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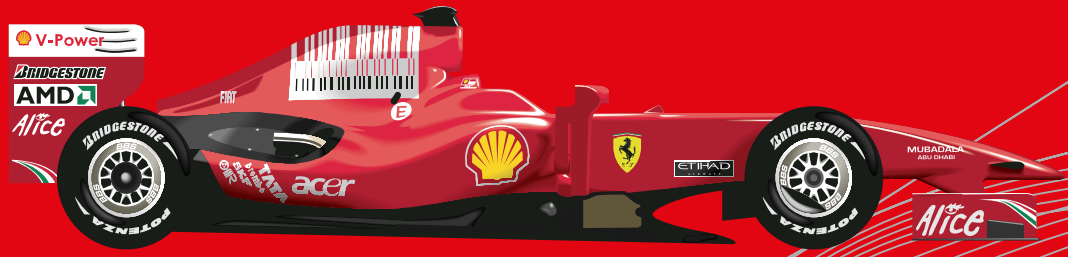

technical analysis 2011

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technical analysis 2010

Teams
2011

Red Bull Racing

Red Bull RB7 Renault

Based in: Milton Keynes, UK
Founded: 2005 (active since 2005)

Website: www.redbullracing.com

Sporting director: Christian Horner (2005-...)
Technical operations director: Günther Steiner (2006)
Technical director: Mark Smith (2006), Geoff Willis (2007)
Chief technical officer: Adrian Newey (2006-...)
Chief designer: Rob Taylor (2006), Rob Marshall (2007-...)
Chief aerodynamics: Ben Agathangelou (2005-2006), Petr Prodromou (2006-...)
Drivers: Sebastian Vettel (1), Mark Webber (2), Daniel Ricciaro (31, Reserve)

Championship winners Red Bull racing launched their car on 1 February at Valencia to put it out immediately on track. Contrary to its predecessors, it ran without problems during the first four days while also being among the fastest cars on track.

Red Bull's RB7 is a careful evolution of the Red Bull RB6, which on its own behalf was already an step up from the Red Bull RB5. Adrian Newey, the team's mastermind, is known for such a cycle, with impressive innovation at times, while carefully improving its cars when they are at their best.

The changes on the RB7 were again influenced by regulation changes. The ban on double deck diffusers mandated a much simpler version, allowing the technical team to again exploit their pull rod rear suspension which they introduced in 2009, also with the idea of running a simple diffuser.

KERS also sees its return, with the the Red Bull being equipped with a system provided by Renault. That comes together with the RS27 engine, a partnership that enters its 5th year. Even though this adds some mass and volume, the car has been further slimmed down at the rear, with exhausts blowing over the diffuser.

Newey said at the launch: "The big challenge for us this year was the reintroduction of the KERS system. It's always a challenge to find solutions, which don't compromise the aerodynamics of the car. This season, with McLaren, Ferrari and Mercedes all having KERS, we need to get it to work, simply for performance off the line."

At the car's presentation, there was still a simple exhaust system with pipes exiting through the sidepods, but already at the second day of testing, Red Bull added a carbon fibre channel on its floor to guide the exhaust widely spread over the diffuser, without being influenced by airflow upwards of the exhaust stream.

Looking at the front of the car, the nose has become a little wider and higher compared to the RB6, just like most other 2011 cars. The front wing remained largely the same. The bulges atop of the nose have become less pronounced, and due to the changed shape of the front-end, the location of the front suspension mounting points was also changed, just like at the rear where the pullrod is now longer as the rocker was moved forward due to the smaller sidepod shape.

In essence, these modifications perfectly show the approach the team took when developing the RB7. Overall, the car also features an apparently longer wheelbase compared to its predecessor, simple rear view mirrors with short vertical supports to reduce their drag penalty. Atop the car, the shark fin was retained as much as the regulations allowed. The new rear wing flap adjuster is hidden in a vertical fence in the middle of the rear wing, in line with the shark fin cover.

Specifications

Chassis: Composite monocoque structure, designed and built in-house, carrying its engine as fully stressed component
Transmission: Seven-speed gearbox, longitudinally mounted with hydraulic system for power shift and clutch operation.
Clutch: AP Racing
Wheels: OZ Racing (front: 12.0in x 13in / rear: 13.7in x 13in)
Tyres: Pirelli PZero
Front suspension: Aluminium alloy uprights, carbon composite, double wishbone with springs and anti-roll bar, push rod actuated
Rear suspension: Aluminium alloy uprights, carboncomposite double wishbone with springs and anti-roll bar, pull rod actuated
Dampers: Multimatic
Brakes: Brembo calipers, Brembo carbon discs and pads
Electronics: FIA (MESL) Standard control unit
Fuel: Total Group

Engine

Designation: Renault engine RS27-2011
Configuration: V8 in 90° bank with 32 valves in total
Capacity: 2400cc
Max. RPM: 18,000RPM (as limited by regulations)
Construction: Cylinder block in cast aluminion
Engine management: FIA (MESL) Standard control unit TAG310B
Oil: Total Group
Weight: FIA minimum weight of 95kg

Scuderia Ferrari SpA

Ferrari F150

Based in: Maranello, Italy
Founded: 1946 (active since 1950)

Website: http://www.ferrariworld.com/

Chairman: Luca Di Montezemolo
Managing director: Jean Todt (1998-2007), Stefano Domenicali
Technical director: Ross Brawn, Aldo Costa (2010-2011), Pat Fry
Chief designer: Giancarlo Colombo (1950-1951), Aurelio Lampredi (1952-1956), Vittorio Jano (1952-1959), Carlo Chiti (1960-1964), Mauro Forghieri (1965-1981), Antonio Tomaini (1981), Harvey Postlethwaite (1982-1987), John Barnard (1988-1990, 1993-1996), Steve Nichols (1991-1992), Rory Byrne (1997-2005), Aldo Costa (2005-2009), Nikolas Tombazis
Team manager: Stefano Domenicali (1996-2007)
Drivers: Fernando Alonso (3), Felipe Massa (4)

The F150 is Ferrari's 57th Formula One car, built under the internal codename of 662. The new F150 was named as such because the Maranello marque chose the name as a tribute and celebration of the one hundred and fiftieth anniversary of the Unification of Italy.

The most important changes compared to the Ferrari F10 are certainly due to regulation changes. As far as the rule changes from 2010 are concerned, the double diffuser and the blown rear wing are banned, as is the use of apertures in the front part of the floor, while the use of a hydraulically controlled adjustable rear wing has been introduced. After an unofficial agreement saw its use banned for 2010, KERS is back, thanks partly to the increase in the car's minimum weight and stricter controls on weight distribution figures. The Scuderia has decided to incorporate this technology on the F150 and this has had a significant impact on the design, also taking into account that the dimensions of the fuel cell are very different to what they were in 2009. Also significant are changes dictated by the introduction of stricter safety requirements in terms of crash-tests, cockpit area protection and wheel-retaining cables for use in accidents.

A second crucial factor for the car's design is the change of tyre supplier. After 13 years of Bridgestone tyre partnership, Ferrari switches to Pirelli which has taken on the role as the sole tyre supplier in Formula One

Technical analysis

Side by side comparison of the F10 and the F150 quickly shows that the 2011 competitor has a higher monocoque and nose. As such, the front suspension has been drastically modified to connect the wheels to the chassis. All wishbones are now more angled upwards towards the chassis attachment points. Additionally, the front wishbones also have an increased angle when looking at their position from above the car.

The sidepods meanwhile have smaller air inlets, more alike those on the McLaren MP4-25. The air inlet in the airbox has been modified as well, now having a more rounded shape to be less influenced by turbulence caused by the driver's helmet.

At each side of the driver, the sidepods are also slightly higher then in 2010 as internal components have been relocated to make room for the KERS system. Batteries for this system have been located below the fuel tank. More towards the back however, the sidepods slope down quickly, creating a very tiny

rear cross section. Here, Ferrari have had to redesign the rear suspension. While the push rod was retained, its attachment point to the chassis was moved forwards considerably, just like the frontal wishbones which are now much longer as well.

Also due to regulation changes, the shark fin engine cover has been replaced by a more conventional one, while the movable rear wing has been introduced.

Overall, the car appears to have been shortened a bit, whereas Ferrari also claim to have redesigned the complete braking system in cooperation with their long term partner Brembo. The car's rear diffuser is again a blown diffuser just like on the F10 during the second half of the season, albeit considerably simpler as the doubled decks were banned. The height increase of the nose and monocoque is also the result of this diffuser change, as the team try to regain the lost downforce.

As the freeze on engine performance development is still ongoing, there have been no actual modifications to the 056 engine, but that does not mean Ferrari's engine specialists have been idle. Work has gone into improving reliability, working especially on the pneumatic front, as well as on reducing costs. Furthermore, the reintroduction of KERS has led to a substantial change in the architecture of the front end of the engine, with modifications to the drive shaft system of the KERS itself and the crankshaft and this has led to changes to the cooling and lubrication systems. The kinetic energy recovery system, designed by Ferrari, has been produced in conjunction with MTS and Magneti Marelli and was fine tuned based on experience acquired in 2009, with the aim of reducing its size and weight, while maintaining, in accordance with the regulations, the maximum useable power and its useage cycle over one lap.

Chassis

Chassis: Monocoque, carbon-fibre and honeycomb composite structure
Gearbox: Ferrari, semiautomatic sequential longitudinal 7-speed quick-shift gearbox. Electronically controlled
Differential: Limited-slip
Brakes: Brembo ventilated carbon-fibre disc brakes
Suspension: Independent suspension, push-rod activated torsion springs front and rear
Weight: 640 kg (incl water, lubricants and driver)
Wheels: BBS Wheels (front and rear): 13"

Engine

Designation: Ferrari type 056
Cylinder configuration: Naturally espirated 90° V8
Cylinder block: and cast aluminium V 90°
Valvetrain: 32 valves with pneumatic distribution
Displacement: 2398 cm^3
Piston bore: 98 mm
Weight: > 95 kg
Injection: Electronic injection and ignition
Fuel: Shell V-Power
Lubricant: Shell Helix Ultra

McLaren International Ltd

McLaren Mercedes MP4-26

Based in: Woking, Surrey
Founded: 1963 (active since 1966)

Website: www.mclaren.com

Team principal: Ron Dennis (1980-2009), Martin Whitmarsh (2009-...)
Managing director: Ron Dennis, Jonathan Neale (since 2004)
Technical Director: Adrian Newey (1997-2007)
Chief Designer of engines: Mario Illien (1995-2005)
Director of Engineering: Neil Oatley, Paddy Lowe (since 2005)
Chief Designer of chassis: Mike Coughlan (2002-2007)
Chief engineer: Tim Goss (since 2001), Pat Fry (since 2002)
Drivers: Lewis Hamilton (5), Jenson Button (6)

McLaren launched their 2011 car in Berlin on 4 February, one day after the end of the year's first winter test. Contrary to most other teams, McLaren decided there to run their old car, the McLaren MP4-25 to evaluate the new Pirelli tyres.

The Woking based team went for an aggressive development route to tackle the changed regulations. The longer wheelbase and U-shaped sidepods are some of the most obvious examples.

Director of engineering Tim Goss explained: "The thinking behind that is to feed as much good-quality air as possible to the rear-lower mainplane and the floor of the car. We want to get the rear-end working as well as possible following the loss of performance caused by the banning of the double-diffuser."

Another important change is the addition of KERS, after it was banned in 2010. The new Mercedes-Benz designed unit is now a single integrated unit that sits within the survival cell, beneath the fuel-tank. In 2009, it was housed in the sidepods..

At the front of the car, the new McLaren features a nose that is raised even further, with a nearly flat profile from its top until the driver's helmet. By retaining the snow plow under the nose - an aerodynamic splitter attached under the nosecone - it is now the only car to feature such a device. The front suspension has been slightly changed in accordance with the new monocoque, but the steering rack is still positioned low in the nose.

Behind the driver, everything has dramatically changed, not the least the cooling concepts of the car. Right under the airbox which provides air to the engine is a small intake to cool the batterypack and motor of the KERS system. Behind the airbox is an additional intake to cool the gearbox and hydraulics, all sitting behind the engine.

The sidepods have also been designed in a particular manner, with an undercut to provide a steady airflow onto the upside of the diffuser. The upside of the sidepods are L-shaped with the cooling radiators inside them custom cut to perfectly fit the unusual shape.

The new rear pullrod suspension also allowed the sidepods to slope down more towards the rear of the car, similar to what Red Bull brought the double championship win with their Red Bull RB6 in 2010.

Finally, the engine exhausts are something which McLaren think is one of the most vital elements of the 2011 car. With dummy exhausts on the car at the launch, the team came to their first Jerez test with 3 different configuration of exhausts, and were running them at different moments to evaluate each solution.

Specifications

Monocoque: McLaren-moulded carbonfibre composite incorporating front and side impact structures
Front suspension: Inboard torsion bar/damper system operated by pushrod and bell crank with a double wishbone arrangement
Rear suspension: Inboard torsion bar/damper system operated by pullrod and bell crank with a double wishbone arrangement
Electronics: McLaren Electronic Systems. Including chassis control, engine control, data acquisition, dashboard, alternator, sensors, data analysis and telemetry. (standardised by the FIA)
Bodywork: Carbon-fibre composite. Separate engine cover, sidepods and floor. Structural nose with intergral front wing
Tyres: Pirelli P Zero
Radio: Kenwood
Race wheels: Enkei
Brake callipers: Akebono
Master cylinders: Akebono
Batteries: GS Yuasa Corporation
Steering: McLaren power-assisted
Instruments: McLaren Electronic Systems
Paint solutions: AkzoNobel Car Refinishes using Sikkens Products
KERS: Mercedes-Benz, Engine-mounted electrical motor/generator with integrated energy storage cells and power electronics. 60kW power.

Transmission

Gearbox: McLaren-moulded carbon-fibre composite. Integral rear impact structure. Seven forward and one reverse gear.
Gear selection: McLaren seamless shift, hand-operated
Clutch: Carbon/carbon, hand-operated
Lubricants: Mobil

Engine

Designation: Mercedes-Benz FO 108Y
Configuration: V8 in 90° bank angle
Capacity: 2.4 litres
Maximum rpm: 18,000
Piston bore maximum: 98mm
Number of valves: 32
Fuel: ExxonMobil High Performance Unleaded (5.75% bio fuel)
Spark plugs: NGK racing spark plugs specially designed for Mercedes-Benz F1 engine
Lubricants: Mobil 1 – combining greater performance, protection and cooling with increased economy and lower emissions
Weight: 95kg (minimum FIA regulation weight)

Mercedes Grand Prix

Mercedes GP W02

Based in: Brackley, Northamptonshire, United Kingdom
Founded: 2009 (active since 2010)

Website: http://www.mercedes-gp.com/

Principal: Ross Brawn
Vice-President Mercedes Motorsport: Norbert Haug
Chief Executive Officer: Nick Fry
Head of Aerodynamics: Loic Bigois
Sporting Director: Ron Meadows
Technical Director: Bob Bell (2011)
Technology Director: Geoff Willis (10/2011)
Engineering Director: Aldo Costa (11/2011)
Drivers: Michael Schumacher (7), Nico Rosberg (8)

The MGP W02 was to be a decisive year for Mercedes GP after their first car proved to be somewhat of a disappointment, despite finishing 4th in the constructors championship. As such, the team decided early on in 2010 to switch their main focus to the W02, resulting in a dramatically different car, launched on 1 Feb at Valencia.

The most striking difference is the nose, which has a much higher nosetip and is very flat, very different from other F1 cars. It does however follow the high nose trend to allow for a better airflow onto the splitter and into the floor of the car.

The 2011 MGP car still preserves the short wheelbase that the W01 also featured, making it the designers difficult to package everything well in the area behind the driver., especially as KERS needed to be integrated again. The result is however impressive, with the engine cover showing high shoulders but still efficiently shaped to not be in the way of clean airflow. The sidepods meanwhile as very compact as the team tried to gain as much airflow as possible onto the diffuser. Along with this came also the switch to pull rod rear suspension, a feature many 2011 cars have after copying the application from Red Bull's successful RB5 and RB6.

Different from its radical sidepod approach is the switch in the airbox area. Where the W01 featured a roll hoop blade that MGP pioneered at the Spanish GP in 2010, the team chose a more conventional design after seeing most of the advantages being cut away by changed regulations.

The first winter test at Valencia however showed that the team had taken the sidepod extremities a bit too far as they kept struggling with overheating during longer runs. Based on that input, a redesign of the sidepods was triggered and introduced at the final winter test, 2 weeks ahead of the first GP of the season. That update reportedly brought the team nearly a full second a lap, thanks to new front and rear wings, different barge boards and reshaped sidepods, with exhausts exiting further from the car's centre line but right above the floor.

Specifications

Construction: Moulded carbon fibre and honeycomb composite structure
Front suspension: Wishbone and pushrod activated torsion springs and rockers
Rear suspension: Wishbone and pullrod activated torsion springs and rockers
Dampers: Penske
Wheels: BBS forged magnesium
Tyres: Pirelli
Brakes: Brembo calipers
Brake: discs/pads Carbon/Carbon
Steering: Power assisted rack and pinion
Steering wheel: Carbon fibre construction
Electronics: FIA standard ECU and FIA homologated electronic and electrical system

Transmission

Gearbox: Seven speed unit with cast aluminium maincase
Gear selection: Sequential, semi-automatic, hydraulic activation
Clutch: Carbon plate

Dimensions

Overall length: 4800mm
Overall height: 950mm
Overall width: 1800mm

Engine

Type: Mercedes-Benz FO108Y
Capacity: 2.4 litres
Configuration: V8 in 90° bank angle
Maximum rpm: 18,000 (maximum FIA regulation)
Piston bore: 98mm (maximum FIA regulation)
No of valves: 32
Weight: 95kg (minimum FIA regulation weight)

Renault F1

Lotus Renault R31 Renault

Based in: Viry-Chatillon (engines) / Enstone (chassis)
Founded: 1898 (active 1977-1985, 2001-...)

Website: http://www.renaultf1.com/

Team President: Bernard Dudot (1998-2003), Patrick Faure (2004-Sep 2007), Bernard Rey (Sep 2007-...)
Managing Director: Flavio Briatore (1998-Sep 2009), Bob Bell (Sep 2009-Oct 2010), Eric Bouiller (Oct 2010-...)
Technical Director: Andre de Cortanze (1977-1978), Michel Tetu (1979-1984), Bernard Touret (1985), Mike Gascoyne (2001-2003), Bob Bell (Oct 2003-Sep 2009)
Engineering Director: Pat Symonds (1998-Sep 2009)
Technical Director Engine: Rob White (Apr 2005-...)
Drivers: Robert Kubica (9), Vitaly Petrov (10)

The R31 was presented by Lotus Renault GP on the 31st of January and debuted the day after that at Valencia. It immediately caught attention of the onlookers, not only because of its attractive livery, but also due to its technical design properties.

After starting from a clean sheet of paper for this car, the R31 features a clear V-shaped nose, a concept thought out by Adrian Newey for the Red Bull RB5. Renault's version however is nicely integrated and has no rough edges. The nose is also quite a bit higher than on the Renault R30 and lacks sidepanels under the nose - a feature which on the R30 created a venturi to gain frontal downforce.

The airbox then features the conventional air intake, but adds to that 2 small intakes on each side of the roll hoop, catching air to cool the hydraulics and gearbox. Last year, similar intakes on the R30 were introduced for the F-duct, a system that is banned in 2011.

The sidepods meanwhile are nothing alike previous Renault designs. The intakes are much larger compared to other cars. Each intake is also divided in 2 because the team have employed a split radiator system inside the sidepods. Towards the rear, the sidepod slope down quickly, with hot air exiting in a small but wide area just above the diffuser, trying to energize its airstream and increase rear downforce.

The combination of these design features were required or made possible by Renault running front exit exhausts (FEE). Rather than having exhaust pipes at the rear end of the sidepods, Renault's R31 has them below the sidepod inlets, blowing exhaust gases under the floor and around the sidepods. Talk in the paddock revealed that other teams have been looking into this design as well during the winter, but neither of them decided to use it.

To further improve their concept of a low rear end, Renault redesigned the gearbox and adapted the rear suspension to make it a pull rod actuated system.

Front exit exhaust

Ahead of the Turkish GP, the team's technical director explained the car's unique front exit exhaust system in-depth. The idea of the FEE is to create a spiralling vortex of exhaust gases as the exhausts are blowing into the curved leading edge of the sidepod's floor.

This handily created a local low pressure area under the front of the sidepods, creating downforce there. Ahead of the season the team compared it with their own Red Bull-alike rearward exhaust (before they knew about it) and found it was generating more downforce than any of its own alternative designs.

The most interesting advantage perhaps of the FEE is also the location of the low pressure area, which for Renault is very close to the aerodynamic centre of the car, whereas the Red Bull system generates it downforce right at the back where the diffuser is.

At the German GP though, the team started experimenting with the rearward blowing exhaust similar to the layout on the Red Bull RB7. They tested it again during FP1 in Hungary, but decided to favour the FEE for the race. It was there where a crack in the exhaust caused chassis R31-04 to be written off as it had too much damage due to a fire on the left hand side of the car.

Specifications

Chassis: Moulded carbon fibre and aluminium honeycomb composite monocoque, manufactured by Lotus Renault GP and designed for maximum strength with minimum weight. RS27-2011 V8 engine installed as a fully-stressed member.
Front suspension: Carbon fibre top and bottom wishbones operate an inboard rocker via a pushrod system. This is connected to a torsion bar and damper units which are mounted inside the front of the monocoque. Aluminium uprights and OZ machined magnesium wheels.
Rear suspension: Carbon fibre top and bottom wishbones with pull rod operated torsion springs and transverse-mounted damper units mounted in the top of the gearbox casing. Aluminium uprights and OZ machined magnesium wheels.
Transmission: Seven-speed semi-automatic titanium gearbox with reverse gear. "Quickshift" system in operation to maximise speed of gearshifts.
Fuel system: Kevlar-reinforced rubber fuel cell by ATL.
Cooling system: Separate oil and water radiators located in the car's sidepods and cooled using airflow from the car's forward motion.
Electrical: MES-Microsoft Standard Electronic Control Unit.
Braking system: Carbon discs and pads, calipers by AP Racing, master cylinders by AP racing and Brembo.
Cockpit: Removable driver's seat made of anatomically formed carbon composite, with six-point harness seat belt by OMP Racing. Steering wheel integrates gear change and clutch paddles, and rear wing adjuster.
KERS: Motor generator unit driving into front of engine with batteries as an energy store. Motor Generator supplied by Renault Sport F1. Electronic control unit by Magneti-Marelli.

Dimensions

Front track: 1450 mm
Rear track: 1400 mm
Overall length: 5100 mm
Overall height: 950 mm
Overall width: 1800 mm
Total weight: 640 kg, including driver, cameras and ballast

Engine

Designation: Renault RS27-2011
Capacity: 2400 cc
Architecture: 90° V8
Weight: 95 kg
Max rpm: 18,000 rpm
ECU: MES SECU
Fuel: TOTAL
Oil: Elf (a brand of TOTAL)
Oil tank: Lotus Renault GP
Battery: Lotus Renault GP

Williams F1

Williams FW33 Cosworth

Based in: Grove, Oxon
Founded: 1968 (active since 1973)

Website: http://www.williamsf1.com/

Managing director & Team principal: Frank Williams
Technical director: Patrick Head (1977-2004), Sam Micheal (2004-...)
Chief designer: Gavin Fisher (1997-...)
Chief aerodynamicist: Adrian Newey (1991-1997), Geoff Willis (1998-2004), Loic Bigois (2004-...)
Team manager: Dickie Stanford
Director of engineering: Patrick Head (2004-...)
Drivers: Rubens Barrichello (11), Pastor Maldonado (12), Valtteri Bottas (test)

Williams have put an enormous amount of work into their FW33 as they were fed up with being a midfield contender. Aerodynamic work started in December 2009, with the mechanical aspects of the FW33 beginning in March 2010. The major layout decisions were finalised in June, following the World Motorsport Council's confirmation of the 2011 rule changes.

Technical analysis

Because of the effort put into the car, it is quite different from its predecessor, the Williams FW32. First this to take into account were the changed diffuser regulations, which made it ever more important to have a clean rear end of the car that would allow plenty of airflow onto the rear wing, the beam wing and over the diffuser. It is especially in this area where the Williams is different from its rivals.

At first sight this car might look as unfinished at the rear due to its compactness and lack of bodywork between the rear wheels. To accomplish this, Williams have designed a completely new seven-speed gearbox, the smallest ever produced by the team. It is an extremely low design to clean airflow above it. Because of its low position, the rear suspension is also very particular, as the rear upper wishbones connect to the central rear wing support, while the front ones connect to the engine. The pull rod still connects to the gearbox, just above the car's floor. A push rod was simply out of the question when designing such a low rear end.

Williams technical director, Sam Michael, noted: "With gearbox usage increasing from four to five races this year, reliability is vital. But I'm not expecting it to be a problem because the new gearbox has the same stiffness characteristics as the old one and the rulebook forces us to be conservative with the internals. For the last few seasons the ratios have to be 12mm wide and 600g per pair, whereas in the past we were down to 8-9mm gears."

Particularly as the double diffuser was banned, it was important to get the rear end developed well in order to try to regain some of the lost downforce: "Not only can you not open any holes between the reference and step planes, you must have continuous material through all lateral and longitudinal sections. The scope for developing anything on the diffuser is limited, so we're looking at the centre, rear and front of the floor, as well as the sides of the floor and the little area around the tyre spat, all of which are still free."

"The ban on double diffusers should tighten up the field. It will probably happen straight away, but even if it doesn't and someone comes to the first or

second test with something you hadn't thought of elsewhere on the car, it'll be easy to replicate it and get it onto the car quickly because it shouldn't affect the underlying car structure such as the gearbox."

More towards the front, Williams have followed the trend to increase the height and width of the nose to feed more air into the floor of the car. Under the nose are now two turning vanes, alike on the Red Bull RB6 during the second half of 2010.

Apart from the aerodynamic changes, Williams have also built in the KERS system as that is permitted again in 2011. The team however chose for a battery system in favour of its own flywheel device.

"Williams Hybrid Power (WHP) is developing a flywheel KERS for use in industry. The system was tested in an F1 car in '09, but the current regulations favour the use of the battery system, which Williams F1 assembles and builds in-house."

"The rules have changed since KERS was last used in F1. Re-fuelling is no longer permitted, so the packaging is different now. We have packaged our KERS system entirely inside the car's survival cell, below the fuel tank, because we didn't want to compromise any of the sidepod area for aerodynamics. The car is longer than last year as a result, but the advantages of doing that outweigh the negatives. Assuming you're on the weight limit, there is no downside to KERS; it's worth 0.3s and it gives you a better start."

Williams have also built in a movable rear wing, a possibility introduced in the 2011 regulations. When trailing another car, the driver can active a hydraulic actuator which will lift the upper rear wing element at the front until the slot gap is 50mm.

Finally, the car's design process also had to be changed slightly as the new Pirelli tyres had to be taken into account. The dimensions of the tyres are the same as in 2010, but the performance characteristics are very different, as Williams F1 discovered during a two-day evaluation of the tyres in Abu Dhabi last November. "The Abu Dhabi test was quite useful. There is a change to the aerodynamics; lots of little details make a difference to the wake of the tyre and we learnt a lot about that in Abu Dhabi. The Pirelli rubber deflects and deforms in a different way to that of Bridgestone and it has different mould lines, all of which can affect the tyre wake. "Overall, though, the arrival of Pirelli is not an intimidating change. We didn't change a lot on the mechanical side of the new car after the Abu Dhabi test; the main changes we've made since then have been aero."

Specifications

Chassis construction: Monocoque construction fabricated from carbon epoxy and honeycomb composite structure, surpassing FIA impact and strength requirements
Front suspension: Carbon fibre double wishbone arrangement, with composite toelink and pushrod activated springs and anti-roll bar
Rear suspension: Double wishbone and pullrod activated springs and anti-roll bar
Transmission: Williams F1 seven speed seamless sequential semi-automatic shift plus reverse gear.
Gear selection: electro-hydraulically actuated
Clutch: Carbon multi-plate
Dampers: Williams F1
Wheels: RAYS forged magnesium
Tyres: Pirelli, Fronts: 325mm wide, Rears: 375mm wide
Brake: system 6 piston callipers all round, carbon discs and pads
Steering: Williams F1 power assisted rack and pinion
Fuel system: Kevlar-reinforced rubber bladder
Electronic systems: FIA standard electronic control unit
Cooling system: Aluminium oil, water, and gearbox radiators
Cockpit: Driver six point safety harness with 75mm shoulder straps & HANS system, removable anatomically formed carbon fibre seat covered in Alcantara

Dimensions & weight

Weight: 640kg with driver, camera and ballast
Wheelbase: 3300mm
Overall length: 5000mm
Overall height: 950mm
Overall width: 1800mm

Engine

Designation: Cosworth 2.4L V8, 90° V angle engine, pneumatic valve train.
Fuel management and ignition systems: Cosworth.
Materials: Block and pistons in aluminium, crankshaft in steel billet, connecting rods in titanium

Force India F1

Force India VJM04 Mercedes

Based in: Dadford Road, Silverstone, Northamptonshire, UK
Founded: 2007 (active since 2008)

Website: http://www.forceindiaf1.com/

Team principal: Colin Kolles (2008)
CEO: Otmar Szafnauer
Technical director: James Key (until Nov 2009), Mark Smith (Nov 2009 - May 2010), Andrew Green (since Jun 2010)
Chief Technical Officer: Mike Gascoyne (2008)
Design Director: Mark Smith (until Nov 2009)
Head of Aerodynamics: Simon Philips
Head of R&D: Simon Gardner
Head of Mechanical design: Dan Carpenter
Drivers: Adrian Sutil (14), Paul Di Resta (15)

The VJM04 was launched online on 8 February 2011 and is the first car of Force India designed and build under the helm of Andrew Green. The team's technical directory rejoined the team the year before as engineering director after spells at Jordan, BAR and Red Bull Racing.

For the third year, the Force India car is powered by a Mercedes engine and McLaren gearbox, while the team are also exploiting KERS supplied by Mercedes. As such, FI have little to do about powertrain design themselves, but there are important other areas of change in the VJM04.

The team's new technical director found that the aerodynamic engineering needed repositioning as the Force India cars of recent years had always suffered on high downforce tracks. At the time the team arrived in Melbourne, that transition was still ongoing, so the team expected a sluggish start of the season.

The team focused over the winter to recover some of the lost downforce due to the removal of the double diffuser - as it was banned. This lead to tweaks and a change in the exhaust system, a major area of development in 2011.

Apart from that, the nose changed slightly but still is clearly a Force India design. The bulge on the lower side of the nose is a design feature typical for the team to negate the lift generated by the central part of the front wing.

The sidepods have been reshaped as well, along with the rear suspension which is now actuated through a pull rod, rather than the previously common push rod. The airbox design was modified to feature a blade rollhoop design, replacing the traditional airbox above the driver's helmet. Andrew Green explained the design decision: "From the outside the biggest change you'll is a move to a 'blade' roll hoop. It just gave us a small packaging advantage, we felt, so we went down that route."

Specifications

Chassis: Carbon fibre composite monocoque with Zylon legality side anti-intrusion panels.
Front suspension: Aluminium uprights with carbon fibre composite wishbones, trackrod and pushrod. Inboard chassis mounted torsion springs, dampers and anti-roll bar assembly.
Rear suspension: Aluminium uprights with carbon fibre composite wishbones, trackrod and pullrod. Inboard gearbox mounted torsion springs, dampers and anti-roll bar assembly.
Clutch: AP Racing carbon clutch
Tyres: Pirelli
Brake system: AP Racing
Brake material: Carbone Industrie
Dampers: Penske
Wheels: BBS forged wheels to Force India specification
KERS: Mercedes-Benz, Engine-mounted electrical motor/generator with integrated energy storage cells and power electronics. 60kW power.

Dimensions

Wheel base: 3500mm
Front track: 1480mm
Rear track: 1440mm
Overall height: 950mm
Overall length: 5100mm
Overall weight: 640kg (with driver, by regulations)

Transmission

Gearbox: McLaren-moulded carbon-fibre composite. Integral rear impact structure. Seven forward and one reverse gear.
Gear selection: McLaren seamless shift, hand-operated
Clutch: Carbon/carbon, hand-operated

Engine

Designation: Mercedes-Benz FO 108Y
Configuration: V8 in 90° bank angle
Capacity: 2.4 litres
Maximum rpm: 18,000
Piston bore maximum: 98mm
Number of valves: 32
Lubricants: Mobil 1 products
Spark plugs: NGK
Weight: 95kg (minimum FIA regulation weight)

Sauber AG

Sauber C30 Ferrari

Based in: Hinwil
Founded: 1970 (active 1993 - 2005)

Managing director: Peter Sauber (1993-2005)
Technical director: Leo Ress(1993-2002), Willy Rampf (2003-2005)
Team manager: Beat Zehnder
Drivers: Kamui Kobayashi (16), Sergio Pérez (17), Esteban Gutièrrez (test)

The Sauber C30 is the first at Sauber to be designed and built under the helm of James Key. The Briton came over from Force India F1 during the 2010 season and brought with him valuable experience of working in a budget aware team while proving to be able to develop cars in a sensible manner.

After Sauber halted development of their C29 early in the season, the C30 already made its first appearance in the windtunnel in May 2010. Nonetheless, the C30 is not a radical step forward, but rather a thoughtful evolution, building on the strenghts and trying to iron out the weaknesses.

At first glance, the Sauber is a fairly simple car. It features a slightly wider nose than the C29, but apart from that nothing much has changed in the front, likely because the team already had it correct the year before.

The airbox above the driver's head still remains simple, without adding special inlets like several other teams team. Instead, Sauber focused to reduce the impact of the driver's helmet on the rear end of the car by cutting away more of the bodywork under the inlet. This leaves the airbox supported by 4 struts, rather than the previous two.

Left and right of the driver as somewhat bulkier sidepods that feature cooling inlets of reduced size. Despite adding KERS in the car, the system provided by Ferrari along with the engine, the sidepods are impressively undercut to reduce form drag at the front the sidepod.

All this leads to a nice flow of air along and over the downward sloping top of the sidepods onto the diffuser and the beam wing. Amidst this flow exit the engine exhausts, exiting just above the car's floor and close to the car's centre line. Thanks to Sauber's smaller gearbox, these exhausts now blow onto the central part of the diffuser, as well as partly through the starter hole.

Specification

Chassis: carbon-fibre monocoque
Wheel suspension: upper and lower wishbones (front and rear), inboard springs and dampers actuated by pushrods (Sachs Race Engineering)
Brakes: six-piston brake callipers (Brembo), carbon-fibre pads and discs (Brembo)
Transmission: Ferrari 7-speed quick-shift carbon gearbox, longitudinally mounted, carbon-fibre clutch
Chassis electronics: MES
KERS: Ferrari
Steering wheel: Sauber F1 Team
Tyres: Pirelli P Zero
Wheels: OZ

Dimensions

Length: 4,935 mm
Width: 1,800 mm
Height: 1,000 mm
Track width, front: 1,495 mm
Track width, rear: 1,410 mm
Weight: 640 kg (incl. driver, tank empty)

Engine

Designation: Ferrari type 056
Configuration: Naturally aspirated V8, 90° cylinder angle
Engine block: sand-cast aluminium
Valves / valve train: 32 / pneumatic
Displacement: 2,398 cc
Bore: 98 mm
Weight: more than 95 kg
Electronic injection and ignition

Scuderia Toro Rosso

Scuderia Toro Rosso STR6 Ferrari

Based in: Faenza, Italy
Founded: 2005 (active since 2006)

Website: http://www.tororosso.com/

Team principal: Franz Tost (since 2006)
Team advisor: Gerhard Berger (since 2006)
Technical director: Alex Hitzinger (2006-2007), Giorgio Ascanello (since 2008)
Drivers: Sebastian Buemi (18), Jaime Alguersuari (19), Daniel Ricciardo (Reserve)

2011 marks the first year for Toro Rosso to run a car which it has designed and built completely by itself. In previous years, the team could rely on Red Bull technology to provide them with a chassis while the team focused on small tweaks. The STR6 is in that respect very different, and it shows.

Technical director Giorgio Ascanelli has led his team to design a car with an interesting approach, especially due to its sidepod cutouts that effectively create a double floor for the car, similar to the Ferrari F92A of 1992.

The car's design is largely influenced by the changed set of regulations, and as rules for the front end of the car have changed little, only smaller changes were done at the front. The nose cone is clearly an evolution of that on the STR5 while the front suspension has been nearly untouched. Aft of that, every single design change was made to try to gain downforce back after the ban on the double diffusers.

With simpler diffusers the only way to generate floor downforce, Toro Rosso found that channeling air underneath the sidepod could help diffuser efficiency. A clean and high speed flow over the diffuser will help suck away air from underneath it, facilitating the generation of downforce underneath the car.

An important disadvantage of these sidepods however is their increased surface. As such, high speed air flowing underneath the sidepod will lose some energy on the boundary layer of both the underside of the sidepods, as well as the upper side of the floor. This problem was effectively also why the 1992 Ferrari failed to materialize its promised performance when out on track. In an attempt to negate this effect, STR have designed a carbon fibre, long and narrow exhaust exit fitted atop the car's floor and ahead of the diffuser. The idea there is to re-energize the air coming from underneath the sidepods with the hot and high speed exhaust gases.

Due to the regulation changes, the shark fin engine cover has also been replaced by a more traditional design, while the airbox inlet remains to be typically round and different from what other teams are doing.

Mechanically, the car is still using their well known Ferrari engine, added with a Ferrari KERS system based on batteries. The KERS package is put on the centreline of the car, beneath the fuel tank.

Specifications

Official car name: STR6
Chassis material: Composite monocoque structure
Bodywork material: Carbon fibre composite
Front suspension: Upper and lower carbon wishbones, torsion bar springs and anti- roll bars
Rear suspension: Upper and lower carbon wishbones, torsion bar springs and anti- roll bars
Dampers: Sachs
Steering: Scuderia Toro Rosso
Gearbox: Seven-speed hydraulic
Clutch: Sachs pull-type
Calipers: Brembo
Pads and discs: Brembo
Cooling system (radiators, heat exchangers): Scuderia Toro Rosso
Cockpit instrumentation: Scuderia Toro Rosso
Seat belts: OMP
Steering wheel: Scuderia Toro Rosso
Driver's seat: Carbon fibre construction, moulded to driver's shape
Extinguisher system: Scuderia Toro Rosso/FEV
Wheels: Advanti Racing
Fuel cell: ATL
Overall weight: 640 kg (including driver and camera)

Engine

Designation: Ferrari V8 Type 056
KERS: Battery energy storage system, supplied by Ferrari

Lotus Racing

Team Lotus T128 Renault

Based in: Hingham, Norfolk, United Kingdom
Founded: 2009 (active since 2010)

Website: http://www.teamlotus.co.uk/

Team principal: Tony Fernandes
Chief Executive Officer: Riad Asmat
Chief Operating Officer: Keith Saunt
Chief Technical Officer: Mike Gascoyne
Technical director: Mark Smith (May 2011)
Dpty. technical director: Dieter Gass
Head of Aerodynamics: Marianne Hinson (since Jun 2010)
Chief designer: Lewis Butler (since Jun 2010)
Head of vehicle dynamics: Elliot Dason-Barber
Head of R&D: Frank Ramowsky
Head of electronics: Rob Reeve
Chief engineer: Jody Eggington
Drivers: Heikki Kovalainen (20), Jarno Trulli (21)

In their second year in Formula One, Team Lotus aims for regular battles with midfield teams and regular point finishes. With all the team in place, the design time for the T128 was much longer than on its predecessor. Technical lead Mike Gascoyne was therefore able to push the limits, despite the limited budget compared to the more established teams.

The team launched their car as the first of all teams by revealing it ahead of the first winter test, in 31 January. The car debuted on 2 February at Valencia, Circuit Ricardo Tormo.

The 2011 car is vastly different from that of 2010 with a higher, wider and more curvy nose cone. From the pushrod connections of the front suspension on to the driver's helmet, the upper side of the cockpit also features a bulge on each side to house the front suspension rockers and increase the cross sectional area of the nose.

The sidepods are seemingly where the team made the biggest progress. As they looked very rudimentary in 2010, those on the T128 have a considerable undercut while also running tight in the back. Together, these two properties help airflow towards the rear end of the car, and hence also the so important rear diffuser. Contrary to what other teams have come up with though, the T128 in launch configuration features rather conventional exhausts, exiting from the sidepods low above the car's floor, but without any other channeling.

Above the driver's helmet, the Team Lotus also redesigned the roll hoop completely by adopting the blade roll hoop, similar to what Mercedes GP ran in 2010 on their 2010 Mercedes GP W01. Mike Gascoyne stated this to be a "small packaging advantage".

Under the hood, the car lacks KERS, but the the team have signed new engine and gearbox contracts. The Cosworth engine was replaced by the Renault RS27-2011, whereas the gearbox of the T128 is supplied by Red Bull Racing. It's actually the 2009 RB5 unit, but after the problems they experienced with the Xtrac transmission in 2010, the team desperately needed something more reliable. Because of the gearbox casing, the team also applied the rear pull-rod suspension system.

Team principal Tony Fernandes said: “The T128 thus has the 2009 RB5 gearbox. That car was a race winner in its own right you may remember, and although it sounds a little outdated it is a better choice for this season because last year’s was tailored for the now banned double diffuser, and was actually heavier than the one Lotus has acquired.”

Specifications

Chassis material: Carbon Fibre
Bodywork material: Carbon Fibre
Suspension: Carbon Fibre wishbones, push rod in front, pull rod in rear
Rear Suspension: Carbon Fibre
Dampers: Penske & Multimatic
Steering: Team Lotus
Gearbox: Red Bull Technologies
Clutch: AP
Brake discs and pads: Carbone Industrie or Hitco
Brake calipers: AP
Cooling system (radiators, heat exchangers): Team Lotus
Cockpit instrumentation: MES (as mandated by the FIA)
Seat belts: Schroth
Steering wheel: Team Lotus
Driver’s seat: Team Lotus
Extinguisher system: FEV
Wheels: BBS to Team Lotus Specification
Fuel cell: ATL
Battery: Yuasa
Fuel provider: Total
Lubricants provider: Various
Wheel base: More than 3000 mm
Overall Length: Approx 5 metres
Overall Height: 950mm

Engine

Designation: Renault RS27-2011
Capacity: 2400 cc
Architecture: 90° V8
Weight: 95 kg
Max rpm: 18,000 rpm
ECU: MES SECU

Hispania Racing F1 Team

HRT F111 Cosworth

Based in: Alzira, Valencia, Spain
Founded: 2009 (active since 2010)

Website: http://www.hispaniaf1team.com/

Team Chairman: Jose Ramon Carabantes
Team principal: Colin Kolles
Director Business Affairs: Dr. Manfredi Ravetto
Technical director: Geoff Willis
Chief operating officer: Boris Bermes
Chief of Racing and Testing: Toni Cuquerella
Drivers: Narain Karthikeyan (22), Vitantonio Liuzzi (23)

The F111 is an evolution of the Dallara designed F110 which competed in the 2010 Formula One season. Although Gary Anderson described the F110 at its inauguration as “neat and tidy”, it was in fact an underdeveloped package without any testing due to financial rumblings within the team.

Unfortunately, the story of the F111 is rather similar. Financially the team is a little bit better organised, and respected designer Geoff Willis was taken on board as a consultant to try and improve the existing chassis.

Again for financial reasons, the team chose to keep the same monocoque to be able to skip some of the crash tests. When the car was then finally shipped to the final pre-season test at Barcelona, HRT called off the single testing day as its dampers got stuck in customs. As such, the F111 starts the season with 0 testing kilometers, just like the F110.

Colin Kolles said at the launch: “The F111 represents a significant step forward for Hispania Racing. We have made a big improvement for our second season in Formula 1 and what you see in our new car confirms Hispania Racing´s commitment to F1.”

The team’s technical director commented: “Starting the programme to develop the F111 has been an enormous challenge. The group of engineers working from many separate locations had to produce the 2011 HRT chassis to meet the new regulations, package the Williams LG14 transmission, design all new rear suspension to suit and develop a complete aero package. Given the tight time frame, I am very impressed with the result and the enormous efforts everyone has put in to achieve the objective. However we have to be realistic in our expectations of performance; this is very much a baseline car which the teammust develop in 2011.”

Specifications

Chassis: Carbon fibre and honeycomb composite Monocoque
Front Suspension: Carbon fibre Double wishbone with pushrod operating torsion springs and anti roll-bar via rocker
Rear Suspension: Carbon fibre Double wishbone with pushrod operating torsion springs and anti roll-bar via rocker
Dampers: Lineal hydraulic dampers
Fuel Tank: Kevlar reinforced rubber fuel cell
Steering Wheel: Carbon Fibre with integrated Dash electronics and instrumentation
Steering System: HRT Hydraulic servo assisted system
Gearbox: Williams seven-speed "Quick-Shift" sequential semi-automatic shift
Clutch: Carbon Multi Plate
Brake Material: Carbon brake discs and pads
Brake Callipers: 6 pistons all round
Cooling System: Aluminium oil, water and gearbox cooler
Seat Belts: OMP
CockPit: Removable seat made of anatomically formed carbon composite and six-point seat belt & HANS system
ECU and Logging System: FIA standard ECU & FIA homologated electronic & electrical system
Wheel Rims: Magnesium alloy
Tyres: Pirelli P Zero
Overall Width: 1800mm
Car Weight: 640Kg (Minimum FIA weight)

Engine

Designation: Cosworth V8 2400cc CA2011
Max rpm: 18000
Engine Weight: 95Kg (minimum FIA regulation weight)

Virgin Racing

Marussia Virgin Racing MVR-02 Cosworth

Based in: Dinnington, South Yorkshire, England
Founded: 2009 (active since 2010)

Website: http://www.virginracing.com/

Team principal: Alex Tai (Dec 2009), John Booth (Jan 2010-...)
Chief executive officer: Any Webb (Feb 2010-...)
Sporting director: John Booth (Dec 2009-...)
Technical director: Nick Wirth (Dec 2009-Jul 2011)
Engineering director: Nikolay Fomenko(Feb 2010-...)
Drivers: Timo Glock (24), Jerôme D'Ambrosio (25)

Virgin Racing continued their path of virtual design by Nick Wirth, and the team are proud yet again to have designed this car solely by CFD. The car was unveiled on 7 February at the BBC TV centre and immediately showed great resemblance to its predecessor.

Nonetheless, there are a few striking features that are quite different from any other car fielded in 2011. First of all, the nose has not been raised, and as such the MVR-02 has the lowest nosecone of all 2011 cars. The nose did get slightly wider though, and the bulges on the upper side have grown a bit. This allowed the team to slightly increase the angle of the push rod, allowing for easier and more precise suspension adjustments.

At the centre of the car, the sidepods are at first rather similar, but nothing is less true. In fact, the air inlets are made aggressively small for increased aerodynamic efficiency, while the undercut is impressive. This was partly made possible because the team have chosen not to run KERS.

As the 2011 launches were mostly about the position of the exhausts, Virgin Racing came up with yet another alternative, as they have very long exhaust pipes that join together right before the diffuser. With has designed them as such that part of the exhaust gases blow through the diffuser's starter hole, effectively creating an open fronted blown diffuser.

Nick Wirth further explained at the launch that his team have also focused to eliminate some of the problem areas of the 2010 Virgin Racing VR-01: "We have addressed every single issue that troubled us last year, but in our own unique digital way. For example, the hydraulics and gearbox oil problems of last year have resulted in us doing more CFD in these areas alone than we used in the entire aero design program our first digital race-winning sportscar in 2008. In Abu Dhabi we took the opportunity to prove out these digital improvements by successfully track-testing a number of systems for the MVR-02."

On a side note, the MVR-02 was designed to be the same length as the original VR-01 chassis whilst retaining the full-size fuel tank after that had caused problems for the team as well in 2010.

Specifications

Construction: Virgin Racing carbon fibre construction monocoque and nosebox
Suspension wishbones: Virgin Racing carbon fibre construction with titanium flexure joints
Uprights: Virgin Racing aluminium ally construction
Dampers: Penske
Wheels: BBS
Tyres: Pirelli Pzero
Fuel cell: 'FT5' safety specification
Fuel capacity: In excess of 220 litres
Brake calipers: AP Racing 4 potcalipers
Brake discs/pads: Hitco Carbon-Carbon
Steering wheel: Virgin Racing carbon fibre construction
Power steering: Virgin Racing hydraulic steering assist
Driver seat: Anatomically formed carbon composite
Seat belts: Six point harness (75mm shoulder straps with HANS system)
Electronics: ECU and logging system, FIA standard ECU & FIA homologated electronic and electrical system

Transmission

Gearbox: Virgin Racing precision aluminium construction with 7-speed, longitudinally Mounted internals
Differential: Electronically controlled hydraulic differencial
Gear selection: Paddle operated hydraulic shift system with "seamless shift"
Clutch: AP Racing
Driveshafts: One-piece driveshafts with integral tripod joints

Dimensions

Overall Length: Approx 5200 mm
Overall Height: Approx 950 mm
Overall Width: Approx 1800 mm
Wheelbase: Approx 3300 mm

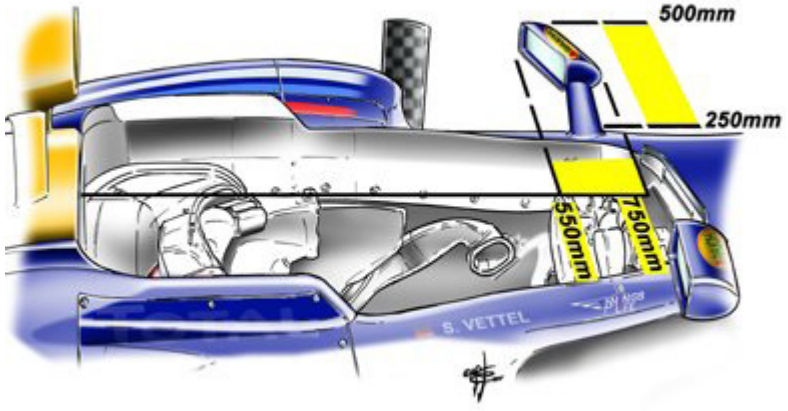
Engine

Designation: Cosworth CA2011
Duty Cycle Type: 4 stroke reciprocating piston, normally aspirated
Configuration: 8 cylinders in banked V configuration with an angle of 90 degrees
Construction: Cast aluminium alloy cylinder block and head, forged aluminium pistons, steel crankshaft
Capacity: 2,400cc
Valves: 32 with pneumatic valve springs
Maximum speed: Limited to 18,000rpm
Timing: Double overhead cams driven via compliant gear from crankshaft
Mass: In excess of 95kg
Cylinder Bore: Less than 98mm
Fuelling: 8 injectors supplied by a pressurized system at 100bar
Ignition: 8 ignition coils each driving single spark plug
Lubrication: Dry sump
Spark Plugs: Champion

Technical Analysis

2011 rule changes - rear-view mirror placement

03 February 2011



Ahead of last year's Spanish Grand Prix, the teams agreed to change the placement of rear-view mirrors for safety reasons and this has now been set in stone in the regulations. Previously, teams had started to position mirrors to boost aero efficiency, with the driver's rearward vision becoming an increasingly secondary consideration. Mirrors must now be 'inboard', where they can be of most benefit to the drivers.

FIA Technical Regulation

14.3.3 - All parts of the rear view mirrors, including their housings and mountings, must be situated between 250mm and 500mm from the car centre line and between 550mm and 750mm from the rear edge of the cockpit entry template.

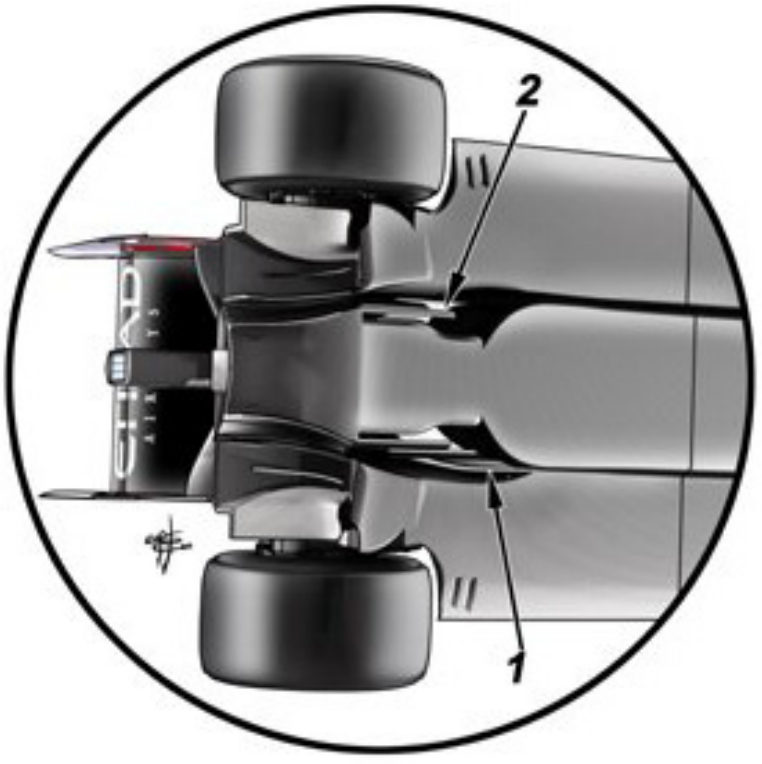
2011 rule changes - fixed weight distribution

03 February 2011

To coincide with the introduction of Pirelli tyres, the FIA have imposed a mandatory weight distribution range for 2011. The standardised distribution of 45.5-46.7 percent front, 53.3-54.5 rear will ensure one team alone doesn't strike lucky and stumble upon the perfect set-up for the as-yet-unknown Pirelli rubber (thus potentially prompting others into costly wheelbase changes). During the qualifying session a car on dry tyres can't weigh less than 342kg at the back and 291kg at the front.

FIA Technical Regulation

4.2 - For 2011 only, the weight applied on the front and rear wheels must not be less than 291kg and 342kg respectively at all times during the qualifying practice session. If, when required for checking, a car is not already fitted with dry-weather tyres, it will be weighed on a set of dry-weather tyres selected by the FIA technical delegate.



2011 rule changes - ban on double diffusers

03 February 2011

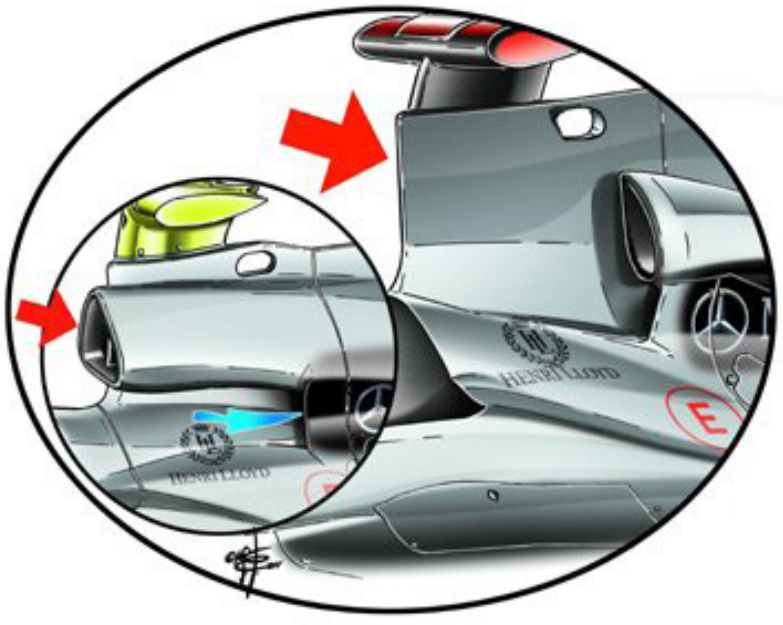
Brawn GP pioneered the concept to championship-winning effect in 2009, everyone had them in 2010, and now they are outlawed. The 2011 rules make it clear that there must be no gap between reference plane, step plane and diffuser, so no more big holes in the underbody like those seen in this Ferrari image from last season. Single, blown diffusers are still allowed, but regardless, the proportion of downforce generated by the diffuser will be far lower.

FIA Technical Regulation

3.12.9 - In an area lying 450mm or less from the car centre line, and from 450mm forward of the rear face of the cockpit entry template to 350mm rearward of the rear wheel centre line, any intersection of any bodywork visible from beneath the car with a lateral or longitudinal vertical plane should form one continuous line which is visible from beneath the car. When assessing the compliance of bodywork surfaces in this area the aperture referred to in Article 3.12.7 need not be considered.

3.12.10 In an area lying 650mm or less from the car centre line, and from 450mm forward of the rear face of the cockpit entry template to 350mm forward of the rear wheel centre line, any intersection of any bodywork visible from beneath the car with a lateral or longitudinal vertical plane should form one continuous line which is visible from beneath the car.

3.12.11 Compliance with Article 3.12 must be demonstrated with the panels referred to in Articles 15.4.7 and 15.4.8 and all unsprung parts of the car removed.



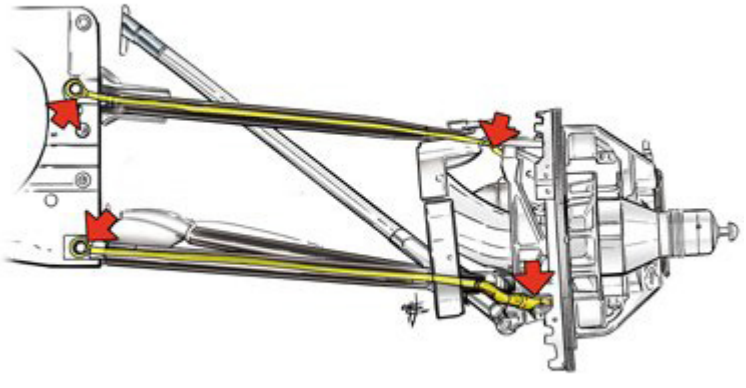
2011 rule changes - blade-style roll hoops

03 February 2011

This blade-style roll hoop design (main drawing) was introduced by Mercedes in 2010 in order to improve airflow to the rear wing. For 2011 the FIA has decided such solutions could prove dangerous in incidents of cars rolling on a soft surface such as grass or sand, where the blade could cut into the ground. A minimum cross section has thus been imposed, to discourage similar designs.

FIA Technical Regulation

15.2.4 - The principal roll structure must have a minimum enclosed structural cross section of 10000mm², in vertical projection, across a horizontal plane 50mm below its highest point. The area thus established must not exceed 200mm in length or width and may not be less than 10000mm2 below this point.



2011 rule changes - aero rims

03 February 2011

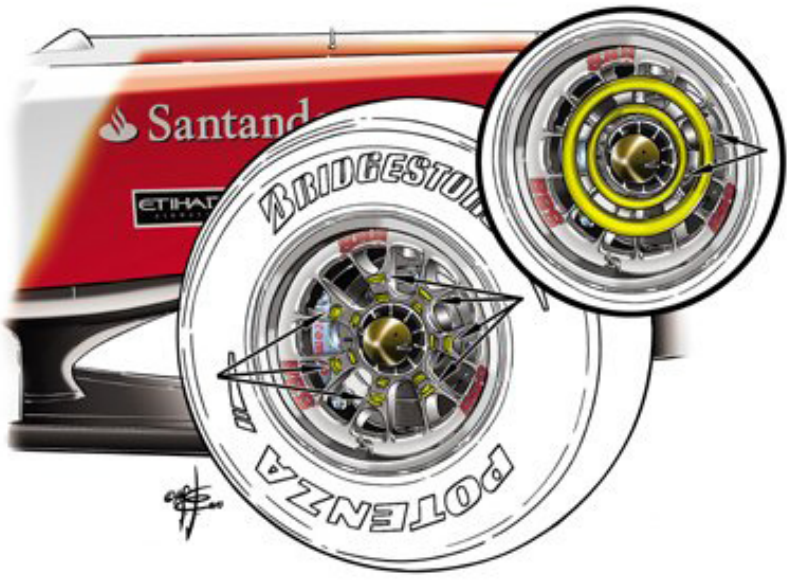
Rotating wheel discs, or 'wheel-spinners', were banned last year, but teams such as Ferrari effectively circumvented this by casting aero features into the wheel rim itself in a bid to optimise airflow passing through the wheel. There will be far less scope for such concepts in 2011, thanks to tighter restrictions on spoke surface area.

FIA Technical Regulation

12.4.6 - When viewed perpendicular to the plane formed by the outer face of the wheel and between the diameters of 120mm and 270mm the wheel may have an area of no greater than 24,000mm².

2011 rule changes - doubled wheel tethers

03 February 2011



In a bid to further reduce the chances of wheels coming loose - and potentially impacting a driver's head - in the event of an accident, the 2011 regulations require four tethers at each corner of the car, double the 2010 requirement. The tethers are bigger, stiffer, and have to pass a more severe load test.

FIA Technical Regulation

10.3.6 - In order to help prevent a wheel becoming separated in the event of all suspension members connecting it to the car failing provision must be made to accommodate flexible tethers, each with a cross sectional area greater than 110mm². The sole purpose of the tethers is to prevent a wheel becoming separated from the car, they should perform no other function.

The tethers and their attachments must also be designed in order to help prevent a wheel making contact with the driver's head during an accident.

Each wheel must be fitted with two tethers each of which exceed the requirements of 3.1.1 of TestProcedure 03/07.

Each tether must have its own separate attachments at both ends which :

- 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 ;

- on the survival cell or gearbox are separated by at least 100mm measured between the centres of the two attachment points ;

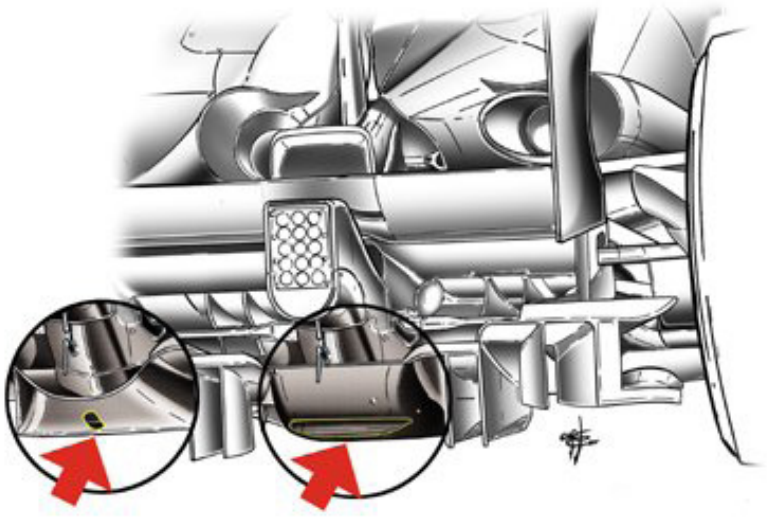
- on each wheel/upright assembly are located on opposite sides of the vertical and horizontal wheel centre lines and are separated by at least 100mm measured between the centres of the two attachment points ;

- are able to accommodate tether end fittings with a minimum inside diameter of 15mm.Furthermore, no suspension member may contain more than one tether.

Each tether must exceed 450mm in length and must utilise end fittings which result in a tether bend radius greater than 7.5mm.

2011 rule changes - starter hole clarification

03 February 2011



Last year some teams pushed the boundaries of the regulations by introducing unusually-shaped engine starters, thus allowing them to have similarly-shaped starter holes in the diffuser (most commonly a slot), bringing aerodynamic benefit by making the diffuser more efficient. The FIA issued one clarification on this during the 2010 season (the drawing shows McLaren's starter hole pre- and post-clarification), and for 2011 the dimensions of the hole have been even more explicitly defined.

FIA Technical Regulation

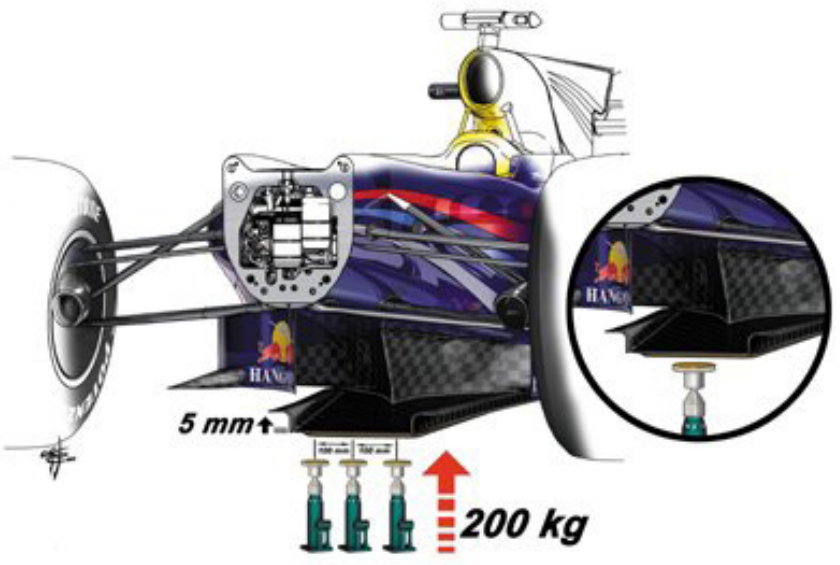
3.12.7 - No bodywork which is visible from beneath the car and which lies between the rear wheel centre line and a point 350mm rearward of it may be more than 125mm above the reference plane. With the exception of the aperture described below, any intersection of the surfaces in this area with a lateral or longitudinal vertical plane should form one continuous line which is visible from beneath the car.

An aperture for the purpose of allowing access for the device referred to in Article 5.16 is permitted in this surface. However, no such aperture may have an area greater than 3500mm2 when projected onto the surface itself and no point on the aperture may be more than 100mm from any other point on the aperture.

Additionally, any bodywork in this area must produce uniform, solid, hard, continuous, rigid (no degree of freedom in relation to the body/chassis unit), impervious surfaces under all circumstances).

2011 rule changes - stricter floor load tests

03 February 2011



The FIA tightened up on floor load testing at last year's Italian Grand Prix, following the much-talked-about 'flexi-floor' controversy and the stricter tests have been written into the regulations for 2011. The floor is now subject to load at three different points, each 100mm apart, rather than at one central point, with a maximum permitted deflection of 5mm.

FIA Technical Regulation

3.17.5 - Bodywork may deflect no more than 5mm vertically when a 2000N load is applied vertically to it at three different points which lie on the car centre line and 100mm either side of it. Each of these loads will be applied in an upward direction at a point 380mm rearward of the front wheel centre line using a 50mm diameter ram in the two outer locations and a 70mm diameter ram on the car centre line. Stays or structures between the front of the bodywork lying on the reference plane and the survival cell may be present for this test, provided they are completely rigid and have no system or mechanism which allows non-linear deflection during any part of the test.

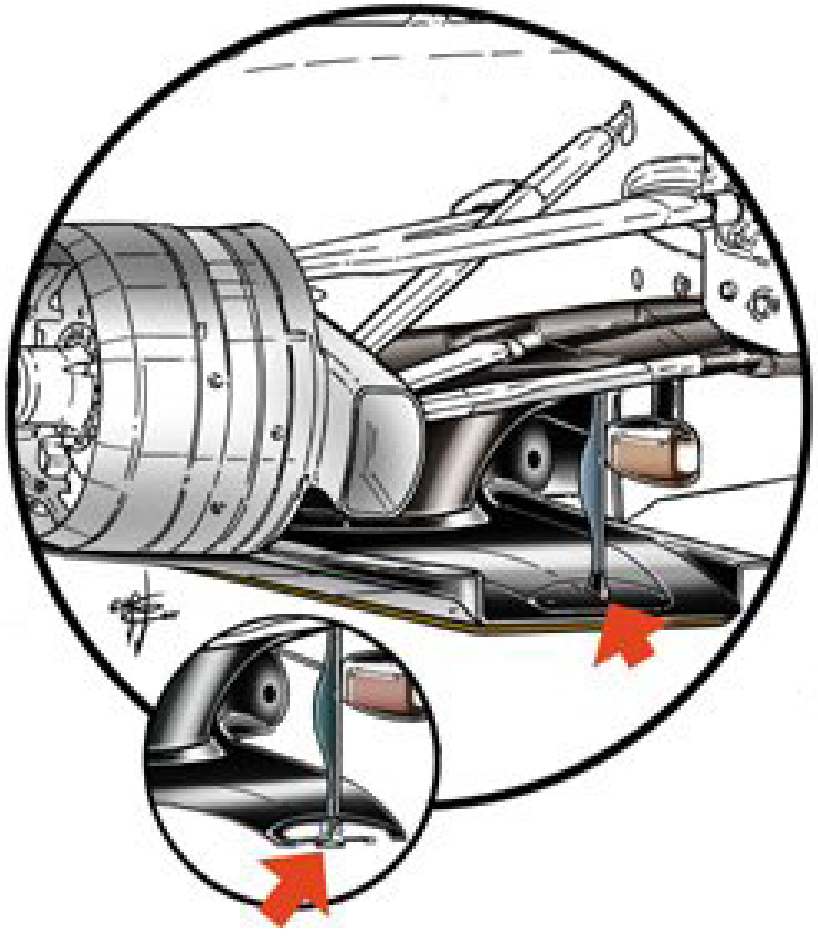
Furthermore, the bodywork being tested in this area may not include any component which is capable of allowing more than the permitted amount of deflection under the test load (including any linear deflection above the test load), such components could include, but are not limited to :

a) Joints, bearings pivots or any other form of articulation.

b) Dampers, hydraulics or any form of time dependent component or structure.

c) Buckling members or any component or design which may have, or is suspected of having, any non-linear characteristics.

d) Any parts which may systematically or routinely exhibit permanent deformation.



2011 rule changes - no sprung plank fixings

03 February 2011

In combination with the stricter floor load tests, the FIA has also banned the use of any springs, pivots, joints or dampers in the mounting of the plank's vertical stay. This means the plank cannot flex upwards at speed and give the car a lower ride height (thus providing an aerodynamic performance gain).

FIA Technical Regulation

3.17.5 - Bodywork may deflect no more than 5mm vertically when a 2000N load is applied vertically to it at three different points which lie on the car centre line and 100mm either side of it. Each of these loads will be applied in an upward direction at a point 380mm rearward of the front wheel centre line using a 50mm diameter ram in the two outer locations and a 70mm diameter ram on the car centre line. Stays or structures between the front of the bodywork lying on the reference plane and the survival cell may be present for this test, provided they are completely rigid and have no system or mechanism which allows non-linear deflection during any part of the test.

Furthermore, the bodywork being tested in this area may not include any component which is capable of allowing more than the permitted amount of deflection under the test load (including any linear deflection above the test load), such components could include, but are not limited to :

a) Joints, bearings pivots or any other form of articulation.

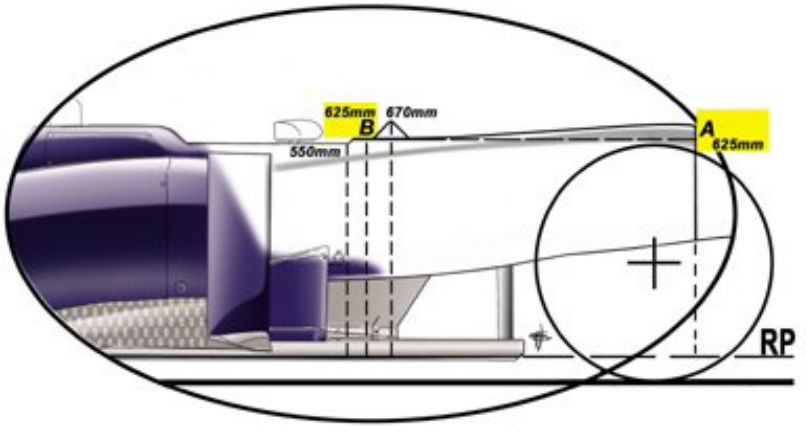
b) Dampers, hydraulics or any form of time dependent component or structure.

c) Buckling members or any component or design which may have, or is suspected of having, any non-linear characteristics.

d) Any parts which may systematically or routinely exhibit permanent deformation.

2011 rule changes - restrictions on front chassis height

03 February 2011



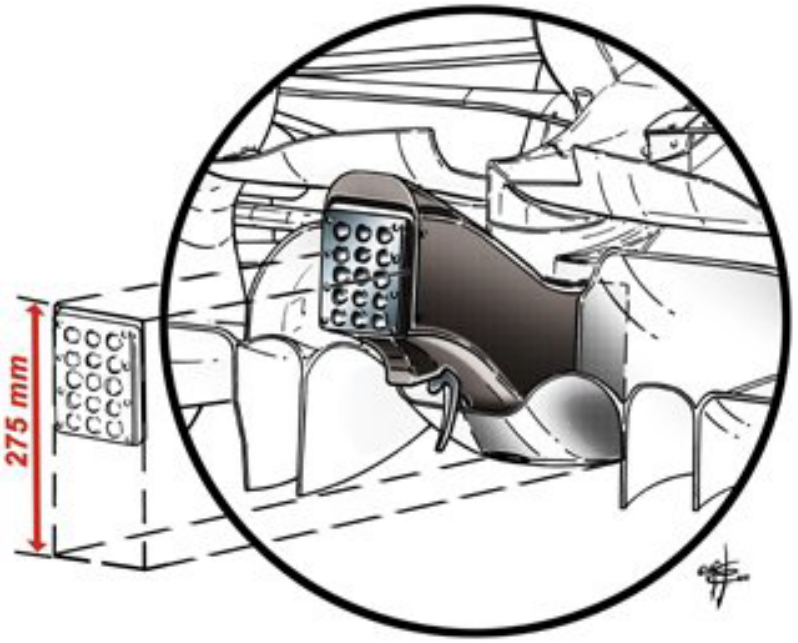
To kerb increasing heights of the front sections of chassis, the FIA has put new limits in place in order to preserve driver visibility and safety. The section between the vertical lines A and B now has a maximum height of 625mm above the reference plane (RP).

FIA Technical Regulation

From 15.4.4 - The maximum height of the survival cell between the lines A-A and B-B is 625mm above the reference plane.

2011 rule changes - restrictions on rear crash structure

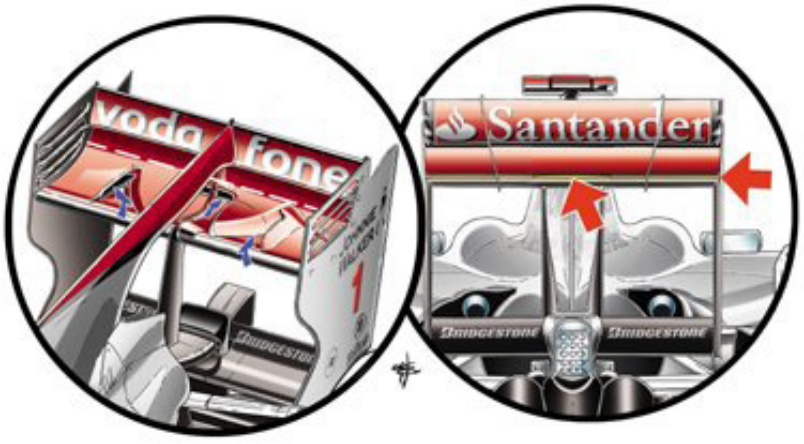
03 February 2011



To stop teams sculpting the shape of the deformable rear crash structure for aerodynamic gain (as per the example in the main drawing), the FIA have more strictly defined its height and positioning (dotted lines).

FIA Technical Regulation

From 15.5.3 - Furthermore, when viewed from the side, the lowest and highest points of the impact absorbing structure between its rear face and 50mm aft of the rear wheel centre line may not be separated vertically by more than 275 mm.



2011 rule changes - rear wing simplification

03 February 2011

Teams are no longer allowed slots in the rear wing's main plane outside of the central 15cm area, and the rear wing may have no more than two sections (main plane and flap). This is to stop the use of main plains with 'sections within sections', such as that introduced by McLaren at Monaco in 2009 and subsequently used by Williams and BMW Sauber (2009), Red Bull, Mercedes, Renault and Toro Rosso (2010). The same restriction applies to the lower beam wing used by Williams last season from Monaco onwards.

FIA Technical Regulation

3.10.2 - Other than the bodywork defined in Article 3.10.9, any bodywork behind a point lying 50mm forward of the rear wheel centre line which is more than 730mm above the reference plane, and less than 355mm from the car centre line, must lie in an area when viewed from the side of the car that is situated between the rear wheel centre line and a point 350mm behind it.

With the exception of minimal parts solely associated with adjustment of the section in accordance with Article 3.18 :

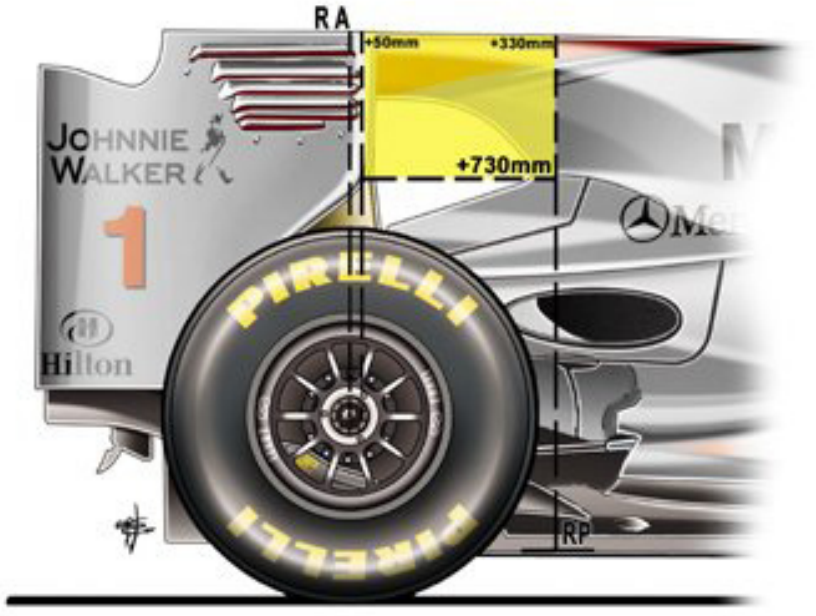
- when viewed from the side of the car, no longitudinal cross section may have more than two sections in this area, each of which must be closed.

- no part of these longitudinal cross sections in contact with the external air stream may have a local concave radius of curvature smaller than 100mm.

Once the rearmost and uppermost section is defined, 'gurney' type trim tabs may be fitted to the trailing edge. When measured in any longitudinal cross section no dimension of any such trim tab may exceed 20mm.

The chord of the rearmost and uppermost closed section must always be smaller than the chord of the lowermost section at the same lateral station.

Furthermore, the distance between adjacent sections at any longitudinal plane must lie between 10mm and 15mm at their closest position, except, in accordance with Article 3.18, when this distance must lie between 10mm and 50mm.



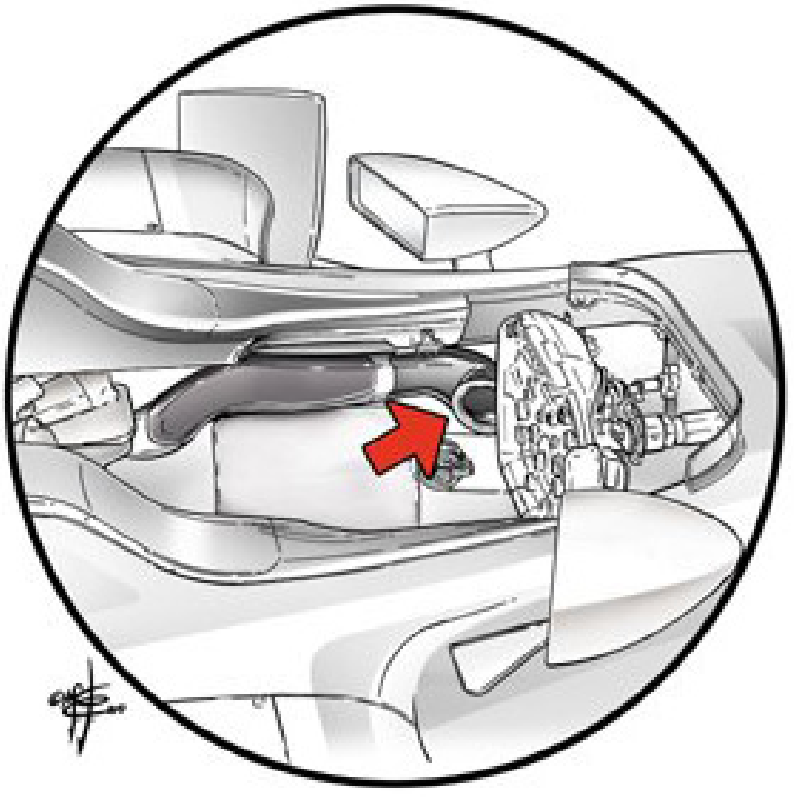
2011 rule changes - shortened shark fins

03 February 2011

Teams are no longer able to connect engine cover extensions (commonly known as 'shark fins') to the rear wing. This is related to the ban on F-ducts - in 2010 many designers used the connection to form an airflow channel for the duct. It's possible some teams may persevere with reduced shark fins, which also give some benefit in terms of stabilising airflow to the rear wing (as well as providing additional advertising space for sponsors).

FIA Technical Regulation

3.9.1 - No bodywork situated between 50mm and 330mm forward of the rear wheel centre line may be more than 730mm above the reference plane.



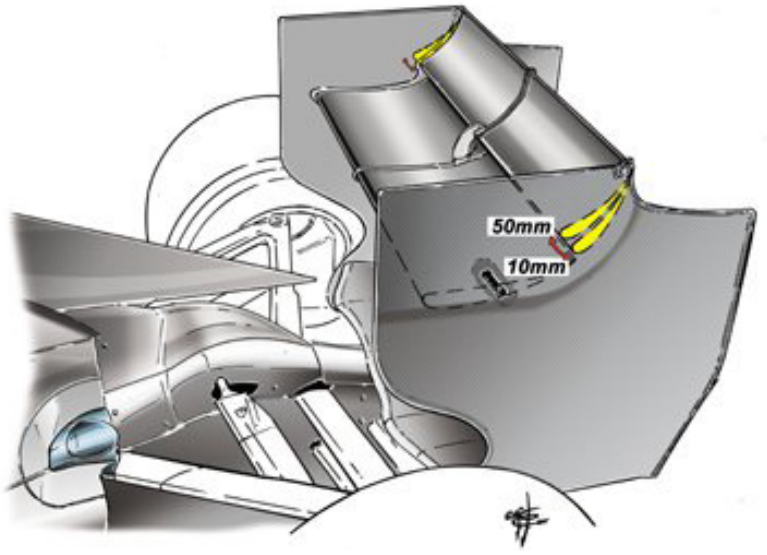
2011 rule changes - F-duct ban

03 February 2011

For 2011 the FIA have specifically outlawed the use of driver movement to control any system that influences the car's aerodynamic characteristics. This means no more F-ducts, where the driver covered a hole in the cockpit to alter the airflow to the rear wing, allowing it to stall and cut drag at high speeds.

FIA Technical Regulation

From 3.15 - Aerodynamic influence - With the exception of the parts necessary for the adjustment described in Article 3.18, any car system, device or procedure which uses, or is suspected of using, driver movement as a means of altering the aerodynamic characteristics of the car is prohibited.



2011 rule changes - adjustable rear wing

03 February 2011

This change is designed to increase the amount of overtaking. The driver-adjustable front wing of 2010 is gone, replaced by a driver-adjustable - but FIA regulated - rear wing. It has just two settings, ON and OFF effectively, with the ON setting increasing the gap between the main plane and the flap from 10-15mm to 50mm. This will reduce drag significantly and so improve top speed. Drivers can use the system at any time in practice and qualifying, but in the race there are restrictions. It cannot be used in the opening two laps, and then will only be made available to the driver at set points on the circuit if he is less than one second behind the car ahead. A dashboard light will notify him when the system is enabled. The system is deactivated when the driver releases the button or brakes.

FIA Technical Regulation

3.18 - Driver adjustable bodywork :

3.18.1 The incidence of the rearmost and uppermost closed section described in Article 3.10.2 may be varied whilst the car is in motion provided :

- It comprises only one component that must be symmetrically arranged about the car centre line with a minimum width of 708mm.

- With the exception of minimal parts solely associated with adjustment of the section, no parts of the section in contact with the external airstream may be located any more than 355mm from of the car centre line.

- With the exception of any minimal parts solely associated with adjustment of the rearmost and uppermost section, two closed sections are used in the area described in Article 3.10.2.

- Any such variation of incidence maintains compliance with all of the bodywork regulations.

- When viewed from the side of the car at any longitudinal vertical cross section, the physical point of rotation of the rearmost

and uppermost closed section must be fixed and located no more than20mm below the upper extremity and no more than 20mm forward of the rear extremity of the area described in Article 3.10.2 at all times.

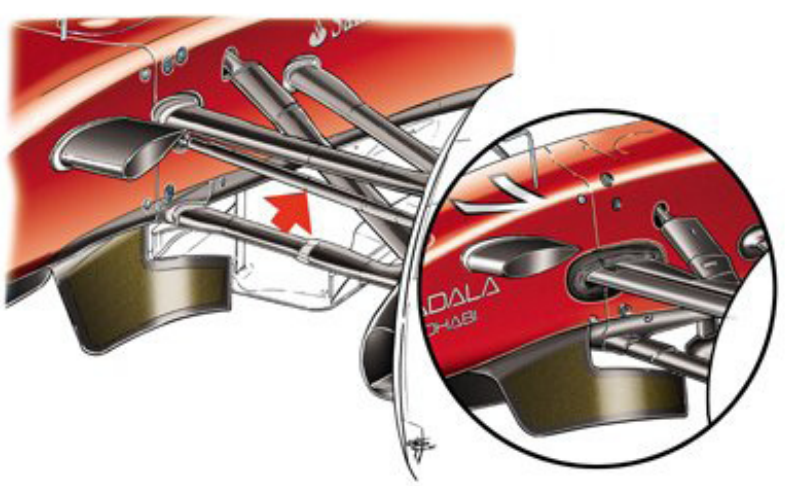
- The design is such that failure of the system will result in the uppermost closed section returning to the normal high incidence position.

- 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 8.2.

3.18.2 The adjustable bodywork may be activated by the driver at any time prior to the start of the race and, for the sole purpose of improving overtaking opportunities during the race, after the driver has completed a minimum of two laps after the race start or following a safety car period.

The driver may only activate the adjustable bodywork in the race when he has been notified via the control electronics (see Article 8.2) that it is enabled. It will only be enabled if the driver is less than one second behind another at any of the predetermined positions around each circuit. The system will be disabled by the control electronics the first time the driver uses the brakes after he has activated the system.

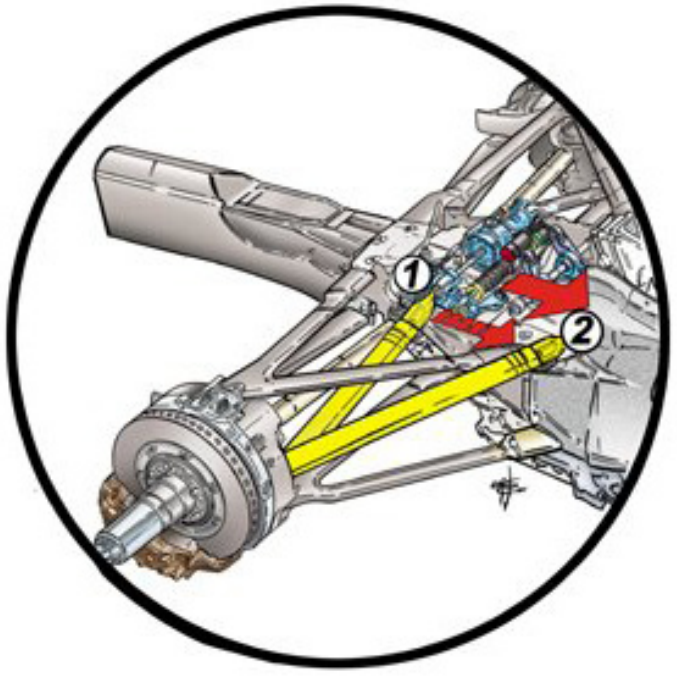
The FIA may, after consulting all competitors, adjust the above time proximity in order to ensure the stated purpose of the adjustable bodywork is met.



Ferrari F150th Italia - 2010/2011 front suspension comparison

09 February 2011

With the chassis positioned five centimetres higher, the suspension pick-up points are also higher (main drawing - 2011; inset - 2010). And in a first for Ferrari, the steering arm is no longer included inside the top wishbone (red arrow).



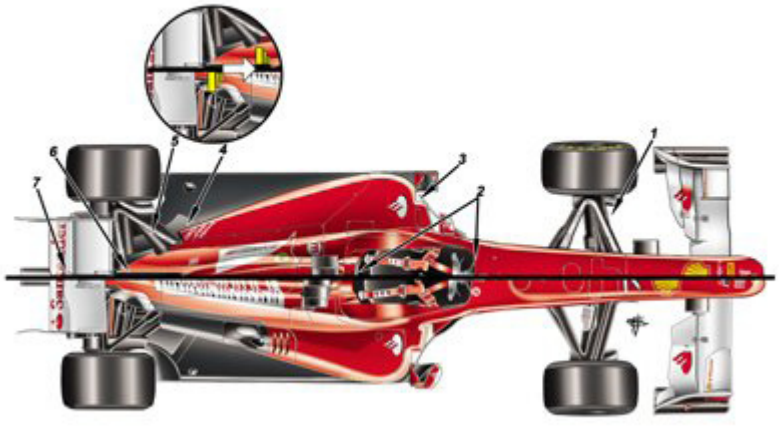
Ferrari F150th Italia - rear suspension

09 February 2011

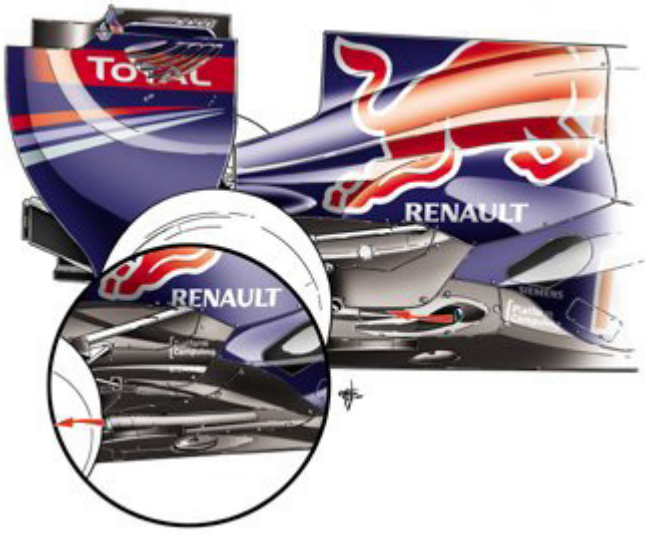
Ferrari have retained their push-rod suspension, but have moved its elements forward. The larger angle of the push-rod link (1 and 2, highlighted in yellow) means the car can have a very narrow and low rear section.

Ferrari F10/F150th Italia - overhead comparison

09 February 2011



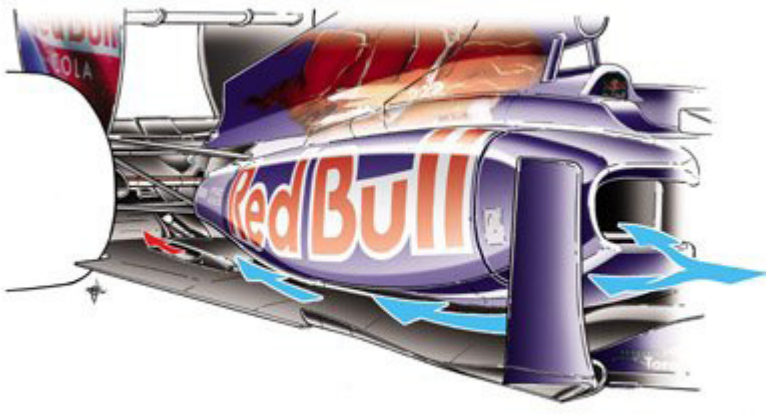
Although the chassis is higher and the nose flatter on the F150 (top), the new car's front wing is the final iteration from last season's F10 (bottom). The new front suspension (1) has higher wishbones and, for the first time on a Ferrari, the steering arm is not inside the top wishbone. To improve visibility and gain some more room for the fuel tank, the driver is seated more vertically in the cockpit (2). The sidepods (3) have improved intrusion protection and inlets shaped in a similar style to those on last season's McLaren. The rear, 'cola bottle' section of the car is much wider, with the exhausts - which will undergo further changes ahead of the season - sited in a very low position (4). Although Ferrari have opted to retain their push-rod suspension (5) for 2011, by reducing the gearbox size and moving the damper and rocker installation forward by 15cm (inset) they can derive similar benefits to those gleaned from a pull-rod suspension system, with very compact packaging. The area in front of the rear wing and diffuser (6) has been neatened and narrowed to improve the flow of air. The rear wing and diffuser themselves are just temporary solutions so the team can run the car and test its reliability. Updated versions will be installed before the first race.



Red Bull RB7 - revised exhausts

11 February 2011

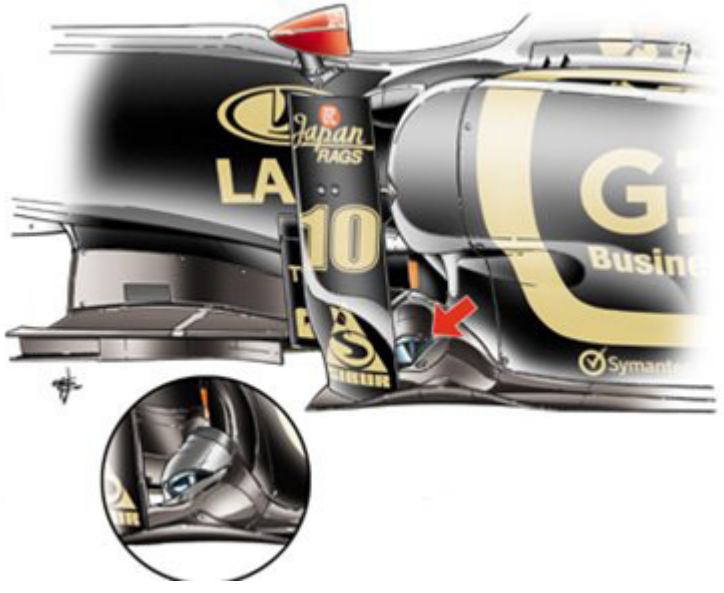
Red Bull rolled out the RB7 at Valencia and by the end of the test had already added a new solution to the new car. Longer exhaust pipes (inset), blowing on to the external section of the diffuser's side channel, replaced the standard design seen on the first day.



Toro Rosso STR6 - double floor arrangement

11 February 2011

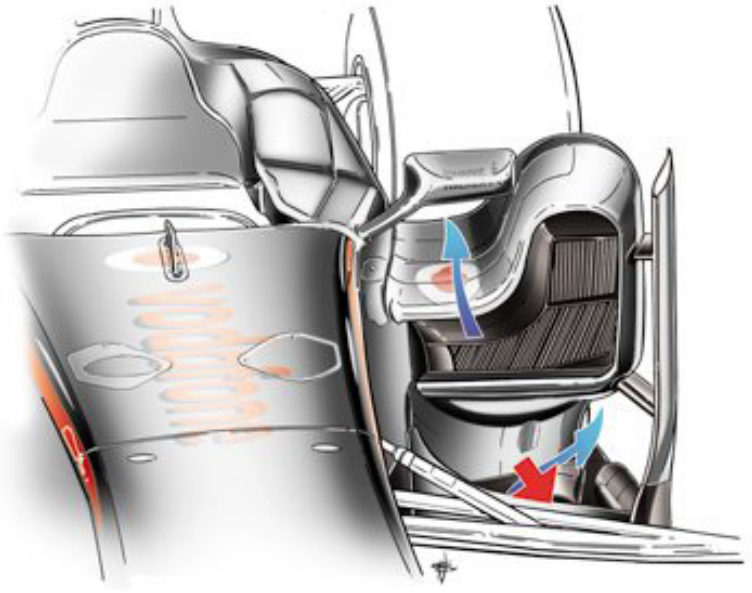
In a solution not dissimilar to that seen on 1992's Ferrari F92, Toro Rosso's 2011 car has raised sidepods to create a second venture channel in order to achieve extra downforce. This is combined with quite long exhausts, with flat exhaust exits (red arrow) towards the rear of the car.



Renault R31 - forward exhausts

11 February 2011

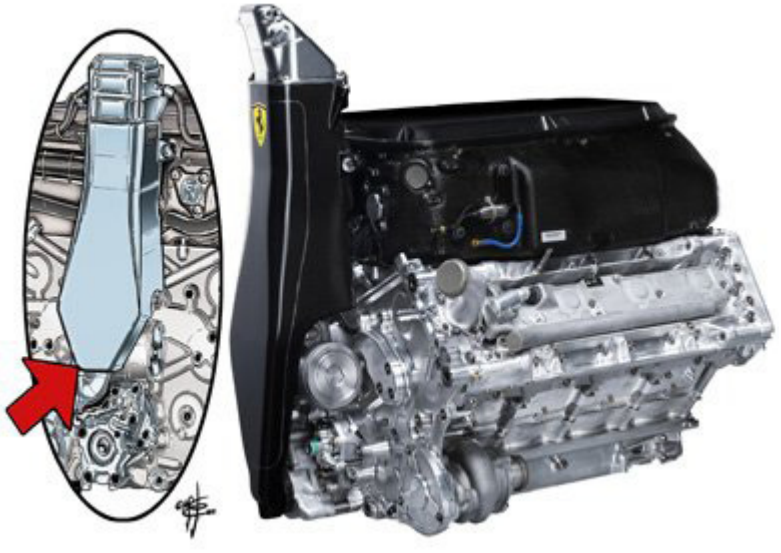
Renault are no strangers to radical exhaust solutions, having launched a design that blew on to the diffuser with the RE30 at Monaco in 1983, and side-exit exhausts on the RE50 in 1985. This season the exits are low down, just in front of the sidepods, in order to accelerate the airflow to the rear diffuser. They are angled backwards slightly, with a very long pipe length designed to minimise the torque and power handicap that comes with the unusual positioning.



McLaren MP4-26 - L-shaped sidepods

11 February 2011

There is no doubting the new MP4-26 is very different from all the other 2011 cars. Technical director Paddy Lowe has exploited to the extreme the idea of higher outer sidepods, last seen on the likes of Benetton's B195 from 1995 and Ferrari's F310 from 1996. The aim is to clean up and better direct the airflow to the beam wing at the rear of the car, an area now even more important thanks to the ban on double diffusers. This solution also gives McLaren the possibility of running Renault-style forward exhaust exits.

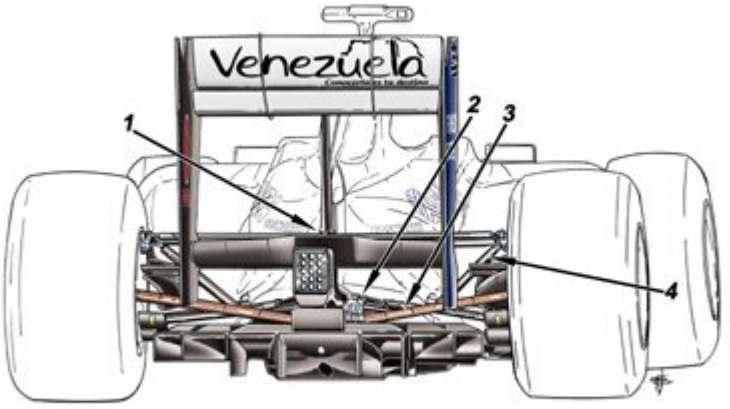


Ferrari F150th Italia - oil tank changes

14 February 2011

The F150th Italia has almost the same wheelbase as 2010's F10, even though the team's KERS system has been positioned inside the car's fuel tank area. In addition, the oil tank has more capacity (see photograph), and is much taller than the one used in the 2009 F60 (see drawing, red arrow).

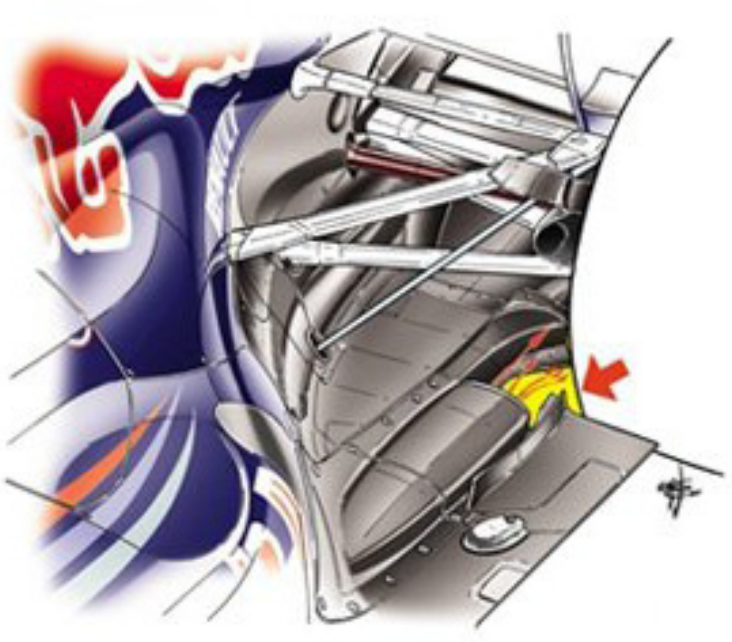
Williams FW33 - innovative rear packaging



15 February 2011

The Williams FW33 has the lowest rear end (2) of all the new cars - lower even than Red Bull's RB7 - due to very compact packaging of the gearbox and differential. So low are they in fact that the driveshaft (3) angle is the greatest ever seen, at around 14° (6-7° is normally considered the maximum limit for this component). Williams spent a lot of time developing and testing this solution before introducing it to the new project. Indeed, the whole rear of the FW33 is innovative - witness the unique pick-up point for the suspension's top wishbone, mounted directly on the central rear wing pillar (1). Williams have also followed the trend for a pull rod rear suspension layout (4) for 2011. Only Ferrari, Sauber (with the Ferrari gearbox), Virgin and HRT have kept a push-rod layout.

Red Bull RB7 - exhaust positioning

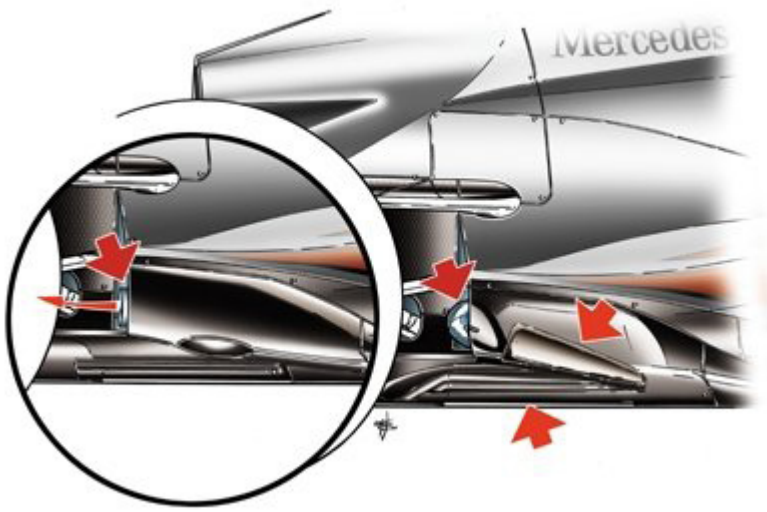


23 February 2011

At the very first test in Valencia Red Bull introduced a new blown exhaust layout. The long flat pipe blows into the area just in front of the rear tyres (see red arrows). In this section (highlighted in yellow) the underbody has been cut away so that the air can blow directly under the side channels of the diffuser. This solution appeared to have been copied by Force India at the most recent test at Barcelona's Circuit de Catalunya.

McLaren MP4-26 - exhaust positioning

25 February 2011



Although McLaren haven't opted to use forward-facing exhausts, the team have come up with two different exhaust solutions at the back. One is very traditional (inset) and blows directly towards the rear of the car. The second is much more complex (main image) and features a U-bend pipe, with a bonded section on the side of the car's stepped bottom. This hides the flat and wide exhaust exit, which blows towards the starter hole in the centre of the rear diffuser.

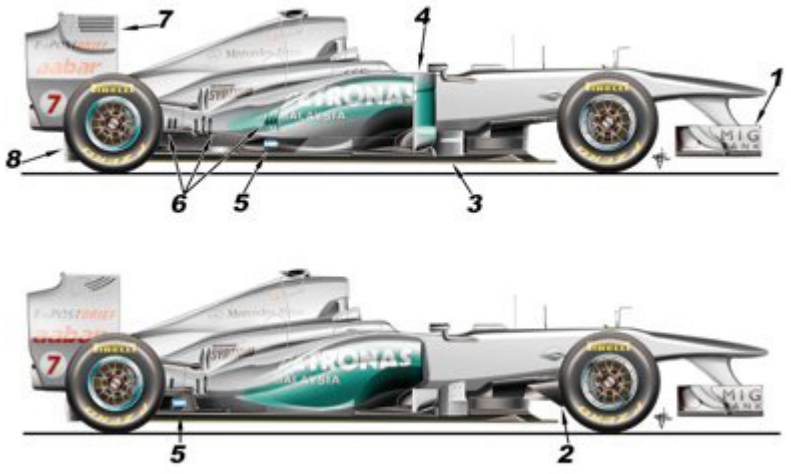
Ferrari 150° Italia - exhaust positioning

07 March 2011

The exhausts on the Ferrari are very low and flat (inset). They blow towards a channel (1) that exits through a thin horizontal window, which is the car's starter hole. The rules limit the size of the starter hole to a maximum surface area of 3,500mm². The centralised nature of the exhaust's positioning has forced the Italian team to add heat protection around the car's deformable rear crash structure (2).

Mercedes MGP W02 - final testing updates

21 March 2011



Following its lacklustre showing in early tests, Mercedes' 2011 car looked far more promising after it was extensively modified for the final Barcelona session, with the team becoming the first to follow Renault's forward exhaust solution, albeit in less extreme form. This drawing shows the original car (bottom) and the modified version (top). Mercedes trialled three different front wings (1), including a double-flap extension to the double-decker flaps, and a blown main plane. The angled fins (2) inside and behind the front wheels have been removed and the turning vanes (3) and sidepods (4) have been revised. The exhaust exits (5) are now in a new bodywork assembly in the middle of the sidepods - previously they were in a standard position at the rear. There are additional gills (6) in the bodywork to improve cooling and a new rear wing (7). The rear diffuser (8) has been updated, with its middle plates in revised positions.

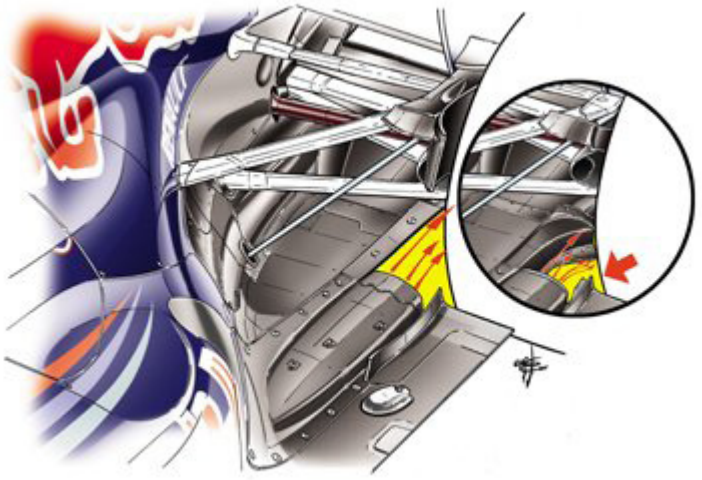
Formula 1™

2011 FORMULA 1

QANTAS AUSTRALIAN GRAND PRIX

MELBOURNE 24-25-26-27 MARCH

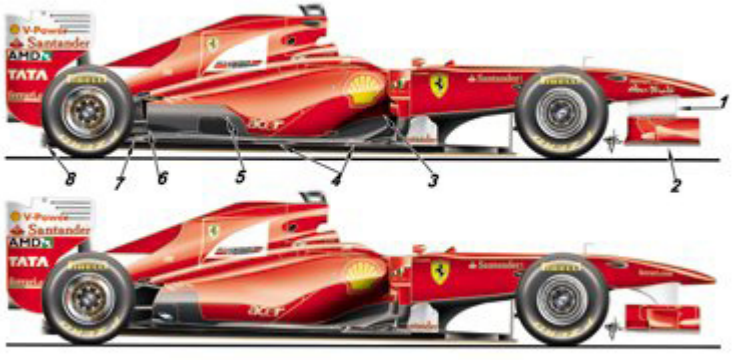

QANTAS



Red Bull RB7 - revised blown exhausts

27 March 2011

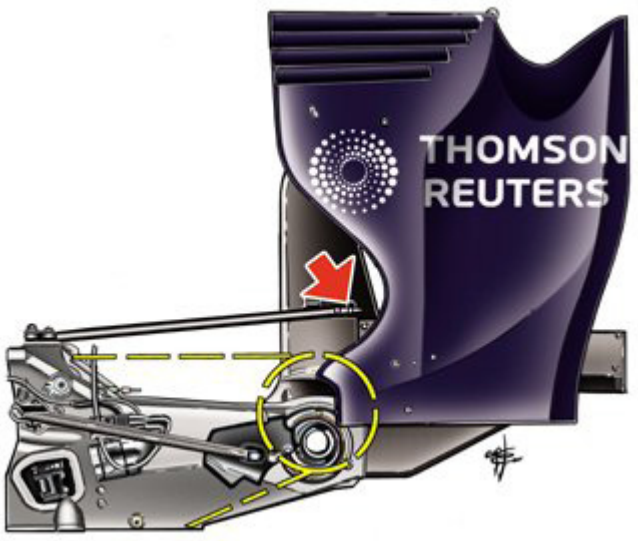
For Australia Red Bull have slightly modified their blown exhausts, with a small extension on the flat pipe blowing just in front of the rear tyres (main drawing - previous design inset). The underbody has been cut slightly differently (highlighted in yellow) in order to divert more airflow under the side channels of the rear diffuser.



Ferrari 150° Italia - pre-season evolution

27 March 2011

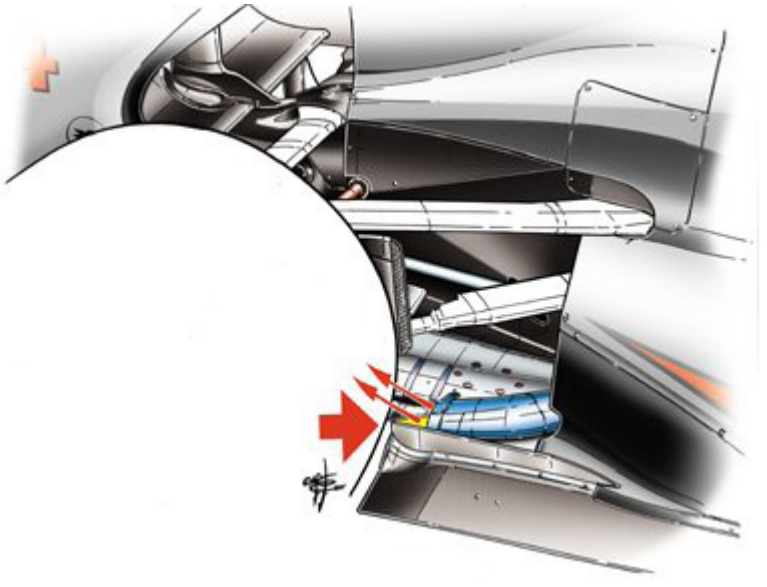
After a hectic winter test programme, Ferrari have introduced the latest version of their 2011 car (top drawing - launch version below) for the Australian Grand Prix. There are new front wing supports (1), featuring very wide pillars, in order to better channel the air under the car, whilst the revised front wing has noticeably different endplates (2). There is a much bigger undercut (3) at the front of the sidepods to feed more air to the back of the car. At the car's midpoint there are new vertical splitters (4), whilst narrower bodywork is highlighted by the larger portion of the black, heat-resistant material (5). There's a revised exhaust (6), inspired by the one featured on the Red Bull, which features longer pipes blowing towards the side diffusers (7). Finally at the back there's a new version of the diffuser designed to complement the revised exhausts (8).



Williams FW33 - innovative gearbox layout

27 March 2011

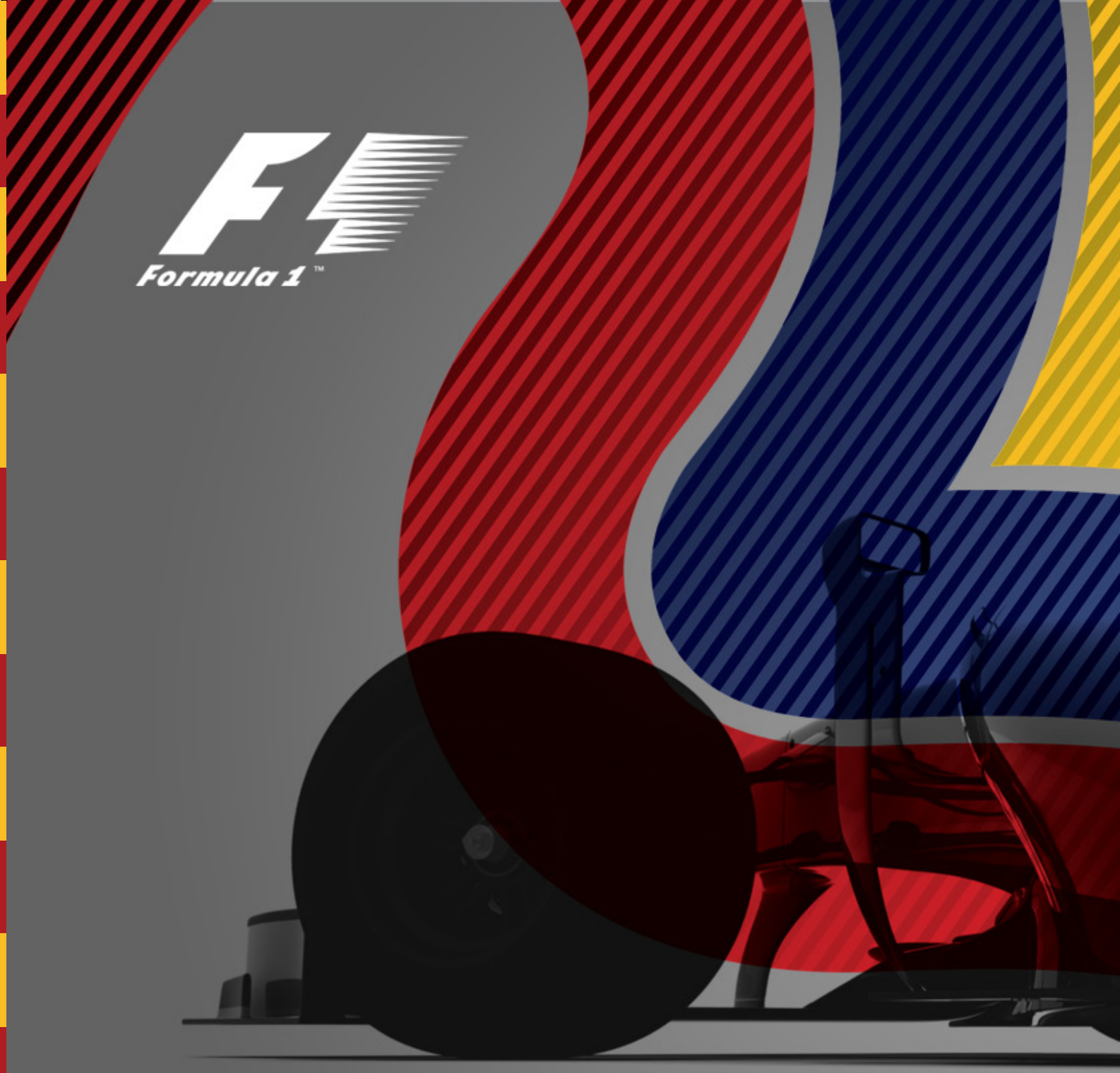
Arguably the most innovative solution on the 2011 Williams is the layout of its new gearbox, which has been designed to match the car's new rear aero package, in light of this year's ban on the double diffusers. The gearbox's vertical dimensions have been dramatically cut and the differential has been lowered (see yellow highlighted area). This forced the team, after a great deal of research, to choose an extreme driveshaft angle of nearly 16 degrees, which is very unusual, as is attaching the suspension's top wishbone to the rear wing support (red arrow). This solution could be very advantageous, although there are still limits, mostly imposed by the dimensions of the car's engine cover.



McLaren MP4-26 - revised exhaust layout

27 March 2011

Both Ferrari and McLaren have followed Red Bull in the layout of their exhaust systems, but while the Scuderia had theirs on the car at the last Barcelona test, complete with new sidepods and aero package, the Woking team only prepared their new pieces in time for Australian Grand Prix. The exhausts are longer and blow into a cut-out outside section of the diffuser (as on the Red Bull). Another change is that the diffuser is now made in titanium (highly resistant to heat), using a quick prototyping technique.



Formula 1™

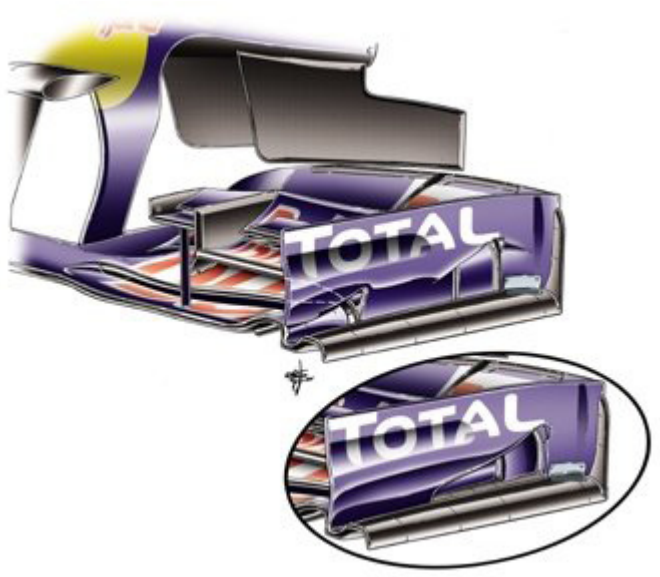
2011

FORMULA 1

PETRONAS MALAYSIA GRAND PRIX

KUALA LUMPUR 08-09-10 APRIL

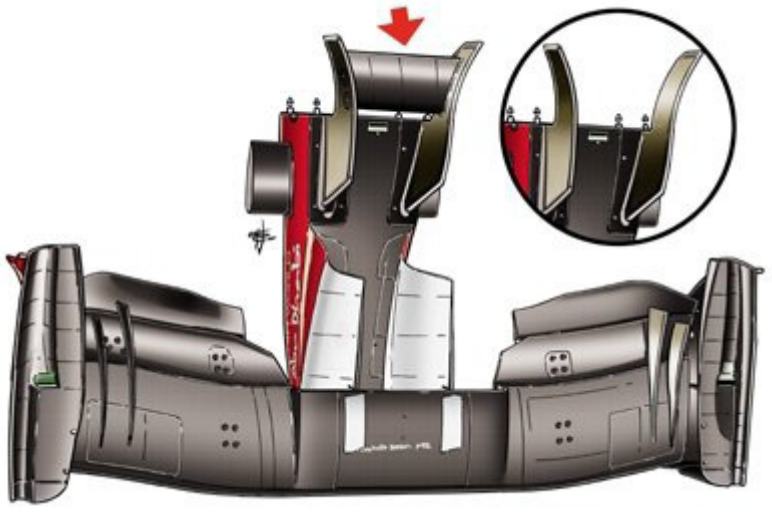

PETRONAS



Red Bull RB7 - front wing selection

09 April 2011

Red Bull have two front wings available to use in Malaysia, both illustrated here, but both Sebastian Vettel and Mark Webber opted for the inset version with its simpler endplate configuration. Arguably more importantly, however, both drivers also expect to use KERS during both qualifying and in Sunday's race, the team having opted not to run it at the previous round in Australia due to reliability concerns.



Ferrari 150° Italia - revised front wing

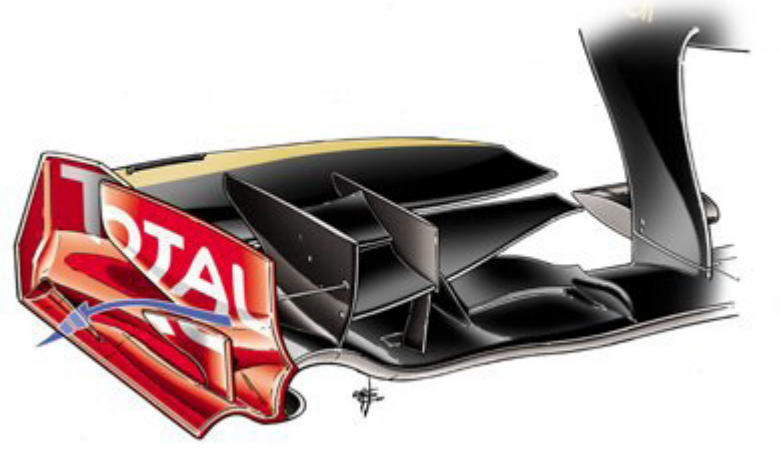
09 April 2011

For Malaysia, Ferrari have modified their car's front wing slightly, with the addition of this small flap (red arrow) between the turning vanes. The team have also made some very subtle changes to the endplates. As they attempt to find more pace in the car, Ferrari's drivers have sampled several different front wing configurations during practice and Fernando Alonso was seen to run with a revised second flap. Felipe Massa, meanwhile, was on track on Friday and Saturday morning with an extra camera on the car so that engineers could watch the deflection of the endplates.

Stricter front-wing load test

09 April 2011

The technical regulations state that a front wing must be no lower than 75mm above the reference plane, which is the lowest point of the car excluding the plank (yellow dotted line). To check compliance with this rule, 100kg loads are applied to the two ends of the front wing (red arrows) in scrutineering, with movement of no more than 20mm allowed. This year the FIA have brought into force a stricter test in which loads are applied either simultaneously or on one side at a time. Despite controversy about their 'flexible' front wing, Red Bull have passed this test, leaving their rivals striving to develop similar solutions.



Renault R31 - new front wing

10 April 2011

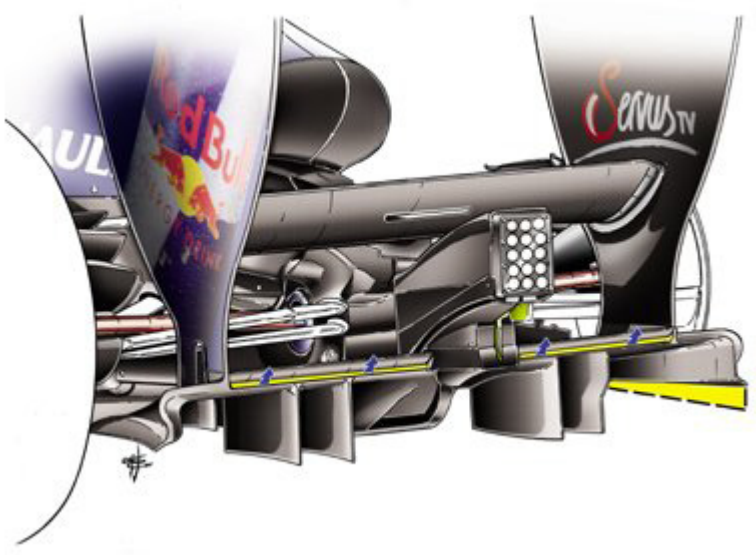
Renault have brought a new front wing to Malaysia, which features an updated endplate. The small fin on the exterior now has a twisted shape, but there is still a longitudinal hole through which airflow can pass (see blue arrow). After running back-to-back tests on Friday and Saturday morning, both Nick Heidfeld and Vitaly Petrov decided to use the new front wing in qualifying and the race. Petrov also briefly tested a new rear wing, before swapping back to the older version, which the team used in Australia.

2011 FORMULA 1

UBS CHINESE GRAND PRIX

SHANGHAI 15-16-17 APRIL


Formula 1™
UBS



Red Bull RB7 - rear diffuser updates

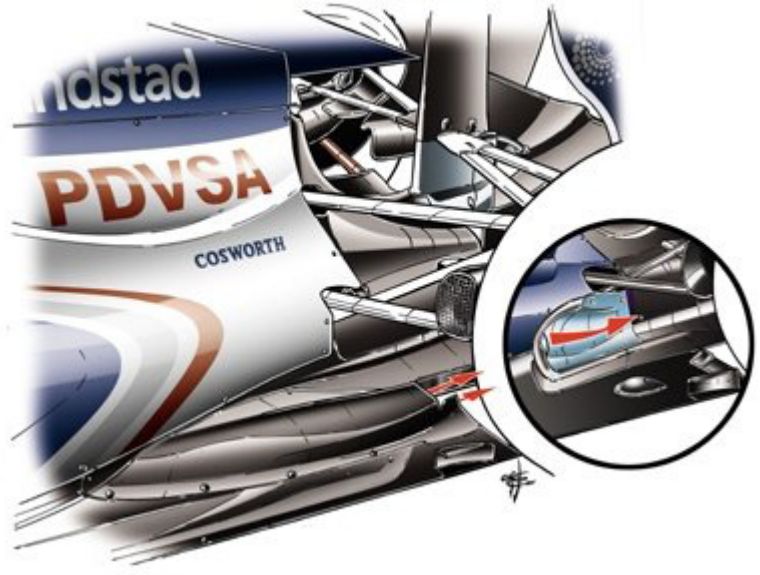
16 April 2011

In China Red Bull have introduced a small change to their diffuser's outer walls, which don't appear to run as close to the ground as you would expect (see yellow area on right) for optimum performance. This is linked to the RB7's unusual set-up, with the back of the car running much higher than that of rival teams' machines. Note also the small flap on top of the diffuser, improving air extraction (blue arrows).

Williams FW33 - exhaust positioning

16 April 2011

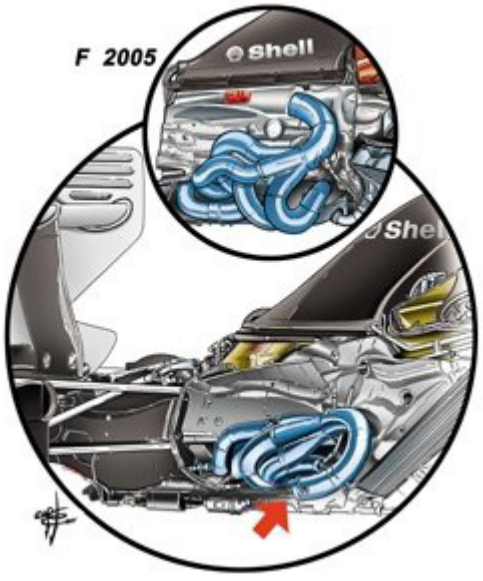
Williams have brought a new Red Bull-inspired exhaust to China (main picture). To adopt the solution, the British team have had to modify the system's positioning in similar style to that seen on the Ferrari. With just one set of parts available, Rubens Barrichello was initially chosen to sample it in practice, whilst team mate Pastor Maldonado kept the standard layout (inset) on his car. However, for qualifying and race Barrichello reverted to the old solution due to the new system causing problems burning bodywork.



Ferrari 150° Italia - exhaust positioning

16 April 2011

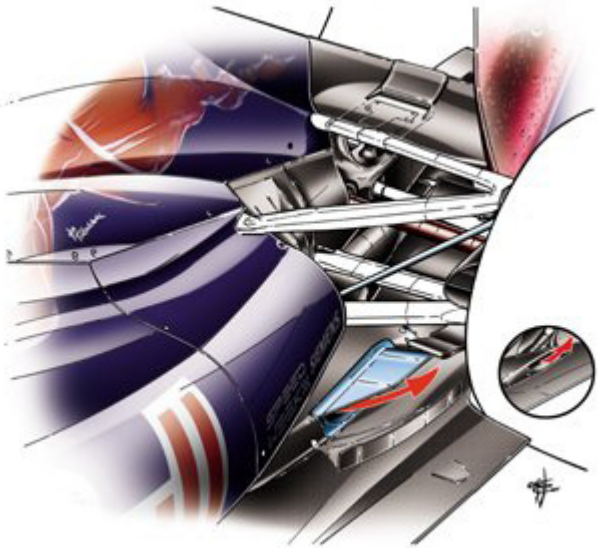
Most teams this season are using a different exhaust layout to those used last year. The primary pipes are directed forwards (main picture). Ferrari introduced this trend in 2005 (inset), although back then the aim was for the exhaust to blow further forwards. Six years later, the latest layout is designed to free up space within the tightly-packed bodywork and improve the airflow to the rear wing and diffuser.



Toro Rosso STR6 - revised exhaust exit

17 April 2011

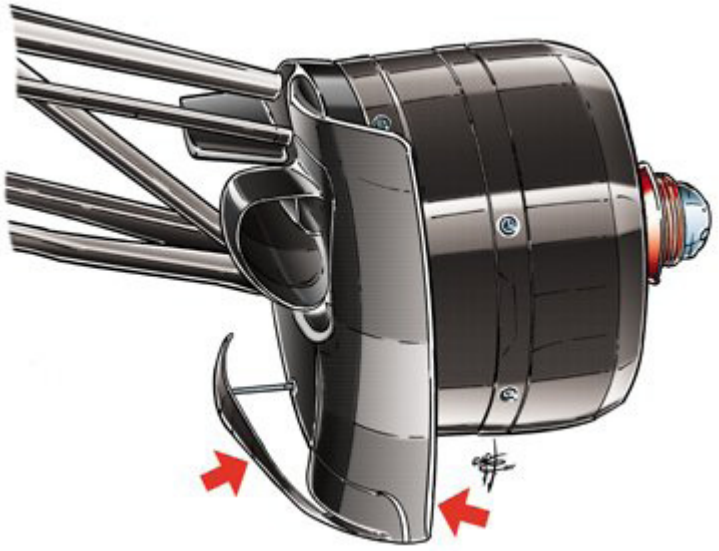
Toro Rosso brought a modified exit for their exhaust to China. The main change over the older version (inset) is the addition of a horizontal fin at the top (highlighted in blue). After their drivers sampled the new exit during practice, the team removed it from their cars for qualifying and race. Toro Rosso also revised the STR06's brake ducts for the China race in order to improve the flow of air towards the diffuser's side channels.

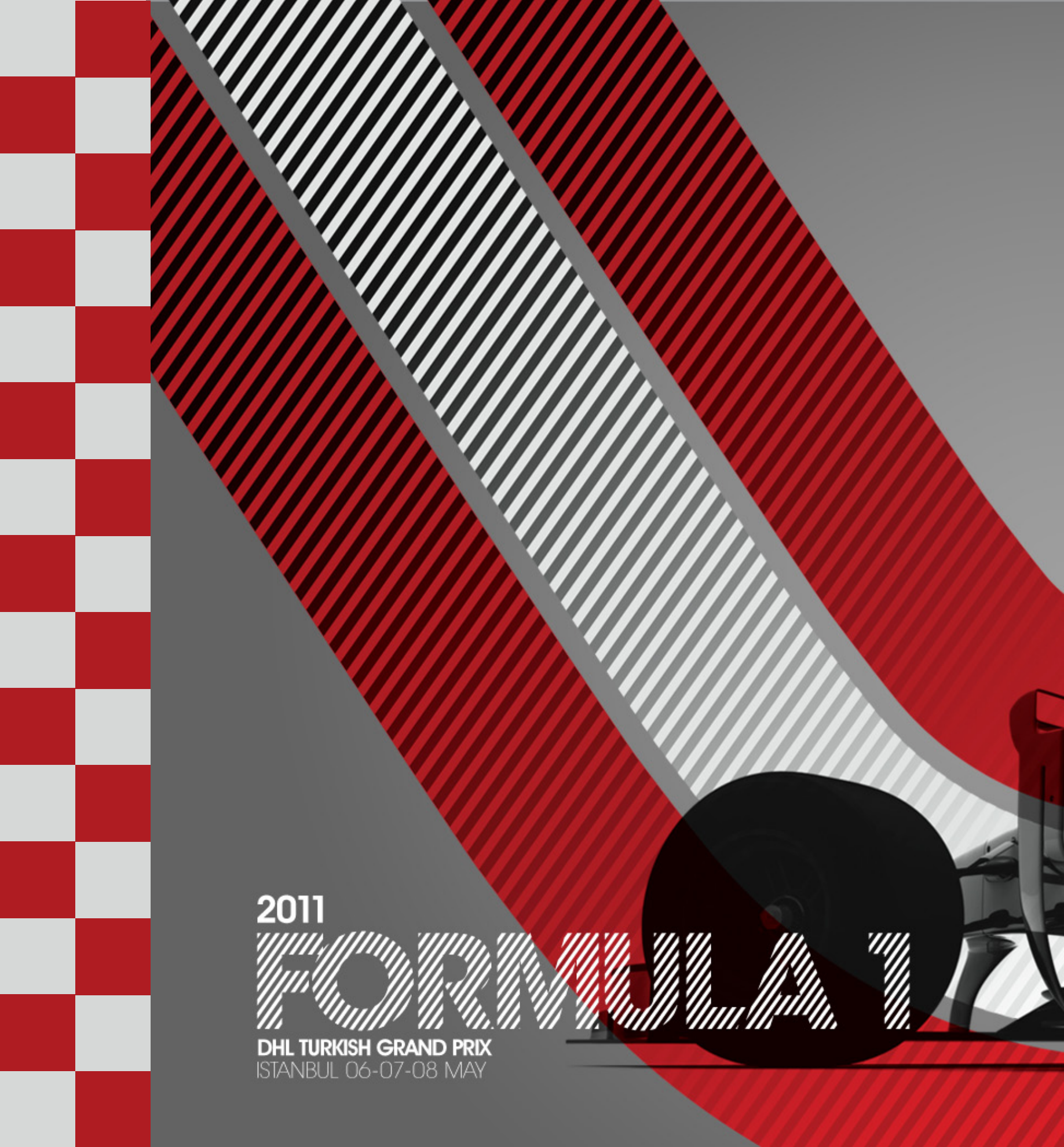


Ferrari 150° Italia - new front brake duct

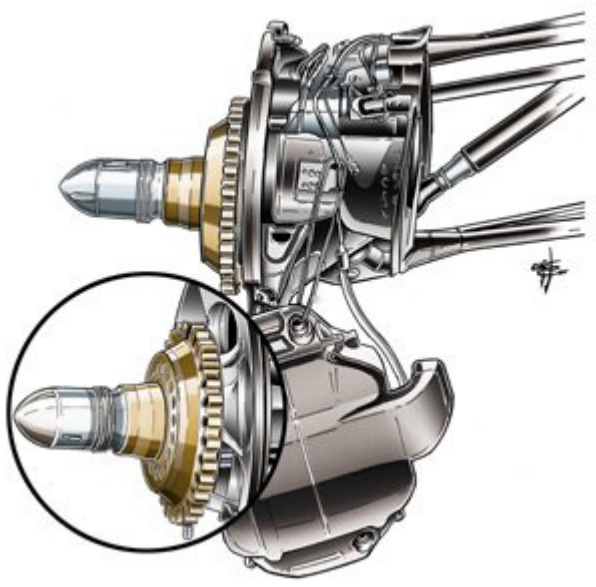
17 April 2011

As well as testing a new front wing on Friday in Shanghai, Ferrari driver Fernando Alonso evaluated a new front brake duct design. Featuring a shroud (right-hand arrow) and a small turning vane (left-hand arrow), the new duct has been designed to better control the flow of air towards the front wing and reduce drag around the tyres. Ferrari (along with Sauber and Toro Rosso) were the only team not using such a solution, which was already seen on most cars last year.




2011
FORMULA 1
DHL TURKISH GRAND PRIX
ISTANBUL 06-07-08 MAY

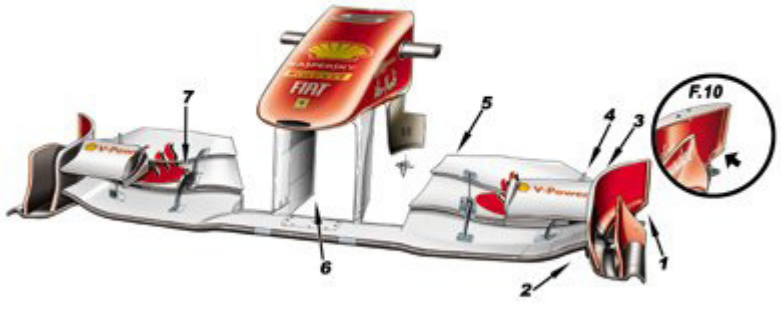

Formula 1™
DHL



Toro Rosso STR6 - integrated brake solution

07 May 2011

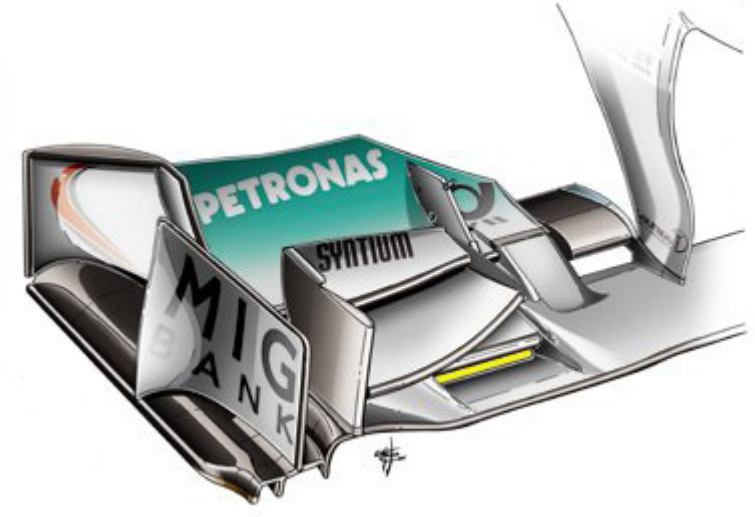
This is a totally new solution introduced by Toro Rosso in Turkey, with the suspension upright and the fixing bell for the brake disc integrated as a single unit. Usually the bell is separate and then attached to the carbon disc to fix it to the upright (inset). This clever solution saves a little weight and is also stiffer.



Ferrari 150° Italia - new front wing

07 May 2011

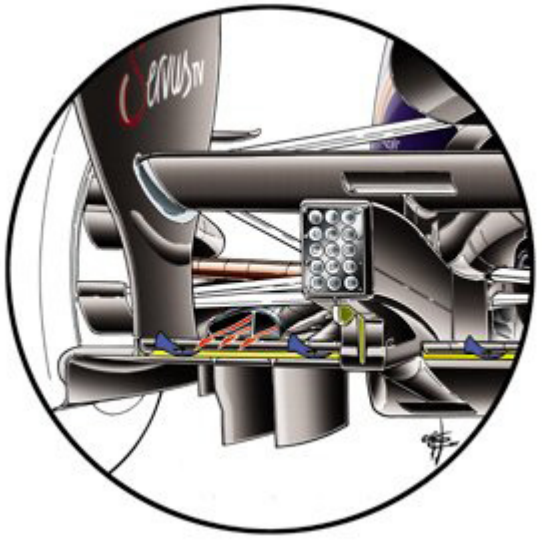
In Turkey, both Ferrari drivers have been using the new front wing tested only briefly by Fernando Alonso in Shangai. It's different from the previous one in all areas. Totally new is the endplate, with the lower part (1) cut as it was on last year's F10. The main profile is shaped differently in the area beside the endplate (2) and the endplate itself is now thinner and more curved towards the outside (3). The flap is divided into two sections which have different profiles (4 & 5), while the central pillars (6) now converge towards the rear of the nose. Finally there is a new adjustment mechanism (7) for the flap's incidence angle, similar to that used by most other teams.



Mercedes MGP W02 - slotted front wing

08 May 2011

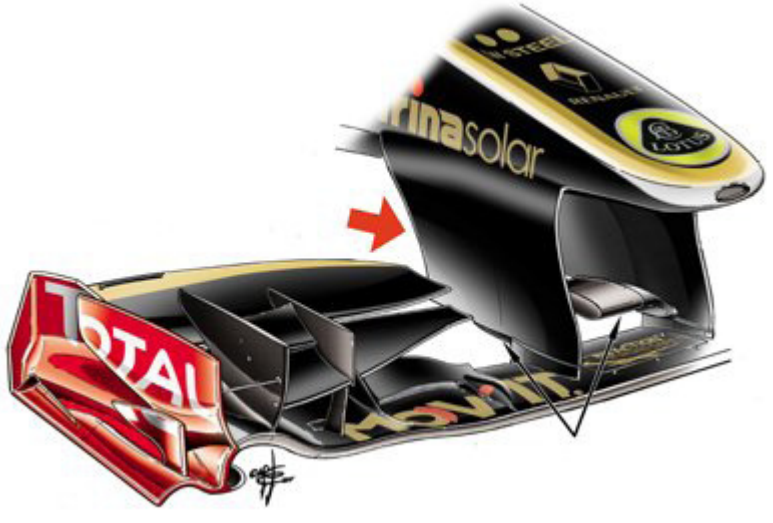
For the next round in Spain there will be a lot of changes on the Mercedes, with a new cooling system and exhausts. In Istanbul, however, they have again been taking advantage of this front wing, as used in China, with a slot in the main plane (highlighted in yellow). Together with a different aero and mechanical set-up, this has significantly improved the handling of the car.



Red Bull RB7 - exhaust layout

08 May 2011

Red Bull brought to Istanbul a more sophisticated version of their exhaust, which better integrates with the car's side diffuser. But the new solution was destroyed when Sebastian Vettel slid off the track and into the barriers during Friday practice. So both Vettel and Mark Webber ran the team's more conventional solution (seen here) during qualifying and the race. It features a small horizontal flap (highlighted in yellow), originally introduced by Toro Rosso at the launch of their car (and subsequently tested by Ferrari on Friday), designed to improve cohesion between the air flowing from the exhausts (red arrows) and from the rear diffuser (blue arrows).



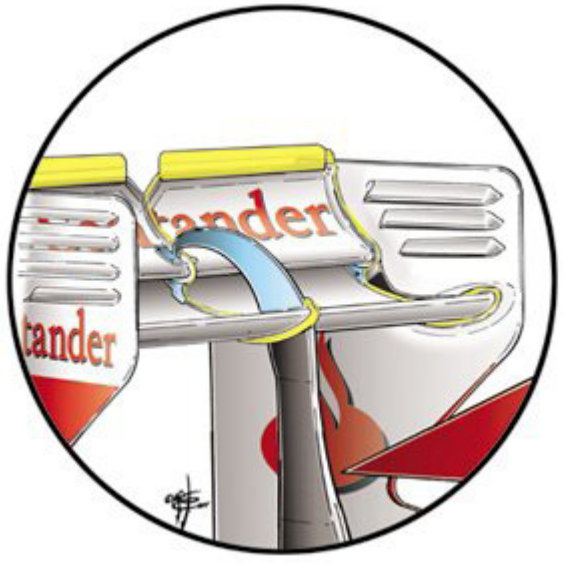
Renault R31 - revised front wing

08 May 2011

Renault came to Istanbul with a front-wing solution similar to Ferrari's in that it has much longer central pillars, with the cameras mounted on the inside. The rest of the wing is largely similar to the team's previous solution.


Formula 1™
FORMULA 1
GRAN PREMIO DE ESPAÑA SANTANDER 2011
CATALUNYA 20-21-22 MAY


Santander



Ferrari 150° Italia - banned rear wing

21 May 2011

Ferrari ran this rear wing in Friday's practice sessions in Spain, but had to revert back to their Turkey-spec design from Saturday onwards after the FIA deemed it illegal. The area of controversy was the additional Gurney flaps on the top (in yellow), which took the wing 30mm over the normal maximum height limit. That limit is 950mm above the reference plane (the lowest part of the car, excepting the plank), the same as for the engine cover and roll-over structure. Ferrari claimed the flaps were not actually not part of the wing, but were actually part of the slot-gap separator, or rear wing supports, which are exempt from the height requirement. The FIA disagreed and decided that the configuration breached article 3.10.3 of the technical regulations. Charlie Whiting conceded that it was a clever interpretation, but felt it was not within the spirit of the rules.

FIA Technical Regulations, Article 3.10.3:

In order to ensure that the individual profiles and the relationship between these two sections can only change whilst the car is in motion in accordance with Article 3.18, they must be bridged by means of pairs of rigid impervious supports arranged such that no part of the trailing edge of the forward section may be more than 200mm laterally from a pair of supports. These pairs of supports must :

- be located no more than 355mm from the car centre line ;

- fully enclose each complete sections such that their inner profiles match that of each section. With the exception of minimal local changes where the two sections are adjacent to each other, their outer profiles must be offset from the inner profiles by between 8mm and 30mm and may not incorporate any radius smaller than 10mm ('gurney' type trim tabs may however be fitted between the supports) ;

- be aligned as a pair so as to provide a bearing across their full thickness and along a profile length of at least 10mm when the

distance between the two sections is at its closest position ;

- not be recessed into the wing profiles (where a recess is defined as a reduction in section at a rate greater than 45° with respect to a lateral axis) ;

- be arranged so that any curvature occurs only in a horizontal plane ;- be between 2mm and 5mm thick ;

- be rigidly fixed to their respective sections ;

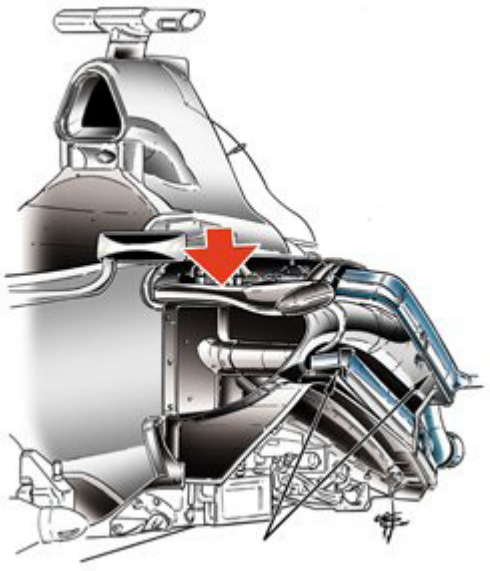
- be constructed from a material with modulus greater than 50GPa.

These supports will be ignored when assessing whether the car is in compliance with Articles 3.6, 3.9.2, 3.10.1, 3.10.2, 3.10.4 and 3.10.6.

Force India VJM04 - revised nose and front wing

21 May 2011

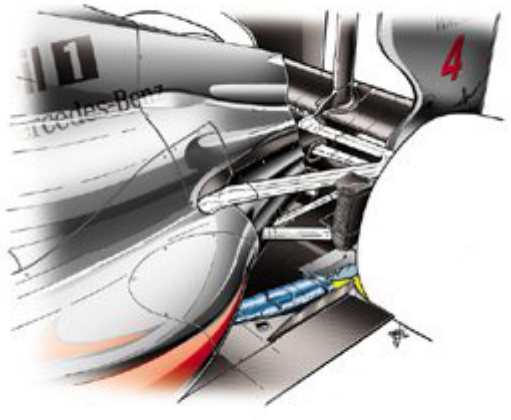
Force India have brought to Spain the new nose and front wing they introduced at the last round in Istanbul (main picture). Very different to the bulkier one used previously (right-hand inset), the new solution has a Red Bull-inspired nose section and features aero devices on its underside similar to those introduced by Williams two years ago and used by McLaren in 2010 and this year (left-hand inset). Other new components to look out for are the revised endplates and the three wing elements. In the end, however, the team opted to use the previous standard wing configuration for qualifying and the race. They also tested Red Bull-style exhausts on Friday, but again decided not to run the solution on Saturday and Sunday.



Mercedes MGP W02 - modified bodywork

21 May 2011

Mercedes have brought new bodywork to Spain, including slightly different deformable side structures (red arrow), necessitating a further FIA side crash test. There is also a revised radiator installation (black arrows), although the double floor layout (currently unique in Formula One), has been retained. The team have also modified the car's rear suspension geometry.



McLaren MP4-26 - revised sidepods

21 May 2011

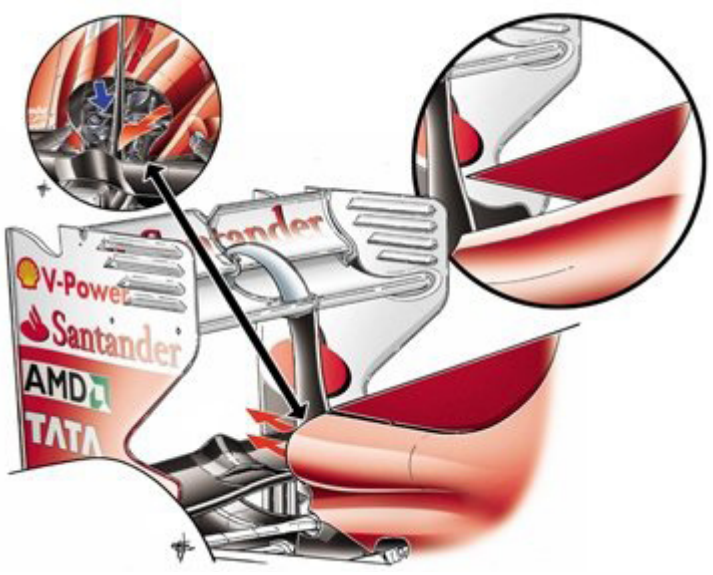
McLaren have brought a massive upgrade to Spain. There's a new gearbox and rear suspension, a new front wing design, plus new sidepods and a modified exhaust/diffuser layout. Here is seen the longer version of the sidepods, which the team tested on Friday. They opted to remove the final section of the sidepods for qualifying and the race.

Formula 1™

PORTFOLIO

GRAND PRIX DE MONACO 2011

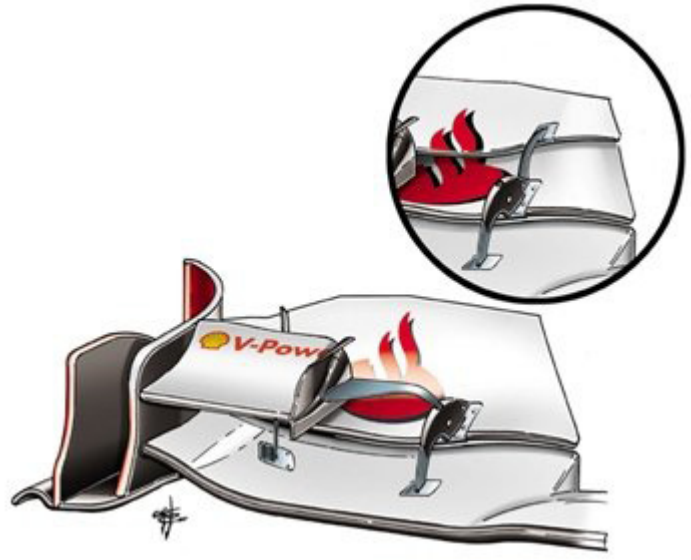
MONTE CARLO 26-27-28-29 MAY



Ferrari 150° Italia - modified engine cover

28 May 2011

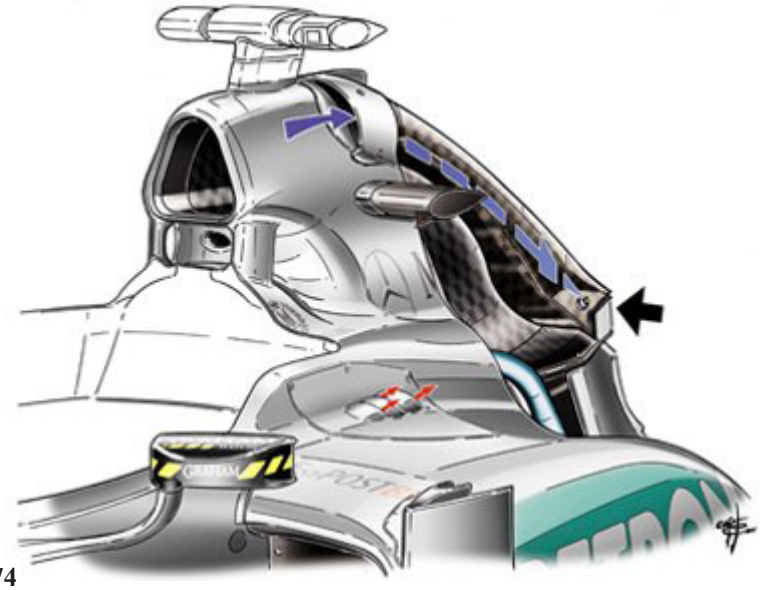
With just a week between the Spanish and Monaco rounds, it was a surprise to see a new engine cover on the Ferrari in Monte Carlo (main picture), but a closer inspection reveals it isn't an entirely new solution. The Italian team developed it for the Malaysian event back in April, but didn't run it in the Sepang race because the cooler-than-expected weather conditions rendered it unnecessary. The large hole at the back (left-hand inset) through which hot air is evacuated allows a glimpse of the car's rear suspension. The solution is very similar, though perhaps not quite as clean, as the one seen on the Red Bull. The change means that the base of the engine cover and upper 'shark fin' now converge, unlike on the previous version (right-hand inset).



Ferrari 150° Italia - revised front wing

28 May 2011

Ferrari introduced a new front wing at the Turkish round and updated it for last weekend's Spanish race. In Monaco another revision has been made to the wing (main picture), with a single flap replacing the two-section version (inset). This is designed to boost downforce at slow speeds around the narrow and tricky Monte Carlo streets. The 150° Italia's rear wing, meanwhile, features no updates, with the team using the same version seen at the car's launch and during pre-season testing.

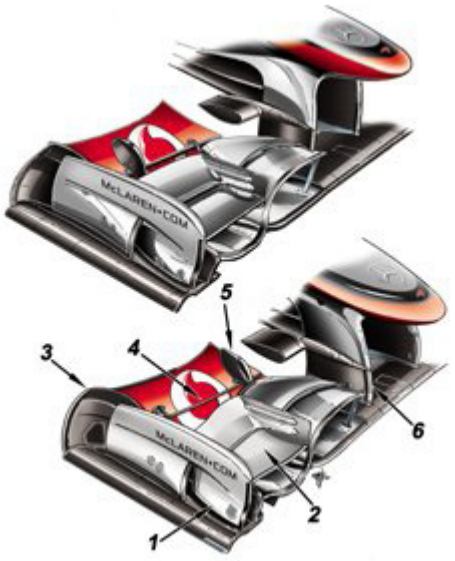


Mercedes MGP W02 - revised cooling solution

29 May 2011

To improve their car's cooling in Monaco, Mercedes have simply adopted the 'ears' solution on the side of the airbox (uppermost purple arrow), as seen from launch on the McLaren MP4-26. It sends air to the oil radiators (black arrow) for the gearbox and KERS in a dedicated channel, separate to the

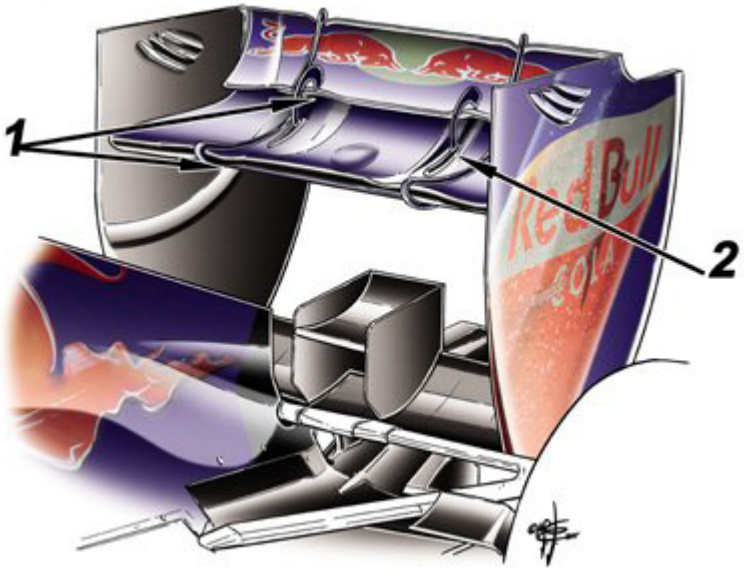
one for the engine manifold.



McLaren MP4-26 - front wing updates

29 May 2011

For Monaco, McLaren have kept the all-new front wing assembly (lower drawing) introduced in Spain. All the components are different to the team's previous solution (upper drawing). The outer-front edge of the endplate (1) is slightly shorter and lower, while the inside-rear section (3) has been extended. New upper flaps (2) are more curved than before and the rear part of the main plane (4) has been modified beside the endplate. The faring for the adjustment mechanism (5) has been moved inwards to increase its aerodynamic influence and help channel airflow to the sidepods. The new wing pillars (6) are now angled forward, converging slightly, and are attached differently to the main plane.



Toro Rosso STR6 - new rear wing

29 May 2011

Toro Rosso are the only team to bring a completely new rear wing with them to Monaco. The wing has quite a complex shape and features a curved section on its main plane and flap (1). The adjustment (2) of the car's Drag Reduction System (DRS) is activated at two points. Also important to note is the small lower wing placed on top of the beam wing. This is only 15cm wide, so fits within the regulations.

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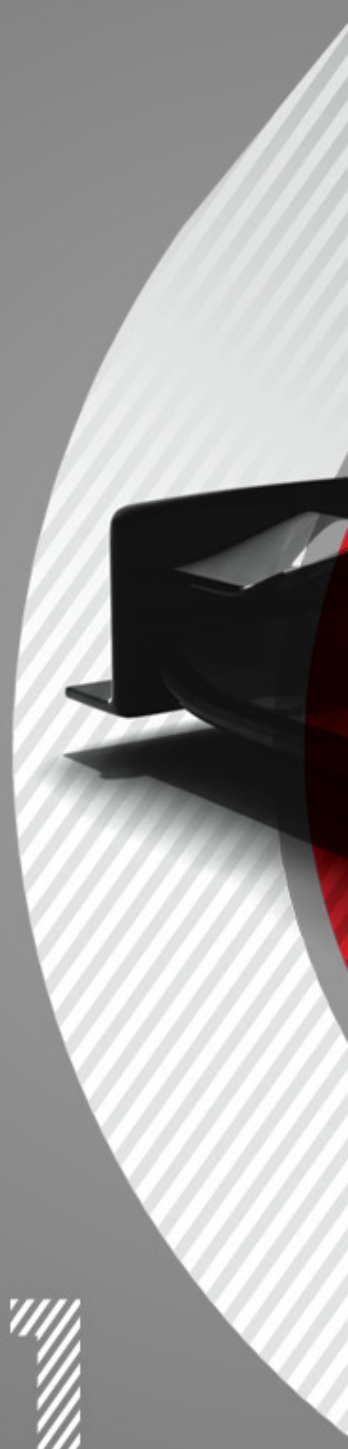
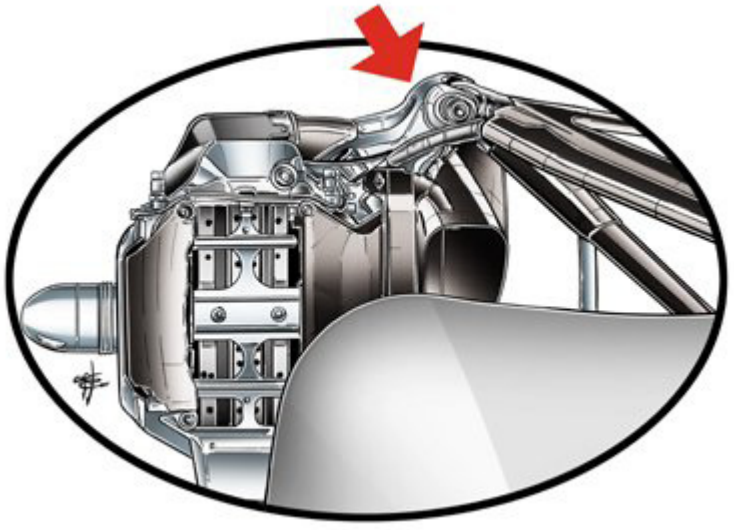


FORMULA 1

GRAND PRIX DU CANADA 2011

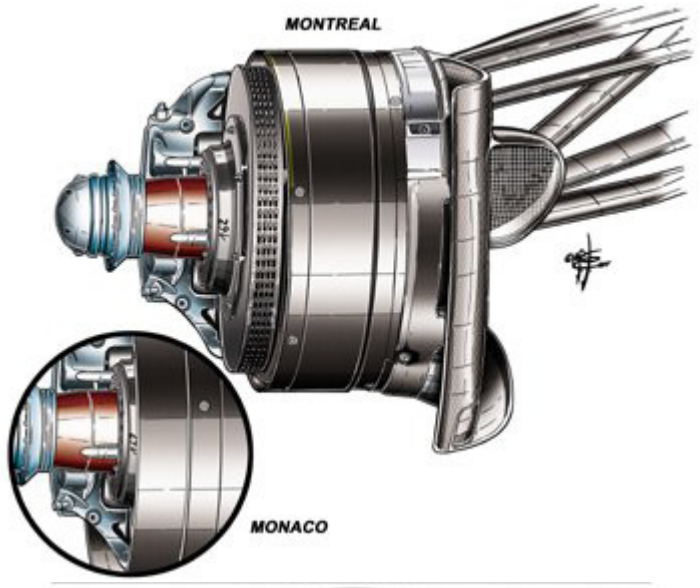
MONTRÉAL 10-11-12 JUNE



Mercedes MGP W02 - revised rear suspension

11 June 2011

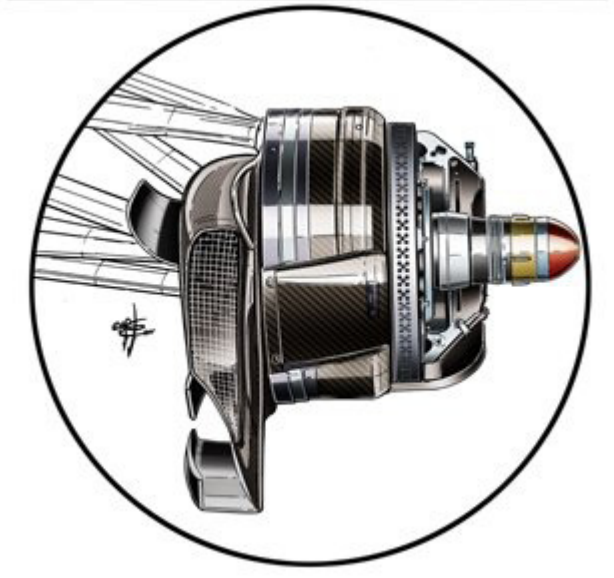
In Montreal Mercedes are evaluating a revised rear suspension set-up. The pick-up point (red arrow) between the top wishbone and the upright is higher and further inboard than before, in order to give a lower roll centre and better camber change. The team ran a comparative test during Friday practice and, if the data compares well, they plan to run the revision in the next few races.



Ferrari 150° Italia - Montreal-spec brakes

11 June 2011

Montreal is one of the hardest tracks on the calendar for brakes. All the teams have brought special ducts to improve cooling and have used more durable carbon discs. Ferrari have followed McLaren's solution and also cut back the aerodynamic drum around the brake. They ran something similar in Monaco (see inset), but here the disc (a Montreal-specific one made by Brembo at Ferrari's suggestion) is almost completely exposed (main image).



McLaren MP4-26 - Montreal-spec brakes

11 June 2011

The Montreal circuit is so demanding on brakes that all of the teams bring more hard-wearing discs and special ducts to improve cooling. Although McLaren are using the same discs they used in Monaco, they feature very different, cross-shaped openings to better dissipate the huge amount of heat that is generated on the Canadian circuit.

Williams FW30 - low-downforce rear wing

12 June 2011

Along with Renault, Williams were the only team in Montreal to test an extreme low-downforce rear wing on Friday, but then not use it for qualifying and the race. Their design had a spoon shape in the central section to increase downforce.

Renault R31 - low-downforce rear wing

12 June 2011

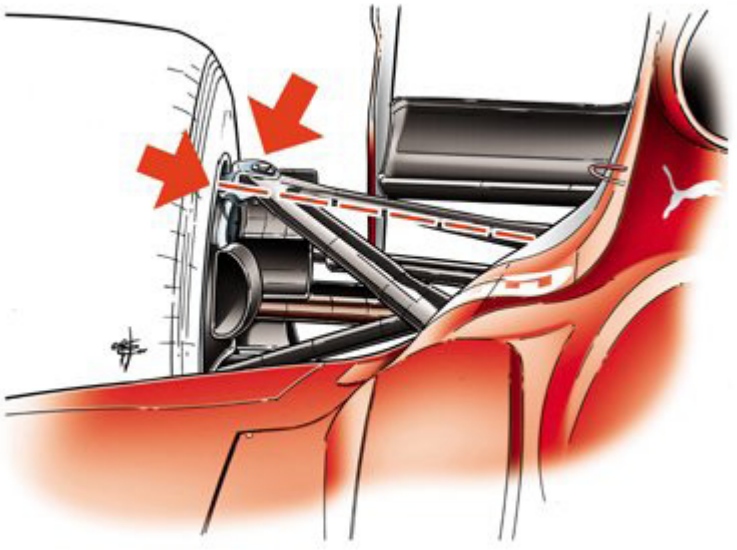
Like Williams, Renault tested an extreme low-downforce rear wing on Friday in Montreal, but then opted not use it for qualifying and the race. Their heavily-sculpted design was an evolution of one tested but not raced in 2010.

Formula 1™

2011 FORMULA 1

GRAND PRIX OF EUROPE

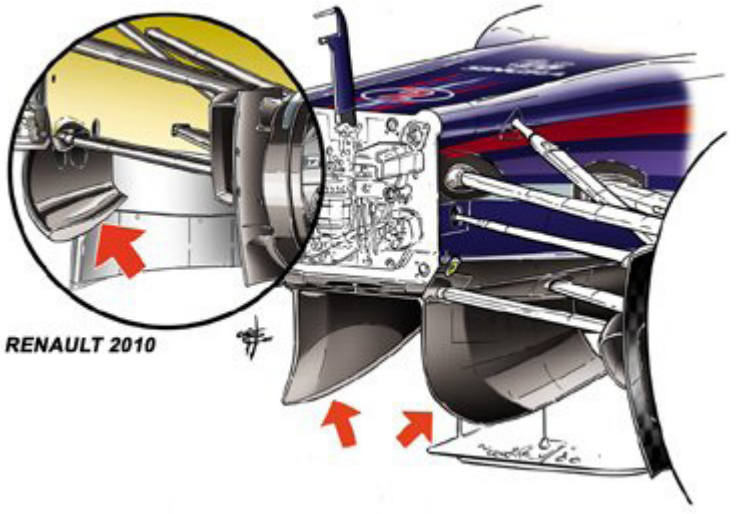
VALENCIA 24-25-26 JUNE



Ferrari 150° Italia - revised rear suspension

25 June 2011

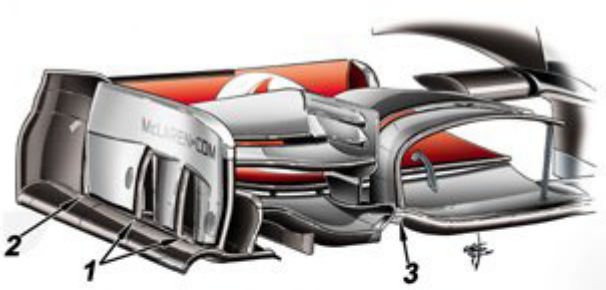
In Valencia practice, Fernando Alonso again tried the new rear suspension introduced in Montreal, with the aim of collecting more data ahead of its planned introduction as part of a major update for Silverstone. This set-up features a higher pick-up point between top wishbone and upright, giving a lower roll centre and better camber change.

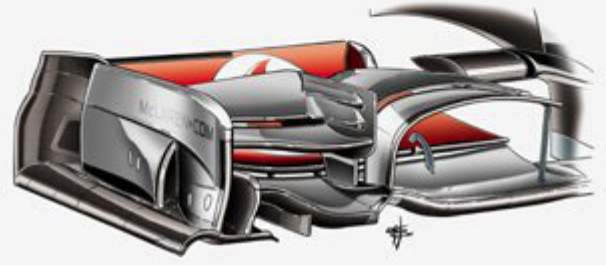


Red Bull RB7 - revised underbody aero package

25 June 2011

Mark Webber tested a new aero package for Red Bull on Friday in Valencia. The evaluation went so well that both drivers used it for qualifying and the race. The nosecone no longer features any fins in its lower section as they have been transferred to the underbody of the chassis (main drawing). A similar solution was introduced by Renault last year (inset) and was retained on this year's R31.

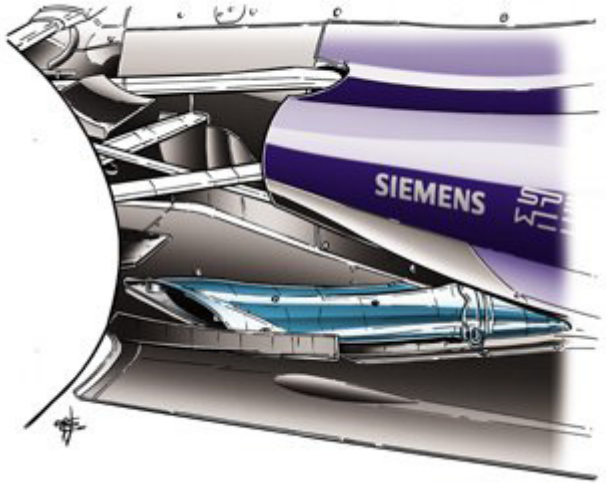




McLaren MP4-26 - new front wing

26 June 2011

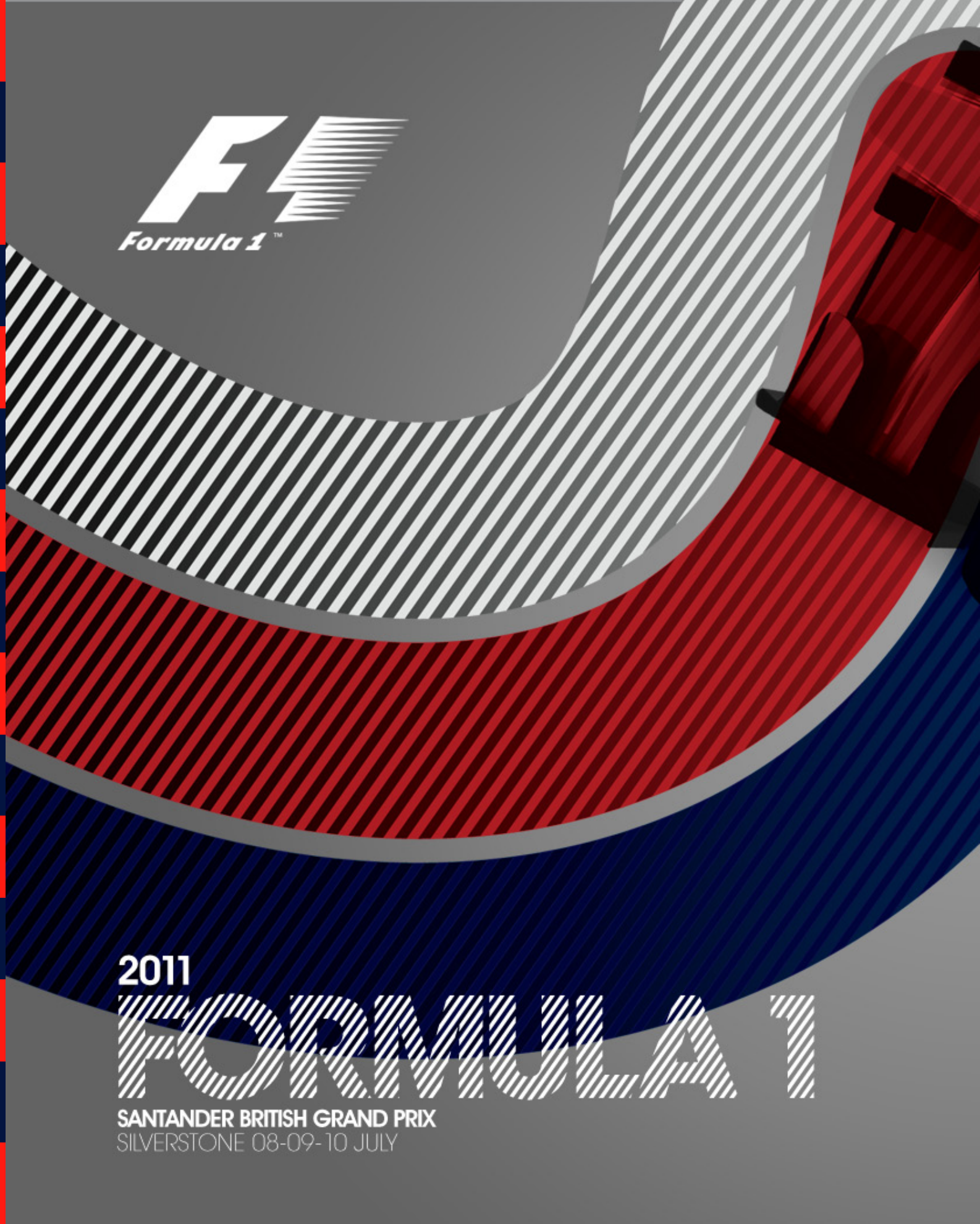
McLaren have brought a new front wing to Valencia, based on the one they introduced at the Spanish race back in May. The new version (top drawing) features a different endplate with two vertical, external openings (1). Also visible is a third vertical slot (2) positioned on the inside of the endplate. Another feature to note is the upper flaps (3), which are shaped differently and mounted closer to the nose than before. Both Jenson Button and Lewis Hamilton used this new front wing in the European race after running a back-to-back test with the old one on Friday.

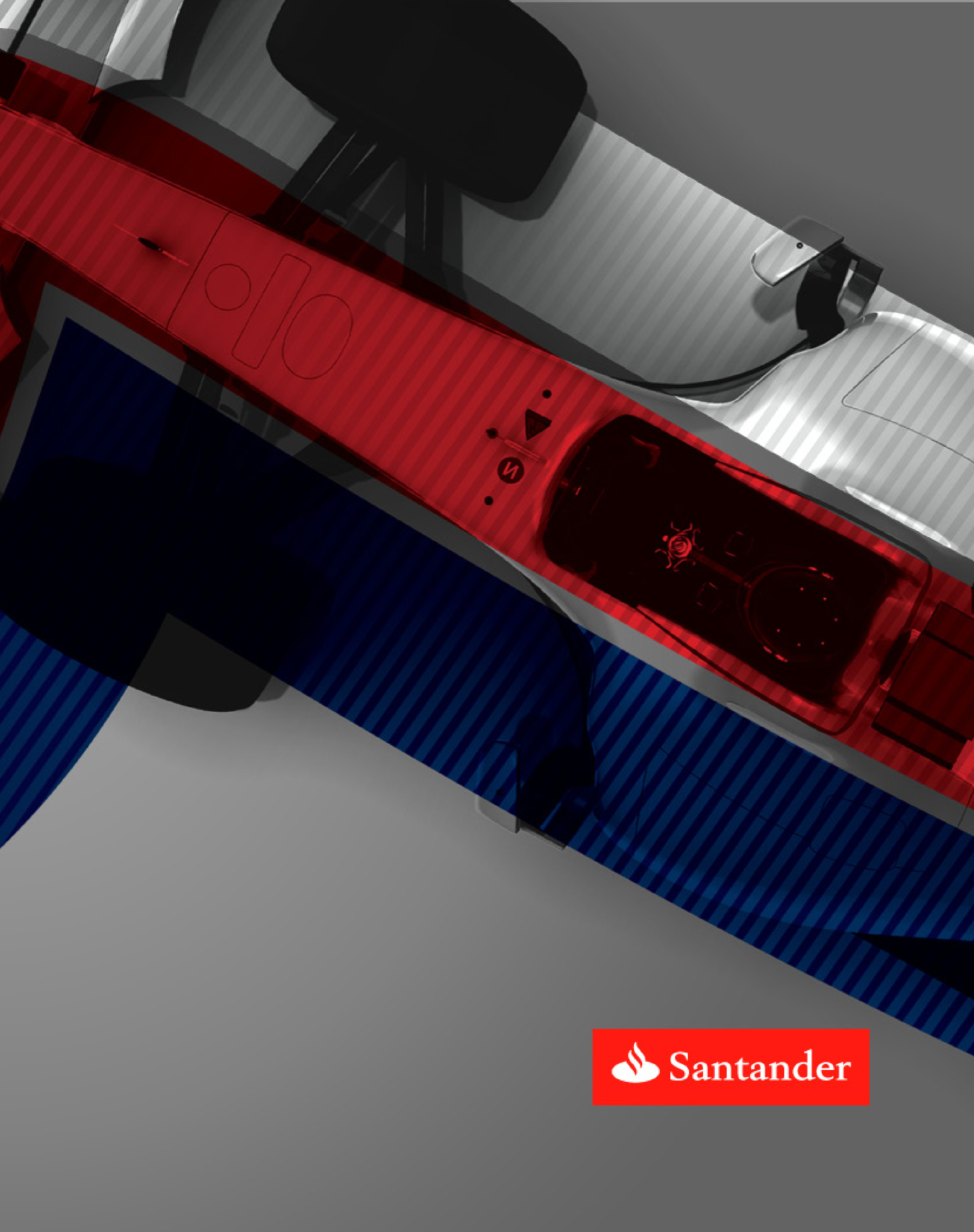


Toro Rosso STR6 - new exhaust

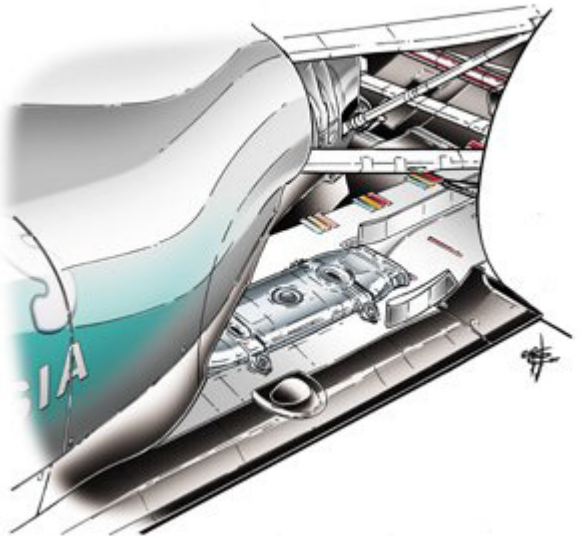
26 June 2011

The Toro Rosso has undergone a lot of changes ahead of the European round. There are different sidepods, which are taller, and different radiators. There are also new exhausts, which are no longer unique in shape but similar to the ones on the Red Bull, with a long and flat section in front of the rear tyres.


Formula 1™
2011
FORMULA 1
SANTANDER BRITISH GRAND PRIX
SILVERSTONE 08-09-10 JULY



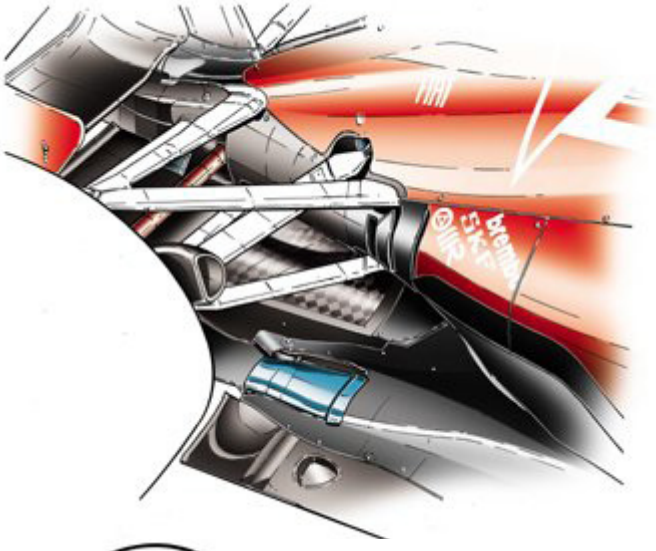
Santander



Mercedes MGP W02 - revised exhausts & diffuser

09 July 2011

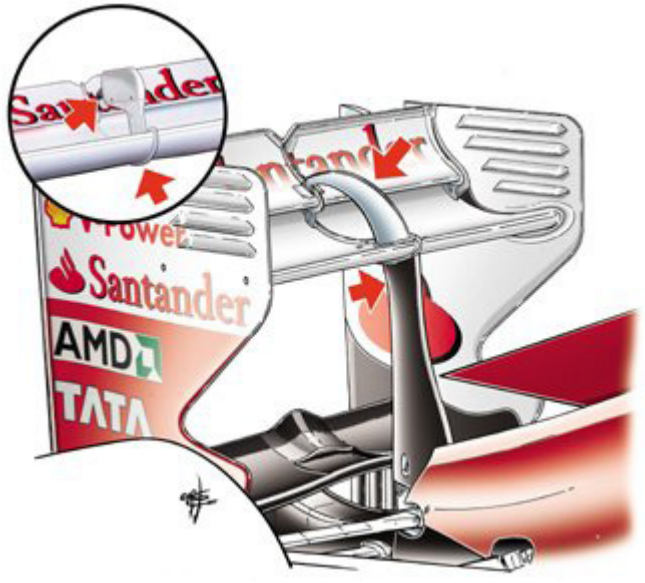
All weekend at Silverstone, Mercedes have been using this new, longer exhaust design (similar to that on the Red Bull, McLaren, Ferrari and others), which was seen but never used at the last round in Valencia. It sees the team move away from the configuration they had been using since pre-season testing, with the exhaust exits further forward, in the middle of the sidepod. Also totally new is the rear diffuser, a large section of which is now protected by heat-resistant material in light of the revised exhaust layout.



Ferrari 150° Italia - revised exhaust layout

09 July 2011

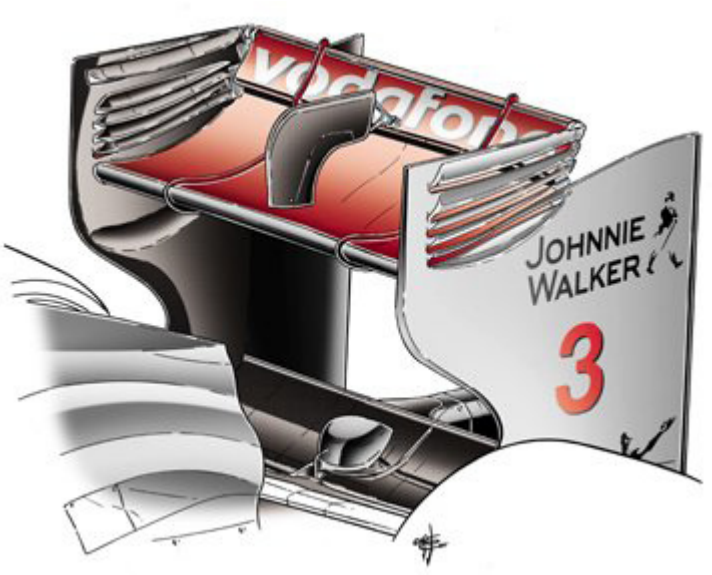
Ferrari introduced a new aero package for Great Britain, together with the new rear suspension layout previously tested in Friday's sessions in Canada and Valencia. On Friday at Silverstone Massa tried out this new exhaust layout, complete with longer sidepods featuring three vertical cooling gills to dissipate heat, and an extension on top of the new rear diffuser to improve airflow. Both cars run the updates on Saturday morning.



Ferrari 150° Italia - revised rear wing

09 July 2011

As part of Ferrari's new aero package for Silverstone, Alonso tried out this new rear wing on Friday, featuring a new DRS control system. Gone is the hydraulic linkage inside a central pillar (main drawing), replaced instead by an electric motor (inset) as used by Red Bull, Renault, Force India and Toro Rosso. Both cars run the update on Saturday morning.



McLaren MP4-26 - revised rear wing

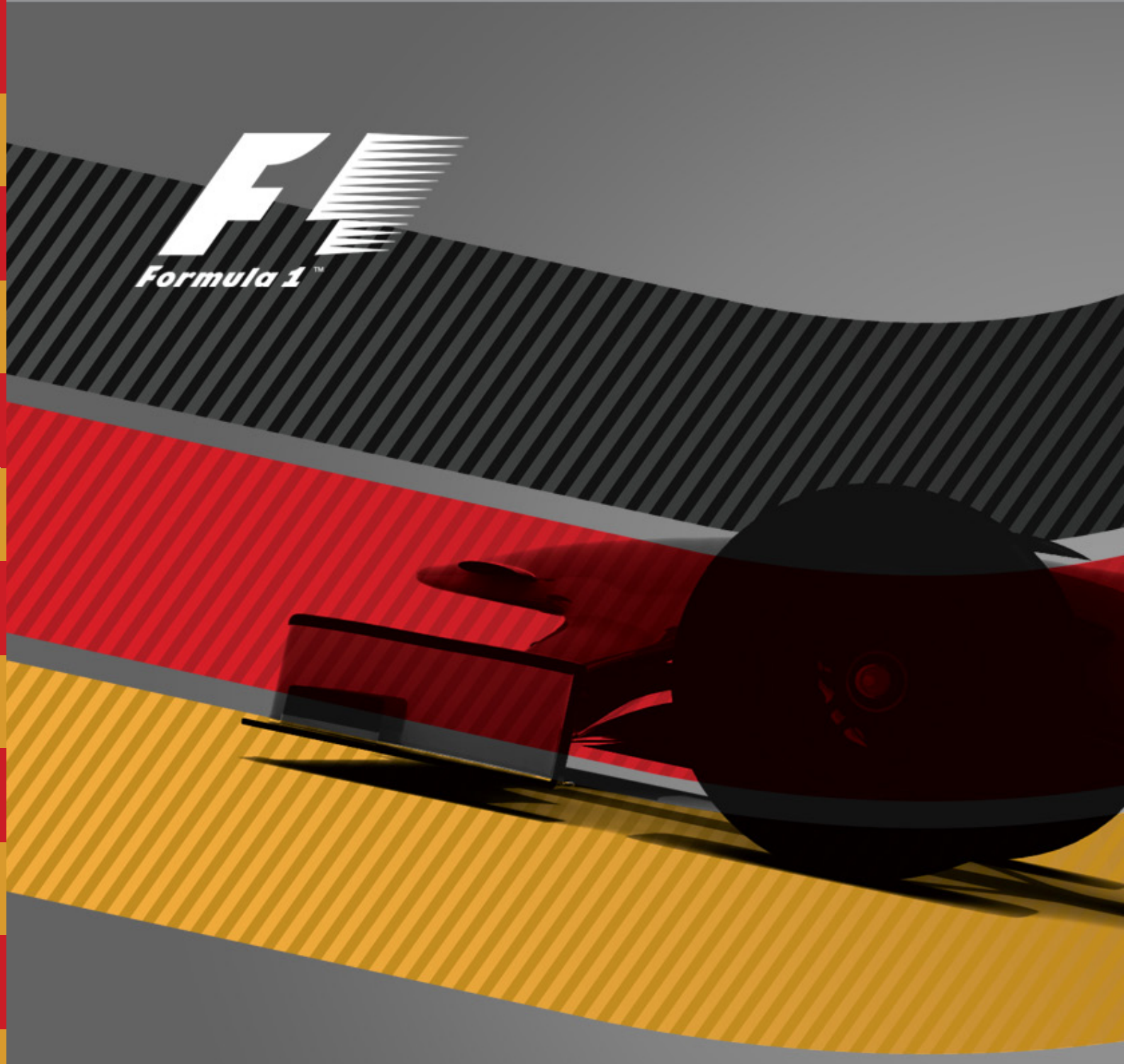
10 July 2011

At Silverstone McLaren introduced a new rear wing that features a smaller chord for the flap, with the DRS activated by an electric motor like that used by Red Bull, Renault, Force India and - for Silverstone - Ferrari. However, a back-to-back comparison between the new and old designs on Jenson Button's car in practice convinced the team to drop the new version for qualifying and the race.

Williams FW33 - revised front wing

10 July 2011

As well as using longer exhausts on both cars like Red Bull, Williams brought a new front wing to Silverstone which they used on both cars during qualifying and the race. Although the main profile is similar to the previous one, the endplates have been changed significantly for the British round.

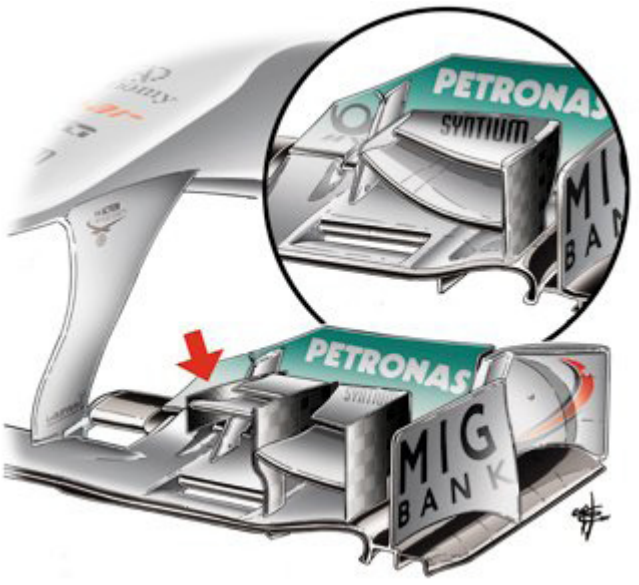


FORMULA 1

GROSSER PREIS SANTANDER VON DEUTSCHLAND 2011

NÜRBURGRING 22-23-24 JULY

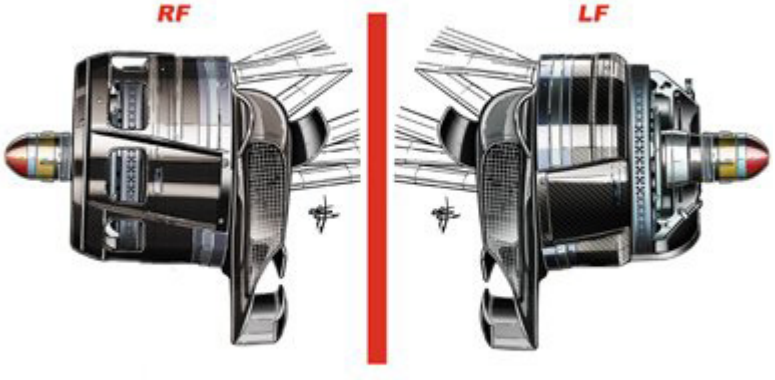

Santander



Mercedes MGP W02 - revised front wing

23 July 2011

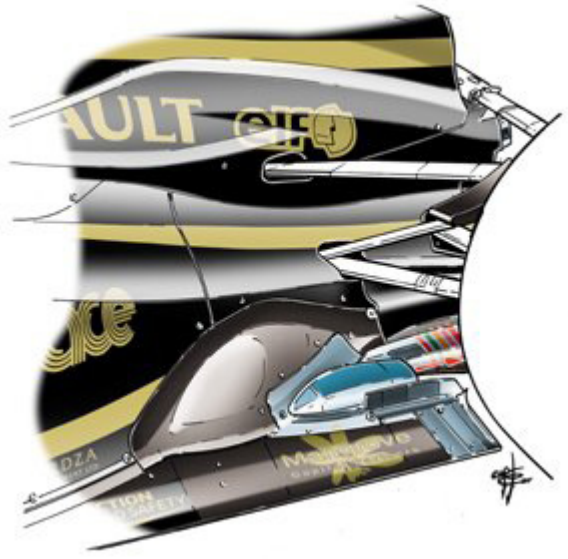
Mercedes have introduced a new front wing at the German event. Similar in style to the one on Red Bull's RB7, the new front wing (see main drawing) features double upper-deck flaps (see red arrow) and is designed to improve the car's aerodynamic balance and corner entry. It has been used by both Michael Schumacher and Nico Rosberg at the Nurburgring. The old style front wing can be seen in the inset.



McLaren MP4-26 - brake duct experiments

23 July 2011

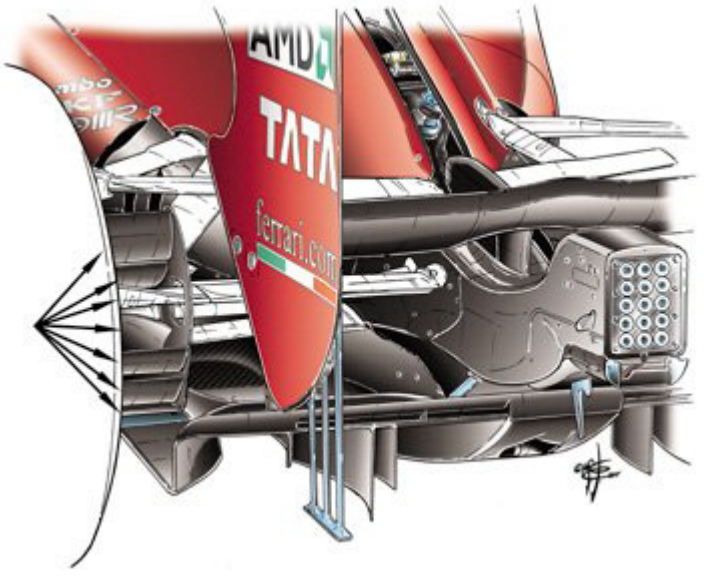
McLaren experimented a lot during practice at the Nurburgring to try and find brake feeling to Lewis Hamiltons liking. Hamilton, who tends to brake very late into corners, started the weekend using discs from Carbon Industries and asymmetric brake ducts, fully open on the left (LF) and partially enclosed (by a drum with rectangular cuts) on the right (RF). During qualifying Hamilton opted to use the open version but with Brembo discs, which team mate Jenson Button had used in the morning practice session. The team also added some corner weight to his car during the Friday and Saturday morning practice sessions in an effort to sort out the instability problem he experienced under heavy braking.



Renault R31 - rearward exhaust

24 July 2011

Renault tested a prototype 'Red Bull-style' rearward exhaust on Nick Heidfeld's car on Friday in Germany (see blue highlighted area and red arrow). However, as the R31 has been built around a unique forward-facing exhaust layout, the team's trial was limited to assessing the system's potential for the future, rather than evaluating it for the Nurburgring event. The car's bodywork, especially in the area in front of the rear tyres, is too wide to fully exploit the benefits of a rear-facing exhaust. After the summer break we should see a heavily updated R31 featuring new sidepods and exhausts.



Ferrari 150° Italia - revised brake ducts

24 July 2011

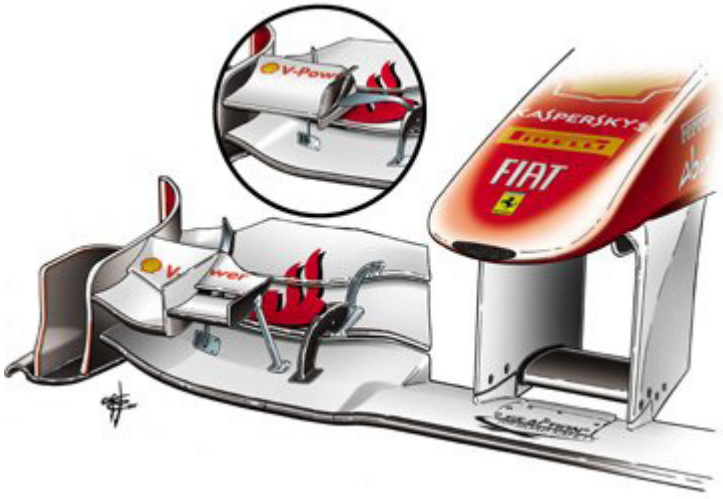
Ferrari have followed a pit lane trend by adding a cascade of small flaps on the inside of the brake duct (see black arrows) in an area where the rules permit teams to gain some rear downforce. The solution was first used by Williams and Sauber last year.

Formula 1™

FORMULA 1

ENI MAGYAR NAGYDÍJ 2011

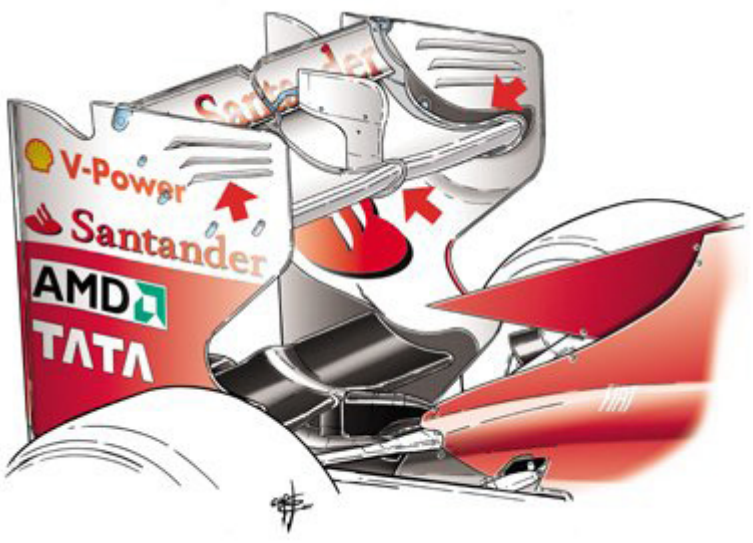
BUDAPEST 29-30-31 JULY



Ferrari 150° Italia - front wing updates

30 July 2011

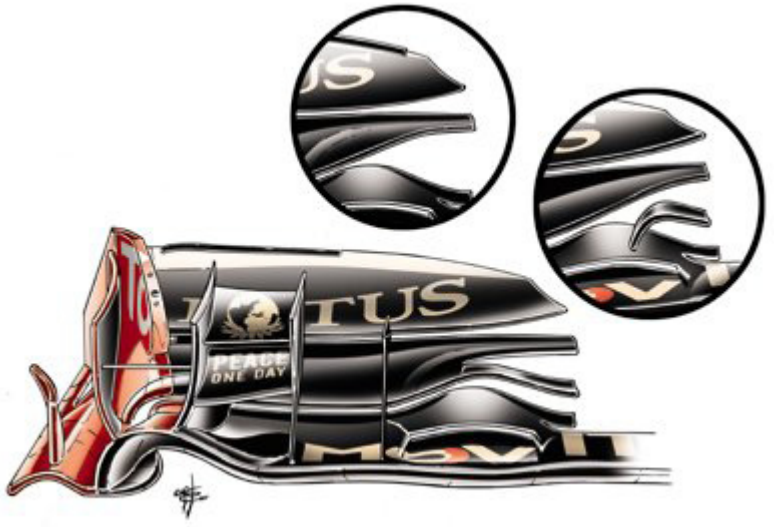
Ferrari tried a lot of new components in Hungary on Friday, even some aero solutions that could be useful on the 2012 car, which will have a differently shaped cockpit. Both Fernando Alonso and Felipe Massa tested this front wing (main drawing), which (in Red Bull style) features an additional upper-deck flap absent on the regular configuration (inset).



Ferrari 150° Italia - rear wing updates

30 July 2011

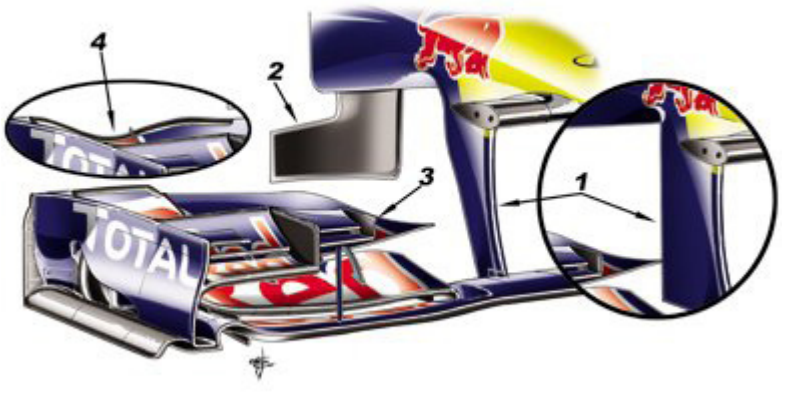
Ferrari tried a lot of new components in Hungary on Friday, even some aero solutions that could be useful on the 2012 car, which will have a differently shaped cockpit. Both Fernando Alonso and Felipe Massa trialled this rear wing in a back-to-back test with the configuration used previously for qualifying and the race in Germany. It has a curved main plane (centre red arrow), where the previous one was straight, with only three gills in the endplate (left red arrow), and different positioning of the planes relative to the endplate (right red arrow). These endplates seem to be in Spa configuration, but with, of course, a different, medium-downforce main plane and flap set-up.



Renault R31 - front wing variations

30 July 2011

Renault's drivers had three different front wings at their disposal on Friday in Hungary, including one used by the team in Monaco (left circle). In the end they chose the one shown in the main drawing for qualifying and the race. This configuration was also used at the Nurburgring last weekend.



Red Bull RB7 - front wing changes

31 July 2011

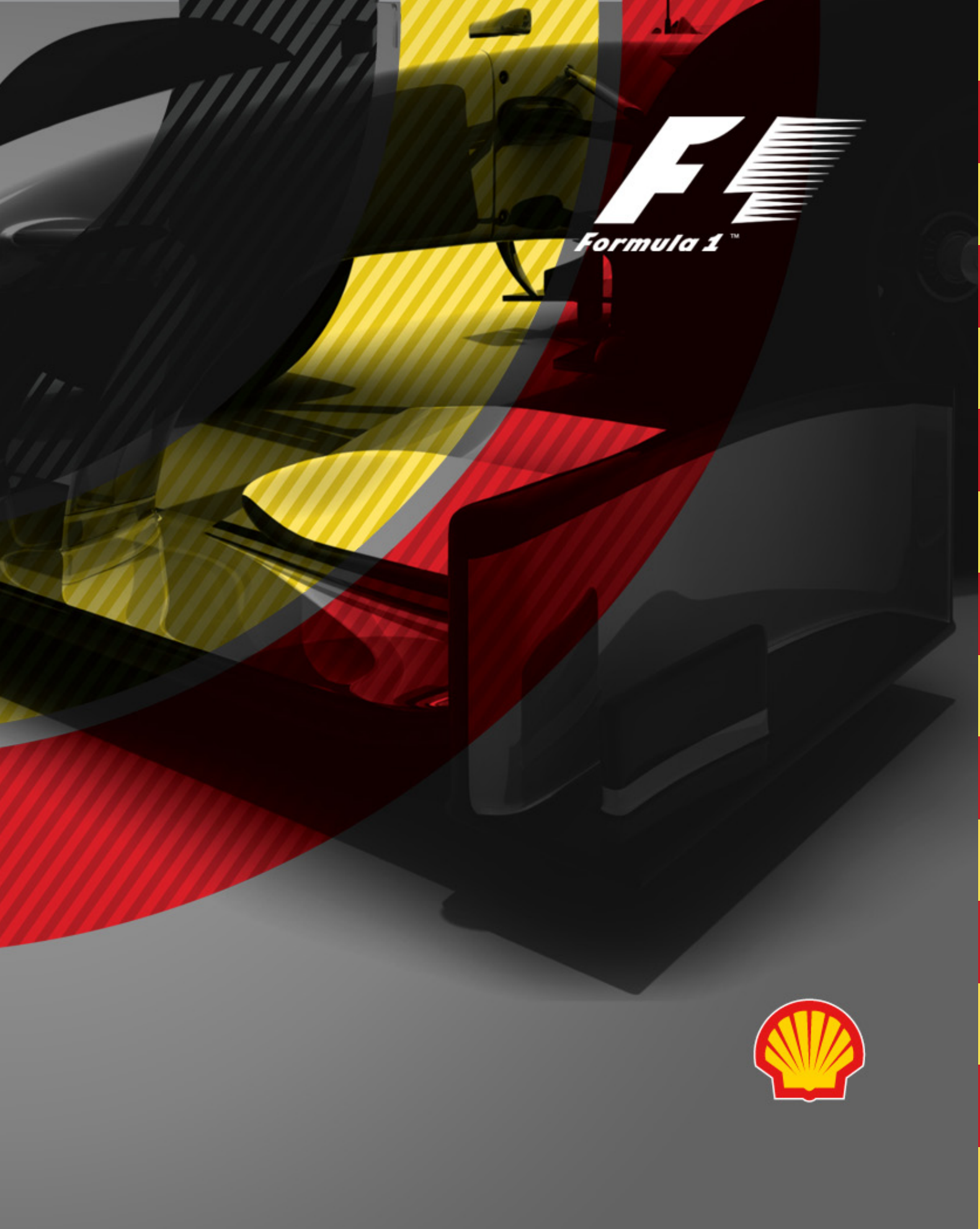
Red Bull used a mix of old and new front-wing solutions in Hungary. They moved back to the original, thin wing support, in place of the newer, wide one (1), and also reverted to the turning vanes under the nose cone (2) rather than those attached to the lower part of the chassis which the team had been running since Valencia. The main plane and flap (3) were new, derived from the Nurburgring configuration, and on Friday Sebastian Vettel also tried a different flap design (4) for a few laps.

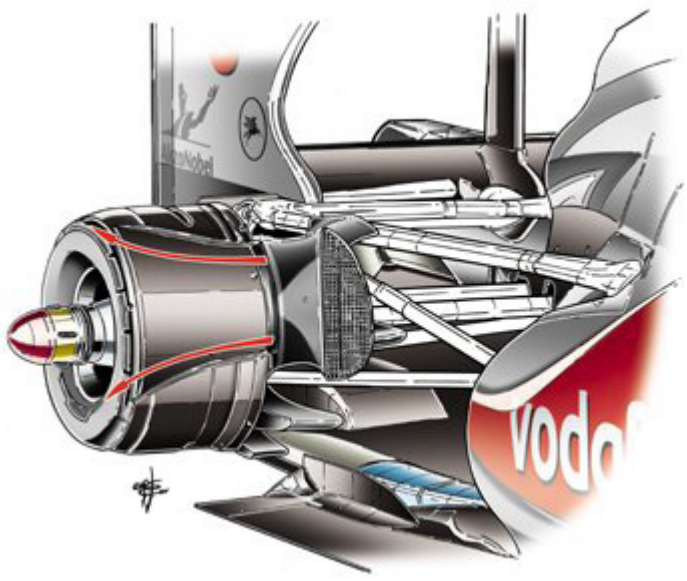
2011

FORMULA 1

SHELL BELGIAN GRAND PRIX

SPA-FRANCORCHAMPS 26-27-28 AUGUST

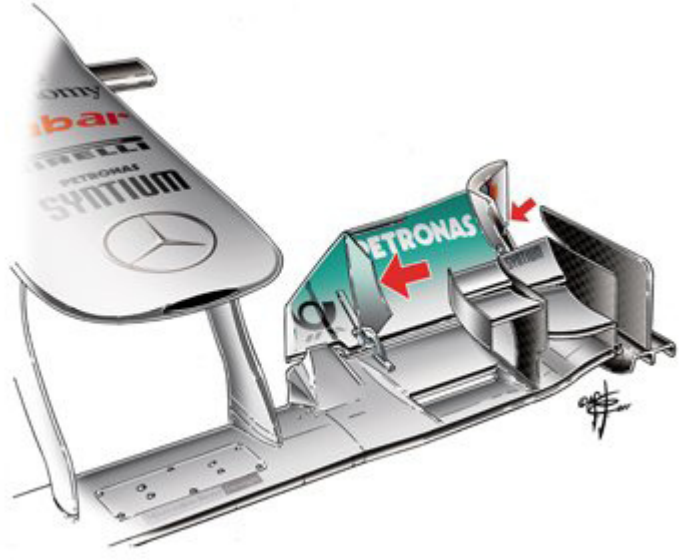

Formula 1™



McLaren MP4-26 - brake duct aero development

27 August 2011

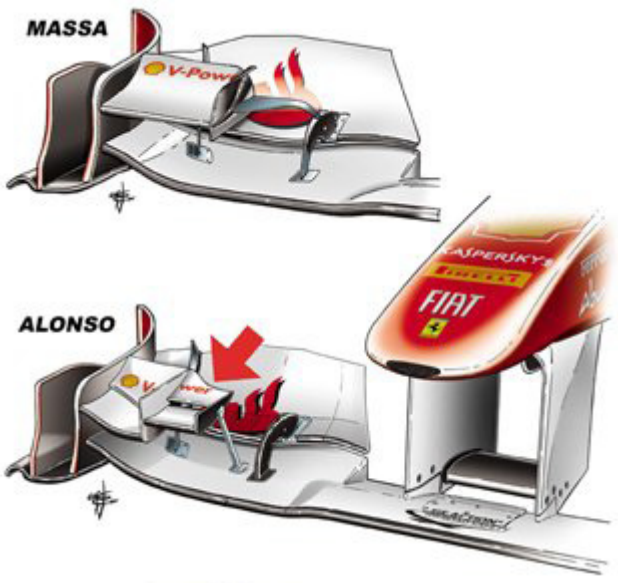
Brake ducts are ever evolving and becoming increasingly important as aerodynamic devices. As well as attaching aero fins to the inside, teams - including McLaren - have started to mimic the effect of the wheel rim covers seen in previous seasons (but now banned) with complex-shaped brake ducts which better control the flow of air around the outside of the wheel. This drawing shows the rear brake drum on the MP4-26.



Mercedes MGP W02 - revised front wing

27 August 2011

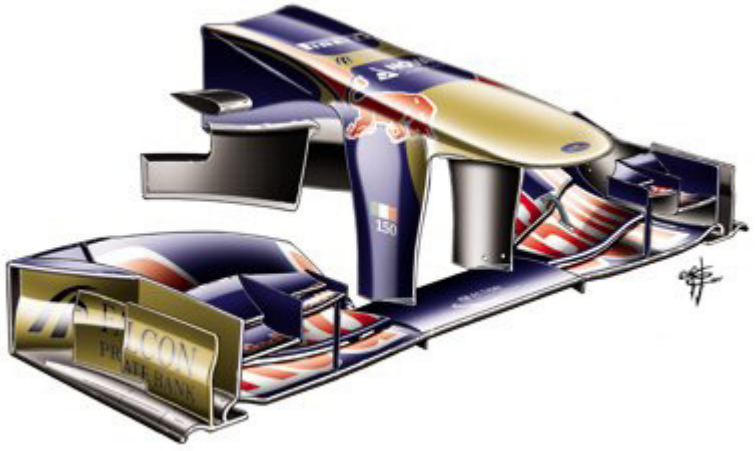
Mercedes have brought another evolution of the front wing they introduced in Hungary to Spa. As well as the additional upper flap, which was inspired by the Red Bull, there is now an additional vertical fin (large red arrow) to better direct air-flow. The team have also modified the system used to adjust the flap's angle of incidence by moving it from its previous central position (where the new fin now is) to the side of the endplate (small red arrow).



Ferrari 150° Italia - front wing variations

27 August 2011

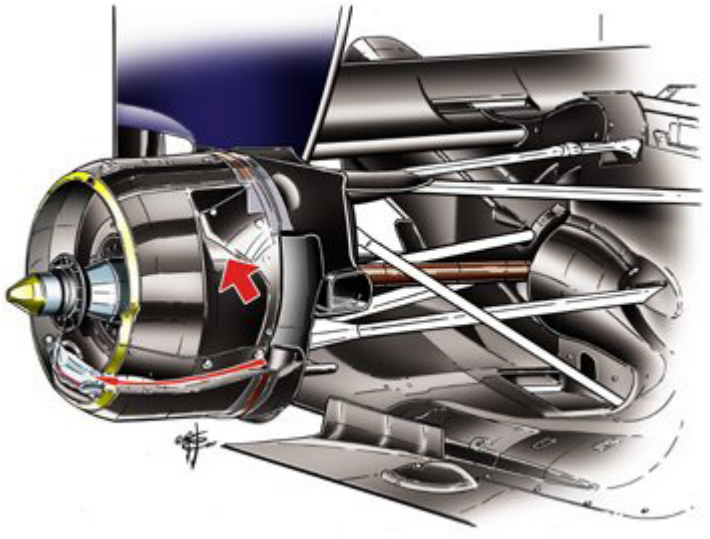
Ferrari have opted to use two different front wings for the qualifying session and race in Belgium. Massa decided to stay with the one he used in Canada, whilst Alonso is running with a new version. Tested in Hungary, it features Red Bull-inspired upper flaps (red arrow), and a single main flap instead of the previous double solution.



Toro Rosso STR6 - new nose design

28 August 2011

Toro Rosso brought a brand new nose to Belgium. Taller, flatter and longer than before, it's similar to that used by Mercedes and will improve airflow in the car's lower sections. It passed its required crash test on August 4.



Red Bull RB7 - brake duct development

28 August 2011

Red Bull brought two different rear brake duct solutions to Belgium. This one was used by Sebastian Vettel. It has a sophisticated shape behind the brake disc, similar to that used by McLaren, to better channel air to the outside of the wheel rim.

FORMULA 1

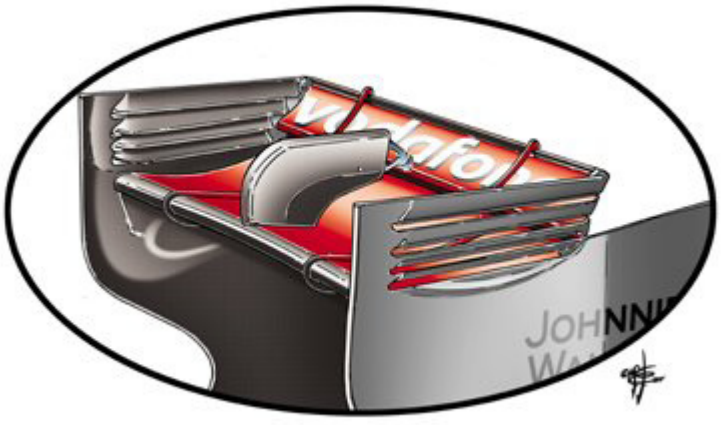
GRAN PREMIO SANTANDER D'ITALIA 2011

MONZA 09-10-11 SEPTEMBER


Formula 1™
Santander

McLaren MP4-26 - rear wing

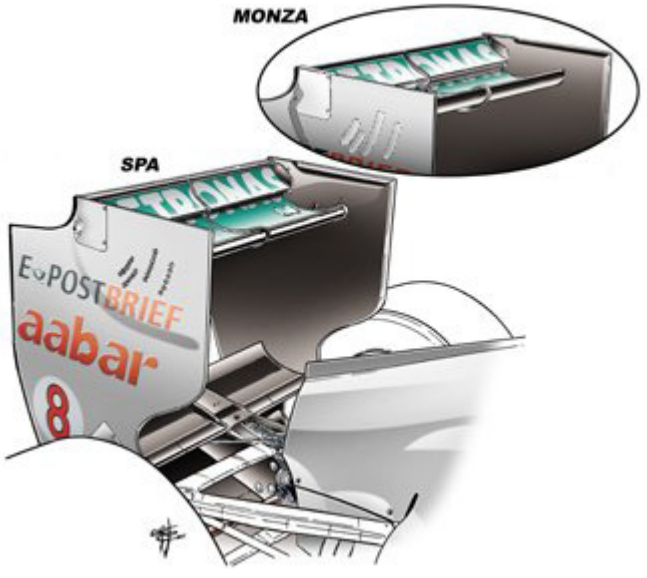
10 September 2011



In Italy McLaren are using the same rear wing they introduced in Spa. It is a touch more angled than those found on other cars, but seems to be advantageous in terms of grip into and out of corners and in braking areas, which in turn helps to conserve tyres.

Mercedes MGP W02 - rear wing

10 September 2011

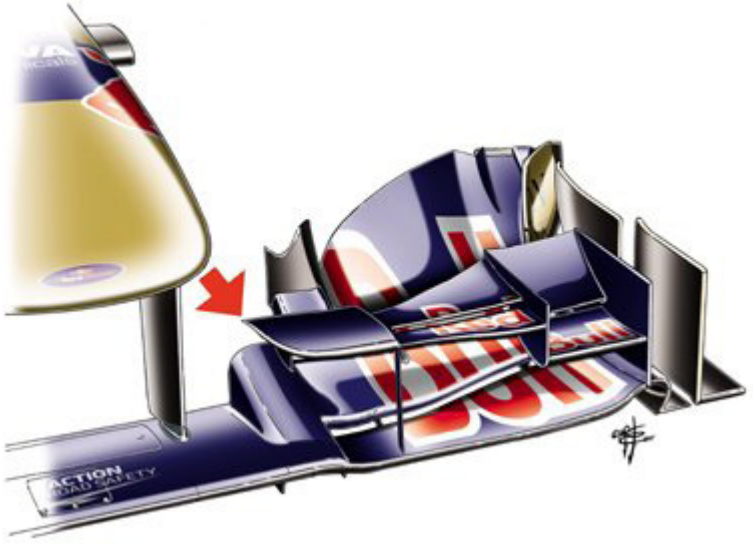


In Italy (see inset) Mercedes are using the same rear wing they took to the last round in Belgium (see main drawing). However, to help achieve higher top speeds on Monza's long straights they have opted to use a different angle of incidence for the main plane, which now has a higher leading edge, and the flap, which is now angled much lower.

Ferrari 150° Italia - modified rear wing

10 September 2011

In Monza Fernando Alonso and Felipe Massa have been using the new rear wing Ferrari introduced at the last round at Spa. But there are some differences on the Monza-spec wing (see main drawing), including different endplates with just two gills instead of three (see upper red arrow and inset) and a lower downforce main profile and flap. The beam wing (see lower red arrow) is also new. No longer straight in shape, it's wider at its centre and has a different chord. In order to produce more downforce and better preserve their tyres, Ferrari used slightly different incidence angles on the rear wing for qualifying and race compared to practice.



Toro Rosso STR6 - revised front wing

10 September 2011

At the last round in Belgium Toro Rosso brought a new nose and in Monza they have tested a new front wing. It features a new small flap (see red arrow) to better direct the flow of air to the back of the car. The team evaluated the new wing on Friday but didn't opt to use it in qualifying and the race.

2011

FORMULA 1

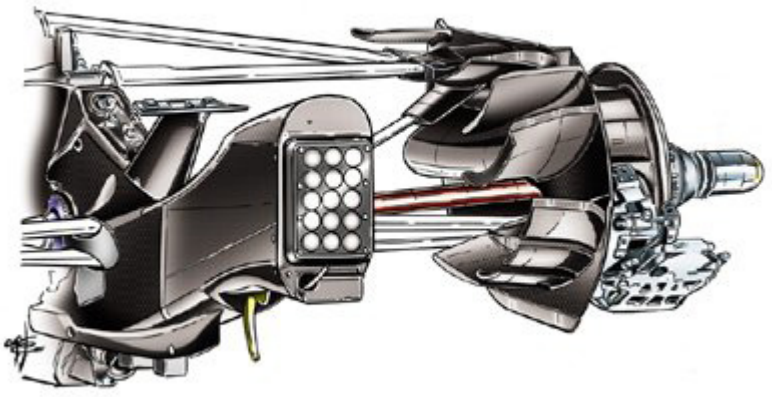
SINGTEL SINGAPORE GRAND PRIX

SINGAPORE 23-24-25 SEPTEMBER


Formula 1™
SingTel

Red Bull RB7 - revised brake ducts

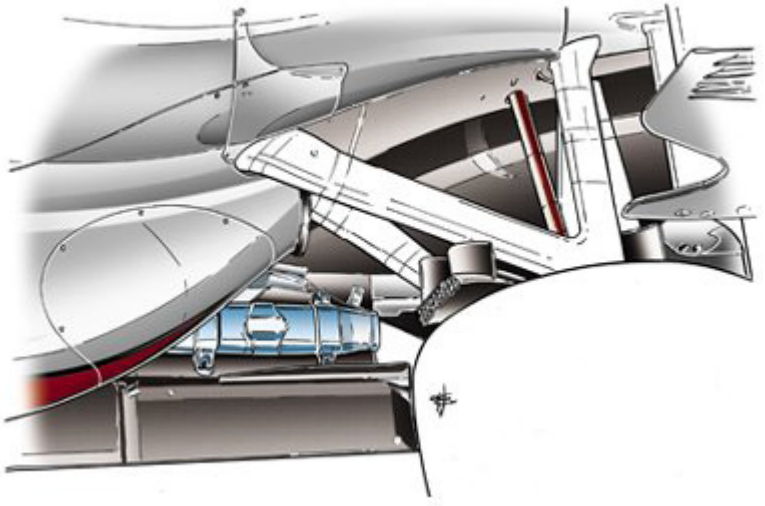
24 September 2011



At the rear of cars, brake ducts have become more and more important as downforce-boosting aerodynamic devices. The Red Bull ducts feature several small planes on the inside of the brake drum to help enhance downforce.

McLaren MP4-26 - new exhaust layout

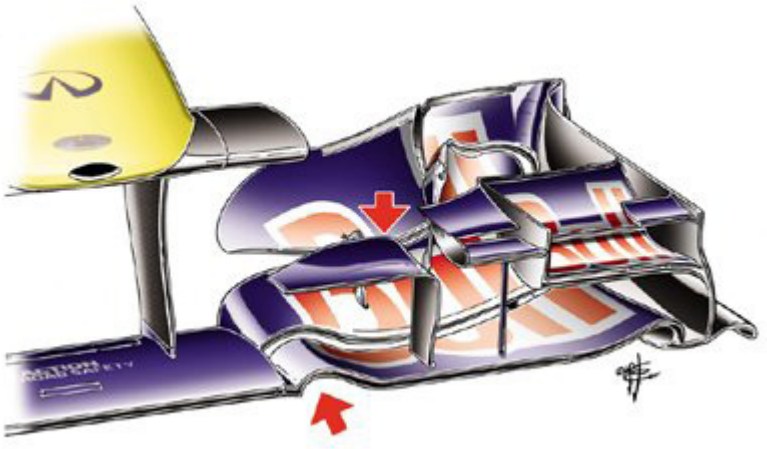
24 September 2011



McLaren are using a new exhaust layout in Singapore. Longer than the previous version, it has been combined with a new diffuser featuring a small, Red Bull-inspired flap in its central section.

Red Bull RB7 - revised front wing

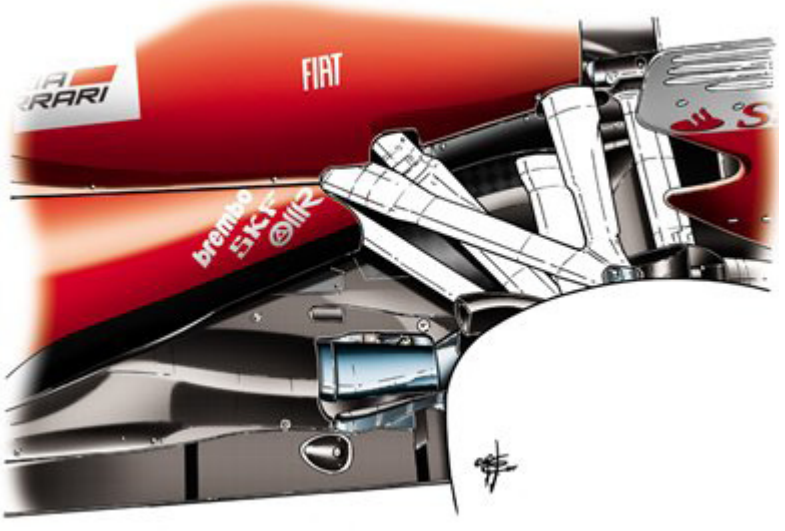
24 September 2011



Red Bull evaluated three different front wings in Singapore on Friday. Pictured is the one tested by Vettel and then used by both drivers during qualifying and for the race. There is a step on the main plane (left-hand arrow). This is similar in style to the solution introduced (but not raced) by McLaren in Spa. There is also a new upper flap (right-hand arrow), inspired by the one McLaren used in Monza.

Ferrari 150° Italia - modified exhaust

25 September 2011

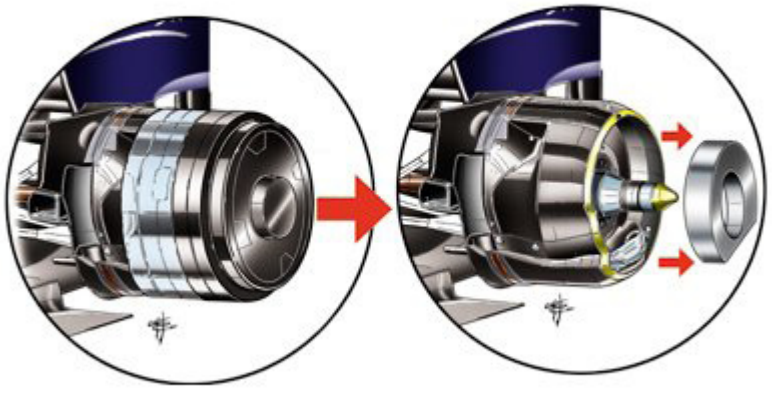


In Singapore Ferrari have modified their exhaust layout. The final section (see blue highlighted area) is a little narrower than before and no longer features the small stepped section which helped to blow air both under and on the top of the side channel.


Formula 1™
2011
FORMULA 1
JAPANESE GRAND PRIX
SUZUKA 07-08-09 OCTOBER

Red Bull RB7 - tyre warming strategy

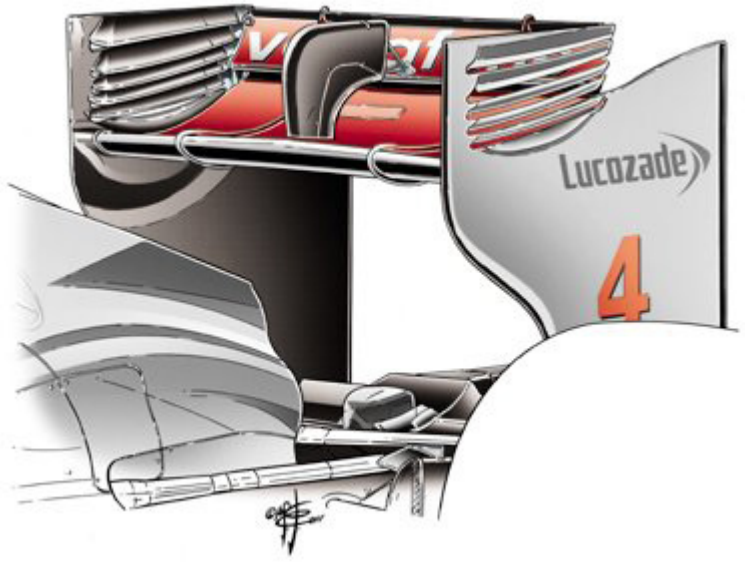
08 October 2011



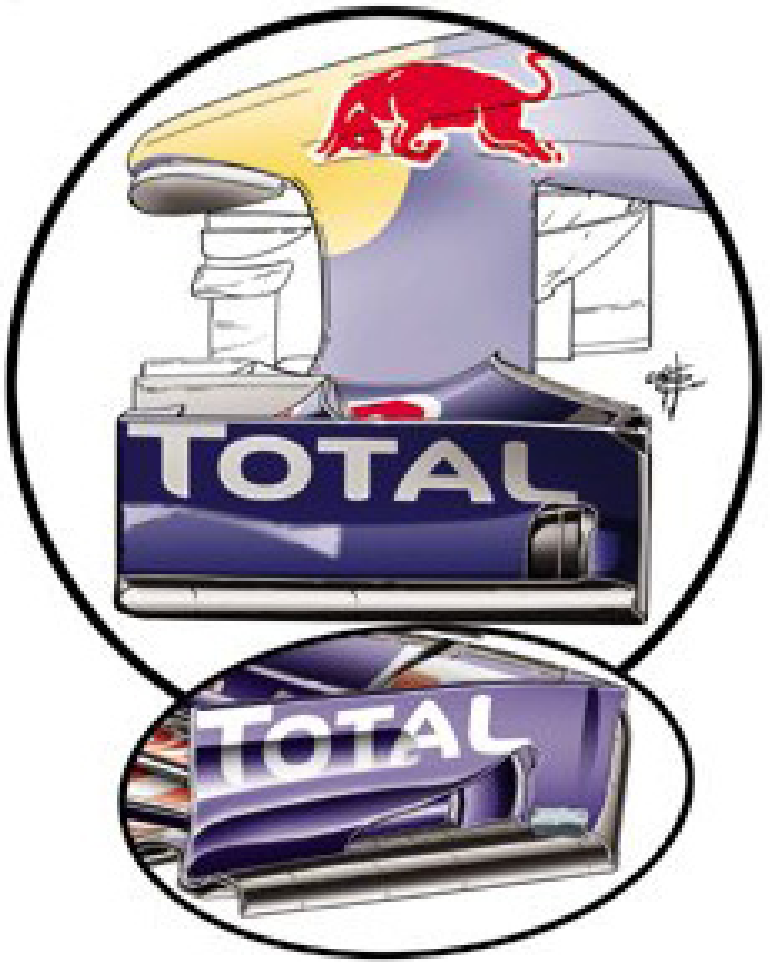
Red Bull have devised a clever way to maintain tyre temperatures in the garage. The FIA long ago banned systems designed to do this by heating the inside of the wheel rim, as introduced by Toyota in Canada 2005. Since Belgium this year, however, Red Bull have been placing a small, pre-heated aluminium cylinder (right) inside all four brake ducts, an idea tested by Williams some years ago. The cylinder's primary function is to heat up the brake discs, but it also stops cold discs and callipers from robbing the blanketed tyres of valuable temperature. Just before the car leaves the garage mechanics wearing special gloves remove the rudimentary brake duct covers (left) and take out the cylinders.

McLaren MP4-26 - rear wing updates

09 October 2011



At Suzuka McLaren introduced at least the fourth edition of the new DRS rear wing first seen at Silverstone. Compared the last update in Singapore, it has a more efficient DRS phase, with a greater reduction in drag, following the trend set by Red Bull and Ferrari.



Red Bull RB7 - front wing update

09 October 2011

At Suzuka Red Bull introduced another new front wing with an endplate comprising only two pieces. Unfortunately Vettel destroyed his in his Friday morning practice crash and the team decided to run with the old wing (lower drawing) on both cars until new spares could be flown out from the factory, arriving by helicopter just 20 minutes before qualifying.

Formula 1™

2011 FORMULA 1

KOREAN GRAND PRIX

YEONGAM 14-15-16 OCTOBER

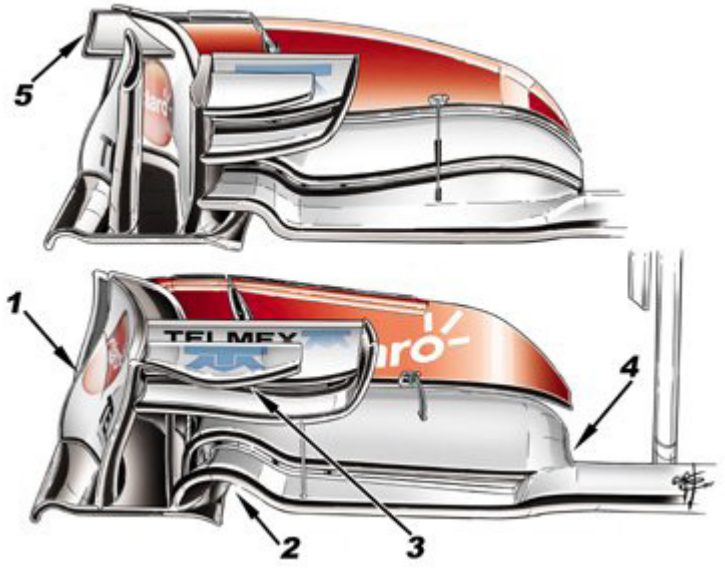
Ferrari 150° Italia - new front wing

15 October 2011

Ferrari have brought a completely new front wing to Korea. It's understood it was initially being evaluated with 2012 in mind, but the team decided to run it on Fernando Alonso's car during qualifying and the race. There are many changes over the older version with most components (nosecone and wing pillars aside) radically different. The endplates (1) are very similar in style to the ones Red Bull introduced at Suzuka and no longer feature a secondary outside vertical fin. The main plane (2) is also reminiscent of the Red Bull with its middle slot (3), as is the large flap (4). The upper-deck flap (5), meanwhile, bears a similarity to the one found on the previous wing, introduced in Budapest back in July.

Sauber C30 - new front wing

15 October 2011



In Korea, Sauber are using the new front wing they introduced in Japan last weekend (see bottom drawing). It features a new endplate (1) which is similar in style to Williams' solution. The attachment between the main profile and the end plate is also different with a curved section (2) whilst the profile and flap are much straighter (4) in style. The upper deck flaps (3) are completely different with a wider and more curved design, whilst the small outside fin found on the previous wing (see top drawing - 5) has been removed.

Toro Rosso STR6 - exhaust modifications

16 October 2011

On Friday in Korea Toro Rosso again tried new Red Bull-style exhausts, with a straight exit to the side channel of the diffuser. However, the team ultimately decided to run the standard, side-blowing solution (inset) for qualifying and the race. The Faenza team also retained the new front wing they introduced at Suzuka.

2011 FORMULA 1

AIRTEL GRAND PRIX OF INDIA

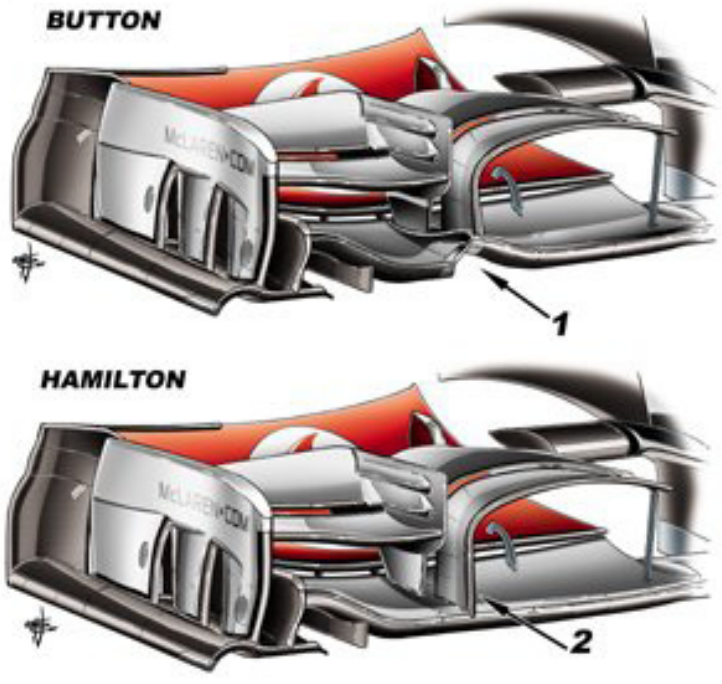
NEW DELHI 28-29-30 OCTOBER


airtel

Renault R31 - revised rear bodywork

29 October 2011

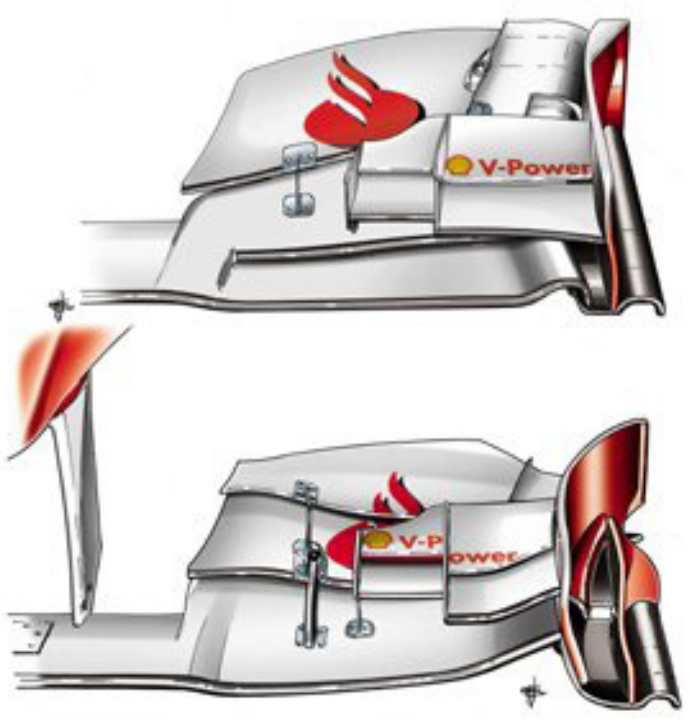
Renault have returned to their standard rear bodywork (inset) for the Indian race. Compared to the narrower configuration, which features a more pronounced 'cola bottle' shape (see how the yellow highlighted area shows the wider area of floor it exposes), the cooling benefits of this wider bodywork outweigh the loss of aerodynamic performance it brings.



McLaren MP4-26 - new front wing

29 October 2011

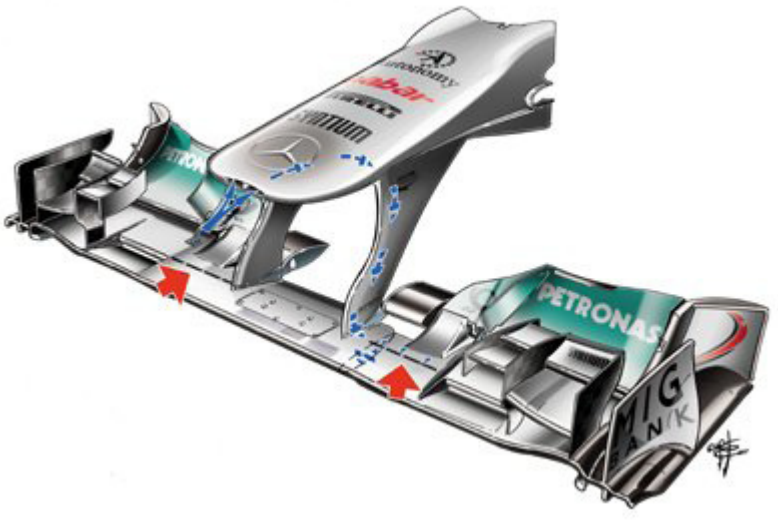
McLaren have brought a new front wing to India. Drivers Jenson Button and Lewis Hamilton completed back-to-back comparisons on Friday and Hamilton eventually used the new version (see lower drawing) during qualifying and the race. Button, meanwhile, used the old version (see upper drawing). The new front wing has a straight main profile (2) and no longer features the indentation which divided the airflow under the car (1). There are also different upper flap mountings, although both solutions are reminiscent of ones used in 2010 before the team introduced the stepped main profile.



Ferrari 150° Italia - new front wing

29 October 2011

In India both Ferrari drivers have been using the team's new, Red Bull-influenced front wing (upper drawing), which Fernando Alonso first sampled in Korea. Compared to the previous version (lower drawing), all components are different. There is now a single endplate, a slotted main plane with a different profile near the endplates, just one large flap and also different upper flaps. Ferrari brought three of the new front wings to New Delhi, so after Felipe Massa's qualifying accident the team have two left.



Mercedes MGP W02 - 'F-duct ' front wing

30 October 2011

2012 has well and truly started for Mercedes after the team briefly tested this innovative solution at Suzuka, prompting much discussion over its possible merits in India. Inspired by F-ducts, which were used extensively last season but were outlawed this year, Mercedes have switched the theory from the rear to the front of the car. The little oval hole, which is common in all the nose cones, features a splitter in the middle, thought to direct the airflow through the side pillars of the wing (blue arrows). Mercedes used a similar layout last year with its F-duct, which had little pipes going through the diffuser and the wing endplates. No opening was visible on the flaps, like in the rear wing last year, so the only possible opening was in underside of the main plane section (red arrows). In order for this system to be legal, unlike last year's F-ducts the driver must have no direct control over it, so it must instead be regulated by an amplifier inside the nose cone, coming into effect and stalling the wing to cut drag only under certain airflow conditions. Speculation continues over the exact workings of this Mercedes solution, but the important thing is that it again highlights the ability of F1 engineers to find loopholes in the rules and to produce innovative solutions.


2011
FORMULA 1
ETIHAD AIRWAYS ABU DHABI GRAND PRIX
YAS MARINA CIRCUIT 11-12-13 NOVEMBER


Formula 1™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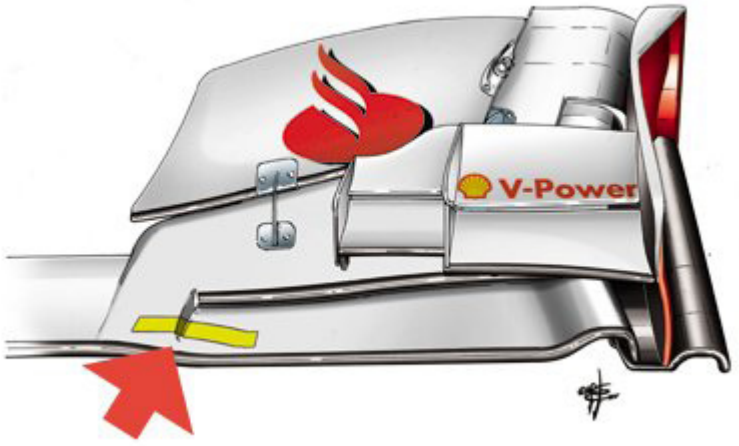
Ferrari 150° Italia - revised front wing

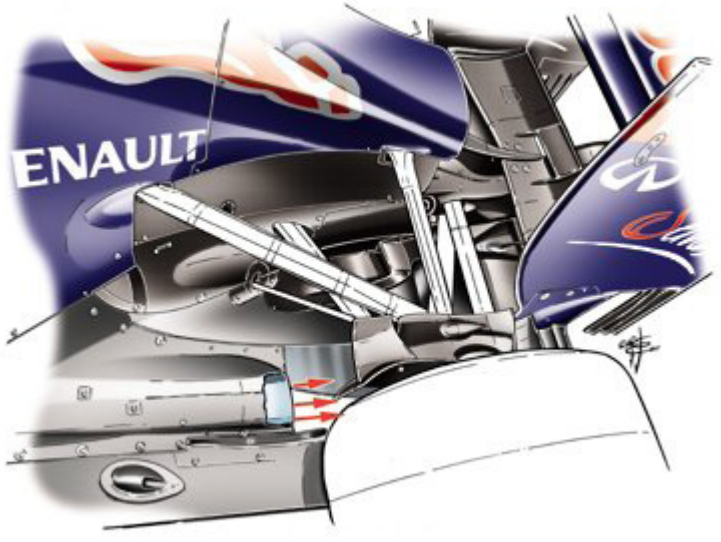
12 November 2011



On Friday afternoon in Abu Dhabi, Ferrari added an additional carbon skin on the pivoting point of their new Red Bull-style front wing on Felipe Massa's car (red arrow). The solution, however, failed to stop the wing from fluttering dramatically at certain speeds so the team decided to revert back to the standard front wing for the Brazilian. Fernando Alonso kept the new solution, but with a stiffer construction.

Red Bull RB7 - rearward exhaust

12 November 2011

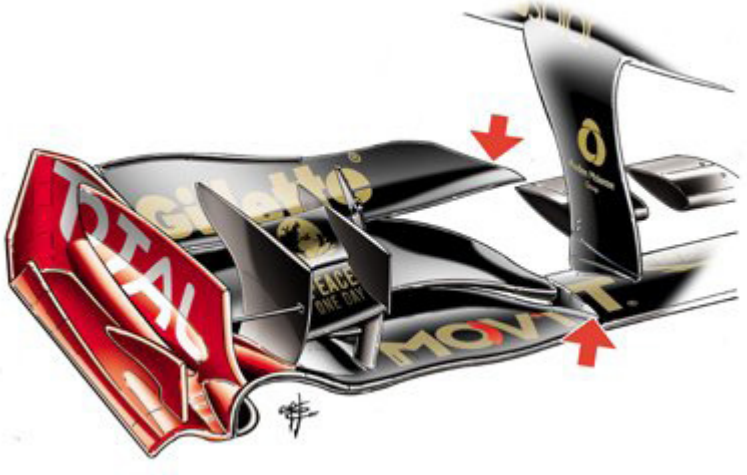


The Abu Dhabi race will be the penultimate time long exhausts can be used to blow air into the side channel of a car's rear diffuser to boost downforce. The Red Bull solution can be seen in the drawing. Next season blown diffusers will be banned, with exhaust exits having to be positioned periscope style atop the rear bodywork.

Red Bull RB7 - brake ducts and calipers

12 November 2011

Yas Marina is a tough circuit on brakes so Red Bull have kept their drum ducts, complete with ventilation fins on the outside, on the RB7s. In the drawing you can also see the distinctively low placement of the brake calipers. These are supplied by Brembo to both Red Bull and Toro Rosso and their positioning lowers the suspension's centre of gravity.



Renault R31 - new front wing

13 November 2011

In Abu Dhabi, Renault finally introduced this new, Red Bull-inspired front wing, which had been expected to appear at Suzuka last month. Run solely by Vitaly Petrov, the more flexible design differs from the previous version in several ways and is intended to boost downforce. The main plane has a different shape with a smaller chord, and the attachment to the central section is also different (lower arrow). The curved flap (upper arrow) is similar in shape and length to that found on the Red Bull.

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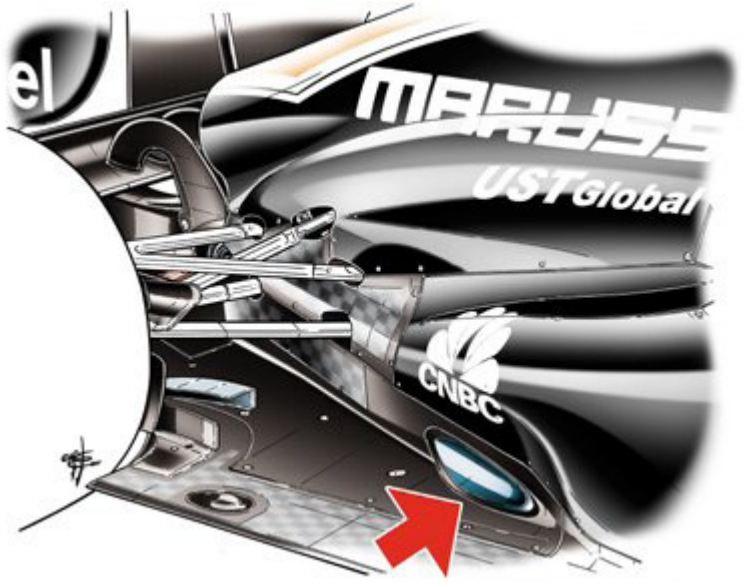


Virgin MVR-02 - 'salami'-cut exhaust

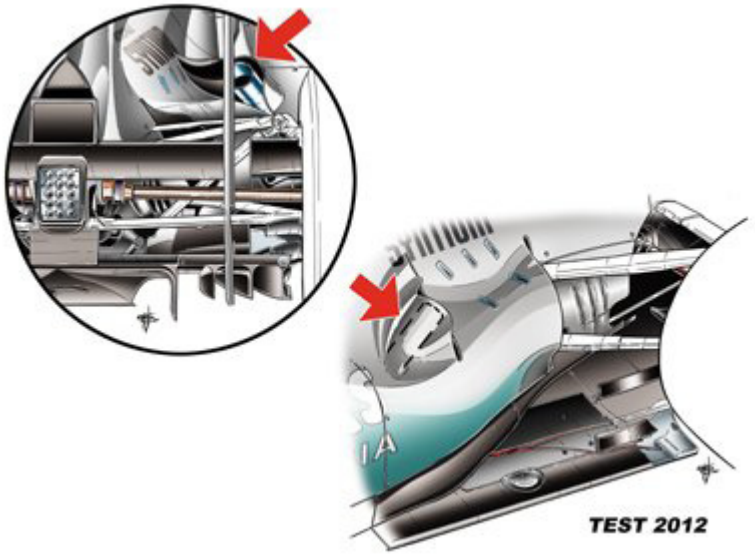
26 November 2011

In 2012 the 'salami'-shaped cut of Virgin's exhaust (see red arrow) will be outlawed. The team have only introduced this solution for the last few races of this season.

Ferrari 150° Italia - vertical extension to exhaust pipe

26 November 2011

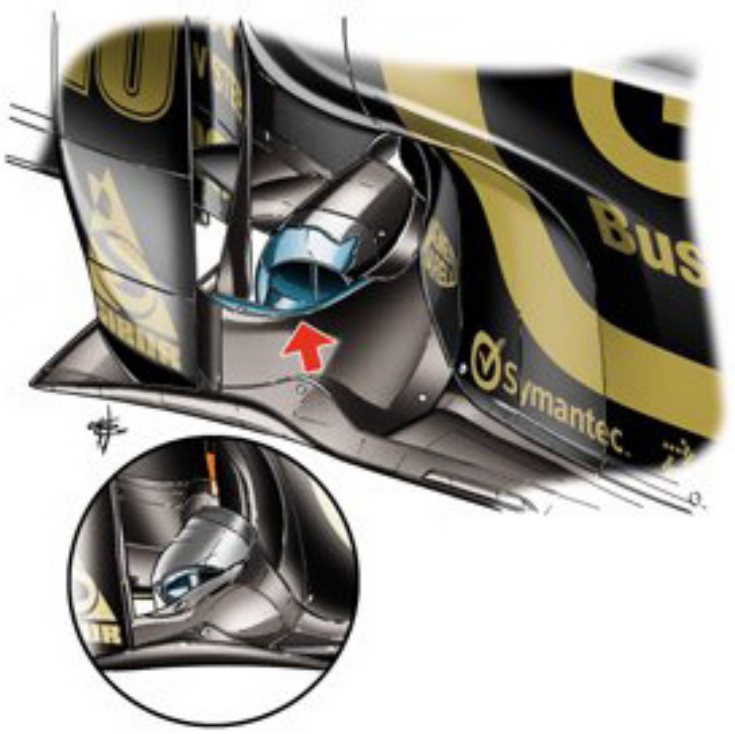
Up until now, Ferrari have managed to keep an important update to their exhausts secret. Back at August's Spa round they introduced a vertical extension to their exhaust pipe (right-hand arrows). The mounting of the extension is integrated with the section of the exhaust near the car's underbody (left-hand arrow) and is covered by the sidepods. The vertical element creates another chamber, which changes the pulse rate of the exhausts and means some flow continues when off-throttle, allowing the team to recover a little blown-exhaust effect even when standard engine maps are being used. This is an interesting experiment ahead of 2012 when 'hot' blowing - widely used this season - will be forbidden.



Mercedes MGP W02 - 2012 exhaust positioning

26 November 2011

At the recent young driver test in Abu Dhabi, Mercedes and Williams trialled the new exhaust positioning which will be mandatory next season. Mercedes' solution (red arrows) is different to the one run by Williams. As per the regulations both exhaust pipes were straight and round over their last 10 cm of length but the Mercedes exhaust had a round fairing. The new-for-2012 rules state the final section of exhaust can be angled between 10 and 30 degrees on the longitudinal axis and 10 degrees on the transverse axis. Expect to see a variety of solutions next year.



Renault R31 - forward exhausts

27 November 2011

For many the season's biggest technical disappointment has been Renault's innovative forward-facing exhaust system. After raising eyebrows - and the pulses of engineers at rival teams - ahead of the start of the season, the solution failed to deliver, with the team realising pretty quickly that it was uncompetitive. The heat generated also proved damaging and Renault were forced to increase the amount of protective metal casing around the exhaust as the season progressed. The inset shows the exhaust at the start of 2011 whilst the main one shows what will be raced in Brazil.

Sporting Regulations

2011 season changes

With moveable rear wings, a new tyre supplier, the return of KERS, a 107 percent qualifying rule and more, there are plenty of regulation changes that will have a major impact on the Formula One field in 2011…

Adjustable rear wings

Under new moveable bodywork regulations, drivers of suitably equipped cars can adjust the rear wing from the cockpit, altering its angle of incidence through a set range. (The moveable front wing, used in 2010, has been dropped.) The system's availability is electronically governed - it can be used at any time in practice and qualifying (unless a driver is on wet-weather tyres), but during the race can only be activated when a driver is less than one second behind another car at pre-determined points on the track. The system is then deactivated once the driver brakes. In combination with KERS, it is designed to boost overtaking. Also like KERS, it isn't compulsory.

No F-ducts or double diffusers

Any system, device or procedure which uses driver movement as a means of altering the aerodynamic characteristics of the car is prohibited from 2011 - that means no F-ducts. Tightening of the regulations on stepped floors means double diffusers in their original sense are also banned.

KERS

A badge of honour for some, a bugbear for others on its debut in 2009, KERS - or Kinetic Energy Recovery Systems - have been re-introduced in 2011 after the teams mutually agreed to suspend their use in 2010. KERS take the waste energy generated under braking and turns it into additional power. This is then made available to the driver in fixed quantities per lap via a steering wheel-mounted 'boost button'. The systems are essentially the same as those seen in '09, with no increase in the maximum permitted power (though that could change in subsequent seasons). The challenge for the engineers this time round is packaging. Last time KERS was run, refuelling was legal. Now, with it banned, fuel tanks are larger and finding room to accommodate battery packs etc is not as easy. Hence don't be surprised if bodywork has grown in places, relative to 2010. On the plus side, minimum car weight has been upped by 20kg to 640kg, meaning larger drivers don't pay the weight-distribution penalty they once did in a KERS-equipped car.

Wheel tethers

In response to several stray wheels over the course of the 2010 season, teams must now place a second tether on every wheel to improve safety. The two tethers must be contained in separate suspension members.

Tyres

Following Bridgestone's decision to withdraw at the end of 2010 after 13 years in Formula One, Pirelli take over as the sport's sole tyre supplier. The Italian company, last part of F1 in 1991, will provide all teams with rubber for the next three years.

Tyre allocation has been reduced for 2011, with 11 rather than 14 sets of dry-weather tyres available to each driver per race weekend. Drivers will receive three sets (two prime, one option) to use in P1 and P2 and must return one set after each session. A further eight sets will then be at their disposal for the rest of the weekend, although one set of each specification must be handed back before qualifying. (At certain events, teams may be given an extra set of primes for use in P1 and P2, or an additional specification of dry-weather tyre - again for P1 and P2 only - for evaluation purposes. Teams will be given at least a week's notice when either of these scenarios is to occur.)

If a driver fails to use both specifications of dry-weather tyres during a (dry) race, they will be excluded from the results. If a (dry) race is suspended and can't be restarted, and a driver has failed to use both specifications, 30 seconds will be added to the driver's race time.

There is new system for visually differentiating tyre types, using various colours for the sidewall lettering: wet - orange; intermediate - light blue; super soft - red; soft - yellow; medium - white; hard - silver.

Gearboxes

As part of the sport's cost-saving and environmental initiatives, gearboxes now need to last for five race weekends, instead of the previous four.

107% qualifying rule

During the first phase of qualifying, any driver who fails to set a lap within 107 percent of the fastest Q1 time will not be allowed to start the race. However, in exceptional circumstances, which could include a driver setting a suitable time during practice, the stewards may permit the car to start.

Team curfew

A clampdown on long working hours has been introduced, with a curfew on team personnel connected with the operation of the cars. They will not be allowed into the circuit between midnight and 6am when practice is scheduled to start at 10am the following day, or between 1am and 7am when practice starts at 11am. Each team is permitted four individual exceptions to this rule during the season.

Penalties

Stewards now have the power to impose a wider range of penalties for driving and other rule transgressions. Added to their armoury are time penalties, the right to exclude drivers from race results, or suspend them from subsequent events.

Team orders

The clause in the sporting regulations banning team orders has been removed.

2011 season changes

From the 2011 Formula One Technical Regulations:

3.18 Driver adjustable bodywork

3.18.1 The incidence of the rearmost and uppermost closed section described in Article 3.10.2 may be varied whilst the car is in motion provided :

- It comprises only one component that must be symmetrically arranged about the car centre line with a minimum width of 708mm.

- With the exception of minimal parts solely associated with adjustment of the section, no parts of the section in contact with the external airstream may be located any more than 355mm from of the car centre line.

- With the exception of any minimal parts solely associated with adjustment of the rearmost and uppermost section, two closed sections are used in the area described in Article 3.10.2.

- Any such variation of incidence maintains compliance with all of the bodywork regulations.

- When viewed from the side of the car at any longitudinal vertical cross section, the physical point of rotation of the rearmost and uppermost closed section must be fixed and located no more than 20mm below the upper extremity and no more than 20mm forward of the rear extremity of the area described in Article 3.10.2 at all times.

- The design is such that failure of the system will result in the uppermost closed section returning to the normal high incidence position.

- 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 8.2.

3.18.2 The adjustable bodywork may be activated by the driver at any time prior to the start of the race and, for the sole purpose of improving overtaking opportunities during the race, after the driver has completed a minimum of two laps after the race start or following a safety car period.

The driver may only activate the adjustable bodywork in the race when he has been notified via the control electronics (see Article

8.2) that it is enabled. It will only be enabled if the driver is less than one second behind another at any of the pre-determined positions around each circuit. The system will be disabled by the control electronics the first time the driver uses the brakes after he has activated the system.

The FIA may, after consulting all competitors, adjust the above time proximity in order to ensure the stated purpose of the adjustable bodywork is met.

3.15 Aerodynamic influence

With the exception of the driver adjustable bodywork described in Article 3.18 (in addition to minimal parts solely associated with its actuation) and the ducts described in Article 11.4, any specific part of the car influencing its aerodynamic performance :

- must comply with the rules relating to bodywork ;

- must be rigidly secured to the entirely sprung part of the car (rigidly secured means not having any degree of freedom) ;

- must remain immobile in relation to the sprung part of the car.

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.

No part having an aerodynamic influence and no part of the bodywork, with the exception of the skid block in 3.13 above, may under any circumstances be located below the reference plane.

With the exception of the parts necessary for the adjustment described in Article 3.18, any car system, device or procedure which uses, or is suspected of using, driver movement as a means of altering the aerodynamic characteristics of the car is prohibited.

4.1 Minimum weight :

The weight of the car must not be less than 640kg at all times during the Event.

If, when required for checking, a car is not already fitted with dryweather tyres, it will be weighed on a set of dryweather tyres selected by the FIA technical delegate.

4.2 Weight distribution

For 2011 only, the weight applied on the front and rear wheels must not be less than 291kg and 342kg respectively at all times during the qualifying practice session.

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

10.3 Suspension members :

10.3.6 In order to help prevent a wheel becoming separated in the event of all suspension members connecting it to the car failing provision must be made to accommodate flexible tethers, each with a cross sectional area greater than 110mm². The sole purpose of the tethers is to prevent a wheel becoming separated from the car, they should perform no other function. The tethers and their attachments must also be designed in order to help prevent a wheel making contact with the driver's head during an accident.

Each wheel must be fitted with two tethers each of which exceed the requirements of 3.1.1 of Test Procedure 03/07.

Each tether must have its own separate attachments at both ends which :

- 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 ;

- on the survival cell or gearbox are separated by at least 100mm measured between the centres of the two attachment points ;

- on each wheel/upright assembly are located on opposite sides of the vertical and horizontal wheel centre lines and are separated by at least 100mm measured between the centres of the two attachment points ;

- are able to accommodate tether end fittings with a minimum inside diameter of 15mm.

Furthermore, no suspension member may contain more than one tether.

Each tether must exceed 450mm in length and must utilise end fittings which result in a tether bend radius greater than 7.5mm.

From the 2011 Formula One Sporting Regulations:

25.4 Use of tyres :

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

a) Three sets of dry-weather tyres will be allocated by the FIA technical delegate to each nominated driver for use during P1 and P2, two of "prime" specification and one of "option" specification. These are the only dry-weather tyres which may be used during these sessions.

One set of "prime" specification must be returned to the tyre supplier before the start of P2 and one further set of "prime" specification and one set of "option" specification before the start of P3.

If Article 25.2(c) is invoked an additional set of "prime" specification tyres will be available to each nominated driver for use during P1 and P2. One set of "prime" specification tyres must be returned to the tyre supplier after P1 and two further sets of "prime" specification and one set of "option" specification before the start of P3.

If an additional driver is used (see Article 19.1(b) he must use the tyres allocated to the nominated driver he replaced.

b) If an additional specification of dry-weather tyre is made available in accordance with Article 25.1 two sets of these tyres will be allocated to each driver for use during P1 and P2. Any such tyres must be returned to the tyre supplier before the start of P3.

c) Eight further sets of dry-weather tyres will be allocated by the FIA technical delegate to each nominated driver, four of each specification, for use during the remainder of the Event. However, one set of each specification must be returned to the tyre supplier before the start of the qualifying practice session and may not be used during the remainder of the Event.

d) Prior to the start of the qualifying practice session intermediate and wet-weather tyres may only be used after the track has been declared wet by the race director, following which intermediate, wet or dry-weather tyres may be used for the remainder of the session.

e) At the start of the race each car which took part in Q3 must be fitted with the tyres with which the driver set his grid time. This will only be necessary if dry-weather tyres were used to set the grid time and if dry-weather are used at the start of the race.

Any such tyres damaged during Q3 will be inspected by the FIA technical delegate who will decide, at his absolute discretion, whether any may be replaced and, if so, which tyres they should be replaced with.

f) Unless he has used intermediate or wet-weather tyres during the race, each driver must use at least one set of each specification of dry-weather tyres during the race.

If the race is suspended and cannot be re-started, thirty seconds will be added to the elapsed time of any driver who was unable to use both specifications of dry-weather tyre during the race. However, any driver who completes the race without using both specifications of dry-weather tyre will be excluded from the race results.

g) If the race is started behind the safety car because of heavy rain (see Article 40.14), or resumed in accordance with Article 42.5(a), the use of wet-weather tyres until the safety car returns to the pits is compulsory.

28) SPARE CARS, ENGINES AND GEARBOXES

28.6 For the purposes of this Article only, an Event will be deemed to comprise P3, the qualifying practice session and the race.

a) Each driver may use no more than one gearbox for five consecutive Events in which his team competes. Should a driver use a replacement gearbox he will drop five places on the starting grid at that Event and an additional five places each time a further gearbox is used.

Any replacement gearbox must be fitted with the same gear ratios that were declared under d) below and will only be required to complete the remainder of the Event in question. Any change to the gear ratios declared under d) below will incur a further five grid place penalty. In either case a new five race sequence may start at the following Event.

Unless the driver fails to finish the race (or is unable to start the race for reasons other than a penalty imposed by the stewards) the gearbox fitted to the car at the end of the Event must remain in it for the remainder of the five race sequence. Any driver who failed to

finish the race at the first, second, third or fourth of the five Events for reasons which the technical delegate accepts as being beyond the control of the team or driver, may start the following Event with a different gearbox without a penalty being incurred.

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

b) If a driver is replaced after the first, second, third or fourth Event of a five Event period, having finished the first, second, third or fourth Events, the replacement driver must use the gearbox which the original driver had been using.

f) For 2011 only, except during the last Event of the Championship season, each driver will be permitted to use a replacement gearbox without incurring a penalty the first time this becomes necessary during the season. Under such circumstances the replacement gearbox will only be required to complete the remainder of the Event in question.

36) THE GRID

36.3 During Q1, any driver whose best qualifying lap exceeds 107% of the fastest time set during that session will not be allowed to take part in the race. Under exceptional circumstances however, which may include setting a suitable lap time in a free practice session, the stewards may permit the car to start the race.

Should there be more than one driver accepted in this manner, the grid order will be determined by the stewards.In either case, a competitor will not be able to appeal against the stewards decision.

30) GENERAL SAFETY

30.19 No team personnel who are associated in any way with the operation of the cars are permitted within the confines of the circuit during two six hour periods which commence ten hours before the scheduled start times of P1 and P3.

However, each team will be permitted four individual exceptions to the above during a Championship season.

16) INCIDENTS

16.3 The stewards may impose any one of the penalties below on any driver involved in an Incident :

a) A drive-through penalty. The driver must enter the pit lane and re-join the race without stopping.

b) A ten second time penalty. The driver must enter the pit lane, stop at his pit for at least ten seconds and then re-join the race.

If either of the two penalties above are imposed during the last five laps, or after the end of a race, Article 16.4b) below will not apply and 20 seconds will be added to the elapsed race time of the driver concerned in the case of a) above and 30 seconds in the case of b).

c) A time penalty.

d) A reprimand.

If any of the four penalties above are imposed they shall not be subject to appeal.

e) A drop of any number of grid positions at the driver's next Event.

f) Exclusion from the results.

g) Suspension from the driver's next Event.

Car livery

Teams must run their two cars with essentially the same race livery throughout the season and must seek prior approval for any major changes.

In addition there are a number of requirements that apply to liveries for all cars and teams. Every car must carry its driver's race number, which must be clearly visible from the front of the car, and the driver's name must appear on the external bodywork of the car. The team's name or emblem must also appear on the nose of the car.

To help distinguish between a team's two cars, the onboard cameras which sit on top of the main rollover structure are coloured differently. On the first car it must be predominantly fluorescent red and on the second car it must be fluorescent yellow.

21) CAR LIVERY

21.1 The provisions of the Code relating to national colours shall not apply to the Championship.

Both cars entered by a competitor must be presented in substantially the same livery at each Event, any change to this livery during a Championship season may only be made with the agreement of the Formula One Commission. In order that the cars of each team may be easily distinguished from one another whilst they are on the track, the on board cameras located above the principle roll structure of the first car must be predominantly fluorescent red, and the second car fluorescent yellow.

21.2 Each car will carry the race number of its driver (or his replacement) as published by the FIA at the beginning of the season. This number must be clearly visible from the front of the car.

21.3 The name or the emblem of the make of the car must appear on the front of the nose of the car and in either case be at least 25mm in its largest dimension. The name of the driver must appear on the external bodywork and be clearly legible.

Classification

A commonly asked question is how drivers can be given a placing in the official race results even though they retired before the end of the race. The explanation can be found within the FIA regulations regarding classification.

These state that any driver who completed at least 90 per cent of the race distance will be classified, whether or not he was running when the winner took the chequered flag.

If a race is stopped before the full distance and a result is declared, the classification will reflect the race order at the end of the lap two laps prior to that on which the race was stopped (see 'Suspending and resuming a race'). For example, if a race is stopped on lap 60, the classification will be as it was at the end of lap 58.

45) CLASSIFICATION

45.1 The car placed first will be the one having covered the scheduled distance in the shortest time, or, where appropriate, passed the Line in the lead at the end of two hours (or more if the race is suspended, see Article 5.3). All cars will be classified taking into account the number of complete laps they have covered, and for those which have completed the same number of laps, the order in which they crossed the Line.

45.2 Cars having covered less than 90% of the number of laps covered by the winner (rounded down to the nearest whole number of laps), will not be classified.

45.3 The official classification will be published after the race. It will be the only valid result subject to any amendments which may be made under the Code and these Sporting Regulations.

Driver changes and additional drivers

Teams may use up to four drivers during a season, all of whom may score points in the championship. A driver change may be made with the permission of the stewards any time before the start of qualifying. The new driver must use the engine and tyres allocated to the original driver.

On top of this, in each of Friday's two practice sessions teams may run additional drivers, though each team is still limited to two cars. Any holder of a Super License may run as an additional driver, but stewards must be informed of a team's plans before the end of initial scrutineering on the Thursday prior to practice.

19) CHANGES OF DRIVER

19.1 a) During a season each team will be permitted to use four drivers. Changes may be made at any time before the start of the qualifying practice session provided any change proposed after 16.00 on the day of scrutineering receives the consent of the stewards.

Additional changes for reasons of force majeure will be considered separately. Any new driver may score points in the Championship.

b) In addition to the above each team will be permitted to run additional drivers during P1 and P2 provided :

- the stewards are informed which cars and drivers each team intends to use in each session before the end of initial scrutineering, changes after this time may only be made with the consent of the stewards ;

- no more than two drivers are used in any one session ;

- they carry the race number of the nominated driver they replace ;

- they use the engine and tyres which are allocated to the nominated driver ;

- they are in possession of a Super Licence.

c) If one of the team's nominated drivers is unable to drive at some stage after the end of initial scrutineering, and the stewards consent to a change of driver, the replacement driver must use the engine, gearbox and tyres which were allocated to the original driver (see Articles 25.3 and 28.4).

Driving protocol and penalties

Stewards have the power to impose various penalties on a driver if he commits an offence during a race. Offences include jumping the start, causing an avoidable accident, unfairly blocking another driver, impeding another driver when being lapped, speeding in the pit lane, or gaining an advantage by leaving the track.

The two most common types are the drive-through penalty and the ten-second time penalty. In the case of the former, the driver must enter the pits, drive through the pit lane at the pit-lane speed limit and rejoin the race without stopping. Depending on the length of the pit lane this can cost a driver a significant amount of time.

More severe is the ten-second time penalty (also commonly known as a stop-go penalty) where the driver must not only enter the pits, but must also stop for ten seconds at his pit before rejoining the race. During this time the driver's team are not permitted to work on the car.

In the case of the drive-through penalty and the ten-second time penalty, a driver has three laps, from the time his team is notified, to enter the pits (failure to do so may result in a black flag and the driver being excluded from the race).

The only exception is when the penalty is awarded during the final five laps of the race. In this case the driver may continue and complete the race. Twenty seconds will be added to his total race time in lieu of a drive-through penalty, or 30 seconds in place of a ten-second time penalty, either of which may drop him considerably in the final race standings.

In extreme cases stewards may choose to enforce tougher penalties. They can drop a driver any number of grid positions at the next Grand Prix (so, for example, if the driver in question goes on to qualify on pole, a ten-place penalty would for drop him to 11th). They can also impose time penalties, reprimand a driver, exclude him from the results, or suspend him from the next race.

Any driver receiving three reprimands for driving infringements during a season will automatically receive a ten-place grid penalty for the current or next event.

16) INCIDENTS

16.1 «Incident» means any occurrence or series of occurrences involving one or more drivers, or any action by any driver, which is reported to the stewards by the race director (or noted by the stewards and referred to the race director for investigation) which:

- necessitated the suspension of a race under Articles 41;

- constituted a breach of these Sporting Regulations or the Code;

- caused a false start by one or more cars;

- caused a collision;

- forced a driver off the track;

- illegitimately prevented a legitimate overtaking manoeuvre by a driver;

- illegitimately impeded another driver during overtaking.

Unless in the opinion of the race director it was completely clear that a driver was in breach of any of the above, any incidents involving more than one car will normally be investigated after the race.

16.2 a) It shall be at the discretion of the stewards to decide, upon a report or a request by the race director, if a driver or drivers involved in an incident shall be penalised.

b) If an incident is under investigation by the stewards a message informing all teams which driver or drivers are involved will be displayed on the timing monitors.

Provided that such a message is displayed no later than five minutes after the race has finished the driver or drivers concerned may not leave the circuit without the consent of the stewards.

16.3 The stewards may impose any one of the penalties below on any driver involved in an Incident :

a) A drive-through penalty. The driver must enter the pit lane and re-join the race without stopping.

b) A ten second time penalty. The driver must enter the pit lane, stop at his pit for at least ten seconds and then re-join the race.

If either of the two penalties above are imposed during the last five laps, or after the end of a race, Article 16.4b) below will not apply and 20 seconds will be added to the elapsed race time of the driver concerned in the case of a) above and 30 seconds in the case of b).

c) A time penalty.

d) A reprimand.

If any of the four penalties above are imposed they shall not be subject to appeal.

e) A drop of any number of grid positions at the driver's next Event.

f) Exclusion from the results.

g) Suspension from the driver's next Event.

16.4 Should the stewards decide to impose either of the penalties under Article 16.3a) or b), the following procedure will be followed:

a) The stewards will give written notification of the penalty which has been imposed to the competitor concerned and will ensure that this information is also displayed on the timing monitors.

b) From the time the stewards' decision is notified on the timing monitors the relevant driver may cross the Line on the track no more than twice before entering the pit lane and, in the case of a penalty under Article 16.3b), proceeding to his garage where he shall remain for the period of the time penalty.

However, unless the driver was already in the pit entry for the purpose of serving his penalty, he may not carry out the penalty after the safety car has been deployed. The number of times the driver crosses the Line behind the safety car will be added to the maximum number of times he may cross the Line on the track.

Whilst a car is stationary in the pit lane as a result of incurring a time penalty it may not be worked on. However, if the engine stops it may be started after the time penalty period has elapsed.

c) When the time penalty period has elapsed the driver may rejoin the race.

d) Any breach or failure to comply with Articles 16.4b) or c) may result in the car being excluded.

18) SANCTIONS

18.1 The stewards may inflict the penalties specifically set out in these Sporting Regulations in addition to or instead of any other penalties available to them under the Code.

18.2 Any driver who receives three reprimands in the same Championship season will, upon the imposition of the third, be given a ten grid place penalty at that Event. If the third reprimand is imposed following an Incident during a race the ten grid place penalty will be applied at the driver's next Event.

The ten grid place penalty will only be imposed if at least two of the reprimands were imposed for a driving infringement.

20) DRIVING

20.1 The driver must drive the car alone and unaided.

20.2 Manoeuvres liable to hinder other drivers, such as more than one change of direction to defend a position,

deliberate crowding of a car beyond the edge of the track or any other abnormal change of direction, are not permitted.

20.3 Drivers must use the track at all times. For the avoidance of doubt the white lines defining the track edges are considered to be part of the track but the kerbs are not.

A driver will be judged to have left the track if no part of the car remains in contact with the track.

Should a car leave the track for any reason the driver may rejoin. However, this may only be done when it is safe to do so and without gaining any advantage.

20.4 As soon as a car is caught by another car which is about to lap it during the race the driver must allow the

faster driver past at the first available opportunity. If the driver who has been caught does not allow the faster driver past, waved blue flags will be shown to indicate that he must allow the following driver to overtake.

Any driver who is deemed to be ignoring the waved blue flags will be reported to the stewards of the meeting.

Officials

At every Grand Prix meeting there are seven key race officials who monitor and control the activities of the stewards and marshals to ensure the smooth and safe running of the event in accordance with FIA regulations.

Five of the seven officials are nominated by the FIA. These are the race director (currently Charlie Whiting), a permanent starter and three additional stewards, one of whom is nominated chairman. The additional stewards must be FIA Super Licence holders.

The other two key officials are nominated by the National Sporting Authority (ASN) of the country holding the race. These are the clerk of the course and an additional steward (who must be a national of the host nation). Both must be FIA Super Licence holders.

The clerk of the course works in consultation with the race director, who has overriding authority. The race director directs the clerk of the course on how to instruct the stewards during the various practice, qualifying and race sessions.

The race director and the clerk of the course, as well as the FIA technical delegate (currently Jo Bauer), must all be present at the event from 10am on Thursday (Wednesday in Monaco) onwards.

The race director, the clerk of the course and the chairman of the stewards must all be in radio contact while cars are on track. Furthermore, at these times the clerk of the course must be in the race-control headquarters and in radio contact with all of the marshal's posts.

12) OFFICIALS

12.1 From among holders of an FIA Super Licence the following officials will be nominated by the FIA:

- Two stewards one of whom will be permanent and appointed the non-voting chairman;

- A race director;

- A permanent starter.

12.2 From among holders of an FIA Super Licence the following officials will be nominated by the ASN and their names sent to the FIA at the same time as the application to organise the Event:

- One steward from among the ASN's nationals.

- The clerk of the course.

12.3 The clerk of the course shall work in permanent consultation with the race director. The race director shall have overriding authority in the following matters and the clerk of the course may give orders in respect of them only with his express agreement:

a) the control of practice and the race, adherence to the timetable and, if he deems it necessary, the making of any proposal to the stewards to modify the timetable in accordance with the Code or Sporting Regulations;

b) the stopping of any car in accordance with the Code or Sporting Regulations;

c) the stopping of practice or suspension of the race in accordance with the Sporting Regulations if he deems it unsafe to continue and ensuring that the correct restart procedure is carried out;

d) the starting procedure;

e) the use of the safety car.

12.4 The race director, the clerk of the course and the technical delegate must be present at the Event from 10.00 on the day of initial scrutineering and the stewards from 15.00 on the same day.

12.5 The race director must be in radio contact with the clerk of the course and the chairman of the stewards at all times when cars are permitted to run on the track. Additionally, the clerk of the course must be in race control and in radio contact with all marshal's posts during these times.

Parc Ferme

Parc ferme is an enclosed and secure area in the paddock where the cars are weighed and any other checks deemed necessary by race officials are made. Teams must leave their cars here from within three and a half hours of the end of the qualifying on Saturday until five hours before the start of the formation lap on Sunday.

However, the cars are deemed to be under parc ferme conditions for a much longer period - from the time they first exit the pits during qualifying until the start of the formation lap immediately prior to the race.

Under these conditions, the work teams may carry out on their cars is limited to strictly-specified routine procedures, which can only be performed under the watchful eye of the FIA Technical Delegate and race scrutineers. Fuel may be added to the cars, tyres changed and brakes bled. Minor front wing adjustments are also allowed, but little else. These controls mean that teams cannot make significant alterations to the set-up of a car between qualifying and the race.

The only exception to this is when there is a «change in climatic conditions», for example a dry qualifying session followed by a wet race, or vice versa. In this case the FIA will give the teams permission to make further appropriate changes to their cars.

34) POST QUALIFYING PARC FERME

34.1 Each car will be deemed to be in parc ferme from the time at which it leaves the pit lane for the first time during qualifying practice until the start of the race. Any car which fails to leave the pit lane during qualifying practice will be deemed to be in parc ferme at the end of Q1.

Between these times, other than when cars are returned to the parc ferme overnight, the following work may be carried out :

- engines may be started ;

- fuel may be added or removed and a fuel breather fitted ;

- wheels, wheel fasteners and tyres may be removed, changed or rebalanced and tyre pressures checked ;

- spark plugs may be removed in order to carry out an internal engine inspection and cylinder compression checks ;

- permitted heating or cooling devices may be fitted ;

- a jump battery may be connected and on board electrical units may be freely accessed via a physical connection to the car ;

- charging and / or discharging of the KERS energy storage devices;

- removal of the KERS energy storage devices which, once marked by the FIA technical delegate, may be retained overnight by the team ;

- the main electrical battery and radio batteries may be changed ;

- the brake system may be bled ;

- engine oil may be drained ;

- compressed gases may be drained or added ;

- fluids with a specific gravity less than 1.1 may be drained and/or replenished, however, fluids used for replenishment must conform to the same specification as the original fluid ;

- the aerodynamic set up of the front wing may be adjusted using the existing parts. No parts may be added, removed or replaced ;

- if the FIA technical delegate is satisfied that changes in climatic conditions necessitate alterations to the specification of a car, changes may be made to the air ducts around the front and rear brakes and radiator ducts. These changes may be made at any time after the message "CHANGE IN CLIMATIC CONDITIONS" is shown on the timing monitors, from this point the choice of air ducts around the front and rear brakes and radiator ducts is free and pitot tubes may be covered or uncovered, subject always to compliance with the relevant Technical Regulations.

- bodywork (excluding radiators) may be removed and / or cleaned ;

- cosmetic changes may be made to the bodywork and tape may be added ;

- any part of the car may be cleaned ;

- on board cameras, marshalling system components, timing transponders and any associated equipment may be removed, refitted or checked ;

- any work required by the FIA technical delegate ;

- changes to improve the driver's comfort. In this context anything other than the adjustment of mirrors, seat belts and pedals may only be carried out with the specific permission of the FIA technical delegate. The addition or removal of padding (or similar material) is also permitted but may only be carried out under supervision and, if required by the FIA technical delegate, must be removed before the post-race weighing procedure.

- drinking fluid for the driver may be added at any time, however, the capacity of the container for any such fluid must not exceed 1.5 litres ;

- repair of genuine accident damage ;

- any parts which are removed from the car in order to carry out any work specifically permitted above, or any parts removed to carry out essential safety checks, must remain close to it and, at all times, be visible to the scrutineer assigned to the relevant car.

Any work not listed above may only be undertaken with the approval of the FIA technical delegate following a written request from the team concerned. It must be clear that any replacement part a team wishes to fit is similar in mass, inertia and function to the original. Any parts removed will be retained by the FIA.

However, if a team wishes to change a part during the qualifying session and/or on the grid before the start of the race, this may be done without first seeking the permission of the technical delegate, provided it is reasonable for the relevant team to believe permission would be given if there was time to ask and the broken or damaged part remains in full view of the scrutineer assigned to the car at all times.

34.2 At the end of the qualifying practice at least six cars will be chosen at random to undergo further checks, once informed their car has been selected the team concerned must take the car to the parc ferme immediately.

34.3 Within three and a half hours of the end of the qualifying practice session all cars used during the session (or which were intended for use but failed to leave the pit lane) must be covered and ready for FIA seals to be applied in order to ensure that they remain secure until the following day. For marketing purposes this deadline may be extended for one car from each competitor for a maximum of two hours by prior arrangement with the FIA technical delegate. However, no work of any kind may be carried out on the car any

later than three and a half hours after the end of the qualifying practice session.

Whilst cars are covered overnight they may be fitted with devices to keep them warm.

34.4 Five hours before the start of the formation lap the seals and covers may be removed but the cars will remain under parc ferme conditions until the start of the race.

34.5 If a competitor modifies any part on the car or makes changes to the set up of the suspension whilst the car is being held under parc ferme conditions the relevant driver must start the race from the pit lane and follow the procedures laid out in Article 38.2.

34.6 One scrutineer will be allocated to each car for the purpose of ensuring that no unauthorised work is carried out whilst cars are being held under parc ferme conditions.

34.7 A list of parts replaced with the specific agreement of the FIA technical delegate whilst cars are being held under parc ferme conditions will be published and distributed to all teams prior to the race.

34.8 In order that the scrutineers may be completely satisfied that no alterations have been made to the suspension systems or aerodynamic configuration of the car (with the exception of the front wing) whilst in post-qualifying parc ferme, it must be clear from physical inspection that changes cannot be made without the use of tools.

44) POST RACE PARC FERME

44.1 Only those officials charged with supervision may enter the post race parc ferme. No intervention of any kind is allowed there unless authorised by such officials.

44.2 When the parc ferme is in use, parc ferme regulations will apply in the area between the Line and the parc ferme entrance.

44.3 The parc ferme shall be secured such that no unauthorised persons can gain access to it.

Pit-lane procedures

The pit-lane at every circuit is divided into two lanes. The lane closest to the pit wall is known as the ‘fast lane’, whilst the lane closest to the garages is the ‘inner lane’.

The FIA allocates garages and an area in the ‘inner lane’ where the teams may work, and within each space is one position - or pit box - where pit stops may be carried out during practice sessions, qualifying and the race.

Apart from drying or sweeping, teams are forbidden from improving the grip of their pit-stop position. Personnel are only allowed in the pit lane immediately before the stop and must withdraw to their garages as soon as their work is complete. It is also the team’s responsibility to release a car from its stop only when it is safe to do so.

During practice, refuelling is only permitted in a team’s garage. The driver may remain in the car, but the engine must be stopped. All personnel working on the car must wear protective fire-resistant clothing and an assistant carrying a suitable fire extinguisher must be beside the car during refuelling.

Teams are free to alter their cars’ fuel loads at will during practice and qualifying, but since 2010 refuelling has been forbidden during races.

23) PIT LANE

23.1 a) For the avoidance of doubt and for description purposes the pit lane will be divided into two lanes.

The lane closest to the pit wall will be designated the «fast lane» and may be no more than 3.5 metres wide, the lane closest to the garages will be designated the «inner lane».

Other than when cars are at the end of the pit lane under Articles 38.2 and 41.5, the inner lane is the only area where any work can be carried out on a car. However, no work may be carried out in the fast lane if it is likely to hinder other cars attempting to leave the pit lane.

b) The FIA will allocate garages and an area in the pit lane on a strictly equal basis where each team may work and, within each of these designated garage areas, one position where pit stops during both practice and the race may be carried out.

c) Powered devices which assist in lifting any part of a car are forbidden in the pit lane during a race.

d) Unless a car is pushed from the grid at any time during the start procedure, cars may only be driven from the team's designated garage area to the end of the pit lane.

Any car(s) driven to the end of the pit lane prior to the start or restart of a practice session, or any car(s) required to stop at the pit exit during a safety car period, must form up in a line in the fast lane and leave in the order they got there unless another car is unduly delayed.

e) Any driver that is required to start the race from the pit lane may not drive his car from his team's designated garage area until the 15 minute signal has been given and must stop in a line in the fast lane.

Under these circumstances working in the fast lane will be permitted but any such work is restricted to:

- starting the engine and any directly associated preparation ;

- the fitting or removal of permitted cooling and heating devices ;

- changes made for driver comfort ;

- changing wheels.

When cars are permitted to leave the pit lane they must do so in the order that was established under Article 38.2 unless another car is unduly delayed. At all times drivers must follow the directions of the marshals.

f) Other than drying, sweeping or any tyre rubber left when cars leave their pit stop position, competitors may not attempt to enhance the grip of the surface in the pit lane unless a problem has been clearly identified and a solution agreed to by the FIA safety delegate.

g) Competitors must not paint lines on any part of the pit lane.

h) Other than under e) above no equipment may be left in the fast lane.

i) Team personnel are only allowed in the pit lane immediately before they are required to work on a car and must withdraw as soon as the work is complete.

j) It is the responsibility of the competitor to release his car after a pit stop only when it is safe to do so. The competitor must also provide a means of clearly establishing, when being viewed from the front of the car, when that car was released.

23.2 Under exceptional circumstances the race director may ask for the pit entry to be closed during the race for safety reasons. At such times drivers may only enter the pit lane in order for essential and entirely evident repairs to be carried out to the car.

29) REFUELLING

29.1 a) Refuelling is only permitted in the team's designated garage area.

b) No car may be refuelled after it has left the pit lane for the first time whilst the pit exit is open for the race.

c) Fuel may not be added to nor removed from a car during a race.

29.2 No car may be refuelled, nor may fuel be removed from a car, at a rate greater than 0.8 litres/second.

29.3 The driver may remain in his car throughout refuelling but the engine must be stopped.

29.4 Each competitor must ensure that an assistant equipped with a suitable fire extinguisher of adequate capacity is beside the car throughout all refuelling operations.

Points

The top ten finishers in each Grand Prix score points towards both the drivers' and the constructors' world championships, according to the following scale:

1st : 25 points

2nd : 18 points

3rd : 15 points

4th : 12 points

5th : 10 points

6th : 8 points

7th : 6 points

8th : 4 points

9th : 2 points

10th : 1 point

(The only exception to this is when a race is suspended and cannot be restarted. If less than 75 per cent of the race distance has been completed half points are awarded, and if less than two laps have been completed, no points are awarded.)

For example, if in a given race Lewis Hamilton finishes second for McLaren and team mate Jenson Button fifth, then Hamilton and Button score 18 and ten points respectively towards the drivers' championship, while McLaren score 28 points (18 plus 10) towards the constructors' championship.

The drivers' and constructors' championship titles are awarded to the driver and constructor who score the most points over the course of the season. In the case of a dead heat for a championship place then the driver or constructor with the higher number of superior race results will be awarded the place.

6) WORLD CHAMPIONSHIP

6.1 The Formula One World Championship driver's title will be awarded to the driver who has scored the highest number of points, taking into consideration all the results obtained during the Events which have actually taken place.

6.2 The title of Formula One World Champion Constructor will be awarded to the make which has scored the highest number of points, results from both cars (see Article 13.6) being taken into account.

6.3 A constructor is the person (including any corporate or unincorporated body) which designs the Listed

Parts set out in Schedule 3 to The 2009 Concorde Agreement. The make of an engine or chassis is the name attributed to it by its constructor.

The obligation to design and use Listed Parts shall not prevent a constructor from outsourcing the design and/or manufacture of any Listed Parts to a third party in accordance with the provisions of Schedule 3 to The 2009 Concorde Agreement.

If the make of the chassis is not the same as that of the engine, the title will be awarded to the former which shall always precede the latter in the name of the car.

6.4 Points for both titles will be awarded at each Event according to the following scale :

1st : 25 points

2nd : 18 points

3rd : 15 points

4th : 12 points

5th : 10 points

6th : 8 points

7th : 6 points

8th : 4 points

9th : 2 points

10th : 1 point

6.5 If a race is suspended under Article 41, and cannot be resumed, no points will be awarded if the leader has completed less than two laps, half points will be awarded if the leader has completed more than two laps but less than 75% of the original race distance and full points will be awarded if the leader has completed more than 75% of the original race distance.

6.6 The drivers finishing first, second and third in the Championship must be present at the annual FIA Prize Giving ceremony.

7) DEAD HEAT

7.1 Prizes and points awarded for all the positions of competitors who tie, will be added together and shared equally.

7.2 If two or more constructors or drivers finish the season with the same number of points, the higher place in the Championship (in either case) shall be awarded to:

a) the holder of the greatest number of first places,

b) if the number of first places is the same, the holder of the greatest number of second places,

c) if the number of second places is the same, the holder of the greatest number of third places and so on until a winner emerges.

d) if this procedure fails to produce a result, the FIA will nominate the winner according to such criteria as it thinks fit.

Practice and qualifying

At each Grand Prix meeting all race drivers may participate in two one and a half-hour practice sessions on Friday (Thursday at Monaco), a one-hour session on Saturday morning and a qualifying session on Saturday afternoon. While individual practice sessions are not compulsory, a driver must take part in at least one Saturday session to be eligible for the race.

Saturday's one-hour qualifying session is split into three distinct parts, each with multiple drivers on track simultaneously, and each with the drivers running as many laps as they want:

Q1: All 26 cars may run laps at any time during the first 20 minutes of the hour. At the end of the first 20 minutes, the eight slowest cars drop out and fill the final eight grid places. However, any driver whose best Q1 lap time exceeds 107 percent of the fastest time set during that session will not be allowed to take part in the race.

(Under exceptional circumstances, which could include setting a suitable lap time in a practice session, the stewards may allow the driver to start the race. Should there be more than one driver accepted in this manner, the grid order will be determined by the stewards.)

Q2: After a seven-minute break, the times will be reset and the 18 remaining cars then will then run in a 15-minute session - again they may complete as many laps as they want at any time during that period. At the end of the 15 minutes, the eight slowest cars drop out and fill places 11 to 18 on the grid.

Q3: After a further eight-minute break, the times are reset and a final 10-minute session will feature a shootout between the remaining 10 cars to decide pole position and the starting order for the top 10 grid places. Again, these cars may run as many laps as they wish.

If a driver is deemed by the stewards to have stopped unnecessarily on the circuit or impeded another driver during qualifying, his times may be cancelled.

31) PRACTICE SESSIONS

31.1 Save where these Sporting Regulations require otherwise, pit lane and track discipline and safety measures will be the same for all practice sessions as for the race.

31.2 No driver may start in the race without taking part in at least one practice session on the second day of practice.

31.3 During all practices there will be a green and a red light at the end of the pit lane. Cars may only leave the pit lane when the green light is on. Additionally, a blue flag and/or a flashing blue light will be shown in the pit exit to warn drivers leaving the pit lane if cars are approaching on the track.

31.4 Unless written permission has been given by the FIA to do otherwise, the circuit may only be used for purposes other than the Event after the last practice session on each day of practice and on the day of the race no less than one hour before the end of the pit lane is opened to allow cars to cover a reconnaissance lap.

31.5 The interval between the first and second free practice sessions, in addition to the interval between the third free practice session and the qualifying practice session, may never be less than two hours.

31.6 In the event of a driving infringement during any practice session the Stewards may drop the driver such number of grid positions as they consider appropriate. Unless it is completely clear that a driver committed a driving infringement any such incident will normally be investigated after the relevant session, any penalty imposed shall not be subject to appeal.

Where appropriate, regard will also be given to the provisions of Article 18.1.

31.7 Any driver taking part in any practice session who, in the opinion of the stewards, stops unnecessarily on the circuit or unnecessarily impedes another driver shall be subject to the penalties referred to in Article 31.6.

31.8 Should it become necessary to stop any practice session because the circuit is blocked by an accident or because weather or other conditions make it dangerous to continue, the clerk of the course will order red flags to be shown at all marshal posts and the abort lights to be shown at the Line.

When the signal is given to stop, all cars shall immediately reduce speed and proceed slowly back to the pit lane, and all cars abandoned on the track will be removed to a safe place.

At the end of each practice session no driver may cross the Line more than once.

31.9 The clerk of the course may interrupt practice as often and for as long as he thinks necessary to clear the track or to allow the recovery of a car. However, only during qualifying practice will the session be extended as a result.

Should one or more sessions be thus interrupted, no protest can be accepted as to the possible effects of the interruption on the qualification of drivers admitted to start.

32) FREE PRACTICE

32.1 Free practice sessions will take place :

a) The day after initial scrutineering from 10.00 to 11.30 (P1) and from 14.00 to 15.30 (P2).

b) The day before the race from 11.00 to 12.00 (P3).

33) QUALIFYING PRACTICE

33.1 The qualifying practice session will take place on the day before the race from 14.00 to 15.00. The session will be run as follows:

a) From 14.00 to 14.20 (Q1) all cars will be permitted on the track and at the end of this period the slowest eight cars will be prohibited from taking any further part in the session.

Lap times achieved by the eighteen remaining cars will then be deleted.

b) From 14.27 to 14.42 (Q2) the eighteen remaining cars will be permitted on the track and at the end of this period the slowest eight

cars will be prohibited from taking any further part in the session.

Lap times achieved by the ten remaining cars will then be deleted.

c) From 14.50 to 15.00 (Q3) the ten remaining cars will be permitted on the track.

The above procedure is based upon a Championship entry of 26 cars. If 24 cars are entered seven will be excluded after Q1 and Q2 and if 22 cars are entered only six cars will be excluded after Q1 and Q2.

33.2 Any driver whose car stops on the circuit during the qualifying session will not be permitted to take any further part in the session. Any car which stops on the circuit during the qualifying session, and which is returned to the pits before the end of the session, will be held in parc ferme until the end of the session.

36) THE GRID

36.1 At the end of qualifying practice the times achieved by each driver will be officially published.

36.2 a) The grid will be drawn up as follows :

i) The last eight positions will be occupied by the cars eliminated during Q1, the fastest in 19th position.

ii) The next eight positions will be occupied by the cars eliminated during Q2, the fastest in 11th position.

iii) The top ten positions will be occupied by the cars which took part in Q3, the fastest from the position on the grid which was the pole position in the previous year or, on a new circuit, has been designated as such by the FIA safety delegate.

If two or more drivers set identical times during Q1, Q2 or Q3 priority will be given to the one who set it first.

If less than 26 cars are entered in the Championship appropriate amendments will be made to the above in accordance with Article 33.1.

b) If more than one driver fails to set a time during Q1, Q2 or Q3 they will be arranged in the following order :

i) any driver who attempted to set a qualifying time by starting a flying lap ;

ii) any driver who failed to start a flying lap ;

iii) any driver who failed to leave the pits during the period.

c) Once the grid has been established in accordance with a) and b) above, grid position penalties will be applied to the drivers in question in the order the offences were committed. If more than one driver incurs a penalty under Article 28.4(a) or Article 28.6(a) preference will be given to the driver whose team first informed the technical delegate that an engine or gearbox change will be carried out.

d) Any driver who incurs a penalty under Article 28.4(a) or Article 28.6(a) will take precedence over any driver whose qualifying times have been deleted for any reason.

If more than one driver falls into a single category in b) or d) above they will be arranged on the grid in numerical order.

36.3 During Q1, any driver whose best qualifying lap exceeds 107% of the fastest time set during that session will not be allowed to take part in the race. Under exceptional circumstances however, which may include setting a suitable lap time in a free practice session, the stewards may permit the car to start the race.

Should there be more than one driver accepted in this manner, the grid order will be determined by the stewards.

In either case, a competitor will not be able to appeal against the stewards decision.

36.4 The starting grid will be published no less than four hours before the start of the formation lap. Any competitor whose car(s) is (are) unable to start for any reason whatsoever (or who has good reason to believe that their car(s) will not be ready to start) must inform the stewards accordingly at the earliest opportunity and, in any event, no later than one hour and fifteen minutes before the start of the formation lap. If one or more cars are withdrawn the grid will be closed up accordingly. The final starting grid will be published one hour before the start of the formation lap.

36.5 The grid will be in a staggered 1 x 1 formation and the rows on the grid will be separated by 16 metres.

Race start procedure

Prior to every Grand Prix the teams and drivers must adhere to a very strict starting procedure. This gets underway 30 minutes before the formation lap when the pit lane is opened.

Drivers are then free to complete a reconnaissance lap of the circuit before taking up their grid positions. If a driver wishes to complete additional reconnaissance laps he must pass through the pit lane each time in order to bypass the grid.

The pit lane closes 15 minutes prior to the formation lap. Any drivers still in the pit lane at this time will have to start the race from there.

Ten minutes before the start the grid must be cleared except for team technical staff, race officials and drivers. With three minutes to go all cars must have their wheels fitted (any car not complying will receive a 10-second time penalty).

With a minute to go all cars must have their engines running. All personnel must then leave the grid at least 15 seconds before the green lights come on to signal the start of the formation lap.

Any driver who has a problem immediately prior to the green light must raise his arm to indicate this. Once the rest of the field has moved off marshals will push the car into the pit lane.

During the formation lap no practice starts are allowed. Overtaking is also forbidden unless passing a car that has slowed due to a technical problem. Passed cars may in turn re-overtake in order to regain their grid position if the problem is resolved during the course of the formation lap.

However, any driver who is still on the grid when all other cars have moved off on the formation lap, but then subsequently gets away, may not re-pass cars to regain his grid position, but must instead start from the back.

Once all cars have safely taken up their grid positions at the end of the formation lap five red lights will appear in sequence at one-second intervals. These red lights are then extinguished to signal the start of the race.

If a driver has a problem on the grid immediately prior to the start he must raise his arm and the start will be aborted. A new formation lap, which will count towards the race distance, will then be completed.

The only exceptions to these start procedures are connected to the weather. If it starts to rain in the three minutes prior to the start then the abort lights will come on and the starting procedure will revert to the 10-minute point to allow teams to change to appropriate tyres.

If the weather is exceptionally bad the race director may choose to abort the start and resume the starting procedure only when conditions have improved. Alternatively, he may decide to start the race behind the safety car.

38) STARTING PROCEDURE

38.1 30 minutes before the start of the formation lap the pit exit will be opened and cars will be permitted to leave the pit lane to cover a reconnaissance lap. At the end of this lap they will stop on the grid in starting order with their engines stopped.

Should they wish to cover more than one reconnaissance lap, this must be done by driving down the pit lane at greatly reduced speed between each of the laps.

Any car which does not complete a reconnaissance lap and reach the grid under its own power will not be permitted to start the race from the grid.

38.2 17 minutes before the start of the formation lap, a warning signal will be given indicating that the end of the pit lane will be closed in two minutes.

15 minutes before the start of the formation lap the end of the pit lane will be closed and a second warning signal will be given. Any car which is still in the pit lane can start from the end of the pit lane provided it got there under its own power. If more than one car is affected they must line up in the order in which they qualified. However, any car reaching the end of the pit lane after the five minute signal must start behind any car already at the pit exit.

All such cars may then join the race once the whole field has passed the end of the pit lane for the first time after the start.

38.3 The approach of the start will be announced by signals shown ten minutes, five minutes, three minutes, one minute and fifteen seconds before the start of the formation lap, each of which will be accompanied by an audible warning.

When the ten minute signal is shown, everybody except drivers, officials and team technical staff must leave the grid.

38.4 When the three minute signal is shown all cars on the grid must have their wheels fitted, after this signal wheels may only be removed in the pit lane or on the grid during a race suspension.

A ten second time penalty (see Article 16.3.b) will be imposed on any driver whose car did not have all its wheels fully fitted at the three minute signal.

38.5 When the one minute signal is shown, engines should be started and all team personnel must leave the grid by the time the 15 second signal is given taking all equipment with them. If any driver needs assistance after the 15 second signal he must raise his arm and, when the remainder of the cars able to do so have left the grid, marshals will be instructed to push the car into the pit lane. In this case, marshals with yellow flags will stand beside any car (or cars) concerned to warn drivers behind.

38.6 When the green lights are illuminated, the cars will begin the formation lap with the pole position driver

leading. When leaving the grid all drivers must respect the pit lane speed limit until they pass pole position. Marshals will be instructed to push any car (or cars) which remain on the grid into the pit lane by the fastest route immediately after cars able to do so have left the grid. Any driver being pushed from the grid may not attempt to start the car and must follow the instructions of the marshals.

38.7 During the formation lap practice starts are forbidden and the formation must be kept as tight as possible.

38.8 Overtaking during the formation lap is only permitted if a car is delayed and cars behind cannot avoid passing it without unduly delaying the remainder of the field. In this case, drivers may only overtake to re-establish the original starting order. Any driver delayed in this way, and who is unable to re-establish the original starting order before he reaches the first safety car line, must enter the pit lane and start from the end of the pit lane as specified in Article 38.2.

Any driver who is delayed leaving the grid may not overtake another moving car if he was stationary after the remainder of the cars had crossed the Line, and must start the race from the back of the grid. If more than one driver is affected, they must form up at the back of the grid in the order they left to complete the formation lap. If the Line is not situated in front of pole position, and for the purposes of this Article as well as Articles 40.14 and 42.6, it will be deemed to be a white line one metre in front of pole position.

Either of the penalties under Articles 16.3a) or b) will be imposed on any driver who, in the opinion of the Stewards, unnecessarily overtook another car during the formation lap.

38.9 When the cars come back to the grid at the end of the formation lap, they will stop on their respective grid positions, keeping their engines running. There will be a standing start, the signal being given by means of lights activated by the permanent starter.

Once all the cars have come to a halt the five second light will appear followed by the four, three, two and one second lights. At any time after the one second light appears, the race will be started by extinguishing all red lights.

38.10 Unless specifically authorised by the FIA, during the start of a race the pit wall must be kept free of all persons with the exception of two people from each team, officials and fire marshals.

38.11 If, after returning to the starting grid at the end of the formation lap a problem arises, the following procedures shall apply :

a) If a car develops a problem that could endanger the start the driver must immediately raise his hands above his head and the marshal responsible for that row must immediately wave a yellow flag. If the race director decides the start should be delayed the green lights will be illuminated two seconds after the abort lights are switched on, a board saying “EXTRA FORMATION LAP” will be displayed and all cars able to do so must complete a further formation lap whilst the car which developed the problem is moved into the pit lane.

The team may then attempt to rectify the problem and, if successful, the car may then start from the end of the pit lane. Should there be more than one car involved their starting order will be determined by the order in which they reached the end of the pit lane.

Every time this happens the race will be shortened by one lap.

b) If any other problem arises, and if the race director decides the start should be delayed, the following procedures shall apply :

1) If the race has not been started, the abort lights will be switched on, a board saying “DELAYED START” will be displayed, all engines will be stopped and the new formation lap will start five minutes later with the race distance reduced by one lap. The next signal will be the three minute signal.

Tyre changing on the grid is not permitted during such a delay.

Every time this happens the race will be shortened by one lap.

2) If the race has been started the marshals alongside the grid will wave their yellow flags to inform the drivers that a car is stationary on the grid.

3) If, after the start, a car is immobilised on the starting grid, it shall be the duty of the marshals to push it into the pit lane by the fastest route. Any driver being pushed from the grid may not attempt to start the car.

4) Once the car is in the pit lane his mechanics may attempt to start it, if successful the driver may rejoin the race. The driver and mechanics must follow the instructions of the track marshals at all times during such a procedure.

38.12 Should Article 38.11 apply, the race will nevertheless count for the Championship no matter how often the procedure is repeated, or how much the race is shortened as a result.

38.13 Either of the penalties under Articles 16.3a) or b) will be imposed for a false start judged using an FIA supplied transponder which must be fitted to the car as specified.

38.14 Only in the following cases will any variation in the start procedure be allowed :

a) If it starts to rain after the five minute signal but before the race is started and, in the opinion of the race director teams should be given the opportunity to change tyres, the abort lights will be shown on the Line and the starting procedure will begin again at the ten minute point.

b) If the start of the race is imminent and, in the opinion of the race director, the volume of water on the track is such that it cannot be negotiated safely even on wet-weather tyres, the abort lights will be shown on the Line and information concerning the likely delay will be displayed on the timing monitors. Once the start time is known at least ten minutes warning will be given.

c) If the race is started behind the safety car, Article 40.14 will apply.

38.15 The stewards may use any video or electronic means to assist them in reaching a decision. The stewards may overrule judges of fact. A breach of the provisions of the Code or these Sporting Regulations relating to the starting procedure, may result in the exclusion of the car and driver concerned from the Event.

Safety car

The safety car's main function, as its name implies, is to assist in maintaining safe track conditions throughout the Grand Prix weekend. It is driven by an experienced circuit driver and carries an FIA observer who is in permanent radio contact with race control.

If an accident or incident occurs that is not severe enough to warrant suspending the race, but which cannot be dealt with under yellow flags, then the safety car will be called on to the circuit to slow the cars down.

It will come on to the circuit with its orange lights on and all drivers must form a queue behind it with no overtaking allowed. The safety car will signal backmarkers to pass by using its green light until the race leader is immediately behind it.

If the incident that brought out the safety car has blocked the pit straight, the clerk of the course may direct the safety car to lead the field through the pit lane. Cars are free to stop at their pit garage should this happen.

When the safety car is ready to leave the circuit it extinguishes its orange lights, indicating to the drivers that it will peel off into the pits at the end of the current lap. The drivers then continue in formation until they cross the first safety-car line where green lights will indicate that they are free to race again.

In exceptional circumstances, such as in extremely poor weather, a race may begin behind the safety car, which will put its orange lights on at least a minute before the start to indicate this. When those lights switch to green the safety car will lead the field around the circuit in grid order.

Overtaking on this first lap is not allowed, unless a car has a problem getting away from the grid, in which case the delayed driver may repass cars in order to regain his original position. (If he fails to regain that position before the end of the lap, he must pit and rejoin the race once the field have passed the pit exit.) The safety car will peel into the pits at the end of the lap and drivers are free to race once they have crossed the first safety car line immediately prior to commencing the next lap. No overtaking is allowed if the safety car is on track on the final lap.

All laps completed behind the safety car count as race laps.

40) SAFETY CAR

40.1 The FIA safety car will be driven by an FIA appointed driver and will carry an FIA observer capable of recognising all the competing cars who is in permanent radio contact with race control.

40.2 Thirty minutes before the start of the formation lap the safety car will take up position at the front of the grid and remain there until the five minute signal is given. At this point (except under 40.14 below) it will cover a whole lap of the circuit and take up position.

40.3 The safety car may be brought into operation to neutralise a race upon the order of the clerk of the course.

It will be used only if competitors or officials are in immediate physical danger but the circumstances are not such as to necessitate suspending the race.

40.4 When the order is given to deploy the safety car the message «SAFETY CAR DEPLOYED» will be displayed on the timing monitors and all marshal's posts will display waved yellow flags and «SC» boards for the duration of the intervention.

40.5 No car may be driven unnecessarily slowly, erratically or in a manner which could be deemed potentially

dangerous to other drivers or any other person at any time whilst the safety car is deployed. This will apply

whether any such car is being driven on the track, the pit entry or the pit lane.

40.6 The safety car will join the track with its orange lights illuminated and will do so regardless of where the race leader is.

40.7 All competing cars must then reduce speed and form up in line behind the safety car no more than ten car lengths apart. In order to ensure that drivers reduce speed sufficiently, from the time at which the "SAFETY CAR DEPLOYED" message is shown on the timing monitors until the time that each car crosses the first safety car line for the second time, drivers must stay above the minimum time set by the FIA ECU.

With the following exceptions, no car may overtake until it has passed the first safety car line for the first time when the safety car is returning to the pits. However, if the safety car is still deployed at the beginning of the last lap, or is deployed during the last lap, Article 40.13 will apply.

- if a car is signalled to do so from the safety car ;

- under 40.14 below ;

- When entering the pits any car may pass another car remaining on the track, including the safety car, after it has crossed the first safety car line.

- When leaving the pits any car, including the safety car, may overtake, or be overtaken by, another car on the track before it crosses the second safety car line.

- when the safety car is returning to the pits it may be overtaken by cars on the track once it has crossed the first safety car line ;

- any car stopping in its designated garage area whilst the safety car is using the pit lane (see 40.10 below) may be overtaken ;

- if any car slows with an obvious problem.

40.8 When ordered to do so by the clerk of the course the observer in the car will use a green light to signal to any cars between it and the race leader that they should pass. These cars will continue at reduced speed and without overtaking until they reach the line of cars behind the safety car.

40.9 The safety car shall be used at least until the leader is behind it and all remaining cars are lined up behind him.

Once behind the safety car, the race leader must keep within ten car lengths of it (except under 40.11 below) and all remaining cars must keep the formation as tight as possible.

40.10 Under certain circumstances the clerk of the course may ask the safety car to use the pit lane. In these

cases, and provided its orange lights remain illuminated, all cars must follow it into the pit lane without overtaking. Any car entering the pit lane under these circumstances may stop at its designated garage area.

Other than when the safety car has been asked to use the pit lane, no car may enter the pits whilst the safety car is deployed unless it is for the purpose of changing tyres.

40.11 When the clerk of the course decides it is safe to call in the safety car the message «SAFETY CAR IN THIS LAP» will be displayed on the timing monitors and the car's orange lights will be extinguished This will be the signal to the teams and drivers that it

will be entering the pit lane at the end of that lap.

At this point the first car in line behind the safety car may dictate the pace and, if necessary, fall more than ten car lengths behind it.

In order to avoid the likelihood of accidents before the safety car returns to the pits, from the point at which the lights on the car are turned out drivers must proceed at a pace which involves no erratic acceleration or braking nor any other manoeuvre which is likely to endanger other drivers or impede the restart.

As the safety car is approaching the pit entry the yellow flags and SC boards will be withdrawn and, other than on the last lap of the race, replaced by waved green flags with green lights at the Line. These will be displayed until the last car crosses the Line.

40.12 Each lap completed while the safety car is deployed will be counted as a race lap.

40.13 If the safety car is still deployed at the beginning of the last lap, or is deployed during the last lap, it will enter the pit lane at the end of the lap and the cars will take the chequered flag as normal without overtaking.

40.14 Under certain circumstances the race may be started behind the safety car or resumed in accordance with Article 42.5(a). In either case, at the ten minute signal its orange lights will be illuminated, this being the signal to the drivers that the race will be started (or resumed) behind the safety car. At the same time a message confirming this will be displayed on the timing monitors.

When the green lights are illuminated the safety car will leave the grid with all cars following in grid order no more than ten car lengths apart. During a race start there will be no formation lap and race will start when the green lights are illuminated.

Overtaking, during the first lap only, is permitted if a car is delayed when leaving its grid position and cars behind cannot avoid passing it without unduly delaying the remainder of the field. In this case, drivers may only overtake to re-establish the original starting order.

Any driver delayed in this way, and who is unable to re-establish the original starting order before he reaches the first safety car line, must enter the pit lane and may only join (or rejoin) the race once the whole field has passed the end of the pit lane.

Scrutineering and weighing

A team of specially appointed scrutineers has the power to check cars at any point during a Grand Prix weekend to ensure that they fully comply with technical and safety regulations.

Every car is initially examined on the Thursday of a race meeting (Wednesday at Monaco) and a car cannot take part in the event until it has passed scrutineering. A car must be re-examined by scrutineers if any significant changes are made to it by the team or if it is involved in an accident.

In addition to scrutineering, cars are also weighed during the Grand Prix weekend to ensure that they comply with minimum weight requirements (640kg). Cars taking part in Q1 and Q2 are called in at random to be weighed, while all cars participating in Q3 are weighed after the session. Classified finishers are weighed again after the race.

Any competitor failing to meet the minimum weight may lose their qualifying times or be excluded from the race results unless this is due to the accidental loss of part of the car.

24) SCRUTINEERING

24.1 Between 10.00 and 16.00 three days before the race (four days in Monaco) initial scrutineering of all cars will take place in the garage assigned to each competitor.

24.2 Unless a waiver is granted by the stewards, competitors who do not keep to these time limits will not be allowed to take part in the Event.

24.3 No car may take part in the Event until it has been passed by the scrutineers.

24.4 The scrutineers may :

a) check the eligibility of a car or of a competitor at any time during an Event ;

b) require a car to be dismantled by the competitor to make sure that the conditions of eligibility or conformity are fully satisfied ;

c) require a competitor to pay the reasonable expenses which exercise of the powers mentioned in this Article may entail ;

d) require a competitor to supply them with such parts or samples as they may deem necessary.

24.5 Any car which, after being passed by the scrutineers, is dismantled or modified in a way which might affect its safety or call into question its eligibility, or which is involved in an accident with similar consequences, must be re-presented for scrutineering approval.

Any such re-scrutineering may only take place with the consent of the stewards (following a written request from a competitor) and will be carried out the next morning.

24.6 The race director or the clerk of the course may require that any car involved in an accident be stopped and checked.

24.7 Checks and scrutineering shall be carried out by duly appointed officials who shall also be responsible for the operation of the parc fermé and who alone are authorised to give instructions to the competitors.

24.8 The stewards will publish the findings of the scrutineers each time cars are checked during the Event. These results will not include any specific figure except when a car is found to be in breach of the Technical Regulations.

26) WEIGHING

26.1 a) During the qualifying practice session cars will be weighed as follows :

1) the FIA will install weighing equipment in the first pit garage (the FIA garage) which will be used for the weighing procedure ;

2) cars taking part in Q1 and Q2 will be selected at random to undergo the weighing procedure ;

3) when signalled to do so the driver will proceed directly to the FIA garage and stop his engine;

4) the car will then be weighed with driver and the result given to the driver or a team representative in writing ;

5) At the end of the qualifying session all cars which took part in Q3 will be weighed. If a driver wishes to leave his car before it is weighed he must ask the technical delegate to weigh him in order that this weight may be added to that of the car.

6) if the car is unable to reach the FIA garage under its own power it will be placed under the exclusive control of the marshals who will take the car to be weighed ;

7) a car or driver may not leave the FIA garage without the consent of the FIA technical delegate;

8) if a car stops on the circuit and the driver leaves the car, he must go to the FIA garage immediately on his return to the pit lane in order for his weight to be established.

b) After the race every classified car will be weighed. If a driver wishes to leave his car before it is weighed he must ask the technical delegate to weigh him in order that this weight may be added to that of the car.

c) The relevant car may be excluded should its weight be less than that specified in Article 4.1 of the Technical Regulations when weighed under a) or b) above, save where the deficiency in weight results from the accidental loss of a component of the car.

d) No substance may be added to, placed on, or removed from a car after it has been selected for weighing or has finished the race or during the weighing procedure. (Except by a scrutineer when acting in his official capacity).

e) No one other than scrutineers and officials may enter or remain in the FIA garage without the specific permission of the FIA technical delegate.

26.2 In the event of any breach of these provisions for the weighing of cars the stewards may drop the driver such number of grid positions as they consider appropriate or exclude him from the race.

Spare cars, engines and gearboxes

FIA regulations state that teams may have no more than two cars available for use at any one time. Spare cars are no longer allowed, though teams may bring additional chassis which can be built up in the event of a race chassis being damaged beyond repair.

If a driver switches car between qualifying and the race then he must start the race from the pit lane. A change of car is not allowed once the race has started.

There are also restrictions on engine and gearbox use. Each driver may use no more than eight engines during a championship season. Should a driver use more than eight engines, he will drop 10 places on the starting grid of the event at which an additional unit is to be used.

Each driver may use no more than one gearbox for five consecutive events. Every unscheduled gearbox change will require the driver to drop five places on the grid at that meeting. Every subsequent unscheduled gearbox change will require the driver to drop five places on the grid.

If a driver fails to finish a race due to reasons beyond his or his team's control, he may start the next meeting with a different gearbox without incurring a penalty.

For 2011 only, each driver gets one penalty-free gearbox change, with the replacement box only required to complete the remainder of the event where the change was made, which cannot be the final event of the season.

28) SPARE CARS, ENGINES AND GEARBOXES

28.1 Each competitor may have no more than two cars available for use at any one time during an Event. Any partially assembled survival cell will be deemed to be a car in this context if it is fitted with an engine, any front suspension external to the survival cell, bodywork, radiators, oil tanks external to the survival cell or heat exchangers.

28.2 Any driver who decides to use another car or whose car has a change of survival cell following the qualifying practice session must start the race from the pit lane following the procedures detailed in Article 38.2. Under these circumstances :

- no restrictions on fuel load will be applied ;

- the car concerned will not have to comply with the requirements of Article 34 ;

- the car will be permitted to carry out one reconnaissance lap when the pit lane is opened for the race.

28.3 No change of car is permitted after the start of the race.

A change of car will be deemed to have taken place once a driver is seated in his new car and such change may only take place in the team's designated garage area.

28.4 a) Each driver may use no more than eight engines during a Championship season. Should a driver use more than eight engines he will drop ten places on the starting grid at the first Event during which each additional engine is used. If two such additional engines are used during a single Event the driver concerned will drop ten places on the starting grid at that Event and at the following Event.

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

b) If a driver is replaced at any time during the Championship season his replacement will be deemed to be the original driver for the purposes of assessing engine usage.

c) After consultation with the relevant engine supplier the FIA will attach seals to each engine prior to it being used for the first time at an Event in order to ensure that no significant moving parts can be rebuilt or replaced.

Within two hours of the end of the post race parc ferme exhaust blanking plates (with one 10mm diameter inspection hole per cylinder) and further seals will be applied to all used engines in order to ensure that these engines cannot be run between Events. Upon request to the FIA these additional seals will be removed after the start of initial scrutineering at the next Event at which the engines are required. All such engines must remain within the team's designated garage area when not fitted to a car and may not be started at any time during an Event other than when fitted to a car eligible to participate in the Event.

d) If any of the FIA seals are damaged or removed from an engine after it has been used for the first time that engine may not be used again unless they were removed under FIA supervision.

e) If an engine is changed in accordance with Article 34.1 the engine which was replaced may not be used during any future qualifying session or race with the exception of the last Event of the Championship.

28.5 Only engines which have been homologated by the FIA in accordance with Appendix 4 may be used at an Event during the 2008-2012 Championship seasons.

28.6 For the purposes of this Article only, an Event will be deemed to comprise P3, the qualifying practice session and the race.

a) Each driver may use no more than one gearbox for five consecutive Events in which his team competes. Should a driver use a replacement gearbox he will drop five places on the starting grid at that Event and an additional five places each time a further gearbox is used. Any replacement gearbox must be fitted with the same gear ratios that were declared under d) below and will only be required to complete the remainder of the Event in question. Any change to the gear ratios declared under d) below will incur a further five grid place penalty. In either case a new five race sequence may start at the following Event.

Unless the driver fails to finish the race (or is unable to start the race for reasons other than a penalty imposed by the stewards) the gearbox fitted to the car at the end of the Event must remain in it for the remainder of the five race sequence. Any driver who failed to finish the race at the first, second, third or fourth of the five Events for reasons which the technical delegate accepts as being beyond the control of the team or driver, may start the following Event with a different gearbox without a penalty being incurred.

A gearbox will be deemed to have been used once the car's timing transponder has shown that it has

left the pit lane.

b) If a driver is replaced after the first, second, third or fourth event of a five event period, having finished the first, second, third or fourth Events, the replacement driver must use the gearbox which the original driver had been using.

c) After consultation with the relevant team the FIA will attach seals to each gearbox in order to ensure that no moving parts, other than those specifically permitted under

d) At each Event seals may be broken once, under supervision and at any time prior to the second day

of practice, for the sole purpose of changing gear ratios and dog rings (excluding final drives or reduction gears). Competitors must inform the FIA technical delegate which ratios they intend to fit no later than two hours after the end of P2. However, one additional change of ratios and dog rings will be permitted if a gearbox change is necessary on the first day of practice before the end of P2. Gear ratios and dog rings (excluding final drives or reduction gears) may also be changed under supervision for others of identical specification at any time during an Event provided the FIA technical delegate is satisfied there is evident physical damage to the parts in question and that such changes are not being carried out on a systematic basis.

e) Other than under d) above, a replacement gearbox will also be deemed to have been used if any of the FIA seals are damaged or removed from the original gearbox after it has been used for the first time.

f) For 2011 only, except during the last Event of the Championship season, each driver will be permitted to use a replacement gearbox without incurring a penalty the first time this becomes necessary during the season. Under such circumstances the replacement gearbox will only be required to complete the remainder of the Event in question.

Suspending and resuming a race

If a race is suspended because of an accident or poor track conditions then red flags will be shown around the circuit. When this happens, the pit exit will be closed and all cars on track must proceed slowly to grid without overtaking and then stop in staggered formation with the first car to arrive taking up pole position. Any driver pitting after the red flag signal will be given a drive-through penalty.

The safety car will then be driven to the front of the queue. While the race is suspended team members may come onto the track to work on the cars, but refuelling is not allowed.

Cars that were already in the pits when the red flag signal was given may be worked on there. These cars, and any that enter the pits while the race is suspended, may only rejoin the track once the race has been resumed.

At least a ten-minute warning will be given before the race is resumed behind the safety car, which will lead the field for one lap before pulling into the pits. As usual, overtaking behind the safety car is forbidden, unless a driver is delayed when leaving the grid, forcing others to pass. In this case, the delayed driver may repass those cars in order to regain his original position. If he fails to regain that position before the end of the lap, he must pit and rejoin the race once the field have passed the pit exit.

If for whatever reason it is impossible to resume the race, the rules state that “the results will be taken at the end of the penultimate lap before the lap during which the signal to suspend the race was given”.

41) SUSPENDING A RACE

41.1 Should it become necessary to suspend the race because the circuit is blocked by an accident or because weather or other conditions make it dangerous to continue, the clerk of the course will order red flags to be shown at all marshal posts and the abort lights to be shown at the Line.

41.2 When the signal is given overtaking is forbidden, the pit exit will be closed and all cars must proceed slowly to the starting grid. The first car to arrive on the grid should occupy pole position and others should fill the remaining grid positions in the order they arrive.

If the safety car has been directed into the pit lane (see Article 40.10) cars should stop in line in the fast lane of the pits.

41.3 If any cars are unable to return to the grid as a result of the track being blocked they will be brought back when the track is cleared and will be arranged in the order they occupied before the race was suspended. The order will be taken at the last point at which it was possible to determine the position of all cars. Any such cars will then be permitted to resume the race.

The Safety Car will then be driven to the front of the grid.

41.4 Whilst the race is suspended :

- neither the race nor the timekeeping system will stop, however, in accordance with Article 5.3 the length of the race suspension will be added to the maximum two hour period ;

- cars may be worked on once they have stopped on the gridor entered the pits but any such work must not impede the resumption of the race ;

- refuelling is forbidden. A ten second time penalty (see Article 16.3b) will be imposed on any driver who enters the pit lane and whose car is refuelled after the signal to suspend the race was given. However, any car which was in the pit entry or pit lane when the signal to suspend the race was given will not incur a penalty ;

- only team members and officials will be permitted on the grid.

41.5 Cars may not enter the pit lane when the race is suspended. A drive through penalty (see Article 16.3.a) will be imposed on any driver who enters the pit lane or whose car is pushed from the grid to the pit lane after the race has been suspended. Any car which was in the pit entry or pit lane when the race was suspended will not incur a penalty. However, if the cars have been directed into the pit lane (see Articles 40.10 and 41.2) a penalty will only be imposed on any driver whose car is moved from the fast lane to any other part of the pit lane.

All cars in the pit lane will be permitted to leave the pits once the race has been resumed but any which were in the pit entry or pit lane when the race was suspended will be released before any others. Subject to the above, any car intending to resume the race from the pit exit may do so in the order they got there under their own power, unless another car was unduly delayed.

Under these circumstances working in the fast lane will be permitted but any such work will be restricted to:

- starting the engine and any directly associated preparation ;

- the fitting or removal of permitted cooling and heating devices ;

- changes made for driver comfort ;

- changing wheels.

At all times drivers must follow the directions of the marshals.

42) RESUMING A RACE

42.1 The delay will be kept as short as possible and as soon as a resumption time is known teams will be informed via the timing monitors, in all cases at least ten minutes warning will be given.

42.2 Signals will be shown ten minutes, five minutes, three minutes, one minute and fifteen seconds before the resumption and each of these will be accompanied by an audible warning.

42.3 When the three minute signal is shown all cars on the grid must have their wheels fitted, after this signal

wheels may only be removed in the pit lane, or on the grid during a further race suspension. If the race has been suspended in the pit lane (see Article 41.2) all cars in the fast lane must have their wheels fitted at the three minute signal.

A ten second time penalty (see Article 16.3.b) will be imposed on any driver whose car did not have all its wheels fully fitted at the three minute signal.

At the two minute point any cars between the safety car and the leader will be waved off to complete a further lap, without overtaking, and join the line of cars behind the safety car.

42.4 When the one minute signal is shown, engines should be started and all team personnel must leave the grid by the time the 15 second signal is given taking all equipment with them. If any driver needs assistance after the 15 second signal he must raise his arm and, when the remainder of the cars able to do so have left the grid, marshals will be instructed to push the car into the pit lane. In this case, marshals with yellow flags will stand beside any car (or cars) concerned to warn drivers behind.

42.5 The race will be resumed behind the safety car when the green lights are illuminated. The safety car will enter the pits after one lap unless :

a) the race is being resumed in wet conditions and the race director deems more than one lap necessary, in which case see Articles 25.4(g) and 40.15 ;

b) all cars are not yet in a line behind the safety car ;

c) team personnel are still clearing the grid ;

d) a further incident occurs necessitating another intervention.

When the green lights are illuminated the safety car will leave the grid with all cars following no more than ten car lengths apart. Soon after the last car in line behind the safety car passes the end of the pit lane (including any cars which were waved off under 42.3 above) the pit exit light will be turned green, any car in the pit lane may then enter the track and join the line of cars behind the safety car.

42.6 Overtaking during the lap is permitted only if a car is delayed when leaving the grid and cars behind cannot avoid passing it without unduly delaying the remainder of the field. In this case, drivers may only overtake to re-establish the order before the race was suspended.

Any driver delayed in this way, and who is unable to re-establish the original starting order before he

reaches the first safety car line, must enter the pit lane and may only rejoin the race once the whole field

has passed the end of the pit lane.

42.7 Either of the penalties under Article 16.3a) or b) will be imposed on any driver who, in the opinion of the stewards, unnecessarily overtook another car during the lap.

During this lap Articles 40.11, 40.12, 40.13, and 40.14 will apply.

42.8 If the race cannot be resumed the results will be taken at the end of the penultimate lap before the lap during which the signal to suspend the race was given.

Testing

As the sport's technical demands have grown in recent years, so too has the importance of testing. But with the FIA ever mindful of rising costs, since 2009 teams have been limited to 15,000 test kilometres during a calendar year. Young driver training (one three-day test per year) and promotional events do not count towards this tally.

Testing can only take place at FIA-approved sites and, ahead of a session, teams must inform the governing body of their schedule so that an observer can be appointed if deemed necessary. All cars must be fitted with the standardised, FIA-approved Electronic Control Unit during tests.

Since 2009, testing during the race season itself has been banned (from the week preceding the first Grand Prix to December 31), with the exception of a small number of straight-line aero tests. There are also restrictions on wind tunnel testing - the scale models used may be no larger than 60 percent and speeds are limited to 50 metres per second.

22) TRACK AND WIND TUNNEL TESTING

22.1 Track testing shall be considered any track running time not part of an Event undertaken by a competitor entered in the Championship, using cars which conform substantially with the 2010, 2011 or 2012 Formula One Technical Regulations, with the exception of promotional events carried out using tyres provided specifically for this purpose by the appointed supplier.

22.2 No competitor may carry out more than 15,000km of track testing during a calendar year.

22.3 No track testing may take place :

a) Whilst a Championship Event is taking place.

b) During the month of August except under c) iii) below.

c) Between the start of the week preceding the first Event of the Championship and 31 December of the same year with the following exceptions :

i) One three day young driver training test, carried out on a site approved by the FIA for Formula 1 cars either, between the end of the last Event of the Championship and 31 December of the same year or, at any other time during the Championship season following the agreement of all competitors and the FIA. No driver who has competed in more than two F1 World Championship races may take part in this test and all drivers must be in possession of an International A Licence.

ii) Four one day aerodynamic tests carried out on FIA approved straight line or constant radius sites between 1 January 2012 and the end of the last Event of the Championship. Any of these days may be substituted for four hours of wind-on full scale wind tunnel testing to be carried out in a single twenty four hour period.

iii) If a team declares that one of its current race drivers is to be substituted by a driver who has not participated in an F1 race in the two previous calendar years, one day of track testing will be permitted between the start of the week preceding second Event and the last Event of the Championship. The following must be observed :

- Any such day may only be carried out by the new driver and may not take place on a circuit hosting a race in the current Championship year.

- Any such day may only take place within a period 14 days prior to the substitution and 14 days after the substitution has taken place.

- If a team, having declared the driver's substitution and performed the test, does not then enter an Event with the new driver, the team will be penalised by a reduction of one day from the pre-season track testing days available in the following year.

22.4 During all track testing cars must be fitted with the FIA ECU required by Article 8.2 of the FIA Formula One Technical Regulations.

22.5 No track testing is permitted at sites which are not currently approved for use by Formula 1 cars. In order to ensure that venue licence conditions are respected at all times during track testing, competitors are required to inform the FIA of their test schedule in order that an observer may be appointed if deemed necessary.

22.6 During all Formula One track testing :

a) Red flag and chequered flag procedures must be respected.

b) No other type of vehicle is permitted on the track.

c) Every reasonable effort should be made to ensure that the recommendations concerning emergency services detailed in Article 16 of Appendix H to the Code are followed.

22.7 If, after an incident during track testing, the Medical Warning Light signals that threshold forces have been exceeded the driver must present himself for examination in the circuit medical centre without delay.

22.8 With the exception of the full scale testing permitted in 22.1(a) above, no wind tunnel testing may be carried out using a scale model which is greater than 60% of full size.

22.9 No wind tunnel testing may be carried out at a speed exceeding 50 metres/second.

Tyres

Formula One racing features a single tyre supplier, with all teams using identical Pirelli rubber. The advantages of this (over multiple tyre suppliers) include closer racing and reduced testing and development costs.

At each Grand Prix every team is given access to two specifications of dry-weather tyre. Unless conditions are wet, drivers must use both specifications during the race. The specifications can be visually differentiated by the colouring of the sidewall lettering: super soft - red; soft - yellow; medium - white; hard - silver.

Over the race weekend, each driver has access to 11 sets of dry-weather tyres (six of the harder 'prime' specification and five of the softer 'option' specification), four sets of intermediate tyres and three sets of wet tyres.

During Friday's first and second practice sessions the drivers are only allowed to use three sets of dry-weather tyres (two 'primes, one 'option'). One set of 'prime' tyres must be returned to the tyre supplier before Practice Two, and one set of each specification before the start of Practice Three.

A driver will then be allocated eight further sets of dry-weather tyres (four of each specification) to use over the rest of the event, but one set of each spec must be returned to the tyre supplier before the start of Saturday's qualifying session. At the start of the race the cars that took part in Q3 must be fitted with the tyres the driver used to set his grid time.

At certain events, teams may be given an extra set of primes for use in P1 and P2, or an additional specification of dry-weather tyre - again for P1 and P2 only - for evaluation purposes. Teams will be given at least a week's notice when either of these scenarios is to occur.

Teams are free to use wet tyres as they see fit during qualifying and the race. However, during the preceding practice sessions, they may only be used if the track has been declared wet by the race director. If a race is started behind the safety car due to heavy rain, the use of wet tyres is compulsory. Wet tyres are denoted by orange sidewall lettering, with light blue for intermediates.

Unless wet tyres have been used, drivers must use both dry tyre compounds during a race and failure to do so will see them excluded from the results. Or if the race is suspended and can't be

restarted, 30 seconds will be added to the elapsed race time of any driver who hasn't used both compounds.

All tyres are given a bar code at the start of the weekend so that the FIA can closely monitor their use and ensure that no team is breaking regulations

25) SUPPLY OF TYRES IN THE CHAMPIONSHIP AND TYRE LIMITATION DURING THE EVENT

25.1 Supply of tyres :

A single tyre manufacturer has been chosen by the FIA for the 2011, 2012 and 2013 seasons following an invitation for tenders to supply tyres to all the cars entered in Championship Events for the duration of these seasons. A single tyre manufacturer will be chosen by the FIA for subsequent seasons following an invitation for tenders to supply tyres to all the cars entered in Championship Events for the duration of such subsequent seasons.

The appointed tyre supplier must undertake to provide :

- two specifications of dry-weather tyre at each Event, each of which must be of one homogenous compound and visibly distinguishable from one another when a car is on the track. At certain Events one additional specification of dry-weather tyre may be made available to all teams for evaluation purposes following a recommendation to the FIA from the appointed tyre supplier. Teams will be informed about such an additional specification at least one week before the start of the relevant Event.

- one specification of intermediate tyre at each Event which must be of one homogenous compound ;

- one specification of wet-weather tyre at each Event which must be of one homogenous compound ;

25.2 Quantity of tyres during an Event:

a) Except under d) below, no driver may use more than eleven sets of dry-weather tyres, six of "prime" specification and five of "option" specification.

b) Except under e) below, no driver may use more than four sets of intermediate tyres and three sets of wet-weather tyres.

c) A set of tyres will be deemed to comprise two front and two rear tyres all of which must be of the same specification.

d) Following a recommendation to the FIA from the appointed tyre supplier, one additional set of "prime" specification tyres may be made available to all drivers. Teams will be informed about such an additional set at least one week before the start of the relevant Event.

e) If either P1 or P2 are declared wet one additional set of intermediate tyres will be made available to all drivers. This set of tyres must be returned to the tyre supplier before the start of P3.

25.3 Control of tyres :

a) The outer sidewall of all tyres which are to be used at an Event must be marked with a unique identification.

b) Other than in cases of force majeure (accepted as such by the stewards of the meeting), all tyres intended for use at an Event must be presented to the FIA technical delegate for allocation prior to the end of initial scrutineering.

c) At any time during an Event, and at his absolute discretion, the FIA technical delegate may select alternative dry-weather tyres to be used by any team or driver from among the stock of tyres the appointed supplier has present at the Event.

d) A competitor wishing to replace one unused tyre by another identical unused one must present both tyres to the FIA technical delegate.

e) The use of tyres without appropriate identification may result in a grid position penalty or exclusion from the race.

f) The only permitted type of tyre heating devices are blankets which use resistive heating elements. The heating elements may only act upon the outer tyre surface.

25.4 Use of tyres :

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

a) Three sets of dry-weather tyres will be allocated by the FIA technical delegate to each nominated driver for use during P1 and P2, two of "prime" specification and one of "option" specification. These are the only dry-weather tyres which may be used during these sessions.

One set of "prime" specification must be returned to the tyre supplier before the start of P2 and one further set of "prime" specification and one set of "option" specification before the start of P3.

If Article 25.2(c) is invoked an additional set of "prime" specification tyres will be available to each

nominated driver for use during P1 and P2. One set of "prime" specification tyres must be returned to

the tyre supplier after P1 and two further sets of "prime" specification and one set of "option"

specification before the start of P3.

If an additional driver is used (see Article 19.1(b) he must use the tyres allocated to the nominated

driver he replaced.

b) If an additional specification of dry-weather tyre is made available in accordance with Article 25.1 two sets of these tyres will be allocated to each driver for use during P1 and P2. Any such tyres must be returned to the tyre supplier before the start of P3.

c) Eight further sets of dry-weather tyres will be allocated by the FIA technical delegate to each nominated driver, four of each specification, for use during the remainder of the Event. However, one set of each specification must be returned to the tyre supplier before the start of the qualifying practice session and may not be used during the remainder of the Event.

d) Prior to the start of the qualifying practice session intermediate and wet-weather tyres may only be used after the track has been declared wet by the race director, following which intermediate, wet or dry-weather tyres may be used for the remainder of the session.

e) At the start of the race each car which took part in Q3 must be fitted with the tyres with which the driver set his grid time. This will only be necessary if dry-weather tyres were used to set the grid time and if dry-weather are used at the start of the race.

Any such tyres damaged during Q3 will be inspected by the FIA technical delegate who will decide, at his absolute discretion, whether any may be replaced and, if so, which tyres they should be replaced with.

f) Unless he has used intermediate or wet-weather tyres during the race, each driver must use at least one set of each specification of dry-weather tyres during the race.

If the race is suspended and cannot be re-started, thirty seconds will be added to the elapsed time of any driver who was unable to use both specifications of dry-weather tyre during the race. However, any driver who completes the race without using both specifications of dry-weather tyre will be excluded from the race results.

g) If the race is started behind the safety car because of heavy rain (see Article 40.14), or resumed in accordance with Article 42.5(a), the use of wet-weather tyres until the safety car returns to the pits is compulsory.

25.5 Testing of tyres :

a)Tyres supplied to any competitor at any time may not be used on any rig or vehicle (other than an F1 car on an F1 approved track, at the exclusion of any kind of road simulator), either Team owned or rented, providing measurements of forces and/or moments produced by a rotating full size F1 tyre, other than uniquely vertical forces, tyre rolling resistance and aerodynamic drag.

b) Tyres may be used on a test rig providing forces control and monitoring by F1 rim manufacturers for the sole purpose of proof testing their products.

Technical Regulations

Bodywork and dimensions

The size and dimensions of Formula One cars are tightly controlled by the regulations. They must be no more than 180cm wide. The length and height of the car are effectively governed by other specific parameters.

For example, bodywork ahead of the rear wheel centre line must be a maximum of 140cm wide. Bodywork behind it must be no more than 100cm wide. Front and rear overhangs are limited to 120cm and 60cm respectively from the wheel centre lines.

The strict regulations mean that the teams inevitably end up with very similarly sized cars. A typical car will be in the region of 4635mm long, 1800mm wide and 950mm high.

With the exception of the rear wing (see below), moveable bodywork is not allowed. Furthermore, any system, device or procedure which uses driver movement as a means of altering the aerodynamic characteristics of the car's bodywork is prohibited, effectively outlawing the F-ducts used in 2010.

From 2011, cars may be equipped with moveable rear wings which allow the driver to control the wing's angle of incidence (within specified limits) from the cockpit. However, during the race the system is electronically governed and is only available when a driver is less than one second behind another car at pre-determined points on the track. The system is then deactivated once the driver brakes. In combination with KERS, the aim is to boost overtaking.

ARTICLE 3: BODYWORK AND DIMENSIONS

One of the purposes of the regulations under Article 3 below is to minimize the detrimental effect that the wake of a car may have on a following car.

Furthermore, infinite precision can be assumed on certain dimensions provided it is clear that such an assumption is not being made in order to circumvent or subvert the intention of the relevant regulation.

For illustrations refer to drawings 1A-17A in the Appendix to these regulations.

3.1 Wheel centre line:

The centre line of any wheel shall be deemed to be half way between two straight edges, perpendicular to the surface on which the car is standing, placed against opposite sides of the complete wheel at the centre of the tyre tread.

3.2 Height measurements:

All height measurements will be taken normal to and from the reference plane.

3.3 Overall width:

The overall width of the car, excluding tyres, must not exceed 1800mm with the steered wheels in the straight ahead position and the tyres inflated to 1.4 bar.

If, when required for checking, a car is not already fitted with dry-weather tyres, the overall width will be measured on a set of dry-weather tyres selected by the FIA technical delegate.

3.4 Width ahead of the rear wheel centre line:

3.4.1 Bodywork width between the front and rear wheel centre lines must not exceed 1400mm.

3.4.2 In order to prevent tyre damage to other cars, any bodywork outboard of the most inboard part of the bodywork used to define the area required by Article 3.7.5, and which is more than 450mm ahead of the front wheel centre line, must be at least 10mm thick (being the minimum distance when measured normal to the surface in any direction) with a 5mm radius applied to all extremities.

3.4.3 In order to avoid the spread of debris on the track following an accident, the outer skins of the front wing endplates and any turning vanes in the vicinity of the front wheels (and any similarly vulnerable bodywork parts in this area), must be made predominantly from materials which are included for the specific purpose of containing debris.

The FIA must be satisfied that all such parts are constructed in order to achieve the stated objective.

3.5 Width behind the rear wheel centre line:

3.5.1 The width of bodywork behind the rear wheel centre line and less than 150mm above the reference plane must not exceed 1000mm.

3.5.2 The width of bodywork behind the rear wheel centre line and more than 150mm above the reference plane must not exceed 750mm.

3.6 Overall height:

No part of the bodywork may be more than 950mm above the reference plane.

3.7 Front bodywork :

3.7.1 All bodywork situated forward of a point lying 330mm behind the front wheel centre line, and more than 250mm from the car centre line, must be no less than 75mm and no more than 275mm above the reference plane.

3.7.2 Any horizontal section taken through bodywork located forward of a point lying 450mm forward of the front wheel centre line, less than 250mm from the car centre line, and between 125mm and 200mm above the reference plane, may only contain two closed symmetrical sections with a maximum total area of 5000mm2 The thickness of each section may not exceed 25mm when measured perpendicular to the car centre line.

Once fully defined, the sections at 125mm above the reference plane must be projected vertically to join the profile required by Article 3.7.3. A radius no greater than 10mm may be used where these sections join.

3.7.3 Forward of a point lying 450mm ahead of the front wheel centre line and less than 250mm from the car centre line and less than 125mm above the reference plane, only one single section may be contained within any longitudinal vertical cross section parallel to the car centre line. Furthermore, with the exception of local changes of section where the bodywork defined in Article 3.7.2 attaches to this section, the profile, incidence and position of this section must conform to Drawing 7.

3.7.4 In the area bounded by lines between 450mm and 1000mm ahead of the front wheel centre line, 250mm and 400mm from the car centre line and between 75mm and 275mm above the reference plane, the projected area of all bodywork onto the longitudinal centre plane of the car must be no more than 20,000mm2.

3.7.5 Ahead of the front wheel centre line and between 750mm and 840mm from the car centre line there must be bodywork with a projected area of no less than 95,000mm2 in side view.

3.7.6 Ahead of the front wheel centre line and between 840mm and 900mm from the car centre line there must be bodywork with a projected area of no less than 28,000mm2 in plan view. Furthermore, when viewed from underneath, the bodywork in this area must form one continuous surface which may not be more than 100mm above the reference plane.

3.7.7 Any longitudinal vertical cross section taken through bodywork ahead of the front wheel centre line and between 840mm and 900mm from the car centre line must contain an area no greater than 15,000mm2.

3.7.8 Only a single section, which must be open, may be contained within any longitudinal vertical cross section taken parallel to the car centre line forward of a point 150mm ahead of the front wheel centre line, less than 250mm from the car centre line and more than 125mm above the reference plane.

Any cameras or camera housings approved by the FIA in addition to a single inlet aperture for the purpose of driver cooling (such aperture having a maximum projected surface area of 1500mm2 and being situated forward of the section referred to in Article 15.4.3) will be exempt from the above.

3.8 Bodywork in front of the rear wheels:

3.8.1 Other than the rear view mirrors (including their mountings), each with a maximum area of 12000mm² and 14000mm2 when viewed from directly above or directly from the side respectively, no bodywork situated more than 330mm behind the front wheel centre line and more than 330mm forward of the rear wheel centre line, which is more than 600mm above the reference plane, may be more than 300mm from the car centre line.

3.8.2 No bodywork between the rear wheel centre line and a line 800mm forward of the rear wheel centre line, which is more than 375mm from the car centre line, may be more than 500mm above the reference plane.

3.8.3 No bodywork between the rear wheel centre line and a line 400mm forward of the rear wheel centre line, which is more than 375mm from the centre line of the car, may be more than 300mm above the reference plane.

3.8.4 Any vertical cross section of bodywork normal to the car centre line situated in the volumes defined below must form one tangent continuous curve on its external surface. This tangent continuous curve may not contain any radius less than 75mm :

a) the volume between 50mm forward of the rear wheel centre line and 300mm rearward of the rear face of the cockpit entry template, which is more than 25mm from the car centre line and more than 100mm above the reference plane ;

b) the volume between 300mm rearward of the rear face of the cockpit entry template and the rear face of the cockpit entry template, which is more than 125mm from the car centre line and more than 100mm above the reference plane ;

c) the volume between the rear face of the cockpit entry template and 450mm forward of the rear face of the cockpit entry template, which is more than 350mm from the car centre line and more than 100mm above the reference plane.

d)the volume between the rear face of the cockpit entry template and 450mm forward of the rear face of the cockpit entry template, which is more than 125mm from the car centre line and more than 675mm above the reference plane.

The surfaces lying within these volumes, which are situated more than 55mm forward of the rear wheel centre line, must not contain any apertures (other than those permitted by Article 3.8.5) or contain any vertical surfaces which lie normal to the car centre line.

3.8.5 Once the relevant bodywork surfaces are defined in accordance with Article 3.8.4, apertures, any of which may adjoin or overlap each other, may be added for the following purposes only :

- single apertures either side of the car centre line for the sole purpose of exhaust exits. These apertures may have a combined area of no more than 50,000mm2 when projected onto the surface itself. No point on an aperture may be more than 350mm from any other point on the aperture.

- apertures either side of the car centre line for the sole purpose of allowing suspension members and driveshafts to protrude through the bodywork. No such aperture may have an area greater than 12,000 mm2 when projected onto the surface itself. No point on an aperture may be more than 200mm from any other point on the aperture.

3.8.6 The impact absorbing structures defined by Article 15.5.2 must be fully enclosed by bodywork, such that no part of the impact structure is in contact with the external air flow. When cut by a longitudinal vertical plane, the bodywork enclosing these impact structures must not form closed sections in the region between 450mm and 875mm forward of the rear edge of the cockpit template.

3.8.7 With the exception of a transparent windscreen, antenna or pitot tubes, no bodywork higher than the top of the front roll structure will be permitted forward of it.

3.9 Bodywork between the rear wheels:

3.9.1 No bodywork situated between 50mm and 330mm forward of the rear wheel centre line may be more than 730mm above the reference plane.

3.9.2 No bodywork situated between 50mm forward of the rear wheel centre line and 150mm behind the rear wheel centre line, and which is between 75mm and 355mm from the car centre line, may be located between 400mm and 730mm above the reference plane.

3.10 Bodywork behind the rear wheel centre line:

3.10.1 Any bodywork more than 150mm behind the rear wheel centre line which is between 150mm and 730mm above the reference plane, and between 75mm and 355mm from the car centre line, must lie in an area when viewed from the side of the car that is situated between 150mm and 350mm behind the rear wheel centre line and between 300mm and 400mm above the reference plane. When viewed from the side of the car no longitudinal cross section may have more than one section in this area. Furthermore, no part of this section in contact with the external air stream may have a local concave radius of curvature smaller than 100mm.

Once this section is defined, ‘gurney’ type trim tabs may be fitted to the trailing edge. When measured in any longitudinal cross section no dimension of any such trim tab may exceed 20mm.

3.10.2 Other than the bodywork defined in Article 3.10.9, any bodywork behind a point lying 50mm forward of the rear wheel centre line which is more than 730mm above the reference plane, and less than 355mm from the car centre line, must lie in an area when viewed from the side of the car that is situated between the rear wheel centre line and a point 350mm behind it.

With the exception of minimal parts solely associated with adjustment of the section in accordance with Article 3.18 :

- when viewed from the side of the car, no longitudinal cross section may have more than two sections in this area, each of which must be closed.

- no part of these longitudinal cross sections in contact with the external air stream may have a local concave radius of curvature smaller than 100mm.

Once the rearmost and uppermost section is defined, 'gurney' type trim tabs may be fitted to the trailing edge. When measured in any longitudinal cross section no dimension of any such trim tab may exceed 20mm.

The chord of the rearmost and uppermost closed section must always be smaller than the chord of the lowermost section at the same lateral station.

Furthermore, the distance between adjacent sections at any longitudinal plane must lie between 10mm and 15mm at their closest position, except, in accordance with Article 3.18, when this distance must lie between 10mm and 50mm.

3.10.3 In order to ensure that the individual profiles and the relationship between these two sections can only change whilst the car is in motion in accordance with Article 3.18, they must be bridged by means of pairs

of rigid impervious supports arranged such that no part of the trailing edge of the forward section may be more than 200mm laterally from a pair of supports. These pairs of supports must :

- be located no more than 355mm from the car centre line ;

- fully enclose each complete sections such that their inner profiles match that of each section. With the exception of minimal local changes where the two sections are adjacent to each other, their outer profiles must be offset from the inner profiles by between 8mm and 30mm and may not incorporate any radius smaller than 10mm ('gurney' type trim tabs may however be fitted between the supports) ;

- be aligned as a pair so as to provide a bearing across their full thickness and along a profile length of at least 10mm when the distance between the two sections is at its closest position ;

- not be recessed into the wing profiles (where a recess is defined as a reduction in section at a rate greater than 45° with respect to a lateral axis) ;

- be arranged so that any curvature occurs only in a horizontal plane;

- be between 2mm and 5mm thick ;

- be rigidly fixed to their respective sections ;

- be constructed from a material with modulus greater than 50GPa.

These supports will be ignored when assessing whether the car is in compliance with Articles 3.6, 3.9.2, 3.10.1, 3.10.2, 3.10.4 and 3.10.6.

3.10.4 No part of the car between 75mm and 355mm from the car centre line may be more than 350mm behind the rear wheel centre line.

3.10.5 Any parts of the car less than 75mm from the car centre line and more than 500mm behind the rear wheel centre line must be situated between 200mm and 400mm above the reference plane.

3.10.6 No part of the car less than 75mm from the car centre line and more than 350mm behind the rear wheel centre line may be more than 400mm above the reference plane.

3.10.7 No part of the car more than 375mm from the car centre line may be more than 350mm behind the rear wheel centre line.

3.10.8 In side view, the projected area of any bodywork lying between 300mm and 950mm above the reference plane and between the rear wheel centre line and a point 600mm behind it and more than 355mm from the car centre line must be greater than 330000mm².

3.10.9 Any horizontal section between 600mm and 730mm above the reference plane, taken through bodywork located rearward of a point lying 50mm forward of the rear wheel centre line and less than 75mm from the car centre line, may contain no more than two closed symmetrical sections with a maximum total area of 5000mm2. The thickness of each section may not exceed 25mm when measured perpendicular to the car centre line.

Once fully defined, the section at 725mm above the reference plane may be extruded upwards to join the sections defined in Article 3.10.2. A fillet radius no greater than 10mm may be used where these sections join.

3.11 Bodywork around the front wheels:

3.11.1 With the exception of the air ducts described in Article 11.4 and the mirrors described in Article 3.8.1, in plan view, there must be no bodywork in the area formed by the intersection of the following lines :

- a longitudinal line parallel to and 900mm from the car centre line ;

- a transverse line 450mm forward of the front wheel centre line ;

- a diagonal line from 450mm forward of the front wheel centre line and 400mm from the car centre line to 750mm forward of the front wheel centre line and 250mm from the car centre line ;

- a transverse line 750mm forward of the front wheel centre line ;

- a longitudinal line parallel to and 165mm from the car centre line ;

- a diagonal line running forwards and inwards, from a point 875mm forward of the rear face of the cockpit entry template and 240mm from the car centre line, at an angle of 4.5 degrees to the car centre line ;

- a diagonal line from 875mm forward of the rear face of the cockpit entry template and 240mm from the car centre line to 625mm forward of the rear face of the cockpit entry template and 415mm from the car centre line ;

- a transverse line 625mm forward of the rear face of the cockpit entry template.

For reference this area is shown in Drawing 17A in the Appendix to these regulations.

3.11.2 With the exception of the air ducts described in Article 11.4, in side view, there must be no bodywork in the area formed by two vertical lines, one 325mm behind the front wheel centre line, one 450mm ahead of the front wheel centre line, one diagonal line intersecting the vertical lines at 100mm and 200mm above the reference plane respectively, and one horizontal line on the reference plane.

3.12 Bodywork facing the ground :

3.12.1 With the skid block referred to in Article 3.13 removed all sprung parts of the car situated from 330mm behind the front wheel centre line to the rear wheel centre line, and which are visible from underneath, must form surfaces which lie on one of two parallel planes, the reference plane or the step plane. This does not apply to any parts of rear view mirrors which are visible, provided each of these areas does not exceed 12000mm² when projected to a horizontal plane above the car, or to any parts of the panels referred to in Article 15.4.7.

The step plane must be 50mm above the reference plane.

3.12.2 Additionally, the surface formed by all parts lying on the reference plane must :

- cover the area which is bounded by two transversal lines, one 330mm behind the front wheel centre line and the other on the rear wheel centre line, and two longitudinal lines 150mm either side of the car centre line ;

- have a maximum width of 500mm ;

- be symmetrical about the car centre line ;

- have a 50mm radius (+/-2mm) on each front corner when viewed from directly beneath the car, this being applied after the surface has been defined.

3.12.3 The surface lying on the reference plane must be joined around its periphery to the surfaces lying on the step plane by a vertical transition. If there is no surface visible on the step plane vertically above any point around the periphery of the reference plane, this transition is not necessary.

3.12.4 The boundaries of the surfaces lying on the reference and step planes may be curved upwards with maximum radii of 25mm and 50mm respectively. Where the vertical transition meets the surfaces on the step plane a radius, no greater than 25mm, is permitted.

A radius in this context will be considered as an arc applied perpendicular to the boundary and tangential to both surfaces.

The surface lying on the reference plane, the surfaces lying on the step plane, the vertical transitions between them and any surfaces rearward of the surfaces lying on the reference or step planes, must first be fully defined before any radius can be applied or the skid block fitted. Any radius applied is still considered part of the relevant surface.

3.12.5 All parts lying on the reference and step planes, in addition to the transition between the two planes, must produce uniform, solid, hard, continuous, rigid (no degree of freedom in relation to the body/chassis unit), impervious surfaces under all circumstances.

Forward of a line 450mm forward of the rear face of the cockpit entry template, fully enclosed holes are permitted in the surfaces lying on the reference and step planes provided no part of the car is visible through them when viewed from directly below. This does not apply to any parts of rear view mirrors which are visible, provided each of these areas does not exceed 12000mm² when projected to a

horizontal plane above the car, or to any parts of the panels referred to in Article 15.4.7.

3.12.6 To help overcome any possible manufacturing problems, and not to permit any design which may contravene any part of these regulations, dimensional tolerances are permitted on bodywork situated between a point lying 330mm behind the front wheel centre line and the rear wheel centre line. A vertical tolerance of +/- 5mm is permissible across the surfaces lying on the reference and step planes and a horizontal tolerance of 5mm is permitted when assessing whether a surface is visible from beneath the car.

3.12.7 No bodywork which is visible from beneath the car and which lies between the rear wheel centre line and a

point 350mm rearward of it may be more than 125mm above the reference plane. With the exception of the aperture described below, any intersection of the surfaces in this area with a lateral or longitudinal vertical plane should form one continuous line which is visible from beneath the car.

An aperture for the purpose of allowing access for the device referred to in Article 5.16 is permitted in this surface. However, no such aperture may have an area greater than 3500mm2 when projected onto the surface itself and no point on the aperture may be more than 100mm from any other point on the aperture.

Additionally, any bodywork in this area must produce uniform, solid, hard, continuous, rigid (no degree of freedom in relation to the body/chassis unit), impervious surfaces under all circumstances.

3.12.8 All sprung parts of the car situated behind the rear wheel centre line, which are visible from underneath and are more than 250mm from the car centre line, must be at least 50mm above the reference plane.

3.12.9 In an area lying 450mm or less from the car centre line, and from 450mm forward of the rear face of the cockpit entry template to 350mm rearward of the rear wheel centre line, any intersection of any bodywork visible from beneath the car with a lateral or longitudinal vertical plane should form one continuous line which is visible from beneath the car. When assessing the compliance of bodywork surfaces in this area the aperture referred to in Article 3.12.7 need not be considered.

3.12.10 In an area lying 650mm or less from the car centre line, and from 450mm forward of the rear face of the cockpit entry template to 350mm forward of the rear wheel centre line, any intersection of any bodywork visible from beneath the car with a lateral or longitudinal vertical plane should form one continuous line which is visible from beneath the car.

3.12.11 Compliance with Article 3.12 must be demonstrated with the panels referred to in Articles 15.4.7 and 15.4.8 and all unsprung parts of the car removed.

3.13 Skid block :

3.13.1 Beneath the surface formed by all parts lying on the reference plane, a rectangular skid block, with a 50mm radius (+/-2mm) on each front corner, must be fitted. This skid block may comprise no more than three pieces, the forward one of which may not be any less than 1000mm in length, but must :

a) extend longitudinally from a point lying 330mm behind the front wheel centre line to the rear wheel centre line.

b) be made from an homogeneous material with a specific gravity between 1.3 and 1.45.

c) have a width of 300mm with a tolerance of +/- 2mm.

d) have a thickness of 10mm with a tolerance of +/- 1mm.

e) have a uniform thickness when new.

f) have no holes or cut outs other than those necessary to fit the fasteners permitted by 3.13.2 or those holes specifically mentioned in g) below.

g) have seven precisely placed holes the positions of which are detailed in Drawing 1. In order to establish the conformity of the skid block after use, it's thickness will only be measured in the four 50mm diameter holes and the two forward 80mm diameter holes.

Four further 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.

h) be fixed symmetrically about the car centre line in such a way that no air may pass between it and the surface formed by the parts lying on the reference plane.

3.13.2 Fasteners used to attach the skid block to the car must :

a) have a total area no greater than 40000mm² when viewed from directly beneath the car ;

b) be no greater than 2000mm² in area individually when viewed from directly beneath the car ;

c) be fitted in order that their entire lower surfaces are visible from directly beneath the car.

When the skid block is new, ten of the fasteners may be flush with its lower surface but the remainder may be no more than 8mm below the reference plane.

3.13.3 The lower edge of the periphery of the skid block may be chamfered at an angle of 30° to a depth of 8mm, the trailing edge however may be chamfered over a distance of 200mm to a depth of 8mm.

3.14 Overhangs :

3.14.1 No part of the car may be more than 600mm behind the rear wheel centre line or more than 1200mm in front of the front wheel centre line.

3.14.2 No part of the bodywork more than 200mm from the car centre line may be more than 1000mm in front of the front wheel centre line.

3.14.3 All overhang measurements will be taken parallel to the reference plane.

3.15 Aerodynamic influence :

With the exception of the driver adjustable bodywork described in Article 3.18 (in addition to minimal parts solely associated with its actuation) and the ducts described in Article 11.4, any specific part of the car influencing its aerodynamic performance :

- must comply with the rules relating to bodywork.

- must be rigidly secured to the entirely sprung part of the car (rigidly secured means not having any degree of freedom).

- must remain immobile in relation to the sprung part of the car.

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.

No part having an aerodynamic influence and no part of the bodywork, with the exception of the skid block in 3.13 above, may under any circumstances be located below the reference plane.

With the exception of the parts necessary for the adjustment described in Article 3.18, any car system, device or procedure which uses, or is suspected of using, driver movement as a means of altering the aerodynamic characteristics of the car is prohibited.

3.16 Upper bodywork :

3.16.1 With the exception of the opening described in Article 3.16.3, when viewed from the side, the car must have bodywork in the area bounded by four lines. One vertical 1330mm forward of the rear wheel centre line, one horizontal 550mm above the reference plane, one horizontal 925mm above the reference plane and one diagonal which intersects the 925mm horizontal at a point 1000mm forward of the rear wheel centre line and the 550mm horizontal at a point lying 50mm forward of the rear wheel centre line.

Bodywork within this area must be arranged symmetrically about the car centre line and, when measured 200mm vertically below the diagonal boundary line, must have minimum widths of 150mm and 50mm respectively at points lying 1000mm and 50mm forward of the rear wheel centre line. This bodywork must lie on or outside the boundary defined by a linear taper between these minimum widths.

3.16.2 Bodywork lying vertically above the upper boundary as defined in 3.16.1 may be no wider than 125mm and must be arranged symmetrically about the car centre line.

3.16.3 In order that a car may be lifted quickly in the event of it stopping on the circuit, the principal rollover structure must incorporate a clearly visible unobstructed opening designed to permit a strap, whose section measures 60mm x 30mm, to pass through it.

3.17 Bodywork flexibility :

3.17.1 Bodywork may deflect no more than 20mm vertically when a 1000N load is applied vertically to it 800mm forward of the front wheel centre line and 795mm from the car centre line. The load will be applied in a downward direction using a 50mm diameter ram to the centre of area of an adapter measuring 300mm x 150mm, the 300mm length having been positioned parallel to the car centre line. Teams must supply the adapter when such a test is deemed necessary.

The deflection will be measured along the loading axis at the bottom of the bodywork at this point and relative to the reference plane.

3.17.2 Bodywork may deflect no more than 10mm vertically when a 500N load is applied vertically to it 450mm forward of the rear

wheel centre line and 650mm from the car centre line. The load will be applied in a downward direction using a 50mm diameter ram and an adapter of the same size. Teams must supply the latter when such a test is deemed necessary.

3.17.3 Bodywork may deflect by no more than one degree horizontally when a load of 1000N is applied simultaneously to its extremities in a rearward direction 925mm above the reference plane and 20mm forward of the forward edge of the rear wing endplate.

3.17.4 Bodywork may deflect no more than 2mm vertically when a 500N load is applied simultaneously to each side of it 200mm behind the rear wheel centre line, 325mm from the car centre line and 970mm above the reference plane. The deflection will be measured at the outer extremities of the bodywork at a point 345mm behind the rear wheel centre line.

The load will be applied in a downward direction through pads measuring 200mm x 100mm which conform to the shape of the bodywork beneath them, and with their uppermost horizontal surface 970mm above the reference plane. The load will be applied to the centre of area of the pads. Teams must supply the latter when such a test is deemed necessary.

3.17.5 Bodywork may deflect no more than 5mm vertically when a 2000N load is applied vertically to it at three different points which lie on the car centre line and 100mm either side of it. Each of these loads will be applied in an upward direction at a point 380mm rearward of the front wheel centre line using a 50mm diameter ram in the two outer locations and a 70mm diameter ram on the car centre line. Stays or structures between the front of the bodywork lying on the reference plane and the survival cell may be present for this test, provided they are completely rigid and have no system or mechanism which allows non-linear deflection during any part of the test.

Furthermore, the bodywork being tested in this area may not include any component which is capable of allowing more than the permitted amount of deflection under the test load (including any linear deflection above the test load), such components could include, but are not limited to :

a) Joints, bearings pivots or any other form of articulation.

b) Dampers, hydraulics or any form of time dependent component or structure.

c) Buckling members or any component or design which may have, or is suspected of having, any non-linear characteristics.

d) Any parts which may systematically or routinely exhibit permanent deformation.

3.17.6 The uppermost aerofoil element lying behind the rear wheel centre line may deflect no more than 5mm horizontally when a 500N load is applied horizontally. The load will be applied 950mm above the reference plane at three separate points which lie on the car centre line and 190mm either side of it. The loads will be applied in a rearward direction using a suitable 25mm wide adapter which must be supplied by the relevant team.

3.17.7 The forward-most aerofoil element lying behind the rear wheel centre line and which lies more than 730mm above the reference plane may deflect no more than 2mm vertically when a 200N load is applied vertically. The load will be applied in line with the trailing edge of the element at any point across its width. The loads will be applied using a suitable adapter, supplied by the relevant team, which :

- may be no more than 50mm wide ;

- which extends no more than 10mm forward of the trailing edge ;

- incorporates an 8mm female thread in the underside.

3.17.8 In order to ensure that the requirements of Article 3.15 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.

3.18 Driver adjustable bodywork :

3.18.1 The incidence of the rearmost and uppermost closed section described in Article 3.10.2 may be varied whilst the car is in motion provided :

- It comprises only one component that must be symmetrically arranged about the car centre line with a minimum width of 708mm.

- With the exception of minimal parts solely associated with adjustment of the section, no parts of the section in contact with the external airstream may be located any more than 355mm from of the car centre line.

- With the exception of any minimal parts solely associated with adjustment of the rearmost and uppermost section, two closed sections are used in the area described in Article 3.10.2.

- Any such variation of incidence maintains compliance with all of

the bodywork regulations.

- When viewed from the side of the car at any longitudinal vertical cross section, the physical point of rotation of the rearmost and uppermost closed section must be fixed and located no more than 20mm below the upper extremity and no more than 20mm forward of the rear extremity of the area described in Article 3.10.2 at all times.

- The design is such that failure of the system will result in the uppermost closed section returning to the normal high incidence position.

- 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 8.2.

3.18.2 The adjustable bodywork may be activated by the driver at any time prior to the start of the race and, for the sole purpose of improving overtaking opportunities during the race, after the driver has completed a minimum of two laps after the race start or following a safety car period.

The driver may only activate the adjustable bodywork in the race when he has been notified via the control electronics (see Article 8.2) that it is enabled. It will only be enabled if the driver is less than one second behind another at any of the pre-determined positions around each circuit. The system will be disabled by the control electronics the first time the driver uses the brakes after he has activated the system.

The FIA may, after consulting all competitors, adjust the above time proximity in order to ensure the stated purpose of the adjustable bodywork is met.

Brake system

Formula One cars must have one brake system operated through a single brake pedal. However, the system must comprise two hydraulic circuits – one for the front wheels and one for the rear. Should one circuit fail the other must remain operational. Power brakes and anti-lock braking systems (ABS) are not allowed.

Each wheel must have no more than one brake disc of 278mm maximum diameter and 28mm maximum thickness. Each disc must have only one aluminium caliper, with a maximum of six circular pistons, and no more than two brake pads.

The size of the air ducts used to cool the brakes is strictly controlled and they must not protrude beyond the wheels. The use of liquid to cool the brakes is forbidden.

ARTICLE 11: BRAKE SYSTEM

11.1 Brake circuits and pressure distribution:

11.1.1 With the exception of a KERS, all cars must be equipped with only one brake system. This system must comprise solely of two separate hydraulic circuits operated by one pedal, one circuit operating on the two front wheels and the other on the two 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.

11.1.2 The brake system must be designed in order that the force exerted on the brake pads within each circuit are the same at all times.

11.1.3 Any powered device 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 moving must be made by the driver's direct physical input, may not be pre-set and must be under his complete control at all times.

11.2 Brake calipers:

11.2.1 All brake calipers must be made from aluminium materials

with a modulus of elasticity no greater than 80Gpa.

11.2.2 No more than two attachments may be used to secure each brake caliper to the car.

11.2.3 No more than one caliper, with a maximum of six pistons, is permitted on each wheel.

11.2.4 The section of each caliper piston must be circular.

11.3 Brake discs:

11.3.1 No more than one brake disc is permitted on each wheel.

11.3.2 All discs must have a maximum thickness of 28mm and a maximum outside diameter of 278mm.

11.3.3 No more than two brake pads are permitted on each wheel.

11.4 Air ducts:

Air ducts around the front and rear brakes will be considered part of the braking system and shall not protrude beyond:

- a plane parallel to the ground situated at a distance of 160mm above the horizontal centre line of the wheel;

- a plane parallel to the ground situated at a distance of 160mm below the horizontal centre line of the wheel;

- a vertical plane parallel to the inner face of the wheel rim and displaced from it by 120mm toward the car centre line.

Furthermore:

- when viewed from the side the ducts must not protrude forwards beyond a radius of 330mm from the centre of the wheel or backwards beyond a radius of 180mm from the centre of the wheel.

- the ducts may not rotate with the wheels nor may they, or any of their mountings, protrude axially beyond the outer face of the wheel fastener ;

- no part of the car, other than those specifically defined in Articles 12.8.1 and 12.8.2, may obscure any part of the wheel when viewed from the outside of the car towards the car centre line along the axis of the wheel.

All measurements will be made with the wheel held in a vertical position.

11.5 Brake pressure modulation:

11.5.1 No braking system may be designed to prevent wheels from locking when the driver applies pressure to the brake pedal.

11.5.2 No braking system may be designed to increase the pressure in the brake calipers above that achievable by the driver applying pressure to the pedal under static conditions.

11.6 Liquid cooling:

Liquid cooling of the brakes is forbidden.

Car construction

The construction of Formula One cars and the materials used are strictly controlled by the regulations to maximise their safety.

The main structure of the car comprises a safety cell which contains the cockpit plus the fuel tank, which is housed immediately behind (but separated from) the driver.

This safety cell must meet minimum size requirements and must have an impact-absorbing structure immediately in front of it. The design of the car must also include an additional impact-absorbing structure at the rear, behind the gearbox.

The car must have two roll structures to protect the driver in the event of the car overturning. One must be immediately behind the driver's head, the other at the front of the cockpit, immediately ahead of the steering wheel.

The car and its survival cell must pass several strict impact, roll and static load tests.

ARTICLE 15: CAR CONSTRUCTION

15.1 Permitted materials:

15.1.1 The following is the list of permitted materials. These are the only materials permitted to be used in the construction of the Formula One Car provided only that in all cases the material is available on a non-exclusive basis and under normal commercial terms to all competitors.

Permitted materials :

1) Aluminium alloys.

2) Silicon carbide particulate reinforced aluminium alloy matrix composites.

3) Steel alloys.

4) Cobalt alloys.

5) Copper alloys containing ¡Â 2.5% by weight of Beryllium.

6) Titanium alloys (but not for use in fasteners with <15mm diameter male thread).

7) Magnesium alloys.

8) Nickel based alloys containing 50% < Ni < 69%.

9) Tungsten alloy.

10) Thermoplastics : monolithic, particulate filled, short fibre reinforced.

11) Thermosets : monolithic, particulate filled, short fibre reinforced.

12) Carbon fibres manufactured from polyacrylonitrile (PAN) precursor. (*)

13) Carbon fibres manufactured from polyacrylonitrile (PAN) precursor which have :

- a tensile modulus ¡Â 550GPa ;

- a density ¡Â 1.92 g/cm ;

- unidirectional or planar reinforcement within their pre-impregnated form, not including three dimensional weaves or stitched fabrics (but three-dimensional preforms and fibre reinforcement using Z-pinning technology are permitted) ;

- no carbon nanotubes incorporated within the fibre or its matrix ;

- a permitted matrix, not including a carbon matrix.

14) Aramid fibres.

15) Poly(p-phenylene benzobisoxazole) fibres (e.g. ¡°Zylon¡±).

16) Polyethylene fibres.

17) Polypropylene fibres.

18) E and S Glass fibres.

19) Sandwich panel cores: Aluminium, Nomex, polymer foams, syntactic foams, balsa wood, carbon foam.

20) The matrix system utilised in all pre-impregnated materials must be epoxy, cyanate ester, phenolic, bismaleimide, polyurethane, polyester or polyimide based. (*)

21) The matrix system utilised in all pre-impregnated materials must be epoxy, cyanate ester or bismaleimide based.

22) Monolithic ceramics.

[Materials marked (*) are permitted only for parts classified as either front, rear or side impact structures, side intrusion panels or suspension members as regulated by Articles 15.4.3, 15.5.3, 15.4.6, 15.4.7 and 10.3 of the Technical Regulations respectively.]

Exceptions :

1) All electrical components (e.g. control boxes, wiring looms, sensors).

2) All seals & rubbers (e.g. rubber boots, o-rings, gaskets, any fluid seals, bump rubbers).

3) Fluids (e.g. water, oils).

4) Tyres.

5) Coatings and platings (e.g. DLC, nitriding, chroming).

6) Paint.

7) Adhesives.

8) Thermal insulation (e.g. felts, gold tape, heat shields).

9) All currently regulated materials (e.g. fuel bladder, headrest, extinguishant, padding, skid block).

10) Brake and clutch friction materials.

11) All parts of engines homologated according to Appendix 4 of the Sporting Regulations.

15.1.2 No parts of the car may be made from metallic materials which have a specific modulus of elasticity greater than 40 GPa/(g/cm3). Tests to establish conformity will be carried out in accordance with FIA Test Procedure 03/02, a copy of which may be found in the Appendix to these regulations.

15.2 Roll structures:

15.2.1 All cars must have two roll structures which are designed to help prevent injury to the driver in the event of the car becoming inverted.

The principal structure must be at least 940mm above the reference plane at a point 30mm behind the cockpit entry template. The second structure must be in front of the steering wheel but no more than 250mm forward of the top of the steering wheel rim in any position.

The two roll structures must be of sufficient height to ensure the driver›s helmet and his steering wheel are at least 70mm and 50mm respectively below a line drawn between their highest points at all times.

15.2.2 The principal structure must pass a static load test details of which may be found in Article 17.2. Furthermore, each team must supply detailed calculations which clearly show that it is capable of withstanding the same load when the longitudinal component is applied in a forward direction.

15.2.3 The highest point of the second structure may not be more than 670mm above the reference plane and must pass a static load test details of which may be found in Article 17.3.

15.2.4 The principal roll structure must have a minimum enclosed structural cross section of 10000mm², in vertical projection, across a horizontal plane 50mm below its highest point. The area thus established must not exceed 200mm in length or width and may not be less than 10000mm2 below this point.

15.2.5 The second roll structure must have a minimum enclosed structural cross section of 10000mm², in vertical projection, across a horizontal plane 50mm below its highest point.

15.3 Structure behind the driver:

The parts of the survival cell immediately behind the driver which separate the cockpit from the car›s fuel tank, and which lie less than 150mm from the car centre line, may be situated no further forward than the line a-b-c-d-e shown in Drawing 2.

In order to validate the integrity of this structure the survival cell must pass an impact test against a solid vertical barrier placed at right angles to the car centre line. Details of the test procedure may be found in Article 16.3.

15.4 Survival cell specifications:

15.4.1 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 6 and must be accessible for verification at any time.

15.4.2 The survival cell must have an opening for the driver, the minimum dimensions of which are given in Article 13.1. Any other

openings in the survival cell must be of the minimum size to allow access to mechanical components.

15.4.3 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.

It must have a minimum external cross section, in horizontal projection, of 9000mm©÷ at a point 50mm behind its forward-most point and, furthermore, no part of the cross-section taken at this point may lie more than 500mm above the reference plane.

15.4.4 Referring to Drawing 5:

The external width of the survival cell between the lines B-B and C-C must be no less than 450mm and must be at least 60mm per side wider than the cockpit opening when measured normal to the inside of the cockpit aperture. These minimum dimensions must be maintained over a height of at least 350mm.

The width of the survival cell may taper forward of the line B-B but, if this is the case, the outer surface must not lie closer to the car centre line than a plane which has a linear taper to a minimum width of 300mm at the line A-A.

The minimum width must be arranged symmetrically about the car centre line, must be maintained over a height of at least 400mm at the line B-B and 275mm at the line A-A. The height at any point between A-A and B-B must not be less than the height defined by a linear taper between these two sections. When assessing the minimum external cross-sections of the survival cell, radii of 50mm at the line B-B, and reducing at a linear rate to 25mm at the line A-A, will be permitted.

Following the application of the permitted radii, the external cross-sections of the survival cell between the lines A-A and B-B must, over their respective minimum widths, have a minimum height of 300mm at the line B-B reducing at a linear rate to a minimum height of 225mm at the line A-A.

The minimum height of the survival cell between the lines A-A and B-B need not be arranged symmetrically about the horizontal centre line of the relevant section but must be maintained over its entire width.

The maximum height of the survival cell between the lines A-A and B-B is 625mm above the reference plane.

The minimum height of the survival cell between the lines B-B and C-C is 550mm.

15.4.5 When the test referred to in Article 13.1.1 is carried out and the template is in position with its lower edge 525mm above the reference plane, the shape of the survival cell must be such that no part of it 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.

In order to ensure that the driver›s head is not unduly exposed and for him to maintain good lateral visibility he must, when seated normally and looking straight ahead with his head as far back as possible, have his eye visible when viewed from the side. The centre of gravity of his head must lie below the top of the survival cell at this position. When viewed from the side of the car, the centre of gravity of the driver›s head will be deemed to be the intersection of a vertical line passing through the centre of his ear and a horizontal line passing through the centre of his eye.

15.4.6 In order to give additional protection to the driver in the event of a side impact a flat test panel of uniform construction, which is designed and constructed in order to represent a section of the survival cell sides, must pass a strength test. Details of the test procedure may be found in Article 18.7.

Referring to Drawing 5, with the exception of local reinforcement and/or inserts, all parts of the survival cell which are as wide or wider than the minimum widths stipulated in Article 15.4.4, including any radii applied, must be manufactured to the same specification as a single panel which satisfies the requirements of Article 18.7. Furthermore, parts to this tested specification must cover an area which:

- begins no less than 250mm high at the line A-A tapering at a linear rate to a minimum of 400mm high at the line B-B ;

- lies between two horizontal lines 100mm and 500mm above the reference plane between the line B-B and the rear of the survival cell.

15.4.7 Once the requirements of Articles 15.4.4, 15.4.6, 15.5.1, 15.5.2, 15.5.4, 15.5.5, 16.1, 16.2, 16.3, 17.1, 17.2, 17.3, 18.1, 18.2, 18.3, 18.4, 18.5, 18.6, 18.7 and 18.9 have been met, panels no less than 6.2mm thick must then be permanently attached to the survival cell sides. These panels must :

a) in a longitudinal sense, cover the area lying between the line B-B and a vertical plane 50mm to the rear of the rear edge of the cockpit entry template. A 50mm horizontal linear taper may be included at both ends ;

b) in a vertical sense, cover the area lying between two horizontal planes 100mm and 550mm above the reference plane ;

c) be constructed from 16 plies of Zylon and two plies of carbon, precise lay-up details must be followed and may be found in the Appendix to these regulations ;

d) be permanently attached to the survival cell with an appropriate adhesive which has been applied over their entire surface.

Cut-outs in these panels totalling 35000mm² per side will be permitted for fitting around side impact structures, wiring loom holes and essential fixings.

15.4.8 Once the requirements of Articles 15.4.4, 15.4.6, 15.5.1, 15.5.2, 15.5.4, 15.5.5, 16.1, 16.2, 16.3, 17.1, 17.2, 17.3, 18.1, 18.2, 18.3, 18.4, 18.5, 18.6, 18.7 and 18.9 have been met one further panel, which may be made in a maximum of three parts but which is no less than 3.0mm thick, must then be permanently attached to the survival cell. This panel must :

a) in a longitudinal sense, cover the area lying between a vertical plane 300mm to the rear of the line A-A and a vertical plane 650mm forward of the rear edge of the cockpit entry template. A 25mm horizontal linear taper may be included at both ends ;

b) in a vertical sense, cover every part of the outer skin of the survival cell in the area lying between two horizontal planes 60mm and 550mm above the reference plane. This will not apply at the top of this panel where any radius permitted by Article 15.4.4 falls inside the minimum permitted chassis width nor for the area fitted with the panel defined by Article 15.4.7;

c) if made in more than one part, have all adjacent parts overlapping by a minimum of 25mm. These overlaps may include linear tapers in the thickness of both parts ;

d) overlap the panel defined by Article 15.4.7 along all joining edges by a minimum of 25mm. These overlaps may include linear tapers in the thickness of both parts ;

e) be constructed from seven plies of Zylon and two plies of carbon, precise lay-up details must be followed and may be found in the Appendix to these regulations ;

f) be permanently attached to the survival cell with an appropriate adhesive which has been applied over its entire surface including all overlapping joints.

Cut-outs in this panel totalling 15000mm² per side will be permitted for fitting around wiring loom holes and essential fixings.

15.5 Survival cell safety requirements:

15.5.1 The survival cell and frontal absorbing structure must pass an impact test against a solid vertical barrier placed at right angles to the car centre line, details of the test procedure may be found in Article 16.2.

15.5.2 Between the front and rear roll structures, on each side of the survival cell, impact absorbing structures must be fitted 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, a lateral strength test in the vicinity of the driver›s seating position must be carried out successfully. Details of the test procedure may be found in Article 18.2.2.

The survival cell and one of these impact absorbing structures must pass an impact test, details of the test procedure may be found in Article 16.3. If these structures are not designed and fitted symmetrically about the car centre line a successful impact test must be carried out on them both.

15.5.3 An impact absorbing structure must be fitted behind the gearbox symmetrically about the car centre line with the centre area of its rearmost face 300mm (+/-5mm) above the reference plane and no less than 575mm behind the rear wheel centre line.

The rearmost face of the impact structure must be a rectangular section no less than 100mm wide, this minimum width must be maintained over a height of at least 130mm and each corner may incorporate a radius no greater than 10mm.

Furthermore, when viewed from the side, the lowest and highest points of the impact absorbing structure between its rear face and 50mm aft of the rear wheel centre line may not be separated vertically by more than 275 mm.

Between the rear face and the rear wheel centre line no dimension of the area thus defined may diminish nor may any part of the structure or gearbox which is visible from below, other than the permit-

ted radii, be higher than the lower edge of the rear face. Pockets of minimum size within the structure are permitted for the sole purpose of attaching suspension members.

This structure must pass an impact test and must be constructed from materials which will not be substantially affected by the temperatures it is likely to be subjected to during use. Details of the test procedure may be found in Article 16.5.

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.

15.5.4 The survival cell must also be subjected to six separate static load tests:

1) on a vertical plane passing through the centre of the fuel tank ;

2) on a vertical 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;

3) on a vertical plane 375mm forward of the rear edge of the cockpit entry template ;

4) from beneath the fuel tank ;

5) on each side of the cockpit opening.

6) from beneath the cockpit floor.

Details of the test procedures may be found in Article 18.2.

15.5.5 To test the attachments of the frontal, side and rear impact absorbing structures static side load tests must be carried out. Details of these test procedures may be found in Articles 18.6, 18.8 and 18.9.2.

Cockpit

The size of a Formula One car's cockpit opening must comply with strict specifications. Compliance with these specifications is tested by lowering a specially made template into the cockpit.

In addition to this, the cockpit must meet numerous other requirements. A driver must be able to get in and out of the car without removing anything other than its steering wheel. Once strapped into the car with all his safety gear on, he must be able to remove the steering wheel and get out within five seconds, and then replace the steering within a further five seconds.

The car's survival cell structure, designed to protect the driver in the event of an accident, must extend at least 300mm beyond the drivers feet, which must not be forward of the front-wheel centre line.

ARTICLE 13: COCKPIT

13.1 Cockpit opening:

13.1.1 In order to ensure that the opening giving access to the cockpit is of adequate size, the template shown in Drawing 2 will be inserted into the survival cell and bodywork.

During this test the steering wheel, steering column, seat and all padding required by Articles 14.6.1-6 (including fixings), may be removed and:

- the template must be held horizontal and lowered vertically from above the car until its lower edge is 525mm above the reference plane ;

- referring to Drawing 2, the edge of the template which lies on the line d-e must be no less than 1800mm behind the line A-A shown in Drawing 5.

Any measurements made from the cockpit entry template (when referred to in Articles 13.1.3, 14.3.3,15.2.2, 15.4.5, 15.4.6, 15.5.4, 16.3 and 18.5), must also be made whilst the template is held in this position.

13.1.2 The forward extremity of the cockpit opening, even if structural and part of the survival cell, must be at least 50mm in front of the steering wheel.

13.1.3 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. When seated normally, the driver must be facing forwards and the rearmost part of his crash helmet may be no more than 125mm forward of the rear edge of the cockpit entry template.

13.1.4 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 5 seconds and then replace the steering wheel in a total of 10 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.

13.2 Steering wheel:

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.

13.3 Internal cross section:

13.3.1 A free vertical cross section, which allows the outer template shown in Drawing 3 to be passed vertically through the cockpit to a point 100mm behind the face of the rearmost pedal when in the inoperative position, must be maintained over its entire length.

The only things which may encroach on this area are the steering wheel and any padding that is required by Article 14.6.7.

13.3.2 A free vertical cross section, which allows the inner template shown in Drawing 3 to be passed vertically through the cockpit to a point 100mm behind the face of rearmost pedal when in the inoperative position, must be maintained over its entire length.

The only thing which may encroach on this area is the steering wheel.

13.3.3 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.

13.4 Position of the driver›s feet:

13.4.1 The survival cell must extend from behind the fuel tank in a forward direction to a point at least 300mm in front of the driver›s feet, with his feet resting on the pedals and the pedals in the inoperative position.

13.4.2 When he is seated normally, the soles of the driver›s feet, resting on the pedals in the inoperative position, must not be situated forward of the front wheel centre line.

Electrical systems

The electrical and software systems of all cars are inspected by the FIA at the start of the season and the teams must notify them in advance of any subsequent changes to the systems. All teams must use the same FIA-specification Electronic Control Unit (ECU) for controlling their engine and gearbox.

All software must be registered with the FIA, who check all the programmable systems on the cars prior to each event to ensure that the correct software versions are being used. Electronic systems which can automatically detect the race start signal are forbidden.

All cars must have an accident data recorder. This is linked to a medical warning light positioned ahead of the cockpit opening, which gives rescue crews an immediate indication of the severity of an accident.

In the cockpit, every car must have a track signal information display, which informs the driver of circuit conditions via red, blue and yellow lights.

ARTICLE 8: ELECTRICAL SYSTEMS

8.1 Software and electronics inspection:

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

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

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

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

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

8.1.5 The FIA must be able to test the operation of any compulsory electronic safety systems at any time during an Event.

8.2 Control electronics :

8.2.1 All components of the engine and gearbox, including clutch, differential and KERS in addition to all associated actuators must be controlled by an Electronic Control Unit (ECU) which has been manufactured by an FIA designated supplier to a specification determined by the FIA.

The 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.

8.2.2 All control sensors, actuators and FIA monitoring sensors will be specified and homologated by the FIA.

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.

8.2.3 The control system wiring loom connectivity will be specified by the FIA.

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

8.2.5 The car hydraulic system will be monitored by the ECU.

8.2.6 The ECU will be designed to run from a car system supply voltage of 12V nominal provided by a homologated voltage regulator.

8.3 Start systems:

Any system, the purpose and/or effect of which is to detect when a race start signal is given, is not permitted.

8.4 Data acquisition :

Any data acquisition system, telemetry system or associated sensors additional to those provided by the ECU and ADR must be physically separate and completely isolated from any control electronics with the exception of the primary regulated voltage supply, car system ground and a single communication link to the ECU and ADR.

8.5 Telemetry :

8.5.1 Telemetry systems must operate at frequencies which have been approved by the FIA.

8.5.2 Pit to car telemetry is prohibited.

8.6 Driver controls and displays :

Any electronic modules used for driver information displays and switch inputs must be supplied by an FIA designated supplier to a specification determined by the FIA and be suitably housed by each team.

8.7 Driver radio :

Other than authorised connections to the FIA 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, where appropriate, broadcasters.

8.8 Accident Data Recorders (ADR):

8.8.1 The recorder must be fitted and operated:

- in accordance with the instructions of the FIA;

- symmetrically about the car centre line and with its top facing upwards;

- with each of its 12 edges parallel to an axis of the car;

- less than 50mm above the reference plane;

- in a position within the cockpit which is readily accessible at all times from within the cockpit without the need to remove skid block or floor;

- in order that the entire unit lies between 30% and 50% of the wheelbase of the car;

- via anti-vibration mountings giving a clearance of 5mm to all other objects;

- with its connectors facing forwards;

- in order that its status light is visible when the driver is seated normally;

- in order that the download connector is easily accessible when the driver is seated normally and without the need to remove bodywork.

8.8.2 The recorder must be connected to two external 500g accelerometers which are solidly bolted to the survival cell, on the car centre line, 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.

8.3.3 The recorder 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.

8.8.4 An ADR and two accelerometers must be fitted to every car at all times during an Event and at all tests attended by more than one team.

8.9 Track signal information display:

All cars must be fitted with red, blue and yellow cockpit lights the purpose of which are to give drivers information concerning track signals or conditions. The lights must be LEDs each with a minimum diameter of 5mm and fitted directly in the driver›s normal line of sight. Details of the light control system, which must be fitted to every car, may be found in the Appendix to these regulations.

8.10 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 data logger.

The light must face upwards and be recessed into the top of the survival cell no more than 150mm from the car centre line and the front of the cockpit opening 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 these regulations.

8.11 Installation of electrical systems or components :

Competitors must be notified of any changes to the installation instructions for any FIA specified systems or components before 30 June of the previous season.

Engines and KERS

Formula One engines may be no more than 2.4 litres in capacity. They must have 8 cylinders in a 90-degree formation, with two inlet and two exhaust valves per cylinder. They must be normally aspirated, weigh at least 95 kilograms and be rev-limited to 18,000rpm.

The only other permitted power source is a Kinetic Energy Recovery System (KERS), which takes waste energy generated under braking and turns it into additional power. This is then made available to the driver in fixed quantities per lap via a steering wheel-mounted boost button.

Turbochargers, superchargers and devices designed to pre-cool air before it enters the engine›s cylinders are not allowed. Nor is the injection of any substance into the cylinders other than air and fuel. Variable-geometry inlet and exhaust systems are also forbidden, as is variable valve timing. Each cylinder may have just one fuel injector and ignition must be by a single spark plug.

The materials used in the manufacture of the engine and its components are strictly controlled by the regulations. The crankcase and cylinder block must be made of cast or wrought aluminium alloys - the use of composite materials is not allowed. The crankshaft and camshafts must be made from an iron-based alloy, pistons from an aluminium alloy and valves from alloys based on iron, nickel, cobalt or titanium.

Formula One cars do not have their own, onboard starting systems. Separate starting devices may be used to start engines in the pits and on the grid. If the engine is fitted with an anti-stall device, this must be set to cut the engine within ten seconds in the event of an accident.

ARTICLE 5: ENGINES AND KINETIC ENERGY RECOVERY SYSTEMS

5.1 Engine specification:

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

5.1.2 Engine capacity must not exceed 2400 cc.

5.1.3 Crankshaft rotational speed must not exceed 18,000rpm.

5.1.4 Supercharging is forbidden.

5.1.5 All engines must have 8 cylinders arranged in a 90º "V" configuration and the normal section of each cylinder must be circular.

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

Only reciprocating poppet valves are permitted.

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

5.2 Other means of propulsion:

5.2.1 The use of any device, other than the 2.4 litre, four stroke engine described in 5.1 above and one KERS, to power the car, is not permitted.

5.2.2 With the exception of one fully charged KERS, the total amount of recoverable energy stored on the car must not exceed 300kJ. Any which may be recovered at a rate greater than 2kW must not exceed 20kJ.

5.2.3 The maximum power, in or out, of any KERS must not exceed 60kW.

Energy released from the KERS may not exceed 400kJ in any one lap

Measurements will be taken at the connection to the rear wheel drivetrain.

5.2.4 The amount of stored energy in any KERS may not be increased whilst the car is stationary during a race pit stop.

Release of power from any such system must remain under the complete control of the driver at all times the car is on the track.

5.2.5 Cars must be fitted with homologated sensors which provide all necessary signals to the SDR in order to verify the requirements above are being respected.

5.3 Engine dimensions:

5.4.1 Cylinder bore diameter may not exceed 98mm.

5.3.2 Cylinder spacing must be fixed at 106.5mm (+/- 0.2mm).

5.3.3 The crankshaft centre line must not be less than 58mm above the reference plane.

5.4 Weight and centre of gravity:

5.4.1 The overall weight of the engine must be a minimum of 95kg.

5.4.2 The centre of gravity of the engine may not lie less than 165mm above the reference plane.

5.4.3 The longitudinal and lateral position of the centre of gravity of the engine must fall within a region that is the geometric centre of the engine, +/- 50mm. The geometric centre of the engine in a lateral sense will be considered to lie on the centre of the crankshaft and at the mid point between the centres of the forward and rear most cylinder bores longitudinally.

5.4.4 When establishing conformity with Articles 5.4.1, 5.4.2, 5.4.3 and Appendix 4 of the F1 Sporting Regulations, the homologated engine will include the intake system up to and including the air filter, fuel rail and injectors, ignition coils, engine mounted sensors and wiring, alternator, coolant pumps and oil pumps.

5.4.5 When establishing conformity with Article 5.4, the engine will not include:

- clutch and clutch actuation system ;

- flywheel ;

- electronic control units or any associated devices containing programmable semiconductors ;

- the alternator regulator ;

- liquids ;

- exhaust manifolds ;

- heat shields ;

- oil tanks, catch tanks or any breather system connected to them;

- studs used to mount the engine to the chassis or gearbox ;

- water system accumulators ;

- heat exchangers ;

- hydraulic system (e.g. pumps, accumulators, manifolds, servo-valves, solenoids, actuators) except servo-valve and actuator for engine throttle control ;

- fuel pumps nor any component not mounted on the engine when fitted to the car.

- any ancillary equipment associated with the engine valve air system, such as hoses, regulators, reservoirs or compressors.

Furthermore, any parts which are not ordinarily part of an engine will not be included when assessing its weight. Examples of this could be, but are not limited to :

- Wiring harnesses having only a partial association with engine actuators or sensors ;

- A bell housing designed to be integral with the engine crankcase;

- Top engine mountings designed higher than necessary with integral webs or struts. The centre of any engine mounting which is part of a cam cover should not be any more than 100mm above a line between the camshaft centres, when measured parallel to it. Any webs integral with the cam cover should not extend further back than the centre of the second cylinder bore.

- Ballast. This is permitted on the engine (subject to the requirements of Article 4.2) but any in excess of 2kg will be removed from the engine before measuring engine weight or centre of gravity height.

5.5 Engine throttles :

5.5.1 The only means by which the driver may control the engine throttle positions is via a single chassis mounted foot pedal.

5.5.2 Designs which allow specific points along the pedal travel range to be identified by the driver or assist him to hold a position are not permitted.

5.5.3 The minimum and maximum throttle pedal travel positions must correspond to the engine throttle minimum (nominal idle) and maximum open positions.

5.6 Exhaust systems:

Engine exhaust systems may incorporate no more than two exits.

5.7 Variable geometry systems:

5.7.1 Variable geometry inlet systems are not permitted.

5.7.2 Variable geometry exhaust systems are not permitted.

5.7.3 Variable valve timing and variable valve lift systems are not permitted.

5.8 Fuel systems

5.8.1 The pressure of the fuel supplied to the injectors may not exceed 100 bar. Sensors must be fitted which directly measure the pressure of the fuel supplied to the injectors, these signals must be supplied to the FIA data logger.

5.8.2 Only one fuel injector per cylinder is permitted which must inject directly into the side or the top of the inlet port.

5.9 Electrical systems:

5.9.1 Ignition is only permitted by means of a single ignition coil and single spark plug per cylinder. The use of plasma, laser or other high frequency ignition techniques is forbidden.

5.9.2 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 5.14 and 5.15.

5.9.3 Other than for the specific purpose of powering KERS components, the primary regulated voltage on the car must not exceed 17.0V DC. This voltage is defined as the stabilised output from the on-car charging system.

With the exception of any KERS or capacitor circuitry or coils being used solely to provide ignition, any device with a current requirement greater than 50mA or a power requirement greater than 1W may only be supplied at or below the primary regulated voltage.

Only capacitor discharge ignition systems (those which generate a spark by means of closing a switch which then discharges a capacitor through the primary side of the ignition coil), are permitted to provide a voltage higher than the primary regulated voltage to an ignition coil.

Other than any parts being used to supply a higher voltage to devices such as those described in the previous paragraphs, no device may step up or increase the primary regulated voltage.

5.10 Engine actuators:

With the following exceptions hydraulic, pneumatic or electronic actuation is forbidden:

a) Electronic solenoids uniquely for the control of engine fluids;

b) Components providing controlled pressure air for a pneumatic valve system;

c) A single actuator to operate the throttle system of the engine.

d) Any components required as part of a KERS.

5.11 Engine auxiliaries:

With the exception of electrical fuel pumps engine auxiliaries must be mechanically driven directly from the engine with a fixed speed ratio to the crankshaft.

5.12 Engine intake air:

5.12.1 Other than injection of fuel for the normal purpose of combustion in the engine, any device, system, procedure, construction or design the purpose or effect of which is any decrease in the temperature of the engine intake air is forbidden.

5.12.2 Other than engine sump breather gases and fuel for the normal purpose of combustion in the engine, the spraying of any substance into the engine intake air is forbidden.

5.13 Materials and Construction - Definitions:

5.13.1 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.

5.13.2 X-Y Based Alloy (e.g. Al-Cu based alloy) – X must be the most abundant element as in 5.13.1 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).

5.13.3 Intermetallic Materials (e.g. TiAl, NiAl, FeAl, Cu3Au, NiCo) – These are materials where the material is based upon intermetallic phases, i.e. the matrix of the material consists of greater then 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.

5.13.4 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 (continuous reinforcement); or short fibres, whiskers and particles (discontinuous reinforcement).

5.13.5 Metal Matrix Composites (MMC›s) – These are composite materials with a metallic matrix containing a phase of greater than 2%v/v which is not soluble in the liquid phase of the metallic matrix.

5.13.6 Ceramic Materials (e.g. Al2O3, SiC, B4C, Ti5Si3, SiO2, Si3N4) – These are inorganic, non metallic solids.

5.14 Materials and construction – General:

5.14.1 Unless explicitly permitted for a specific engine component, the following materials may not be used anywhere on the engine:

a) Magnesium based alloys

b) Metal Matrix Composites (MMC›s)

c) Intermetallic materials

d) Alloys containing more than 5% by weight of Beryllium, Iridium or Rhenium.

5.14.2 Coatings are free 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.

5.15 Materials and construction – Components:

5.15.1 Pistons must be manufactured from an aluminium alloy which is either Al-Si; Al-Cu; Al-Mg or Al-Zn based.

5.15.2 Piston pins must be manufactured from an iron based alloy and must be machined from a single piece of material.

5.15.3 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).

5.15.4 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 19,000kg/m3 may be assembled to the crankshaft.

5.15.5 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.

5.15.6 Valves must be manufactured from alloys based on Iron, Nickel, Cobalt or Titanium.

Hollow structures cooled by sodium, lithium or similar are permitted.

5.15.7 Reciprocating and rotating components:

a) 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. Ceramic bearings are not permitted in ancillaries which are included when assessing the weight of the engine, e.g. alternator, coolant pumps and oil pumps ;

b) Rolling elements of rolling element bearings must be manufactured from an iron based alloy;

c) Timing gears between the crankshaft and camshafts (including hubs) must be manufactured from an iron based alloy.

5.15.8 Static components:

a) Engine crankcases and cylinder heads must be manufactured from cast or wrought aluminium alloys.

No composite materials or metal matrix composites are permitted either for the whole component or locally.

b) 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 or an aluminium alloy of the Al-Si, Al-Cu, Al-Zn or Al-Mg alloying systems.

c) All threaded fasteners must be manufactured from an alloy based on Cobalt, Iron or Nickel.

Composite materials are not permitted.

d) 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.

5.16 Starting the engine:

A supplementary device temporarily connected to the car may be used to start the engine both on the grid and in the pits.

5.17 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.

5.18 Replacing engine parts:

The parts in lists A and B below may be changed without incurring a penalty under Article 28.4 of the F1 Sporting Regulations. If changing any of these parts involves breaking a seal this may be done but must carried out under FIA supervision. The parts in List B may only be replaced by identical homologated parts in accordance with Appendix 4 of the F1 Sporting Regulations.

List A

- Clutch

- Clutch basket

- Hydraulic pumps

- Engine electronic boxes (ECU›s, power modules, control boxes)

- Fuel filters

- Fuel pumps

- Oil filters

- Oil tank systems

- Pneumatic bottles, regulators, pumps and pipes for valve actuation

- Exhaust systems

- Supports and brackets related to the auxiliaries, mentioned above

- Screws, nuts, dowels or washers related to the auxiliaries, mentioned above

- Cables, tubes or hoses related to the auxiliaries, mentioned above

- Oil or air seals related to the auxiliaries, mentioned above

- Spark plugs

List B

- Throttle system (including but not limited to throttle device, linkage, actuator, hydraulics)

- Intake system external to cylinder head (including but not limited to trumpets, trumpet tray, air box, air filter)

- Ignition coils

- Injection system

- Alternators

- Oil scavenging pumps

- Oil supply pumps

- Oil air separators

- Water pumps

- Electric and electronic sensors

Fuel

Formula One cars run on petrol, the specification of which is not that far removed from that used in regular road cars. Indeed, the FIA regulations state that the rules are "intended to ensure the use of fuels which are predominantly composed of compounds normally found in commercial fuels and to prohibit the use of specific power-boosting chemical compounds."

All fuel must comply with strict requirements and prior to each race the teams must supply the FIA with two separate five-litre samples for analysis and approval. Additional samples can then be taken during the event to ensure that there is no discrepancy between the fuel being used and that previously supplied in the samples.

ARTICLE 19: FUEL

19.1 Purpose of Article 19:

19.1.1 The purpose of this Article is to ensure that the fuel used in Formula One is petrol as this term is generally understood.

19.1.2 The detailed requirements of this Article are intended to ensure the use of fuels which are predominantly 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 19.2 and 19.4.3. In addition, to cover the presence of low level impurities, the sum of components lying outside the 19.2 and 19.4.3 definitions are limited to 1% max m/m of the total fuel.

19.1.3 Any petrol which appears to have been formulated in order to subvert the purpose of this regulation will be deemed to be outside it.

19.2 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 or olefinic side chains. Only one double bond may be present outside the aromatic ring.

Oxygenates - organic compounds containing oxygen.

Biocomponents - Paraffins, olefins, di-olefins, naphthenes, aromatics and oxygenates, as defined above, derived in whole or part from biological origins. For the purposes of quantification, the biocomponent contribution of a given molecule is defined as the carbon, hydrogen and oxygen atoms from biological origin as a percent of the total molecule, on a mass/mass basis. The biocomponent contribution of a co-produced stream is determined as the bio feedstock percentage on a mass/mass basis.

19.3 Properties:

Property	Units	Min	Max	Test Method
(RON+MON)/2		87.0		ASTM D 2699/D 2700
Oxygen	wt%		3.7	Elemental Analysis
Nitrogen	mg/kg		500	ASTM D 4629
Benzene	wt%		1.0	GC-MS
RVP	kPa	45	60(1)	EN13016-1
Lead	g/l		0.005	ASTM D 3237
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		2.0	ISO 3405

(1) The maximum RVP may rise to 68kPa if a minimum of 2% bio-methanol and/or bio-ethanol are included in the fuel.

The fuel will be accepted or rejected according to ASTM D 3244 with a confidence limit of 95%.

19.4 Composition of the fuel:

19.4.1 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%		1.0	GCMS
Total styrene and alkyl derivatives	wt%		1.0	GCMS

*Values corrected for fuel oxygenate content.

In addition, the fuel must contain no substance which is capable of exothermic reaction in the absence of external oxygen.

19.4.2 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 content of the fuel.

19.4.3 The only oxygenates permitted are paraffinic mono-alcohols and paraffinic mono-ethers with a final boiling point below 210°C.

19.4.4 A minimum of 5.75% (m/m) of the fuel must comprise bio-components.

19.4.5 Initially the bio-components are restricted to oxygenates. However, hydrocarbons and oxygenates (lying outside the 19.4.3 definition) or mixtures thereof, which have been produced from biomass, will be included into Formula One fuel, provided that a suitable analytical procedure is available to verify their biological origin. Their use in F1 fuel will be dependent on evidence indicating that the supplier is genuinely developing these compounds for use in commercial fuels.

19.4.6 Manganese based additives are not permitted

19.5 Air:

Only ambient air may be mixed with the fuel as an oxidant.

19.6 Safety:

19.6.1 All competitors must be in possession of a Material Safety Data Sheet for each type of petrol used. This sheet must be made out in accordance with EC Directive 93/112/EEC and all information contained therein strictly adhered to.

19.7 Fuel approval:

19.7.1 Before any fuel may be used in an Event, two separate five litre samples, in suitable containers, must be submitted to the FIA for analysis and approval.

19.7.2 No fuel may be used in an Event without prior written approval of the FIA.

19.8 Sampling and testing at an Event:

19.8.1 All samples will be taken in accordance with FIA Formula One fuel sampling procedure, a copy of which may be found in the Appendix to these regulations.

19.8.2 Fuel samples taken during an Event 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.

19.8.3 GC peak areas of the sample will be compared with those obtained from the reference fuel. Increases in any given peak area (relative to its adjacent peak areas) which are greater than 12%, or an absolute amount greater than 0.1% 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.

Fuel system and refuelling

The fuel tanks on Formula One cars comprise a single rubber bladder. These must be made of materials approved by the FIA and must be manufactured by certain approved companies.

The tank must be situated directly behind the driver and directly ahead of the engine. All fuel lines must be self-sealing in the event of an accident and no lines must pass through the cockpit.

The fuel tank must be encased within a crushable structure that forms part of the car›s safety cell. This structure must be able to withstand very high impact loads as specified in the regulations.

The FIA may take a one-litre fuel sample from any car at any time during a Grand Prix meeting to check that the fuel being used is legal.

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/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 these regulations.

6.1.2 All the fuel stored on board the car must be situated between the front face of the engine and the driver›s back when viewed in lateral projection. When establishing the front face of the engine, no parts of the fuel, oil, water or electrical systems will be considered.

Furthermore, no fuel can be stored more than 300mm forward of the highest point at which the driver›s back makes contact with his seat. However, a maximum of 2 litres of fuel may be kept outside the survival cell, but only that which is necessary for the normal running of the engine.

6.1.3 Fuel must not be stored more than 400mm from the longitudinal axis of the car.

6.1.4 All rubber bladders must be made by manufacturers recognised by the FIA. In order to obtain the agreement of the FIA, the manufacturer must prove the compliance of his product with the specifications approved by the FIA. These manufacturers must undertake to deliver to their customers exclusively tanks complying to the approved standards.

A list of approved manufacturers may be found in the Appendix to these regulations.

6.1.5 All rubber bladders shall be printed with the name of the manufacturer, the specifications to which the tank has been manufactured and the date of manufacture.

6.1.6 No rubber bladders shall be used more than 5 years after the date of manufacture.

6.2 Fittings and piping:

6.2.1 All apertures in the fuel tank must be closed by hatches or fittings which are secured to metallic or composite bolt rings bonded to the inside of the bladder. The total area of any such hatches or fittings which are in contact with the fuel may not exceed 30000mm².

Bolt hole edges must be no less than 5mm from the edge of the bolt ring, hatch or fitting.

6.2.2 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.

6.2.3 No lines containing fuel may pass through the cockpit.

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

6.3 Crushable structure:

The fuel tank must be completely surrounded by a crushable structure, which is an integral part of the survival cell and must be able to withstand the loads required by the tests in Articles 18.2.1 and 18.3.

6.4 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 ef-

ficient locking action which reduces the risk of an accidental opening following a crash impact or incomplete locking after refuelling.

6.5 Refuelling:

6.5.1 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.

6.5.2 No fuel intended for immediate use in a car may be more than ten degrees centigrade below ambient temperature. When assessing compliance the ambient temperature will be that recorded by the FIA appointed weather service provider one hour before any practice session or two hours before the race. This information will also be displayed on the timing monitors.

The temperature of fuel intended for use in a car must be measured via an FIA approved and sealed sensor.

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

6.6 Fuel draining and sampling:

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

6.6.2 Competitors must ensure that a one litre sample of fuel may be taken from the car at any time during the Event.

Except in cases of force majeure (accepted as such by the stewards of the meeting), if a sample of fuel is required after a practice session the car concerned must have first been driven back to the pits under its own power.

6.6.3 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 these regulations.

6.6.4 The sampling procedure must not necessitate starting the engine or the removal of bodywork (other than the cover over the refuelling connector).

Impact testing

Formula One cars must pass strict impact tests to ensure they meet the necessary safety standards. The tests must be carried out under FIA guidelines and in the presence of an FIA technical delegate.

The cars undergo a front, side and rear test. The tests focus on the car's survival cell, which must be left undamaged by the impacts. All structural damage must be limited to the car's impact absorbing structures, for example, the side-pods, the nose etc.

The car's steering column must also pass an impact test, which simulates the unlikely event of a driver's head striking the steering wheel. The column itself must deform to absorb the majority of the impact and the wheel's quick release mechanism must not be damaged.

ARTICLE 16: IMPACT TESTING

16.1 Conditions applicable to all impact tests:

16.1.1 All 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 these regulations.

16.1.2 Any significant modification introduced into any of the structures tested shall require that part to pass a further test.

16.1.3 The reference survival cell must have passed every static load test described in Articles 15.2, 15.5.4 and 15.5.5 before being subjected to any impact test.

16.2 Frontal test 1:

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 may contain water.

A dummy weighing at least 75kg must be fitted with safety belts described in Article 14.4 fastened. However, with the safety belts unfastened, the dummy must be able to move forwards freely in the cockpit.

The extinguishers, as described in Article 14.1 must also be fitted.

For the purposes of this test, the total weight of the trolley and test structure shall be 780kg (+1%/-0) and the velocity of impact not less than 15 metres/second.

The resistance of the test structure must be such that during the impact either:

- the peak deceleration over the first 150mm of deformation does not exceed 10g ;

- the peak deceleration over the first 60kJ energy absorption does not exceed 20g ;

- the average deceleration of the trolley does not exceed 40g ;

- the peak deceleration in the chest of the dummy does not exceed 60g for more than a cumulative 3ms, this being the resultant of data from three axes.

Or :

- the peak force over the first 150mm of deformation does not exceed 75kN ;

- the peak force over the first 60kJ energy absorption does not exceed 150kN ;

- the average deceleration of the trolley does not exceed 40g ;

- the peak deceleration in the chest of the dummy does not exceed 60g for more than a cumulative 3ms, this being the resultant of data from three axes.

Furthermore, there must be no damage to the survival cell or to the mountings of the safety belts or fire extinguishers.

This test must be carried out on the survival cell subjected to the higher loads in the tests described in Articles 18.2-5, and on the frontal impact absorbing structure which was subjected to the test described in Article 18.6.

16.3 Frontal test 2 :

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 :

- measure 375mm (+/-1mm) wide x 375mm (+/-1mm) high ;

- be fitted symmetrically about the car centre line ;

- be fitted in a vertical sense in order to ensure force distribution is similar to that measured during the first frontal test ;

- have four M10 x 30mm holes in the outer face arranged in a 125mm square pattern about it›s geometric centre. The test laboratory will then fit a 5mm thick 300mm x 275mm 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 14.4 fastened. However, with the safety belts unfastened, the dummy must be able to move forwards freely in the cockpit.

For the purposes of this test, the total weight of the trolley and test structure shall be 900kg (+1%/-0) and the velocity of impact not less than 15 metres/second.

The impact wall must be fitted with six 60kN crush tubes which develop a combined 360kN as follows :

- 2 x 60kN from T-zero to T-end, directed into the two lower M10 attachment points.

- 2 x 60kN from T-100mm to T-end, directed into the two upper M10 attachment points.

- 2 x 60kN from T-200mm to T-end, directed into the sled.

The resistance of the test structure must be such that following the impact there is no damage to the survival cell rearwards of a point 300mm behind the line A-A (see Drawing 5) or to the mountings of the safety belts.

This test must be carried out on the survival cell subjected to the higher loads in the tests described in Articles 18.2-5.

Specifications of the crush tubes and test arrangement may be found in the Appendix to these regulations.

16.4 Side test:

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 ground and a solid object, having a mass of 780kg (+1%/-0) and travelling at a velocity of not less than 10 metres/sec, will be projected into it.

The object used for this test must:

- incorporate an impactor assembly, the specification of which may be found in the Appendix to these regulations ;

- be positioned in order that its centre of area strikes the structure 300mm (+/-25mm) above the reference plane and at a point 500mm (+/-3mm) forward of the rear edge of the cockpit opening template.

During the test the striking object may not pivot in any axis and the survival cell may be supported in any way provided this does not increase the impact resistance of the parts being tested. The impact axis must be perpendicular to the car centre line and parallel to the ground.

The resistance of the test structure must be such that during the impact:

- the average deceleration of the object, measured in the direction of impact, does not exceed 20g ;

- the force applied to any one of the four impactor segments does not exceed 80kN for more than a cumulative 3ms ;

- the energy absorbed by each of the four impactor segments must be between 15% and 35% of the total energy absorption.

Furthermore, all structural damage must be contained within the impact absorbing structure.

This test must be carried out on the survival cell subjected to the higher loads in the tests described in Articles 18.2-5 and on the side impact absorbing structure(s) which were subjected to the test described in Article 18.9.

16.5 Rear 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 780kg (+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 at 90° to the car centre line.

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:

- the peak deceleration over the first 225mm of deformation does not exceed 20g ;

- the maximum deceleration does not exceed 20g for more than a cumulative 15ms, this being measured only in the direction of impact

Furthermore, all structural damage must be contained within the area behind the rear wheel centre line.

This test must be carried out on the rear impact absorbing structure which was subjected to the test described in Article 18.8.

16.6 Steering column test:

The parts referred to in Article 10.4.4 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 7 metres/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.

Oil and coolant systems

The design and location of the oil tanks on Formula One cars are strictly controlled to minimise the risk of oil leaking in the event of an engine failure or an accident. Oil may not be added to cars during the race.

The car's coolant header tank must have an FIA-approved pressure release valve. The cooling system must not make any use of the latent heat produced by the cooling process.

Coolant and oil lines are not allowed to pass through the cockpit. They must also be fitted so that any leaked fluid cannot find its way into the cockpit.

ARTICLE 7: OIL AND COOLANT SYSTEMS

7.1 Location of oil tanks:

All oil storage tanks must be situated between the front wheel axis and the rearmost gearbox casing longitudinally, and must be no further than the lateral extremities of the survival cell are from the longitudinal axis of the car.

7.2 Longitudinal location of oil system:

No other part of the car containing oil may be situated behind the complete rear wheels.

7.3 Catch tank:

In order to avoid the possibility of oil being deposited on the track, the engine sump breather must vent into the main engine air intake system.

7.4 Transversal location of oil system:

No part of the car containing oil may be more than 700mm from the car centre line.

7.5 Coolant header tank:

The coolant header tank on the car must be fitted with an FIA approved pressure relief valve which is set to a maximum of 3.75 bar gauge pressure, details of the relief valve may be found in the

Appendix to these regulations. If the car is not fitted with a header tank, an alternative position must be approved by the FIA.

7.6 Cooling systems:

The cooling systems of the engine must not intentionally make use of the latent heat of vaporisation of any fluid.

7.7 Oil and coolant lines:

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

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

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

Roll structure testing

All Formula One cars must pass strict roll structure tests to ensure that the driver is adequately protected should the car turn over during an accident.

ARTICLE 17: ROLL STRUCTURE TESTING

17.1 Conditions applicable to both roll structure tests:

17.1.1 Rubber 3mm thick may be used between the load pads and the roll structure.

17.1.2 Both peak loads must be applied in less than three minutes and be maintained for 10 seconds.

17.1.3 Under the load, deformation must be less than 25mm in the case of the principal roll structure and 50mm in

the case of the second roll structure, measured along the loading axis and any structural failure limited to 100mm below the top of the rollover structure when measured vertically.

17.1.4 Any significant modification introduced into any of the structures tested shall require that part to pass a further test.

17.2 Principal roll structure test:

A load equivalent to 50kN laterally, 60kN longitudinally in a rearward direction and 90kN vertically, 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.

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 18.2.

17.3 Second roll structure test:

A vertical load of 75kN must be applied to the top of the structure through a rigid flat pad which is 100mm in diameter and perpendicular to the loading axis.

During the test, the rollover structure must be attached to the survival cell which is fixed to a flat horizontal plate.

Safety equipment

All cars must be fitted with a fire extinguishing system that will discharge into the cockpit and engine compartment. It must be operable by the driver and must function even if the car's main electrical circuit fails.

There must also be a switch to trigger the system from outside the cockpit. Its location on the bodywork is indicated by a red letter "E" inside a white circle.

There must be a circuit breaker switch in the cockpit that the driver can use to cut all the car's main electrical circuits. This is marked on the dashboard by a red spark in a white-edged blue triangle. There must be an additional switch that marshals can operate from a distance with the use of a special hook. This switch is located at the base of the car's main roll-over structure.

All cars must have two rear-view mirrors, whose size and location must comply with strict requirements. Drivers must demonstrate to the FIA the effectiveness of the mirrors by identifying special letter and number boards placed at various distances behind the car whilst seated in the cockpit.

Seatbelts are compulsory in Formula One racing. Drivers must wear two shoulder straps, one abdominal strap and two straps between the legs. These must comply with strictly specified FIA standards.

All cars must have a red light on the rear of the car in a specific location defined by the FIA regulations. The driver must be able to switch this light on at any time. This is usually done in poor weather conditions in order to make the car more visible to following drivers.

The cockpit of the car must be padded to protect the driver in the event of an impact. In particular, the areas immediately behind and to the sides of his head, and above and to the sides of his legs.

In order to easily extract a driver from a car in the event of an accident its seat must be removable with the driver in place and his seatbelts fastened. The seat must be secured by no more than two bolts, which can be released using a standard tool issued to all rescue crews.

ARTICLE 14: SAFETY EQUIPMENT

14.1 Fire extinguishers:

14.1.1 All cars must be fitted with a fire extinguishing system which will discharge into the cockpit and into the engine compartment.

14.1.2 Any extinguishant listed in the Appendix to the regulations is permitted.

14.1.3 The quantity of extinguishant may vary according to the type of extinguishant used, a list of quantities may be found in the Appendix to these regulations.

14.1.4 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.

14.1.5 Each pressure vessel must be equipped with a means of checking its pressure which may vary according to the type of extinguishant used. A list of pressures may be found in the Appendix to the regulations.

14.1.6 The following information must be visible on each container with extinguishant:

a) Type of extinguishant

b) Weight 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.

14.1.7 All parts of the extinguishing system must be situated within the survival cell and all extinguishing equipment must withstand fire.

14.1.8 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 com-

bined with the circuit breaker switch described in Article 14.2.2. They must be marked with a letter «E» in red inside a white circle of at least 100mm diameter with a red edge.

14.1.9 The system must work in any position, even when the car is inverted.

14.1.10 All extinguisher nozzles must be suitable for the extinguishant and be installed in such a way that they are not directly pointed at the driver.

14.2 Master switch:

14.2.1 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 light 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.

14.2.2 There must also be two exterior 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 14.2.1.

14.3 Rear view mirrors:

14.3.1 All cars must have at least two mirrors mounted so that the driver has visibility to the rear and both sides of the car.

14.3.2 The reflective surface of each mirror must be at least 150mm wide, this being maintained over a height of at least 50mm. Additionally, each corner may have a radius no greater than 10mm.

14.3.3 All parts of the rear view mirrors, including their housings and mountings, must be situated between 250mm and 500mm from the car centre line and between 550mm and 750mm from the rear edge of the cockpit entry template.

14.3.4 The FIA technical delegate must be satisfied by a practical demonstration that the driver, when seated normally, can clearly define following vehicles.

For this purpose, the driver shall be required to identify any letter or number, 150mm high and 100mm wide, placed anywhere on boards behind the car, the positions of which are detailed below:

Height: From 400mm to 1000mm from the ground.

Width: 4000mm either side of the car centre line.

Position: 10m behind the rear wheel centre line.

14.4 Safety belts:

It is mandatory to wear two shoulder straps, one abdominal strap and two straps between the legs. These straps must be securely fixed to the car and must comply with FIA standard 8853/98.

14.5 Rear light:

All cars must have a red light in working order throughout the Event which:

- has been supplied by an FIA designated manufacturer;

- faces rearwards at 90° to the car centre line and the reference plane;

- is clearly visible from the rear;

- is mounted nominally on the car centre line;

- is mounted 300mm (+/-5mm) above the reference plane;

- is no less than 595mm behind the rear wheel centre line measured parallel to the reference plane;

- can be switched on by the driver when seated normally in the car.

The two measurements above will be taken to the centre of the rear face of the light unit.

14.6 Cockpit padding:

14.6.1 All cars must be equipped with three areas of padding for the driver›s head which:

- are so arranged that they can be removed from the car as one part;

- are located by two horizontal pegs behind the driver›s head and two fixings, which are clearly indicated and easily removable without tools, at the front corners;

- 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 these regulations;

- are covered, in all areas where the driver›s head is likely to make contact, with two plies of Aramid fibre/epoxy resin composite pre-preg material in plain weave 60gsm fabric with a cured resin content of 50% (+/-5%) by weight;

- are positioned so as 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.

14.6.2 The first area of padding for the driver›s head must be positioned behind him and be between 75mm and 90mm thick over an area of at least 40000mm². 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 a similar material which incorporates a low friction surface.

14.6.3 Whilst he is seated normally the two further areas of padding for the driver›s head must be positioned in an area bounded by two vertical lines and one horizontal line through the front, rear and lower extremities of the driver›s helmet (on the car centre line) and the upper surface of the survival cell.

Each of these must cover an area greater than 33000mm² when viewed from the side of the car and be no less than 95mm thick, this minimum thickness being 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 line but a radius no greater than 10mm may be applied along their upper inboard edges.

If necessary, and only for driver comfort, an additional piece of padding no greater than 10mm thick may be attached to these headrests provided they are made from a similar material which incorporates a low friction surface.

14.6.4 Forward of the side areas of padding further cockpit 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.

These extensions must:

- be symmetrically positioned about the car centre line and a continuation of the side areas of padding;

- be positioned with their upper surfaces at least as high as the survival cell over their entire length;

- have a radius on their upper inboard edge no greater than 10mm;

- be positioned in order that the distance between the two is no less than 320mm;

- be as high as practicable within the constraints of driver comfort.

14.6.5 All of the padding described above must be so installed that if movement of the driver›s head, in any expected trajectory during an accident, were to compress the foam fully at any point, his helmet would not make contact with any structural part of the car.

Furthermore, for the benefit of rescue crews all of the padding described above must be installed using the system described in the Appendix to these regulations. The method of removal must also be clearly indicated.

14.6.6 No part of the padding described above may obscure sight of any part of the driver›s helmet when he is seated normally and viewed from directly above the car.

14.6.7 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:

- be made from a material described in the Appendix to these regulations;

- be no less than 25mm thick over their entire area;

- cover the area situated between points lying 50mm behind the centre of the point at which the second roll structure test is carried out and 100mm behind the face of the rearmost pedal when in the inoperative position, as shown in Drawing 4;

- cover the area above the line A-A shown in Drawing 3.

14.7 Wheel retention:

All cars, whilst under their own power, must be fitted with devices which will retain the wheel fastener in the event of it coming loose.

After the wheel nut is fastened, these devices must be manually fitted in a separate action to that of securing the wheel nut.

14.8 Seat fixing and removal:

14.8.1 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 clearly indicated and easily accessible to rescue crews;

- be fitted vertically;

- be removable with the same tool for all teams and which is issued to all rescue crews.

14.8.2 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.

14.8.3 The seat must be removable without the need to cut or remove any of the seat belts.

14.8.4 Details of the tool referred to above, the belt receptacles and the head stabilisation device may be found in the Appendix to these regulations.

14.9 Head and neck supports :

No head and neck support worn by the driver may be less 25mm from any structural part of the car when he is seated in his normal driving position.

Static load testing

In addition to impact tests, Formula One cars, and in particular the survival cell that houses the driver, must also pass static load tests. These ensure that the structure of the car meets minimum strength requirements.

The survival cell is tested, as is the nose and the rear impact structure of the car. In addition, the floor below the fuel tank and the cockpit, and the rim of the cockpit must also pass strict tests. All of these requirements help to make Formula One cars safer than ever before.

ARTICLE 18: STATIC LOAD TESTING

18.1 Conditions applicable to all static load tests:

18.1.1 The tests described in Articles 18.2, 18.3, 18.4, 18.5, 18.6 and 18.9.2 must be carried out on the survival cell which will be subjected to the impact tests described in Article 16.

18.1.2 Every subsequent survival cell produced must also be subjected to the tests described in Articles 18.2, 18.3, 18.4 and 18.5.

However, the tests described in Articles 18.2.1, 18.3, 18.4 and 18.5 may be carried out on subsequent survival cells with peak loads reduced by 20%. During these subsequent tests (on deflections greater than 3.0mm), the deflection across the inner surfaces must not exceed 120% of the deflection obtained at 80% of the peak load during the first test.

18.1.3 Deflections and deformations will be measured at the centre of area of circular load pads and at the top of rectangular pads.

18.1.4 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.

18.1.5 Following the tests described in 18.2, 18.3, 18.4 and 18.5, permanent deformation must be less than 1.0mm (0.5mm in 18.3 and 18.4) after the load has been released for 1 minute.

18.1.6 All tests must be carried out by using measuring equipment which has been calibrated to the satisfaction of the FIA technical delegate.

18.1.7 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.

18.1.8 For the tests described in 18.2, 18.3, 18.4 and 18.5, the survival cells must always be produced in an identical condition in order that their weights may be compared. If the weight differs by more than 5% from the one subjected to the impact tests described in Articles 16.2 and 16.3 further frontal and side impact tests and roll structure tests must be carried out.

18.1.9 Any significant modification introduced into any of the structures tested shall require that part to pass a further test.

18.2 Survival cell side tests:

18.2.1 For test 1, referred to in Article 15.5.4, pads 100mm long and 300mm high, which conform to the shape of the survival cell, must be placed against the outermost sides of the survival cell with the lower edge of the pad at the lowest part of the survival cell at that section.

A constant transverse horizontal load of 25.0kN will be applied and, under the load, there must be no structural failure of the inner or outer surfaces of the survival cell.

18.2.2 For test 2), referred to in Article 15.5.4, 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 the pads must pass through the plane mentioned above and the mid point of the height of the structure at that section.

A constant transverse horizontal load of 30.0kN 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.

18.2.3 For test 3), referred to in Article 15.5.4, 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 the pads must be located 350mm above the reference plane and on the vertical plane mentioned in Article 15.5.4.

A constant transverse horizontal load of 30.0kN 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.

18.3 Fuel tank floor test:

A pad of 200mm diameter must be placed in the centre of area of the fuel tank floor and a vertical upwards load of 12.5kN applied. Under the load, there must be no structural failure of the inner or outer surfaces of the survival cell.

18.4 Cockpit floor test :

A pad of 200mm diameter must be placed beneath the survival cell, on the car centre line and with its centre 600mm forward of the rear edge of the cockpit entry template, and a vertical upwards load of 15kN applied.

Under the load, there must be no structural failure of the inner or outer surfaces of the survival cell.

18.5 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 a point 250mm forward of the rear edge of the cockpit opening template longitudinally.

A constant transverse horizontal load of 15.0kN will then be applied at 90° to the car centre line 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 20mm.

This test must be repeated at positions 50mm and 150mm forward of the rear edge of the cockpit opening template longitudinally.

18.6 Nose push off test:

During the 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 constant transversal horizontal load of 40.0kN must then be applied to one side of the impact absorbing structure, using a pad identical to the ones used in the lateral tests in Article 18.2.1, at a point 550mm from the front wheel axis.

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 survival cell.

18.7 Side intrusion test:

18.7.1 The test must be carried out in accordance with FIA Test Procedure 02/05, 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 these regulations.

18.7.2 The test panel must be 500mm x 500mm and will be tested by forcing a rigid truncated cone through the centre of the panel at a rate of 2mm (+/-1mm) per second until the displacement exceeds 150mm.

During the first 100mm of displacement the load must exceed 250kN and the energy absorption must exceed 6000J. There must be no systematic damage to the border or damage to the fixture before these requirements have been met.

18.8 Rear impact structure push off test:

During the test the gearbox and the structure must be solidly fixed to the ground but not in a way that could increase the strength of the attachments being tested.

A constant transversal horizontal load of 40kN must then be applied to one side of the impact absorbing structure, using a pad identical to the ones used in the lateral tests in Article 18.2.1, at a point 400mm behind the rear wheel axis.

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 gearbox.

18.9 Side impact structure push off test:

18.9.1 Each team must supply detailed calculations which clearly show that the structure(s) are capable of withstanding:

- horizontal loads of 20kN applied separately in a forward and a rearward direction by a ball-jointed pad, which may conform to the shape of the structure(s), measuring 550mm high x 100mm wide and whose centre of area lies 600mm from the car centre line and 300mm above the reference plane;

- a vertical load of 10kN applied in an upward or downward direction by a ball-jointed pad, which may conform to the shape of the structure(s), measuring 400mm long x 100mm wide whose centre of area lies 600mm from the car centre line and 500mm forward of the rear edge of the cockpit entry template.

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.

If multiple impact structures are fitted to the car only those in contact with the pads need have the load applied to them.

18.9.2 During the push off 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 constant rearward horizontal load of 20.0kN must then be applied to the impact absorbing structure(s) using a ball-jointed pad 550mm high and 100mm wide, which may conform to the shape of the structure(s), at a point 600mm from the car centre line.

The centre of area of the pad must lie 300mm above the reference plane and there must be no failure of any structure or of any attachment between the structure(s) and the survival cell.

If multiple impact structures are fitted to the car only those in contact with the pads will be tested.

Suspension and steering systems

Formula One cars must have conventional sprung suspension. Any system, such as active suspension, that can alter the suspension or its geometry while the car is moving is forbidden.

The suspension members must have a symmetrical profile for the majority of their length. This is to prevent designers using them as aerodynamic devices.

Each wheel must be tied to the body of the car by two tethers, each contained within a separate suspension member and with its own attachments at either end. The tethers must meet specific tensile strength requirements and are designed to stop the wheels coming loose from the car in the event of an accident or suspension failure.

Power steering systems are allowed, but these must not be electronically controlled or powered. Four-wheel steering is forbidden. The car's steering wheel, steering column and steering rack all have to pass an FIA impact test.

ARTICLE 10: SUSPENSION AND STEERING SYSTEMS

10.1 Sprung suspension:

10.1.1 Cars must be fitted with sprung suspension.

10.1.2 The suspension system must be so arranged that its response results only from changes in load applied to the wheels.

10.2 Suspension geometry:

10.2.1 With the steering wheel 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.

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

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

10.3 Suspension members:

10.3.1 With the exception of minimal local changes of section for the passage of hydraulic brake lines, electrical wiring and wheel tethers or the attachment of flexures, rod ends and spherical bearings, the cross-sections of each member of every suspension component, when taken normal to a straight line between the inner and outer attachment points, must :

- intersect the straight line between the inner and outer attachment points ;

- have a major axis no greater than 100mm ;

- have an aspect ratio no greater than 3.5:1 ;

- be nominally symmetrical about its major axis.

The major axis will be defined as the largest dimension of any such cross-section.

10.3.2 When assessing compliance with Article 10.3.1, suspension members having shared attachment points will be considered by a virtual dissection into discrete members.

10.3.3 No major axis of a cross section of a suspension member, when assessed in accordance with Article 10.3.1, may subtend an angle greater than 5° to the reference plane when projected onto, and normal to, a vertical plane on the car centre line with the car set to the nominal design ride height.

10.3.4 Non-structural parts of suspension members are considered bodywork.

10.3.5 Redundant suspension members are not permitted.

10.3.6 In order to help prevent a wheel becoming separated in the event of all suspension members connecting it to the car failing provision must be made to accommodate flexible tethers, each with a cross sectional area greater than 110mm². The sole purpose of the tethers is to prevent a wheel becoming separated from the car, they should perform no other function.

The tethers and their attachments must also be designed in order to help prevent a wheel making contact with the driver›s head during an accident.

Each wheel must be fitted with two tethers each of which exceed the requirements of 3.1.1 of Test Procedure 03/07.

Each tether must have its own separate attachments at both ends which :

- 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 ;

- on the survival cell or gearbox are separated by at least 100mm measured between the centres of the two attachment points ;

- on each wheel/upright assembly are located on opposite sides of the vertical and horizontal wheel centre lines and are separated by at least 100mm measured between the centres of the two attachment points ;

- are able to accommodate tether end fittings with a minimum inside diameter of 15mm.

Furthermore, no suspension member may contain more than one tether.

Each tether must exceed 450mm in length and must utilise end fittings which result in a tether bend radius greater than 7.5mm.

10.4 Steering:

10.4.1 Any steering system which permits the re-alignment of more than two wheels is not permitted.

10.4.2 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.

10.4.3 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.

10.4.4 The steering wheel, steering column and steering rack assembly must pass an impact test, details of the test procedure may be found in Article 16.5.

10.5 Suspension Uprights:

10.5.1 UThe suspension uprights must be made from a permitted aluminium alloy. Particulate reinforced aluminium alloy matrix composites are forbidden.

10.5.2 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.

Television cameras and timing transponders

Throughout the Grand Prix weekend all cars must be fitted with at least five housings for cameras which are used to provide on-board TV footage.

The positions of the housings are specified in the regulations and the one mounted on top of the air box immediately behind the driver's head must always contain a camera.

All cars must also be fitted with two timing transponders supplied by the officially appointed timekeepers. These transponders allow the timekeepers to record every lap time of every car throughout the weekend.

ARTICLE 20: TELEVISION CAMERAS AND TIMING TRANSPONDERS

20.1 Presence of cameras and camera housings:

All cars must be fitted with at least five cameras or camera housings at all times throughout the Event.

20.2 Location of camera housings:

Camera housings, when used, must be fitted in the same location as cameras. Details concerning the size and weight of all camera housings may be found in the Appendix to these regulations.

20.3 Location and fitting of camera equipment:

20.3.1 All cars must be equipped with five positions in which cameras or camera housings can be fitted. Referring

to Drawing 6, all cars must carry (i) a camera in position 4 and (ii) a camera or camera housing in positions 2 (both sides), 3 and either 1 or 5.

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.

20.3.2 Any part provided by the Competitor for the purpose of aligning a camera or camera housing in positions 2 or 3 correctly will be considered part of the camera or camera housing provided it is being fitted for that sole purpose.

20.3.3 Any camera or camera housing fitted in positions 2, 3 or 4 shown in Drawing 6 must be mounted in order that its major axis does not subtend an angle greater than 1° to the reference plane.

20.4 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 these regulations.

20.5 Installation :

Competitors must be notified of any changes to the camera or transponder installation instructions before 30 June of the previous season.

Transmission system

The majority of modern Formula One cars use seven-speed semi-automatic gearboxes. Regulations stipulate a maximum of seven forward gears plus reverse. Continuously Variable Transmission (CVT) systems are not allowed and cars may have no more than two driven wheels. Transmissions may not feature traction control systems, nor devices that help the driver to hold the clutch at a specific point to aid getaway at the start of the race.

For safety reasons all cars must have a means of disengaging the clutch that is operable from outside the cockpit by marshals. This control is usually situated just ahead of the cockpit opening and is marked on the car's body by a red letter "N" within a white circle.

ARTICLE 9: TRANSMISSION SYSTEM

9.1 Transmission types:

No transmission system may permit more than two wheels to be driven.

9.2 Clutch control:

The following applies only to the main drivetrain clutch or clutches, any clutch used exclusively as part of a KERS is exempt.

9.2.1 If multiple clutch operating devices are used, they must all have the same mechanical travel characteristics and be mapped identically.

9.2.2 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.

9.2.3 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.

9.2.4 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 ECU, are not permitted.

9.3 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 throttle demand by the driver.

Any device or system which notifies the driver of the onset of wheel spin 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 Event even if the main hydraulic, pneumatic or electrical systems on the car have failed. This system must also disconnect any KERS 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 :

- face upwards and be recessed into the top of the survival cell no more than 150mm from the car centre line ;

- be designed in order that a marshal is unable to accidentally re-engage the clutch ;

- be less than 150mm from the front of the cockpit opening ;

- be marked with a letter «N» in red inside a white circle of at least 50mm diameter with a red edge.

9.5 Gearboxes

9.5.1 A gearbox is defined as all the parts in the drive line which transfer torque from the engine crankshaft to the drive shafts (the drive shafts being defined as those components which transfer drive torque from the sprung mass to the un-sprung mass). It includes all components whose primary purpose is for the transmission of power or mechanical selection of gears, bearings associated with these components and the casing in which they are housed.

9.5.2 In this context the following parts are not considered part of the gearbox and may be changed without incurring a penalty under the F1 Sporting Regulations. If changing any of these parts involves breaking an FIA applied seal this may be done but must be carried out under FIA supervision :

- the clutch assembly and any shaft connecting the clutch to the crankshaft or first motion shaft of the gearbox, provided this is located prior to any mechanical speed reduction from the engine ;

- the clutch actuator and clutch release bearing(s) ;

- 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 ;

- 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) ;

- oil, oil pumps, oil filters, oil seals, oil coolers and any associated hoses or pipes ;

- electrical sensors, actuators, servo valves and wiring ;

- any parts associated with the suspension or functioning of the sprung suspension that are attached to the gearbox casing ;

- the rear impact structure provided it can be separated from any gearbox casing ;

- any other component mounted to the casing whose primary purpose is unconnected with the transmission of power or selection of gears.

9.6 Gear ratios :

9.6.1 The maximum number of forward gear ratios is 7.

9.6.2 The maximum number of numerical change gear ratio pairs a competitor has available to him during a Championship season is 30. All such gear ratio pairs must be declared to the FIA technical delegate at or before the first Event of the Championship.

9.6.3 No forward gear ratio pair may be :

- 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°. In addition, a chamfer or radius not exceeding 2.0mm may be applied to the sides and the tip of the teeth ;

- less than 85mm between centres ;

- less than 600g in weight (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.

9.6.4 Gear ratios must be made from steel.

9.6.5 Continuously variable transmission systems are not permitted to transmit the power of the engine defined in Article 5.1.

9.7 Reverse gear :

All cars must have a reverse gear operable any time during the Event by the driver when the engine is running.

9.8 Torque transfer systems :

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

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

9.9 Kinetic Energy Recovery System :

9.9.1 The KERS must connect at any point in the rear wheel drivetrain before the differential.

9.9.2 The system will be considered shut down when all energy is contained within the KERS modules and no

high voltage is present on any external or accessible part of any KERS module.

The shutdown process must take no longer than two seconds from activation.

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

- the switch required by Article 14.2.1 ;

- the switches required by Article 14.2.2 ;

- the switch or button required by Article 9.4.

9.9.4 The KERS must shut down when the ECU required by Article 8.2 initiates an anti-stall engine shut off.

9.9.5 All cars fitted with a KERS must be fitted with a KERS status light which :

- is in working order throughout the Event even if the main hydraulic, pneumatic or electrical systems on the car have failed ;

- is located in the same general location as the light required by Article 8.10 ;

- is green only when the system is shut down and no electrical insulation fault has been detected ;

- remains powered for at least 15 minutes if the car comes to rest with its engine stopped ;

- is marked with a “HIGH VOLTAGE” symbol.

Weight

Cars must weigh at least 640kg (including the driver) at all times. Teams may use ballast to bring cars up to weight. This must be firmly secured to the cars. Ballast may not be removed or added during a race.

ARTICLE 4: WEIGHT

4.1 Minimum weight:

The weight of the car must not be less than 640kg at all times during the Event.

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

4.2 Weight distribution :

For 2011 only, the weight applied on the front and rear wheels must not be less than 291kg and 342kg respectively at all times during the qualifying practice session.

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

4.3 Weight of tyres :

The weight limits specified in Articles 4.1 and 4.2 will be adjusted according to any differences (rounded up to the nearest 1kg) between the total set and individual axle set weights respectively of the 2010 and 2011 dry-weather tyres.

4.4 Ballast:

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

4.5 Adding during the race:

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

Wheels and tyres

Formula One cars must have four, uncovered wheels, all made of the same metallic material, which must be one of two magnesium alloys specified by the FIA. Front wheels must be between 305 and 355mm wide, the rears between 365 and 380mm.

With tyres fitted the wheels must be no more than 660mm in diameter (670mm with wet-weather tyres). Measurements are taken with tyres inflated to 1.4 bar. Tyres may only be inflated with air or nitrogen.

ARTICLE 12: WHEELS AND TYRES

12.1 Location:

Wheels must be external to the bodywork in plan view, with the rear aerodynamic device removed.

12.2 Number of wheels:

The number of wheels is fixed at four.

12.3 Wheel material:

Wheels must be made from AZ70 or AZ80 magnesium alloys.

12.4 Wheel dimensions :

12.4.1 Complete wheel width must lie between 305mm and 355mm when fitted to the front of the car and between 365mm and 380mm when fitted to the rear.

12.4.2 Complete wheel diameter must not exceed 660mm when fitted with dry-weather tyres or 670mm when fitted with wet weather tyres.

12.4.3 Complete wheel width and diameter will be measured horizontally at axle height, with the wheel held in a vertical position and when fitted with new tyres inflated to 1.4 bar.

12.4.4 Wheel dimensions and geometry must comply with the following specifications :

- the minimum wheel thickness is 3.0mm ;

- the minimum bead thickness is 4.0mm (measured from hump to outer edge of the lip) ;

- the ETRTO standard bead profile is prescribed ;

- the tyre mounting widths are 12” (304.8mm +/-0.5mm) front; 13.7” (348.0mm +/-0.5mm) rear ;

- the wheel lip thickness is 9mm (+/-1mm) ;

- the outer lip diameter is 358mm (+/-1mm) ;

- a lip recess of maximum 1.0mm depth between a radius of 165mm and a radius of 173mm from wheel axis is permitted (for wheel branding, logo, part number, etc) ;

- with the exception of the wheel lip, only a single turned profile with a maximum thickness of 8mm is allowed radially outboard of the exclusion zones specified in Article 12.4.5 ;

- the design of the wheel must meet the general requirements of the tyre supplier for the mounting and dismounting of tyres including allowance for sensors and valves ;

- the wheel design cannot be handed between left and right designs.

12.4.5 No wheel material is permitted in the following exclusion zones :

- A concentric cylinder of diameter 305mm and length 115mm positioned with its inner face lying in the same plane as the inboard face of the front wheel ;

- A concentric cylinder of diameter 305mm and length 25mm positioned with its outer face lying in the same plane as the outboard face of the front wheel ;

- A concentric cylinder of diameter 305mm and length 100mm positioned with its inner face lying in the same plane as the inboard face of the rear wheel ;

- A concentric cylinder of diameter 305mm and length 30mm positioned with its outer face lying in the same plane as the outboard face of the rear wheel.

12.4.6 When viewed perpendicular to the plane formed by the outer face of the wheel and between the diameters of 120mm and 270mm the wheel may have an area of no greater than 24,000mm2.

12.5 Supply of tyres :

12.5.1 All tyres must be used as supplied by the manufacturer, any modification or treatment such as cutting,

grooving or the application of solvents or softeners is prohibited. This applies to dry, intermediate and wet-weather tyres.

12.5.2 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.

12.5.3 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.

12.6 Specification of tyres :

12.6.1 An intermediate tyre is one which has been designed for use on a wet or damp track.

All intermediate tyres must, when new, have a contact area which does not exceed 280cm² when fitted to the front of the car and 440cm² when fitted to the rear. Contact areas will be measured over any square section of the tyre which is normal to and symmetrical about the tyre centre line and which measures 200mm x 200mm when fitted to the front of the car and 250mm x 250mm when fitted to the rear. For the purposes of establishing conformity, void areas which are less than 2.5mm in depth will be deemed to be contact areas.

12.6.2 A wet-weather tyre is one which has been designed for use on a wet track.

All wet-weather tyres must, when new, have a contact area which does not exceed 240cm² when fitted to the front of the car and 375cm² when fitted to the rear. Contact areas will be measured over any square section of the tyre which is normal to and symmetrical about the tyre centre line and which measures 200mm x 200mm when fitted to the front of the car and 250mm x 250mm when fitted to the rear. For the purposes of establishing conformity, void areas which are less than 5.0mm in depth will be deemed to be contact areas.

12.6.3 Tyre specifications will be determined by the FIA no later than 1 September of the previous season. Once

determined in this way, the specification of the tyres will not be changed during the Championship season without the agreement of all competing teams.

12.7 Tyre Gases :

12.7.1 Tyres may only be inflated with air or nitrogen.

12.7.2 Any process the intent of which is to reduce the amount of moisture in the tyre and/or in it›s inflation gas is forbidden.

12.8 Wheel assembly :

12.8.1 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, balance weights, drive pegs, tyre pressure and temperature monitoring devices and spacers on the inboard mounting face of identical specification on all wheels for the same axle.

12.8.2 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 12.8.1.

12.8.3 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.

12.8.4 Powered devices which assist in the fitting or removal of wheel fasteners may only be powered by compressed gas.