BRITISH MODEL FLYING ASSOCIATION

THE R/C ACHIEVEMENT SCHEME

TEST STANDARDS for CHIEF EXAMINERS and CLUB EXAMINERS

GUIDANCE for TEST CANDIDATES

THE 'B' CERTIFICATE

(Multi-Rotor)

2014 ISSUE

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 'B' Certificate is "designed to recognise the pilot's more advanced ability and a demonstrated level of safety which may be considered by an event organiser as suitable for flying at a public display."

As an Examiner, therefore, the level of competence required from a candidate should firstly be based on the question; 'has this person demonstrated their flying ability and safety to me in a satisfactory manner' and, secondly, 'how do I feel about them appearing in public, possibly at a large display, on the strength of the certificate which I may be about to award them'.

The aim of the 'B' certificate has always been to give the club flyer a personal attainment goal beyond the 'A' Certificate; a demonstrated level of competence and safety which is attainable by the average pilot with a little thought and practice.

The examination for a 'B' Certificate may be taken on application to a Registered Examiner.
The examination may be carried out by:
(a) Two Registered Examiners (the 'lead' must be a Helicopter Examiner).
(b) A Helicopter Chief Examiner

For many years the 'B' Certificate has been seen by some as a 'display licence' but, whilst it certainly has its uses in the context of displays, it has always been much more than that. It was set up in the first place as a method of encouraging club flyers to gain further flying skills by meeting and being tested to a recognised national standard and this is still its main function.

The long term strategy behind this is that if enough club flyers qualify for their 'B' certificates then the general standard of flying both within your club, and nationally cannot help but rise. Examiners should be pressing this concept positively within their clubs and discouraging the idea of the 'B' certificate of being 'just a display licence'.

A candidate wishing to take the 'B' must already have passed the 'A' in that discipline.

However where a candidate presents for a 'B' test who does not already hold an 'A' certificate it is acceptable for the candidate to complete the flying portion of the 'A' test successfully and then move immediately to the flying portion of the 'B' test before attempting the test questions.

If the candidate passes the 'A' flying test but fails the 'B', then you should ask the 'A' questions. If the candidate passes both the 'A' and the 'B' flying tests, then you should ask the 'B' questions.
Note that the 'A' flying test does not finish until the model has been retrieved and the post flight checks have been completed

The candidate for the 'B' certificate should have studied the BMFA Members' Handbook and be familiar with the 'Safety Code for General Flying' and the display safety codes. as well as the 'operational guides, 'all models', 'radio control' and 'helicopters'. Besides being an excellent guide to the safe flying of helicopters and other model aircraft, most of the

questions asked at the end of the test will be from these sections of the Handbook. There is a section in the Handbook that will give you the relevant page numbers of these sections but remember that addendum sheets to the Handbook are published in BMFA News and on the BMFA website and these may also be relevant as they contain up-to-date information.

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 flight 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 test can be performed with virtually any model multirotor, fixed pitch or collective. A multirotor for the benefit of this test is defined as a rotorcraft with two or more motors, but excluding tandem helicopters. The only exception to this is that the multirotor must not be operated with autopilot, GPS or self leveling activated.
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.
The flight time required may be marginal for electric powered models but a change of battery packs part way through the test is allowable.
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.

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 multirotor being used to take the test although electronic stabilisation is restricted to enabling flight, at no point should the stabilisation effect take over control from the pilot or achieve automated or self leveled flight. This allows a range of gyros to be fitted, from simple yaw dampers to solid state heading lock units.
The use of any autopilot and/or artificial stability features which are (or may be) designed into such units beyond definition above is not acceptable during the test and is not allowed.
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 the test.

Height and Speed

The ‘B’ certificate candidate should be a confident pilot, and this should show in the height and speed at which they fly the test. The hovering parts of the test should be flown with the model at eye level. The flying sections should typically be completed at a height of between ten and twenty five metres (roughly one to two houses 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 accurate height control are factors you should attach some importance to.

Wind Direction

There is no requirement for the fixed positioning of manoeuvres relative to the wind direction in the Multirotor ‘B’ certificate and you will find no reference to the wind in the text of either the test or this Standards Document.

This makes it absolutely ESSENTIAL that you discuss this with the candidate at length so that you are both aware of exactly how you want the manoeuvres to be presented and what limitations will be accepted if the wind direction is not favourable.

Consistency

Good use of the controls should ensure that the model stays at a constant height, and moves at a steady speeds suitable to each of the separate elements of the test. All deviations from these constants should be noted, and will form part of the judgement 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 practised the test or has not reached the required standard of flying and are legitimate reasons to fail them.

Continuity

The manoeuvres are set out in such a way that they are flown one after the other as a sequence. You should discuss with the candidate before the flight the way in which you would like the various elements flown and the candidate should have a good knowledge of the test before the event. If the candidate is very hesitant during the test and is not capable of following the sequence then you might conclude that they have either not had enough practice or that their basic flying skills are not yet well enough developed.

Although the manoeuvres are set out as a sequence, it is **ABSOLUTELY NOT** expected that they will 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 practised. 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 tank of fuel or flight battery but If the model does have to be refuelled or the flight battery changed 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

At ‘B’ certificate level the candidate should be competent enough to fly the test with very few errors. If you identify any major faults, the test should be taken again. It may be, however, that the candidate will make minor mistakes on a manoeuvre and if you are not fully satisfied with what you have seen you should not hesitate to ask for the manoeuvre to be repeated.
Some judgement is called for on your part here. A major mistake is grounds for failing the candidate, especially if loss of control or a dangerous situation occurs. you should definitely not let the candidate 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 ‘that could be better’ than a request that the manoeuvre be repeated is probably justified. Be extremely careful about using this option, however, as you could degrade the worth of the test. Under no circumstance must the test degenerate into a series of practice manoeuvres.

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 arrange one or two coaching 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. It could then be extremely useful for you to arrange a demonstration test for them 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, possibly with a little coaching, is far more useful to everyone than simply telling the candidate that they have failed.

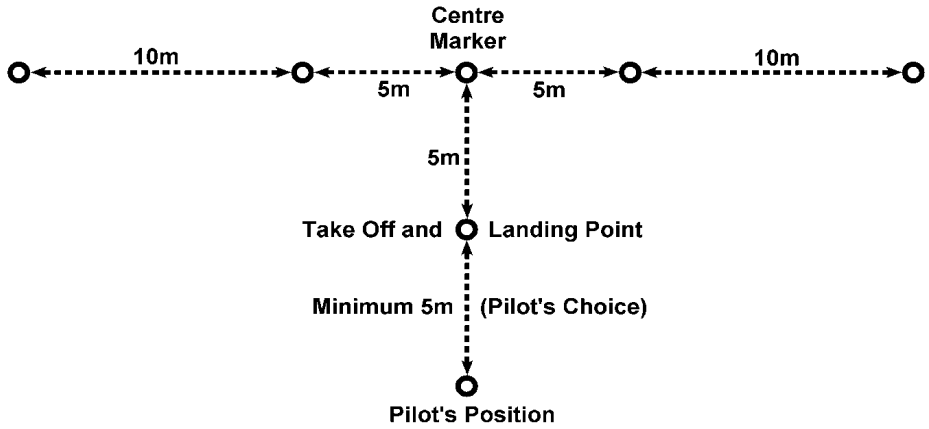
A flight which is abandoned for any reason prior to starting manoeuvre (b) will not count as a test flight attempt

Interruptions to the Test

A possibility that may occur during a test is an engine failure part way through, which with multirotors 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 engine trouble or even engine-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 judgement 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 a multirotor test, it is your responsibility as the Examiner to lay out a series of ground markers to assist both the candidate and yourself to assess the manoeuvres being flown. Small cones or any other similar marker may be used as long as they don't interfere with the flying of the model. However, it is vital that the marker used for the take off/landing point (TOLP) does not affect the model at all and probably the best marker in this case would be something like the fluorescent discs that lay flat on the ground. Alternatively, you could use some of the biodegradable ground marker spray paint that is readily available.
The layout of markers required is shown below and it must be emphasised that absolute accuracy of distance is not required when setting them out. Pacing will be quite accurate enough. It is essential, though, that the centre marker, the TOLP and the pilot's position are in line.



GROUND POSITIONING MARKERS

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 set them out with these factors in mind.

It is not a requirement that the markers in the cross bar are used by the pilot but they are there to help. However, the centre marker, the takeoff/landing point and the pilot's position must be used with some accuracy.

Landings should generally be no more than a metre from the takeoff/landing point and the pilot is expected to stay close to the selected pilot's position mark although it is not required that they 'plant' their feet. If you feel that the pilot is starting to wander, you should stop them and insist that they stand near the pre-selected mark.

Remember that it is a requirement that 'all manoeuvres are carried out in front of the pilot' so the use of the pilot's position point will be important.

General Manoeuvres and Hovering

All take-offs and landings should be smooth, without undue oscillations, and lifts and descents should be straight and controlled with the model a comfortable and safe distance in front of the pilot. In any stationary hovering the model should remain steady and should not oscillate unduly.
The standard 'brief' hover time is about five seconds. You should discuss this with the candidate before the test so that they know that you will want to see a positive stop with the hover long enough to show that the model is well controlled and steady with little wandering or oscillation. Stopwatch accuracy is not required.
The candidate should also be aware that the decision to move on is theirs and that you will not be asking them to commence with the next manoeuvre. However, during your pre-flight briefing, they may ask that you indicate when you are satisfied that they have completed their 'brief' hover times to help them decide when to move on. This is quite permissible if requested by the candidate.
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 whilst in the hover should be done at a steady walking pace.

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.

Administration

There are specific forms for Examiners to use during the Multirotor 'B' test, 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.

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 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 Test

(a) Carry out pre-flight checks as required by the BMFA Safety Codes and BMFA Multirotor Certification Appendix document.

The pre-flight checks are laid out clearly in the BMFA Multirotor Certification Appendix document. The candidate should also go through the pre-flying session checks, laid out in the BMFA handbook. Ask the candidate to go through their checks as if the test was their first flight of the day.

Points to look for are that the candidate has a steady and regular ground routine, especially when starting and tuning the engine. Nerves should not play a part in the pits, and you should satisfy yourself that the candidate is in full control of what they are doing whilst preparing the multi-rotor for flight.

A tidy flight box and a neat ground layout makes a good impression and is to be expected from ‘B’ certificate candidates

A poor performance in this area is not direct grounds for failing the candidate but it is inevitable that you will be making mental notes of all aspects of the candidates performance and this is one that may 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 usual Tx on, Rx on sequence. 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.

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 on before doing so should be failed on the spot.

Electric powered models must be carried out from the pits area to a safe point before the flight battery is connected and they MUST be considered live as soon as the flight battery is plugged in. Great care should be taken at this point and any help available to the candidate should be used in the interests of safety.

If there is no one else available then there is nothing to stop you aiding the candidate by, for instance, carrying the model to the test pad, etc., but any such actions must only 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.

It is important that you talk these points over with the candidate in your pre-flight briefing.

(b) Perform one hovering bow tie

All sections of the manoeuvre are numbered and referenced to the manoeuvre drawing. The manoeuvre as described is flown anti-clockwise. However the direction of the flight may be either clockwise or anti-clockwise, at the discretion of the Examiner.

At all times in the manoeuvre, the model must be facing forward.
(1) The model starts on the TOLP, takes of and flies to a position over the centre marker where it is hovered for about 5 seconds.

(2) The model then hovers sideways to the left for about 5 metres to a position over the left inner marker where it is held and hovered for about 5 seconds.

(3) The model then hovers backwards for about 5 metres to a position immediately behind the left inner marker and level with the TOLP where it is held and hovered for about 5 seconds.

(4) The model then hovers diagonally forward and to the right to a position over the centre marker where it is held and hovered for about 5 seconds.

(5) The model then hovers diagonally backward and to the right to a position immediately behind the right inner marker and level with the TOLP where it is held and hovered for about 5 seconds.

(6) The model then hovers forwards for about 5 metres to a position over the right inner marker where it is held and hovered for about 5 seconds.

(7) The model then hovers sideways to the left for about 5 metres to a position over the centre marker where it is held and hovered for about 5 seconds.

This completes the manoeuvre.

Hover height must be consistent throughout the manoeuvre and there should be minimum wandering away from the straight lines between the designated hovering points as the manoeuvre is flown.

(c) Perform one 4-point pirouette

From the previous manoeuvre, the manoeuvre is begun with the multirotor hovering over the centre marker, with the rear or the model facing the pilot and it is held in that position for about 5 seconds. The model is then rotated 90 degrees and held in the hover, sideways on to the pilot for about 5 seconds.

The model is then rotated a further 90 degrees in the same direction to have the front of the model facing the pilot and hovered in that position for about 5 seconds.

The model is then rotated a further 90 degrees in the same direction to the sideways on position to the pilot and hovered in that position for about 5 seconds

The model is then rotated a further 90 degrees in the same direction to the starting position, with the rear of the model facing the pilot and hovered in that position for about 5 seconds.

The model is then hovered backwards for approximately 5 metres and landed on the TOLP.

This completes the manoeuvre.

The multi-rotor must rotate either clockwise or anti–clockwise for the entire manoeuvre. The

Examiner will state which direction he wishes to see. The clear inference is that the candidate must be competent to perform the rotations in both directions prior to the test.
Hover height must be consistent throughout the manoeuvre with minimum wandering away from the Centre marker. The landing must be within the 2 metre diameter circle centred on the TOLP.

(d) Perform one 'Top Hat'
The pilot should now take off and hover the model to a position either hovering over the appropriate outer marker or approaching it at hovering pace along the line of the cross markers.

The model now moves forward at the normal hovering pace for ten metres, stops and hovers for about five seconds then climbs vertically for four metres before hovering again for about five seconds. The pilot will now hover the model forward for ten metres so that the model passes the pilot sideways on to them. The model again hovers for about five seconds and the pilot now causes the model to descend four metres until the model is once again at eye level where it again hovers for about five seconds. The model now moves forward for another ten metres and passes over the opposite end outer marker which concludes the manoeuvre.
The model, still at eye level, must then be hovered back to the take off/landing point and landed smoothly and steadily.

The speed during the top hat should approximate to a normal walking pace, and the heading is constant throughout. The entry and exit to the manoeuvre is a test of the pilots ability to correctly position the model. The model should not drift away from or toward the pilot significantly and the model should be under accurate control for the whole manoeuvre.
The manoeuvre may be flown either from left to right or from right to left and the direction is decided by the Examiner.

(e) Take off and climb to a safe altitude.

The pilot must ensure that the route of his proposed flight path is clear before taking-off; watch for head movement as they scan the area. On taking-off, the multirotor will lift to a brief hover at about half a metre high. After again checking for obstacles and obstructions the pilot then climbs out at an angle greater than 45° to his selected safe height. When reaching this height the model can be transitioned into forward flight and the pilot can now position it for either a left or right hand circuit as he pleases.
During the climb out you will be looking for a positive approach to the manoeuvre, a constant angle and velocity. the pilot will also be looking for other traffic along the intended route.

(f) Fly a left hand rectangular circuit.

(g) Fly a right hand rectangular circuit.

The pilot can elect to fly these manoeuvres in either order. The circuits should be rectangular as shown in the manoeuvre diagrams. the longest legs of the circuit must extend over at least fifty metres. It is important that the initial turn on each circuit is made away from the flightline and the model must never pass behind the pilot.
On the run in to the first circuit and on completion of it, the model will be flying past the front of the pilot, and, for safety reasons, twenty or thirty metres out from the take off pad. Tell the candidate prior to the flight the line you wish them to follow.
You must ensure that the candidate is clear on this, the line will be set by the model flying in front of them on a heading which will be agreed before the flight (and this will not always be into wind), and passing over a set point. The first pass in front of the pilot is extremely important as it sets the standard height and line for the rest of the 'flying' manoeuvres.

(h) Fly a Figure of Eight at circuit height with crossover in front of the pilot

This should be flown as a banked circuit manoeuvre (not from the hover) and as shown in the diagram. The crossover point must always be in front of the pilot and, after a run in at standard height and line, the model MUST be turned through ninety degrees in the first turn so that it is flying exactly away from the pilot.
The first circle must also end with the model flying exactly away from the pilot, through the crossover point before it is turned into the second circle. Both circles should be of the same diameter as seen from the ground.

The main problems with this manoeuvre nearly always happen on the circle that is upwind of the pilot and if they do not adjust the angle of bank/turn rate to compensate they will either miss the crossover point by being a good way downwind, fly too near the pilots line, fly circles that are distorted or panic as the model accelerates towards them as it begins to come downwind and pull far too much bank (vertical!) to get the crossover point correct. This is not a sign that they have thought about the manoeuvre or practised it.

The second circle (3/4 circle actually) is rarely a problem. The manoeuvre finishes with the model flying at standard height and line across the front of the pilot, not with another turn away.

The initial run-in to the manoeuvre may be either from left to right or from right to left and the direction is decided by the Examiner.

(i) Perform one twenty second nose-in hover.
The model must now transition from forward flight to the hover in a safe and steady manner and position for the nose-in hover, where the model is hovered with the front facing the pilot.

The pilot should position the model over the centre marker, hovering at a height of between eye level and up to three metres. After a brief hover, the model is turned so that the front is towards the pilot and held steadily in the nose-in hover for at least 20 seconds, then turned back, climbed away and transitioned to forward flight.

If the model is not completely nose in you should ask the pilot to correct it's position before starting the twenty second count. The multirotor should not drift significantly in any direction and height control should be good.

(j) Perform one loop.

The model should be flown out to a point between 30-50 metres past the pilot, then flown back past the pilot on standard height and line, at the point the model reaches in front of the pilot a loop of approximately 15-25 metres diameter should be performed. A perfect loop is not required but the exit height and line should be very close to the original.

Skewing out is a sign that the model has not been trimmed correctly or that the model was not level at the start of the manoeuvre. The pilot should not get into this situation to start with but if they do then they must be able to compensate; if they cannot then you have to draw your own conclusions. Throttle is typically required at all times for a multirotor to manouvre, but watch that the throttle is controlled during the manoeuvre and penalise the pilot if they fly the manoeuvre at a constant high throttle setting.

The initial run-in to the manoeuvre may be flown either from left to right or from right to left and the direction is decided by the Examiner.

(k) Perform an approach at 45° to the vertical, landing within a pre-determined two metre square.

It is difficult to judge the angle of descent unless the model is almost sideways on to the pilot. For this reason the pilot should consider the planned approach path carefully and agree it with the Examiner during the pre-flight briefing. The direction of approach is the pilot's decision and everyone concerned with the test should be very clear exactly how the pilot will be attempting to fly the manoeuvre.

It is not a requirement that this manoeuvre should be entered from full forward flight so the pilot may set up the model in a steady hover or be moving forward in steady hovering flight at a minimum height of fifteen metres and at an appropriate distance away from the TOLP. The model should then sink at a constant rate with constant forward movement at an angle near to 45_o, heading down towards the TOLP. Finishing this descent exactly over the TOLP is not required but the model should be no more than a metre or so out. The candidate is allowed a short hover at a height of around half a metre to make minor corrections before settling the model on the ground.

The landing should be made with the model on the same heading as on the 45^0 descent.

After landing, the candidate should shut down the engine and allow the rotor blades to stop turning before collecting the model to return to the pits.

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

These are clearly set out in the BMFA Members' Handbook and BMFA Multirotor Certification Appendix document, but you should pay particular attention to the correct Rx off, Tx off sequence and ensure that the frequency control system in use is cleared correctly.

All manoeuvres must be carried out in airspace and orientations pre-determined by the Examiner and Candidate prior to the commencement of the test flight. The test must be completed in one flight.

The test must be taken outdoors.

Exceptionally, at a pre-determined point in the flight an intermediate landing may be permitted for the sole purpose of either refuelling or the fitting of a freshly charged flight battery. This landing may only be made with the prior consent of the Examiners. 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 Examiners. Two attempts per examination will be allowed in any one day.

The use of self stabilising multirotors or GPS is not allowed.

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.

The Questions

The candidate then ‘must answer correctly a minimum of eight questions on safety matters, based on the BMFA Safety Codes for General flying, the BMFA Multirotor Certification Appendix document and local flying rules’

Remember that on **no account** can a good performance on the questions make up for a flying test that you have considered too have failed. 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 does not matter how well the candidate can fly, if they are unable to answer the safety questions they must not pass the test. How many questions you should actually ask will depend on the circumstances at the time. for instance, if the candidate has completed a good flying test and answers the first eight questions with confidence then you need go no further. An acceptable test with some rough edges can be offset to some degree by the candidate performing well in the first eight 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 eight questions and if you are still not satisfied that they have actually read the safety codes , you should no hesitate to fail them.

There is some debate as to whether a list of ‘approved’ questions should be published for examiners to use. Current opinion is that if such a list is published then candidates will also be able to study the list, and will not need to study the BMFA handbook. This is probably not a good idea.

As an examiner, however, you should prepare yourself thoroughly for any testing that you do, and you are encouraged to sort out a personal list of suitable questions. Do not forget that you can call upon any local rules which you are aware of and that the candidate should know. If you do compile a personal list of questions, do not let the candidate see them.

Remember that the majority of the 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 in that manner either.

This opens up the possibility of asking the 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 could go wrong? , Why should models not be hovered out of or into the pit area?

Examiners and Candidates 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'
'Operational Guide, All Models and Radio Control'
Code of Practice for Model Flying Displays

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 anything that the helper does for them as the test progresses

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

6 Discuss the various manoeuvres and any options that may be available so that there can be no misunderstanding during the test

7 In particular, does the candidate understand how you expect to see the model positioned with regard to the wind throughout the test.

8 Clearly identify the landing area and agree with the candidate the required landing pattern that he will be flying and you will being looking for.

‘B’ CERTIFICATE (MULTIROTOR)

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 one hovering ‘bow tie	
(c)	Perform one four-point pirouette	
(d)	Perform one ‘Top Hat’	
(e)	Take off and climb to a safe altitude	
(f)	Fly a left rectangular hand circuit	
(g)	Fly a right rectangular hand circuit	
(h)	Perform one figure eight at circuit height	
(i)	Perform one twenty second nose-in hover	
(j)	Perform one loop	
(k)	Perform an approach at 45o to the vertical, landing within a predetermined two metre square	
(l)	Complete post-flight checks as required by the BMFA Safety Codes	
Answer satisfactorily a minimum of eight questions on safety matters based on the BMFA Safety Codes for General Flying and Model Flying Displays and local flying rules.		

Appendix 1

Index

Multi-Rotor types

Multirotors come in numerous variations, sizes and formats, not all of which will be suitable for the multirotor 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 multirotors 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 / Octacopter

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 counter clockwise. When set up as a quad-rotor format there will be one motor of each direction on each arm.

Variable Pitch Multirotors

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 to be set and sustained inverted flight to be achieved.

Reverse Direction Multirotors

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

Multirotor Flight Modes

All multirotors 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 multirotor to fly, the flight controller will be making constant adjustments to al parts of the flight train, however it can also offer additional flight modes.

It should be noted that multirotors of all formats and sizes can 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 multirotor 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 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 it's 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 it's 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 it's 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 or maintaining there altitude.

Multirotor 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.

(B) Checks before and after each flight.

1. If the multirotor 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 take off 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 multirotors arms secure, especially in the case of collapsible or folding air frames.

Multirotor Additional Safety Considerations

The following is a list of additional scenarios that multirotors 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 multirotors this list should not be considered definitive.

Different multirotors 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 multirotors 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.

Multirotors 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.

Multirotors 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 as all times and capable of taking control and over riding any preprogrammed 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.

Currently 'Return to Home' may only be used as a flight mode while under control and not set as a failsafe option.

It is not easy to safely restrain a multirotor 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 multirotor is flying through it's 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 multirotor with too much gyro gain will oscillate in the air, where as too little will create a model that rocks or drifts excessively.

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