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The safe flying and operation of FPV model aircraft.

At first glance FPV model flying appears to involve adding additional potential causes of failure to the operation of RC model aircraft – specifically by adding the possibility of failure of the video link. But this argument is flawed - most obviously because it does not start with a proper analysis of risk.

Whilst most of us prefer to take our models home from the flying field in the same condition they were in at the start of the session, the risk of damaging our model is actually, in the grand scheme of things, a complete irrelevance. The only risk that modellers really need to be concerned about is the risk of our model causing damage to third party property or, much more importantly, the risk of our model causing injury to a person.

So let us assess the risk of causing injury to a person.

Risk Assessment

Severity of Hazard (i.e. What outcome should the hazard become a reality?)

Trivial	Minor Injury	Serious Injury	Single Fatality	Multiple Fatality
1	2	3	4	5

Likelihood of Occurrence

Highly Unlikely	Possible	Quite Possible	Likely	Highly Likely
1	2	3	4	5

Hazard	Severity	Likelihood	Rating	Mitigation	M/Factor	Final Rating
2 Control is lost due to video link failure and the rc fpv aircraft hits a person	4 (Explanation: it is possible that a regular 40 size i/c 2.5kg aircraft with a 60mph speed could, if it hit a person in the head, result in a fatality.)	2 (Explanation: for this to happen the video failure has to happen, the model has then got to crash, it has to hit the spot on the planet where somebody is standing – and has to hit them in a specific part of the body.)	8	Fly low weight (<1kg) low airspeed (<30mph) a/c with rounded features. Do not fly near people	Severity reduced to 2.5 Likelihood reduced to 1	2.5

Risk Rating

< 6 indicates a low risk
Between 6 and 15 a medium risk
>15 a high risk.

So compared to operating r/c turbine powered jets, large helicopters, F5B a/c etc., all of which are flown at events open to the public, the risks involved in FPV flying (as practiced by most adherents) are miniscule.

That said, even if it only reduces the chances of taking our models home in a bin liner, it is always worth seeing what we can do to make our activity even safer - i.e. can we mitigate the risk further?

FPV Risk Mitigation

1) Safe Models

As already identified in the risk assessment above, this is a major risk mitigation factor. Where appropriate, pilots should use a 'safe', lightweight, low-speed model which will minimise impact forces if things go wrong.

Faster, heavier aircraft should only be used when the pilot is expert and is flying in a suitable safe location (ie far away from people and property).

2) Safe Location

Pilots should make a considered judgement when choosing their FPV flying field and only fly from a safe location away from populated areas and busy roads. The key here is to consider whether, in the event of something going wrong during a flight, the location is safe.

3) Quality Equipment

As with all r/c flying it is important to use good quality components. In addition to a good quality radio transmitter, receiver, servos, etc. a good quality camera should be used that has adequate resolution to easily see the plane's attitude, location, and proximity to other objects. Pilots should also ensure that a high quality video downlink and viewing system (eg video goggles) are used. Pilots should select high quality tried and tested components available from the dedicated FPV sources.

As with all r/c flying a check of all systems should be carried out before each flight.

4) Redundancy

Where possible the pilot should add redundancy to his FPV systems. A video diversity system constantly compares the picture from two separate receivers and antennas and outputs the best signal to the pilot. This gives the pilot redundancy in case of failure of a receiver and also gives the best possible picture available from different antennas (eg an omni-directional dipole and a narrow-beam patch antenna).

5) Charge status

Flying FPV can involve many more batteries than normal r/c flight. All batteries should be checked for full charge before each flight. If possible the pilot should power all ground equipment from a single, voltage-monitored audio-alarmed high-capacity source (eg a gel cell).

It is also a good idea to monitor the battery of the aircraft whilst flying FPV. There are a number of ways to do this. Either with a simple timer on the ground, with a 'low-power' warning LED installed on the aircraft which is visible through the camera, or by using an OSD (on screen display) which monitors the battery condition and overlays it on the pilot's view. Several OSDs on the market can be configured to flash a warning when the battery is low.

6) Spotter/ Observer

A 'spotter' is someone that maintains visual line-of-sight on the aircraft during flight. In the event of a problem, the spotter can tell the pilot what needs to be done to return safely home – or if the pilot has to revert to 'line-of-sight' flight, can immediately direct his vision.

Where appropriate a spotter should be used.

7) Training

First Person View flying means that the pilot controls the aircraft by reference to the horizon – just as with full-sized aviation. Pilots should practice on a computer flight simulator that gives 'cockpit view' and become proficient before attempting FPV flight

Before attempting a first flight it is a good idea for a novice FPV pilot to wear the goggles and view the video feed as a "passenger" whilst another pilot flies the aircraft by line of sight. This will give the new pilot a feel for FPV flying and allow him to become familiar with the flying field and locality before taking control.

Until the pilot is proficient at flying FPV, it is advisable that flights are carried out with an experienced co-pilot with a buddy lead arrangement and that take off and landings are done by traditional line of sight flying.

8) Positional awareness

FPV flying is different to line-of-sight flying. The pilot sees a completely different perspective, and during his first flights, it is easy to lose track of where the aircraft is relative to the flying field – especially when directly above it.

Pilots should get to know the flying field and locality from the air by flying as a "passenger" and also by using tools such as OS maps, or Google Maps/ Google Earth to become familiar with the terrain, trees, buildings, roads, etc.

Equipment such as OSDs (on screen displays) which can overlay GPS data on to the pilot's screen and provide an arrow and distance back to the field ensure that positional awareness is never lost.

9) Distance from the field

The EU 10mW limit on maximum power for airborne video transmissions means that the range of FPV transmissions, even with the best receiving equipment, will always be limited to around 1km. Pilots should not operate at the limits of the equipment and should therefore stay well within 1km of the ground station. This also ensures that pilots remain well within the range of their r/c equipment.

10) Interference

In addition to the normal r/c risks of interference from other modellers on your frequency, with FPV equipment on the EU 2.4GHz frequency it is possible that interference from WiFi installations could interrupt the pilot's video image.

This is another reason that pilots should ensure that their flying field is away from residential areas, etc.

There are known issues with using 2.4GHz r/c equipment with 2.4GHz video equipment. It is best to use r/c equipment on a frequency that is significantly separated from your 2.4GHz video equipment such as 35Mhz.

11) Capacity

If the aircraft uses servos for a pan/tilt mount, the pilot should ensure that the BEC on the ESC can drive the total number of servos in the system. Most BECs, especially when running off 3s LiPos, can only drive 3 or 4 servos. (Regulating the voltage down to 5v creates heat – and supplying amps to servos creates heat: too many volts or too many servos can result in thermal overload – which shuts down the BEC and the power to the Receiver.)

If 3 or 4 servos are already in use to fly the plane, adding 2 more for the pan/tilt mount could result in disaster. Pilots need to take care not to overload their BEC.