available to all Competitors. This provision applies if these components or sub-assemblies are not specifically listed as LTC. The FIA may request Competitors to provide a list of such sub-components and their technical specification. The FIA may classify such sub-components or sub-assemblies as LTC if it deems that they are being contrived to circumvent the purpose of this Article 17.

## **17.4 Standard Supply Components (SSC)**

- 17.4.1** “Standard Supply Components” (SSC) are components whose design and manufacture will be carried out by a supplier appointed by the FIA, to be supplied on an identical technical and commercial basis to each Competitor (including, without limitation, the components identified as such in Appendix 5).
- 17.4.2** Should a selection process fail to lead to appointment of a supplier of a component classified as a SSC, or should the arrangement with such supplier be terminated for whatever reason, the FIA reserves the right to re-classify the SSC as an LTC, TRC, or OSC and to introduce appropriate technical rules in the relevant Article of these Technical Regulations in order to control the technical specification and cost of this component.
- 17.4.3** Components supplied as SSC must not be modified, and they must be installed and operated exactly as specified by the supplier, except for minor changes explicitly permitted in the Appendix to the Technical and Sporting Regulations. However, each Competitor is responsible for communicating directly to the relevant SSC supplier, while keeping the FIA informed at all times, regarding any issues of compatibility, reliability or safety in respect of a SSC. This may include submitting proposals for modifications to the SSC that a Competitor considers should be made to ensure the necessary levels of safety, compatibility and reliability while at all times having due regard to cost and performance implications. In consultation with the relevant SSC supplier, the FIA will consider in good faith all issues raised (and modifications proposed) during the consultation process, and shall determine in its sole discretion whether or not to take any action. In exceptional circumstances, where a Competitor establishes that a SSC is critically incompatible, unreliable or unsafe, the FIA may, at its sole discretion, authorise such Competitor to carry out modifications to the SSC in question or use an alternative component in order to resolve the compatibility, reliability or safety issue. Permission for such a modification or usage of an alternative component will be communicated to all Competitors, and will continue to be applied until the relevant supplier introduces a new specification that resolves the reliability, compatibility or safety concern. In accordance with the severity of the reliability, compatibility or safety concern, the FIA may authorise a phased introduction of the modified SSC. In such cases, after consultation with Competitors and with the Supplier, the FIA will define the period of the phase-in, and any measures that need to be taken to ensure that no performance advantage (e.g., mass) is obtained by using either the old or the new specification of the SSC.
- 17.4.4** The use of an SSC is mandatory and the particular function of that SSC must not be by-passed, replaced, duplicated or complemented by another component. This provision also applies to any TCC as defined in the Sporting Regulations. In exceptional circumstances, the FIA, at its sole discretion may authorise the use of alternative components.
- 17.4.5** No Competitor may, either directly or via a third party pass any information (including but not limited to data, know how, operating procedures, properties and calibrations) or

methodology (including but not limited to simulation software, analysis tools, etc.) which can be used to enhance the performance of a SSC to another Competitor, or receive any such methodology from another Competitor.

## **17.5 Transferable Components (TRC)**

- 17.5.1** “**Transferable Components**” (TRC) are components whose design, manufacture and Intellectual Property resides within a single Supplying Competitor, or third party, but can be supplied to another Customer Competitor (including, without limitation, the components identified as such in Appendix 5).
- 17.5.2** The provisions of this Article 17.5 regard the supply of such TRC components by a Supplying Competitor or a third party to a Customer Competitor. In the event a component classified as TRC does not get supplied to any Customer Competitor, the rules governing such a component will be identical to the rules governing LTC’s. Furthermore, with regard to any component classed as TRC, any two teams who are not operating in a Supplying Competitor-Customer Competitor relationship with regard to the specific component must observe all the rules that govern LTC’s.
- 17.5.3** The Supplying Competitor (or its agent) must own and/or control all rights, information and/or data of any nature (including all aspects of the design, manufacturing, know-how, operating procedures, properties and calibrations) in respect of TRC, but it may supply such TRC to other Competitors.
- 17.5.4** The components supplied as TRC by a Supplying Competitor to a Customer Competitor must be components identical to those used by the Supplying Competitor in the same Championship or a previous one. Under no circumstances is it permitted for the Supplying Competitor to carry out the design or manufacture of bespoke TRC’s for the specific use by a Customer Competitor. The Customer Competitor may however elect to replace or modify sub components of a TRC, but in that case all the related additional work (including, but not limited to Research and Development, simulations, design, manufacture etc.) must be carried out by the Customer Competitor or its agents. In exceptional circumstances, and with the prior approval of the FIA, the Supplying Competitor may provide assistance to the Customer Competitor for the resolution of reliability or safety issues regarding the TRC.
- 17.5.5** The Supplying Competitor may outsource the design (intended for this Article as any R&D, Engineering and CAD design) and/or manufacture of any TRC to a third party (including, for the avoidance of doubt, an Associate of such Competitor) provided that:
- a. the third party to whom manufacture of the TRC is Outsourced may not be another Competitor; and
  - b. the third party to whom design of the TRC is Outsourced may not be another Competitor, or a party that directly or indirectly designs TRCs or LTCs for any other Competitor.
- 17.5.6** The Supplying Competitor (or its agents) must have exclusive ownership of and/or control over any and all rights, information or data of any nature (including but not limited to all aspects of the design, manufacturing, know-how, operating procedures, properties and calibrations) in respect of the TRC in its Formula One cars. However, notwithstanding the foregoing:
- a. the use of specialist Intellectual Property or technology of third parties is permitted in respect of TRC, provided that this Intellectual Property or technology is commercially available to all Competitors. The principal parameters of such components must in any case be determined by the Competitor and not be available to other Competitors.
  - b. similarly, it is permitted to use commercially available sub-components or sub-assemblies in respect of TRC, provided these are commercially available to all Competitors.

- 17.5.7** A third party unrelated to any Competitor may supply a TRC to a Customer Competitor, provided that it also offers to supply the TRC to any other Customer Competitor on similar commercial terms.
- 17.5.8** In respect of the conditions at Article 17.3.4, any information on TRC passed on or received by a Competitor or any consultancy or any other kind of services involving a Competitor in relation to TRC shall be strictly limited to the designs or drawings necessary for the integration of the TRC into the design of the car and/or the data of the TRC necessary for the correct operation of the TRC on the car. For the avoidance of doubt, the following passage of information is strictly prohibited:
- a. Information specific to a particular circuit or race (e.g. suspension setup information)
  - b. Software or methodology for the optimisation of the performance of a TRC (e.g. simulation software)
- 17.5.9** In respect of the compliance by the Customer Competitor with the Financial Regulations, the Supplying Competitor is mandated to provide the Customer Competitor all financial information that may be necessary to allow the Customer Competitor to demonstrate compliance with all FIA Regulations in force.

## **17.6 Open Source Components (OSC)**

- 17.6.1** “Open Source Components” (OSC) are components whose Design Specification and Intellectual Property is made available to all Competitors through the mechanisms defined in this Article 17.6 (including, without limitation, the components identified as such in Appendix 5).
- 17.6.2** For all OSC in use by all Competitors, the Design Specification must reside on a designated server specified by the FIA, and be accessible by all Competitors. Details about the server, access credentials and file naming and format conventions may be found in the Appendix to the Technical and Sporting Regulations.
- 17.6.3** Any Competitor who designs a new OSC or modifies the Design Specification of a previous OSC must upload the new Design Specification to the designated server as specified in the Appendix to the Technical and Sporting Regulations.
- 17.6.4** Any Competitor who creates a new, or modifies an existing, Design Specification of an OSC or any OSC manufactured to a Design Specification grants an irrevocable, royalty-free, non-exclusive, worldwide licence to all other Competitors to use and modify any of its Intellectual Property subsisting in such OSCs or Design Specifications to the extent contemplated by these Technical Regulations.
- 17.6.5** Any Competitor wishing to access the server referred to in Article 17.6.3, or to exercise its rights under the licence described in Article 17.6.4, may only do so if it has agreed to be bound by the terms and conditions applicable to the FIA's designated server, by accepting the FIA Open Source Component Licence (“FOSCL”), as provided by the FIA from time to time.
- 17.6.6** In the event the OSC or the Design Specification of any OSC contains proprietary information and/or Intellectual Property of a third party supplier, this must be made clear by the Competitor when uploading the Design Specification of the OSC, and use of the uploaded Design Specification (and any OSC manufactured to that Design Specification) by any other Competitor exercising its rights in accordance with these Technical Regulations must be approved in writing by the third party supplier, with a copy of such approval to be available to the FIA on request. Should it become necessary to remove any sensitive information, then the uploaded Design Specification must:
- a. Contain a clear reference to the supplier in question.
  - b. Contain sufficient information for another Competitor to be able to order an identical component from the supplier.
  - c. Contain all the necessary information to permit another Competitor to install the OSC in their own car.



- 17.6.7** All Competitors are obliged to declare to the FIA the version of each OSC that gets used on their car. This information will be made available to all Competitors.
- 17.6.8** The complete responsibility for the installation and operation of an OSC (including any matters related to its function, performance, reliability, compatibility or safety) resides with the Competitor who uses this version of the OSC. Notwithstanding this provision, any Competitor who encounters a functionality, reliability, compatibility or safety issue with a particular version of an OSC is obliged to provide such information to the FIA and all other Competitors via the designated server.
- 17.6.9** OSC's may be provided from one Competitor to another, provided that the specification supplied from the Supplying Competitor to the Customer Competitor is of the same specification utilized by the Supplying Competitor. In such cases, their supply should be governed by all the provisions detailed in Article 17.5 for TRCs, however none of these restrictions shall prevent a Competitor from fulfilling their obligations with respect to OSC as required by Article 17.6.
- 17.6.10** For any year (N) where a component is designated as OSC for the first time, Competitors in the preceding year (N-1) must upload the design of the equivalent component in use during that preceding Championship (N-1), no later than 15 July of that year (N-1), regardless of the suitability of this component to the Technical Regulations of the following year (N).
- 17.6.11** No Competitor may, either directly or via a third party pass any information (including but not limited to data, know how, operating procedures, properties and calibrations) or methodology (including but not limited to simulation software, analysis tools, etc.) which can be used to enhance the performance of an OSC to another Competitor, or receive any such information or methodology from another Competitor.

## **17.7 List of LTC, SSC, TRC and OSC**

A complete list of the parts' classification, as well as a definition of the perimeter of each assembly can be found in Appendix 5.

Components which are part of an assembly will assume the classification status of that assembly unless otherwise specified.

## APPENDIX 1: REGULATION VOLUMES

### 1 General Definitions

- 1.1 This Appendix defines the construction of CAD reference sections, reference surfaces and reference volumes used throughout the Regulations in order to assess legality. The primary usage of these Reference Volumes and Surfaces is Aerodynamic legality, in conjunction with Article 3. However numerous further usages of such definitions are used in other Articles.
- 1.2 Unless otherwise stated, only the declared reference section, reference surface or reference volume from each Article can be used to assess legality. All other geometry used during the construction of these sections, surfaces or volumes must be considered for reference purposes only.
- 1.3 In cases where an object (surface or volume) is trimmed using a surface, this must be performed by first finding the intersection between the object and the surface and then partitioning the object into two, by separating it at this intersection. One of these two parts is then discarded according to the relevant Article and the residual of the trimmed object is all that remains after the operation.
- 1.4 All volumes are implicitly symmetrical about the car centre plane.
- 1.5 The prefix "RV-" always refers to a Reference Volume, whereas the prefix "RS-" refers to a Reference Surface.
- 1.6 The CAD models of all the volumes and surfaces listed in this Appendix are available for Teams to download with a standard range of parameters. The FIA will provide a Team with a specific model on request.
- 1.7 Should an inconsistency arise between a volume generated manually using the process outlined in this Article, or a volume that has been downloaded by the process outlined in §1.6, the FIA will adjudicate on a case-by-case basis the volume that will be applicable and correct the one that will be judged to have an inconsistency or error.

### 2 Floor Body Planform Reference Surface (RS-FLOOR-PLAN)

**RS-FLOOR-PLAN** is composed of the following elements:

- 2.1 On the plane  $Z=450$ , a surface enclosed by the following peripheral elements:
  - a. A line between  $[X_F=650, 0]$ ,  $[X_R=450, 0]$ .
  - b. A line between  $[X_R=450, 0]$ ,  $[X_R=450, 375]$ .
  - c. A line between  $[X_R=-350, 495]$ ,  $[X_R=-350, 650]$ .
  - d. A line between  $[X_F=1290, 800]$ ,  $[X_F=2000, 800]$ .
  - e. A minor arc of constant radius, extending from  $[X_R=-350, 495]$  to  $[X_R=450, 375]$  and tangent to X at  $[X_R=450, 375]$ .
  - f. A minor arc with a constant radius of 2000mm, extending from  $[X_F=1290, 800]$  to  $[X_F=960, 685]$  with its centre of curvature forward of  $X_F=960$ .
  - g. A minor arc with a constant radius of 2000mm, extending from  $[X_F=650, 0]$  to  $[X_F=960, 685]$  with its centre of curvature rearward of  $X_F=960$ .
  - h. A minor arc of constant radius, extending from  $[X_R=-350, 650]$  to  $[X_F=2000, 800]$ , and tangent to X at  $[X_F=2000, 800]$ .

- 2.2 Once the surface in §2.1 is fully defined, regions of the surface within 10mm of §2.1b to §2.1h must be discarded. Regions of the surface obscured by RV-FLOOR-EDGE when viewed from below are also discarded.
- 2.3 On the plane  $Z=0$ , a minor arc with a constant radius of 2120mm, extending from  $[X_F=475, 505]$  to  $[X_F=1550, 800]$  with its centre of curvature forward of  $X_F=1000$ .
- 2.4 Once the section in §2.3 is fully defined, it must be extruded along  $Z$  to  $Z=500$  and used to trim the surface in §2.2, with all material outboard of the extrusion discarded.

The fully defined surface in §2.4 is **RS-FLOOR-PLAN**.

### 3 Floor Body Middle Reference Surface (RS-FLOOR-MID)

**RS-FLOOR-MID** is composed of the following elements:

- 3.1 On the plane  $Z=0$ , a section composed of the following boundary elements:
- A line between  $[X_F=575, 0]$ ,  $[X_R= -550, 0]$ .
  - A line between  $[X_R= -550, 0]$ ,  $[X_R= -550, 150]$ .
  - A line between  $[X_F=575, 0]$  and  $[X_F=575, 50]$
  - A minor arc with a constant radius of 6000mm, extending from  $[X_F=575, 50]$  to  $[X_F=1800, 270]$  with its centre of curvature rearward of  $X_F=1800$ .
  - A minor arc of constant radius, extending from  $[X_R= -550, 150]$  to  $[X_R= -1380, 270]$  and tangent to  $X$  at  $[X_R= -1380, 270]$ .
  - A line between  $[X_F=1800, 270]$ ,  $[X_R= -1380, 270]$ .

The fully defined surface in §3.1 is **RS-FLOOR-MID**.

### 4 Floor Body Rear Reference Surface (RS-FLOOR-REAR)

**RS-FLOOR-REAR** is composed of the following elements:

- 4.1 On the plane  $Y= 350$ , a triangle with its vertices at the following three points:  $[X_R, Z] = [-290, 65]$ ,  $[440, 65]$ ,  $[440,180]$ .

The fully defined surface in §4.1 is **RS-FLOOR-REAR**.

### 5 Floor Body Reference Volume (RV-FLOOR-BODY)

**RV-FLOOR-BODY** is composed of the following elements:

- 5.1 An extrusion of the fully defined surface in §2.1 along  $Z$  to  $Z=0$ .
- 5.2 On the plane  $Z=0$ , a surface enclosed by the following peripheral elements:
- A line between  $[X_F=650, 0]$ ,  $[X_R=450, 0]$ .
  - A line between  $[X_R=450, 0]$ ,  $[X_R=450, 365]$ .
  - A minor arc of constant radius, extending from  $[X_R=450, 365]$  to  $[X_R= -350, 430]$  and tangent to  $X$  at  $[X_R=450, 365]$ .
  - A minor arc of constant radius, extending from  $[X_F=2000, 590]$  to  $[X_R= -350, 430]$  and tangent to  $X$  at  $[X_F=2000, 590]$ .
  - A minor arc of constant radius, extending from  $[X_F=2000, 590]$  to  $[X_F=960, 685]$  and tangent to  $X$  at  $[X_F=2000, 590]$ .
  - A minor arc with a constant radius of 2000mm, extending from  $[X_F=650, 0]$  to  $[X_F=960, 685]$  with its centre of curvature rearward of  $X_F=960$ .

- 5.3 Once the surface in §5.2 is fully defined it must be extruded along Z to Z=450.
- 5.4 On the plane Y=0, a section composed of the following elements:
- A line between  $[X_R = -450, 70]$ ,  $[X_R = 450, 200]$ .
  - A minor arc of constant radius, extending from  $[X_R = -450, 70]$  to  $[X_F = 2000, 50]$  and tangent to X at  $[X_F = 2000, 50]$ .
  - A minor arc of constant radius, extending from to  $[X_F = 550, 175]$  to  $[X_F = 2000, 50]$  and tangent to X at  $[X_F = 2000, 50]$ .
- 5.5 Once the section in §5.4 is fully defined it must be extruded along Y to Y=800.
- 5.6 Once the volume in §5.3 is fully defined it must be trimmed using the extruded section in §5.5 with all material above the extrusion discarded.
- 5.7 Once the volumes in §5.1 and §5.6 are fully defined the volume defined in §5.6 must be subtracted from the volume defined in §5.1 to leave one remaining unified volume.
- 5.8 A plane through the points  $[X_F, Y, Z] = [635, 630, 42]$ ,  $[550, 0, 25]$ ,  $[2200, 800, 0]$ .
- 5.9 Once the volume in §5.7 is fully defined, it must be trimmed using the plane in §5.8 with all material below the plane discarded.
- 5.10 On the plane Z=0, a surface enclosed by the following peripheral elements:
- A line between  $[X_F = 325, 0]$ ,  $[X_F = 325, 25]$ .
  - A line between  $[X_F = 325, 0]$ ,  $[X_R = 450, 0]$ .
  - A line between  $[X_R = 450, 0]$ ,  $[X_R = 450, 100]$ .
  - A minor arc of constant radius, extending from  $[X_F = 325, 25]$  to  $[X_F = 2100, 375]$  and tangent to X at  $[X_F = 2100, 375]$ .
  - A minor arc of constant radius, extending from  $[X_R = 450, 100]$  to  $[X_R = -350, 180]$  and tangent to X at  $[X_R = 450, 100]$ .
  - A minor arc of constant radius, extending from  $[X_F = 2100, 375]$  to  $[X_R = -350, 180]$ , and tangent to X at  $[X_F = 2100, 375]$ .
- 5.11 Once the surface in §5.10 is fully defined it must be extruded along Z to Z=450 and united with the volume in §5.9 to leave one remaining unified volume.
- 5.12 On the plane Y=0, a section composed of the following elements:
- A line between  $[X_R = -527, 110]$ ,  $[X_R = 450, 310]$ .
  - A minor arc with a constant radius of 1000mm, extending from  $[X_R = -527, 110]$  to  $[X_R = -750, 91]$  with its centre of curvature above Z=0.
  - A line between  $[X_R = -750, 91]$ ,  $[X_F = 2100, 110]$ .
  - A minor arc with a constant radius of 8000mm, extending from  $[X_F = 325, 425]$  to  $[X_F = 2100, 110]$  with its centre of curvature above Z=0.
- 5.13 Once the section in §5.12 is fully defined it must be extruded along Y to Y=800 and used to trim the volume in §5.11 with all material above the extrusion discarded.
- 5.14 A volume defined by a four-sided simple polygon on the plane Z=0, with its vertices at the points  $[X_F, Y] = [2100, 0]$ ,  $[2100, 375]$ ,  $[X_R, Y] = [-527, 0]$ ,  $[-527, 205]$ , extruded along Z to Z=450.
- 5.15 On the plane Y=0, a section composed of the following elements:
- A line between  $[X_R = -700, 75]$ ,  $[X_R = -527, 110]$ .
  - A line between  $[X_R = -700, 75]$ ,  $[X_F = 2100, 110]$ .

- 5.16 Once the section in §5.15 is fully defined it must be extruded along Y to Y=800 and used to trim the volume in §5.14 with all material below the extrusion discarded.
- 5.17 Once the volumes in §5.13 and §5.16 are fully defined the volume defined in §5.16 must be subtracted from the volume defined in §5.13 to leave one remaining unified volume
- 5.18 On the plane Z=0, a surface enclosed by the following peripheral elements:
- A line between  $[X_F=1000, 700]$ ,  $[X_F=1000, 800]$ .
  - A line between  $[X_F=1000, 800]$ ,  $[X_R= -350, 800]$ .
  - A line between  $[X_R= -350, 800]$ ,  $[X_R= -350, 495]$ .
  - A line between  $[X_F=1000, 700]$ ,  $[X_F=2000, 700]$ .
  - A minor arc of constant radius, extending from  $[X_R= -350, 495]$  to  $[X_F=2000, 700]$  and tangent to X at  $[X_F=2000, 700]$ .
- 5.19 Once the surface in §5.18 is fully defined it must be extruded along Z=450.
- 5.20 On the plane Y=0, a section composed of the following elements:
- A line between  $[X_R= -350, 45]$ ,  $[X_R= -700, 45]$ .
  - A line between  $[X_R= -700, 45]$ ,  $[X_F=2000, 80]$ .
  - A minor arc with a constant radius of 3000mm, extending from  $[X_F=970, 325]$  to  $[X_F=2000, 80]$  with its centre of curvature above Z=0.
- 5.21 Once the section in §5.20 is fully defined it must be extruded along Y to Y=800 and used to trim the volume in §5.19 with all material below the extrusion discarded.
- 5.22 Once the volumes in §5.17 and §5.21 are fully defined the volume defined in §5.21 must be subtracted from the volume defined in §5.17 to leave one remaining unified volume.
- 5.23 A plane through the following three points:
- $[X_F= 425, 0, 50]$ ,  $[X_F= 325, 0, 450]$ ,  $[X_F= 325, 25, 450]$ .
- 5.24 Once the plane in §5.23 is fully defined it must be used to trim the volume defined in §5.22 with ALL material below the plane discarded.
- 5.25 A plane through the following three points:
- $[X_F= 2100, 375, 0]$ ,  $[X_R= -350, 375, 0]$ ,  $[X_F= 2100, 800, 15]$ .
- 5.26 Once the plane in §5.25 is fully defined it must be used to trim the volume defined in §5.24 with ALL material below the plane discarded.

The fully defined volume in §5.26 is **RV-FLOOR-BODY**.

## 6 Floor Fences Reference Surface (RS-FLOOR-FENCE)

**RS-FLOOR-FENCE** is composed of the following elements:

- 6.1 Once the section in §2.3 is fully defined it must be extruded along Z to Z=450. Regions of the extrusion forward of  $X_F=760$  and regions rearward of  $X_F=1290$  must all be discarded.
- 6.2 The extruded section in §5.5 must be translated +50mm in the Z-direction and then used to trim the fully defined surface in §6.1, with all material above the extrusion discarded.
- 6.3 The plane in §5.8 must be translated +15mm in the Z-direction and then used to trim the fully defined surface in §6.2, with all material below the translated plane discarded.
- 6.4 The plane through the points  $[X_F, Y, Z] = [1290, 0, 60]$ ,  $[500, 0, 450]$ ,  $[500, 800, 450]$  must be used to trim the fully defined surface in §6.3, with all material rearward of the plane discarded.

The fully defined surface in §6.4 is **RS-FLOOR-FENCE**.

## 7 Floor Fences Reference Volume (RV-FLOOR-FENCE)

**RV-FLOOR-FENCE** is composed of the following elements:

- 7.1 On the plane  $Z=0$ , a surface enclosed by the following peripheral elements:
- A line between  $[X_F=1290, 800]$ ,  $[X_F=1700, 800]$ .
  - A line between  $[X_F=1700, 800]$ ,  $[X_F=1700, 0]$ .
  - A line between  $[X_F=1700, 0]$ ,  $[X_F=550, 0]$ .
  - A line between  $[X_F=550, 0]$ ,  $[X_F=550, 50]$ .
  - A line between  $[X_F=475, 505]$ ,  $[X_F=475, 625]$ .
  - A minor arc with a constant radius of 2000mm, extending from  $[X_F=550, 50]$  to  $[X_F=730, 520]$  with its centre of curvature rearward of  $X_F=730$ .
  - A minor arc with a constant radius of 2000mm, extending from  $[X_F=1290, 800]$  to  $[X_F=960, 685]$  with its centre of curvature forward of  $X_F=960$ .
  - A minor arc with a constant radius of 2000mm, extending from  $[X_F=960, 685]$  to  $[X_F=475, 625]$  with its centre of curvature forward of  $X_F=700$ .
  - A minor arc with a constant radius of 2120mm, extending from  $[X_F=475, 505]$  to  $[X_F=730, 520]$  with its centre of curvature forward of  $X_F=600$ .
- 7.2 Once the surface in §7.1 is fully defined it must be extruded along Z to  $Z=450$ .
- 7.3 Once the section in §5.12 is fully defined, it must be extruded along Y to  $Y=800$  and used to trim the volume in §7.2 with all material above the extrusion discarded.
- 7.4 On the plane  $Y=800$ , a line between  $[X_F=475, 385]$ ,  $[X_F=650, 0]$ .
- 7.5 Once the section in §7.4 is fully defined, it must be extruded along Y to  $Y=400$  and used to trim the volume in §7.3 with all material forward of the extrusion discarded.
- 7.6 Once the volume in §7.5 is fully defined it must be trimmed using the plane in §5.8 with all material below the plane discarded.

The fully defined volume in §7.6 is **RV-FLOOR-FENCE**.

## 8 Floor Edge Reference Volume (RV-FLOOR-EDGE)

**RV-FLOOR-EDGE** is composed of the following elements:

- 8.1 On the plane  $Z=0$ , a surface enclosed by the following peripheral elements:
- A line between  $[X_F=1700, 800]$ ,  $[X_F=2000, 800]$ .
  - A line between  $[X_F=1700, 700]$ ,  $[X_F=2000, 700]$ .
  - A line between  $[X_F=1700, 800]$ ,  $[X_F=1700, 700]$ .
  - A line between  $[X_R=-350, 475]$ ,  $[X_R=-350, 650]$ .
  - A minor arc of constant radius, extending from  $[X_R=-350, 650]$  to  $[X_F=2000, 800]$ , and tangent to X at  $[X_F=2000, 800]$ .
  - A minor arc of constant radius, extending from  $[X_R=-350, 475]$  to  $[X_F=2000, 700]$  and tangent to X at  $[X_F=2000, 700]$ .
- 8.2 Once the surface in §8.1 is fully defined it must be extruded along Z to  $Z=90$  and trimmed using the plane  $X_R=-700$ , with all material rearward of the plane discarded.
- 8.3 Once the volume in §8.2 is fully defined it must be trimmed using the plane in §5.8 with all material below the plane discarded.
- 8.4 Once the volume in §8.3 is fully defined it must be trimmed using the plane in §5.25 with all material below the plane discarded.

The fully defined volume in §8.4 is **RV-FLOOR-EDGE**.

## 9 Front Bodywork Reference Volume (RV-BODY-FRONT)

**RV-BODY-FRONT** is composed of the following elements:

- 9.1 On the plane  $Y=0$ , a surface enclosed by the following peripheral elements:
- A line between  $[X_B=-100, 645]$ ,  $[X_C=-350, 645]$ .
  - A line between  $[X_C=-350, 645]$ ,  $[X_C=-350, 770]$ .
  - A line between  $[X_C=-350, 770]$ ,  $[X_C=0, 770]$ .
  - A line between  $[X_C=0, 770]$ ,  $[X_C=0, 970]$ .
  - A line between  $[X_C=0, 970]$ ,  $[X_C=300, 970]$ .
  - A line between  $[X_C=300, 970]$ ,  $[X_C=300, 0]$ .
  - A line between  $[X_C=300, 0]$ ,  $[X_B=0, 0]$ .
  - A line between  $[X_B=0, 0]$ ,  $[X_B=0, 195]$ .
  - An arc of constant radius, extending from  $[X_A=0, 553]$  to  $[X_B=-100, 645]$  and tangent to (a) at  $[X_B=-100, 645]$ .
  - An arc of constant radius, extending from  $[X_A=0, 553]$  to  $X_F=-1350$ , passing through  $[X_F=-1300, 235]$  and tangent to (i) at  $[X_A=0, 553]$ .
  - An arc with a constant radius of 6000mm, extending from  $[X_B=0, 195]$  to  $[X_A=0, 220]$ . The arc's centre of curvature must lie below  $Z=0$ .
  - An arc of constant radius, extending from  $[X_F=-1100, 110]$  to  $[X_A=0, 220]$  that is tangent to (k) at  $[X_A=0, 220]$ .
  - A line on  $X_F=-1350$ , from  $[X_F=-1350, 110]$  to the endpoint of (j).
  - A line between  $[X_F=-1350, 110]$ ,  $[X_F=-1100, 110]$
- 9.2 Once the surface in §9.1 is fully defined it must be extruded along Y to  $Y=400$ .
- 9.3 On the plane  $Z=0$ , a section composed of the following elements:
- A line between  $[X_F=-1350, 165]$ ,  $[X_A=0, 205]$ .
  - A line between  $[X_A=0, 205]$ ,  $[X_B=-140, 265]$ .
  - A line between  $[X_B=-140, 265]$ ,  $[X_C=-400, 400]$
- 9.4 Once the section in §9.3 is fully defined it must be extruded along Z to  $Z=645$ mm and used to trim the volume defined in §9.2 with ALL material outboard of the section discarded.
- 9.5 An axis-aligned cuboid, which has one interior diagonal defined by points  $[X_C=20, 125, 0]$  and  $[X_C=300, 400, 970]$ .
- 9.6 Once the volume in §9.5 is fully defined it must be subtracted from the volume defined in §9.4 to create one unified volume.
- 9.7 An axis-aligned cuboid, which has one interior diagonal defined by points  $[X_C=0, 175, 770]$  and  $[X_C=20, 400, 970]$ .
- 9.8 Once the volume in §9.7 is fully defined it must be subtracted from the volume defined in §9.6 to create one unified volume.
- The fully defined volume in §9.8 is **RV-BODY-FRONT**
- 9.9 **RV-BODY-FRONT** is further split by the planes defined in Article 12.1.4:
- RV-CH-NOSE** refers to a sub part of **RV-BODY-FRONT** forward of plane A-A.
  - RV-CH-FRONT** refers to a sub part of **RV-BODY-FRONT** between plane A-A and plane B-B.
  - RV-CH-MID** refers to a sub part of **RV-BODY-FRONT** rearwards of plane B-B.
- The fully defined volume in §9.9a is **RV-CH-NOSE**.

The fully defined volume in §9.9b is **RV-CH-FRONT**.

The fully defined volume in §9.9c is **RV-CH-MID**.

## 10 Survival Cell Front Minimum Reference Volume (RV-CH-FRONT-MIN)

**RV-CH-FRONT-MIN** is composed of the following elements:

- 10.1 A volume bounded by  $X_A$  and  $X_B$  that must be symmetrical about  $Y=0$ , and when cut with any  $X$  plane, the cross section must:
- contain a four-sided section, with two sides parallel to  $Z$ .
  - Have width that varies linearly from 300mm at  $X_A$  to 380mm at  $X_A=500$  and then linearly to 490mm at  $X_B=0$ .
  - Have height at  $Y=0$  that varies linearly from 305 at  $X_A$  to 415 at  $X_B=0$ .
  - Have the side visible from above, a convex circular arc, with radius varying linearly from  $R=575$  at  $X_A$  to  $R=2500$  at  $X_B=0$ .
  - Have the side visible from below, a convex circular arc, with a constant radius of  $R=2500$ .
- 10.2 Once the volume in §10.1 is fully defined, radii with a convex radius of curvature of 50mm must be applied to the longitudinal edges, drawn tangent to both surfaces and perpendicular to the boundary.

The fully defined volume in §10.2 is **RV-CH-FRONT-MIN**.

## 11 Nose Reference Surface (RS-CH-NOSE)

**RS-CH-NOSE** is composed of the following elements:

- 11.1 On the plane  $Z=0$ , a surface enclosed by the following peripheral elements:
- A line between  $[X_F=-1150, 0]$ ,  $[X_F=-1125, 100]$ .
  - A line between  $[X_F=-1125, 100]$ ,  $[X_A=0, 150]$ .
  - A line between  $[X_A=0, 150]$ ,  $[X_A=0, 0]$ .
  - A line between  $[X_A=0, 0]$ ,  $[X_F=-1150, 0]$ .

The fully defined surface in §11.1 is **RS-CH-NOSE**.

## 12 Rear Bodywork Reference Volume (RV-BODY-REAR)

**RV-BODY-REAR** is composed of the following elements:

- 12.1 On the plane  $Z=0$ , a surface enclosed by the following peripheral elements:
- A line between  $[X_F=900, 450]$ ,  $[X_F=900, 0]$ .
  - A line between  $[X_F=900, 0]$ ,  $[X_R=-50, 0]$ .
  - A line between  $[X_R=-50, 0]$ ,  $[X_R=-50, 350]$ .
  - A line between  $[X_R=-50, 350]$ ,  $[X_C=450, 775]$ .
  - A line between  $[X_C=450, 775]$ ,  $[X_F=1300, 775]$ .
  - A line between  $[X_F=1300, 775]$ ,  $[X_F=900, 450]$ .
- 12.2 Once the surface in §12.1 is fully defined it must be extruded along  $Z$  to  $Z=600$ .
- 12.3 A plane through the following three points:
- $[X_C, 0, 600]$ ,  $[X_C, 675, 600]$ ,  $[X_R=-50, 0, 350]$ .



12.4 Once the plane in §12.3 is fully defined it must be used to trim the volume defined in §12.2 with ALL material above the plane discarded.

12.5 **RV-BODY-REAR** is further split as follows:

- a. **RV-RBW-SPOD** refers to a sub part of **RV-BODY-REAR** forward of  $X_F=1300$ .
- b. **RV-RBW-COKE** refers to a sub part of **RV-BODY-REAR** rearwards of  $X_F=1300$ .

The fully defined volume in §12.5.a is **RV-RBW-SPOD**.

The fully defined volume in §12.5.b is **RV-RBW-COKE**.

### 13 Mirror Housing Reference Volume (RV-MIR-HOU)

**RV-MIR-HOU** is composed of the following elements:

13.1 On the plane  $Z=640$ , a surface enclosed by the following peripheral elements:

- a. A line between  $[X_C = -830, 470]$ ,  $[X_C = -730, 470]$
- b. A line between  $[X_C = -730, 470]$ ,  $[X_C = -650, 680]$
- c. A line between  $[X_C = -650, 680]$ ,  $[X_C = -750, 680]$
- d. A line between  $[X_C = -750, 680]$ ,  $[X_C = -830, 470]$

13.2 Once the surface in §13.1 is fully defined it must be extruded along Z to  $Z=720$ .

The fully defined volume in §13.2 is **RV-MIR-HOU**.

### 14 Louvre Aperture Reference Surface (RS-RBW-APERTURE)

**RS-RBW-APERTURE** is composed of the following elements:

14.1 On the plane  $Z=400$ , a surface enclosed by the following peripheral elements:

- a. A line between  $[X_C = -400, 400]$ ,  $[X_R = -850, 100]$ .
- b. A line between  $[X_R = -850, 100]$ ,  $[X_R = -850, 400]$ .
- c. A line between  $[X_R = -850, 400]$ ,  $[X_C = 0, 675]$ .
- d. A line between  $[X_C = 0, 675]$ ,  $[X_C = -400, 675]$ .
- e. A line between  $[X_C = -400, 675]$ ,  $[X_C = -400, 400]$ .

The fully defined surface in §14.1 is **RS-RBW-APERTURE**.

### 15 Louvre Aperture Reference Volume (RV-RBW-APERTURE)

**RV-RBW-APERTURE** is composed of the following elements:

15.1 Once the surface in §14.1 is fully defined it must be extruded along Z to  $Z=700$ .

15.2 Once the volume in §15.1 has been fully defined it must be trimmed with the following two planes:

- a. A plane defined by the three points  $[X_C=-400, 400, 675]$ ,  $[X_R=-850, 100, 700]$  and  $[X_R=-850, 400, 675]$ , with all material above the plane discarded.
- b. A plane offset by 200mm, parallel to and below the plane defined in §12.3 with all material below the plane discarded.

The fully defined volume in §15.2 is **RV-RBW-APERTURE**.

### 16 Engine Cover Reference Volume (RV-RBW-EC)

**RV-RBW-EC** is composed of the following elements:

- 16.1 On the plane  $Y=0$ , a surface enclosed by the following peripheral elements:
- A line between  $[X_C=300, 0]$ ,  $[X_R= -50, 0]$ .
  - A line between  $[X_R= -50, 0]$ ,  $[X_R= -50, 580]$ .
  - A line between  $[X_R= -50, 580]$ ,  $[X_C=600, 970]$ .
  - A line between  $[X_C=600, 970]$ ,  $[X_C=300, 970]$ .
  - A line between  $[X_C=300, 970]$ ,  $[X_C=300, 0]$ .
- 16.2 Once the surface in §16.1 is fully defined it must be extruded along  $Y$  to  $Y=450$ .
- 16.3 An axis-aligned cuboid, which has one interior diagonal defined by points  $[X_C=20, 125, 0]$  and  $[X_C=300, 450, 970]$ .
- 16.4 An axis-aligned cuboid, which has one interior diagonal defined by points  $[X_C= -350, 400, 0]$  and  $[X_C=20, 450, 770]$ .
- 16.5 Once the volumes in §16.2, §16.3, and §16.4 are fully defined they must all be joined to create a single unified volume.
- 16.6 An extrusion of the section defined in §12.1 (d), along  $Z$ , to  $Z=770$ .
- 16.7 Once the section in §16.6 is fully defined it must be used to trim the volume in §16.5 with ALL material outboard of the extrusion discarded.
- 16.8 On the plane  $Y=0$ , a surface enclosed by the following peripheral elements:
- A line between  $[X_C=600, 500]$ ,  $[X_C=600, 970]$ .
  - A line between  $[X_C=600, 970]$ ,  $[X_R= -200, 735]$ .
  - A line between  $[X_R= -200, 735]$ ,  $[X_R= -50, 500]$ .
  - A line between  $[X_R= -50, 500]$ ,  $[X_C=600, 500]$ .
- 16.9 Once the surface in §16.8 is fully defined it must be extruded along  $Y$  to  $Y=25$ .
- 16.10 Once the volumes in §16.9 and §16.7 are fully defined they must be joined to create a single unified volume.
- 16.11 Once the volume in §16.10 is fully defined, the **RV-RBW-COKE** must be subtracted from it to leave one remaining unified volume.
- The fully defined volume in §16.11 is **RV-RBW-EC**.

## 17 Engine Cover Reference Surface (RS-RBW-EC)

**RS-RBW-EC** is composed of the following elements:

- 17.1 On the plane  $Y=0$ , a surface enclosed by the following peripheral elements:
- A line between  $[X_R= -53, 50]$ ,  $[X_R= -53, 500]$ .
  - A line between  $[X_R= -53, 500]$ ,  $[X_R= -200, 550]$ .
  - A line between  $[X_R= -200, 550]$ ,  $[X_R= -200, 727]$
  - A line between  $[X_R= -200, 727]$ ,  $[X_R= -325, 727]$
  - A line between  $[X_R= -325, 727]$   $[X_C=300, 967]$
  - A line between  $[X_C=300, 967]$ ,  $[X_C=300, 50]$ .
  - A line between  $[X_C=300, 50]$ ,  $[X_R= -53, 50]$ .
- 17.2 The surface defined in §17.1 should be trimmed using the extruded section fully defined in §5.5 with ALL material below the extrusion discarded.
- The fully defined surface in §17.2 is **RS-RBW-EC**.

## 18 Tail Reference Volume (RV-TAIL)

**RV-TAIL** is composed of the following elements:

- 18.1 On the plane  $Y=0$ , a surface enclosed by the following peripheral elements:
- A line between  $[X_{DIF}=-110, 0]$ ,  $[X_{DIF}=-110, 480]$ .
  - A line between  $[X_{DIF}=-110, 480]$ ,  $[X_{DIF}=10, 480]$ .
  - A line between  $[X_{DIF}=10, 480]$ ,  $[X_{DIF}=625, 380]$ .
  - A line between  $[X_{DIF}=625, 380]$ ,  $[X_{DIF}=760, 380]$ .
  - A line between  $[X_{DIF}=760, 380]$ ,  $[X_{DIF}=760, 175]$ .
  - A line between  $[X_{DIF}=760, 175]$ ,  $[X_{DIF}=625, 175]$ .
  - A line between  $[X_{DIF}=625, 175]$ ,  $[X_{DIF}=10, 0]$ .
  - A line between  $[X_{DIF}=10, 0]$ ,  $[X_{DIF}=-110, 0]$ .
- 18.2 Once the surface in §18.1 is fully defined it must be extruded along Y to  $Y=150$ .
- 18.3 On the plane  $Z=0$ , a section composed of the following elements:
- A line between  $[X_{DIF}=-110, 150]$ ,  $[X_{DIF}=10, 150]$ .
  - A line between  $[X_{DIF}=10, 150]$ ,  $[X_{DIF}=410, 60]$ .
  - A line between  $[X_{DIF}=410, 60]$ ,  $[X_{DIF}=760, 60]$ .
- 18.4 Once the section in §18.3 is fully defined it must be extruded along Z to  $Z=480$ mm.
- 18.5 The extruded section defined in §18.4 must be used to trim the volume defined in §18.2 with all material outboard of the extrusion discarded.

The fully defined volume in §18.5 is **RV-TAIL**.

## 19 Exhaust Reference Volume (RV-TAIL-EXH)

**RV-TAIL-EXH** is composed of the following elements:

- 19.1 On the plane  $Y=0$ , a surface enclosed by the following peripheral elements:
- A line between  $[X_R = -53, 425]$ ,  $[X_R = -53, 580]$ .
  - A line between  $[X_R = -53, 580]$ ,  $[X_R = 565, 525]$ .
  - A line between  $[X_R = 565, 525]$ ,  $[X_R = 565, 375]$ .
  - A line between  $[X_R = 565, 375]$ ,  $[X_R = -53, 425]$ .
- 19.2 Once the surface in §19.1 is fully defined it must be extruded along Y to  $Y=75$ .
- The fully defined volume in §19.2 is **RV-TAIL-EXH**.

## 20 RIS Reference Volume (RV-TAIL-RIS)

- 20.1 On the plane  $X_{DIF}=750$ , a surface enclosed by the following peripheral elements:
- A line between  $[0, 227.5]$  and  $[0, 372.5]$
  - A minor circular arc of radius 270mm from  $[46.5, 231]$  to  $[46.5, 369]$  with its centre inboard of  $Y=46.5$
  - A minor circular arc from  $[0, 227.5]$  to  $[46.5, 231]$  tangent to Y at  $[0, 227.5]$
  - A minor circular arc from  $[0, 372.5]$  to  $[46.5, 369]$  tangent to Y at  $[0, 372.5]$

- 20.2** Once the profile surface in §20.1 is fully defined it should must be extruded in along X to  $X_{DIF}=325$
- 20.3** Once the volume in §20.2 is fully defined, radii with a convex radius of curvature of 20mm must be applied to both outboard corners, drawn tangent to both surfaces and perpendicular to the boundary.

The Fully Defined volume in §20.3 is **RV-TAIL-RIS**

## **21 Front Wing Reference Volume (RV-FW)**

A volume subsequently used to define **RV-FW** is composed of the following elements:

- 21.1** On the plane through  $X_F = -1350$ , a surface enclosed by the following peripheral elements:
- A line between [0, 135], [0, 280].
  - A line between [0, 280], [250, 315].
  - A line between [250, 315], [650, 315].
  - A line between [650, 315], [900, 200].
  - A line between [900, 200], [900, 475].
  - A line between [900, 475], [975, 475].
  - A line between [975, 475], [975, 100].
  - A line between [975, 100], [900, 100].
  - A line between [900, 100], [125, 135].
  - A line between [125, 135], [0, 135].
- 21.2** Once the surface in §21.1 is fully defined it must be extruded along X to  $X_F = -450$ .
- 21.3** A plane through the following three points:
- $[X_F = -825, 975, 100]$ ,  $[X_F = -475, 975, 125]$ ,  $[X_F = -475, 350, 160]$ .
- 21.4** Once the plane in §21.3 is fully defined it must be used to trim the volume defined in §21.2 with ALL material below the plane discarded.
- 21.5** On the plane through  $X_F = -1350$ , a surface enclosed by the following peripheral elements:
- A line between [0, 110], [0, 160].
  - A line between [0, 160], [445, 160].
  - A line between [445, 160], [165, 110].
  - A line between [165, 110], [0, 110].
- 21.6** Once the surface in §21.5 is fully defined it must be extruded along X to  $X_F = -450$ .
- 21.7** An extrusion of section defined in §9.1 (I) along Y to  $Y=445$ .
- 21.8** Once the surface in §21.7 is fully defined it must be used to trim the volume in §21.6 with ALL material below the extrusion discarded.
- 21.9** Once the volume in §21.8 is fully defined it must be unified with the volume in §21.4 to create a single volume.
- 21.10** On the plane  $Z=0$ , an open section composed of the following boundary elements:
- A line between  $[X_F = -1350, 0]$ ,  $[X_F = -975, 975]$ .
  - A line between  $[X_F = -975, 975]$ ,  $[X_F = -475, 975]$ .
  - A line between  $[X_F = -475, 975]$ ,  $[X_F = -475, 900]$ .
  - A line between  $[X_F = -475, 900]$ ,  $[X_F = -550, 350]$ .
  - A line between  $[X_F = -550, 350]$ ,  $[X_F = -800, 0]$ .

- 21.11 Once the section in §21.10 is fully defined it must be extruded along Z to Z=500.
- 21.12 Using the extruded section defined in §21.11, the volume defined in §21.9 must be trimmed with ALL material outside of the section discarded.
- 21.13 Once the volume in §21.12 is fully defined it is further split by a number of planar surfaces:
- RV-FW-PROFILES** refers to a sub part of this volume inboard of Y=900.
  - RV-FW-EP** refers to a sub part of this volume above Z=200 and outboard of Y=900.
  - RV-FW-TIP** refers to the remaining parts of this volume not explicitly defined in (a) or (b).
- 21.14 **RV-FW-EP** must be further trimmed by a plane through the following three points:
- $[X_F = -975, 975, 200]$ ,  $[X_F = -975, 900, 200]$ ,  $[X_F = -825, 975, 475]$ .
- All material forward of this plane must be discarded.
- 21.15 **RV-FW-TIP** must be further trimmed such that all material inboard of Y=910 and that is also above Z=170 must be removed.
- 21.16 The fully defined volume in §21.13.a is **RV-FW-PROFILES**.  
The fully defined volume in §21.14 is **RV-FW-EP**.  
The fully defined volume in §21.15 is **RV-FW-TIP**.  
RV-FW is a combination of RV-FW-PROFILES, RV-FW-EP and RV-FW-TIP.

## 22 Front Wing Diveplane Reference Volume (RV-FW-DP)

**RV-FW-DP** is composed of the following elements:

- 22.1 An axis-aligned cuboid, which has one interior diagonal defined by points  $[X_F = -960, 900, 200]$  and  $[X_F = -475, 1000, 350]$ .
- 22.2 Once the volume in §22.1 is fully defined it must be trimmed by the plane defined in §21.9 with ALL material forward of the plane discarded.  
The fully defined volume in §22.2 is **RV-FW-DP**.

## 23 Front Wing Endplate Body Reference Surface (RS-FWEP-BODY)

**RS-FWEP-BODY** is composed of the following elements:

- 23.1 On the plane Y=900, a surface enclosed by the following peripheral elements:
- A line between  $[X_F = -950, 200]$  and  $[X_F = -525, 200]$ .
  - A line between  $[X_F = -525, 200]$  and  $[X_F = -525, 470]$ .
  - A line between  $[X_F = -525, 470]$  and  $[X_F = -775, 425]$ .
  - A line between  $[X_F = -775, 425]$  and  $[X_F = -950, 200]$ .

The fully defined surface in §23.1 is **RS-FWEP-BODY**.

## 24 Front Wing Profiles Reference Surface (RS-FW-PROFILES)

**RS-FW-PROFILES** is composed of the following elements:

- 24.1 On the plane Z=400, a surface enclosed by the following peripheral elements:
- A line between  $[X_F = -1320, 0]$  and  $[X_F = -990, 900]$ .
  - A line between  $[X_F = -990, 900]$  and  $[X_F = -525, 900]$ .
  - A line between  $[X_F = -525, 900]$  and  $[X_F = -525, 800]$ .
  - A line between  $[X_F = -525, 800]$  and  $[X_F = -1320, 0]$ .

The fully defined surface in §24.1 is **RS-FW-PROFILES**.

## **25 Front Wing Diveplane Reference Surface (RS-FW-DP)**

**RS-FW-DP** is composed of the following elements:

- 25.1 On the plane  $Z=100$ , an axis-aligned rectangular surface, which has one diagonal defined by points  $[X_F=-850, 900]$  and  $[X_F=-535, 997]$ .

The fully defined surface in §25.1 is **RS-FW-DP**.

## **26 Front Wing Profiles Reference Section (RS-FW-SECTION)**

**RS-FW-SECTION** is composed of the following elements:

- 26.1 A plane through the following three points:
- $[X_F=-1350, 0, 0]$ ,  $[X_F=-975, 975, 0]$ ,  $[X_F=-1350, 0, 500]$ .

The fully defined plane in §26.1 is **RS-FW-SECTION**.

## **27 Rear Wing Endplate Reference Volume (RV-RWEP-BODY)**

**RV-RWEP-BODY** is composed of the following elements:

- 27.1 On the plane  $X_R=140$ , a surface enclosed by the following peripheral elements:
- A line between  $[410, 325]$ ,  $[430, 515]$ .
  - A line between  $[430, 515]$ ,  $[480, 660]$ .
  - A line between  $[480, 660]$ ,  $[555, 660]$ .
  - A line between  $[555, 660]$ ,  $[490, 515]$ .
  - A line between  $[490, 515]$ ,  $[460, 325]$ .
  - A line between  $[460, 325]$ ,  $[410, 325]$ .
- 27.2 Once the surface in §27.1 is fully defined it must be extruded along X to  $X_R=680$ .
- 27.3 On the plane  $Y=0$ , an open section composed of the following boundary elements:
- A line between  $[X_R=140, 660]$ ,  $[X_R=270, 325]$ .
  - A line between  $[X_R=270, 325]$ ,  $[X_R=470, 325]$ .
  - A line between  $[X_R=470, 325]$ ,  $[X_R=680, 375]$
  - A line between  $[X_R=680, 375]$ ,  $[X_R=680, 675]$ .
- 27.4 Once the section in §27.3 is fully defined it must be extruded along Y to  $Y=600$ .
- 27.5 Using the extruded section defined in §27.4 the volume defined in §27.2 must be trimmed with ALL material outside of the section discarded.

The fully defined volume in §27.5 is **RV-RWEP-BODY**

## **28 Rear Wing Profiles Reference Volume (RV-RW-PROFILES)**

**RV-RW-PROFILES** is composed of the following elements:

- 28.1 On the plane  $Y=0$ , a surface enclosed by the following peripheral elements:
- A line between  $[X_R=140, 670]$ ,  $[X_R=140, 825]$ .
  - A line between  $[X_R=140, 825]$ ,  $[X_R=355, 825]$ .
  - A line between  $[X_R=355, 825]$ ,  $[X_R=530, 910]$ .
  - A line between  $[X_R=530, 910]$ ,  $[X_R=555, 910]$ .
  - A line between  $[X_R=555, 910]$ ,  $[X_R=555, 670]$ .

f. A line between  $[X_R=555, 670]$ ,  $[X_R=140, 670]$ .

28.2 Once the surface in §28.1 is fully defined it must be extruded along Y to  $Y=480$ .

The fully defined volume in §28.2 is **RV-RW-PROFILES**

## 29 Rear Wing Tip Reference Volume (RV-RW-TIP)

**RV-RW-TIP** is composed of the following elements:

29.1 On the plane  $X_R=140$ , a surface enclosed by the following peripheral elements:

- a. A line between  $[480, 660]$ ,  $[480, 910]$ .
- b. A line between  $[480, 910]$ ,  $[615, 910]$ .
- c. A line between  $[615, 910]$ ,  $[615, 775]$ .
- d. A line between  $[615, 775]$ ,  $[555, 660]$ .
- e. A line between  $[555, 660]$ ,  $[480, 660]$ .

29.2 Once the surface in §29.1 is fully defined it must be extruded along X to  $X_R=680$ .

29.3 An extrusion of sections defined in §28.1 (b) and (c) along Y to  $Y=800$ .

29.4 Once the sections in §29.3 are fully defined they must be used to trim the volume in §29.2 with ALL material above the extrusion discarded.

29.5 On the plane  $X_R=555$ , a surface enclosed by the following peripheral elements:

- a. A line between  $[580, 910]$ ,  $[480, 910]$ .
- b. A line between  $[480, 910]$ ,  $[480, 685]$ .
- c. A line between  $[480, 685]$ ,  $[580, 785]$ .
- d. A line between  $[580, 785]$ ,  $[580, 910]$ .

29.6 Once the surface in §29.5 is fully defined it must be extruded along X to  $X_R=680$ .

29.7 Once the volume in §29.6 is fully defined it must be subtracted from the volume defined in §29.4 to leave one unified volume.

The fully defined volume in §29.7 is **RV-RW-TIP**

## 30 Rear Wing Beam Reference Volume (RV-RW-BEAM)

**RV-RW-BEAM** is composed of the following elements:

30.1 An axis-aligned cuboid, which has one interior diagonal defined by points  $[X_R=270, 0, 325]$  and  $[X_R=550, 490, 500]$ .

30.2 An extrusion of section defined in §27.3 (c) along Y to  $Y=490$ .

30.3 Once the surface in §30.2 is fully defined it must be used to trim the volume in §30.1 with ALL material below the extrusion discarded.

30.4. Once the volume in §30.3 is fully defined it must be trimmed by the plane through the points  $[X_R, Y, Z] = [270, 460, 325]$ ,  $[550, 460, 325]$ ,  $[270, 490, 515]$  with ALL material outboard of the plane discarded.

The fully defined volume in §30.4 is **RV-RW-BEAM**

## 31 Rear Wing Endplate Reference Surface (RS-RW-RWEP)

**RS-RW-RWEP** is composed of the following elements:

31.1 On the plane  $Y=350$ , a surface enclosed by the following peripheral elements:

- a. A line between  $[X_R=625, 400]$ ,  $[X_R=670, 770]$ .
- b. A line between  $[X_R=670, 770]$ ,  $[X_R=150, 770]$ .

- c. A line between  $[X_R=150, 770]$ ,  $[X_R= 290, 370]$ .
- d. A line between  $[X_R= 290, 370]$ ,  $[X_R=625, 400]$ .

The fully defined surface in §31.1 is **RS-RW-RWEP**.

### 32 Rear Wing Beam Reference Surface (RS-RW-BEAM)

**RS-RW-BEAM** is composed of the following elements:

- 32.1 On the plane  $Z=300$ , an axis-aligned rectangular surface, which has one diagonal defined by points  $[X_R= 270, 0]$  and  $[X_R= 550, 460]$ .

The fully defined surface in §32.1 is **RS-RW-BEAM**.

### 33 Rear Wing Pylon Reference Volume (RV-RW-PYLON)

**RV-RW-PYLON** is composed of the following elements:

- 33.1 On the plane  $Y=0$ , a surface enclosed by the following peripheral elements:

- a. A line between  $[X_R= -50, 250]$ ,  $[X_R= -50, 580]$
- b. A line between  $[X_R=-50, 580]$ ,  $[X_R=50, 860]$ .
- c. A line between  $[X_R=50, 860]$ ,  $[X_R=300, 860]$ .
- d. A line between  $[X_R=300, 860]$ ,  $[X_R=300, 725]$ .
- e. A line between  $[X_R=300, 725]$ ,  $[X_{DIF}=160, 250]$ .
- f. A line between  $[X_{DIF}=160, 250]$ ,  $[X_R= -50, 250]$ .

- 33.2 Once the surface in §33.1 is fully defined it must be extruded along  $Y$  to  $Y=100$ .

The fully defined volume in §33.2 is **RV-RW-PYLON**.

### 34 Front Wheel Scoop Reference Volume (RV-FWH-SCO)

**RV-FWH-SCO** is composed of the following elements

- 34.1 On a plane through  $Y_W=-6$ , a circle of radius 220.3mm centred at  $[0, 0]$  and extruded along  $Y_w$  to  $Y_w=150$  retaining only the material between  $Z_w= 200$  and  $Z_w = -100$ .

- 34.2 A plane through the following three points:

- a.  $[X_w = 0, 150, 20]$ ,  $[X_w = 50, 150, 20]$ ,  $[X_w = 0, 0, -100]$

- 34.3 Once the plane in 34.2 is defined it must be used to trim the volume in 34.1 with ALL material below the plane discarded.

- 34.4 A plane through the following three points:

- a.  $[X_w = 0, 150, 20]$ ,  $[X_w = 100, 150, 200]$ ,  $[X_w = 200, 0, -100]$

- 34.5 Once the plane in 34.4 is defined it must be used to trim the volume in 34.3 with ALL material inboard of the plane discarded.

The fully defined volume in §34.5 is **RV-FWH-SCO**.

### 35 Rear Wheel Scoop Reference Volume (RV-RWH-SCO)

**RV-RWH-SCO** is composed of the following elements:

- 35.1 On a plane through  $Y_w=-6$ , a circle of radius 220.3mm centred at  $[0, 0]$  and extruded along  $Y_w$  to  $Y_w =100$  retaining only the material above  $Z_w=0$ .

The fully defined volume in §35.1 is **RV-RWH-SCO**.



### 36 Rear Scoop Lip Reference Volume (RV-RWH-LIP)

RV-RWH-LIP is composed of the following elements:

- 36.1 On the plane  $Y_w = -6$ , a surface enclosed between circles of radius 195mm and 325mm, both centred at  $[0, 0]$  extruded along  $Y_w$  to  $Y_w = 50$  retaining only the material between  $Z_w = 195$  and  $Z_w = 0$  with ALL material rearward of  $X_w = 0$  discarded.

### 37 Bib Reference Volume (RV-BIB)

RV-BIB is composed of the following elements.

- 37.1 On the plane  $Z=0$ , a surface whose boundary is a five-sided polygon with its vertices at the following five points:

- a.  $[X_F = 425, 0]$ .
- b.  $[X_F = 425, 85]$ .
- c.  $[X_F = 800, 150]$ .
- d.  $[X_C = -700, 150]$
- e.  $[X_C = -700, 0]$ .

- 37.2 A plane normal to  $Y=0$  containing the points  $[X_F=425, 0, 50]$  and  $[X_C=-700, 0, 95]$

- 37.3 Once the surface in §37.1 is fully defined it must be extruded along  $Z$  to  $Z=100$  and trimmed with the plane defined in §37.2 with all material above this plane being discarded.

The fully defined volume in §37.3 is RV-BIB.

### 38 Bib Stay Reference Volume (RV-BIB-STAY)

- 38.1 On the plane  $Z=0$ , an axis aligned rectangular surface which has one diagonal defined by points  $[X_F = 425, 0]$  and  $[X_F=625, 10]$ .

- 38.2 Once the surface in §38.1 is fully defined it must be extruded along  $Z$  to  $Z=275$ .

The fully defined volume in §38.2 is RV-BIB-STAY.

### 39 Plank Reference Volume (RV-PLANK)

RV-PLANK is composed of the following elements:

- 39.1 On the plane  $Z=0$ , a surface bounded by a five-sided simple polygon with vertices at the points:

- a.  $[X_F=430, 0]$
- b.  $[X_F=430, 75]$
- c.  $[X_F=690, 125]$
- d.  $[X_R=-600, 125]$
- e.  $[X_R=-600, 0]$

- 39.2 Once the surface in §39.1 is fully defined, a fillet of radius 25mm must be applied at vertex (b) and a fillet of radius 2000mm must be applied at vertex (c).

- 39.3 Once the surface in §39.2 is fully defined it must be extruded along  $Z$  to  $Z=-10$ .

- 39.4 Once the volume in §39.3 is fully defined; a chamfer of 6mm x 150mm must be applied to the lower edge at  $X_R=-600$  and a chamfer of 6mm x 12mm must be applied to the remaining lower edges.

39.5 Once the surface in §39.4 is fully defined 50mm diameter holes must be cut through the volume parallel to the Z-axis, with centres at  $[X_F=500, 0]$ ,  $[X_F=1080, 75]$ , and  $[-825 \geq X_R \geq -1025, 0]$

39.6 The fully defined volume in §39.5 is **RV-PLANK**

#### **40 Camera 2 Reference Volume (RV-CAMERA-2)**

**RV-CAMERA-2** is composed of the following elements:

40.1 An axis-aligned cuboid, which has one interior diagonal bounded by points  $[X_F=-150, 0, 325]$  and  $[X_F=-450, 330, 550]$ .

40.2 A plane defined by the three points  $[X_F=-1300, 0, 220]$ ,  $[X_A=0, 0, 550]$  and  $[X_A=-0, 200, 550]$

40.3 The cuboid in §40.1 must be trimmed with the plane defined in §40.2, with all material above this plane being discarded.

40.4 A plane defined by the three points  $[X_F=-1125, 85, 0]$ ,  $[X_A=0, 135, 0]$  and  $[X_A=0, 135, 200]$

40.5 The volume in §40.3 must be trimmed with the plane defined in §40.4, with all material inboard of this plane being discarded.

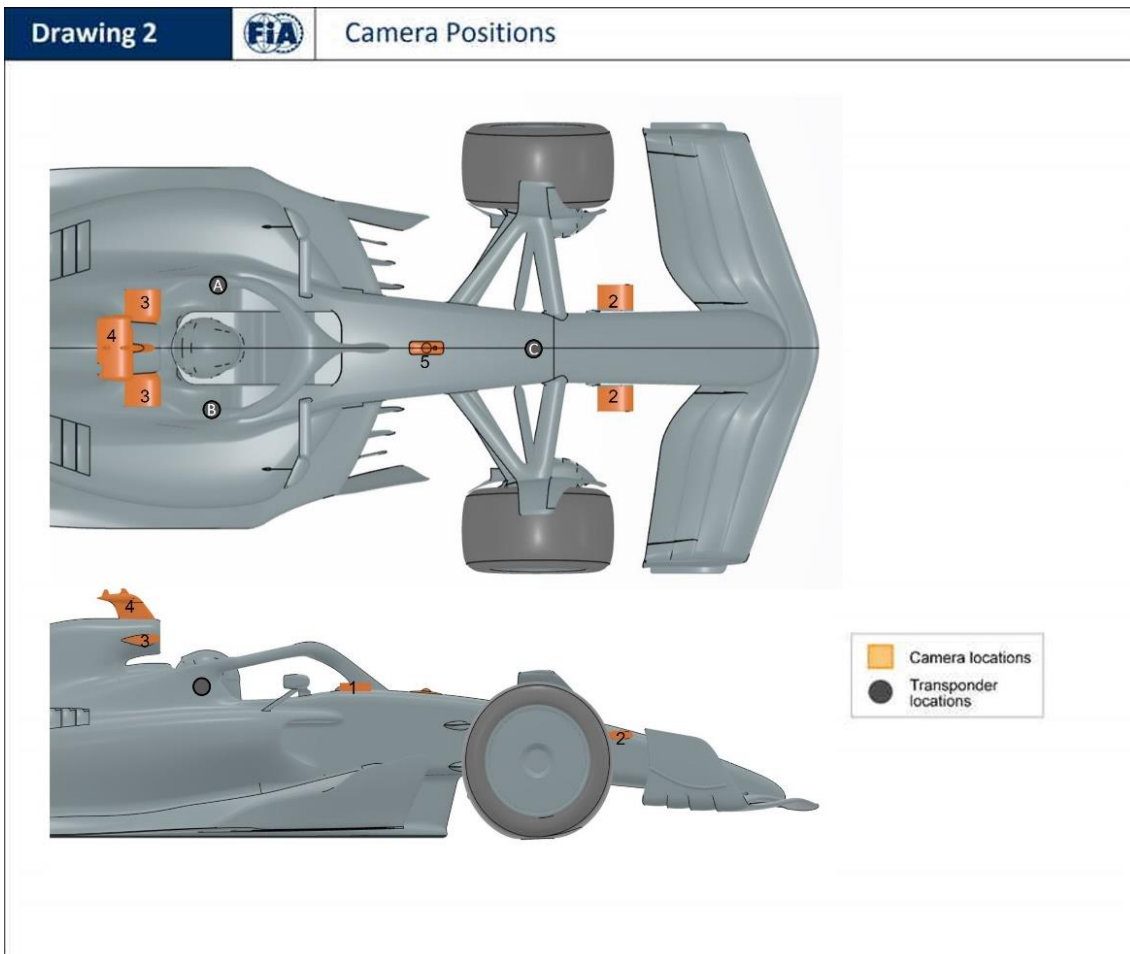
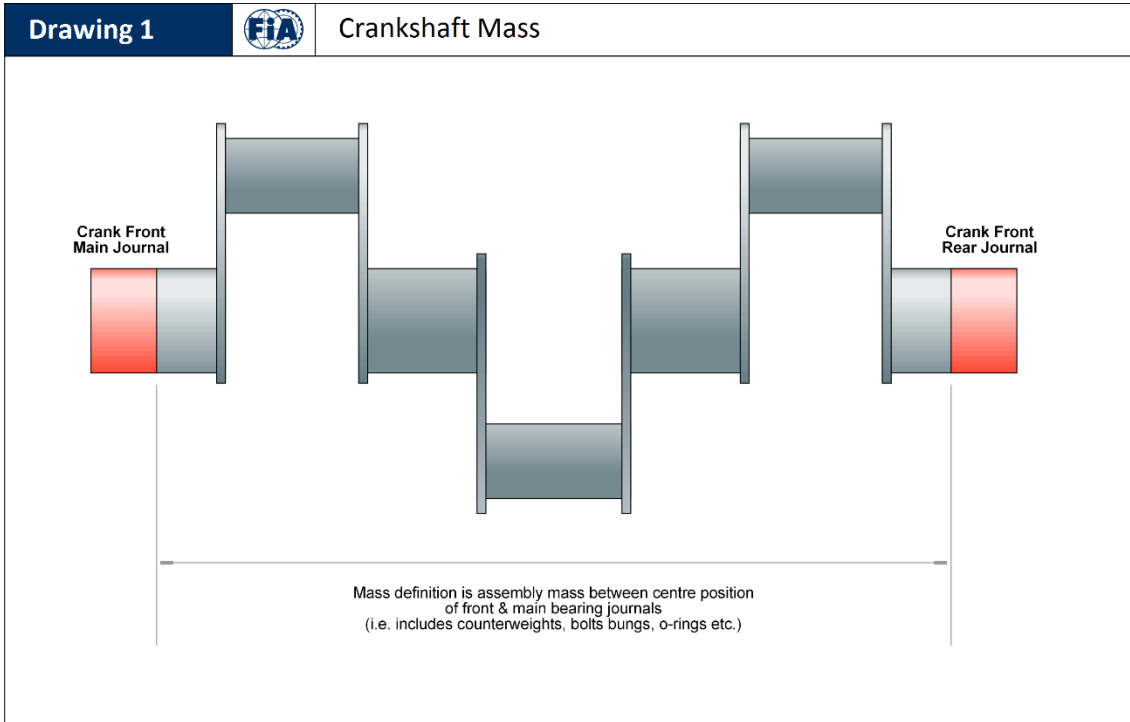
The fully defined volume in §40.5 is **RV-CAMERA-2**.

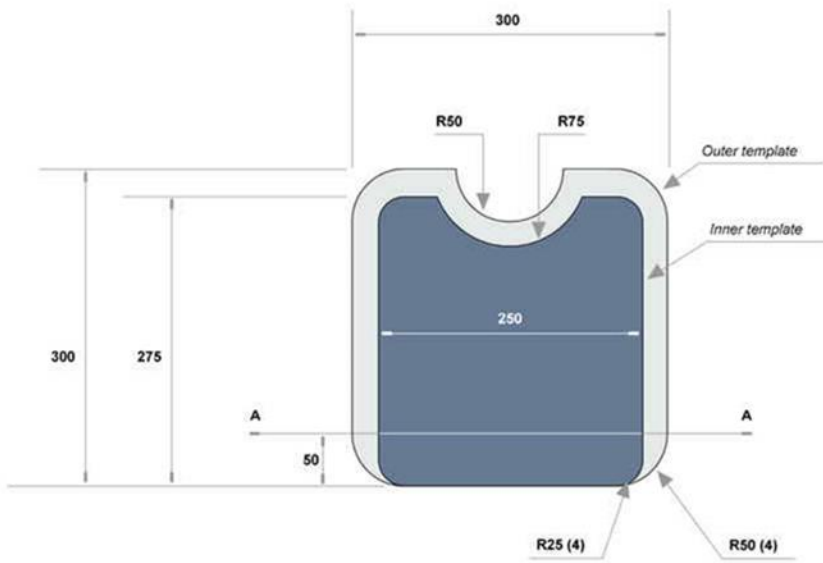
## 41 Legality Volumes or Surfaces Defined by CAD Models

41.1 The legality volumes and surfaces listed here are defined exclusively by CAD data and are available to download from the FIA's CAD Portal. Unless otherwise stated, the volumes must be positioned with the origin of the model at the coordinates given and with the model axes parallel to, and in the same direction as the corresponding car axes.

Volume or Surface	CAD Part No	Revision	Notes
RV-CASSETTE	<del>FIA-0000752</del> FIA-LEG-0005	C.1	Positioned at $[X_{DIF}=0, 0, 0]$
RS-CASSETTE	<del>FIA-00004377</del> FIA-LEG-0011	A.1	Positioned at $[X_{DIF}=0, 0, 0]$
RV-CH-MID-MIN	<del>FIA-00004321</del> FIA-LEG-0001	E.1	Positioned at $[X_C=0, 0, 0]$
RV-CH-MID-STRUCT	<del>FIA-00007500</del> FIA-LEG-0015	C.1	Positioned at $[X_C=0, 0, 0]$
RV-COCKPIT-ENTRY	<del>FIA-0000753</del> FIA-LEG-0004	C.1	Positioned at $[X_C=0, 0, 0]$
RV-COCKPIT-DRIVER	<del>FIA-00006695</del> FIA-LEG-0006	D.1	Positioned at $[X_C=0, 0, 0]$
RS-FWD-FUEL-LIMIT	<del>FIA-0000754</del> FIA-LEG-0010	C.1	Positioned at $[X_C=0, 0, 0]$
Appendix 1 Volumes	FIA-00004401	F.1	Positioned at $[X_A=0, 0, 0]$ . Parametric model driven by $X_F, X_C, X_{DIF}$ and $X_R$ .
RV-COCKPIT-HELMET	<del>FIA-00001223</del> FIA-LEG-0012	B.1	Positioned at $[X_C=0, 0, 0]$
RS-FWH-DRUM	<del>FIA-00007582</del> FIA-LEG-0008	F.1	Positioned at $[X_w, Y_w, Z_w] = [0, 0, 0]$ (front wheel)
RS-RWH-DRUM	<del>FIA-00007583</del> FIA-LEG-00014	F.1 or G.1	Positioned at $[X_w, Y_w, Z_w] = [0, 0, 0]$ (rear wheel)
RS-FWH-DEFL	FIA-00007584 FIA-LEG-0009	C.1	Positioned at $[X_w, Y_w, Z_w] = [0, 0, 0]$ (front wheel)
RS-RWH-DEFL	<del>FIA-00007585</del> FIA-LEG-0016	E.1	Positioned at $[X_w, Y_w, Z_w] = [0, 0, 0]$ (rear wheel)
RS-FWH-COV	FIA-00007586 FIA-LEG-0013	D.1	Positioned at $[X_w, Y_w, Z_w] = [0, 0, 0]$ (front wheel)
RS-RWH-COV	<del>FIA-00007587</del> FIA-LEG-0007	D.1	Positioned at $[X_w, Y_w, Z_w] = [0, 0, 0]$ (rear wheel)

## APPENDIX 2: DRAWINGS





See Article 12.5.4

## APPENDIX 3: POWER UNIT SYSTEMS, FUNCTIONS, COMPONENTS AND SUPPLY PERIMETER

Item No	List of PU functions/systems/components	Art. 5.1.2	Art. 5.4.7	Art. 5.5.1	Art. 5.5.2	Art. 5.23	App. 4		App. 4 - 5) & 7)
		Defin.	Legal Box	mass	Centre Gravity	Seal. Perim.	PU Homol.	Supply perim.	PU Element associated
1	All Engine casings and sub-assemblies sealed according to Article 28 of the Sporting Regulations (e.g. engine casings such as cam-covers, cylinder heads, crankcase, sump, gear case and engine components within these)	INC	INC	INC	INC	INC	INC	INC	ICE
2	PU pressure charging components (e.g. compressor from inlet to outlet including wheel; turbine from inlet to outlet including wheel; shaft, bearings and housings)	INC	INC	INC	INC	INC	INC	INC	TC
3	Wastegate, Pop-off valve or similar	INC	INC	INC	INC	EXC	INC	INC	ICE or TC or Engine Exhaust System
4	PU Engine air inlet system from Engine plenum entry to cylinder head (e.g. plenum, trumpets, throttles)	INC	INC	INC	INC	EXC	INC	INC	ICE
5	Engine exhaust system (excluding fasteners and seals)	INC	INC	INC	EXC	INC	INC	EXC	Engine Exhaust System
6	PU mounted fuel system components: (e.g. High Pressure fuel hose, fuel rail, fuel injectors, accumulators)	INC	INC	INC	INC	EXC	INC	INC	ICE
7	PU mounted electrical components (e.g. wiring loom within legality volume, sensors, actuators, ignition coils, alternator, spark plugs)	INC	INC	INC	INC	EXC	INC	INC	ICE or TC or MGU-H or MGU-K or Engine Exhaust System
8	All PU coolant pumps, oil pumps, scavenge pumps, oil air separators and fuel high pressure pumps (delivering more than 10barG) including any of the following associated components: motors, actuators, filters, brackets, supports, screws, nuts, dowels, washers, cables, oil or air seals. All tubes or hoses between components of the PU that are not described by line 28. Excludes hydraulic pumps and ERS parts described in line 9.	INC	INC	INC	INC	EXC	INC	INC	ICE

Item No	List of PU functions/systems/components	Art. 5.1.2	Art. 5.4.7	Art. 5.5.1	Art. 5.5.2	Art. 5.23	App. 4		App. 4 - 5) & 7)
		Defin.	Legal Box	mass	Centre Gravity	Seal. Perim.	PU Homol.	Supply perim.	PU Element associated
9	Cooling pumps (and associated motors, actuators, associated filters, brackets, support, screws, nuts, dowels, washers, cables, tubes, hoses, oil or air seals) partly or wholly for ERS components not mandatorily included in the PU legality volume.	INC	EXC	INC	EXC	EXC	INC	INC	ICE or ES or MGU-H or MGU-K or CE
10	Main PU oil tank, catch tanks, and any breather system connected to the PU and associated filters, brackets, support, screws, nuts, dowels, washers, cables, tubes, hoses, oil or air seals, with the exception of parts described in line 11.	INC	INC	INC	INC	EXC	INC	INC	ICE
11	Any breather system ducting between the PU and the orifice referenced in 5.2.12.	EXC	EXC	EXC	EXC	EXC	EXC	EXC	-
12	MGU-K excluding mechanical power transmission components, MGU-K Torque sensor housing assembly and mounting accessories	INC	INC	INC	INC	INC	INC	INC	MGU-K
13	MGU-K mechanical power transmission components, MGU-K Torque sensor housing assembly and mounting accessories	INC	INC	INC	INC	EXC	INC	INC	ICE or MGU-K
14	MGU-H excluding mechanical power transmission components and mounting accessories.	INC	INC	INC	INC	INC	INC	INC	MGU-H
15	MGU-H mechanical power transmission components and mounting accessories	INC	INC	INC	INC	EXC	INC	INC	TC or MGU-H
16	ES parts defined in Article 5.5.3	INC	EXC	EXC	EXC	INC	INC	INC	ES
17	ES excluding parts defined in Article 5.5.3	INC	EXC	EXC	EXC	EXC	INC	INC	ES
18	Wiring between any ECU and phases of MGU-K	INC	EXC	INC	EXC	EXC	INC	INC	MGU-K or CE
19	Wiring between any ECU and phases of MGU-H	INC	EXC	INC	EXC	EXC	INC	INC	MGU-H or CE
20	Wiring between any ECU and ES	INC	EXC	INC	EXC	EXC	INC	INC	ES or CE
21	PU-CE excluding associated brackets, supports, screws, nuts, dowels, washers or cables.	INC	EXC	INC	EXC	INC	INC	INC	CE

Item No	List of PU functions/systems/components	Art. 5.1.2	Art. 5.4.7	Art. 5.5.1	Art. 5.5.2	Art. 5.23	App. 4		App. 4 - 5) & 7)
		Defin.	Legal Box	mass	Centre Gravity	Seal. Perim.	PU Homol.	Supply perim.	PU Element associated
22	Brackets, supports, screws, nuts, dowels, washers or cables associated to the parts listed in line 21.	INC	EXC	INC	EXC	EXC	INC	INC	CE
23	FIA Standard ECU.	INC	EXC	EXC	EXC	EXC	INC	EXC	-
24	Any actuators needed to make the PU function at all times. (except specific exclusions)	INC	INC	INC	INC	EXC	INC	INC	ICE or TC or ES or Engine Exhaust System
25	Intake upstream of compressor inlet up to and including the air filter.	EXC	EXC	EXC	EXC	EXC	EXC	EXC	-
26	Heat Shields and associated mounting hardware.	EXC	EXC	EXC	EXC	EXC	EXC	EXC	-
27	Coolant header tanks	EXC	EXC	EXC	EXC	EXC	EXC	EXC	-
28a	Heat exchangers, other than those in 28b, and their associated accessories (including but not limited to housings, tubes, pipes, hoses, supports, brackets, and fasteners).	EXC	EXC	EXC	EXC	EXC	EXC	EXC	-
28b	Engine intake air heat exchangers and their associated accessories (including but not limited to housings, supports, brackets, fasteners and maximum 2 simple and smooth bore outlet tubes for intake air lines).	EXC	EXC	EXC	EXC	EXC	EXC	EXC	-
29	Hydraulic system (e.g. pumps, accumulators, manifolds, servo-valves, solenoids, actuators) other than servo valve(s) and actuator(s) for PU control.	EXC	EXC	EXC	EXC	EXC	EXC	EXC	-
30	Hydraulic system servo valve(s) and actuator(s) for PU control.	INC	INC	INC	INC	EXC	INC	INC	ICE or TC or Engine Exhaust System
31	Fuel feed pumps delivering less than 10 barGs and their associated accessories (included but not limited to tubes, hoses, supports, brackets and fasteners).	EXC	EXC	EXC	EXC	EXC	EXC	EXC	-
32A	PU air valve regulators	INC	EXC	EXC	EXC	EXC	INC	EXC	ICE
32B	Any ancillary equipment associated with the PU air valve system excluding regulators (e.g. pneumatic bottles, hoses, filling valves).	INC	EXC	EXC	EXC	EXC	EXC	EXC	



Item No	List of PU functions/systems/components	Art. 5.1.2	Art. 5.4.7	Art. 5.5.1	Art. 5.5.2	Art. 5.23	App. 4		App. 4 - 5) & 7)
		Defin.	Legal Box	mass	Centre Gravity	Seal. Perim.	PU Homol.	Supply perim.	PU Element associated
33	Exhaust beyond turbine exit and WG exit and associated brackets, support, screws, nuts, dowels, washers or cables.	EXC	EXC	EXC	EXC	EXC	EXC	EXC	-
34	Studs used to mount PU to chassis or gearbox.	EXC	EXC	EXC	EXC	EXC	EXC	EXC	-
35	Flywheel	INC	EXC	EXC	EXC	EXC	EXC	INC	-
36	Clutch and clutch actuation system between the PU and the gearbox	EXC	EXC	EXC	EXC	EXC	EXC	EXC	-
37	Fuel	EXC	EXC	EXC	EXC	EXC	INC	EXC	Fuel
38	Engine oil	EXC	EXC	EXC	EXC	EXC	INC	EXC	Engine Oil
39	Liquids other than Fuel and Engine oil.	EXC	EXC	EXC	EXC	EXC	EXC	EXC	-
40	Ballast mounted on the PU up to 2kg. This is permitted (subject to Article 4.4) but any in excess of 2kg will be removed before measuring PU mass.	INC	INC	INC	INC	EXC	EXC	INC	-
41	Ballast mounted on the PU in excess of 2kg.	EXC	EXC	EXC	EXC	EXC	EXC	EXC	-
42	Wiring harnesses which are not ordinarily part of a power unit.	EXC	EXC	EXC	EXC	EXC	EXC	EXC	-
43	High Pressure Fuel Pump Driver Unit	INC	EXC	INC	EXC	EXC	INC	INC	-
44	PU Engine air inlet system downstream of the components included in row 28b and upstream of those included in row 4.	INC	EXC	INC	EXC	EXC	INC	EXC	ICE
A	PU and spares for all Competitions in F1 World Championship plus 5000 km testing. Minimum number of PUs per team to be (number of PUs per driver per season according to Sporting Regulations) x 2 + Necessary number of units to achieve 5000 km of testing. Additional PUs or spares required to replace units out of service due to accident damage or other cause induced by team will be outside the supply perimeter and will incur additional charges							INC	-
B	Demo event Power Units							EXC	-

Item No	List of PU functions/systems/components	Art. 5.1.2	Art. 5.4.7	Art. 5.5.1	Art. 5.5.2	Art. 5.23	App. 4		App. 4 - 5) & 7)
		Defin.	Legal Box	mass	Centre Gravity	Seal. Perim.	PU Homol.	Supply perim.	PU Element associated
C	Transport of Power Units and support equipment from Manufacturer's factory to event							EXC	-
D	Personnel to support Power Unit (5 people) at test and race events							INC	-
E	Travel, accommodation and reasonable expenses for support personnel							EXC	-
F	Quantity of manufacturer specified fuel and oil							EXC	-
G	Garage equipment defined as compulsory by Manufacturer (e.g. battery management)							INC	-
H	Garage IT equipment, connection to factory, servers, telemetry, radio, team clothing							EXC	-
I	Dyno testing of installation components (Y hours or km)							EXC	-

If more than one PU Element is listed in the last column of the above table, the PU Manufacturer will have to specify for any item for which it wishes to modify the specification which PU Element it belongs to in the updated homologation dossier. It is not mandatory that it be associated with the same PU Element for every change of specification.

For items in rows 7, 24 and 30 above, an independent change of specification as per the table below will be permitted for each individual component directly affected.

Maximum permitted number of specification upgrades per PU Element and per Season	2022	2022 Specification upgrade deadline	2023-2025
Engine (ICE)	1	1 Mar 2022	0
Turbocharger (TC)	1	1 Mar 2022	0
Motor Generator Unit – Heat (MGU-H)	1	1 Mar 2022	0
Motor Generator Unit – Kinetic (MGU-K)	1	1 Sep 2022	0
Energy Store (ES)	1	1 Sep 2022	0
Control Electronics (CE)*	1	1 Sep 2022	0
Engine Exhaust System	1	1 Mar 2022	0
Fuel	1	1 Mar 2022	0
Engine Oil	1	1 Mar 2022	0

\* above limits apply separately to each individual Control Electronics unit.

For the above table, "0" means that the specification of the previous Championship season must be maintained, subject to the exceptions permitted in Appendix 4 of the Technical Regulations.

## APPENDIX 4: 2022-2025 POWER UNIT, FUEL AND ENGINE OIL HOMOLOGATION

### 1 Obligations and declaration or notification deadlines

#### 1.1 Obligations in order to supply Power Units to a Competitor

Any Power Unit Manufacturer wishing to supply Power Units to a Competitor must:

- a. notify in writing the FIA of its intention to do so no later than 1 January (or such other date as agreed in writing between all of the Power Unit Manufacturers and the FIA) preceding the year during which such power units will be supplied. ~~For the supply of Power Units in the 2022 Championship, this deadline will be extended to 31 March 2021;~~
- b. agree to be bound by the provisions of the Code, the Technical Regulations, the Sporting Regulations, the Financial Regulations, the Judicial and Disciplinary Rules and all other relevant and applicable FIA rules and/or regulations (as supplemented or amended from time to time) and further to observe them; and
- c. agree to be subject to the jurisdiction of the internal judicial and disciplinary bodies of the FIA.

#### 1.2 Obligations in order to supply fuel and engine oil to a Competitor

Any Supplier wishing to supply fuel and/or engine oil to a Competitor must:

- a. notify in writing the FIA of its intention to do so no later than 1 January (or such other date as agreed in writing between all of the Suppliers and the FIA) preceding the year during which such fuel and/or engine oil will be supplied. ~~For the supply of fuel and/or engine oil in the 2022 Championship, this deadline will be extended to 31 March 2021;~~
- b. agree to be bound by the provisions of the Code, the Technical Regulations, the Sporting Regulations, the Judicial and Disciplinary Rules and all other relevant and applicable FIA rules and/or regulations (as supplemented or amended from time to time) and further to observe them; and
- c. agree to be subject to the jurisdiction of the internal judicial and disciplinary bodies of the FIA.

#### 1.3 Information provided by the Power Unit Manufacturer to their customer Competitors

Any Power Unit Manufacturer intending to homologate a Power Unit for use by a Competitor during a Championship must:

- a. Declare to the FIA, before 1 August of the preceding year, that they provided to their customer Competitors :
  - i. An initial full external space model of the Power Unit including details and locations of all physical interfaces required by the team to install the Power Unit.
  - ii. Preliminary estimates of important operating parameters such as heat rejection, fuel mass and density, clutch shaft stiffness and engine stiffness.
- b. Declare to the FIA, before 1 November of the preceding year, that they provided to their customer Competitors :
  - i. A final full external space model of the Power Unit including details and locations of all physical interfaces required by the team to install the Power Unit.
  - ii. Firm predictions of important operating parameters such as heat rejection, fuel mass and density, clutch shaft stiffness and engine stiffness.
  - iii. Initial details of any other parts, procedures, operating conditions and limits or any other information required by the team to install and operate the Power Unit as intended.

From the 1<sup>st</sup> of August onwards, any significant change compared to previous communication, except for any changes permitted by the FIA in accordance with the

procedure set out in 5) below, must be notified to the customer Competitors in due time. Should a customer Competitor consider that the change has an unreasonable impact on the Power Unit installation in the car, they may contact the FIA within 7 days of the notification. The FIA will then contact the relevant Power Unit Manufacturer and its customer Competitors in order to conduct its investigation. If the FIA is satisfied, in its absolute discretion, that these changes are acceptable, the FIA will confirm to the Power Unit manufacturer and the customer Competitors within 14 days that they may be carried out.

## 2 Homologation dossier

- 2.1 Any Power Unit Manufacturer intending to homologate a Power Unit for use by one or more Competitors in the 2022 to 2025 Championships must submit to the FIA a Power Unit homologation dossier before 1 March of the year in which it intends to supply such power unit for use during the Championship period indicated. Each Power Unit Manufacturer shall be permitted to present only one homologation dossier with respect to the period and the homologation granted will be valid until the end of the 2025 Championship.
- 2.2 The homologation dossier must:
- include details of all the parts described as “INC” in the “App. 4 PU homol.” column of Appendix 3 of the Technical Regulations.
  - include all documents required in section 1 of this Appendix.
  - be submitted and updated according to the procedure detailed in the Appendix of the Regulations.
- 2.3 A Power Unit will be homologated for a Competitor once a complete homologation dossier has been submitted by the relevant Power Unit Manufacturer and has been approved by the FIA, such approval to take place within 14 days from the submission of the homologation dossier.
- 2.4 Each Power Unit Manufacturer must submit one homologation dossier which applies to all Competitors it intends to supply. Only the fuel specification, the engine oil specification, ~~the and~~ Power Unit wirings, and any minor parts which have undergone an incidental modification in accordance with the provisions of 5.4 below may differ between Competitors. In this event they must be declared separately in the dedicated sections of the homologation dossier.

All Power Units supplied by a single Power Unit Manufacturer must also be operated in the same way, they must therefore be:

- Identical according to the dossier for each Competitor, and;

Unless a Competitor informs the FIA Technical Department that they have declined any of the following, they must be:

- Run with identical software for PU control and must be capable of being operated in precisely the same way.
- Run with identical specifications of engine oil and fuel unless an alternative supplier is preferred by a customer Competitor.

- 2.5 once a Power Unit has been homologated, any subsequent changes as permitted by paragraphs 4 & 5 below will not constitute a new dossier but will instead be considered as updates to the initial dossier. The documentation associated to the modified parts shall be updated accordingly in the dossier as per the procedure described in the Appendix of the Regulations.

## 3 Power unit maximum supply price

The Power Unit supply perimeter listed in the corresponding column of Appendix 3 of the Technical Regulations shall be supplied at the maximum price of fifteen million euros. The supply of additional goods or services not listed in the Appendix hereto (which shall be

agreed between the Power Unit Manufacturer and the Competitor) shall incur additional charges, the amount of which shall be based on the usages and practices generally recognised and respected in the market for the supply of parts and services in the Championship. In case of any alleged material breach or alleged material failure to comply with the provisions of this Paragraph 3, the FIA shall be entitled to engage proceedings before the FIA International Tribunal against the Power Unit Manufacturer. In the case that, in accordance of the provisions of the Code and of the Judicial and Disciplinary Rules, the International Tribunal rules that the Power Unit Manufacturer has materially breached or materially failed to comply with this Paragraph 3, the International Tribunal may impose on the Power Unit Manufacturer concerned (to the exclusion of any other sanction it may have the power to impose), a fine the amount of which shall be no more than fifteen million euros and shall be determined, on a case by case basis, depending on the merits and circumstances of the applicable case. During its first two Championship seasons (or part thereof), whether consecutive or not, within the [2014-2025] period, a manufacturer will not be required to comply with the maximum price as set out above.

#### **4 Specification of PU Elements during the 2022-2025 period**

- 4.1** For the purposes of this Article, a specification upgrade is defined as a modification of a homologated part for any purpose other than those listed in 5.1 below.
- 4.2** With reference to Article 28.2 of the Sporting Regulations, each Power Unit Manufacturer may supply only the maximum number of specification upgrades of PU elements as set in the second table of Appendix 3 of the Technical Regulations during a Championship season, except for any changes permitted by the FIA in accordance with the procedures set out in Paragraph 5 below.
- 4.3** In order to be registered, a specification upgrade must be used by at least one car powered by the Power Unit Manufacturer no later than:
- the first Event following the deadline specified in the second table of Appendix 3 of the Technical Regulations if at least one car would incur no penalty under art. 28.3 of the Sporting Regulations.
  - the fifth Event following the deadline specified in the second table of Appendix 3 of the Technical Regulations if all cars would incur a penalty under art. 28.3 of the Sporting Regulations.
- 4.4** Requests for the homologation of parts with permitted specification upgrades must be submitted at least 14 days before the requested date of homologation.
- 4.5** With reference to Article 40.3 of the Sporting Regulations, if a Power Unit part is subsequently replaced by another of a different specification according to 4.2 after qualifying practice, the replacement Power Unit part will not be considered the same in design or similar in mass, inertia or function.
- 4.6** A customer Competitor may refuse a specification upgrade, or request a delay, in case of installation issues of the new Power Unit element in its car. The customer Competitor must apply in writing to the FIA Technical Department and must provide all necessary supporting information. If the FIA is satisfied, in its absolute discretion, that the installation issues are genuine, they will confirm approval to the customer Competitor and to the Power Unit Manufacturer. In this case, the provisions of 6.2 below won't apply.

#### **5 Permitted modifications to the homologated power unit elements**

- 5.1** A manufacturer may apply to the FIA during the course of the homologation period to carry out modifications to the homologated Power Unit elements for the sole purposes of reliability, safety, cost saving, or minimal incidental changes permitted in 5.4 below.

Applications must be made in writing to the FIA Technical Department and must provide all necessary supporting information including, where appropriate, clear evidence of failures. The FIA will circulate the correspondence to all Power Unit Manufacturers for comment. If

the FIA is satisfied, in its absolute discretion, that these changes are acceptable, they will confirm to the Power Unit Manufacturer concerned that they may be carried out.

Wherever practical, such requests must be submitted at least 14 days before the requested date of homologation.

The procedure and associated document templates that must be used by the Power Unit Manufacturers for their requests are available in the Appendix of the Regulations.

- 5.2 Modifications may be considered as minor if there is no or very limited effect on reliability and either the design of the part is not changed (e.g. change of supplier, change of part number ...etc) or the geometrical change is minor, this attribute being subject to approval of the FIA at its sole discretion. These modifications must be clearly identified as minor in the requests, and they will be registered as such after approval by the other PU Manufacturers and the FIA. For such minor modifications, the PU Manufacturer may also request the possibility of exhausting the existing stock of parts alongside the use of the modified parts, and this must also be clearly specified in the request if applicable. In this case, there must be no preferential allocation of the modified parts between the Competitors supplied by the PU Manufacturer.
- 5.3 An amendment to the published regulations that occurs after the start of the homologation may be used to modify components concerned by that amendment.
- 5.4 Minimal incidental changes may be carried out for car installation purposes to the following components of the Power Unit:
- a. Wirings
  - b. Exhaust system, provided the key defining parameters of the system (diameters, lengths, etc.) remain fundamentally unchanged
  - c. Turbo-compressor position (within 20mm from the original position in relation to the ICE), turbo clocking, turbo supports
  - d. Position of the wastegates with housings and pipes
  - e. Position of the pop-off valves with housings and pipes
  - f. Air Inlet system as defined in row 44 of the first table of Appendix 3, provided the key defining parameters of the system (diameters, lengths, etc.) remain fundamentally unchanged
- 5.5 Any permitted modifications concerning parts that are inside the sealed perimeter (i.e. parts described as "INC" in the "Art. 5.23 Seal. Perim." column of Appendix 3 of the Technical Regulations) can only be applied to new Power Unit elements, i.e. no element already used (Art. 28 of the Sporting Regulations) may be modified.
- 5.6 Changes of fuel and oil suppliers will be accepted, provided such changes are intended for commercial and not for performance reasons.
- 5.7 With reference to Article 40.3 of the Sporting Regulations, if a Power Unit part is subsequently replaced after qualifying practice by another which differs only by one or more modifications permitted by this Paragraph 5, the replacement Power Unit part will be considered the same in design and similar in mass, inertia and function.
- 5.8 Requests for repair of a PU component in the form of a patch made of the same material or made of composite material, following damage or failure, may be accepted if it is only local and minimal. If accepted such repair can be applied to all components available but only on a temporary basis. It must not be present on the components used during the following Championship season if it is not made of the same material.

## **6 Schedule for the introduction at Events of modified Power Unit parts**

- 6.1 The first time one or more Power Units comprising modified parts, as permitted by Paragraphs 4 and 5, are used in any of the cars powered by the Power Unit Manufacturer, a minimum of 1 Power Unit with the exact same specification must be available for each

Competitor. Each Competitor will have priority use of one of these Power Units until the end of the first day of the Competition.

In the case of a Manufacturer supplying Power Units to more than 2 Competitors, one exception per Championship season can be granted by the FIA, in its absolute discretion, in the event of genuine supply issues. The request must be made in writing to the FIA Technical Department and must provide all necessary information and evidence of the supply issue. If the FIA is satisfied, the minimum required number of Power Units available for all Competitors may be reduced to 2 for the Event where the modified part is used for the first time.

- 6.2 Any new Power Unit element used for the first time in an Event must always include all modifications included in any Power Unit element already used by any of the cars powered by the PU Manufacturer.
- 6.3 The requirements of 6.1 and 6.2 don't apply to minor modifications as defined in 5.2.
- 6.4 A Power Unit element will be deemed to have been used once the car's timing transponder has shown that it has left the pit lane.

## **7 Conformity with the power unit homologation dossier**

All Power Units must be delivered such that the seals required under Article 28.5 of the Sporting Regulations can be fitted. Both the Power Unit Manufacturer and users of a homologated Power Unit must take whatever steps are required at any time by the FIA Technical Department, in its absolute discretion, to demonstrate that a Power Unit used at a Competition is in conformity with the corresponding Power Unit homologation dossier.

## APPENDIX 5: COMPONENTS' CLASSIFICATION AND PERIMETER

The following table defines the classification, of components for Formula One cars and support equipment.

Ref.	Component or Assembly	Art.	Class.	System Description & Boundaries	Included Components (List not exhaustive)	Excluded Components
<b>1</b>	<b>Survival Cell Items &amp; Safety Structures</b>					
1A	Survival Cell and Primary Roll Structure	12	LTC	The structure that includes the cockpit, takes suspension loads and aerodynamic loads and transfers them from and to the FIS through the FIS fixings and power unit through the engine studs plus the roll structure as defined in 12.4.1.	Bonded component as submitted for homologation.	Any additional bonded components not required for FIA tests, any components fitted for FIA tests that are then subsequently removed
1D	Front Floor Structure	12.2.7	OSC	Front floor assembly	Front floor structure, mounting brackets and any device or structure, and their mounting brackets, between the front floor structure and the survival cell.	Fairings.
1G	Front Impact structure	13.6.1	LTC	The structure that takes aerodynamic loads from the front wing and transfers them to the chassis	FIS, hangers, fixings to chassis that are part of the FIS assembly	Fairings, Camera brackets
1H	Rear Impact structure	13.7.1	TRC	The structure that mounts to the rear of the gearbox behind the differential	Part as bonded to gearbox carrier. Details of flange for Rear Wing Beam attachment, excluding profile details.	Fairings, bolted components
1K	Pedals		OSC	Pedal Assembly	Brake pedal assembly including pushrod connecting to the brake master cylinders(s), throttle Pedal including throttle damper, heel-rest, mounting brackets and local electrical and electronic components	Fixings to the survival cell.
<b>2</b>	<b>Aerodynamic Components</b>					
2A	Aerodynamic components, unless otherwise specified	3	LTC			
2B	Plank assembly	3.5.9	LTC	Plank assembly as defined in 3.5.9	Plank structure and skids	
2C	Rear wing adjuster (DRS)	3.10.1 0	OSC	DRS actuator including linkages	Machined DRS Actuators, linkages, local electrical and electronic components	Hoses, any component rigidly attached to the rear wing flap.



Ref.	Component or Assembly	Art.	Class.	System Description & Boundaries	Included Components (List not exhaustive)	Excluded Components
2E	Wheel drum and drum deflector	3.13.1 - 3.13.6	LTC		Drum and deflector strictly to supplied geometry plus all the brake ducts components inside the rim	
2F	Wheel cover	3.13.7	SSC			
<b>3</b>	<b>Transmission</b>					
3A	Gearbox Carrier	9.5	TRC	The structure that supports the Cassette, mounts the rear impact structure, takes suspension loads and aerodynamic loads and transfers them to the power unit through the engine studs.	Gearbox carrier, associated fastenings, internal heat shields	RIS, Inboard suspension components, Engine mountings
3B	Gearbox Cassette	9.5	TRC	The housing that immediately encloses the Driveline Components and Gear-Change Components including all associated covers, integrated or not to the Gearbox carrier.	Cassette, Front Cover, Diff Cap, Seals, Fasteners, Cross-shaft Covers	
3C	Clutch	9.2	TRC	Rotating clutch assembly and fixings to PU or Gearbox as appropriate.	Clutch basket assembly, Plates, Spring, fixings to PU or Gearbox, Spigot bearing	
3D	Clutch actuation system	9.2	TRC	Clutch actuator assembly including sensors and cooling shroud and sensors	Clutch Actuator, Actuator support, local electrical and electronic components, Fixings to PU or Gearbox, Cooling Shroud.	Servo Valves
3E	Clutch shaft	9.2	TRC	Shaft between clutch and gearbox (if PU mounted) or PU (if Gearbox mounted)	Clutch shaft, intermediate support bearing and bracket if required.	Clutch shaft torque sensor
3F	Clutch shaft torque sensor	9.2	SSC			
3G	Gearbox Internals	9.5	TRC	All components involved in transmitting torque between the gearbox input shaft and the drive shafts and components essential for the functioning of the gearbox.	Driveline and Gear-change components defined in Article 9.1	Servo valves
3K	Auxiliary Components (Oil system, reverse gear etc.)	9.5	TRC	Components that are not included in Driveline or Gear-Change Components but interact directly with these components and are essential for the functioning of the gearbox.	Oil Pressure and Scavenge Pumps, Oil Filter, Oil Tank, Reverse-gear idler & Actuator, Differential Actuator, local electrical and electronic components.	Oil cooler

Ref.	Component or Assembly	Art.	Class.	System Description & Boundaries	Included Components (List not exhaustive)	Excluded Components
3L	Drive shaft	9	OSC	The assembly that transfers load from the gearbox driveline components to the Axles	Driveshaft, joints, bearings and any required fixings, torque sensors and/or trigger wheels if present	
<b>4</b>	<b>Suspension and Steering</b>					
4A	Inboard Front Suspension	10.4	TRC	All parts of the front suspension between the connection to the push / pull rod and the survival cell.	Rockers, springs, ARB system, damper, bearings, local electrical and electronic components, ride height adjustment, any brackets which are not integral with the survival cell. A range of set-up options	
4B	Front Suspension Members	10.3	TRC	Structural members connecting the upright to the survival cell, steering or inboard suspension	Wishbones / Links, Track-rod, Push/pull Rod, Bearings, Inboard Brackets not integrated in the survival cell, Fasteners, Wheel Tethers, local electrical and electronic components	Suspension fairings as defined in 3.14
4C	Front Upright Assembly (Excluding Axles, bearings, nuts & retention system)	10.6	TRC	Upright assembly between the connection to the suspension members and the wheel bearings	Upright, Brackets - including variants for set-up changes, Fasteners, local electrical and electronic components, Upright Loom.	Any braking system components described in Article 11
4D	Front Axles (Inboard of the contact surface with the wheel spacer) and bearings,		TRC	Axle geometry lying inboard of the contact surface with the wheel spacers and wheel bearing assembly	Axle geometry lying inboard of the contact surface with the wheel spacers, wheel bearings and spacers, interface and mounting to the brake disc bell.	
4E	Front Axles (outboard of the contact surface with the wheel spacer), nuts & retention system	10.9	OSC	Axle geometry lying outboard of the contact surface with the wheel spacers, wheel nut and dual stage mechanism to retain nut if loose	Axle geometry lying outboard of the contact surface with the wheel spacers, axle nuts, wheel nut, fasteners, and wheel nut retention system.	
4F	Inboard Rear Suspension	10.4	TRC	All parts of the rear suspension between the connection to the push / pull rod and the gearbox carrier	Rockers, springs, ARB system, dampers, bearings, local electrical and electronic components, ride height adjustment, any brackets which are not integral with the Gearbox Carrier. A range of set-up options	

Ref.	Component or Assembly	Art.	Class.	System Description & Boundaries	Included Components (List not exhaustive)	Excluded Components
4G	Rear Suspension Members	10.3	TRC	Structural members connecting the upright to the gearbox case or inboard suspension	Wishbones / Links, Track-rod, Push/pull Rod, Bearings, Inboard Brackets not integrated in the Gearbox Carrier, Fasteners, Wheel Tethers, local electrical and electronic components.	Suspension fairings as defined in 3.14
4H	Rear Upright Assembly (Excluding Axles, bearings, nuts & retention system)	10.6	TRC	Upright assembly between the connection to the suspension members and the wheel bearings	Upright, Brackets - including variants for set-up changes, Fasteners, local electrical and electronic components.	Any braking system components described in Article 11
4I	Rear Axles (Inboard of the contact surface with the wheel spacer) and bearings,		TRC	Axle geometry lying inboard of the contact surface with the wheel spacers and wheel bearing assembly	Axle geometry lying inboard of the contact surface with the wheel spacers, wheel bearings and spacers, interface and mounting to the brake disc bell,	
4J	Rear Axles (outboard of the contact surface with the wheel spacer), nuts & retention system	10.9	OSC	Axle geometry lying outboard of the contact surface with the wheel spacers, wheel nut and dual stage mechanism to retain nut if loose	Axle geometry lying outboard of the contact surface with the wheel spacers, axle nuts, wheel nut, fasteners, and wheel nut retention system.	
4L	Power Assisted Steering	10.5.3	TRC	Steering unit from the attachment to the steering column to the clevises for the track rods, connection to the hydraulic system and connection to the electrical loom	Rack assembly, local electrical and electronic components, protective cover, fasteners to survival cell, options for varying assistance.	
4M	Steering column	10.x	OSC	The assembly that transfers load from the steering wheel QD through to the Power Assisted Steering	Forward and Rearward columns, bearings, mounting brackets, attachments to chassis, parts required to pass impact test. local electrical and electronic components.	Fixings to the survival cell.
4N	Steering wheel and quick release		OSC	The assembly that transfers load from the driver to the steering column	Steering Wheel, quick release mechanism, gear shift and clutch paddles, local electrical and electronic components, SECU elements integrated in the assembly	Any component that cannot be removed via the operation of the quick release
4P	Wheel rims	10.7	SSC	BBS Wheel Rim Assembly	Rim, drive pegs, spacers, valve	TPMS sensor, wheel cover

Ref.	Component or Assembly	Art.	Class.	System Description & Boundaries	Included Components (List not exhaustive)	Excluded Components
4Q	Tyre pressure sensor (TPMS)		SSC	BF1 TPMS	Mountings	Tyre valve
4R	Tyres	10.8	SSC			
<b>5</b>	<b>Brakes</b>					
5A	Brake disc, disc Bell, and pad assembly	11	OSC		Structural brake disk bell transferring torque from the axle to the brake disc, brake disk and pads	Any component bolted on the structural disk bell (i.e. deflectors)
5B	Brake calipers	11	OSC		Machined Brake Calipers, pistons, seals, QD's, local electrical and electronic components	Hoses, pipes, and mounting system to the uprights.
5C	Rear brake control system (BBW)	12	OSC		BBW master cylinder and actuator, servo or solenoid valves, directly mounted local electrical and electronic components master cylinders, balance bar assembly	Hoses and pipes
5D	Brake master cylinder	12	OSC		Master cylinder(s), push-rods, brake balance system, local electrical and electronic components	Fixings to the survival cell.
<b>6</b>	<b>Fuel System</b>					
6A	Collector	6.6.4, 6.6.6	OSC	Collector assembly and pressurisation system if fitted.	Collector assembly including any pressurisation system, any local electrical and electronic components, level sensor, filters, AV mounts and mounting fasteners	Hoses and pipes
6B	Primer pumps, and flexible pipes and hoses	6.6.2,6.6.3	SSC	Primer pump(s), and pipes between the primer pump(s) and the breakaway valve.	Primer pump(s), flexible pipes and hoses and their fittings between pump(s) and breakaway valve, fuel flow meter inlet pressure and temperature sensors.	Components classified as part of collector. Components upstream of primer pump(s). Components between primer pump(s) and breakaway valve listed as OSC.
6C	Fuel Bladder	6.1	LTC			
6D	Fuel system components not listed as OSC or SSC or LTC	6.2, 6.3, 6.5, 6.6	TRC			Fuel bladder
6E	Fuel System Hydraulic Layout as described by	6.6.1, 6.6.3, 6.6.4,	OSC	Low pressure fuel system from lift pump inlet filters up to and including chassis breakaway valve or	Pressure Relief Valves (PRV), Non-Return Valves (NRV), Breakaway Valve, filters, lift pumps, optional	Fuel cell pressurisation system. Fuel cell fill/drain, and vent.

Ref.	Component or Assembly	Art.	Class.	System Description & Boundaries	Included Components (List not exhaustive)	Excluded Components
	schematic in article 6.6	6.6.5, 6.6.6		optional inlet filter to high pressure fuel pump (if fitted)	damper, rigid pipes and manifolds and their fittings, FIA sample, collector fill/drain port, optional collector pressure sensor, optional running bleed Any additional parts which are not shown on the schematic, but which will be deemed to be necessary for the proper behaviour of the hydraulic circuit shown in the schematic, subject to the approval of the FIA Technical Department	Primer pump(s), flexible pipes and hoses and their fittings, fuel flow meters and their inlet pressure and temperature sensors
6F	Fuel tank pressure sensor and PRV	6.1.4 6.6.4	LTC	The Sensor and PRV specified in 6.1.4 and shown in diagram 6.6.4	Sensor and fittings to fuel bladder. PRV and fittings to fuel bladder	Fuel bladder
<b>7</b>	<b>Hydraulic System</b>					
7A	Hydraulic pump and accumulator		TRC		Hydraulic pump, hydraulic accumulator, local electrical and electronic components, parts required to mount the unit to the PU	
7B	Hydraulic manifold, sensors & control valves		TRC		Hydraulic manifold block, servo valves, solenoid valves, filters, local electrical and electronic components, AV mounts.	
7C	Pipes between hydraulic pump, hydraulic manifold & gearbox or engine actuators		TRC		Pipes, fittings, QD connectors.	Pipes to/from cooler, pipes to/from actuators not associated with gearbox, PU (BBW, PAS etc).
<b>9</b>	<b>Oil &amp; Coolant Systems</b>					
9C	Primary heat exchangers	7.4.1b	LTC	Heat exchanger assembly as defined in 7.4.1b	Welded cooler, electrical and electronic components directly fitted to cooler	Fittings, hoses, pipes, AV mounts
9D	Secondary heat exchangers	7.4.1c	TRC	Secondary heat exchanger units as defined in 7.4.1c	Heat exchanger unit, directly mounted electrical and electronic components	Ducts feeding cooling air, pipes, hoses, AV mounts.
<b>10</b>	<b>Power Unit Ancillaries and Sensors</b>					
10A	ES IVT sensor	5.3.2	SSC			

Ref.	Component or Assembly	Art.	Class.	System Description & Boundaries	Included Components (List not exhaustive)	Excluded Components
10B	Fuel Flow Meter	5.11.3	SSC	Prescribed fuel flow meters		Fittings, hoses, pipes, AV mounts
10C	Power Unit Pressure and Temperature sensors	5.14.3	SSC			
10D	Power Unit mountings to gearbox and survival cell	5.4.8	TRC	Studs between PU and Survival Cell and between PU and Gearbox.	Studs, Nuts, Top-hat Bushes, Barrel nuts.	Inserts integrated into survival cell or gearbox carrier
10E	High Pressure fuel pump	5.11.6	SSC			
10F	Exhaust System Beyond Turbine and Wastegate Exits	3.8.2	TRC	Exhaust and wastegate pipes downstream of turbine exit / wastegate exit.	Pipes, clamps	
<b>11</b>	<b>Electrical Systems Hardware</b>					
11B	Electrical looms		TRC	Looms interfacing the main chassis electrical system with PU systems, transmission systems and other peripheral control or measurement systems.	Main chassis looms, can be made of separate parts, up to and including the connectors to local PU looms, transmission looms or other local looms for peripheral control or measurement systems.	Looms for test installations linked to Article 8.15.1
11C	car to team telemetry	8.6.1	SSC			
11D	Driver radio	8.9	SSC			
11E	Accident Data Recorder (ADR)	8.10.1	SSC			
11F	High speed camera	8.10.3	SSC			
11G	In-ear accelerometers	8.10.4	SSC			
11H	Biometric gloves	8.10.5	SSC			
11J	Marshalling system	8.12	SSC			
11K	Timing Transponders	8.16	SSC			
11L	TV Cameras	8.17	SSC			
11R	Wheel display panel	8.18	SSC			
11S	Standard Electronic Control Unit (SECU)	8.1.4	SSC			
11T	SECU FIA applications		SSC			

Ref.	Component or Assembly	Art.	Class.	System Description & Boundaries	Included Components (List not exhaustive)	Excluded Components
11U	SECU Team applications		LTC			
<b>12</b>	<b>Safety Equipment</b>					
12A	Fire Extinguishers	14.1	OSC			Pipes, hoses, mountings to the survival cell.
12B	Rear lights	14.3	SSC			Local electrical looms
<b>13</b>	<b>Miscellaneous Components</b>					
13A	Water drink system		OSC			Pipes, hoses, mountings to the survival cell.

## APPENDIX 6: APPROVED CHANGES FOR SUBSEQUENT YEARS

Note: changes (in relation to the 2023 text of this document) are shown **thus**. Changes added at this issue are highlighted **thus**

### 1 Changes for 2024

9.7.2 Each Competitor must nominate the forward gear ratios (calculated from engine crankshaft to drive shafts) to be employed within their gearbox. These nominations must be declared to the FIA technical delegate at or before the first Competition of the Championship.

In the event the Competitor obtains the Gearbox from another Competitor as a TRC, the gear ratios used must be the same between those two Competitors **unless the customer competitor opts to continue with the ratios used in the previous Championship Season.**

For the avoidance of doubt, changes to the forward gear ratios under the provisions of this Article may involve changes to either the gear ratio pairs defined in Article 9.7.3, or to the final drive.

### 10.8.4 & 10.8.5 Treatment of tyres

Articles 10.8.4 and 10.8.5 from the 2023 Technical Regulations will be retained as the default regulations for 2024 for the period that the FIA and the official tyre supplier are evaluating the technical and safety requirements of operating dry-weather, intermediate and wet-weather tyres without heating devices.

Following this evaluation period, the FIA will provide its recommendation on the use of tyre heating devices for 2024 and subsequent years. If the recommendation is to prohibit tyre heating devices a vote will be held, including the FIA, F1 and the Competitors, no later than the 31<sup>st</sup> July 2023, on the **dark red highlighted text** below. For the regulation change to be adopted successfully, the FIA, F1 and a simple majority of Competitors (5 out of 10) will all have to vote in favour. For the avoidance of doubt, one vote will be taken on the combined changes to tyre heating devices (tyre blankets) detailed in both the Appendix 6 of the Technical Regulations and Appendix 9 of the Sporting Regulations.

#### 10.8.4 Treatment of tyres

- a. Tyres may only be inflated with air or nitrogen.
- b. Any process the intent of which is to reduce the amount of moisture in the tyre and/or in its inflation gas is forbidden.
- c. A complete wheel must contain a single fixed internal gas volume. No valves, bleeds or permeable membranes are permitted other than to inflate or deflate the tyre whilst the car is stationary.
- d. **Tyre heating devices are prohibited. The only permitted type of tyre heating devices are blankets that comply with the design prescriptions listed in Article 10.8.5.** Any other device, system or procedure (except for driving of the car) the purpose and/or effect of which is to heat the wheels, hubs or brakes above the ambient air temperature, or to maintain their temperature if they are already warm, is prohibited.

#### ~~10.8.5 Tyre heating systems design prescriptions~~

- ~~a. Tyre heating systems may only use resistive heating elements and act upon the outer tyre surface.~~
- ~~b. No more than three temperature controllable zones may be present on a single tyre blanket.~~
- ~~c. A temperature controllable zone is at most composed of one heating element (the actuator) and one or more temperature sensor(s) solidly mounted on the blanket.~~
- ~~d. The blanket temperature sensors may be used to control the delivered power of the actuator using a single input single output (SISO) feedback control strategy approved by the FIA. There should be no other sensors involved in the temperature control strategy.~~



If a temperature controllable zone contains more than one temperature sensor, the signals must be arbitrated by software prior to being used in the SISO feedback control loop. Additional software design guidelines may be found in the Appendix to the Technical and Sporting Regulations.

e. At any time during a Competition, the heating system must provide mechanisms to:

- i. Log and download an accurate record of the last 96 hours of operations;
- ii. Accurately display in real time the calibration, inputs and outputs of all control and arbitration strategies;
- iii. Enable the FIA to test the operation of any tyre heating systems.

f. All software, hardware and wiring must:

- i. Be approved and homologated by the FIA prior to being used at a Competition;
- ii. Provide a unique and unambiguous identification that enables the FIA to identify and compare the versions being used to the version presented in the homologation dossier at any time during a Competition.

Additional details may be found in the Appendix to the Technical and Sporting Regulations.

#### 12.4.1 Principal Roll Structure

The principal roll structure must satisfy the following geometric requirements:

- a. It must have structure at  $[X_C=55, 0, 968]$ .
- b. A horizontal section through the structure at  $Z=950$  must enclose an area of at least ~~Have a minimum enclosed structural cross-section of~~  $6000\text{mm}^2$ , ~~in vertical projection, across a horizontal plane at  $Z=950$ .~~ The cross-sectional area may not be less than  $6000\text{mm}^2$  in any horizontal section below this plane.
- c. Above  $Z=935$ , ~~have~~ the external surface of the structure must be ~~that is~~ tangent continuous, and ~~does not~~ must not contain any concave radius of curvature. Any convex radius of curvature must be no smaller than 20mm.

Compliance will be assessed without considering an opening in the structure to allow aerodynamic ducts to pass through. Any such opening must be below  $Z=955$

Minimal local deviations from this surface are permitted where the load pad described in Article 13.3.1 contacts the structure, at the intersection of the external surface and openings for an internal duct, and for the mounting of Camera 4.

- d. A horizontal section through the structure at  $Z=910$  must enclose an area of at least ~~Have a minimum enclosed structural cross-section of~~  $10000\text{mm}^2$ , ~~in vertical projection, across a horizontal plane at  $Z=910$ . The area thus established must not exceed 200mm in length or width and may not be less than  $10000\text{mm}^2$  below this point.~~ Furthermore, the section must enclose an axis-aligned square of side 70mm. These requirements must be maintained in any horizontal section below this plane.

When evaluating the above, only parts that genuinely contribute to the strength of the principal roll structure will be considered and no fairings may be included. Parts of the structure above  $Z=935$  must be designed to support the car in a 15g vertical impact with the ground and be made from an abrasion resistant material.

The areas required in (b) and (d) above, will be taken as the area of the minimum convex polygon enclosing the structural parts of the roll hoop in that plane.

In order that a car may be lifted quickly in the event of it stopping on the circuit, the principal rollover structure must incorporate an unobstructed opening, whose section measures 60mm x 30mm with internal radii of no more than R15mm, clearly visible in side view, to permit a strap to pass through it.

It must be shown by calculation that this opening is capable of resisting a load of 20kN applied by a strap in an upwards direction, on the ZX plane between  $+45^\circ$  and  $-45^\circ$  to the

Z-axis. In designs where the strap could be threaded in different ways, calculations must be provided for all possibilities.

### 13.3 Roll Structure Testing

13.3.1 The principal roll structure must be subjected to one of the following static tests at 75% of the load (105kN), followed by one of the tests at full load (140kN). Both tests must be carried out on the same structure. The tests will be chosen at random and communicated to the Competitor 3 weeks before their scheduled homologation date.

- a. A load of [81, 81, -80]kN
- b. A load of [-81, 81, -80]kN
- c. A load of [0, 0, -140]kN
- ~~a. A load equivalent to 60kN laterally, 70kN longitudinally in a rearward direction and 105kN vertically downwards, must be applied to the top of the structure through a rigid flat pad which is 200mm in diameter and perpendicular to the loading axis.~~
- ~~b. A load equivalent to 42kN laterally, 49kN longitudinally in a forward direction and 73.5kN vertically downwards, must be applied to the top of the structure through a rigid flat pad which is 200mm in diameter and perpendicular to the loading axis.~~

For each test:

- i. Initially, the pad must not contact the roll structure below Z=935.
- ii. At any time during the test, the pad must not contact the structure below Z=900.
- iii. Rubber 3mm thick may be used between the load pads and the roll structure.
- iv. The peak load must be applied in less than three minutes and be maintained for 10 seconds.
- v. Under the load, deformation must be less than 25mm when measured along the loading axis and any structural failure limited to 100mm below the top of the roll structure when measured vertically.
- vi. During the test, the roll structure must be attached to the survival cell which is supported on its underside on a flat plate, fixed to it through its engine mounting points and wedged laterally by any of the static load test pads described in Article 13.4.2.
- vii. The load must be applied to the structure through a rigid flat pad which is 200mm in diameter and perpendicular to the loading axis.

Before performing the physical tests specified above, the Competitor must submit detailed calculations to show that the principle roll structure and survival cell are able to sustain the 3 loads above and following loads:

- d. [115, 0, -80]kN
- e. [-115, 0, -80]kN
- f. [0, 115, -80]kN
- ~~e. The test described in (b) with a load equivalent to 60kN laterally, 70kN longitudinally in a forward direction and 105kN vertically downwards.  
The methodology for the calculations shall be authenticated by comparing data from the physical test (b).~~
- ~~d. A load of 140kN vertically downwards, applied to the centre of the top of the structure through a rigid flat pad which is 200mm in diameter and perpendicular to the loading axis.~~
- g. A load of 50kN applied normal to the surface through a 10mm diameter pad, anywhere on the structure above Z=935.

### 15.3.2 Metallic Materials Used for Additive Manufacture

Components produced by additive manufacture can be made from materials in the following list. A full list of applicable standards and criteria for acceptance of metals under the provisions of Article 15.2.5 in this list is given in the Appendix to the Technical and Sporting Regulations.

- a. Aluminium Alloys; AlSi10Mg, AlSi7MG, Al Cl-30AL, P339 AM, EOS Aluminium 2139 AM, **Ahead CP1**
- b. Aluminium Alloys with particulate reinforcing, A20X, 2024-RAM2, 6061-RAM2
- c. Aluminium-Magnesium Alloys; Scalmalloy, **HRL 7A77**
- d. Titanium Alloys; Grade 1, Grade 2, Ti6Al4V, Ti6AL4V ELI, Ti 5553, Ti 6242.
- e. Steel Alloys; 316, 304, MS1, 15-5PH, 17-4PH, 300M, 4140.
- f. Copper Alloys not containing Beryllium.
- g. Superalloys; Inconel 625, Inconel 718, Cobalt-Chrome.

Furthermore, the finished mass of a component made by additive manufacture should be no less than 60% of the mass of the printed component, excluding support structures.

## 2 Changes for 2025