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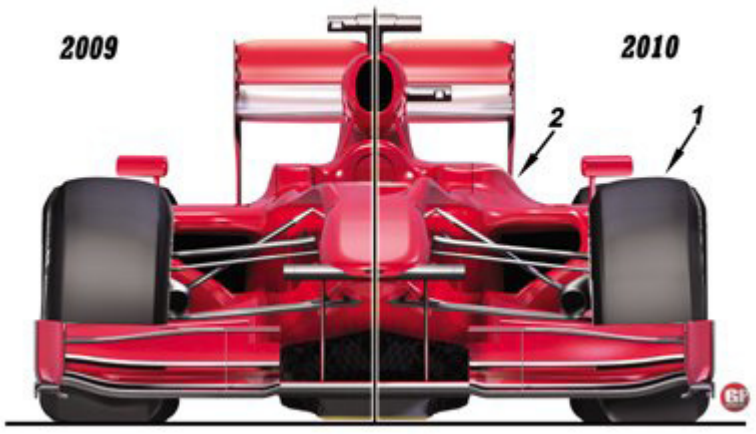
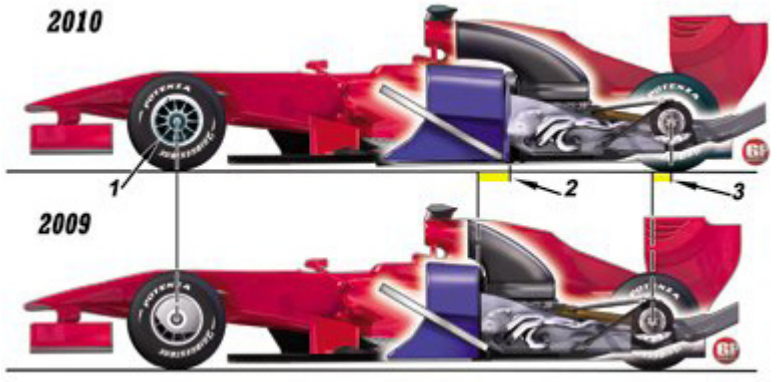


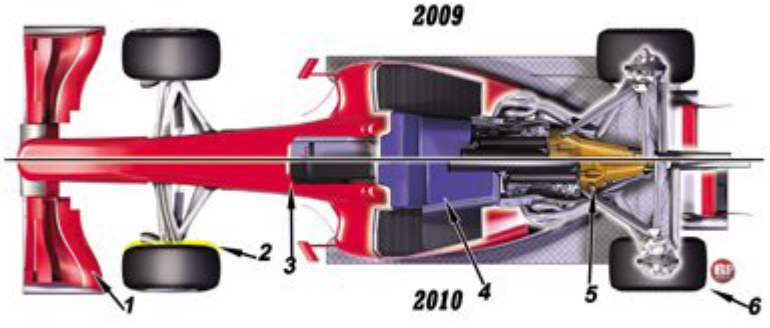
2009/2010 front comparison

From the front, the 2010 cars will look distinctly different to their '09 predecessors due to the narrower front tyres (1) and the wider rear bodywork needed to accommodate the larger fuel tank (2) required following the ban on refuelling. The slimmer front tyres - which address the imbalance of front and rear grip that resulted from the reintroduction of slicks last year - will widen the space between tyre and chassis, thus making this area even more important aerodynamically, so expect to see it featuring some interesting aero components.



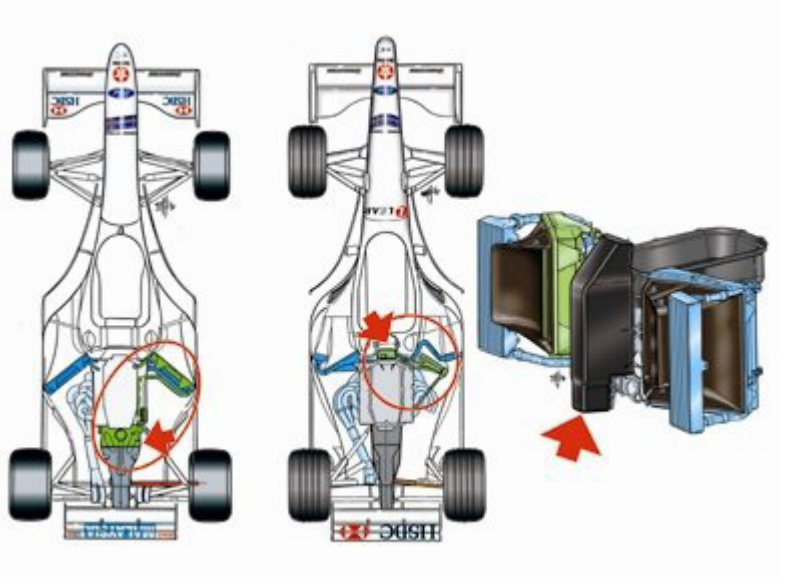
2009/2010 side comparison

Although the refuelling ban for 2010 is a change to the sporting regulations, it has technical implications too. The fuel tank's capacity (2) has almost doubled from around 120 litres to at least 235 litres, while the car's minimum weight has been increased from 605kg to 620kg. To accommodate the larger tank, the car's wheelbase will likely be increased by around 15cm (3). Another 2010 change is that wheels covers (1) have been banned. This is primarily to avoid problems during pit stops which, with no refuelling, will be incredibly fast. It's been estimated that pit stop times will be cut to under four seconds.



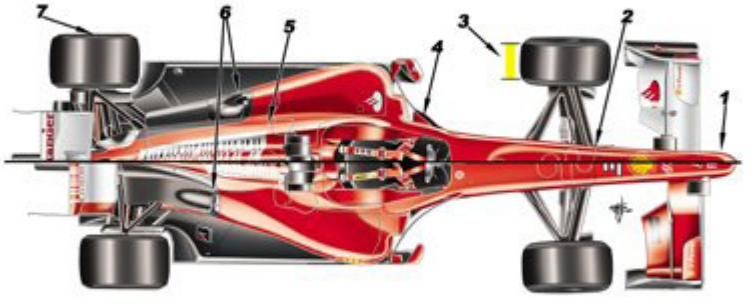
2009/2010 overhead comparison

The changes for 2010 are perhaps most striking from overhead. As a result of the ban on refuelling, the fuel tank (4) will be longer and wider. The wheelbase is likely to be about 15 cm longer than in '09 to accommodate this larger tank (6), though teams could opt to move the driver forward slightly (3) or build shorter gearboxes (5) to minimise this increase. At the front, the narrower front tyres (2) will change the handling characteristics and weight distribution of the car, while the driver has control of the front wing flap angle (1) from the cockpit.



Accommodating larger fuel tanks

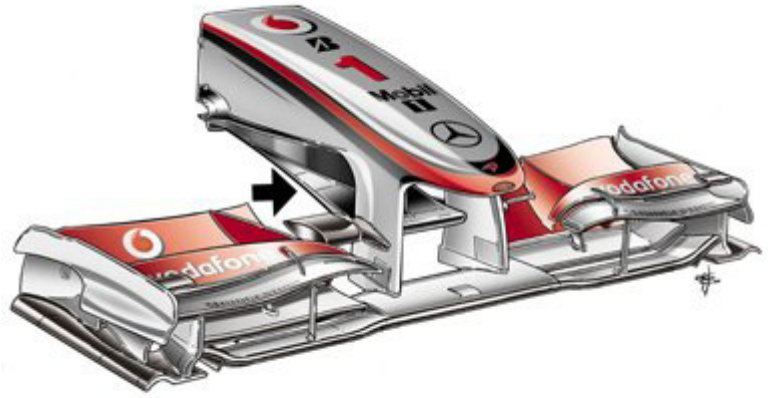
As a result of the ban on refuelling, 2010 cars will almost certainly have longer wheelbases as designers are forced to accommodate fuel tanks close to double the size of their predecessors'. One of the biggest engineering challenges will be to minimise this increase in wheelbase - and to minimise the impact of any increase. Moving the cockpit forward slightly and a shorter gearbox design are two possible options. A third could see teams harking back to a concept not seen on the grid in over a decade. In 1998 Stewart's Alan Jenkins and Arrows' John Barnard moved the oil tank from its then traditional position in the gearbox casing (left car, red arrow) to a new location immediately behind the cockpit (middle drawing, red arrow). This had the advantages of positioning the tank's weight near the car's centre of gravity, and reducing the car's overall weight thanks to the need for shorter piping. And that's where the oil tank has stayed, until now. Under the new rules, rather than housing the oil tank behind the newly-expanded fuel tank (which would mean increasing the wheelbase), we could see it once more shifted rearwards, where it can be housed with the gearbox without penalty.



Ferrari F60/F10 - overhead comparison

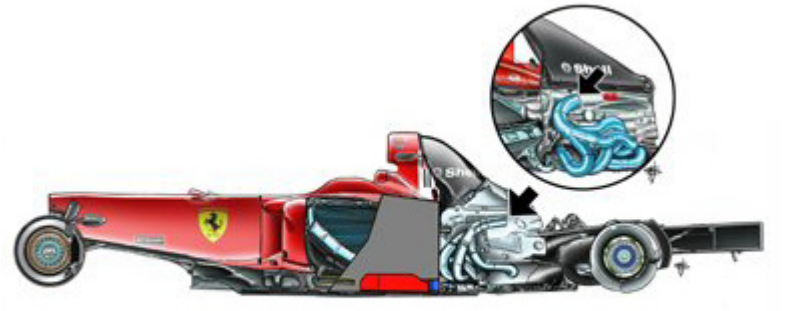
Like all the 2010 cars, the new Ferrari features a multitude of modifications. On the F10 (top half of drawing) the most dramatic difference is the longer wheelbase, which ensures the car can now fit a larger fuel tank and a longer and narrower gearbox. The car's rear axle is now some 20-22 cm further back (7). An old F60 front wing was fitted to the F10 at its launch, but the nosecone was longer (1). The front suspension (2) has been angled backwards to reduce the car's length, while the front tyres are 20 mm narrower (3). The team have fitted a small triangular fin in front of the sidepods (4) to better direct the airflow and have exploited the rules' maximum permitted width of 80 cm to fit in the longer and wider fuel tank (5). Although the engine itself is mounted around 15 cm further back, the exhaust exit is further forward (6).

McLaren MP4-25 - new front wing



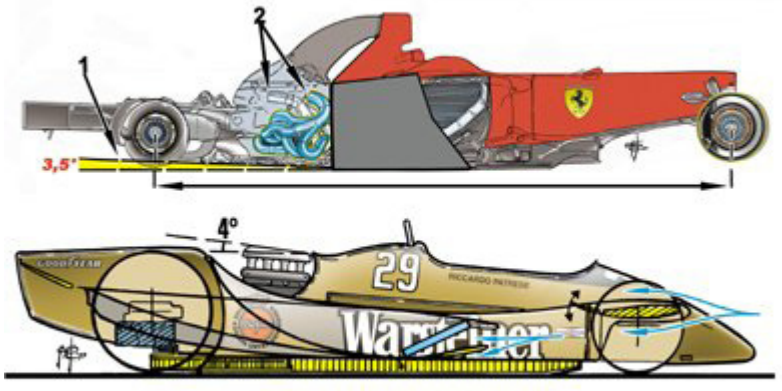
McLaren's new MP4-25 features a totally new front wing, although the endplates are derived from ones that the team often tested but never raced with during the 2009 season. Of particular interest is the nosecone splitter (see black arrow), which is similar to one used by Williams last year and is designed to better separate the airflow passing over and under the car.

Ferrari F60/F10 - exhaust comparison

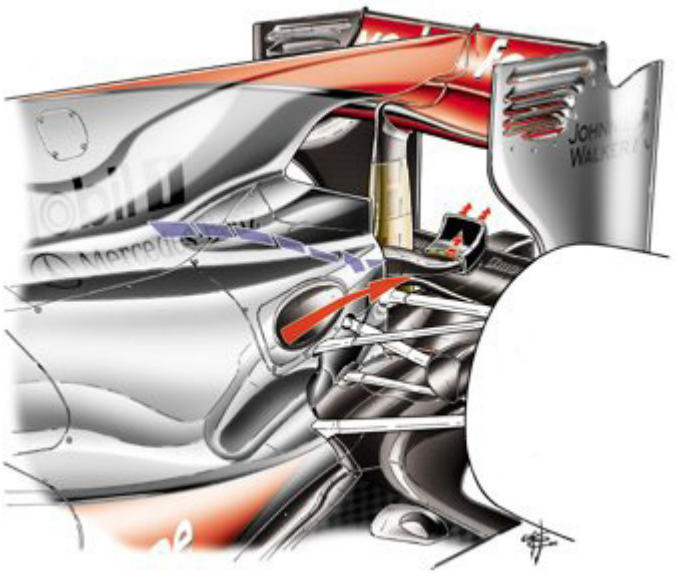


To ensure the exhaust pipe vents as far away from the rear wing as possible, Ferrari have reverted to a solution they used five seasons ago on the F2005. In contrast to the design of last year's car (see main picture, black arrow), the pipes have been mounted so they'll vent nearer the front of the car, rather than the back (see inset, black arrow).

Ferrari F10 - angled engine mounting

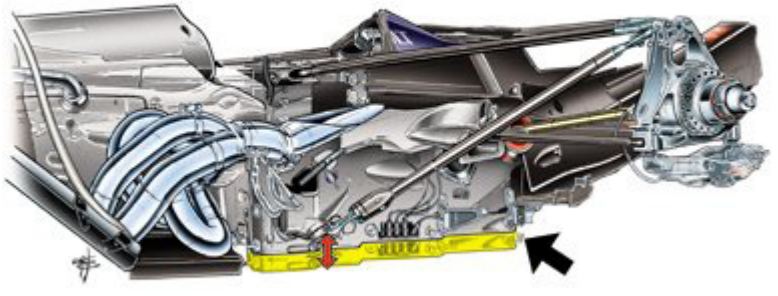


To create more room for a larger double diffuser, the F10 has its engine is mounted at a 3.5 degree angle (1). As a result, the exhaust pipe vents are located nearer the front of the car (2) than before, creating more space for a large chamber on the central diffuser. Interestingly there is a historical precedent for this approach - back in 1970, Arrows designer Tony Southgate mounted the engine of the sophisticated A2 at an angle of four degrees (bottom drawing).



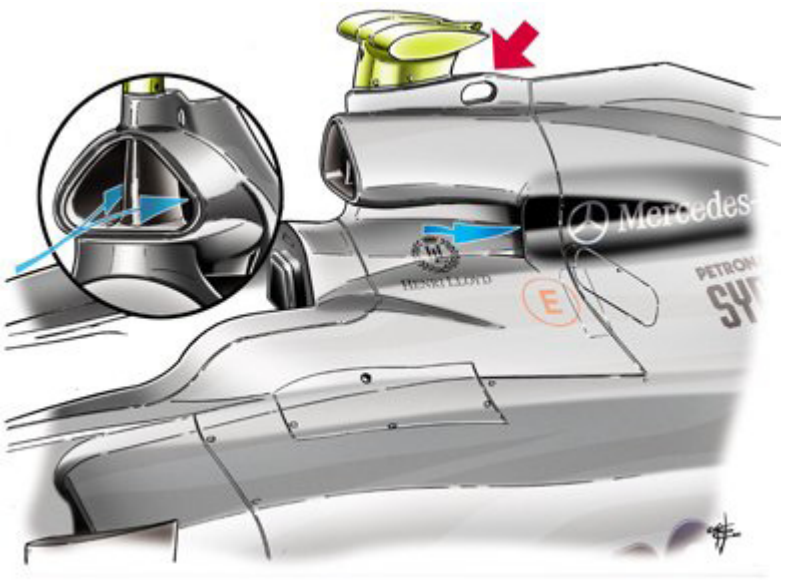
McLaren MP4-25 - rear aero solutions

The rear of the new MP4-25 features various aerodynamic solutions that have been devised through wind-tunnel testing and on-track work. At first glance it's the car's long wheelbase, with its long and narrow gearbox, that catches the eye, but it's actually the airflow management at the back which is more unusual. Like the Red Bull, the exhaust exits have been moved towards the rear of the car (large red arrow), whilst air from the gearbox radiator, which has been cooled with the help of air carefully channelled through the airbox (blue arrow), is also utilised for aerodynamic benefit. Directed towards the top of the rear wing's lower section and the diffuser (small red arrows), it intentionally interferes with airflow over these parts at certain speeds, causing them to stall. Another change to the design of the MP4-25 is the unique central pillar (yellow area) on which the rear wing is mounted.



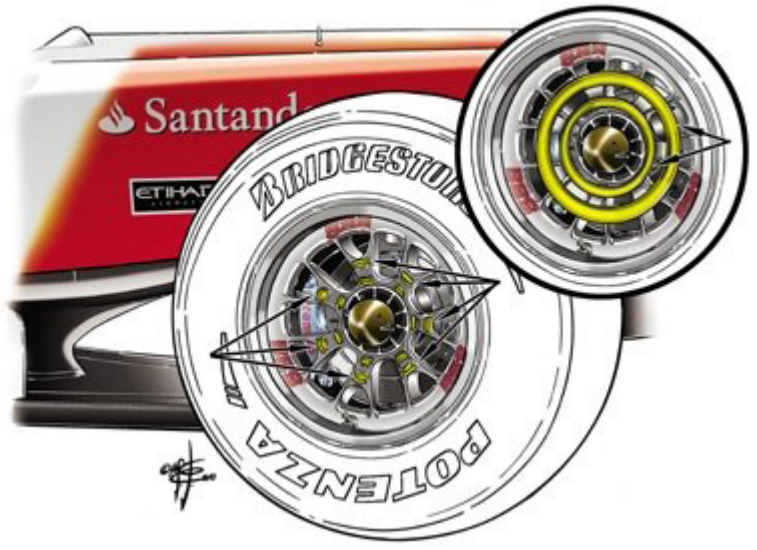
Red Bull RB6 - higher gearbox positioning

Like Ferrari, Red Bull wanted more space for their double diffuser. Chief technical officer Adrian Newey's simple solution was to elevate the position of the gearbox (see yellow highlighted area). The RB6's rear suspension is now slightly higher off the ground than before. An additional benefit of this solution is that the team have been able to keep the suspension's pull-rod configuration, since with its lower pick-up points now higher, they don't interfere with the new central diffuser section.



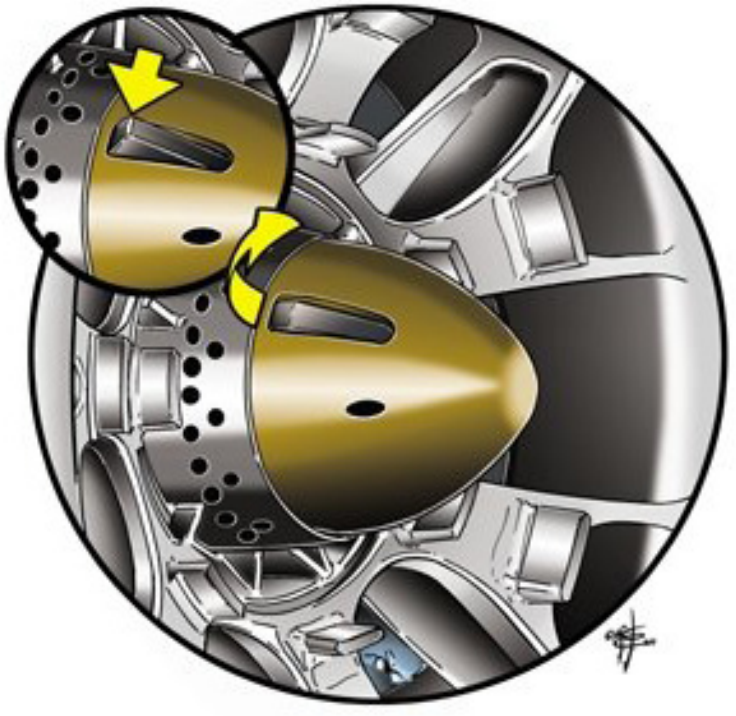
Mercedes MGP W01 - pyramid-shaped roll structure

A new solution on the Mercedes is this pyramid-shaped roll structure, which acts as an aero splitter within the airbox, separating and accelerating the incoming airflow (double blue arrow). Usually the roll structure simply follows the shape of the airbox, but Mercedes' design means the shape of the airbox can be altered independantly, avoiding the need for a new crash test, should changes be deemed necessary over the course of the season. The single blue arrow indicates a second air duct, while the red arrow shows the mandatory hole that all cars must have in order to be able to crane them off the circuit in the event of an accident.



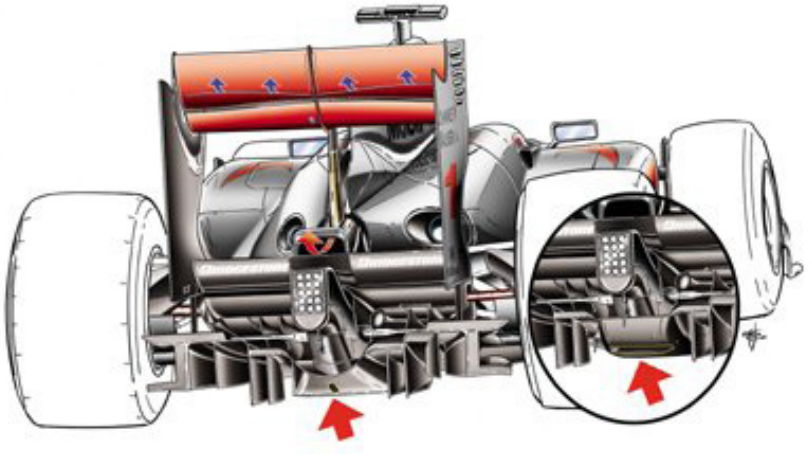
Ferrari F10 - aerodynamic wheel device

For the 2010 season the FIA have outlawed the carbon fibre wheel fairings that became so popular in 2009. In a move that may be seen as going against the spirit of the regulations (but which has been approved by the FIA), Ferrari have instead incorporated an integral aero device (inset - yellow rings) into the design of their wheel rim. The device is detachable (main drawing), but to be legal it is made from the same material as the rim itself. As wheel rims have to be homologated and can't be changed during the season, Ferrari's rivals will be unable to copy this.



Ferrari F10 - secured wheel nuts

The sight of an errant wheel from Fernando Alonso's Renault bouncing across the track at the 2009 Hungarian Grand Prix, prompted the FIA to impose new rules this season to ensure wheel nuts remain fastened. Ferrari's solution has been to create an entirely new wheel hub, which features a catch either side of the nut that locks into position (see inset) when the mechanic removes his tyre gun following the wheel change.



Rear diffusers - potential modifications

Ahead of round two of the season in Australia, the FIA is expected to issue a clarification of the rules relating to rear diffusers. The regulations permit a hole in the diffuser to allow access for the engine starter motor. However, there are concerns that teams could be exploiting this 'loophole' to gain aerodynamic benefit, by adopting unusually shaped starter motors in order to justify particularly large and sculpted diffuser openings. Don't be surprised if many have been modified come Melbourne so as to appease the scrutineers.

2010 FORMULA 1
GULF AIR BAHRAIN GRAND PRIX

SAKHIR
12 - 13 - 14 MARCH

طيران الخليج
GULF AIR

1950-2010
FIA FORMULA ONE WORLD CHAMPIONSHIP
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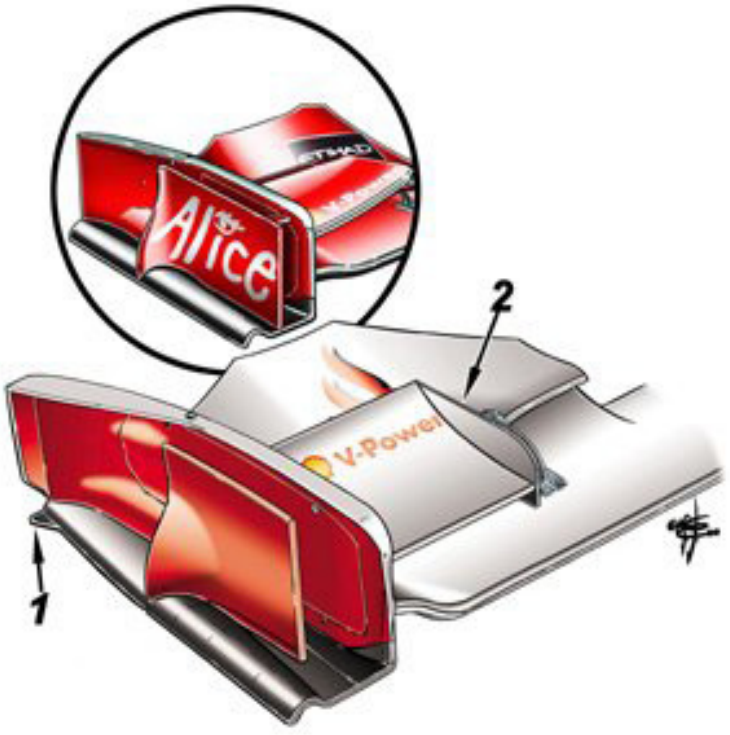
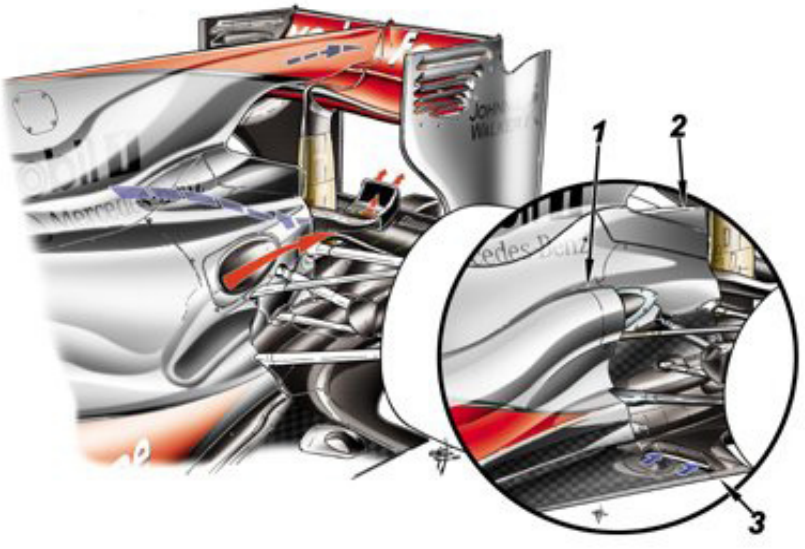


Ferrari F10 - modified front wing

During the last pre-season test at Barcelona, Ferrari introduced a new version of the F10's front wing. When compared to the older version (inset), we can see it features a tiny addition to the rear of the endplate (1) and a new main profile with a different flap which has a small endplate (2) on its inner edge.

Red Bull RB6 - new exhaust positioning

The exhausts on the RB6 have been repositioned in Bahrain. Before the exits were above the rear suspension's lower wishbones (as on last year's car). Now they are much lower, just inside the rear tyres. This is designed to increase the efficiency of the rear diffuser's side channels. However, it could prove a cooling risk at the start or if running at low speed (such as behind the safety car), when the slower airflow over the car will have less power to redirect the hot air from the exhaust.



McLaren MP4-25 - front chassis duct / rear aero package

Ever since the car's launch, the MP4-25's sophisticated aero package has attracted a lot of attention. The airbox is split into two channels. The lower one (bottom blue arrow) is designed to cool the gearbox radiator. The hot air expelled then hits the exit edge of the lower beam wing and diffuser (see small red arrows). The upper channel (top blue arrow) feeds air through the long fin that connects to the rear wing. The air is then expelled on to the wing's flap through a slot at a certain speed. These two processes combine to stall the rear wing at high speeds, reducing drag and hence increasing maximum speed. There is a clever solution to control the system. A duct has been placed at the front of the chassis, which feeds additional air into the process, over saturating it and stopping it functioning. On the straights, where this solution is most important, the drivers have the ability to close the duct with either their left leg or arm.

2010 FORMULA 1 AUSTRALIAN GRAND PRIX

MELBOURNE
25-26-27-28 MARCH

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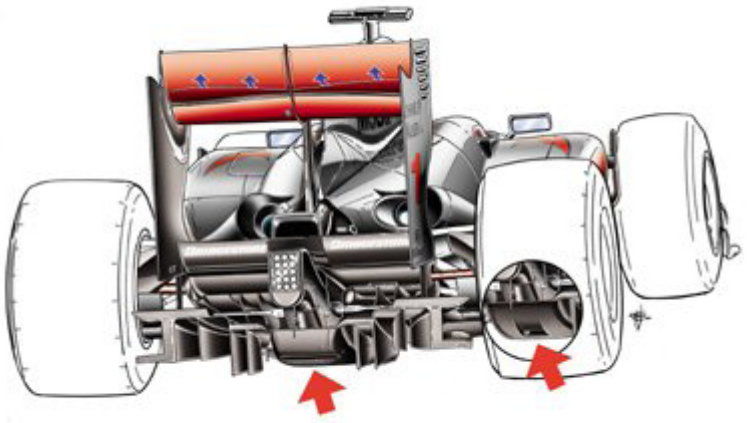
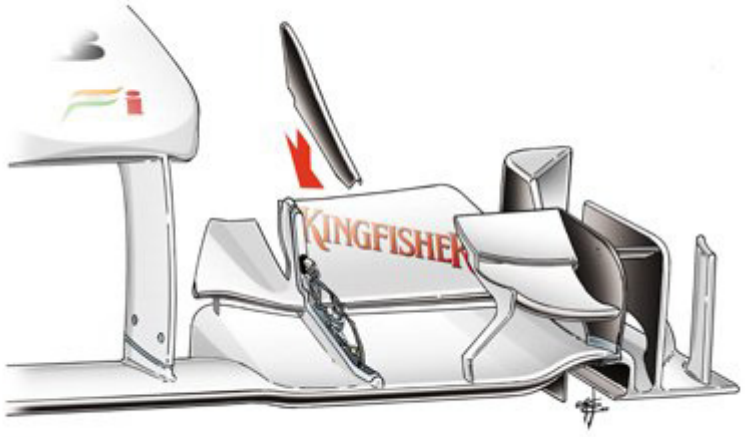


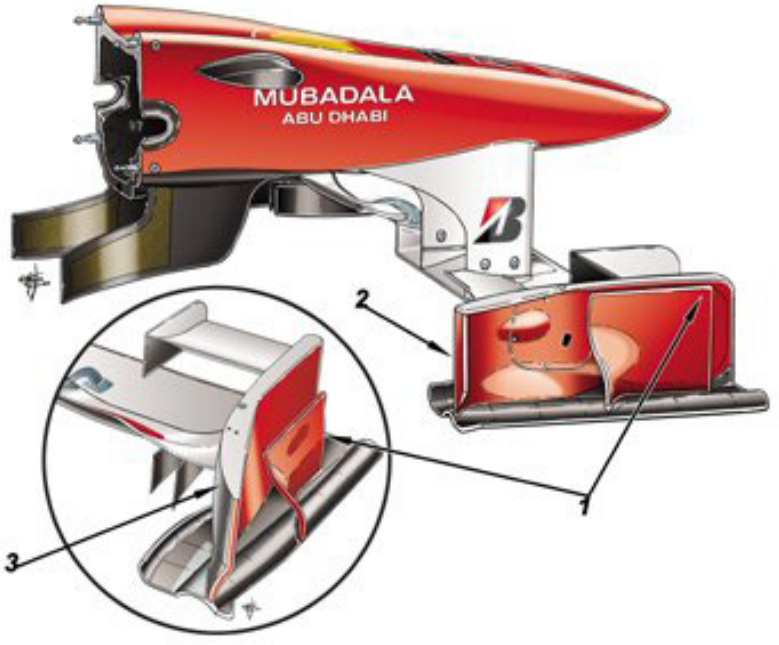
McLaren MP4-25 - modified diffuser

McLaren have had to modify the MP4-25's rear diffuser following a rule clarification from the FIA. The horizontal window in the central section was considered to be wider than necessary for simply allowing access for the external engine starter. They have kept almost the same shape (see inset) but with a smaller opening.



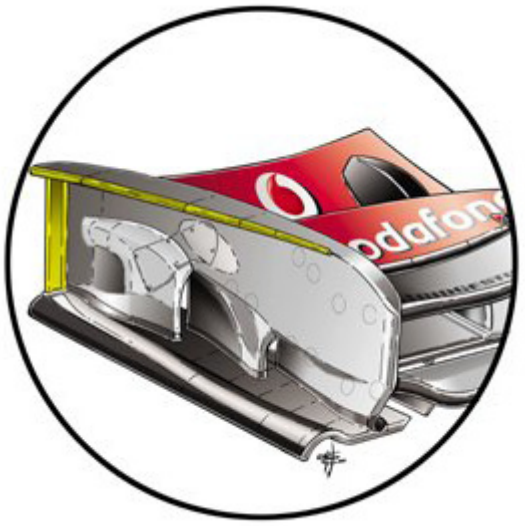
Force India VJM03 - adjustable front wing flaps

Together with new wider central pillars, which are similar to those on the Mercedes, the Force India drivers could use adjustable flaps (red arrow) for the first time in Australia in order to reduce the understeer problems they endured in Bahrain.



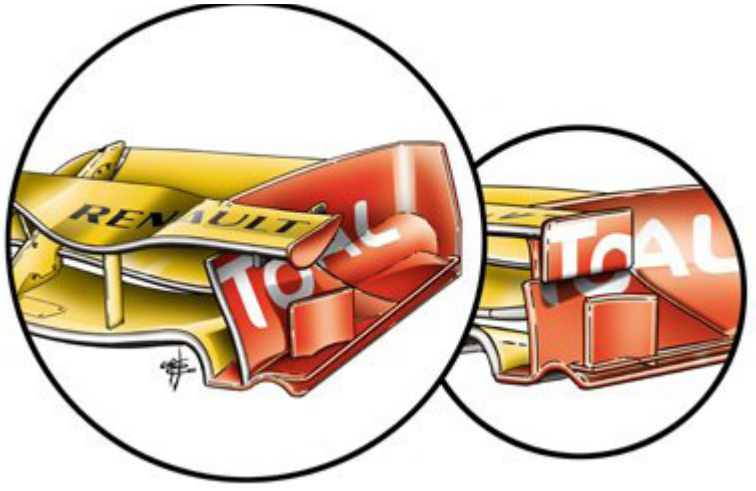
Ferrari F10 - revised front wing

Ferrari have introduced a new aero package for the F10 in Melbourne. The new front wing has notably different endplates. The outer small turning vanes are now more straight (1) and lower, while the endplate itself is more curved towards the outside (3) at the rear to better direct airflow away from the front tyres. With this new shape, the vertical gurney flap (2) has been reduced.



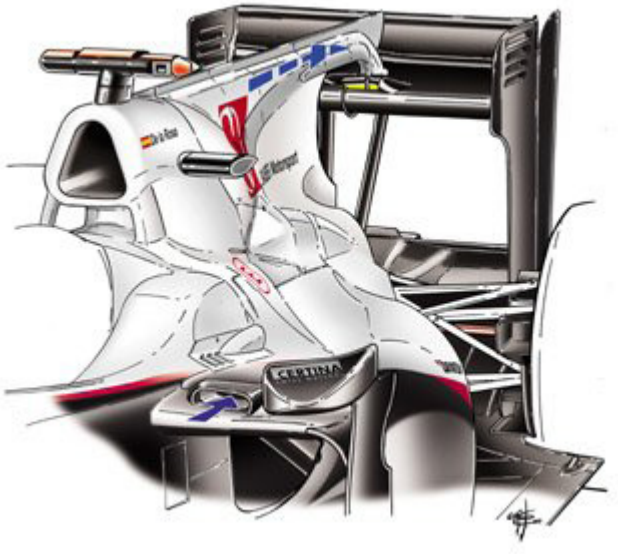
McLaren MP4-24 - revised front wing endplates

The stewards in Bahrain requested McLaren change the profile of certain parts of their front wing endplates (in yellow), to give previous sharp edges a safer, more rounded shape. They have thus introduced this revised solution in Australia, the changes coming in an area that is very important in controlling air vortices in front of the front tyres.



Renault R30 - modified front wing endplates

Renault have modified the front wing they introduced in Bahrain for the Australian Grand Prix. The new version (left drawing) features a different version of the top flaps small endplate. As well as being smaller, it has also been reshaped, and is now wing shaped rather than square in profile as previously (right drawing). Robert Kubica tested this solution during Friday practice and both he and team mate Vitaly Petrov ran it during Melbourne's qualifying and race.



BMW Sauber C29 - 'F-duct' system

BMW Sauber are the first team to introduce their own version of McLaren's innovative F-duct system, the speed of introduction helped by the fact that they had already tried using a critical part of this solution - a rear wing with a slot in it - at last years Singapore race. That slot effectively creates a three-element rear wing. However, there are notable differences compared to the McLaren system. The air directs on to the main section of the wing (longer blue arrow and yellow highlighted area), not the flap, whilst the 'F-duct' itself (smaller blue arrow) is positioned on the sidepods, not on top of the chassis like on the McLaren.

2010 FORMULA 1
PETRONAS MALAYSIAN GRAND PRIX

KUALA LUMPUR
02-03-04 APRIL


PETRONAS
1950-2010
FIA FORMULA ONE WORLD CHAMPIONSHIP
60
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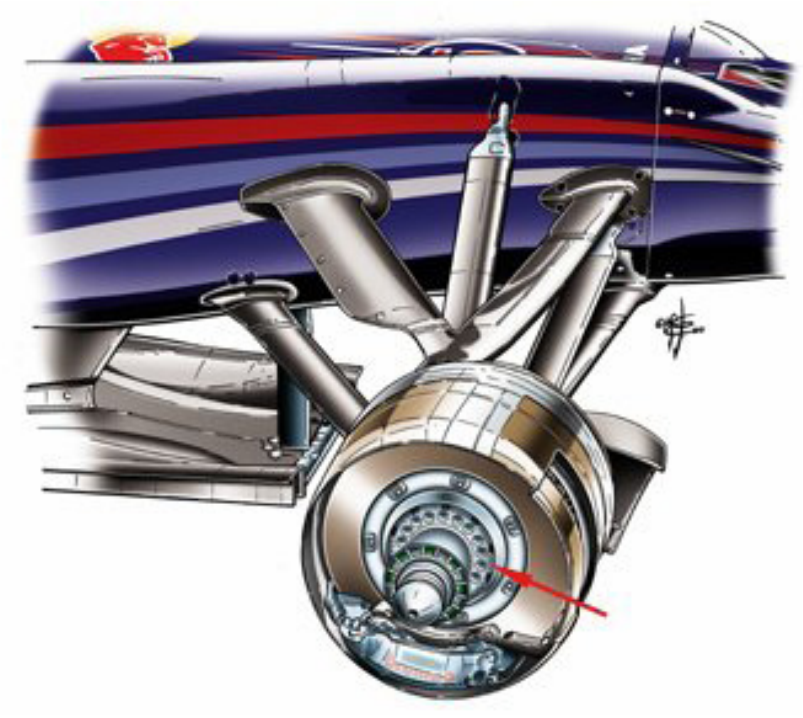
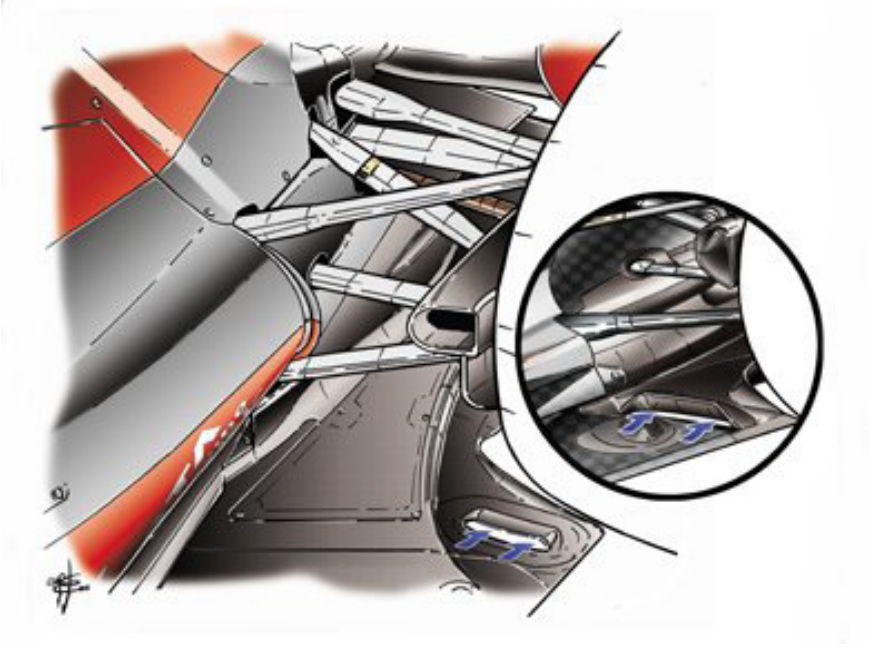


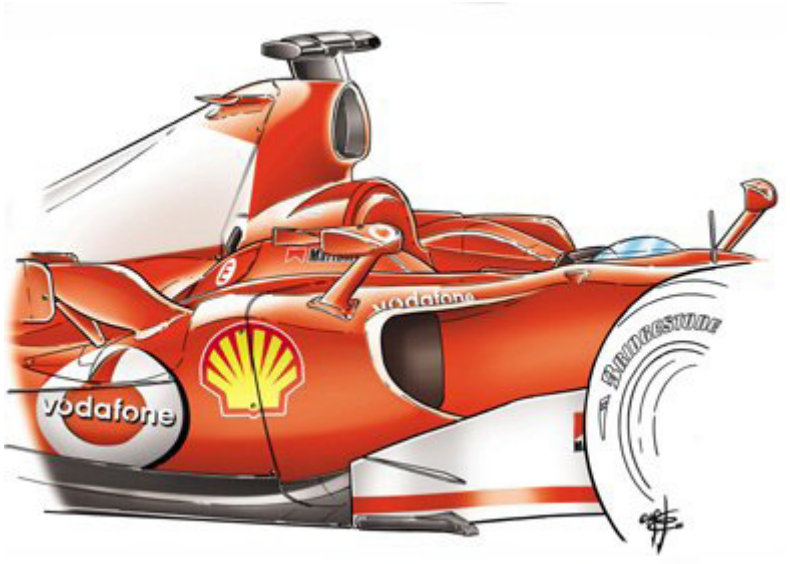
Red Bull RB6 - front brake-rim attachment

In both the first two races Red Bull suffered problems with their front wheel upright's brake-rim attachment - on Friday morning in Bahrain on Vettel's car, and on his again in Melbourne when the front-left wheel came loose. For Malaysia the team have worked hard to avoid the problem, checking the assembly of the components (hub, wheel nut and rim) after nearly every run. As you can see in the drawing, Red Bull don't have the locking pins (arrow) in the hub plate but instead in the inside of the rim.



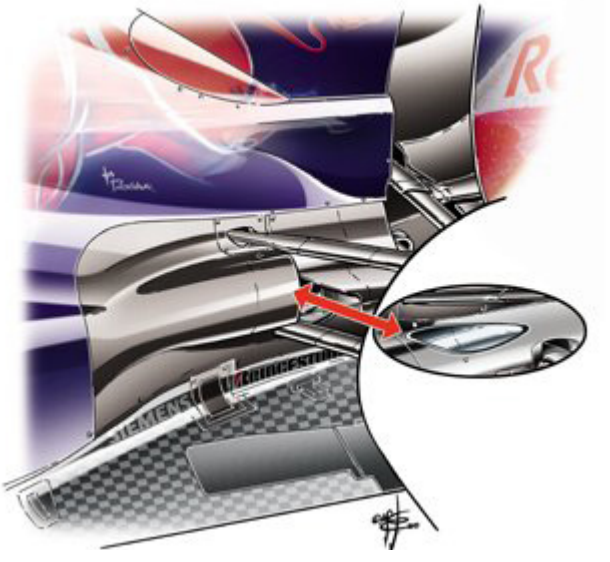
Ferrari F10 - new floor

Ferrari tested a new floor in Malaysia that included an opening in front of the rear tyres, something only McLaren have had from the beginning of the season. Its purpose is to feed air to the side channel of the rear diffuser in order to increase its efficiency. This solution was taken off the Ferrari on Saturday at Sepang, but we will probably see it again in China. The team also introduced cooling vanes beside the cockpit due to the hot conditions, but again these were not used on Saturday.



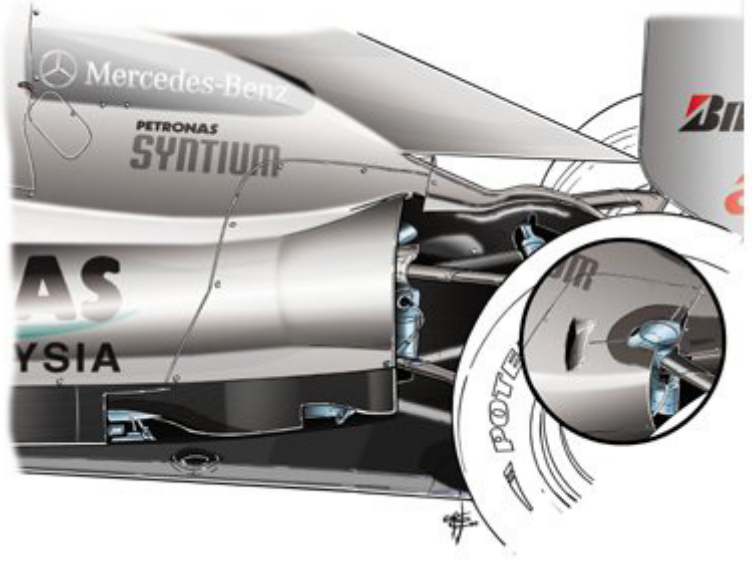
Forthcoming ban on outboard mirrors

Three races into the season the FIA have declared outboard mirrors too dangerous and have banned them. The ban was to come in at the forthcoming Chinese Grand Prix, but after the teams complained of time constraints, it will instead be introduced from May's Spanish race. Ferrari were the first team to place their mirrors on the extremities of their car's sidepods back in 2006 (see drawing). Since then several teams have designed similar solutions, and currently six - Ferrari, Red Bull, Williams, BMW Sauber, Force India and HRT - are using mirrors attached to the vertical turning vanes in front of the sidepods. Mirrors don't usually have a good aerodynamic shape, but by putting them in the flow of air coming from the front tyres - an area already disturbed by drag - their negative influence is reduced. The difference they make is thought to be approximately half of one-tenth of a second per lap.



Toro Rosso STR05 - modified exhaust

To improve the cooling of the Toro Rosso in Malaysia's high temperatures, the team have modified the bodywork around the exhausts. Unlike the exhaust used in Melbourne (see inset), the exhaust opening is no longer visible from the side (see main drawing). This solution was also used in Bahrain.



Mercedes MGP-W01 - revised rear bodywork

Here you can see how Mercedes have evolved the bodywork around the MGP-W01's exhausts. In Melbourne (see inset) there was an additional gill linked to the exhaust opening (highlighted in blue), which respected the single-opening rule. In Sepang they have modified the bodywork (see main drawing) to create a wider opening around the exhaust to aid cooling. The team have also opened two small windows at the point where the bodywork meets the car's floor (highlighted in blue).

2010 FORMULA 1
CHINESE GRAND PRIX

SHANGHAI
16-17-18 APRIL


1950-2010
FIA FORMULA ONE WORLD CHAMPIONSHIP
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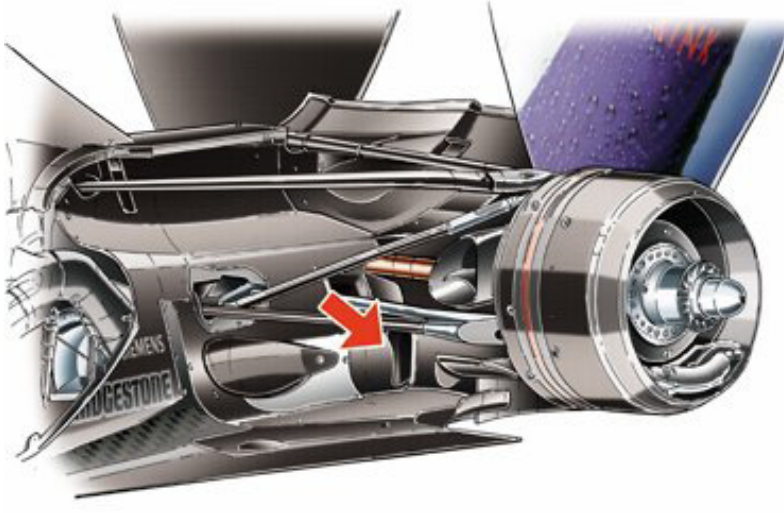
Mercedes GP MGP-W01 - modified rear wing

Mercedes have introduced a simpler, and more experimental version of McLaren's current rear wing solution. Like on the Ferrari, there isn't an F-duct, and the air doesn't flow inside the engine cover fin. Two small openings (1) feed airflow through an aero channel to two slots on the back of the flap (2). The system has been tested by both drivers and is controlled by pressure sensors on both surfaces of the wing.

Ferrari F10 - aerodynamic revisions

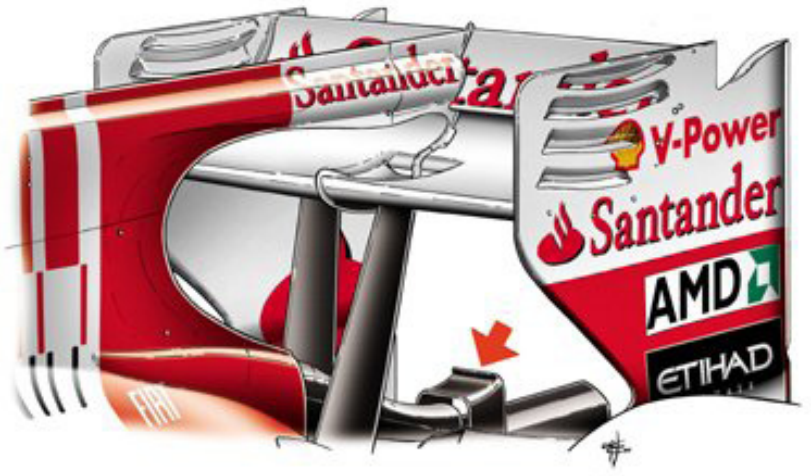
In China Ferrari were the second team, after BMW Sauber, to introduce a system similar to McLaren's solution to reduce rear wing drag and downforce on straights. Mercedes and Williams have also trialled systems this weekend. Other changes on the Ferrari include a new underbody behind the front wing (1) and a new double-decked floor (2) similar to the one used by Renault in Malaysia. The F10's diffuser also has a revised central section. Compared to the McLaren, the only feature missing from the Ferrari is the British team's 'F-duct', which allows the drivers to control the level of downforce generated by the rear wing at high speeds. And instead of splitting the airbox in two like on the MP4-25, the F10 has two small openings (3) similar to the ones on Force India's VJM03. Like on the McLaren, however, there are two distinct airflows. One flows (bottom yellow line) to the top of the diffuser's leading edge (4) via a pipe. The other (top yellow line) flows on to the rear wing flap (5), which features a slot like on the McLaren. Fernando Alonso tested the items on Friday to collect data, which will be used to build a final version of the solution for next month's Spanish Grand Prix.



Red Bull RB6 - additional exhaust duct

In China Red Bull introduced a small vertical duct (see red arrow) to the rear of the RB6. This has been designed to prevent the hot air from the exhaust blowing onto the rear tyres and to better direct the air towards the diffuser's side channel.

Ferrari F10 - modified rear wing



Although Ferrari's version of McLaren's rear aero package doesn't yet feature an interpretation of the MP4-25's driver-controlled F-duct system, most of the new F10 components are very similar to the British team's solution. Not only is air directed on to the rear wing's flap, which features a slot, but it also flows on to the top of the diffuser's leading edge via a pipe (see red arrow). Fernando Alonso tested this solution during Friday practice for the Chinese Grand Prix.

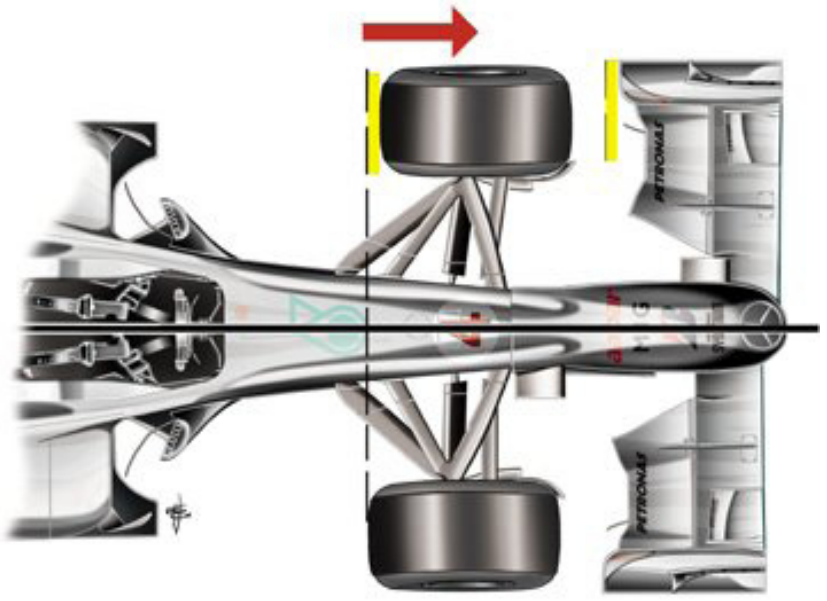
Red Bull RB6 - front aero update

Red Bull introduced a modified front wing in China. Although it featured an altered flap, the most interesting change was the addition of two turning vanes under the RB6's nose (see red arrow). The vanes are similar in style to those run by Toyota last year, and they also feature on this year's Ferrari F10. Sebastian Vettel tested the new front wing on Friday, but by Saturday Mark Webber was also running with it.

FORMULA 1
GRAN PREMIO DE ESPÃNA
TELEFÓNICA 2010

CATALUNYA
07-08-09 MAY


Telefónica
1950 - 2010
FORMULA1.COM

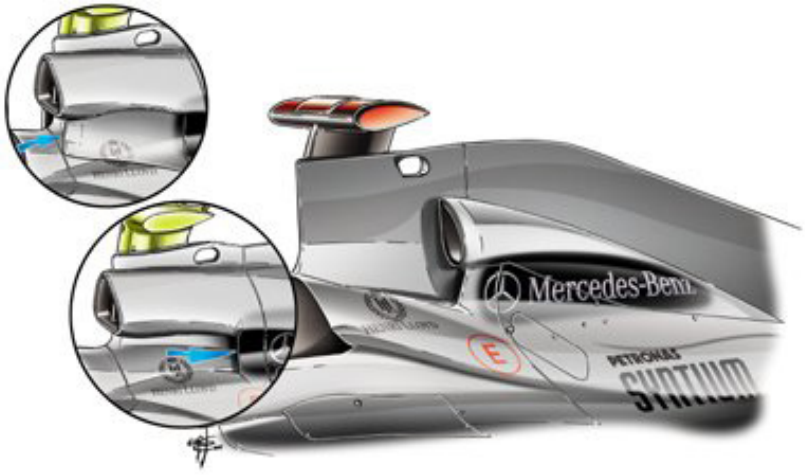


Mercedes GP MGP W01 - longer wheelbase

Mercedes have lengthened the wheelbase of the MGP W01 by approximately five centimetres. They have done this by angling the suspension's front wishbones differently. They have also moved the front wing forward, thus keeping the same gap between wing and tyre as required by the regulations. This modification has altered the car's weight distribution, which should help reduce the chronic understeer seen during the opening four races.

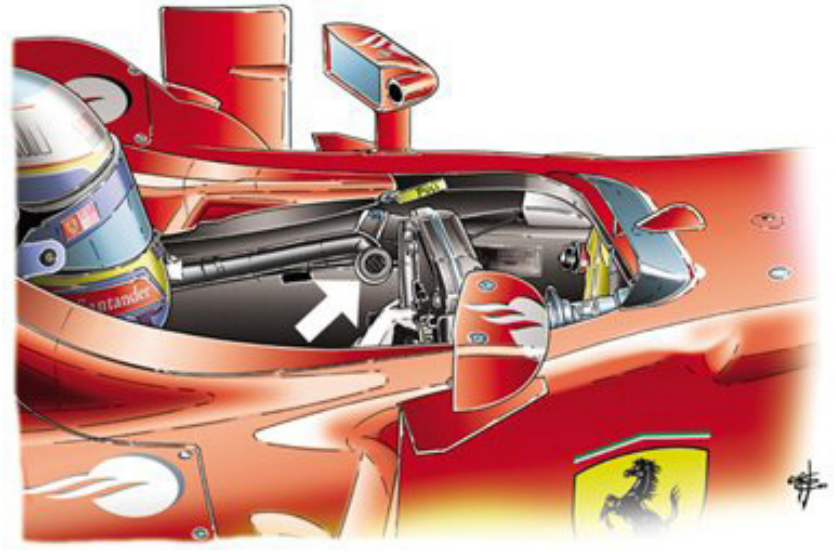
McLaren MP4-25 - new front wing

McLaren's new aero package for Spain includes a wider rear diffuser inspired by Renault's solution and this new front wing, which features different endplates, split into two sections. Despite the revisions, the wing itself retains four element profiles.



Mercedes GP MGP W01 - revised airbox and roll structure

At the MGP W01's pre-season launch it became clear team principal Ross Brawn had managed to avoid making its airbox design a structural part of the car's rollover protection - and was thus not hamstrung on future developments by the FIA's rules which restrict chassis changes (bottom left inset, blue arrow). Even before the season opener in Bahrain the team made a revision (top left inset, blue arrow). In Spain, however, a dramatic change to the shape of the airbox (main picture) has been introduced, with its intakes lower and further back. The rollover structure now has a narrow, knife-shaped leading edge. All this should help clean up airflow over the engine cover and help boost the performance of the car's 'blown' rear wing.



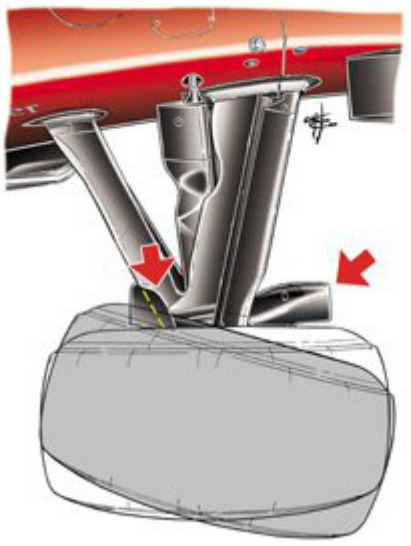
Ferrari F10 - 'F-duct' system

In Barcelona Ferrari have introduced a full version of their 'F-duct' system. In principle, it is the same as McLaren's original design, apart from the way it is controlled by the drivers. The air streams in from one of the new side ducts on the engine cover and is then channelled into the cockpit via the electronics cable hole (white arrow). The driver can then activate the system by blocking the hole at the side of the steering wheel with the back of his left hand. As we saw from onboard footage, this can interfere with the driver adjusting the car's brake balance, which is usually carried out with the same hand. This forces the driver to race for a fraction of a second without their hand on the steering wheel.

FORMULA 1 GRAND PRIX DE MONACO 2010

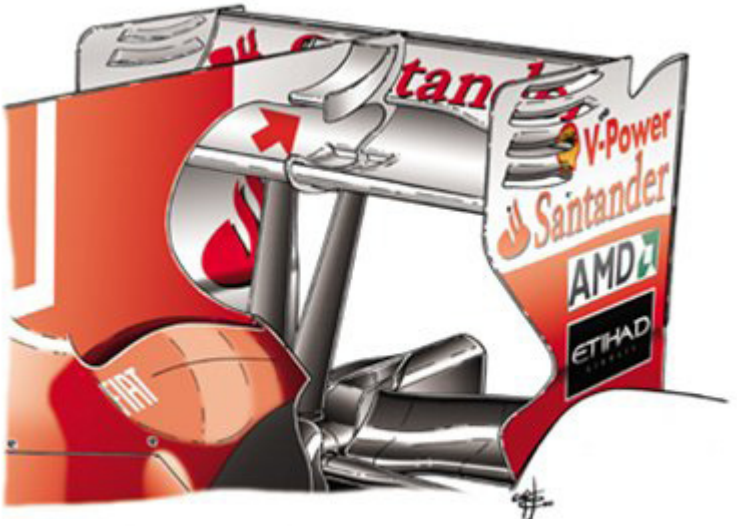
MONTE CARLO
13-14-15-16 MAY

FORMULA1.COM



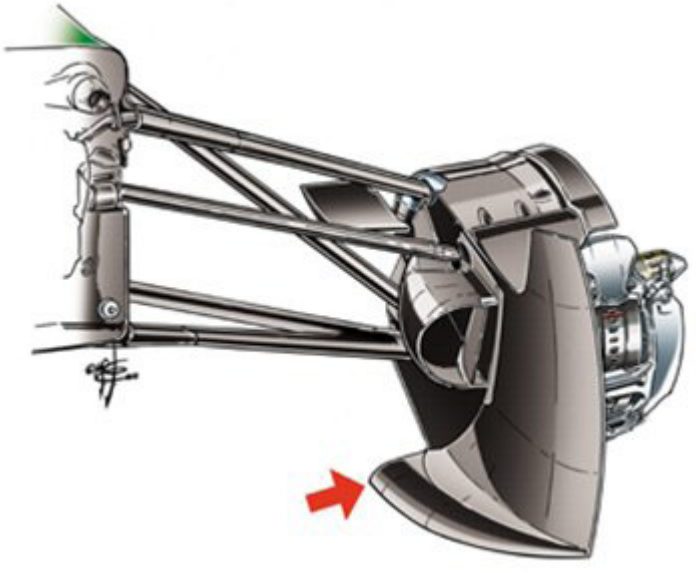
Monaco-specific steering angle

Every year it's necessary to increase the maximum steering angle of the cars so they are able to run in Monaco's narrow streets, and in particular around the old, tight Loews hairpin. A car needs a steering angle of 22 degrees in Monte Carlo, and so the front wishbones are modified accordingly to allow greater movement of the front wheels. Stiffer suspension pieces, particularly steering arms and toe-in arms, are also used here to cope with the occasional brush with the barriers, and the cars run a higher ride height than anywhere else to cope with the bumps.



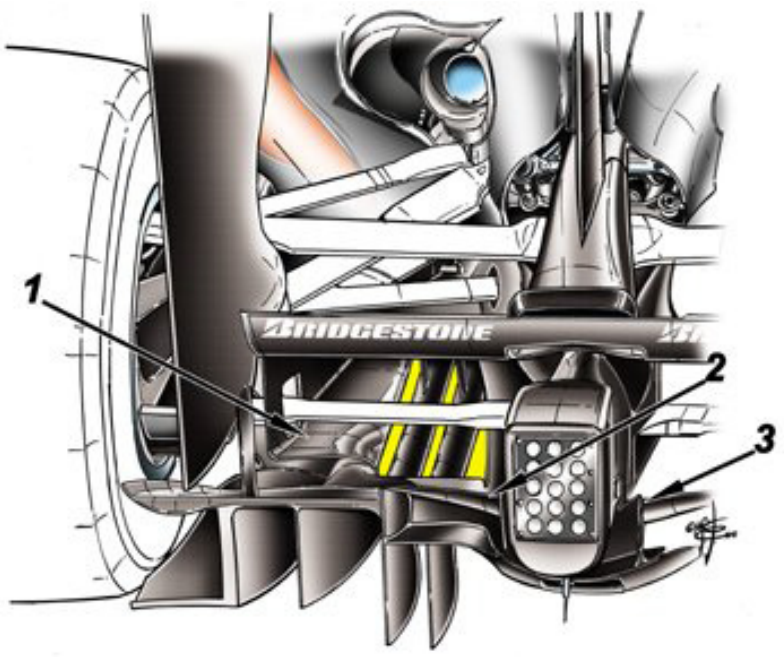
Ferrari F10 - new engine cover wing

For Monaco Ferrari have modified the F10's engine cover to include this small wing (red arrow), in a bid to gain any downforce possible at what is the slowest circuit on the calendar. It is a solution that was tested last year by Williams and is located within the unregulated, 15cm-wide central section. You can also see the team have removed their 'F-duct' system for this race, where it would provide only minimal gain due to the lack of long straights.



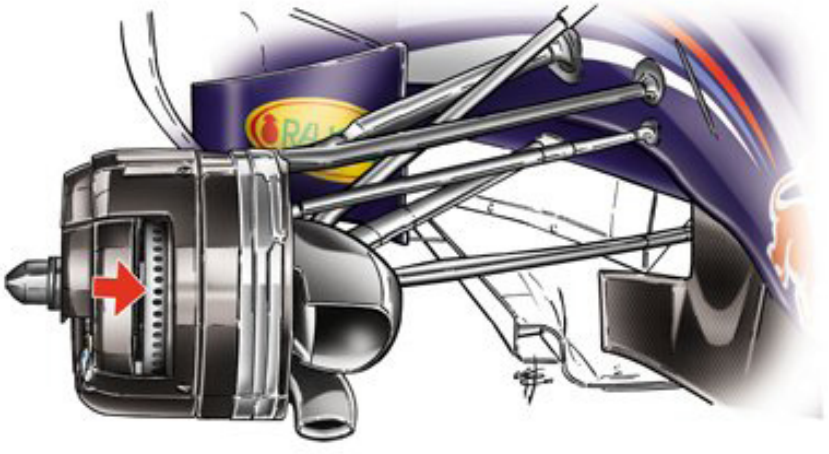
Force India VJM03 - new front brake ducts

There are a lot of new solutions on the Force India in Monaco, including a new front wing, with different central pillars and endplates. The team have also introduced this new front brake duct, with a wide and rounded extension in its lower section (see arrow). This is designed to improve the management of airflow in this area, better directing it under the car and towards the rear diffuser's central section.



McLaren MP4-25 - revised rear diffuser

The latest version of McLaren's diffuser is very similar to the one introduced by Renault, with double longitudinal profiles (yellow-highlighted area). However, there are differences to the French team's solution. The side diffuser is less angled (1), very long and has a unique profile in its end section. There is also a new, small flap (2) and an additional one (3) under the deformable structure, which is designed to boost suction of air from underneath the car.



Red Bull RB6 - modified brake discs

In order to improve reliability following Sebastian Vettel's difficulties at the Spanish race, Red Bull have changed the RB6's brakes discs for the Monaco Grand Prix. They now feature smaller holes than the ones originally requested from brake supplier Brembo. During Thursday practice the team used the discs pictured, with small oval holes (red arrow), whereas for qualifying and the race the team opted for the same discs Ferrari use.

2010 FORMULA 1 TURKISH GRAND PRIX

ISTANBUL
28-29-30 MAY

1950-2010
FIA FORMULA ONE WORLD CHAMPIONSHIP
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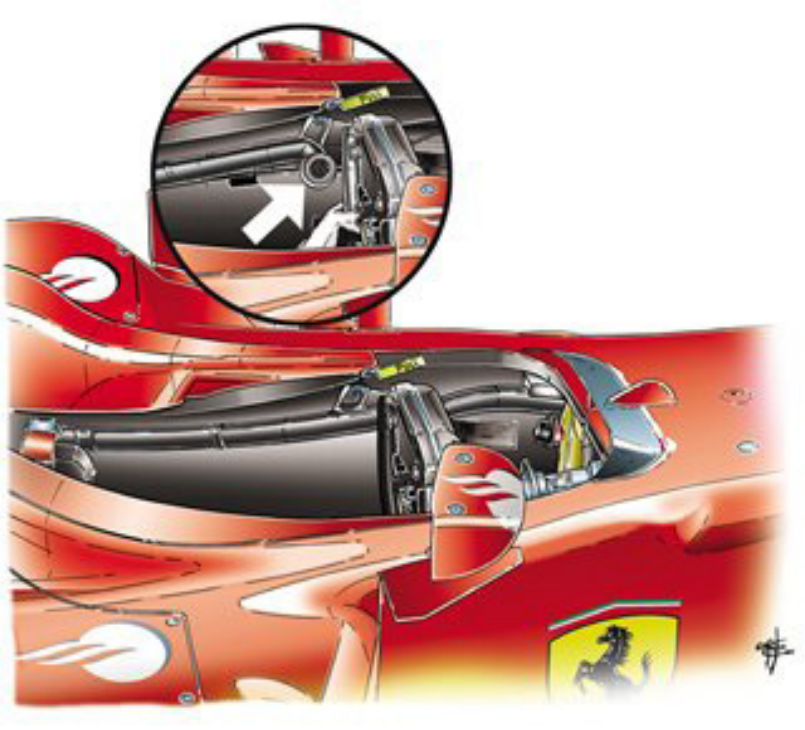
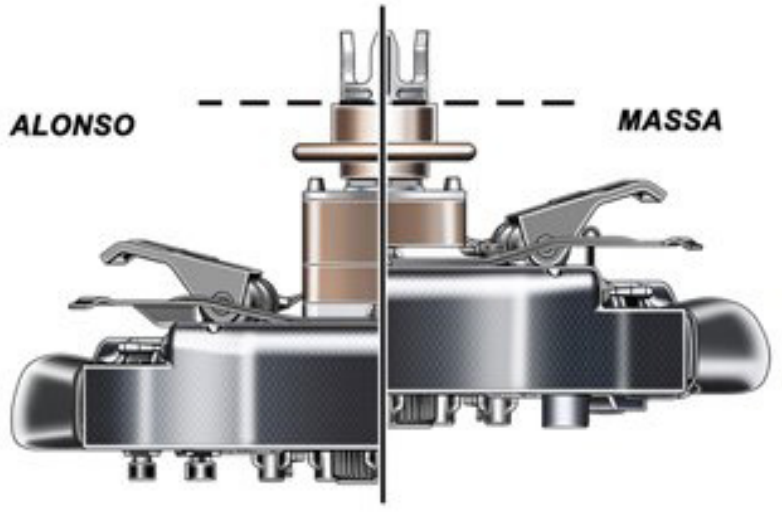


Ferrari F10 - revised F-duct control (a)

Ferrari have revised the layout of their F-duct system for Turkey, in particular the mechanism by which the driver controls it. In Barcelona the driver was closing the hole using the back of his left hand (inset), a manoeuvre that was not very comfortable for Alonso, and even less so for Massa, who has his steering wheel positioned further forward and hence actually had to take his hand off the wheel. In Istanbul, the hole is now closed with the driver's left leg and here you can see the pipe inside the chassis, very similar to the McLaren's.

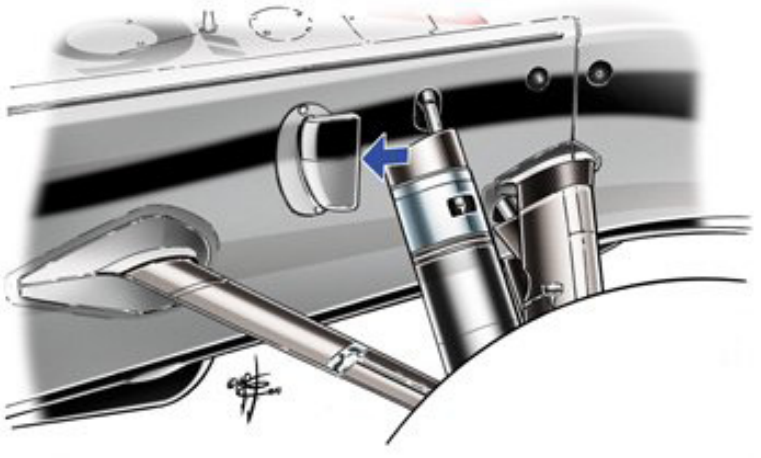


Ferrari F10 - revised F-duct control (b)

Ferrari have revised the layout of their F-duct system for Turkey, in particular the mechanism by which the driver controls it. In Barcelona the driver was closing the hole using the back of his left hand, a manoeuvre that was not very comfortable for Alonso, and even less so for Massa, who has his steering wheel positioned further forward and hence actually had to take his hand off the wheel. In Istanbul, the hole is now closed with the driver's left leg, very similar to the McLaren's.

Red Bull RB6 - F-duct system

Red Bull have introduced their version of the F-Duct system at Istanbul Park. It's a very similar concept to those on the McLaren and Ferrari, with the air blowing on to the rear wing via two big pipes inside the engine cover (red arrows). Like the first version of Ferrari's system, the duct is controlled by the driver's left hand. The team tested it during Friday in Turkey, but it was removed from both cars for qualifying and the race because it was not consistent enough and it was difficult to operate. It will be back on the cars in Canada.



Mercedes MGP W01 - updated F-duct system

Mercedes GP's F-Duct system, which was introduced in China, has received an upgrade in Turkey. It can now be activated by the driver's foot thanks to a bigger duct on the side of the chassis (blue arrow). This was previously much smaller and used to cool the drivers. The system of pipes used to direct the air to the rear wing is very complicated and they are all concealed by the engine cover, eventually reaching the wing's main profile through the side endplates.

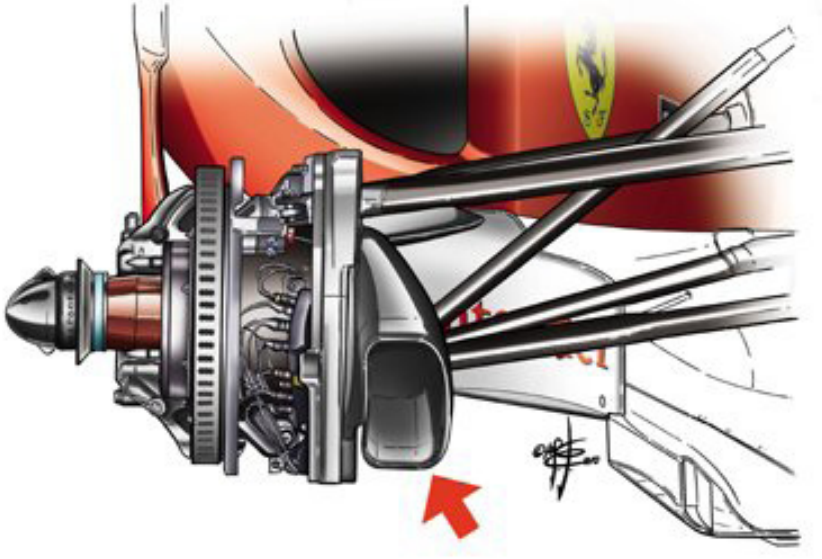
FORMULA 1 GRAND PRIX DU CANADA 2010

MONTRÉAL
11-12-13 JUNE

FORMULA1.COM

Renault R30 - revised front wing

Renault have introduced a new front wing at nearly every track this year and Montreal is no different. As the first low-downforce circuit of the year it definitely warrants a change. Only the main plane is the same as the previous wing. All other components are different - a more complex endplate with an additional vertical inner fence, a revised flap with an extra element at the rear, and no additional top flap.

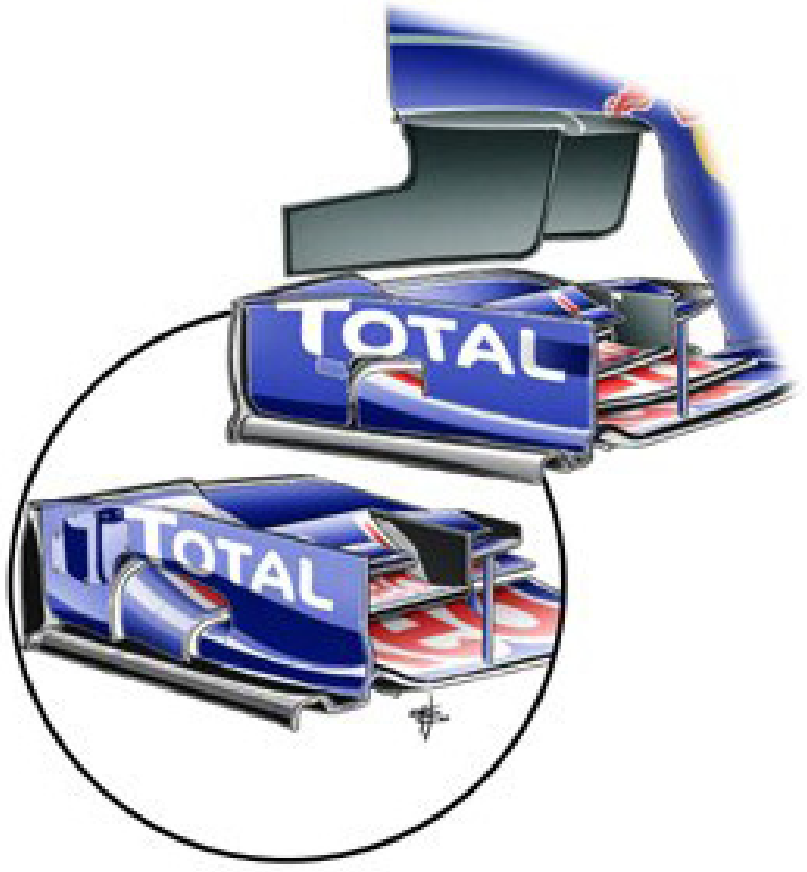


Ferrari F10 - enlarged brake ducts

Montreal is the toughest circuit for brakes - that's the reason everybody is very keen to produce bigger brake ducts to improve cooling here, as you can see with this Ferrari front duct. In addition, it is critical to choose the right friction materials for the brake pads and discs in order to cope with the high levels of heat and wear. Ferrari, as is their tradition for the Circuit Gilles Villeneuve, have temporarily swapped from Brembo to Carbon Industries products, as used by the likes of McLaren and Williams.

Williams FW32 - revised front wing

Williams have introduced two new front wings in Montreal. Both feature two vertical turning vanes and are designed to boost the airflow from underneath the raised front section of the chassis (1). Each front wing has a different forward upper wing (2). On one example there was a small splitter (3) on the outside of the endplate. The team has also brought two different rear wings.



Red Bull RB6 - modified front wing

Red Bull started the Canada weekend with a new front wing. It was based on the one with two openings on the endplate, which they introduced in Turkey, but featured a wider main plane and single flap. For qualifying - and for the race - they have reverted to the previous wing, which features only one opening and a slotted main plane. The team have also modified the car's diffuser and bodywork around the exhaust area. In addition, a lot of work has been carried out to improve the cooling of the brakes.

2010 FORMULA 1 TELEFÓNICA GRAND PRIX OF EUROPE

VALENCIA
25-26-27 JUNE


Telefónica
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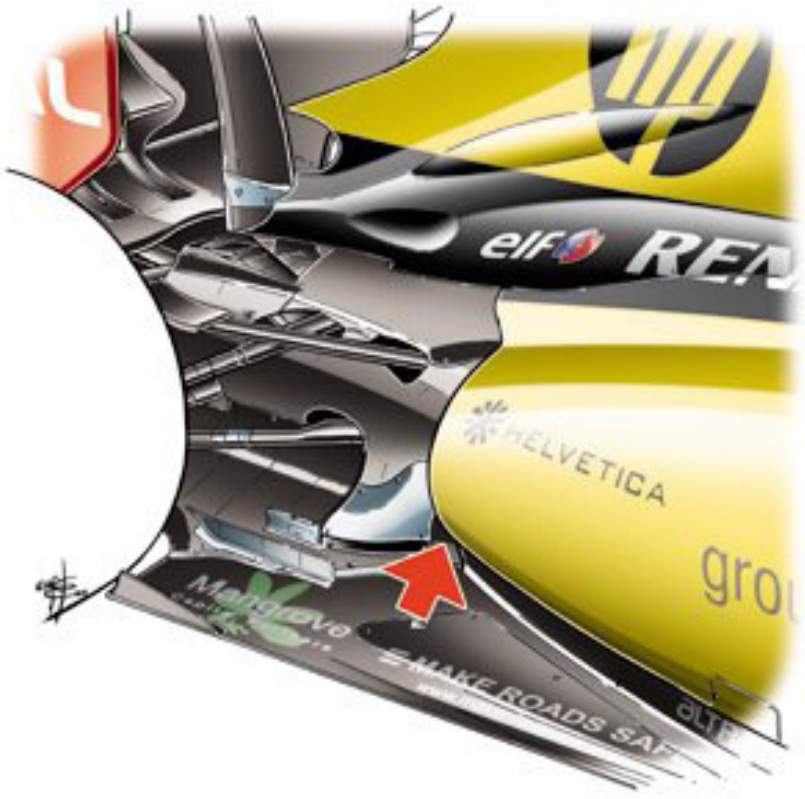
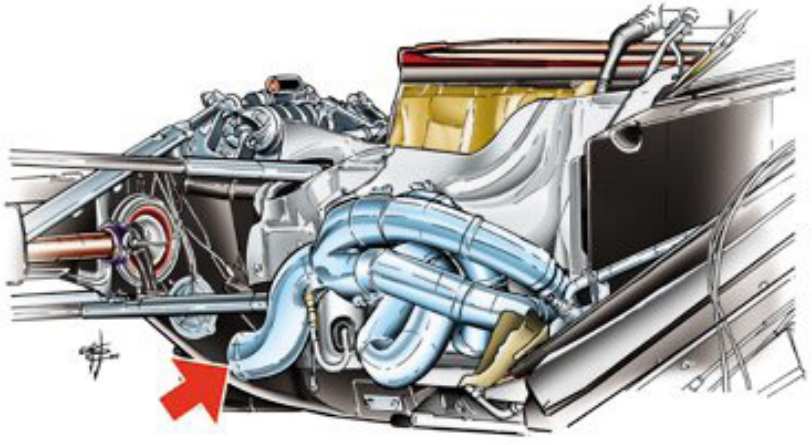
FIA FORMULA ONE WORLD CHAMPIONSHIP
60
FORMULA1.COM



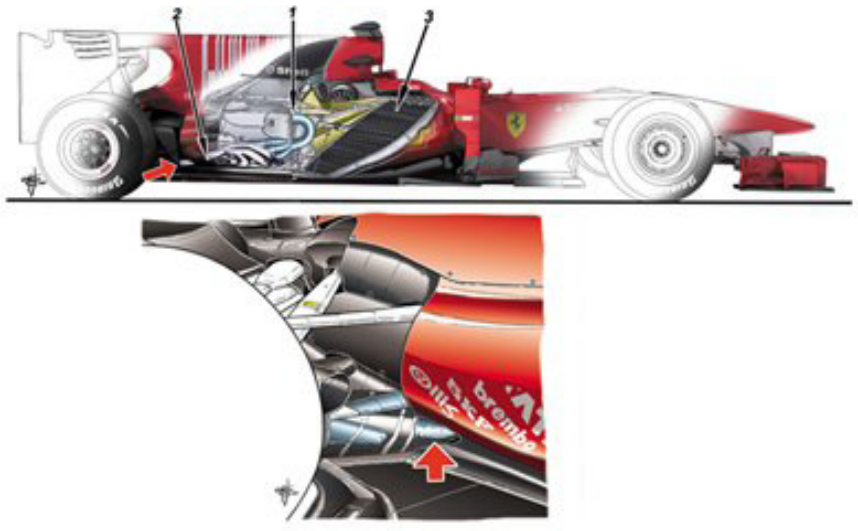
Renault R30 - low blowing exhausts

Renault are another team to introduce a Red Bull-style low blowing exhaust configuration in Valencia, joining Mercedes and Ferrari (Force India and McLaren are expected to follow at the next round at Silverstone). The exhaust exit is covered (red arrow) and has some thermal protection against the high temperatures. Renault have also introduced a new gearbox casing to allow for the higher suspension pick-up points that are needed to accommodate the revised configuration.



Mercedes MGP W01 - revised exhausts

Like Ferrari, Mercedes GP have introduced shorter exhaust pipes and lower bodywork at the rear of their car in Valencia to mimic Red Bull's exhaust-blown diffuser. Unlike Ferrari, they haven't brought a new gearbox casing, but have adapted their original design. A new rear diffuser has also made its debut on the MGP W01 for the European Grand Prix weekend to utilize the air blowing from the exhausts to the fullest.



Ferrari F10 - exhaust-blown diffuser

Ferrari have made radical changes for Valencia, introducing their version of Red Bull's exhaust-blown diffuser. They have dramatically modified the shape of their exhausts, from the previous design (1), to a lower, more RB6-inspired layout (2). They've also introduced a new gearbox case to Felipe Massa's car to raise the rear suspension pick-up points to help accommodate the changes. There's also a larger radiator layout (3) to handle the additional heat within the lower and more enclosed bodywork. Inset, you can see the exhaust on the F10 is shorter, and therefore ends before Red Bull's.

2010 FORMULA 1 SANTANDER BRITISH GRAND PRIX

SILVERSTONE
09-10-11 JULY

Santander

1950-2010
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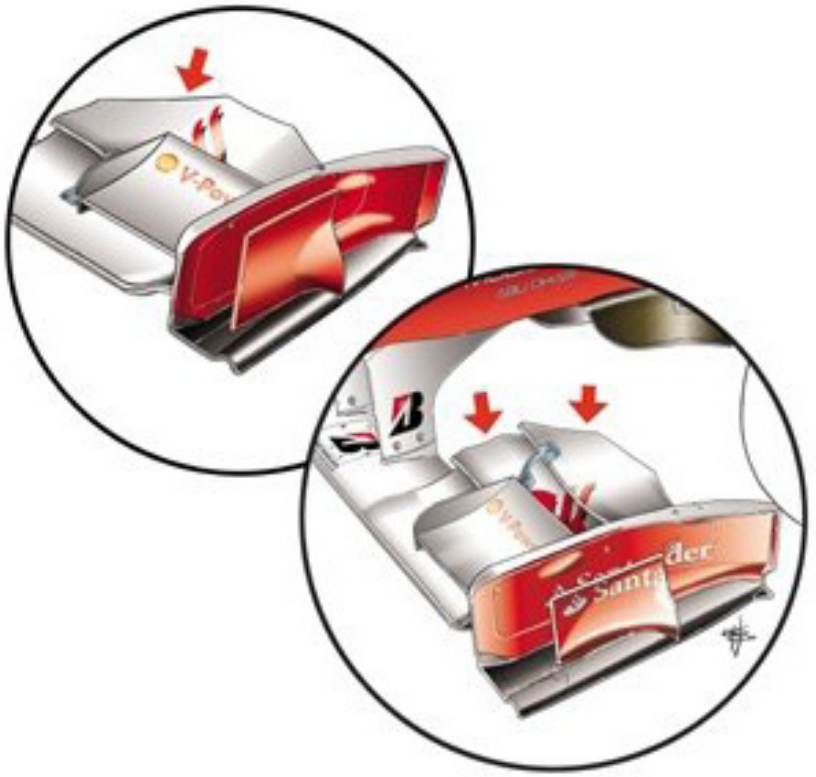
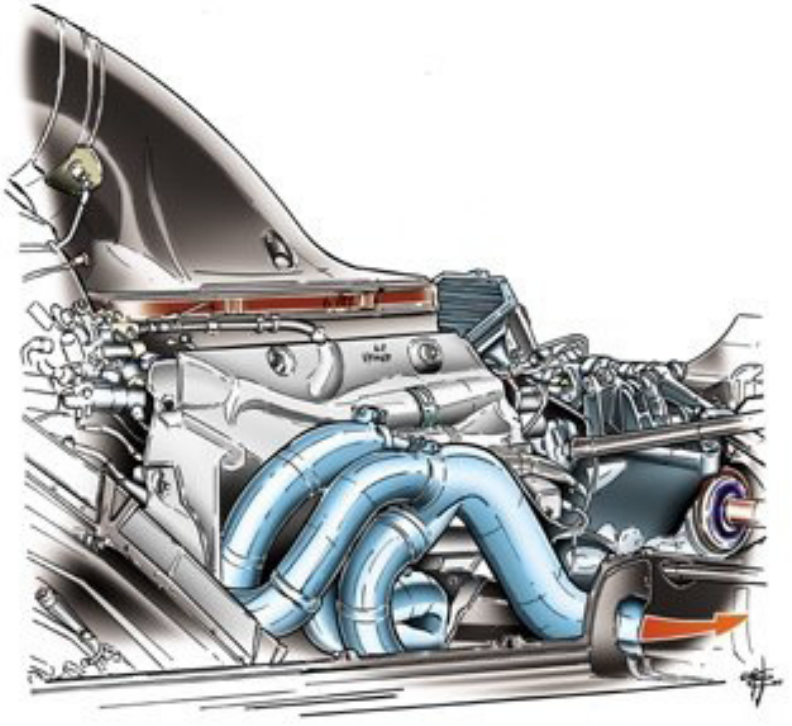


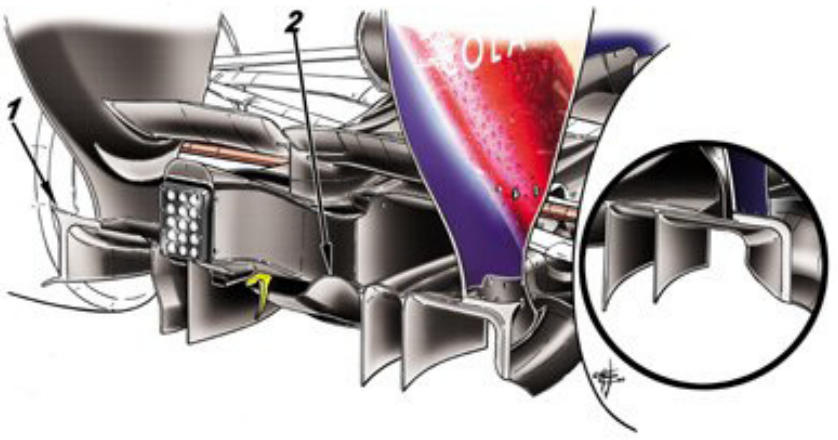
Ferrari F10 - revised front wing

For the first time this season, Ferrari have introduced a double-flap solution on their front wing at Silverstone to increase downforce. The previous, single-flap solution can be seen in the top drawing and the new version in the bottom drawing. Of particular interest is the more sophisticated shape of the profiles, which rise up in the middle section of the wing (see red arrows in bottom drawing).



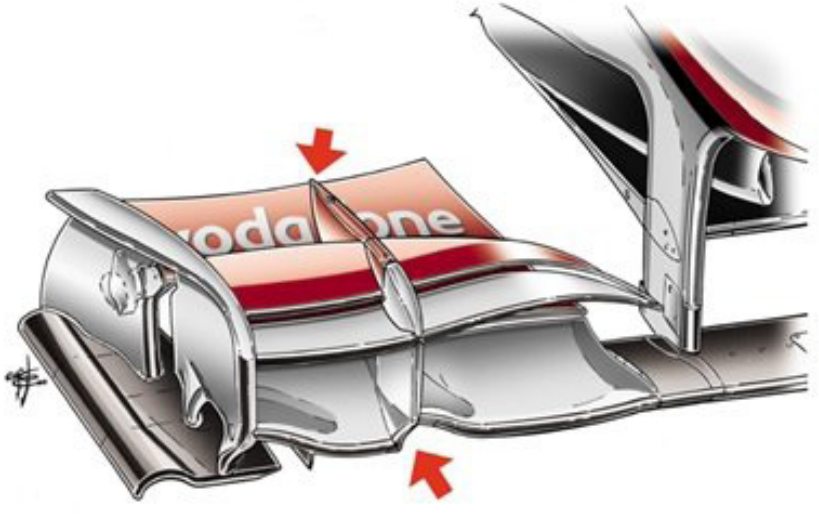
Williams FW32 - low-blowing exhaust system

Previously only Nico Hulkenberg has used Williams' low-blowing exhaust (red arrow), but on Friday morning at Silverstone team mate Rubens Barrichello was also running the upgrade. It's quite similar to Ferrari's system, and is therefore less complicated than the ones used by Red Bull and McLaren. The FW32 also features new bodywork and engine cover for the British race.



Red Bull RB6 - updated diffuser

At Silverstone Red Bull are again using the revised diffuser they introduced in Valencia. It's different to the previous incarnation (inset), featuring a pointed top section on the outer edge (1), similar to the McLaren, and a round shape (2) at the point where the vertical middle plate meets the top edge of the diffuser.



McLaren MP4-25 - revised front wing

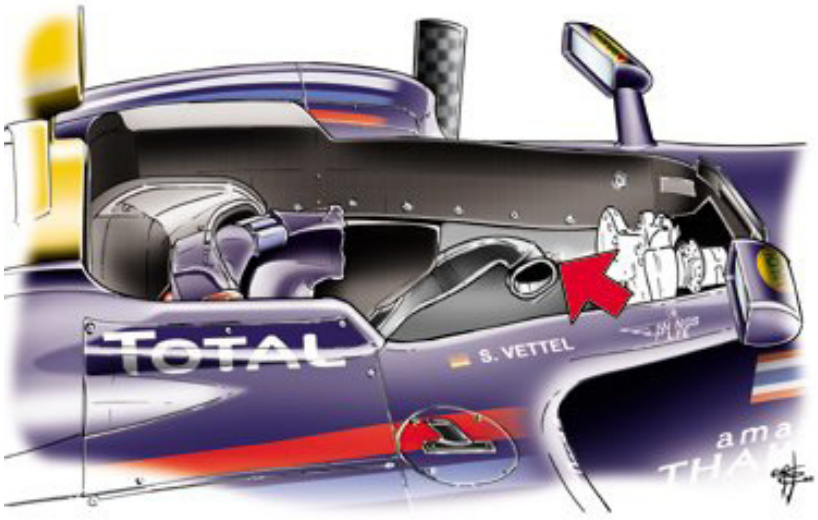
Although they dropped their blown diffuser for Silverstone, McLaren are using their new front wing. It features two main differences. The vertical splitter in the middle of the wing is new (top arrow). It is nearly level with the inner edge of the front tyres and is designed to improve the airflow directed to the inside of the tyres. The second change is the raised curved section under the splitter (bottom arrow), which acts as a skirt to improve the efficiency of the main profile.

Red Bull RB6 - revised front wing

Red Bull introduced a heavily-revised front wing at Silverstone, though only Vettel got to qualify and race with it. A new camera position in the centre of the wing (1) helps produce more downforce there, allowing the team to reduce the main wing angle, hence cutting drag. The design also features a new flap adjustment (2), two vertical slots (previously one) in the endplates and a revised main profile. The overall effect of the changes is improved airflow to the leading edge of the sidepods, which in turn means the diffuser can work more efficiently and produce greater downforce.

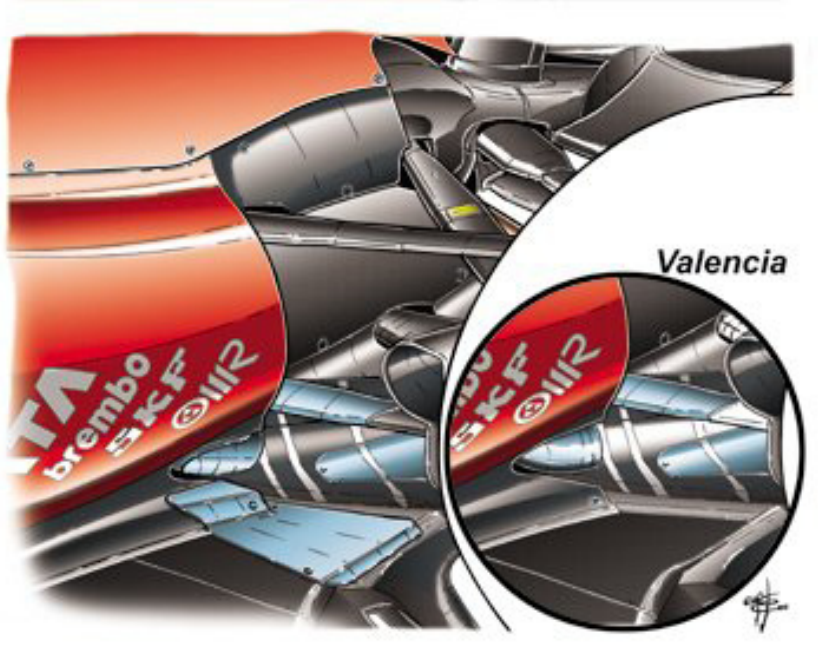
FORMULA 1
GROSSER PREIS SANTANDER
VON DEUTSCHLAND 2010

HOCKENHEIM
23-24-25 JULY



Red Bull RB6 - F-duct system modification

There are no large modifications on the RB6 at Hockenheim, with both drivers using the new front wing which sparked such controversy at Silverstone. There have been minor improvements to the team's F-duct system, which, as illustrated here, is activated from within the cockpit by the driver covering a special vent (red arrow) with his left hand.

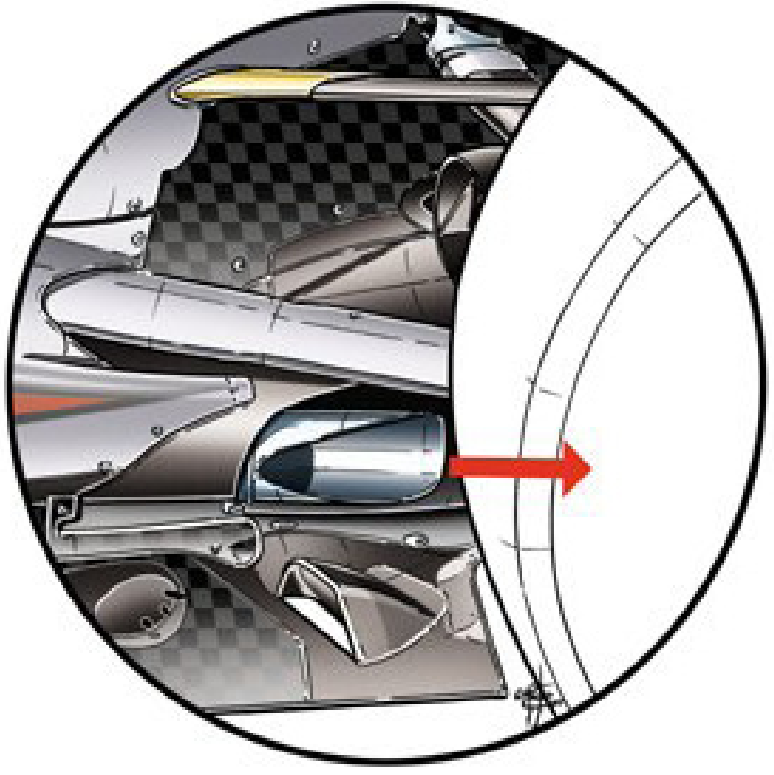


Ferrari F10 - revised exhaust system

Following on from the new front and rear wings introduced at Silverstone, in Hockenheim Ferrari have brought refinements to the F10's exhaust system and modified the side channels of their diffuser. Inset is the first evolution of the exhaust system, introduced in Valencia, whilst the main drawing shows the more open configuration being used in Germany. Strong qualifying times suggest the changes mean the team's F-duct, floor and blown diffuser are now working in much closer unison.

Mercedes MGP W01 - revised rear wing

Mercedes have introduced a new rear wing in Germany. It has a large opening in the main plane (see red arrow), which creates something akin to a three-profile rear wing. The solution was introduced in Monaco last year by McLaren and copied by BMW Sauber. This rear wing is designed to work better with the car's sophisticated F-duct system.



McLaren MP4-25 - blown diffuser modifications

In Hockenheim McLaren have run the blown diffuser that they discarded on Friday evening at Silverstone, with some new modifications. The exhausts have been moved outwards, with a longer inner section, and the pipe is now cut off at an angle rather than having a straight ending. The carbon materials used on the diffuser's side channel have also been changed.

FORMULA 1
ENI MAGYAR NAGYDÍJ
2010

BUDAPEST
30-31 JULY - 01 AUGUST


eni
1950 - 2010
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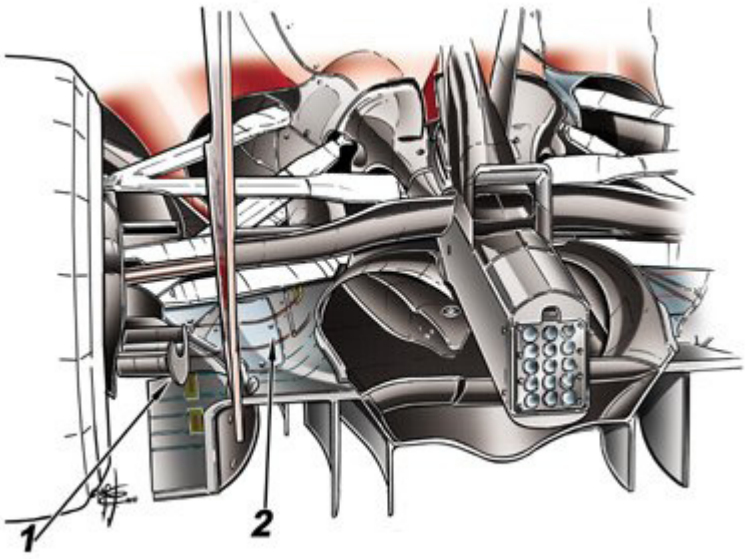
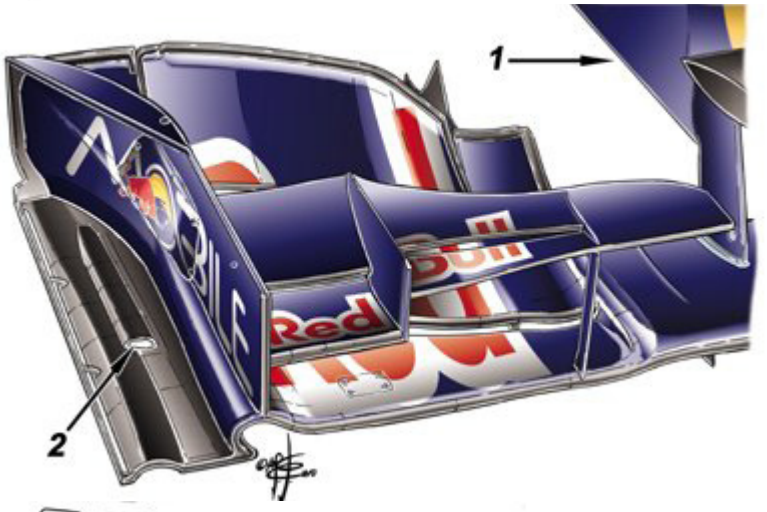


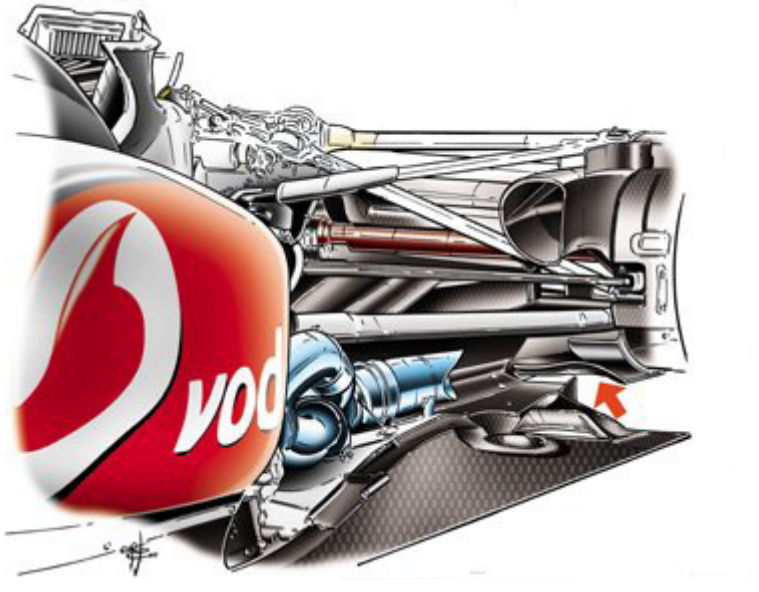
Ferrari F10 - modified rear diffuser

This drawing from Hungary shows how Ferrari's diffuser has been modified to deal with the exhaust air now blowing under the floor, with the element just inside the rear tyres (1) now curved. The diffuser's side channels (2), which used to be more vertical in shape, are now also curved. The modifications are designed to use the air from the exhaust to better effect.



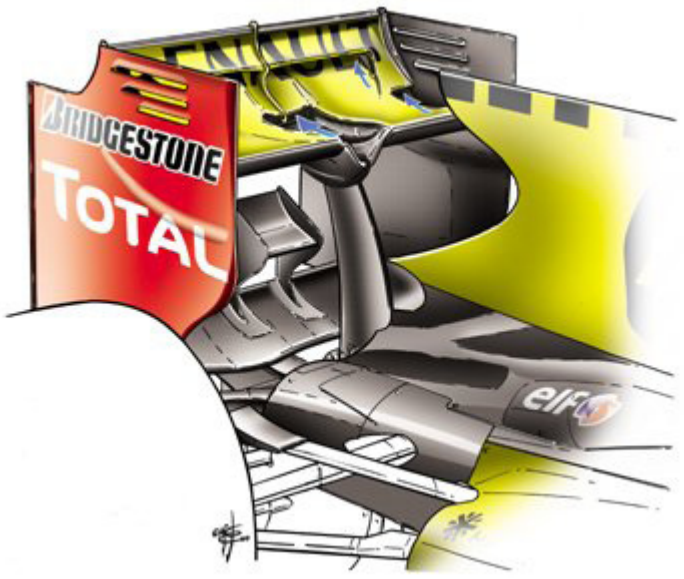
Toro Rosso STR05 - new front wing

Toro Rosso have introduced a new maximum-downforce front wing in Hungary. It features a vertical section (1) which creates a kind of skirt under the high shape of the standard nose. The new endplate, introduced in Hockenheim, has been revised to include a second horizontal slot (2), which better 'seals' this section to the ground.



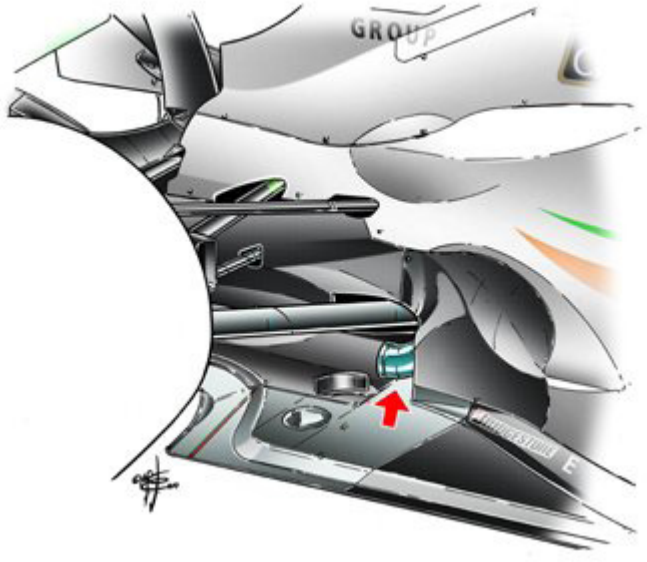
McLaren MP4-25 - revised rear underbody

Since first introducing their exhaust-blown diffuser at Silverstone, McLaren have made many changes to its configuration. In this drawing you can see the reshaped section of underbody (red arrow) and also the different, lower position of the exhaust (highlighted in blue) being used on the MP4-25 in Hungary.



Renault R30 - revised rear wing

In Hungary Renault introduced this new, high-downforce rear wing. It's based on the McLaren concept of having two profiles, with a hole passing through, effectively giving the wing three slots. The difference on the R30 is that it's the flap that has been divided in two, with two separate slots.



Force India VJM03 - blown diffuser

In Hungary, Force India introduced their version of the blown diffuser (see red arrow) to just one car - Adrian Sutil's. It was tested on Friday, but the team then decided to run both cars in the standard configuration for the race. With the expense of tooling the new exhausts, a dyno test for tuning the exhausts to the engine, the demand for five sets of diffusers and all the wind tunnel and Computational Fluid Dynamics (CFD) programming, it could cost up to an estimated $1.5 million to introduce.

Red Bull RB6 - front wing controversy

Although TV footage has shown the Red Bull front wing appear to almost touch the track surface at speed, the rules demand that when static it has to stay 75mm above the ground. Even so the car has passed all the necessary scrutineering checks, including a rigorous one on Saturday in Hungary with 200 kilogrammes applied to the RB6's underbody and the plank.

Formula 1™

2010 FORMULA 1 BELGIAN GRAND PRIX

SPA-FRANCORCHAMPS
27-28-29 AUGUST


1950 - 2010
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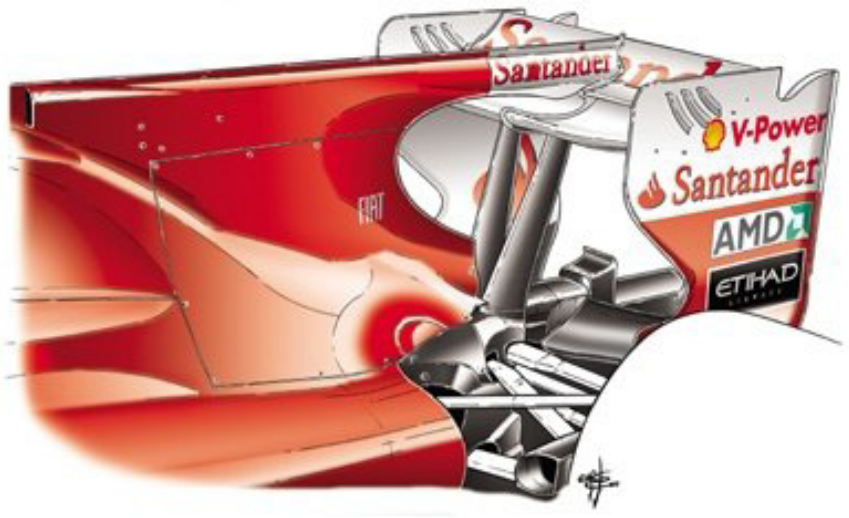
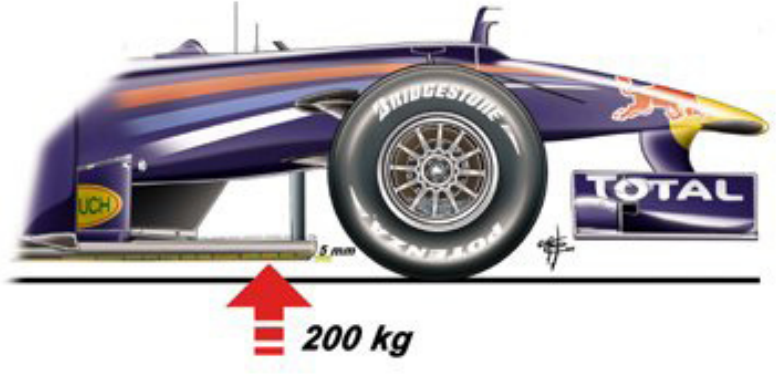


Ferrari F10 - revised rear wing

Ferrari have brought a new lower-downforce rear wing to Belgium, which will be used by Felipe Massa during qualifying and in the race. The revised endplates feature Red Bull-inspired gills, while the wing's main profile has a smaller flap and no longer features a slot.

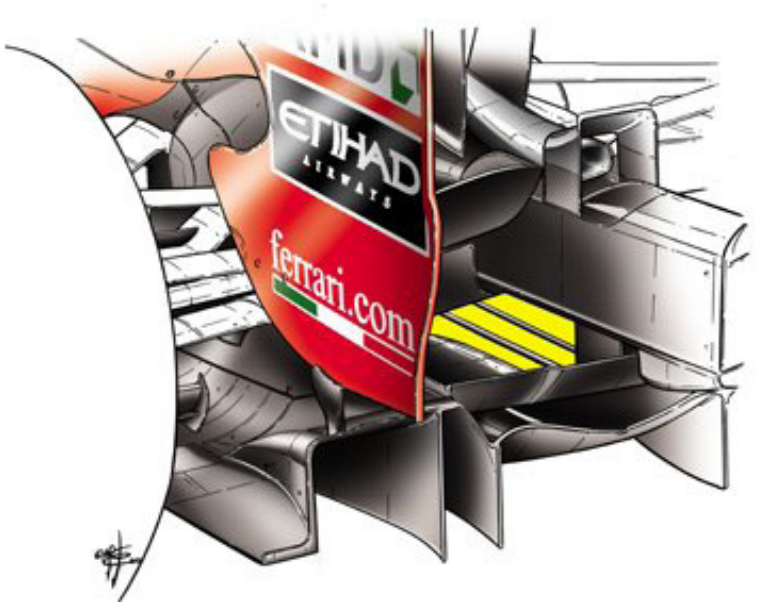
Revised front-wing flex test

The front wing must be no lower than 75mm above the reference plane, which is the lowest point of the car without the plank (yellow dotted line). To check compliance with this rule, prior to this weekend's Belgian Grand Prix, in scrutineering a load of 50kg was applied to the endplates (smaller red arrow), with a permitted flex of up to 10mm. After rival teams voiced suspicions that the front wings of Red Bull and Ferrari were flexing more than this at speed, the FIA has doubled the load applied in the test to 100kg, now measured in the middle of the wing's side section (larger red arrow), with a permitted flex of 20mm. Both Red Bull and Ferrari cleared scrutineering at Spa.



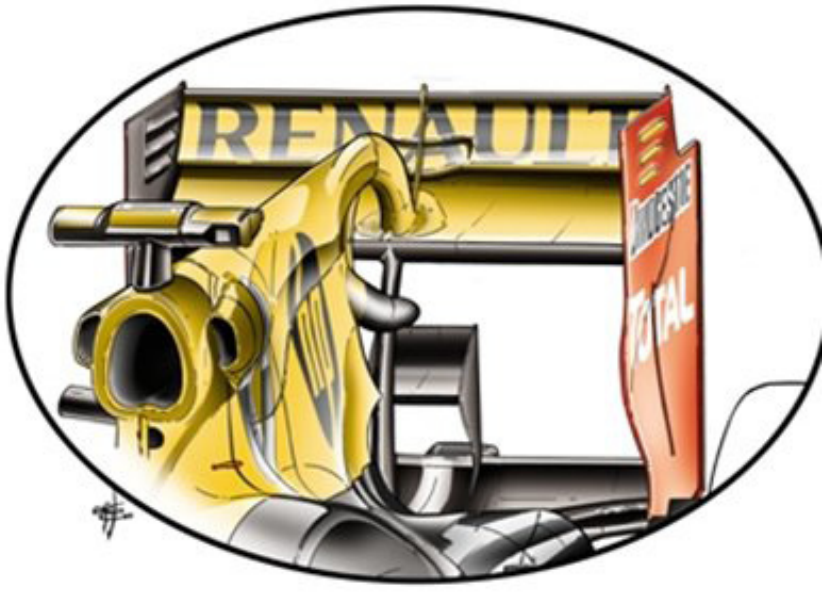
Revised floor flex test

The FIA carry out load tests to check whether a car's floor flexes beyond the permitted 5mm (yellow highlighted area) under a 200kg load. The test, which uses a piston in the centre of the floor, was introduced at the 2007 Spanish Grand Prix following the controversy surrounding Ferrari's 'moveable' floor device. Stricter front-wing flex tests have been introduced here at Spa and at the next round in Italy a stricter floor test will be added. Whilst the same weight will be used, the test will be applied to the side of the floor too. It will also be prohibited to run a section of plank less than 100cm in length.



Ferrari F10 - updated diffuser

In Belgium, Ferrari have been running a modified diffuser and floor, which are similar to the ones used by McLaren and Renault. The size of the longitudinal inlet is shown clearly by the amount of visible road surface (see area highlighted in yellow). There are two longitudinal fairings in order to respect the rule dimensions.



Renault R30 - F-duct system

In Belgium, Renault were the latest team to introduce their version of McLaren's innovative F-duct system. It has worked well over the course of the weekend, helping the car achieve very competitive straight-line speeds on Spa's long straights, with some estimating it to be worth over 0.5s of lap time at the Belgian circuit. The air directs on to the main section of the wing, not the flap, and is activated by the driver's left hand.

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FORMULA 1
GRAN PREMIO
SANTANDER D'ITALIA 2010

MONZA
10-11-12 SEPTEMBER


Santander
1950-2010
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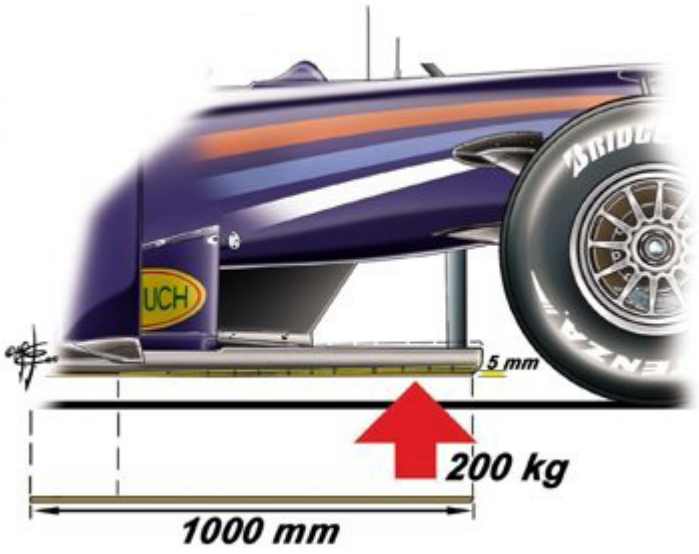
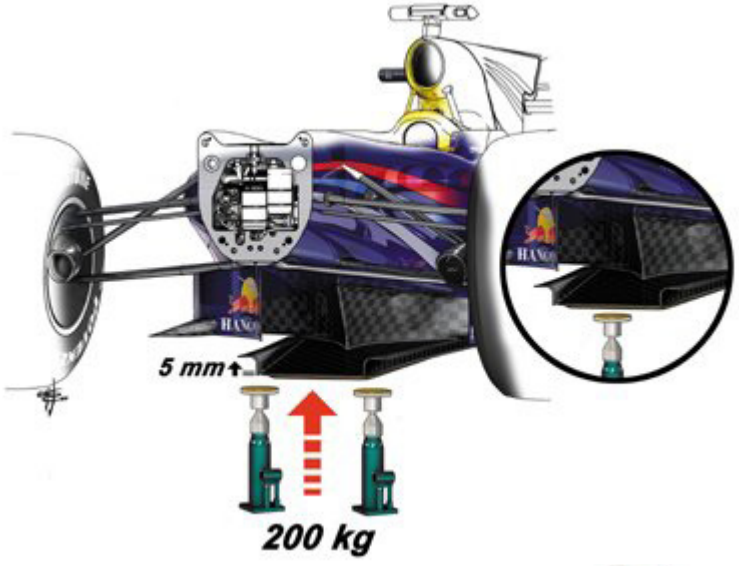


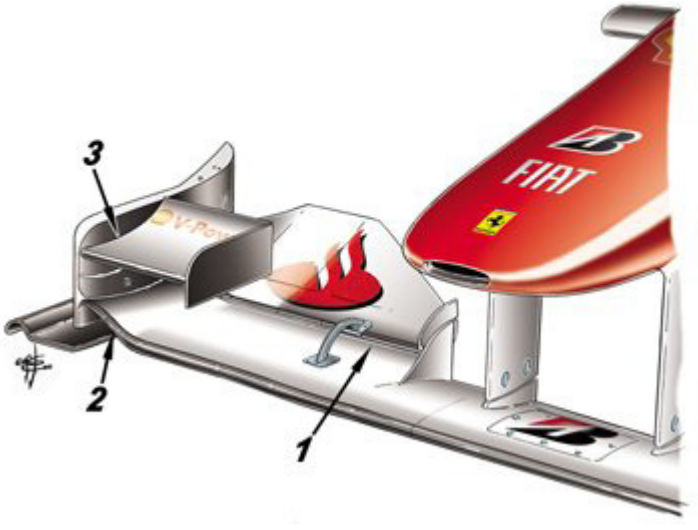
New regulation - plank length

At Monza, the FIA have introduced a new rule which means it is now prohibited to run a section of plank less than 1000mm in length. The plank is a hard wooden strip (also known as a skid block) fitted down the middle of a car's underside (see red arrow). This regulation is designed to prevent teams from running 'articulated' planks that are made up of multiple pieces.



Additional floor load test

The FIA carry out load tests to ascertain whether a car's floor flexes beyond the permitted 5mm under a 200kg load. The test, which uses a piston in the centre of the floor (see inset), was introduced at the 2007 Spanish Grand Prix following the controversy surrounding Ferrari's 'moveable' floor device. At Monza the sport's governing body has introduced an even stricter test, which sees the same weight also applied to the side of the floor, 100mm from the centre line (see main illustration).



Ferrari F10 - updated front wing

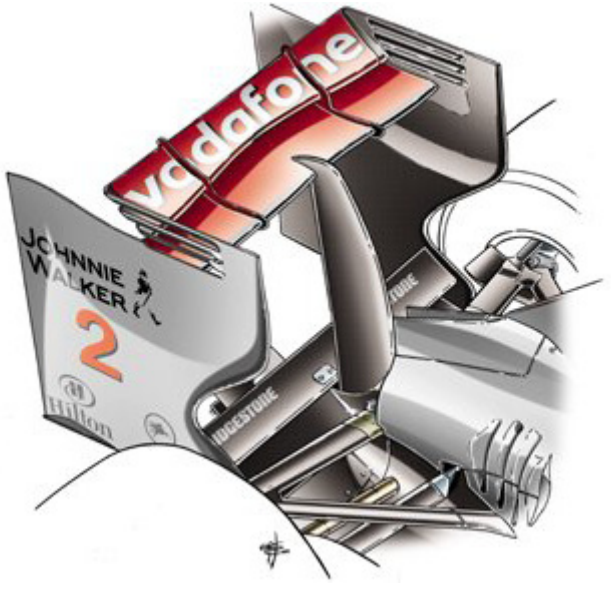
Both Ferraris are also a running revised front wing at Monza as part of the team's low-downforce package for this circuit. It features an almost straight main plane (2), and the main flap (1) and upper flap (3) both have a far lower angle of incidence than seen at most tracks.

Ferrari F10 - revised rear wing

Ferrari's Fernando Alonso and Felipe Massa ran different rear aero packages on their cars at the last round in Spa. But at Monza, the Italian team are running the same low-downforce package on both F10s. The rear wing is fitted with a revised F-duct, which features a much smaller pipe inside the engine cover. In addition, the end-plates no longer have gills and the main plane and flap have a smaller chord.

Renault R30 - revised front wing

In Monza, Renault have been running a new front wing. This is based on the previous version, but it has been simplified with no upper flaps and a multiple endplate section (bottom arrow). The 'V' cut in the main flap (top arrow) creates a kind of vortex, which energises the airflow under the car's central section.



McLaren MP4-25 - low-downforce rear set-up

McLaren team mates Jenson Button and Lewis Hamilton decided to run different set-ups for the Monza race. Button used the F-duct and the Spa-spec rear wing, which features quite a big flap. Hamilton decided to use a very low-downforce rear wing, shown here, with last year's end plates, and didn't use the F-duct. On Saturday the set-up gave Hamilton a 14km/h advantage over Button, with the qualifying speed trap recording 344.3 and 329.5 respectively for the duo.

Formula 1™

2010 FORMULA 1 SINGTEL SINGAPORE GRAND PRIX

SINGAPORE
24-25-26 SEPTEMBER


SingTel
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60
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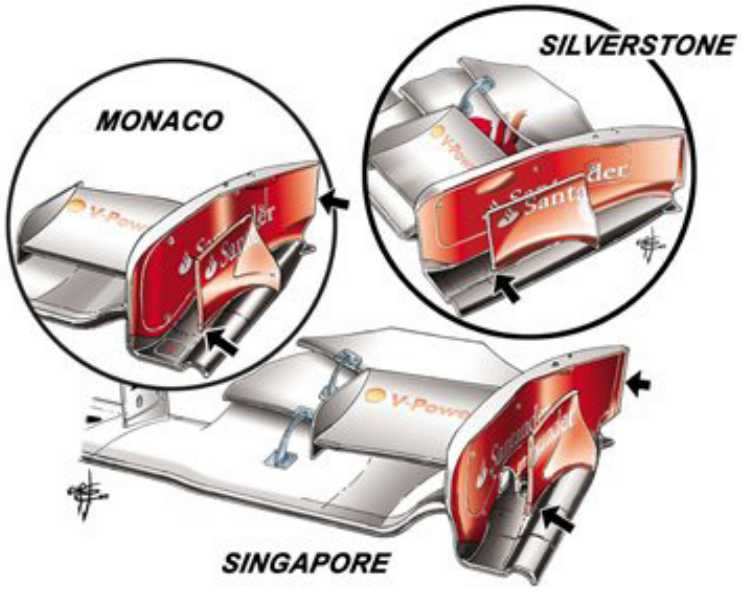
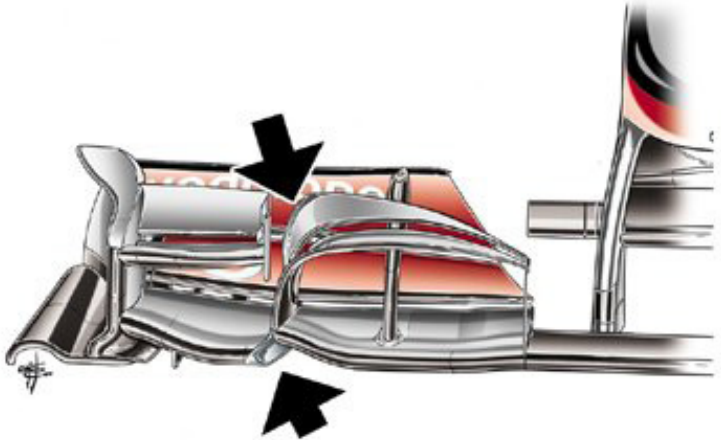


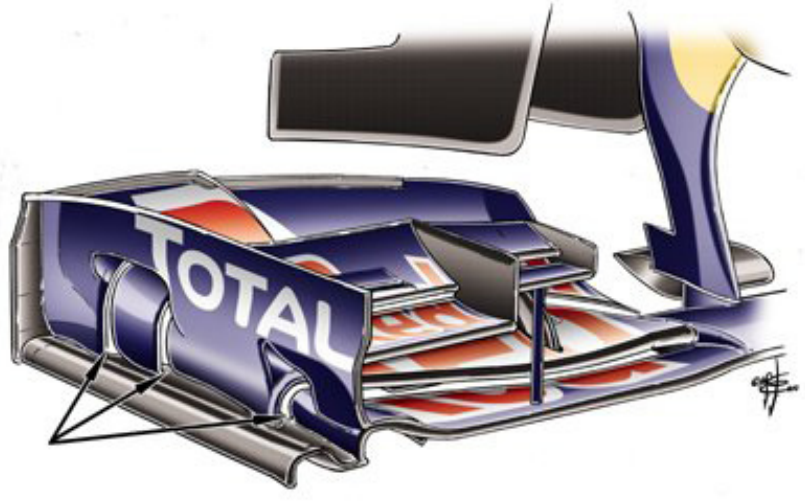
Ferrari F10 - front wing variations

The Ferrari drivers had three different front wings to choose from on Friday at Marina Bay - a Monaco-spec, a Silverstone-spec and a new Singapore-spec. Felipe Massa tested the new one, but spent more time on the Monaco version with its single flap. Fernando Alonso alternated between the Silverstone and Singapore specs, which differ only in the small fin on the outside of the endplate, which has been moved backwards by around 8cm. Both drivers went on to qualify and race with the new wing. Ferrari also have a new floor, revised in the tea-tray section.



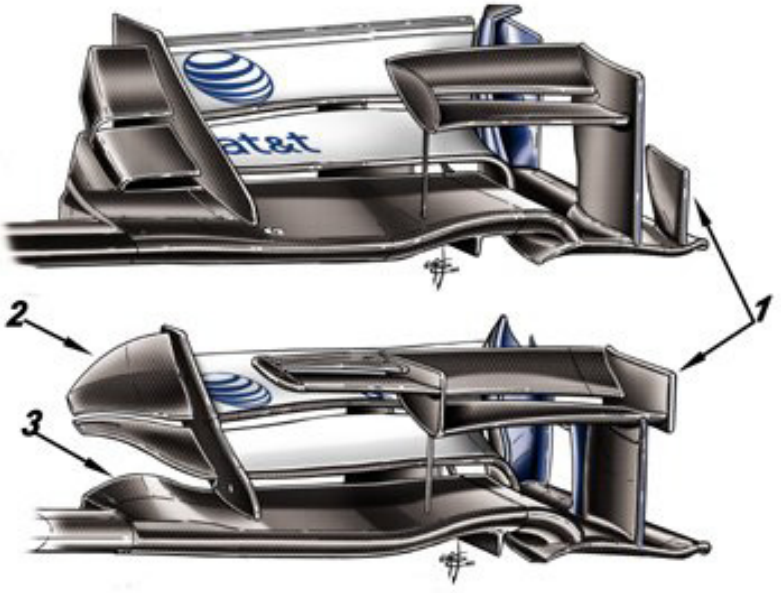
McLaren MP4-25 - revised front wing

McLaren introduced a radical new front wing in Singapore, based on the main profile introduced at Silverstone. Its design makes even more clear the intention to separate the airflow into two channels, but with both directing airflow around the outside of the front tyres. On Friday only Jenson Button ran with the new wing, but both drivers ultimately qualified and raced with it.



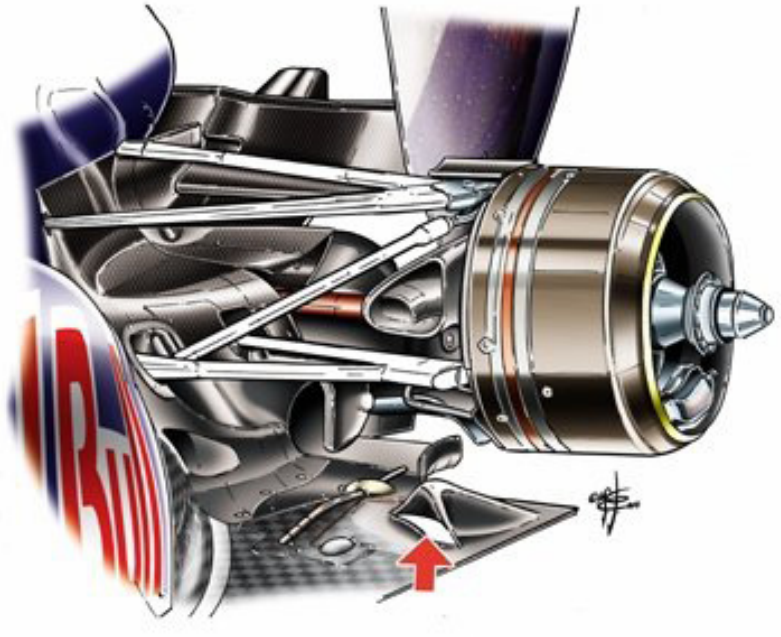
Red Bull RB6 - revised front wing

Red Bull have brought a new front wing to Singapore, based on the one they introduced at Silverstone, which features a low position for the television cameras. As well as the two vertical slots to the rear of the endplate, there is an additional vertical slot at the front of the endplate to avoid the creation of a vortex when it's working in conjunction with the planes and the endplate itself. For qualifying and the race, however, both Sebastian Vettel and Mark Webber decided to use the original Silverstone wing.



Williams FW32 - new front wing

Williams arrived in Singapore with a completely new front-wing assembly, which is quite similar to Renault's solution. Compared to the older version (top drawing), the new front wing (bottom drawing) features several differences. There is a more pronounced upward sweep of the outer lower wing, just inboard of the endplate. While the former small vertical fence at the outer edge of the endplate has gone (1, upper), the upper flap section now features an extension with a small endplate outside the main endplate (1, lower). It is all designed to help the tyre act like a diffuser, sucking air from the front wing to improve its efficiency. There are also two new flaps in the central section (2) and the main plane twists upwards (3).



Red Bull RB6 - revised diffuser

In qualifying and the race in Singapore, Red Bull used a new diffuser, modified both in the tea-tray section at the front (not shown) and in the critical area in front of the rear tyres. Here a bigger duct, angled more away from the longitudinal, is an attempt to better manage the airflow to the top of the diffuser's side section. Slightly different exhaust positions mean the pipes are always blowing under and inside the diffuser's side channels.

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2010 FORMULA 1 JAPANESE GRAND PRIX

SUZUKA
08-09-10 OCTOBER

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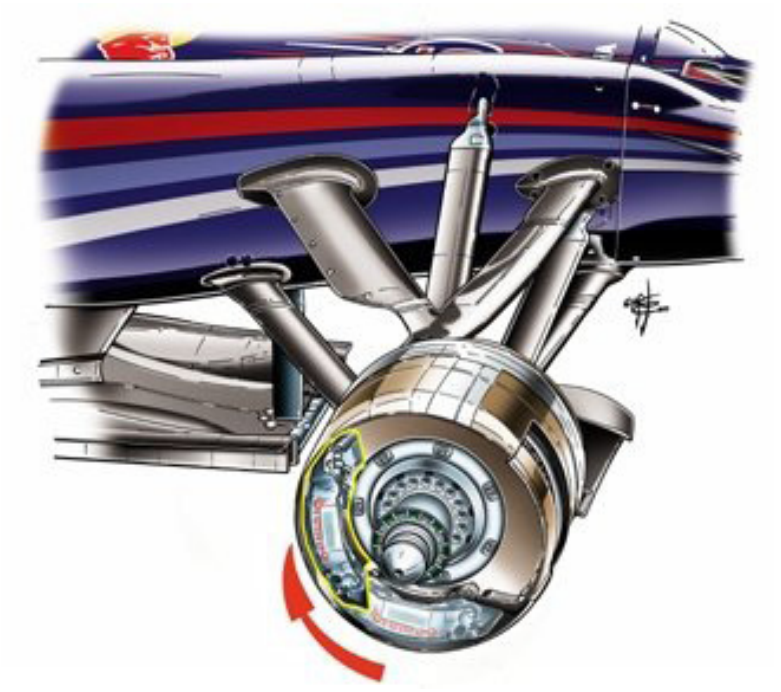
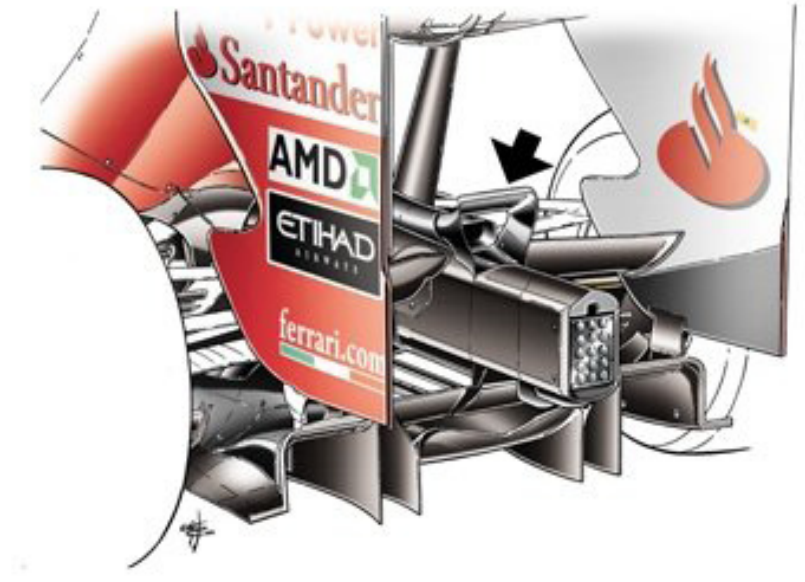


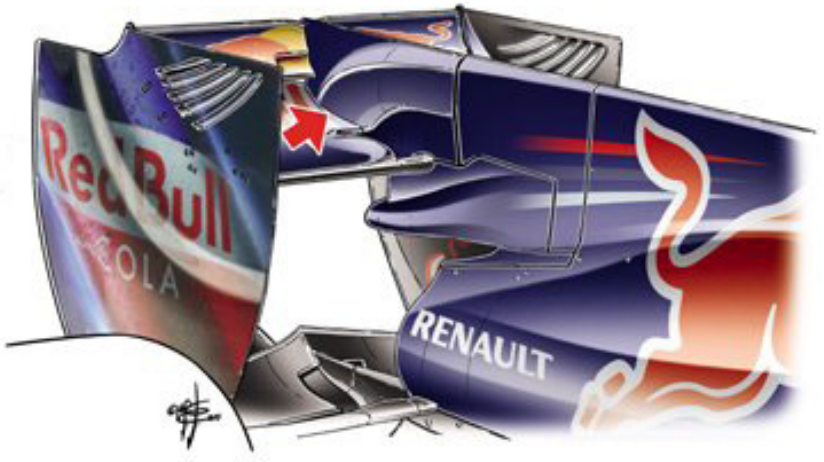
Red Bull RB6 - revised brake caliper positioning

After several reliability issues, Red Bull's chief technical officer Adrian Newey has changed the positioning of the RB6's front brake calipers. Instead of the horizontal position, which lowered the suspension's centre of gravity, he's moved the front calipers back to the more standard vertical position. The previous positioning had led to occasional mechanical failure due to greater movement of the brake pistons, pads and discs. This was a change planned for 2011, but the team took the decision to run with it for qualifying and the race in Japan.



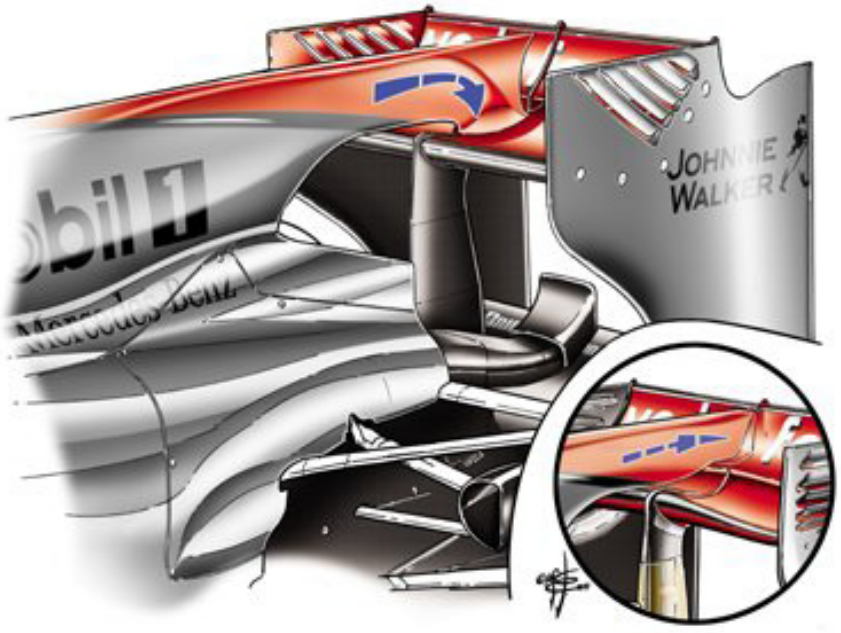
Ferrari F10 - modified diffuser

In Japan Ferrari are using a slightly modified version of the diffuser they introduced at August's Belgian Grand Prix. A small omega-shaped wing (black arrow) has been added on top of the deformable structure to boost downforce slightly. The front and rear wings being used at Suzuka are virtually the same as those run by Ferrari at the last round in Singapore, but with some small changes to the front wing's second flap.



Red Bull RB6 - revised rear wing

In Japan the two Red Bull drivers ran two different front wings, two different diffusers and the same new rear wing the team introduced at the last round in Singapore. This featured an F-duct directed on to the main plane (red arrow), in a similar way to the one featured on the Renault. A new feature was the beam wing, with a delta shape in the middle.



McLaren MP4-25 - revised rear wing

The new aero package introduced by McLaren in Japan included a revised version of the Singapore front wing, new longer exhausts, a new engine cover and a new rear wing. The team also changed the way their F-duct worked, as the new version blows on to the main plane (blue arrow, main picture) rather than the flap (blue arrow, inset). The team only had two sets of this new rear wing, so when Lewis Hamilton crashed during Friday practice and damaged it there was no spare and he reverted to the standard rear wing in the afternoon. On Saturday, after a plane and helicopter ride, a new rear wing arrived at Suzuka, but after not completing any running in the rain-hit third practice the team opted to use the standard version (inset) in qualifying and the race. The new wing also had angled gills like the Red Bull, rather than horizontal gills.

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2010 FORMULA 1 KOREAN GRAND PRIX

YEONGAM
22-23-24 OCTOBER

1950-2010
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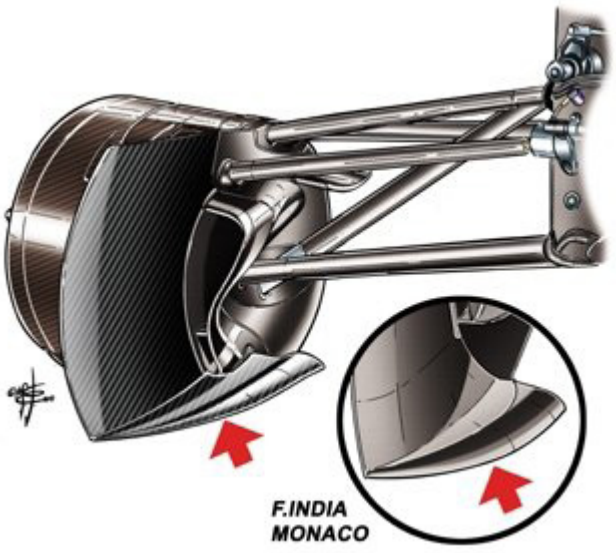
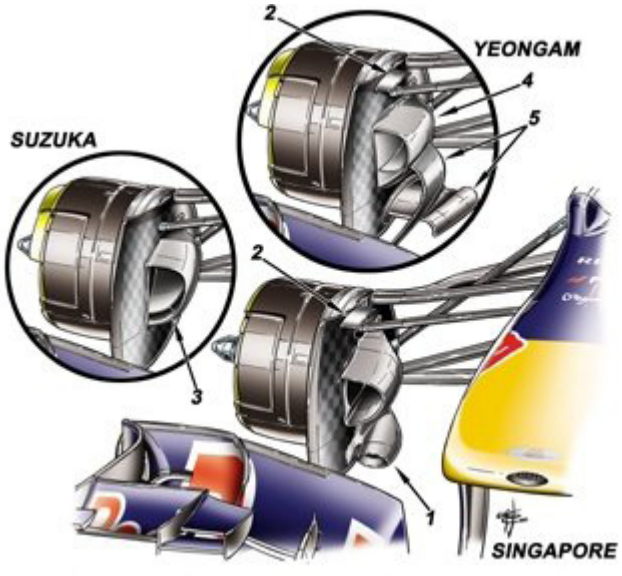


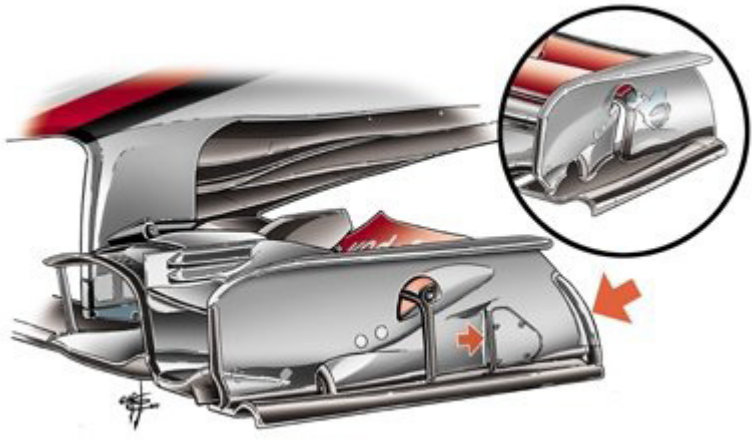
Williams FW32 - modified brake ducts

Williams' last update of the season included revised front and rear brake ducts. The front version aims to improve the airflow inside the tyres and direct it to the central section in a more efficient manner (see main drawing). The duct's shape is very similar to the one introduced in Monaco by Force India (see inset), which also influenced ducts used by Renault in Singapore.



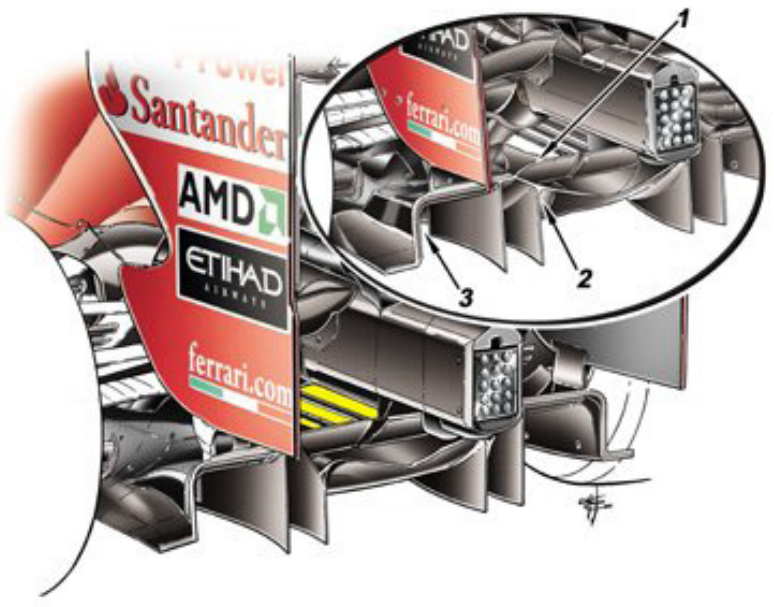
Red Bull RB6 - varying brake ducts

Over the last three races, Red Bull have tried out three different brake ducts. At Singapore, the horizontal caliper had a dedicated duct (Singapore drawing - 1) and there was also a small fin (Singapore drawing - 2). At Suzuka, the Singapore duct disappeared and was replaced by a single larger duct (Suzuka drawing - 3). The small fin was also removed for the Suzuka event, but this weekend in Korea it has been included again (Yeongam drawing - 2). There is a single larger duct (Yeongam drawing - 4) and also two new aerodynamic fins (Yeongam drawing - 5), which have been influenced by the Renault.



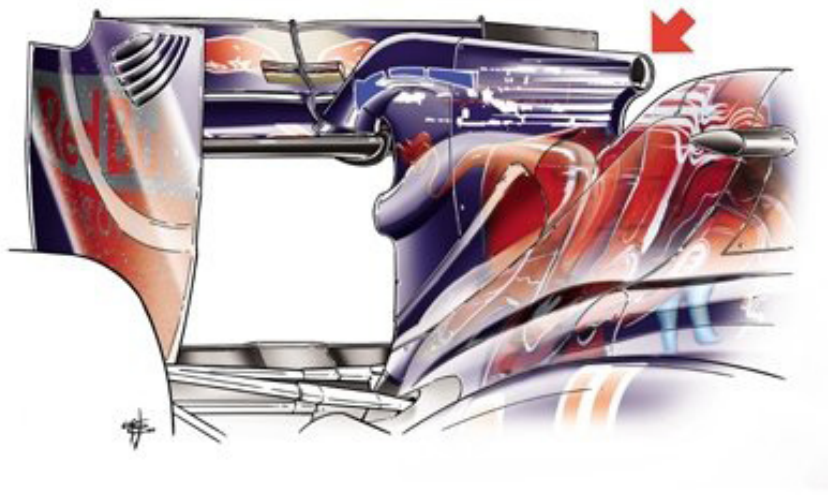
McLaren MP4-25 - revised front wing

For Korea, McLaren have once again modified the new front wing they introduced in Singapore. This time the new section can be found on the endplate. An additional vertical slot (smaller red arrow) and a vertical gurney flap at the end of the endplate (larger red arrow) have been added to improve airflow outside the front tyres and to gain some more downforce. The inset drawing shows the version the team ran at Suzuka, which featured just two slots and no gurney flap.



Ferrari F10 - modified rear diffuser

In Korea, Ferrari have introduced the biggest evolution to the F10's diffuser since its major update at Spa. The new-look diffuser (main drawing) is visibly different in its central section from its previous incarnation (inset). The top (1) and the bottom (2) profiles are now more curved to improve the extraction of air from the bottom of the car. The side channels now feature just one large middle plate, in place of the older version which was much smaller (3).



Toro Rosso STR05 - F-duct system

In Korea on Friday, Toro Rosso once again ran their F-Duct system, as they had done at Suzuka. It is quite a unique design, with the inlet of the duct separated from the engine cover (see red arrow). More conventional is that the air blows on to the rear wing's main plane (see blue arrow). This follows the example set by Force India from Silverstone, Renault from Spa, Red Bull in Singapore and McLaren, who trialled the different configuration in Suzuka before racing with it in Korea.

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FORMULA 1
GRANDE PRÊMIO
DO BRASIL 2010

SÃO PAULO
05-06-07 NOVEMBER


1950 - 2010
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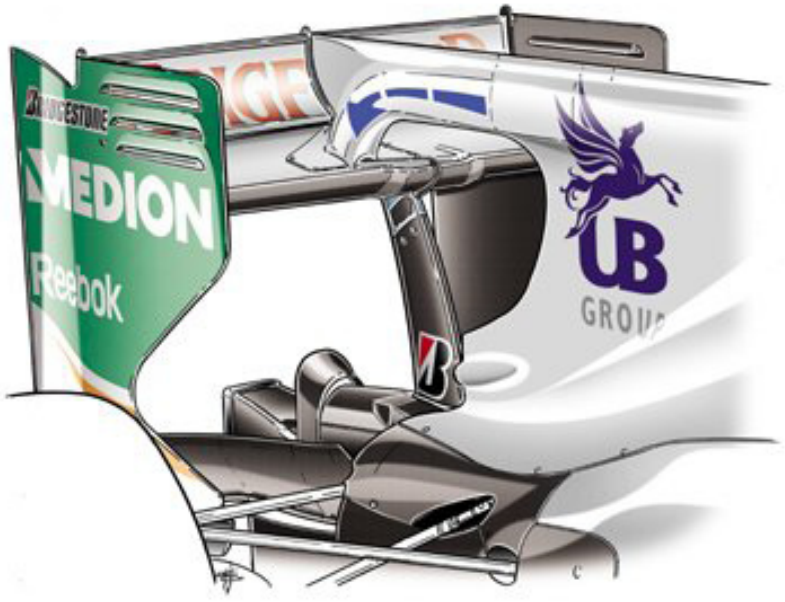
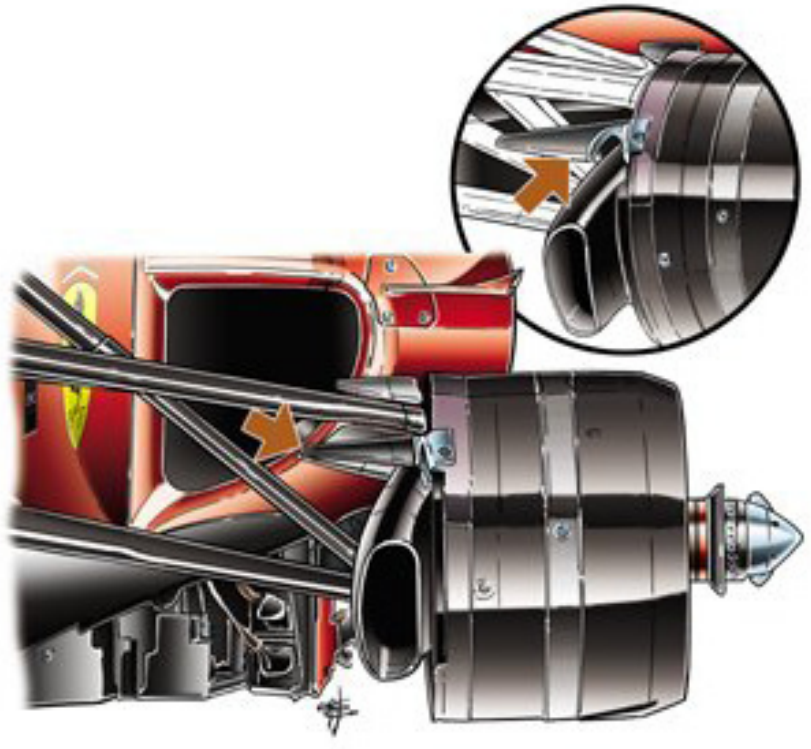


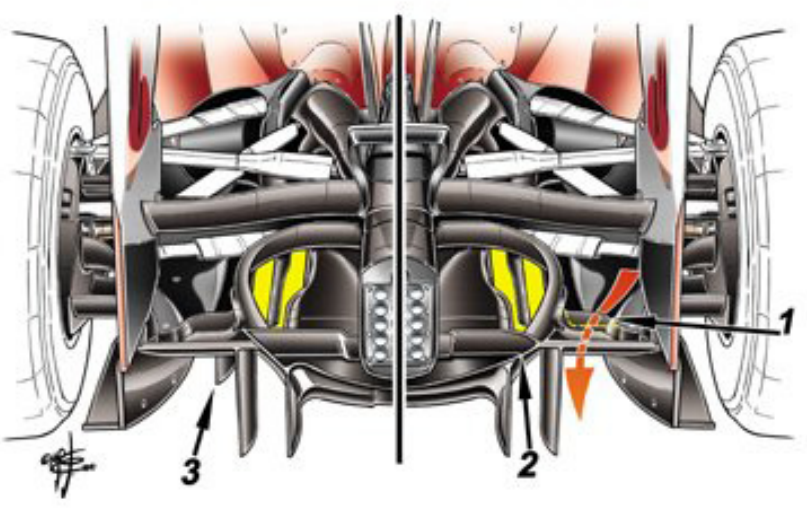
Force India VJM03 - F-duct

Force India were the first team to have the F-duct blowing on to the rear wing's main plane instead of the flap (blue arrow). This system was introduced in Silverstone then copied by Renault at Spa, Red Bull and BMW Sauber in Singapore, and McLaren in Japan and Korea. It's a more powerful and efficient solution. Ferrari were also expected to follow Force India's example, but chose instead to concentrate on their blown diffuser solution.



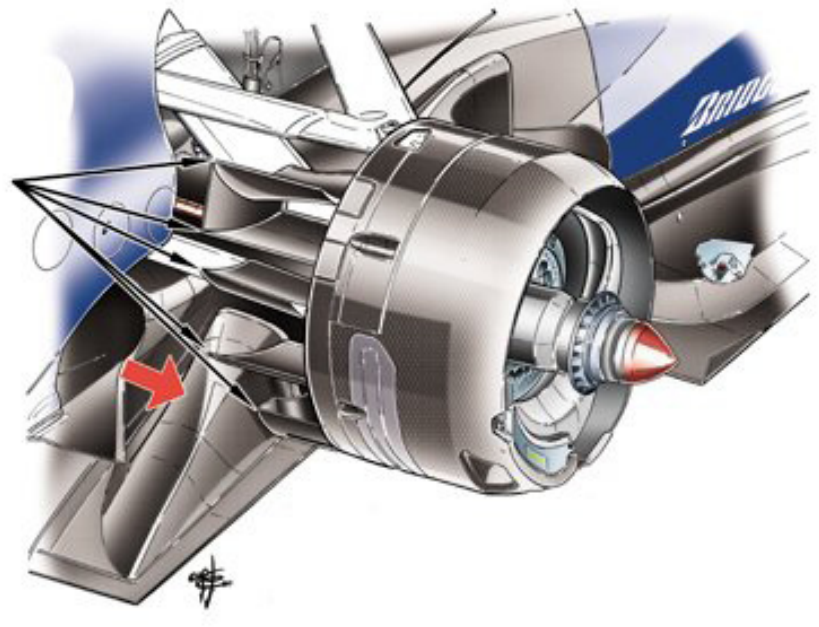
Ferrari F10 - modified brake ducts

An additional, small fin has been added to the front brake ducts in Brazil to gain any extra downforce possible. On Friday only Alonso had it, together with a three-slot configuration in the underbody in front of the rear tyres. It's interesting to note that in the final few races of 2010 a lot of effort has been made by all the teams to optimise the aero efficiency of the brake ducts, almost treating them as aerodynamic devices.



Ferrari F10 - blown diffuser

Finally Ferrari implemented their complete blown diffuser solution in Brazil with the airflow from the exhausts also blowing inside the side channels. Unlike the Red Bull, it features a horizontal hole (1) rather than the vertical one of the RB6. The central section used in Korea has been modified with more rounded profiles (2) and the additional middle plate (3) that was seen on the car up until Suzuka has now been removed.



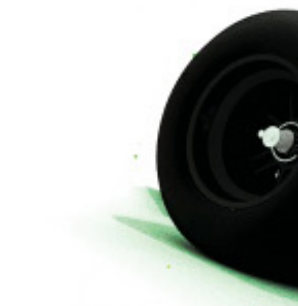
Williams FW32 - rear brake ducts

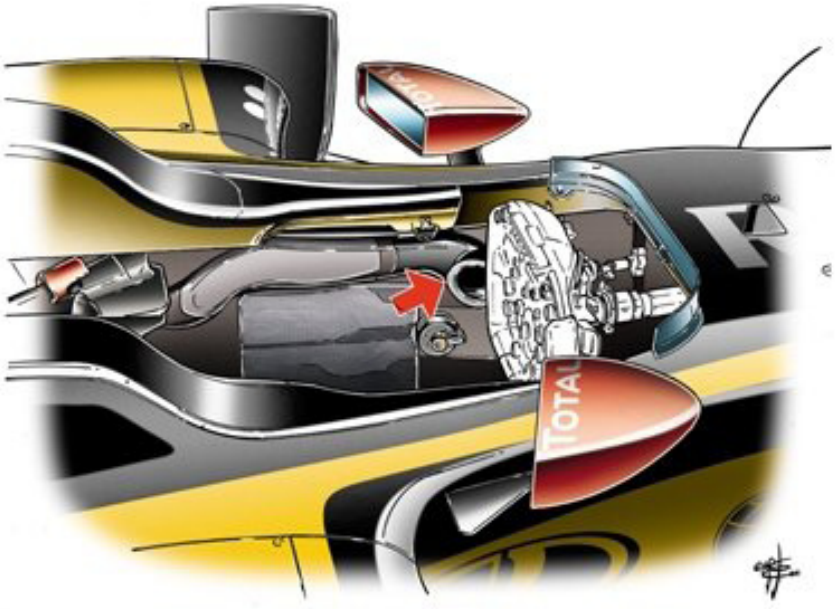
The majority of teams have been busily evolving their brake ducts, to the point that they are becoming more like aero devices. Williams' most recent version, as seen in Brazil, has been designed to recover as much downforce as possible and uses a series of fins (black arrows). The shape of the area between the rear tyres and the side channels of the diffuser (red arrow) is designed to receive air blowing from the car's exhausts.

Formula 1™

2010 FORMULA 1 ETIHAD AIRWAYS ABU DHABI GRAND PRIX

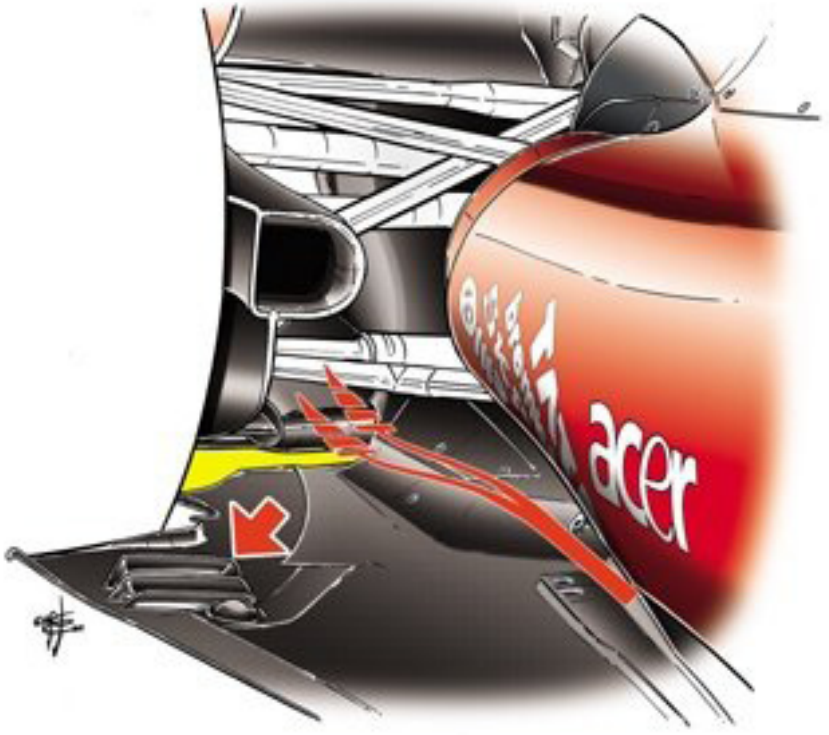
YAS MARINA CIRCUIT
12-13-14 NOVEMBER





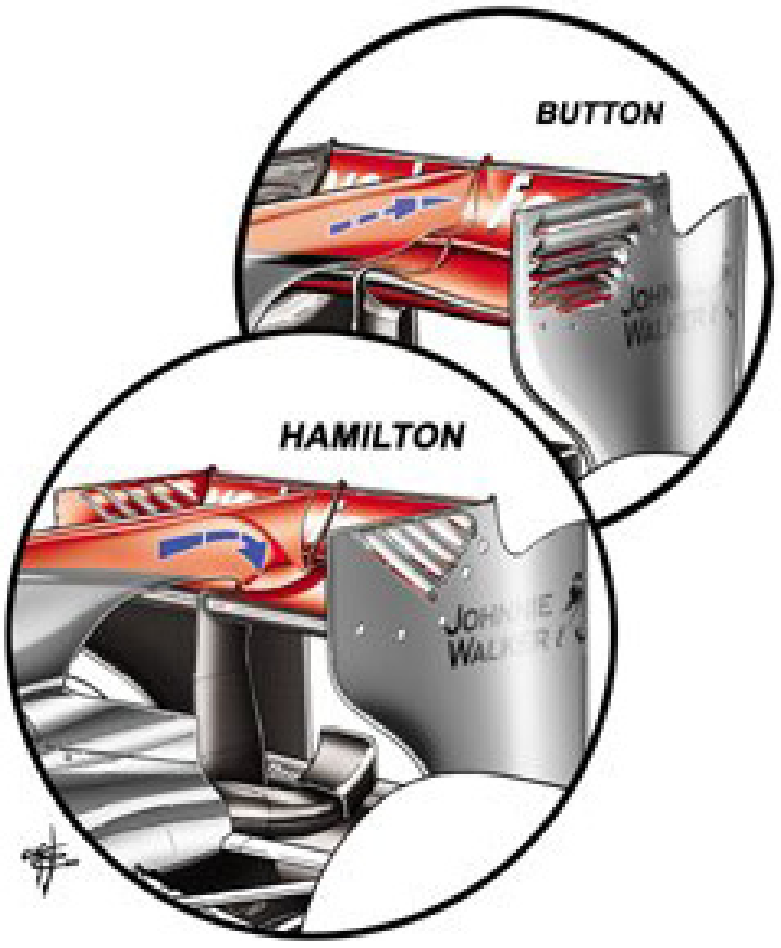
Renault R30 - F-duct system

The drivers are pleased F-duct systems will be banned next season, as they take a risk when they operate them. This illustration shows Renault's F-duct, which is a good example of the system used by many teams. The driver can operate it by blocking the hole at the side of the steering wheel with his left hand (red arrow). This often requires the driver to briefly let go of the steering wheel.



Ferrari F10 - exhaust air management

Air blowing from the F10's exhausts goes not only under the rear of the car beside the tyres (left, single arrow), but also inside the side channels of the rear diffuser. Unlike the Red Bull, which uses a vertical window in the side channel, the Ferrari has a horizontal opening to filter the hot air (right, twin arrows). This solution was introduced with the new diffuser in Korea and kept for the last two races of the season.



McLaren MP4-25 - rear-wing comparison

On Friday in Abu Dhabi McLaren carried out back-to-back tests with two rear wings. Hamilton's car featured a new version (bottom illustration), where the air from the F-duct system blows on to the main plane of the rear wing. Button ran with the older high-downforce rear wing, where the air blows on to the rear wing's flap (top illustration). In qualifying and for Sunday's race, both drivers used the newer version of the wing on their cars.

SPORTING REGULATIONS

2010 season changes

Though not as dramatic as the rule changes introduced for the 2009 season, the revisions for 2010 could still have a significant impact on the teams' relative performance…

Refuelling

The biggest change for the 2010 season is the banning of refuelling during races for the first time since 1993. Pit stops will not become a thing of the past, however, as drivers still have to use both dry-weather tyre compounds during a Grand Prix. Of course, those stops will now be much quicker, quite possibly under four seconds.

The change requires cars to possess a much larger fuel tank - up from around 80 litres to something nearer 250 - and has a major effect on race strategy, with drivers having to pay more attention to tyre and brake conservation. To accommodate the bigger tank, the cars are likely to feature wider rear bodywork and a longer wheelbase. As a result, the weight distribution will be quite different to that of a 2009 car.

Points system

In place of the previous structure, which saw the top eight drivers scoring 10, 8, 6, 5, 4, 3, 2 and 1 point respectively, from 2010 the top ten finishers in a Grand Prix score points. The change has been introduced as a result of the expanded grid of 13 teams. Under the new system, the race winner takes 25 points, with 18 and 15 being awarded for second and third places respectively. The next seven finishers will score 12, 10, 8, 6, 4, 2 and 1 point respectively.

Weight

The minimum weight of the car has been raised from 605kg to 620kg. The initial thinking behind this was to offset the disadvantage faced by taller, heavier drivers in KERS-equipped cars (the additional weight of the KERS system meant they were left with less flexibility in terms of weight distribution than their lighter rivals). By mutual agreement, however, teams are now not expected to run KERS in 2010.

Narrower front tyres

When slick tyres returned to Formula One racing in 2009, the tyre size remained unchanged. In terms of contact area, this meant that the fronts gained proportionally more grip than the rears. This has been addressed for 2010, with front tyre width reduced from 270mm to 245mm, thus helping to bring back a better grip balance. Also, the ban on refuelling means cars will be around 100kg heavier at the start of a race than in 2009, so Bridgestone will use slightly harder tyre compounds to compensate.

The number of dry tyres available to each driver has been decreased from 14 to 11 sets per weekend and any driver who participates in Q3 must start the race on the same tyres he used to set his grid time.

No wheel fairings

Teams are no longer allowed to use the wheel rim covers that became so commonplace in 2009. Their removal means one less thing to go wrong when pit crews are trying to change of set of tyres in less than four seconds, and could also aid overtaking by making the airflow immediately behind cars less turbulent.

More teams

Twelve teams - 24 cars - will feature on the grid in 2010. This means a slight alteration to the knockout qualifying session, which will now see seven drivers (as opposed to five) eliminated in Q1 and Q2, leaving ten to fight it out for pole in Q3. The ban on refuelling means that cars will qualify on low fuel in all three phases of the session.

Testing

If a team declares that one of their 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 now be permitted, on an approved circuit not being used for a Grand Prix in the current season. This is to avoid scenarios such as that seen in 2009 when Jaime Alguersuari made his Formula One debut with Toro Rosso having only previously driven an F1 car in straight-line testing.

In another minor change, teams will be allowed six rather than eight days of straight-line aero testing per season. They will also have the option of substituting any of these days for four hours of wind tunnel testing with a full-scale (rather than the normal 60 percent-scale) model.

From the 2010 Formula One Technical Regulations:

ARTICLE 4: WEIGHT

4.1 Minimum weight:
The weight of the car must not be less than 620kg at all times during the Event.
4.2 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.
4.3 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.

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 an homogeneous metallic material with a minimum density of 1.74g/cmUPU3UPU at 20°C.
The use of magnesium M18430 is forbidden.
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.
U12.4.5U UNo 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.
12.5 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.

ARTICLE 11: BRAKE SYSTEM

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.

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.

FIA REGULATIONS IN DETAIL

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.

FIA REGULATIONS IN DETAIL

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.

FIA REGULATIONS IN DETAIL

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).

Driver penalties

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

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 extreme cases the stewards may choose to enforce a third type of penalty whereby they can force a driver to drop any number of grid positions at the next Grand Prix. So even if the driver in question goes on to qualify in pole position, he will in fact start from a lower grid slot; 11th for example in the case of a ten-place penalty.

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. However, 25 seconds will be added to his total race time, which may drop him considerably in the final race standings.

FIA REGULATIONS IN DETAIL

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 three penalties 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.
c) a drop of any number of grid positions at the driver's next Event.
However, should either of the penalties under a) and b) above be 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).
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.

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.

FIA REGULATIONS IN DETAIL

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.

FIA REGULATIONS IN DETAIL

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 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 brake cooling and radiator ducts is free, 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.
34.3Within 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

44.1Only 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.

Points

The top ten finishers in each Grand Prix score points towards both the drivers' and the constructors' world championships. (The only exception to this is when a race is suspended and cannot be re-started. 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.

FIA REGULATIONS IN DETAIL

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.

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.

FIA REGULATIONS IN DETAIL

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.

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.

FIA REGULATIONS IN DETAIL

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 proceed at a greatly reduced speed until clear of any team personnel standing beside the track. 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 38.12 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.

Refuelling

During practice, refuelling is only permitted in a team’s garage area. 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. However, no refuelling is allowed during the race.

FIA REGULATIONS IN DETAIL

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.

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. 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 line to commence 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.

FIA REGULATIONS IN DETAIL

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 From this time, any car being driven unnecessarily slowly, erratically or which is deemed potentially dangerous to other drivers at any time whilst the safety car is deployed will be reported to the stewards. 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 first 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 ;
- any car entering the pits may pass another car or the safety car remaining on the track after it has crossed the first safety car line ;
- any car leaving the pits may 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 Whilst the safety car is in operation, competing cars may enter the pit lane, but may only rejoin the track when the green light at the end of the pit lane is on. It will be on at all times except when the safety car and the line of cars following it are about to pass or are passing the pit exit . A car rejoining the track must proceed at an appropriate speed until it reaches the end of the line of cars behind the safety car.
Under certain circumstances the clerk of the course may ask the safety car to use the pit lane. In these cases, and provided it's 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.
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 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 form up at the back of the line of cars behind the safety car. If more than one driver is affected, they must form up at the back of the field in the order they left the grid.
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 first lap.

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 throughout the Grand Prix weekend to ensure that they comply with minimum weight requirements (620kg). During practice and qualifying cars are called in at random to be weighed. After the race every car and driver is weighed.

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.

FIA REGULATIONS IN DETAIL

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 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) 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 ;
6) a car or driver may not leave the FIA garage without the consent of the FIA technical delegate;
7) 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, gearboxes and homologated parts

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 four 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.

FIA REGULATIONS IN DETAIL

28) SPARE CARS, ENGINES, GEARBOXES AND HOMOLOGATED PARTS

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 four 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 four race sequence may start at the following Event.
Unless the driver fails to finish the race (see below) the gearbox fitted to the car at the end of the Event must remain in it for three further Events. Any driver who failed to finish the race at the first, second or third of the four 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 or third of a four Event period, having finished the first, second or third 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) below, can be rebuilt or replaced.
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.
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.

28.7
a) One specification of each of the following parts must be homologated prior to the first Event of the Championship season :
- survival cell ;
- principal and second roll structures ;
- front, rear and side impact structures ;
- front wheel ;
- rear wheel.
Once homologated, changes to the these parts will only be permitted for clear safety or reliability reasons following written approval from the FIA.

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 the red flag line without overtaking and then stop in staggered formation with the leading car at the front. 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.

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".

FIA REGULATIONS IN DETAIL

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(e) 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 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 form up at the back of the line of cars behind the safety car. If more than one driver is affected, they must form up at the back of the field in the order they left the grid.
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.

FIA REGULATIONS IN DETAIL

22) TRACK AND WIND TUNNEL TESTING

22.1 a) Track testing shall be considered any track running time undertaken by a competitor entered in the
Championship with the exception of :
i) promotional or demonstration events carried out using tyres provided specifically for this purpose by the appointed supplier ;
ii) one three day young driver training test, carried out on a site approved by the FIA for Formula 1 cars and between the end of the last Event of the Championship and 31 December of the same year, any such driver having not competed in more than two F1 World Championship Events ;
iii) four one day aerodynamic tests carried out on FIA approved straight line or constant radius sites between 1 January 2010 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.
b) No competitor may carry out more than 15,000km of track testing during a calendar year.
c) No track testing may take place between the start of the week preceding the first Event of the Championship and 31 December of the same year with the following exception.
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.
d) During all track testing cars must be fitted with the FIA ECU required by Article 8.2 of the 2009 FIA Formula One Technical Regulations.
e) 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.
f) During all Formula One track testing :
- red flag and chequered flag procedures must be respected ;

- no other type of vehicle is permitted on the track ;
- 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.
g) 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.
h) 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 percent of full size.
i) 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 Bridgestone 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. A green band on the sidewall of the softer compound allows spectators to distinguish which tyre a driver is on.

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.

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.

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.

FIA REGULATIONS IN DETAIL

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 2008, 2009 and 2010 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 ;
- 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 the Event no driver may use more than eleven sets of dry-weather tyres (six of "prime" specification and five of "option" specification), four sets of intermediate tyres and three sets of wet-weather tyres.
No driver may use more than two sets of each specification of dry-weather tyre during P1 and P2.
A set of tyres will be deemed to comprise two front and two rear tyres all of which must be of the same specification.
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 :
a) Each nominated driver will be allocated three sets of dry-weather tyres 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 an additional driver is used (see Article 19.1(b) he must use the tyres allocated to the nominated driver he replaced.
b) Each nominated driver will be allocated eight further sets of dry-weather tyres, 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.
c) 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.
d) 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.
e)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.
f) 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. As a reference, the 2009 season Toyota TF109 is 4636mm long, 1800mm wide and 950mm high.

FIA REGULATIONS IN DETAIL

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, including complete wheels, 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, the top, forward and outer edges of the lateral extremities of any bodywork more than 450mm ahead of the front wheel centre line and more than 750mm from the car centre line must be at least 10mm thick with a radius of at least 5mm.
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 200mm above the reference plane must not exceed 1000mm.
3.5.2 The width of bodywork behind the rear wheel centre line and more than 200mm 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, and which is more than 75mm from the car centre line, may be more than 600mm 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 200mm 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.
3.10.2 Any bodywork behind a point lying 50mm forward of the rear wheel centre line which is more than 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 the rear wheel centre line and a point 350mm behind it. When viewed from the side of the car, no longitudinal cross section may have more than two closed sections in this area. Furthermore, the distance between adjacent sections at any longitudinal plane must not exceed 15mm at their closest position.
3.10.3 In order to ensure that the relationship between these two sections cannot change whilst the car is in motion they must be bridged by means of rigid impervious supports (including any adjustment mechanism) arranged such that no part of the trailing edge of the forward section may be more than 200mm laterally from a support. These rigid supports must :
- fully enclose the two complete sections such that their inner profile matches that of the two sections. Their outer profile must be offset from the inner profile 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) ;
- 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 3mm thick ;
- be rigidly fixed to the two sections. Some form of adjustment mechanism between the sections may be incorporated for the sole purpose of allowing adjustment of the sections relative to one another whilst the car is in the pits ;
- 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.

3.11 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 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 :
- extend from a point lying 330mm behind the front wheel centre line to the rear wheel centre line ;
- have minimum and maximum widths of 300mm and 500mm respectively ;
- 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.
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 175mm above the reference plane. 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. A single break in the surface is permitted solely to allow the minimum required access for the device referred to in Article 5.15.
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.
3.13 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 more than one piece 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 cover described in Article 6.5.2 (when used in the pit lane), the driver adjustable bodywork described in Article 3.18 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.
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 10mm vertically when a 500N 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 and an adapter 300mm long and 150mm wide. Teams must supply the latter when such a test is deemed necessary.
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 a point which lies on the car centre line and 380mm rearward of the front wheel centre line. The load will be applied in an upward direction using a 50mm diameter ram. 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.
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 :
A single closed section situated each side of car centre line in the volume bounded by :
- lines 450mm and 800mm in front of the front wheel centre line ;
- a vertical plane which intersects these lines at a distance 250mm from the car centre line ;
- and the inboard face of the bodywork described in Article 3.7.5 ;
is allowed to change incidence while the vehicle is in motion within a maximum range of 6 degrees, provided any such change maintains compliance with all of the bodywork dimensional regulations. Alteration of the incidence of these sections must be made simultaneously and may only be commanded by direct driver input and controlled using the control electronics specified in Article 8.2. Except when the car is in the pit lane, a maximum of two adjustments may be made within any single lap of a circuit.

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.

FIA REGULATIONS IN DETAIL

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.

FIA REGULATIONS IN DETAIL

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 fibre reinforcement using Z-pinning technology is 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 second structure must pass a static load test details of which may be found in Article 17.3.
15.2.4 Both roll structures must have minimum structural cross sections of 10000mm©÷, in vertical projection, across a horizontal plane 50mm below the their highest points.
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 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 18.6.
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 18.6. Furthermore, parts to this tested specification must cover an area which:
- begins at least 250mm high at line A-A ;
- tapers at a linear rate to at least 400mm high at line B-B and which remains at this height to the rear of the survival cell ;
- is no less than 100mm 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 and 18.8 have been met, panels no less than 6.2mm thick must then be permanently attached to the survival cell sides. These panels must:
- in a longitudinal sense, cover the area lying between two vertical planes, one 125mm forward of the cockpit entry template and one 50mm to the rear of the template. A 50mm horizontal linear taper may be included at both ends ;
- in a vertical sense, cover an area which has been constructed in accordance with Articles 15.4.6 and 18.6. This will not apply where any radius permitted by Article 15.4.4 falls inside the minimum permitted chassis width ;
- 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 ;
- 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 25000mm©÷ per side will be permitted for fitting around side impact structures, 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.
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 permitted 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 16.4.
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 five 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.
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 18.5, 18.7 and 18.8.2.

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.

FIA REGULATIONS IN DETAIL

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 18.4), 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.

FIA REGULATIONS IN DETAIL

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 40% and 60% 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.

Engines and Kinetic Energy Recovery Systems (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.

FIA REGULATIONS IN DETAIL

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:

5.3.1 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.

FIA REGULATIONS IN DETAIL

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.

19.4.2 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 biocomponents.
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.

FIA REGULATIONS IN DETAIL

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 efficient 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.

FIA REGULATIONS IN DETAIL

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:
- 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.
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 18.2-4, and on the frontal impact absorbing structure which was subjected to the test described in Article 18.5.
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 18.2-4.
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 18.2-4 and on the side impact absorbing structure(s) which were subjected to the test described in Article 18.8.
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 18.7.
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.

FIA REGULATIONS IN DETAIL

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.

FIA REGULATIONS IN DETAIL

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 50mm, 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:
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:
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 perpen-

dicular 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.

FIA REGULATIONS IN DETAIL

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 combined 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 No part of the reflective surface may be less than 250mm from the car centre line or more than 750mm from the rear 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 Headrests and head protection:
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 prepreg 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 con-

tinuation 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 rim of the cockpit must also pass strict tests. All of these requirements help to make Formula One cars safer than ever before.

FIA REGULATIONS IN DETAIL

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 and 18.8.2 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 and 18.4.
However, the tests described in Articles 18.2.1, 18.3 and 18.4 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 and 18.4, permanent deformation must be less than 1.0mm (0.5mm in 18.3) 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 and 18.4, 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 rim test:
Two pads, each of which is 100mm 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.
18.5 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.
18.6 Side intrusion test:
18.6.1 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.
18.6.2 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.
18.7 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.
18.8 Side impact structure push off test:
18.8.1 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.
18.8.2 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 tethered to the body of the car by one or two cables, each with its own attachment. The cables 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.

FIA REGULATIONS IN DETAIL

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 cables, each with a cross sectional area greater than 110mm², the purpose of which is to connect each wheel/upright assembly to the main structure of the car. The cables 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 cable must have its own separate attachment which :
- is able to withstand a tensile force of 70kN ;
- is able to accommodate a cable end fitting with a minimum inside diameter of 15mm.
Each wheel may be fitted with one or two cables, dependent upon their performance when tested under FIA Test Procedure 03/07. If one cable is fitted it must exceed the requirements of 3.1.1 of Test Procedure 03/07 and if two are fitted each must exceed the requirements of 3.1.2.
Each cable 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 a timing transponder supplied by the officially appointed timekeepers. These transponders allow the timekeepers to record every lap time of every car throughout the weekend.

FIA REGULATIONS IN DETAIL

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 5° to the reference plane.
20.4 Transponders:
All cars must be fitted with a timing transponder supplied by the officially appointed timekeepers. This transponder 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 1 September 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.

FIA REGULATIONS IN DETAIL

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 620kg (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.

FIA REGULATIONS IN DETAIL

ARTICLE 4: WEIGHT

4.1 Minimum weight:
The weight of the car must not be less than 620kg 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 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.

4.3 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. 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.

FIA REGULATIONS IN DETAIL

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 an homogeneous metallic material with a minimum density of 1.74g/cmUPU3UPU at 20°C.
The use of magnesium M18430 is forbidden.
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.
U12.4.5U UNo 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.
12.5 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.