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**BRITISH MODEL FLYING ASSOCIATION
THE R/C ACHIEVEMENT SCHEME
TEST STANDARDS for CHIEF EXAMINERS
and CLUB EXAMINERS
GUIDANCE for TEST CANDIDATES
THE MULTI-ROTOR FPV RACING
(A) CERTIFICATE**

2023 ISSUE
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(Jan 2022)

The Achievement Scheme Review Committee strongly recommends taking the "on line" BMFA Registration Competency Certificate (RCC) in advance of the test. This RCC test is updated in line with legal requirements, which helps to ensure all model pilots are both informed and current and is standardised for all candidates.

As a test candidate if you can evidence a pass of the latest RCC version to the examiner there will be NO requirement to answer the 5 mandatory questions.

Achievement Scheme Information & Communication

The BMFA Achievement Scheme provides every RC flyer the opportunity to set themselves an achievement target to aim for, and then have their progress assessed and confirmed by an examiner.

It is important that All those involved in training, examining and preparing for the tests, are well informed and up to date with all that the scheme has to offer. To this end, and to aid communication, important information regarding scheme developments, as well as details of all of the tests and their associated guidance documents, are made available to everyone via a number of sources, which include:-

- The Achievement Scheme website - <http://achievements.bmfa.org/>
- The BMFA website - <http://bmfa.org>
- The BMFA News
- The Achievement Scheme closed Facebook group

It's important to appreciate that **ALL** of the scheme documents are reviewed and updated on an annual basis. Whichever document you are using, you will know if you have the right one, simply by looking at the date on the front cover. If it's not dated with the current year, it's the wrong one!

Most BMFA Clubs have Club Instructors/Examiners who will be familiar with the scheme and what is expected of anyone thinking of participating. If your club does not have a club examiner then each BMFA Area has an Achievement Scheme Coordinator (contact details can usually be found on the BMFA Area website) who can usually help in coordinating tests, or answering queries about tests etc. All BMFA Areas have Area Chief Examiners who would normally undertake Club Examiner tests, but are also available to help out with club tests, if requested. Importantly, they are also very knowledgeable about the scheme and its requirements. Area coordinators can often find an ACE that is close to your club, if you are having difficulty arranging for a test.

All BMFA Achievement Scheme & training documents are available to download from the BMFA Achievement Scheme website <http://achievements.bmfa.org/>. You can also register your email address with the Achievement Scheme website and receive email notification of any news flashes, notification of scheme events and updates to documentation etc. as soon as they are published.

The Achievement Scheme also has a closed Facebook group (you just have to apply to be included) where comment and queries can be posted and examiners/instructors and members of the Achievement Scheme Review Committee can answer questions, or offer clarification.

If you have any query about the scheme or constructive comment on the scheme you can contact the Power/Silent Flight Scheme Controller (RCPAS@bmfa.org), or the Achievement Scheme Review Committee, via the BMFA Office.

General

The Achievement Scheme is run by the BMFA as a National Scheme and it is open to all model flyers. Where a non-member wishes to participate in the achievement scheme the examiner who will be conducting the test must inform the BMFA office via email or telephone no later than the day prior to the test being carried out of the non-member's full name, address and the date that the test will be conducted. This enables the BMFA to extend insurance at suitable levels for the day of the test. If this procedure is not followed the test will be invalid.

The examination for a Multi-Rotor FPV Racing A Certificate may be taken on application to **any** Registered Examiner.

The candidate must successfully complete the test schedules in one attempt. A maximum of two attempts at the examination are permitted in any one day.

Legal Responsibilities

Only pilots with a suitable model that are operating legally are eligible to take the test.

There are clearly defined legal requirements for the operation of Small Unmanned Aircraft (model aircraft), from passing a CAA (or BMFA) legal & safety knowledge test before piloting a model, to registering with the CAA as an SUA Operator (can also be done via the BMFA) if the pilot is also the owner and operator of the model aircraft, then ensuring the SUA Operator identity number is appropriately attached to the model. There are also restrictions on where a model can be flown and the heights and distances from people, property, vehicles or structures that the model can be operated. Finally, there is a legal requirement to operate the model safely e.g. ensuring the model is 'fit for safe flight' and the pilot is in a fit state to undertake that flight, as well as the site and weather conditions being suitable.

The test schedule is split broadly into five areas; the pre-flight safety checks, moving from the pits/start-up area to the take-off/landing area, the flying manoeuvres, the recovery & return to the pits, and the questions.

First Person View Multi-Rotor Racing 'A' Certificate

The Multi-Rotor FPV Racing Certificate is a measure of flying ability and safety, which "may be equated to a safe solo standard of Multi-Rotor FPV flying for the purpose of racing."

As an Examiner, the level of competence you should expect of a candidate should be based on that criterion; that is 'is this person, in your opinion, fit to be allowed to fly FPV unsupervised'. **(Note:- this test is in no way a means of removing the CAA requirement of using a Competent Observer for FPV flying)**

The candidate should have studied the BMFA Member's Handbook and the associated Annexes and safety codes. As well as being an excellent guide to the safe flying of model aircraft, most of the questions asked at the end of the test will be from these sources.

Remember that the Member's Handbook and associated annexes etc. are now 'active' documents published on the BMFA website. <https://handbook.bmfa.uk>

Also be aware that you may ask questions on any local site rules that the candidate should be aware of and these may form an important part of the test questions you ask.

Outdoors

The test may not be flown indoors. It was designed to be flown outdoors and the text of the test manoeuvres highlights this. It is important to remind candidates that their ability to cope with various wind conditions is an integral part of the test.

The Model

The Multi-Rotor FPV Racing tests are designed to be taken with a Multi-Rotor suitable for FPV racing, **with a maximum frame dimension of 300mm across motor shaft centres, a maximum propeller diameter of 6 inches and a total mass (including flight batteries and or fuel) of less than 3.5 kg**. A multi-rotor for the benefit of this test is defined as a rotorcraft with three or more rotors. Whatever model is brought by the candidate, it must be suitable to fly the manoeuvres required by the test they are taking. You do not have the authority to alter the required manoeuvres to suit a model and if, in your opinion, the model is unsuitable for the test then you should explain this to the candidate and tell them that they cannot use that model. The selection of the model to do the test is the responsibility of the pilot and it is their ability you are testing, not the model.

On no account may the candidate use defects or limitations in the performance of the model as an excuse for poor performance on their part and you should make no allowance on this point. The type of model presented cannot be used as an excuse for not completing certain manoeuvres.

Electric Powered Models must be treated as LIVE as soon as the main flight battery is connected, irrespective of radio state and great care must be demonstrated by the candidate. The arming sequence should be clearly understood and discussed/demonstrated to you by the candidate.

Competent Observer

Although there are occasions where a Competent Observer is not required for FPV flying, for the purpose of this test, a Competent Observer must be used, as the way in which the candidate interacts with their observer is to be viewed as a safety element within the test.

The Examiner **must not** fulfil the role of the Competent Observer for the test. The candidate will be expected to provide their own individual. Ideally this will be someone they have used in this role previously and or flown with regularly. The candidate will be expected to provide a detailed brief to the competent observer, regarding their role and responsibilities, prior to the test. As a minimum, this will include any local rules and or limitations associated with the site that might impact on the test, as well as the positions of any relevant no-fly zone(s).

The candidate must give due consideration to any input provided by the competent observer during the test. However, the competent observer should not need to make repeated inputs and the candidate should not be over-reliant on their input. The candidate must be able to demonstrate sufficient spatial awareness to remain in a safe flying area and not infringe any no-fly zone(s) without requiring repeated inputs. The examiner should warn both the pilot and the competent observer if he feels the level of input from the competent observer is too high.

At some point during the test the Examiner will make an input as the competent observer and the candidate will be expected to take appropriate action, as required. Example inputs might be; an individual walking out onto the flying area, an airspace incursion by another aircraft, or incapacitation of the competent person.

Buddy Box Systems

Buddy leads and other dual control training aids must not be used during any achievement scheme test.

Gyros, Electronic Stabilisation and GPS

It is acceptable to use an electro-mechanical or solid state gyro/s in a model being used to take the test although electronic stabilisation is restricted to flight enabling only. This allows a range of flight controllers / gyros to be fitted, from simple yaw dampers to solid state heading lock units.

The use of any autopilot, GPS and/or waypoint programming, which may or may not be designed into such units beyond the definition above, is not acceptable during the test.

Candidates should be prepared to explain the capabilities of the system they are using and show that it does not take over control from the pilot and that automated flight will not be achieved during the test.

GPS must not be used during any test.

Height and Speed

The Multi-Rotor FPV Racing certificate candidate should be a reasonably confident pilot, even though they may have been flying for only a few months. FPV flying differs from line-of-sight flying in that the pilot sees a completely different perspective and, especially during initial flights, it is easy to lose track of where the aircraft is relative to the flying field. Flying too close or too far away is not the mark of a confident pilot. Height control is one of the more demanding aspects of FPV flying (particularly for Multi-rotors) and reasonable allowance should be made for this. However, the test should be flown at the heights specified in the individual elements without drastic deviation.

The flying sections should typically be completed at a height of below twenty feet (roughly one house high). The pilot should show good use of the controls to maintain a constant height throughout each of the separate elements of the test and transitions between various heights should be smooth and steady. Height selection and control are important factors, as mentioned above.

Overall the test manoeuvres should be flown at a minimum of a fast walking pace. A candidate should not pause, hover or show excessive hesitation during individual exercises, however may use a hover between manoeuvres as a method of setting up for the next manoeuvre.

Although the test is based on Multi-Rotor FPV Racing, the test is not designed to be completed as a 'race', or in a timed manner, however the candidate should be able to demonstrate a confident approach to each exercise and not show excessive hesitation at clearing the obstacles set out in the manoeuvres.

Wind Direction

There is no requirement for the fixed positioning of manoeuvres relative to the wind direction in the FPV Extension test for Multi-rotors.

Consistency

Good use of the controls should ensure that the model stays at a reasonably constant height, and moves at a steady speed suitable to each of the separate elements of the test. All deviations from these constants should be noted, and will form part of the judgment of the test.

Unnecessary varying of height and inconsistent lines are valid reasons to fail a candidate at this level as they give a good indication of the flyer's general level of competence and they must strongly influence your final decision. Poorly flown height or lines are a sure sign that the flyer has either not practiced the test or has not reached the required standard of flying and are legitimate reasons to fail them.

Continuity

For the Multi-Rotor FPV Racing test the manoeuvres are set out in such a way that they may be flown one after the other as a short sequence, however it is **ABSOLUTELY NOT** expected that they be flown as a schedule with one manoeuvre flowing into the next. The candidate may opt to fly the test in that manner but that is their choice. Most flights will have a combination of transitions and positioning circuits between the various elements and you should note any additional flying for positioning etc., just as carefully as the rest of the flight, as this can say much about the competence of the pilot.

A pilot who transitions directly from one manoeuvre to the next is not to be penalised, as this is quite acceptable, but watch out for the pilot who is not sufficiently practiced. Flying some of the manoeuvres in this manner can get them into some very awkward positions. The candidate should have a good knowledge of the test before the event.

It should be possible to fly the test on one flight battery (or tank of fuel) but if the model does have to have the flight battery changed (or refuelled) then the pilot must clear this with you before the test starts as required by the test procedure. It is allowable only once during the test and anything the pilot does during this time must be considered by you to be part of the test. This includes the way they land, retrieve, carry out and take off. With I/C models the correct re-fuelling and start procedures must be used, For electric models, isolating the flight battery before carrying the model in and not re-connecting until the model has been carried out to an appropriate safe point are important.

Trim

It is expected that the candidate will start the test with a model that has been trimmed out previously but, if necessary, they should be able to trim the model out relatively quickly. If you see obvious signs that the model is out of trim and the candidate makes no attempt to rectify the matter, you may well question their basic competence. On the other hand, if they do need to re-trim and are making attempts to do so, you should make allowances for a short time of flight with a somewhat erratic path. This should not be penalised unless it puts the model in any dangerous situations or unless the model flies behind the pilot or into any other unsafe area. If the pilot does use the first part of the flight as a trimming exercise, they should be required to land as soon as they are satisfied with the trim and the test should then commence at manoeuvre (b). If a flight is abandoned prior to starting manoeuvre (b) because of trim problems it will not count as a test flight attempt.

Nerves

Quiet competence is what you are looking for during the flight, but most candidates may well be nervous and you should make some allowance for this. If the flyer is very nervous you should seriously consider abandoning the test for the time being and arranging a coaching flight or two to settle the candidate down before re-taking the test. This can be done on the same day and can really help those candidates who have trouble with nerves when flying in a test situation.

Repeating Manoeuvres

The manoeuvres for the Multi-Rotor FPV Racing are designed to be the basis for competent racing and the candidate should be competent to fly them with very few errors. If you see any major faults the test should be taken again. It may be, however, that the candidate will make a **minor** mistake on a manoeuvre and if you are not fully satisfied with what you have seen you should consider asking for the manoeuvre to be repeated.

Some judgement is called for on your part here. A **major** mistake, such as infringing any no-fly zone, is grounds for failing the candidate, especially if loss of control has occurred or a dangerous situation has arisen. You should definitely not let them have multiple attempts at each manoeuvre until they get it right but you must give yourself the best chance of assessing the competence of the pilot you are testing.

You should consider what you have seen the model do and if you think to yourself "could be better" than a request that the manoeuvre be repeated may be considered. Be extremely careful about using this option, however, as you could very easily be degrading the worth of the test. It must not, under any circumstances, degenerate into a series of 'practice' manoeuvres.

Contact with Obstacles

As the model is going to be passing through and between obstacles there is a high risk of contact between the model and said obstacles. For the purpose of this test there are two kinds of contact that may occur between the model and an obstacle:

- Minor contact – The model clips an obstacle, but suffers no discernible effects to its speed or trajectory.
- Major contact – The model clips or hits an obstacle in a manner that causes a detrimental effect to its speed or trajectory.

During the test it is acceptable to have a maximum of two minor contacts and one major contact. In the event of a major contact, the candidate should shut the throttle immediately and allow the model to have a 'controlled crash', if the candidate attempts to 'fly-out' of the problem, then the test must be considered an instant fail. A candidate should not be penalised for having one 'controlled crash' as a result of a major contact, or two minor contacts, but such events may be taken into consideration by the examiner as part of an overall assessment of ability if a test is deemed to be marginal in other areas.

For the sake of the test, the ground is not to be considered an obstacle and crashing as a result of hitting the ground (other than during landing) is to be considered an instant fail.

A crash for any other reason is not acceptable and should be considered an instant fail. Multiple crashes or repeated contact with the obstacles can be considered an indicator that the pilot is not ready for the test.

Repeating the test

The rules allow two attempts at the test in one day and if the candidate fails the first of these you must consider their performance in deciding what to do next. Many failures will be reasonably good or borderline cases and in these circumstances it may be appropriate to allow the candidate one or two practice flights before repeating the test. Remember that many of the candidates will be unfamiliar with flying under pressure and might do very well on the second test.

However, it will probably be obvious to you on many occasions that the pilot you are testing is simply not ready for the test they are taking. In this situation it is better that you tell them so quite clearly. If possible, it might then be useful to suggest that they arrange a demonstration by an experienced flyer who has passed the test, so that they can gain an understanding of the standard of flying that is required, especially if they are not clear about the manoeuvres and the positioning for them. This is far more useful to everyone than simply telling the candidate that they have failed.

A flight which is abandoned for any reason prior to starting manoeuvre (b) will not count as a test flight attempt

Interruptions to the Test

A possibility that may occur during a test is a motor failure part way through, which with multi-rotors could very well lead to a damaged model. If this is the case then the test obviously cannot continue and you should invoke the rule that the test should be performed in one flight and count the flight as one of the two attempts allowed during the day.

Genuine motor trouble or even motor-out situations during the test may be dealt with in one of three ways.

If the test was being generally flown in a satisfactory manner and the problem can be rectified quickly then the candidate may be allowed to continue the test from the start of the manoeuvre in which the problem occurred.

If the problem cannot be rectified quickly but you consider that it was a genuine unforeseen occurrence, you may annul the test and not count it as one of the two attempts.

If the test up to the point of failure was not satisfactory, you have the option to cancel the rest of the test and count the flight as one of the two attempts allowed during the day.

Obviously, you will have to use your judgment on this matter as there will rarely be black and white situations but how they handled the emergency should be of great interest to you when you come to review the candidate's overall standard of flying.

Ground Positioning

When taking the Multi-Rotor FPV Racing test, it is your responsibility as the Examiner to agree the layout of the obstacles with the candidate before commencing the test to ensure all of the manoeuvres can be adequately completed, however it is NOT a requirement to position them in a way as to create a full racing circuit.

It is also necessary to agree a maximum flight boundary of 30m outside of the obstacles as a maximum flying area. For such boundaries it is acceptable to use either naturally occurring objects as markers, such as trees or terrain changes, or man made markers such as cones, flags or biodegradable paint. However it is vital that any marker used does not interfere with the safe operation of the model.

It must be emphasised that absolute accuracy of distance is not required when setting out any markers. Pacing will be quite accurate enough.

The general positioning of the markers will depend very much on the geography of the flying site and safe operation of the model and you should agree them with the candidate with these factors in mind.

Obstacles

It is not the responsibility of the examiner to provide the required gates, cones and/or flags for the purpose of the test, it is expected that the candidate taking the test will have access to and provide these.

For the purpose of the test there are two key types of obstacle, which should have the following minimum and maximum criteria:

- **Racing Gate** – This has no minimum size and can be square or arched in shape, however the opening in the gate must not exceed 2.5 meters wide by 7 feet high.
- **Racing Flag** – This has no minimum size and can be a pure pole, however must be a minimum of 6 feet in height. (10 feet in height is recommended)

The candidate is allowed to use additional cones, flags or biodegradable paint-marks as they feel appropriate to mark out the approach to obstacles.

Due to possible limitations on equipment such as gates and flags from site to site, it may be necessary to run through the same obstacle on more than one occasion in different directions to complete all of the manoeuvres, however it is NOT acceptable to stop flying to rearrange obstacles during the test.

All manoeuvres must be completed in one flight, unless an agreed refuelling stop has been agreed before the test.

Although written in a specific order, the flying manoeuvres listed as (b) to (G) inclusively can be performed in any order. This should enable the exercises to be best performed based upon obstacle equipment layout and availability at the given site. It should be stressed however that the test is **NOT** designed to be performed as a single racing circuit and although a candidate may opt to perform all of the exercise back-to-back in a single circuit, this is not expected and the candidate should **NOT** be penalised if opting to perform each manoeuvre one at a time, with a basic circuit between each manoeuvre. However, these basic circuits between manoeuvres should also be monitored by the examiner, as these can also be used as a measure of overall flying ability, with an excessive number of circuits between manoeuvres or failing to align correctly for the start of a manoeuvre, demonstrating that the candidate may not have fully prepared for the test.

Pilot and Competent Observer Position

Despite flying FPV, the pilot is expected to fly from a similar location to any other pilot operating from the site in order to maintain clear communication with their fellow pilots.

It is also expected that the Competent Observer remain in the immediate vicinity of the pilot for the duration of any flying part of the test, although they may be used to position or remove a model from the take off/landing area, but only once the pilot has confirmed the model is safe to move.

The pilot may use a chair or sit on the floor if preferred to standing.

It is important for the examiner have a suitable view of the obstacles in order to accurately

assess that the candidate has indeed transitioned through the obstacles fully.

Remember that it is a requirement that 'all manoeuvres are carried out in front of the pilot' so their perception and awareness of their own position is important.

Frequency Control

Unlike most models, FPV aircraft typically operate on more than one radio frequency, one for control and one for video downlink. It is therefore important that the candidate is aware of any additional frequency restrictions.

Take Off and Landing

For the purpose of this test, the take off point and landing point may or may not be the same location, depending on how the obstacles are set out. The take off point should be set inline with the 'Start' manoeuvre and the landing area should be set as a 5 meter by 5 meter square area directly behind the Finish line as set out in the 'Finish' manoeuvre.

It is important as an examiner to allow a little tolerance for the quality of a Multi-rotor landing, as the camera may be in a position/angle to enable orientation in forward flight, which will make stable hovering a challenge. The candidate should not be penalised if the Multi-rotor tips over or rolls up to half a meter along the ground on landing, or drops the last few inches. Rolling excessively along the ground on landing however is an indication that the pilot has not made a suitable adjustment to control the Multi-rotor's speed before attempting to land.

General Manoeuvres and Hovering

FPV flight may be conducted by the use of either goggles or a screen.

All take-offs and landings should be smooth, without undue oscillations, and climbs and descents should be straight and controlled with the model a comfortable and safe distance in front of the pilot. Due to the nature of the flight control systems (and sometimes the position of the camera) the touch-down of a Multi-rotor aircraft will generally be more 'abrupt' than for a conventional helicopter or fixed wing aircraft. The candidate should not be penalised if the Multi-rotor tips over or rolls up to half a meter along the ground on landing. Rolling more than 1m along the ground on landing is an indication that the pilot has not made a suitable attempt to control the Multi-rotor's speed before attempting to land.

Circuit and other 'flying' manoeuvres should be performed at the heights mentioned in 'Height and Speed' above. Movement of the model from one point to another should be done within the agreed flight boundaries.

Care should be taken in the flying manoeuvres that the line of approach and height each time is consistent and you should take particular note of performance in this area.

Intermediate Landing

Exceptionally, at a pre-determined point in the flight an intermediate landing may be permitted for the sole purpose of refuelling or the fitting of a freshly charged flight battery. This landing may only be made with the prior consent of the Examiner. The pre-determined point may be either after a specific manoeuvre or at a specific time of flight, whichever is requested by the candidate and agreed by the Examiner.

Full pre and post flight checks are not normally required during an intermediate landing and take off unless the model suffered a hard landing. However, the candidate should give the model at least a quick visual examination whilst on the ground.

Helpers for Disabled Candidates, Young Candidates and Others Who have Requested Help During the Test

When disabled or young candidates present themselves for the test it may be that they will not physically be able to perform all the actions that most candidates can. At times, other candidates may also request help with certain physical aspects during the test (they may, for instance, have an injured finger). There will be times when you, as an Examiner, will think 'how much can I relax the test requirements for this person'.

Some Examiners make the decision to make no allowances at all but this effectively bars many people from attempting the tests. If we think of the achievement scheme as a true national scheme then we must consider how we can accommodate candidates, not how we can stop them from participating.

The answer, of course, is that you, as an Examiner, must make on-the-spot decisions about what you will allow during the test and, in such cases, you are within your authority to take such decisions. The guidelines set out below may help but at all times the two items at the end of this section must take precedence. They are not negotiable and mean that, whoever the candidate is, they have to convince you that they know what they are doing or what is happening for the full duration of the test.

For instance, a disabled flyer may have difficulty handling the model and may not be able to carry it out to the strip, release it for launch or retrieve it after the flight. The sensible use of a helper is certainly allowable in such cases but it is essential that they only do what the candidate asks them to do. Pre-flight checks and engine starting may be another problem area that can be overcome by a helper but you should expect the candidate to do as much of the work as possible themselves and they should be able to talk you through anything that the helper does for them. Be sure to discuss all this with the candidate before starting the test.

All of these comments can apply to younger flyers too but there is an added complication with engine starting. Many parents are very unhappy about letting their children near a running engine and will not allow them to start their own engines. This is a perfectly valid view and, again, is a case where a helper can be used. If this situation does occur with the younger candidates, however, you should insist that they do all the pre-flight and preparation work themselves, up to applying the starter to the engine. If they cannot do this then they should not pass.

After engine start, the helper can adjust engine controls and carry the model but only on the instructions of the candidate.

In all cases:

- (1) If, at any time, the helper takes over the decision making process from the candidate then the candidate must fail.**
- (2) You can make no allowances whatsoever for anyone during the flying of the test. The candidate can either perform the flight manoeuvres as specified or they can't. If they can't then they must not be passed.**

Make sure in your briefing that both the candidate and the helper are fully aware of both of these points.

The Multi-Rotor FPV Racing Test

(a) Carry out pre-flight checks as required by the BMFA safety codes and demonstrate an understanding of 'SWEETS'.

The candidate must demonstrate their understanding of risk assessing a site for flying by talking through SWEETS as described in the Member's Handbook. A candidate must be expected to be able to demonstrate how they have come to the decision it is safe to fly at the location, which must still be applied even if the site is an established flying site.

The candidate must demonstrate the model's failsafe, which as a minimum should be set as 'throttle to idle' upon loss of control signal. The candidate must ensure this is done safely following the guidance in the Member's Handbook. A candidate must be failed immediately if the candidate does not make the model 'safe' by means of either a suitable restraint or removing components that might spin uncontrollably such as propellers or blades.

If the failsafe does not work when tested for any reason, then the test must be considered a failure.

The pre-flight checks are laid out clearly in the BMFA handbook. Ask the candidate to go through their checks as if the test flight was their first flight of the day. Particular attention should be given to airframe, propeller, control linkages and surfaces.

Points to look for are that the candidate has a steady and regular ground routine, especially when starting and tuning the engine. Nerves may play a part in the pits but you should satisfy yourself that the candidate is actually in control of what they are doing when preparing their aircraft for flight.

A neat ground layout makes a good impression but bear in mind that many candidates may not have been flying for too long and you should be prepared to make allowances. A poor performance in this area is not grounds for failing the candidate, however, but it is inevitable that you will be making mental notes of all aspects of the candidate's competence and this is one that might have an effect on a real 'borderline' case.

Pay particular attention to the way the candidate uses the local frequency control system and make sure that they fully understand it and use the correct sequence appropriate to their model. For 35 MHz, this is usually 'get the peg, Tx on, Rx on'. For 2.4 GHz, the candidate should be aware of any local transmitter usage limitations and if a flight peg is required, it must be obtained before the Tx is turned on. Some radio equipment and, occasionally, a specific model requirement requires that the Rx be switched on first and, if this is the case, the candidate should explain this clearly to you.

Attention should also be paid to the frequency that the pilot intends to use for their FPV

equipment. The pilot must comply with any local video frequency control system, where applicable. In addition they should understand that switching their FPV equipment on while other pilots are flying FPV could result in a pilot losing video signal, so they should check that the frequency/channel they intend to use is clear before switching on.

With electric powered models, take note that the candidate is aware that the model is 'live' as soon as the flight battery is plugged in and that they take appropriate safety precautions. If a separate receiver battery is fitted, the candidate should have the opportunity to check the operation of the radio equipment before the flight battery is plugged in.

Watch carefully and take note that the transmitter controls, trims and switches are checked by the pilot.

All candidates are required to be aware of the local the frequency control system and anyone who is required to use it but switches their radio or FPV module on before doing so should be failed on the spot.

If there is no one else available then there is nothing to stop you aiding the candidate by holding the model for the power check, carrying it out for take-off etc. but any such actions must be performed by you directly on the instructions of the candidate. You must not prompt them or carry out any actions of your own accord. Talk this over with the candidate in your pre-flight briefing.

If the test is being taken with an electric powered model then the candidate should show that they are familiar with the safe handling of such models.

In particular they must demonstrate to you the 'arming' sequence for their model. For safety reasons many speed controllers have a pre-programmed sequence of actions that have to be followed before the motor will respond to throttle stick movements. For instance, after switching on Tx and Rx and then plugging in the main flight battery, one type of controller requires that you move the throttle stick from low to full throttle and then back to low before the motor is 'armed' and ready for flight.

The candidate must be fully familiar with the system fitted to the model and should brief you on the system and demonstrate it working at some time during the pre-flight checks. Generally, they must show that they are paying particular attention to the transmitter and receiver switch on sequence and they must make you aware that they are treating the model as 'live' as soon as the flight battery is plugged in, no matter what arming sequence they may then have to go through.

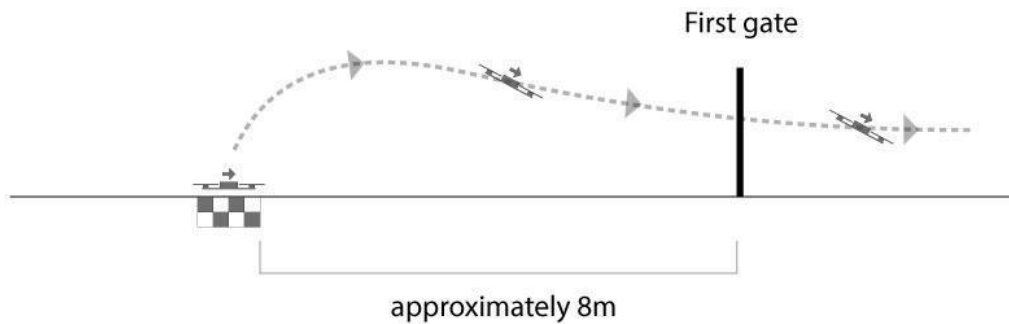
The pilot must demonstrate the correct function of the failsafe, where appropriate, before committing to the flight.

After the take off, the pilot must remain in the designated pilot area for the entirety of the flying part of the test.

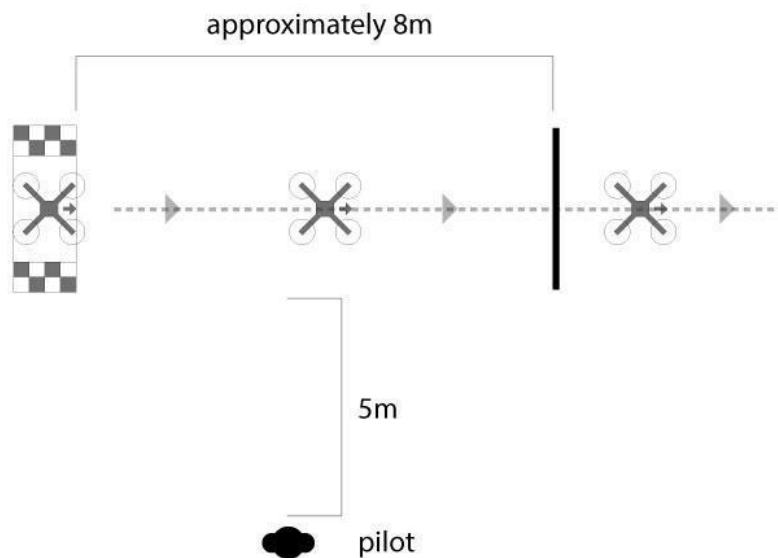
(b) Perform a racing start and clear a racing gate within 8 meters.

The aim of this manoeuvre is to simulate a 'Racing Start', so the model should be flown swiftly from the starting point and directly through a racing gate positioned 8 meters from the start line.

Elevation:



Plan view:



The model should be positioned on the start line and armed ready for take off, at which point the candidate should indicate they are ready to the examiner. The examiner should then give a 3 second countdown followed by the command 'RACE'.

Upon hearing 'RACE' the pilot should perform a swift take off and proceed straight to and through a racing gate positioned 8 meters from the start line.

This completes the manoeuvre, at this point the candidate is free to transition directly to manoeuvre (c) or perform a controlled positioning circuit ready for manoeuvre (c).

The model must be carried out to the start line by the candidate or a helper. **Taxiing out of the pits is an instant fail.** Prior to carrying out, the pilot should inform other pilots flying that his model is going out onto the active area. The model should be positioned in a way that benefits a swift take off and transition to the first gate.

Take off must be performed with the model a safe distance from the pilot box area and on a line which does not take the model towards the pits, other people or any other danger/no fly area.

It is expected that the candidate will check with their Competent Observer that it is 'safe to fly' before indicating that they are ready to start to the examiner.

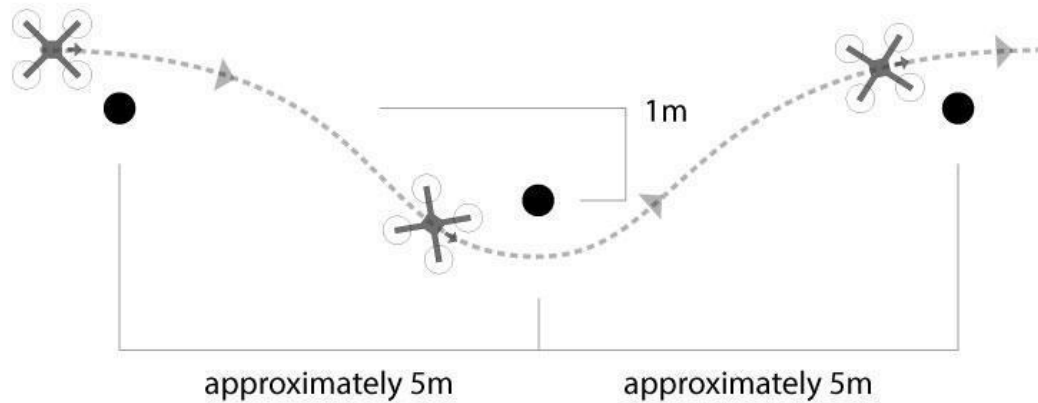
Take off should be reasonably straight and positive with the model not being climbed too steeply in order to clear the racing gate. It can be a point in the flyer's favour if, in the case of the take-off going wrong, they abandon it in a safe manner. It's far better that they think about what they are doing rather than try to coax a model with a sick engine into the air. If a take-off is aborted in a safe manner you should immediately reassure the candidate that they will not be penalised for taking correct actions, even though these may conflict with what the test requires.

The model may gain a small amount of excessive height before dropping back to transition through the gate, however this should not exceed 20 feet and the model should not deviate more than 1 meter side-to-side from its course towards the gate.

(c) Fly through a slalom of 3 or more flags (gates may be substituted).

The candidate may transition straight in to this manoeuvre from manoeuvre (b) or they may enter in to it from a controlled positioning circuit.

Plan:

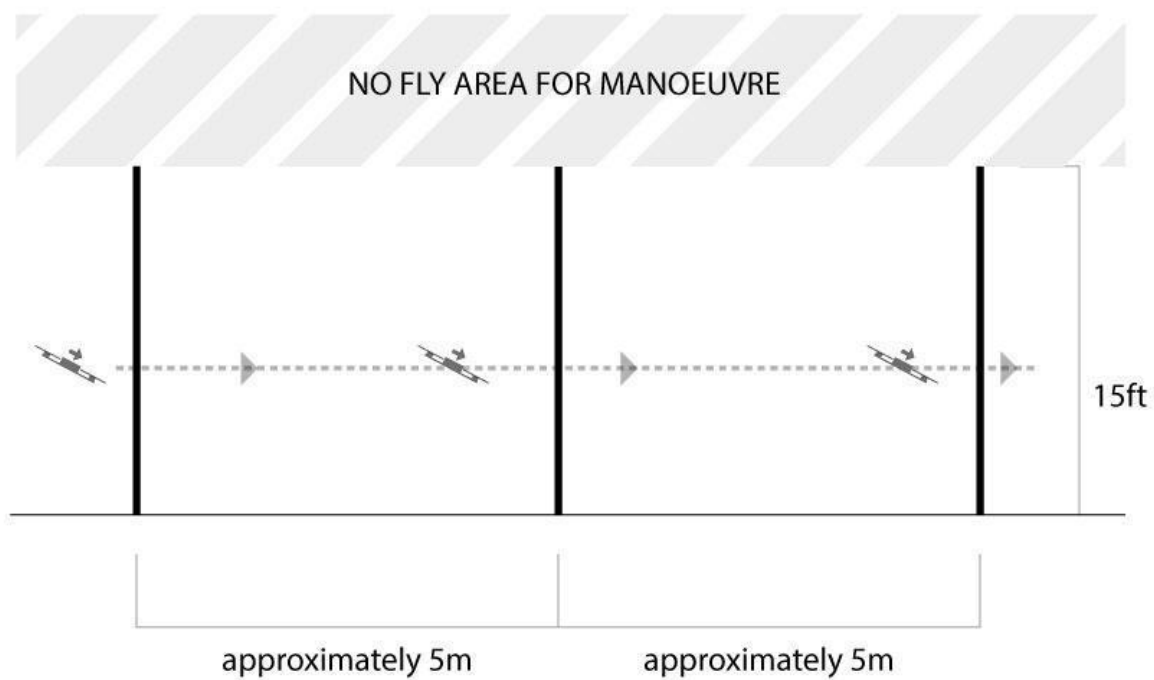


The candidate must slalom their model through at least 3 racing flags (racing gates may be used if suitable flags are not available). The flags should be positioned 5 meters apart, with 1 meters of side-to-side deviation (2 meters of side-to-side deviation if using gates).

The model must be flown on the outside of the flags as shown in the diagram and **NOT** in a straight line between the flags.

Passing the last flag completes the manoeuvre, at this point the candidate is free to transition directly to manoeuvre (d) or perform a controlled positioning circuit ready for manoeuvre (d).

Elevation:



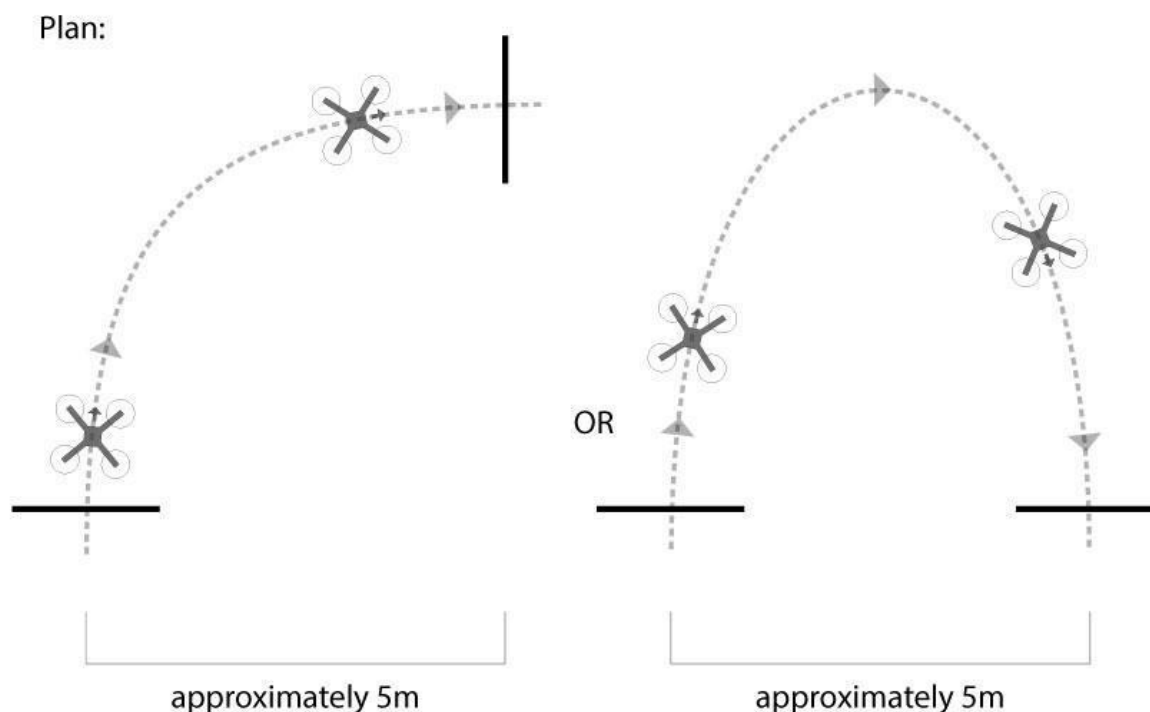
The model must be weaved between the flags and **NOT** flown above the flags, (or must pass through the gates) for the manoeuvre to be considered successful.

(d) Fly a 90 degree turn between 2 racing gates (or a 180 degree turn).

The candidate may transition straight in to this manoeuvre from manoeuvre (c) or they may enter in to it from a controlled positioning circuit.

Whether this turn is 90 or 180 degrees should be decided between the candidate and the examiner before starting the test and will depend on what obstacles are available on the site.

This manoeuvre starts by flying through a racing gate and is completed by passing through a second gate after completing the given turn.



Passing the second gate completes the manoeuvre, at this point the candidate is free to transition directly to manoeuvre (e) or perform a controlled positioning circuit ready for manoeuvre (e).

During the turn height should remain consistent and not balloon excessively between the gates.

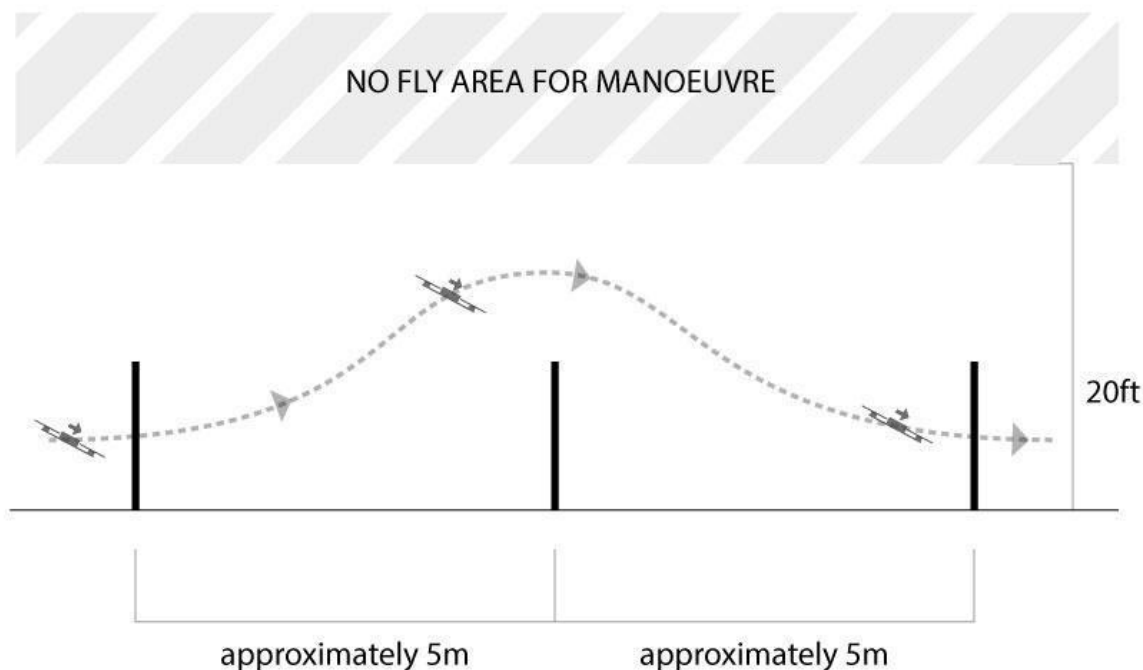
It is not necessary to make a perfect arc between the gates, however it should be one consistent L-shaped turn (or a U-shape in the case of a 180 degree turn) with only minor adjustments as necessary from gate 1 to gate 2.

(e) Under-over-under.

The candidate may transition straight in to this manoeuvre from manoeuvre (d) or they may enter in to it from a controlled positioning circuit.

This exercise requires the candidate to pass through a racing gate, transition over a gate, before then passing back through another gate. The gates can either be positioned 5 meters apart in a straight line or spread out in a circuit pattern, provided both the candidate and examiner are able to clearly assess that each obstacle have been passed correctly.

Elevation:



Passing through the third gate completes the manoeuvre, at this point the candidate is free to transition directly to manoeuvre (f) or perform a controlled positioning circuit ready for manoeuvre (f).

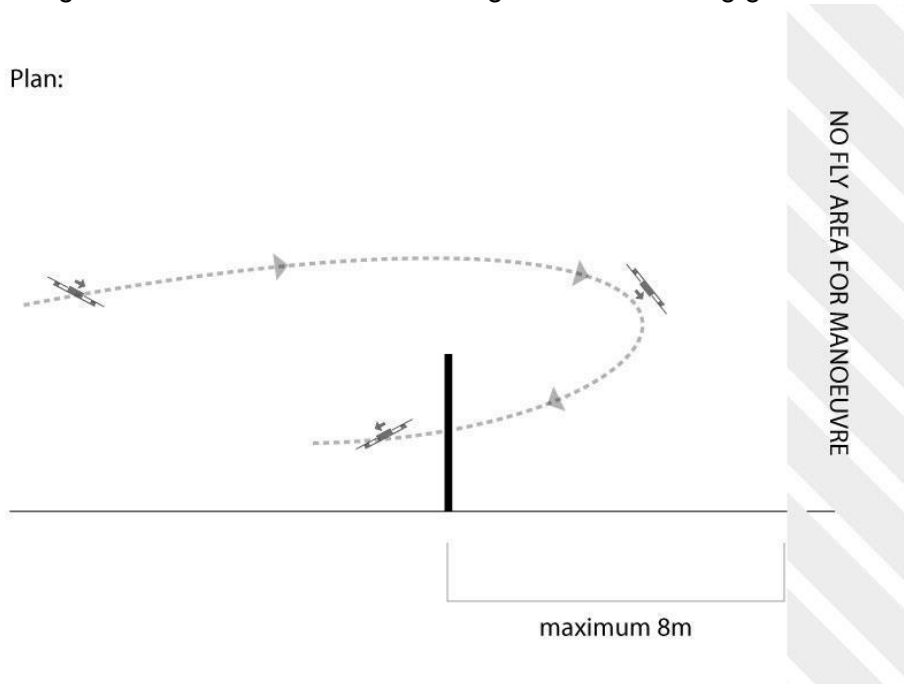
The height gained to clear the middle second gate should be around the same as if the pilot is trying to pass through a gate positioned directly on top of the said gate.

(f) Perform a 180 degree reversal over and back through a single racing gate.

The candidate may transition straight in to this manoeuvre from manoeuvre (e) or they may enter in to it from a controlled positioning circuit.

This exercise requires the candidate to fly over a racing gate and perform a rapid drop and 180 degree reversal to come back through the same racing gate in the opposite direction.

Plan:



A Split-S is a very efficient and preferred method for performing this manoeuvre, however the candidate should **NOT** be penalised for doing a basic 180 degree flat U-turn.

The candidate should be able to stop their model and turn without passing more than 8 meters past the gate.

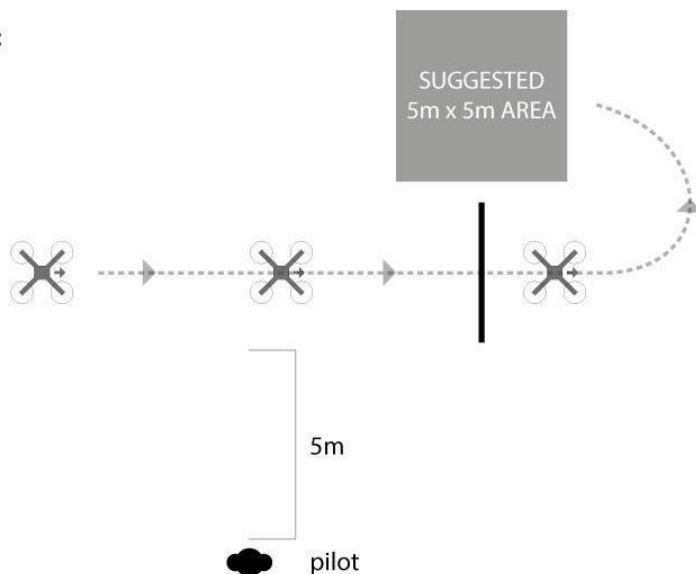
Passing back through the gate completes the manoeuvre, at this point the candidate is free to transition directly to manoeuvre (g) or perform a controlled positioning circuit ready for manoeuvre (g).

(g) Perform a race to the finish, stop and land.

The candidate may transition straight in to this manoeuvre from manoeuvre (f) or they may enter in to it from a controlled positioning circuit.

This exercise requires the candidate to fly through a racing gate and perform a swift stop in order to land in a dedicated 5 meter by 5 meter landing area. It is therefore important for the candidate and examiner to agree this landing area before starting the test.

Plan:



The candidate must fly through a racing gate at a good pace, before then stopping the drone while also moving safely off the 'racing line' to land in a safe area.

The agreed landing area should be a 'safe area' that is not part of the racing circuit and will not effect other models that may still be in flight.

(h) Complete post-flight checks as required by the BMFA Safety Codes.

These are set out clearly in the handbook but you should watch particularly that the Rx off, Tx off, frequency system cleared sequence is followed correctly.

The Questions

Having successfully completed the safety and flying elements of the test, the candidate must then answer correctly five mandatory questions based on legal compliance, as well as a **minimum** of five further supplementary questions on safety matters, based on the BMFA Safety Codes for General Flying and local flying rules etc.

Remember that on **no account** can a good performance on the questions make up for a flying test that you considered a failure. If you have failed the candidate's flying you should not even start to ask the questions. On the other hand the achievement scheme is a test of both flying ability and knowledge. It doesn't matter how well the candidate can fly, if they cannot answer the questions they should not pass.

Mandatory Questions

From April 2016 it is a requirement of all tests that candidates must answer correctly 5 questions taken from the list of mandatory questions based on legal aspects of model aircraft flying. (See Appendix 5) The examiner should only ask 5 questions and if the candidate does not know the answer to any question the test must be considered as a fail.

The examiner must indicate on the test form which questions have been asked.

It is expected that examiners will select questions that are appropriate to the test being taken, however candidates should familiarise themselves with all of the questions on the list. Candidates are not expected to be "word perfect" with their answers but they should be able to demonstrate that they are fully aware of the legal controls for model aircraft flying. For example if a candidate gives the answer to Question 4 (What does article 241 of the ANO state?) when asked Question 3 (What does article 240 of the ANO state?) it is likely they are aware of both answers and the examiner should point out they have answered the wrong question and ask for the correct answer.

Supplementary Questions

How many supplementary questions you should actually ask will depend on the circumstances at the time. For instance, if the candidate has done a good flying test and answers the first five questions with confidence then you need go no further. An acceptable test but with some rough edges can be offset to an extent by the candidate performing well in the first five questions.

A candidate who has done a test which you found only just acceptable and who hesitates on the questions should be asked a few more than five and if you are not satisfied that they have actually read the safety codes, you should not hesitate to fail them.

As an examiner, however, you should prepare yourself thoroughly for any testing that you do and you may wish to sort out your own personal and private list of sensible questions. Don't forget that you can use any local rules which you know and which the candidate should be aware of.

Remember that the majority of questions you ask are to be BASED on the BMFA Safety Codes; you are not expected to ask them 'parrot fashion' and the candidate is not expected to answer that way either.

This opens up the possibility of asking a candidate if they can think of reasons behind specific rules. For instance, why is the club frequency control system operated as it is and what might go wrong? There is always the possibility that the examiner may use the supplementary questions to further explore the candidates understanding of the mandatory questions.

Administration

There are specific forms for Examiners to use during the FPV Extension tests, and if you do not have one then a call to the BMFA Leicester office will have some in the post to you by return.

Completed forms should be sent to the Leicester office within seven days of the test and, whilst they must be filled in by the Examiner, they may be sent in to the office by either the Examiner or the Candidate. You should take great care that all the details are filled in correctly, especially the successful candidates **NAME** and their **BMFA number** (this can save a great deal of confusion). If the candidate is not a BMFA member then it is especially important that you get their name and address correct and in full.

This is very important as what is seen on the pass form is what will appear on the final certificate. It is embarrassing for you to have to send one back to be re-done and it gives the candidate a definite impression of sloppy work by someone.

Please note that the A4 Certificate(s) and updated membership card are not routinely sent directly to the individual tested. However, the Leicester office will send the documents directly to the individual, upon direct and specific request from the Examiner concerned.

Appendix 1

Examiners and Candidates FPV Extension Test Check List

The following is a short checklist of matters to discuss with the candidate taken from this document. This checklist can be used to ensure that all points raised above have been discussed with the pilot prior to any flights:

- 1 Has the candidate read: -
The BMFA handbook
Local site rules (if applicable)
'Safety Code for General Flying'
'Safety Code for FPV Flying'
and 'Operational Guide, All Models and Radio Control'.

- 2 Discuss
whether the model is suitable in "these conditions"

- 3 Any "no"
fly zones" need to be identified

- 4 Remind candidate to talk you through the role of the competent observer

- 5 Agree any manoeuvre requirements that need to be pre-determined by
the Examiner and Candidate prior to the commencement of the test flight

- 6 Clearly identify the take off / landing point and agree with the candidate
the appropriate flying area.

MULTI-ROTOR FPV RACING CERTIFICATE

Examiners Test Flight Check List

Candidates Name	BMFA Number	Date	Examiners
FLIGHT TASK		COMMENTS	
(a)	Carry out pre-flight checks as required by the BMFA Safety Codes.		
(b)	Perform a racing start and clear a racing gate within 8 metres.		
(c)	Fly through a slalom of 3 or more flags (gates may be substituted).		
(d)	Fly a 90 degree turn between 2 racing gates (or 180 degree turn).		
(e)	Perform an under-over-under manoeuvre.		
(f)	Perform a 180 degree reversal over and back through a single racing gate.		
(g)	Perform a race to the finish, stop and land.		
(h)	Complete post-flight checks as required by the BMFA Safety Codes.		
Answer five questions from the list of mandatory questions on legal aspects of model aircraft flying.			
Answer a minimum of five questions on safety matters from the BMFA Safety Codes and local flying rules.			

Appendix 3

Mandatory Questions List

May 2021

1. Can you fly your model aircraft or drone out of sight behind trees?
 - No, because you must be able to see your aircraft at all times.
2. You should never fly above what height without appropriate permission or an authorisation?
 - 400ft
3. What is the main reason for not flying above 400ft without permission or an authorisation?
 - Because the airspace above 400ft is used by other aircraft.
4. When do you need permission from an airport to fly a model aircraft or drone?
 - When you wish to fly in a flight restriction zone.
5. If you are flying your glider, which has a mass of more than 7.5kg but less than 14kg, from the top of a 150 ft high hill, how high can you fly from where you are standing?
 - 400ft
6. You arrive at a site and want to get ready to fly your model aircraft. What four things must you check?
 - That the weather is going to be suitable for your flight.
 - That you are 'fit to fly'
 - That you make sure there are no airspace restrictions where you intend to fly.
 - That your aircraft is in a safe condition to complete the flight safely.
7. When can you fly your model aircraft or drone using First Person View equipment without a competent observer?
 - If you are flying at a drone racing event within a 'sterile area' and you do not fly above 160 feet (50m).
8. You are flying your model aircraft or drone using FPV equipment accompanied by a competent observer, what four conditions must you comply with?
 - The take-off mass of your aircraft must be less than 3.5kg
 - You must not fly above 1000 feet
 - You must not fly above 400 feet if you are flying a rotorcraft with more than one propellor.
 - Your competent observer must maintain direct unaided visual contact with your aircraft.

9. You are flying your model aircraft or drone safely at a safe height but there are other people in the vicinity. You notice an air ambulance flying in your direction. What should you do?
- Quickly fly your aircraft out of the way of the air ambulance and either wait or land safely.
10. You want to fly in an empty field near to an airport. The field is outside the airport boundary fence, so is it OK to fly there?
- You must check that the field is outside the airport's flight restriction zone before you fly.
11. Who is directly responsible for the safe operation of an aircraft?
- The Remote Pilot
12. Before any flight can take place in the Flight Restriction Zone of a Protected Aerodrome, permission must be obtained from whom?
- The Air Traffic Control unit or owners of the Protected Aerodrome
13. Whilst flying, as a Remote Pilot, you should always comply with what two conditions?
- Comply with the limitations of the Article 16 Authorisation or CAP 722
 - Comply with any airspace restrictions
14. Whilst flying, as a Remote Pilot, you should always avoid what?
- Any risk of collision with any manned aircraft
 - Flying close to or inside any area where an emergency response is taking place, without permission to do so
 - Continuing a flight if it may pose a risk to other aircraft, people, animals, environment or property
15. The Article 16 Authorisation stipulates that model aircraft with a Maximum Take Off Mass between 250g and 7.5kg cannot be operated within what separation distances?
- Within a horizontal distance of 30m of assemblies of people.
 - Within 30m of any uninvolved person (this may be reduced to 15m for take-off and landing).
16. The Article 16 Authorisation stipulates that model aircraft with a Maximum Take Off Mass between 7.5kg and 25kg cannot be operated within what separation distances and above what height?
- Within a horizontal distance of 50m of assemblies of people (this may be reduced to 30m for take-off and landing).
 - Within 30m of any uninvolved person
 - At an altitude of more than 400' without permission from the CAA.
17. Serious Incidents or other Occurrences must be reported to the CAA as a condition of our Authorisation, if they involve any of what four circumstances?

- Incidents involving manned aircraft.
- Operating above 400 feet
- Operating less than 50m from uninvolved people.
- Any instances of flight beyond the visual line of sight of the Remote pilot.

18. Any Model Aircraft or drone Operator making use of the Article 16 Authorisation must ensure that they comply with what three requirements?

- They must be registered with the CAA.
- They must clearly display their Operator ID on (or in) their aircraft.
- They must be a current BMFA member.

19. The Article 16 Authorisation permits you to give a 'trial flight' to a non-member providing you meet what three conditions?

- They are under your direct instruction and supervision.
- You meet the competency requirements and a valid Operator ID is on the aircraft.
- You must be a current BMFA member.

20. What does the Article 16 authorisation state with regards to the dropping of articles from a model aircraft or drone?

- The Remote pilot must not cause or permit any article or animal to be dropped from an unmanned aircraft so as to endanger persons or property.

Appendix 4

Multi-rotor Types

Multi-rotors come in numerous variations, sizes and formats, not all of which will be suitable for the multi-rotor tests. Some use servos to tilt motors, but these should not be confused with tilt shift aircraft.

Bi-rotor

These have two motors only and two servos. Each motor is mounted on a servo-controlled pivot. **These are the least stable of the multi-rotors and are therefore not recommended to use for either test.**

Tri-rotor / Tricopter

As the name suggests these have 3 motors, typically spaced in a Y-shape, with the rear single motor being mounted on a servo-controlled pivot.

Quad-rotor / Quadcopter

These are likely to be the most common model used, using four motors and no servos. (This excludes variable pitch models mentioned further down this list) They can be safely flown in either a plus or cross format, this will boil down to what the individual pilot feels is easier to orientate and no preference should be given to either. There will be two motors spinning clockwise and two counter clockwise to overcome the torque effect. By slowing a pair of motors down and speeding up the other pair, the torque effect is used for yaw.

Hex-rotor / Hexacopter

With six motors, these can either have the motors spaced out evenly in a circle or doubled up in a Y-format. Again no servos are used for this format. Hex-rotors offer no more stability than a quad, but do offer an ability to keep flying in the event of a certain motor failures. These will have three motors spinning clockwise and three counter clockwise, when set up as a Y-shape, there will be one motor of each direction on each arm.

Octo-rotor / Octocopter

As per the hex-rotor, these can be set up with all motors in a circle, or set up with double motors as per the plus or cross quad-rotors. As with hex-rotors these offer more resistance to motor failures. These will have four motors spinning clockwise and four counters clockwise. When set up as a quad-rotor format there will be one motor of each direction on each arm.

Variable Pitch Multi-rotors

These can be any format from above, but are most typically done as quad-rotors as this tends to be the best balance between size and aerobatic performance. In the quad-rotor format a single motor drives four variable pitch rotors, which are intern controlled by servos. This variable pitch approach allows for a motor idle up being set and sustained inverted flight to be achieved.

Reverse Direction Multi-rotors

Another recent development has seen multi-rotors with reversible speed controllers / motors, this allows for sustained inverted flight as the motors reverse when inverted.

Multi-rotor Flight Modes

All multi-rotors will require a flight controller for operation, a device which contains a three axis gyro, much like a flybarless helicopter, but with the additional task of taking the radio control signals (Throttle, Aileron, Elevator and Rudder) and converting them in to motor or servo outputs. In order for a multi-rotor to fly, the flight controller will be making constant adjustments to all parts of the flight train, however it can also offer additional flight modes.

It should be noted that multi-rotors of all formats and sizes could be fitted with none or all of the following flight modes as part of the main flight controller or in separate units.

Manual

This is the only flight mode acceptable for use in the tests, as in this mode the multi-rotor is not self-stabilised. A continued aileron input for example will see the model continue to rotate around the aileron axis. An easy demonstration to request from the pilot to confirm this is the flight mode in use is to ask the pilot to apply a small aileron input and then release the stick to centre. The model should continue along the new aileron trajectory and not self-level, requiring opposite aileron input to stop the slide and return the model to level.

Attitude / Stabilised Mode

Often referred to as ATTI mode or STAB, this is the first of the auto pilot modes. In this mode the model will self-level when the sticks are centred and the model will simply drift with the wind if no input is given. In addition full aileron or elevator will only result in the model reaching a maximum tilt of 30-40 degrees and never tipping over.

GPS Mode

Occasionally referred to as Loiter Mode, the model uses GPS to lock its position via satellite. The model will often still accept flight control inputs and behave much like in ATTI Mode, however centering the sticks will see the model stop still in its position. In this mode the model will also resist external forces such as wind and make corrections to stay still. It is also possible with some GPS equipped models to set waypoints and send the model on its way completely autonomously or have the model 'Return to Home'.

Compass Mode

Often also referred to as CAREFREE mode. This mode works by setting an artificial North. With the model facing in a set direction, entering compass mode will see the model travel along its new North from forward elevator input irrelevant of which way the model is now facing. Essentially this allows the model to be pirouetted while always travelling in the same direction from forward elevator input. It should be noted that the compass will typically take the front of the model as its new North when activated, so it is possible for forwards on the stick to become left, right or backwards, depending on which way the model was facing when activated.

Altitude Mode

Some models are also capable of maintaining their altitude.

Multi-rotor Pre & Post Flight Checks

(A) Checks before daily flying session.

1. Check that all rotor blades are in good condition with no damage and securely attached to the motors or blade grips.
2. Check for loose or missing nuts and bolts.
3. Check all ball links for slop and change as necessary.
4. Check there is no backlash in the drive system apart from gear backlash, which should not be excessive.
5. Check that servos are secure.
6. Check that the receiver aerial is secure and in good condition with no chafing or damage.
7. Check that the flight controller is secure and that all aerials including GPS are secure and orientated in the correct direction.
8. Check all transmitter switches are in the right positions.

(B) Checks before and after each flight.

1. If the multi-rotor suffers damage or a heavy landing, recheck all of (A) above.
2. Check all controls before starting especially for binding links or slowing servos.
3. Check for vibration and eliminate before flight.
4. Check that all wiring is secure and cannot become entangled with any moving or rotating part, especially the receiver aerial.
5. Before starting insure all switches are in the correct position for takeoff and the correct flight mode selected before **EVERY** flight.
6. If planning to use GPS at any point during the flight, confirm that you have a suitable lock before taking off. (Method for this will vary from unit to unit, but is typically by way of a flashing indication LED)
7. Are the multi-rotors arms secure, especially in the case of collapsible or folding air frames.

Multi-rotor Additional Safety Considerations

The following is a list of additional scenarios that multi-rotors can create, but is in addition to standard procedures for electric or I/C models and general safe flying practices. Due to the fast changing nature of multi-rotors this list should not be considered definitive.

Different multi-rotors will use a vast selection of propellers from soft plastic, through wood and up to carbon. In all cases the propeller should be suitable for the type and power output of each motor and metal propellers must never be used.

Many multi-rotors use the frame as a power distribution board, it is important to insure that all wires are secure and that there is no risk of short-circuiting. Multi-rotors can create more RF interference than the average model aircraft and although the use of ferrite rings might not be necessary with 2.4Ghz radios it is advised to carefully consider the positioning of any and all aerials and wiring.

Multi-rotors are predominantly electric, so all standard controls of electric models should be applied, especially the consideration that the model is live the moment it is connected. As a result models should not be connected in pits areas or car parks.

Models with GPS can typically be programmed to follow waypoints, at no point may the craft become fully autonomous, in other words the pilot should be in control at all times and capable of taking control and overriding any pre-programmed flight commands with the transmitter. The same applies to the use of the 'Return to Home' feature.

Models using Waypoints or Return to Home must consider the flight path of the model and insure no obstacles will interfere with the model, as this type of flight is often 'As the crow flies'.

Careful consideration must be taken with models with GPS and 'Return to Home' features as to where they are connected and or started, as this is often the 'Return to Home location' and must be set as a safe area, e.g. a safe distance in to the runway and not the pits or car park.

It is not easy to safely restrain a multi-rotor so when testing the failsafe it is necessary to remove the propellers.

GPS is typically very good at holding a model to within inches of its position, but is only truly accurate to within 5m of latitude, longitude and altitude.

GPS can take time to 'find itself', especially on the first initialization of the day, so time should be given to achieve a safe and stable lock before **EVERY** flight.

A descending multi-rotor is flying through its own prop wash and will often 'wobble' as it descends. Trying to descend too fast can cause a model to suffer too much wobble creating a tip stall. A great method to avoid excessive wobble is to descend while travelling, e.g. a 45deg descent.

A multi-rotor with too much gyro gain will oscillate in the air, where as too little will create a model that rocks or drifts excessively.

A multi-rotor that appears to "toilet bowl" (drifting around in a circle) is typically searching for

a GPS lock.

Models with GPS that are armed too quickly can shoot off trying to return to their last known GPS position. This again refers to arming and flying before GPS is fully engaged.

Pre-test considerations / checks for examiners.

The following is a guide for examiners to assess that a pilot truly understands the aircraft they are flying and the modes it operates in.

Flight modes:

As mentioned in the earlier section of this document, multi-rotors can have numerous flight modes. The pilot being tested should be able to clearly explain what each mode is on their model and what switch it is assigned to. They should also be able to explain how the model will react in each mode and any special considerations that should be made for each mode. Again, you can refer back to the earlier section on flight modes for reference, but here are some key things to consider for each mode that the pilot should understand.

Things that need to be considered for each mode:

GPS:

GPS does not work instantly when a model is armed and may take time to arm, especially on the first flight. All GPS equipped models will have a warning LED indicating the GPS Status, i.e. is it locked, how many satellites it's reading etc. Also many will not work indoors, under trees or near power lines. Failing to wait for a successful GPS lock can result in a model struggling to hold location or even a fly away. GPS units typically have an orientation and a pilot should be able to demonstrate that is in the right position/angle.

RTH – Return To Home:

A pilot using RTH should understand exactly when the model sets its home position. In some cases this is as soon as the battery is plugged in, whereas on others it is when the model is first armed for flight. In either case, the pilot should explain this for their model and arm the model in line with this.

If equipped with RTH the pilot should be able to explain what will happen in this mode. Many models will stop where they are, gain height, then fly in a straight line as the crow flies to their RTH point before then entering a slow decent to landing. Others may simply fly back at the altitude they are starting at and some may then only loiter at a set height once reaching the RTH point and not land.

The pilot should also understand the legal implications of RTH. At this moment in time, RTH is not a legal option for failsafe (This is currently being discussed with the CAA and may change). RTH can only be used as a controlled mode of flight, i.e. the pilot can deliberately put the model in a RTH state, but then instantly regain control at any time. RTH is not legal if the model decides to enter RTH mode on its own due to say loss of signal or low battery, or if the pilot cannot re-take control once RTH's is initiated.

Compass Mode / Carefree Mode:

Carefree mode as mentioned earlier sets an artificial north for the model. The pilot should mainly be aware of the risk of setting an unusual or uncomfortable attitude for this mode. I.e. setting the mode while flying towards yourself will result in a model being set in a permanent 'nose-in' attitude. The pilot should be able to explain how to either exit this mode to normal

flight or what they would do if this was accidentally set in flight.

Attitude / Stabilised Mode

This is mostly an idiot proof mode, however some of the earlier control units required the model to be positioned horizontally at point of arming to set the level point, i.e. arming with the model at 20deg will see the model always wanting to level to that angle in flight. As with many gyros devices, many control units don't like to be moved during the initial arming.

Gain adjustment.

Even a basic board that is only capable of manual flight mode can still have a switch assigned to adjust the gyro gains, essentially like a helicopter tail gyro having heading hold and rate mode. On a multi-rotor the behaviour difference between the two could best be described as high and low rates. With the gyro gain high the multi will be more docile / sluggish, where as with the gain dialled down it will be twitchy and able to rotate faster. A pilot should be willing to demonstrate to an examiner that both modes are still manual mode and that the 'low rate' mode is not in fact self-levelling.

Motor Arming:

Many control units have a safe mode, where the motors will not react to control inputs, requiring the transmitter to first use some set positions. For example this might be throttle down and full right rudder to arm, with throttle down and full rudder left to disarm.

Failsafe:

Multi-rotors are capable of various levels of failsafe, from the basic motors to idle minimum, to automatic flight modes. Such self flight modes are; **auto land**, where the multi-rotor self stabilises and goes in to a slow decent and **RTH** (return to home), in this mode the multi-rotor will typically climb by a set amount, turn and fly straight home to its initial arming point and land. Consideration should be taken in RTH mode as the craft typically flies in a straight line, so any obstacles in between such as trees or people may be hit.

Examination question suggestions:

Flight mode: The pilot should be able to explain all their flight modes and how the aircraft will behave in each mode.

Failsafe settings: The pilot should be able to explain what will happen on loss of signal, i.e., standard motors to idle or slow decent or return to home. This can also be linked to switches.

Arming sequence: Most multi-rotors have a set stick/switch position to start or stop motors.

Switches: The pilot should be able to clearly explain what flight modes are assigned to each switch.

Specific craft considerations: A pilot should be aware of specific behaviours relevant to their multi-rotor. I.e. a motor failure on a bicopter, tricopter or quad will result in a crash, however on a hexacopter or octocopter the model will typically begin to pirouette, but still fly.

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