

# Formula One Safety: A Review

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**Abstract**— This paper aims at defining and decoding the various safety measures, precisely focusing on the evolution of safety on Formula One racing track and the usage of different colour flags and their significance used during the race for signalling the drivers. The first race season of Formula One was held in 1950, it was a seven race series which started on 13th May and completed on 3rd September. Back then the safety precautions were not as good as they are today. Over the past few decades the races have seen a great improvement considering safety to be the first priority. Advancement in science and technology has led to the decrease in deaths or critical injuries to the drivers during the racing. Safety equipment used by the drivers and the pit crew also ensure the safety. A study was carried out by Australian Grand Prix Medical Centre in the year 2011 which shows the reasons due to which the patients were admitted in the centre. So to prevent critical accidents various techniques and safety measures are implemented. It is crucial to follow the guidelines stated by FIA not only by the drivers but also for the pit crew.

**Key words:** Formula One, Safety, Flags, Equipment, Regulations

## I. INTRODUCTION

Formula One racing is a great spectator sport. It includes high speed cars and with high speed comes high risks of not only critical injuries but also death. To overcome the risk without losing the sport essence is an important aspect; care should be taken to achieve these various different strategies and techniques. FIA is the organization which is responsible for the track safety including the drivers, pit crew as well as spectator's safety.

The various rules and regulations followed by the driver and his team which are stated by FIA are in the paper. The drivers are signalled by waving different colour flags, each flag has its individual meaning. Formula one racing is admired by people all around the globe. The cars undergo various kind of testing before using them in order to ensure maximum safety of the drivers. It is crucial to know the danger associated with Formula one in order to avoid unwanted incident. To increase the safety efforts are being taken in order to have minimum damage in case of an accident.

## II. HISTORY OF SAFETY

Safety being the major part of Formula one racing, the safety measures or the mandatory rules taken along all the years changes eventually.

1950-In this year the very first formula one world championship was organized. The main focus in this race was cars with high speed, this was achieved by designing the cars with drum brakes and engine placed at the front side of the car.

1955-Cars were redesigned and the position of engine was in the middle and disc brakes were installed.

1960-1969-Safety measures were made known to Formula one. Roll over bars, flag signals, dual brake circuit is made compulsory. FIA obligates for safety of the drivers on racing track, Fire resistant suits for drivers are made mandatory. Most important dual fire extinguishing system is installed in all the cars.

1970-Survey of the tracks is carried out by the FIA officials before any race begins. The track fence and audience benches are at distance of 3 meters apart.

1971-Reconstruction of cockpit to get the driver out of it in less than 5 sec.

1972-1979-Head rests for drivers are installed. Glowing red colour lights are placed at the back side of the car.

Health check-up of the drivers is made mandatory. Walls at the track periphery becomes important part of the track. FIA standardizes norms for fire resistant suit and helmet. Cockpit size is increased for easy in and easy out of the driver.

1980-1989-Medical centres are built at the circuit. Helicopters are present and always ready for any emergency. Minimum dimension of the track walls and walls adjacent to the pit must be according to the standard dimension mentioned by the FIA.

1990-1999-Rear view mirrors are increased in size and the removable steering wheel is made compulsory for all the cars. Test for seatbelts are introduced. Formula one safety car is introduced. The use of high end fuel mixtures was banned. ABS and power assisted brakes which helps the driver for easy control of the car are restricted. All the cars are equipped with accident data recorders to ease the accident investigation. Medical safety cars are introduced which aid on the track whenever required.

2000-2010-Cockpit and roll over bar dimensions are increased. Time penalties are charged for intentionally stopping other drivers to overtake. Rear red light size is increased. Head and neck support system is made compulsory for all the racers. Cars are fitted with LED lights which indicate the flag signal. A three member team is fixed to help the steward who make the decision linked to race event.

## III. TECHNICAL REGULATIONS

### A. Cockpit

The cockpit of any formula one car is made of carbon fibre. The fuel or oil lines are not allowed through the cockpit as it may catch fire. The cockpit size is increasing in width starting from the foot to the head having 30cms and 50cms respectively, making an easy exit for the driver with only removal of seatbelt and steering wheel. The cockpit dimensions changes with advancement. The cockpit is surrounded by energy absorber composite helpful during an accident. All the cars have a reliable fire extinguishing system which is operated by a switch. It has lights indicating the flag waved on the track [1].

### B. Crash Test

Like every normal cars are crash tested, likewise the Formula One car is also tested. These tests include stationary load test, moving test and rolling test. These test implementation have not only helped the Formula one cars but also improving the normal road cars [1].

### C. Safety Car

The Formula one safety car comes inaction when there is a need of speed reduction during any race, mainly if any accident takes place on track or if track is wet. This does not stops the race, it's just a safety measure for slowing down the racers for some time. When safety car is deployed then the racers are not allowed to overtake each other. Once the work of safety car is carried out it stops the orange flashing light which is an indicator for the drivers that their race is going to start from the next lap [2].

### D. Track Safety

There are patches in the track which are vacant spaces just next to the racing track, to reduce the speed of the cars and avoiding a collision with the walls. There are small stones placed on specific corners for decreasing the speed of a car which skids along the track. A Marshals are present on both the side of the track after every 300meters with a fire extinguisher [3].

### E. Medical

The key thing in racing is safety of the drivers, to ensure this there is a good arrangement of medical facility to the drivers. There are mobile response team which are six different types of cars among which two have Doctors present in it. The circuits have permanent medical centres which has all the latest medical equipment. Helicopters are also present for any critical injury [3].

- The steering wheel should be easily removable within 5secs in case of accident it is easy for the driver to escape.
- The front side of cockpit i.e. where driver's legs are here, should be installed with enough padding so as to reduce the risk of injury to legs during any accident.
- Enough padding also near to the driver's head while in the cockpit for reducing the force of impact during an accident.
- A red light is installed at the rear of the car which is there for visibility purpose. The drivers which are behind can see the cars in their front. This is under the FIA regulation.
- Drivers are forced to wear the seatbelt which is specified by the FIA. This seatbelt consist of two shoulder harness, two legs harness and one stomach harness.
- Two rear view mirrors installed at the specified location on the car to make the visibility more effective.
- A switch is present in the car which can be operated by the driver to cut out the electrical
- Systems. As soon as the switch is pressed the electrical circuit breaks.
- Fire extinguishing system is mandatory in all the cars and should be function able with a switch. This should be in working condition even if the electrical circuit are switched of or the contact is broken.

- The fire extinguishing system should also be able to operate from outside of the car with the help of a switch [5].



Fig. 1: Side View of Car

## IV. SAFETY EQUIPMENT

### A. Helmet

Head injury is most common in Formula one accidents, so to avoid these helmets are made mandatory to wear for all the Formula one car drivers during racing as well as testing. Helmets have the ability to absorb the shocks. Helmets are made lighter in order to avoid the force acting on the driver's head. They are designed in such a way that the force exerted on driver's head during braking, taking corner turns and accelerating is minimized. These helmets are made of fire resistant material but the main composite is carbon-fiber. Testing of helmets is carried out to ensure the safety of the driver wearing the helmet. Most of the helmet glass are tinted having a coat of anti-fog chemicals. The helmet has a great ventilation system with filters installed in order to stop the dirt particles from getting inside. The helmet are designed aerodynamically to reduce the drag force produced.

### B. Head & Neck Support

There is a support made of carbon-fibre attached to the belt and connects the helmet in such a way that if an accident occur then it restrain the driver's head from bumping on the steering wheel. The head and neck support is designed so as to absorb the shocks that are generated during an accident, if the support is not present these forces will be directly transferred to the driver's skull and neck causing critical injury.

### C. Clothing

The suit that a Formula one driver wears during a race is fire resistant to provide safety during any fire issue. The fiber is tested before using it to make the clothing from it. The suit is washed 15times as well as dry cleaned 15times before testing. The zip, thread and any patch on the clothing must be fire proof. The suit consist of two handles on the shoulders to lift the driver with his seat to prevent critical injuries. The gloves, ankle boots and even the cloth that driver wears under the helmet are all fire resistant [4].

## V. SAFETY MEASURES

### A. Ear Protection

Protecting the ears from loud noise i.e. high decibel sound is a must in Formula one racing. Because continuous exposure to noise may damage the ear leading to permanent loss of hearing. Loss of hearing is unrecoverable so to avoid this care should be taken by wearing effective ear protection plugs.

### B. Safety Harness

Safety harness is nothing but the seatbelt that the racers use. Stiff best is more effective than the loose belt/chain. Most of the times there is a six strap harness in which two straps supports the shoulder and are wrapped around the legs and the remaining two wrapped around the abdomen. Regular check-up of the harness is a must because belts breakdown due to abrasion or any cuts present on the belts.

### C. Protection against Fire

For protecting against the fire erupted in an accident the fire extinguishing system should be working properly which is installed in the car, it should operate by the press of a switch. This ensures the safety, but in addition to this the driver must wear a fire resistant underwear and a balaclava under the helmet which is also fire resistant. Sometimes the fire burns the skin though the suit does not look damaged from outside, when this happens care should be taken and the area must be douse with water and the clothing must not be removed.

### D. Precaution after an Accident Happens

In case an accident happens in front of the driver he should brake and decelerate as much as possible in order to avoid the contact with that accident. Driver should not contract his muscles to prevent the accident. Or the medical aid they receive after an accident. Electric supply should be cut out by the kill switch [6]

## VI. OVERVIEW

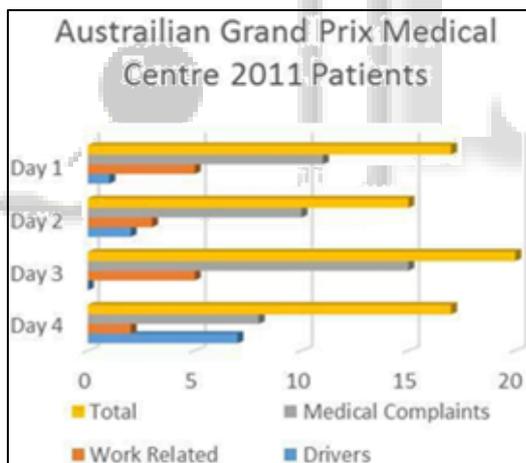


Fig. 2: The Australian Formula 1tm Grand Prix Medical Centre, Melbourne, March 2011

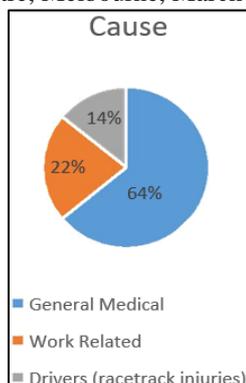


Fig. 3: The Australian Formula 1tm Grand Prix Medical Centre, Melbourne, March 2011

Fig. (2) Represent the total patients admitted in the Medical Centre, Melbourne during the Grand Prix 2011. It is a study based on the admittance of patients for consecutive 4 days.

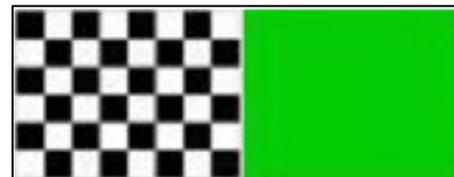
Fig. (3) Shows the study that the 64% of the patient admitted in 4days suffered general medical complaints, 22% suffered work related injuries and the remaining 14% were the drivers who were injured on the racetrack [9].

But with increasing technology the driver's job is getting easy to counteract it the FIA has standardized its guidelines in order to test the driver's skills. The use of composite fibre has helped to reduce the car's weight and increase the lateral stiffness [8].

## VII. SIGNIFICANCE OF FLAGS

### A. Chequered Flag

It is used to designate that session has completed. During qualifying and practice races, it is waved at specific intervals and during the race it is shown first to the first car to cross the finish line and then to rest of the drivers that finishes behind the winner.

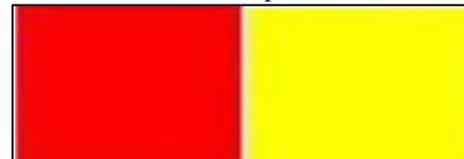


### B. Green Flag

It indicates that the obstacles have been cleared and the drivers are good to go.

### C. Red Flag

Most of the times it is waved to warn about an accident or imperfect track conditions or the particular session is stopped.



### D. Yellow flag

It indicates danger ahead on track. If only one yellow flag is waved it instructs drivers to slow down, whereas two yellow flags waved at the same post indicates that the drivers must reduce the speed and be prepared to stop in case of an emergency.

### E. Blue Flag

Blue flag signals a driver that another car is going to overlap him, so let the driver overtake him.

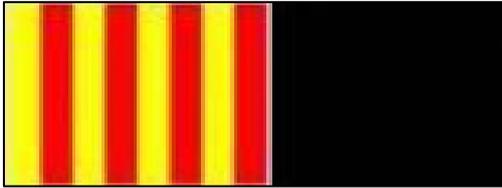


### F. Black Flag with Orange Circle

This flag indicates that the driver is having some mechanical problem in his car and must return to his pit stop.

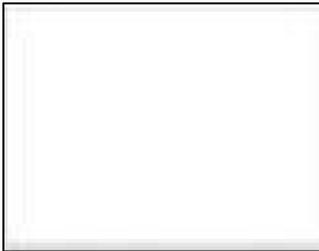
### G. Yellow & Red Stripped Flag

This flag warns the drivers about a slippery track ahead mostly due to presence of oil or water on the track.



### H. Black Flag

This is a signal to the driver to return to his pit stop at once and he might be disqualified from the race.



### I. White Flag

It instructs the drivers that there is a slow moving vehicle on the race track [7].

## VIII. CONCLUSION

The safety measures, driving strategies, safety equipment and rules and regulations are responsible for safety of the people on the track. Injuries can be avoided by following the guidelines standardized by FIA. Cars are installed with data recorder in order to record data related to safety during the crash, this helps in improving the safety issues. Safety measures has been completely transformed and made even better than it was back then.

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