MFNZ ‘*Wings*’ Proficiency Scheme
Multirotor, Basic and Advanced

1. Aim

1.1. To provide certification of a basic proficiency level for Radio Control model pilots enabling them to operate unsupervised. Pilots achieving the required level are entitled to hold the MFNZ *‘Wings’* qualification, endorsed to one or more of 10 disciplines, plus 3 specialist qualifications.

1.2. To meet the requirements of Civil Aviation Rule 101.205 for flying within 4km of aerodromes.

1.3. To provide a way of demonstrating a higher level of skill by completing an advanced test, with ‘advanced’ certification.

2. Method

2.1. MFNZ encourages all clubs to ensure that members follow this proficiency scheme and to ensure that all Radio Control pilots to obtain their ‘*Wings’*.

2.2. Many club flying sites, rallies and contests are on or near aerodromes and this qualification is mandatory to fly at those sites. The qualification provides ready proof of the holder’s skill level.

2.3. Within 4km of an aerodrome all pilots must either hold a *‘Wings’* qualification or operate under direct supervision of a ‘*Wings*’ qualification holder or an approved Instructor. Away from aerodromes trainees should not be considered safe to fly on their own until they have reached the ‘*Wings*’ standard.

2.4. The '*Wing's* Qualification is compulsory for:

(a) all new flying members joining MFNZ.

(b) all members who fly at sites on or within 4km of an aerodrome.

Members are encouraged to gain their '*Wings*' qualifications at the earliest time.

2.5. Clubs should keep records of all the members holding '*Wings*' certification and forward to the MFNZ membership administrator the name of members attaining the certification in the various disciplines.

3. Examiners and Instructors

3.1. Instructors

Instructors will be proficient *'Wings'* certified holders with the same discipline qualification that is being 'instructed'. Instructors will be appointed by the club(s). Clubs will assess their membership and select their instructors to meet the above criteria. Clubs will forward the name and MFNZ number of each appointed instructor to the MFNZ membership administrator for recording in the Association's database and the issue of a Instructor's endorsement to the instructors membership card.

Instructors should be:

(a) Experienced proficient flyers that exhibit well-disciplined flying and operate in a safety conscious manner and are committed to training students to *'Wings'* standard.

(b) Be willing to spend considerable time training without letting their own skills suffer.

(c) Have empathy with the student and be able to guide the student through the learning process.

A training manual for the student is available on the MFNZ web site. The MFNZ Members Manual is structured to take students through training to *'Wings*' standard and also acts as a prompt to instructors and has a check list for the student to keep as a record of training progress.

3.2. Examiners

For '**Basic Multirotor'** examiners will be any *'Wings'* qualification holder. It is not required for the Examiner to be proficient in the skill being tested but they should be familiar with the requirements of the qualification being tested and may conduct 'dummy tests' with a qualification holder to understand the manoeuvres fully. For **Advanced Multirotor** examiners will be a Multirotor 'Wings' qualification holder. Clubs will assess their membership and select their examiners to meet the above criteria. Clubs should keep a register of Approved examiners and forward to MFNZ on an annual basis. To ensure a common standard among Examiners, Area Representatives will conduct Examiner workshops whereby methods and ideas can be exchanged. The membership secretary will issue an Examiner's endorsement to the examiners membership card.

4. Qualification

There are 10 disciplines of Qualification:

Basic fixed wing Powered (**BP**)	Advanced Power (**AP**)
Glider (**GD**)	Advanced Glider (**AG**)
Helicopter (**HP**)	Advanced Helicopter (**AH**)
Multirotor (**MR**)	Advanced Multirotor (**AM**)
Basic Jet Turbine (**BT**)	Advanced Jet Turbine (**AT**)

There are additional specialist qualifications for the following categories:

Large fixed wing powered (**LM**)
First Person View (**FP**)
High Speed (**HS**)

5. Certification

5.1. The proficiency qualification gained will be issued by MFNZ in the form of an endorsement on the membership card. Applications should be made through local Club Secretaries on the official form, signed by the examiner. Annual membership cards will show the details of all qualifications held, including 'Instructor' and 'Examiner'. Members attaining a new qualification within the membership year may request the issue of a replacement membership card.

5.2. A pilot must be a current financial member of MFNZ to be the holder of a *'Wings'* qualification and the issue / retention of a *'Wings'* qualification is at the discretion of the MFNZ Council.

5.3. Any qualification may be withdrawn by a club if the pilot is considered to be no longer able to satisfactorily meet the required standard. The *'Wings'* qualification will be reissued upon the satisfactory passing of a full *'Wings'* test. You can have your *'Wings'* certification taken away if you become incapable of flying safely due to an ongoing medical condition such as failing eyesight.

If you do not renew your MFNZ membership for 3 consecutive years you will be required to retake your qualification upon re-joining.

Holders of qualifications from overseas organisations must take the MFNZ *'Wings'* qualification in order to comply with CAA regulations to be familiar with NZ airspace law.

6. The Basic Certificate

The Basic Certificate is a measure of flying ability and safety which "may be equated to a safe solo standard of flying".

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 unsupervised'. The candidate should have studied the MFNZ Members Manual, any local site rules (if applicable). Besides being an excellent guide to the safe flying of model aircraft, most of the questions asked will be from these sections of the Members Manual.

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.

7. The Advanced Certificate

The Advanced Certificate is designed to recognise the pilot's more advanced ability and a demonstrated level of safety. As an Examiner, therefore, the level of competence required from a candidate should be based on the question; has this person demonstrated their flying ability and safety to me in a satisfactory manner?

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

The long-term strategy behind this is that if enough club flyers qualify for their Advanced certificates then the general standard of flying both within your club and nationally cannot help but rise.

8. Testing Procedure

There are four parts to each proficiency *'Wings'* test:

(a) The oral test
(b) Pre 'flight inspection' of the model
(c) Pre flight procedures test
(d) The 'flight test'

It is suggested that the 'oral' testing be done first.

8.1. Each part is marked on a competent/not yet competent basis and <u>total mastery</u> is required to qualify.

8.2. Retesting is permitted. The examiner may decide if a retest can be carried out on the same day or if there needs to be some retraining or consolidation before the retest.

8.3. A guide to each test as well as test sheets and oral questions are included elsewhere in this manual.

9. The Test model

The tests 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 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.

10. 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-levelled 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 for the Advanced and Basic certificates and is not permitted. (**refer to Appendix 7, Multirotor Flight Modes**)

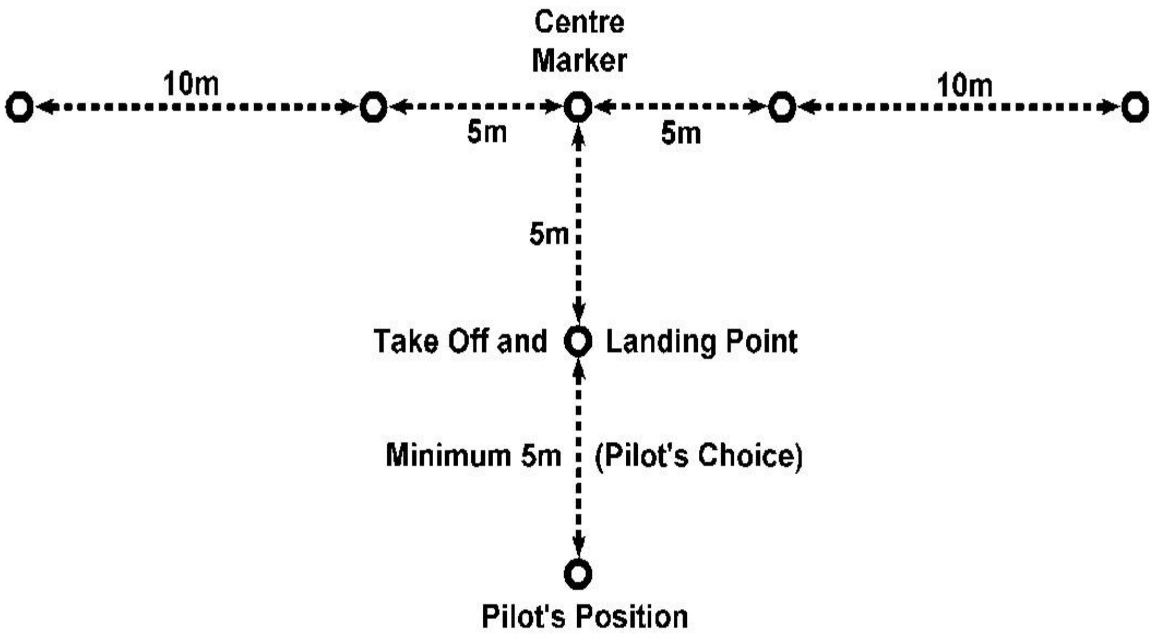
Candidates should be prepared to explain the capabilities of the system they are using and show that it does not take over control from the pilot and that automated flight will not be achieved during the test.

GPS must not be used during any test.

11. 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 if 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 take-off/landing point and the pilot's position must be used with some accuracy.

Landings should generally be no more than a metre from the take-off/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.

12. 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 note of performance in this area.

13. Intermediate Landing

Exceptionally, at a pre-determined point in the flight an intermediate landing may be permitted for the sole purpose of 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.

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.

14. General test guidance

14.1. The *'Wings'* Proficiency Scheme is run by MFNZ as a National Scheme and it is open to all financial MFNZ model flyers.

14.2. The 'Basic' Certificate is a measure of flying ability and safety which 'may be equated to a safe solo standard of flying' and an increasing number of clubs use it as their 'solo' test. The level of competence expected of a candidate should be based on the criterion; 'is this person fit to be allowed to fly unsupervised'.

14.3 A candidate wishing to take the 'Advanced' qualification must already have passed the 'Basic' qualification in that discipline.

14.4. The candidate should have studied the MFNZ Members Manual, any local site rules (if applicable) and be familiar with the MFNZ Safety Code. Besides 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 sections of the MFNZ Members Manual and Safety code. There is a further guide for Multirotors in Appendix 7 of this document.

14.5. Examiners may also 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.

15. Nerves

Quiet competence is what is required during the flight but most candidates will be nervous and allowance should be made for this. If the flyer is very nervous the examiner should seriously consider abandoning the test for the time being and offering the candidate a coaching flight or two to settle them 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.

16. Repeating Manoeuvres

16.1. At 'Basic' certificate level the manoeuvres are simple and the candidate should be competent to fly them with very few errors. If there are 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 the examiner is not fully satisfied, he/she may consider asking for the manoeuvres to be repeated.

16.2. Some judgment is called for here. A major mistake is grounds for failing the candidate, especially if loss of control has occurred or a dangerous situation has arisen. The examiner should definitely not let them have multiple attempts at each manoeuvre until they get it right but must give themselves the best chance of assessing the competence of the pilot being tested. Examiners should be extremely careful about using this option, however, as it could very easily be degrading the worth of the test. It must not, under any circumstances, degenerate into a series of 'practice' manoeuvres.

17. Repeating the Test

There maybe two attempts at the test in a day. If the candidate fails the first of these the examiner must consider their performance in deciding what to do next. Many failures will be reasonably good pilots or they could be borderline cases. In these circumstances it might be appropriate to offer one or two coaching flights and then a repeat of the test. Remember that many of the candidates will be unfamiliar with flying under pressure and might do very well on the second test.

On the other hand, it will probably be obvious that on many occasions that the pilot being tested is simply not ready for the test they are taking. In this situation it is better that to tell them so quite clearly. It could then be extremely useful to offer to fly a demonstration test for them so that they can gain an idea of the standard of flying required, especially if they have shown a lack of understanding of the manoeuvres and positioning. This, possibly along with a little coaching is far more useful to everyone than simply telling the candidate that they have failed.

18 . **Helpers for Disabled Candidates, Young Candidates and Others who have requested help during the test**

18.1. 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. There will be times when the Examiner, will think ‘how much can the test requirements be relaxed for this person’.

18.2. 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 Proficiency scheme as a true national scheme then we must consider how we can accommodate candidates, not how we can stop them from participating.

18.3. The answer of course, is that the Examiner must make on-the-spot decisions about what will be allowed during the test and in such cases the examiner is within their 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 the examiner that they know what they are doing or what is happening for the full duration of the test.

18.4. 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. but the candidate should be expected to do as much of the work as possible themselves and they should be able to talk through anything that the helper does for them. Examiners should be sure to discuss all this with the candidate before starting the test.

18.5. All of these comments can apply to younger flyers too. If this situation does occur with younger candidates, the examiner should insist that they do all the pre-flight and preparation work If they cannot do this then they should not pass.

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) The Examiner 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 the briefing that both the candidate and the helper are fully aware of both of these points.

19. Administration notes for Examiners

There are specific forms for Examiners to use during the tests (included in this document); further copies can be downloaded from the MFNZ website. Completed forms should be sent to the local Club Secretary within seven days of the test and, whilst they must be filled in by the Examiner, they may be sent in to the local Club Secretary 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 **MFNZ number** (this can save a great deal of time and confusion).

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.

Club secretary's should collate the information and pass on the original or copied forms to the MFNZ membership administrator promptly for the issue of an updated membership card showing the qualification(s) achieved.

Appendicies in this document

Basic Multirotor (MR) and Advanced Multirotor (AM)

Basic Multirotor (MR)

The Basic Test

(a) Carry out pre-flight checks as required by the MFNZ Safety Codes and MFNZ Multirotor Certification Appendix document. See appendix 1.

The pre-flight checks are laid out clearly in the MFNZ Multirotor Certification Appendix document. The candidate should also go through the pre-flying session checks, laid out in the MFNZ Members Manual. 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 helicopter for flight.

A tidy flight box and a neat ground layout makes a good impression but bear in mind that that Basic certificate candidates may not have been flying for too long and you should make allowances.

A poor performance in this area is not direct grounds for failing the candidate but can certainly be part of a cumulative fail if other aspects of the performance are below the standard you expect.

Pay 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 area 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.

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

During manoeuvres **(b), (c), (d), (e), (f)** and **(g)** (below) the model should not have deviated significantly from a straight line drawn between the end points. Slight drifting may be permissible in adverse wind conditions, but should be rapidly corrected and put back on the correct course. If the deviation is severe, or the model does not follow the line at all, the candidate should not pass. The hovering speed between the end points is at the discretion of the candidate but must be no faster than a slow walk.

Each stop should be a controlled hover, with any movement being quickly checked, without signs of large over-corrections. The pauses at each hovering point should be about five seconds, other than in (b).

The height of the multirotor should be consistent throughout these manoeuvres with no major deviations.

(b) Take off and hover over the take-off point, with the multirotor at approximately 10 feet, for about twenty seconds and then land.

Take off should be smooth and the lift to 10 feet should be vertical, straight and controlled with the model a comfortable and safe distance in front of the pilot. Once at 10 feet the model should remain stationary and should not oscillate unduly. You should notify the candidate when the hover time of about twenty seconds has passed and ask him to commence with the next part of the manoeuvre. The descent and landing should be smooth and steady with little oscillation on touchdown.

(c) Take off and hover for about five seconds, then hover the multirotor slowly forwards for approximately five metres, stop, and hover for about five seconds.

After the take off and five seconds' hover time and, on your command, the pilot now hovers the model forward, at a slow hovering pace, for about five metres then stopping and hovering for about five seconds. All the previous comments about line, height at approximately 10 feet, speed and steadiness apply and the orientation of the model should still be facing in the same direction as this initial forward hover, as for all the rest of the first set of manoeuvres.

(d) Hover the multirotor slowly sideways for approximately five metres, stop, and hover for about five seconds.

The pilot may choose to perform the initial sideways hover in either direction (to his left or right) and, once you have been told the direction, the candidate should, without turning the model, commence a sideways hover at a height of approximately 10 feet for approximately five metres. Having travelled about five metres the pilot will stop the model and hold it in a steady hover at 10 feet and, with the rear of the model pointing in the same direction as it was when it took off, for about five seconds

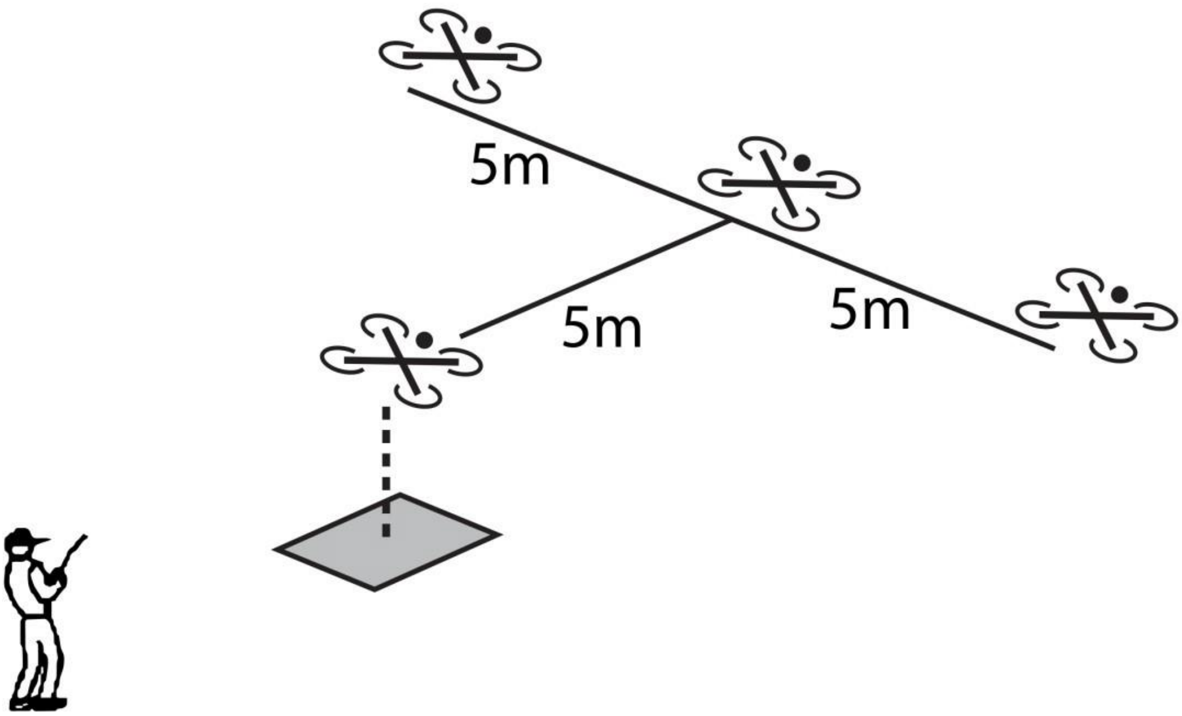
(e) Hover the multirotor slowly sideways in the opposite direction for approximately ten metres (five metres past its original position in front of the pilot), stop, and hover for about five seconds.

At the end of the hover time the pilot, without turning the model, will hover it sideways in the opposite direction, passing in front of them and stopping 5 metres past the centre line.

At this point the pilot will once again stop and hover the model with it still facing in the same direction as it was at take-off.

(f) Hover the multirotor slowly sideways in the first direction to bring it back to its original position in front of the pilot, stop, and hover for about five seconds.

The candidate should, without turning the model, commence a sideways hover at approximately 10 feet for approximately five metres back to the centre marker. Having travelled to the centre marker the pilot will stop the model and hold it in a steady hover for about five seconds at approximately 10 feet and, with the rear of the model pointing in the same direction as it was when it took off.



(g) Fly slowly backwards, bringing the multirotor back to its original position over the take off point, stop, hover for about five seconds and land.

After hovering for about five seconds, the model is hovered backwards (without turning it) to the start position, stopped and hovered for about five seconds above the TOLP with skids at approximately 10 feet. After the hover time, has been completed the model should descend and land close to the original take off point. During this last section, you will be observing the same criteria as previously and the model should have performed as before in relation to the course and at a similar speed. The descent and landing should be smooth and steady with little bouncing on landing, caused by not being level or poor throttle control.

(h) Take off and fly slowly forward for approximately 5 metres, stop and hover for about five seconds. Turn 90 degrees either left or right and fly forward to perform two 'lazy eights', each at least 30 metres in length. Each time the multirotor passes in front of the pilot it must be sideways on to the pilot and throughout the manoeuvre the model must be flying forward, not sideways.

The pilot should make a quick visual check that the area he intends to overfly is clear and that no other models are flying in the near vicinity; you should be watching for definite head movements as they scan the area.

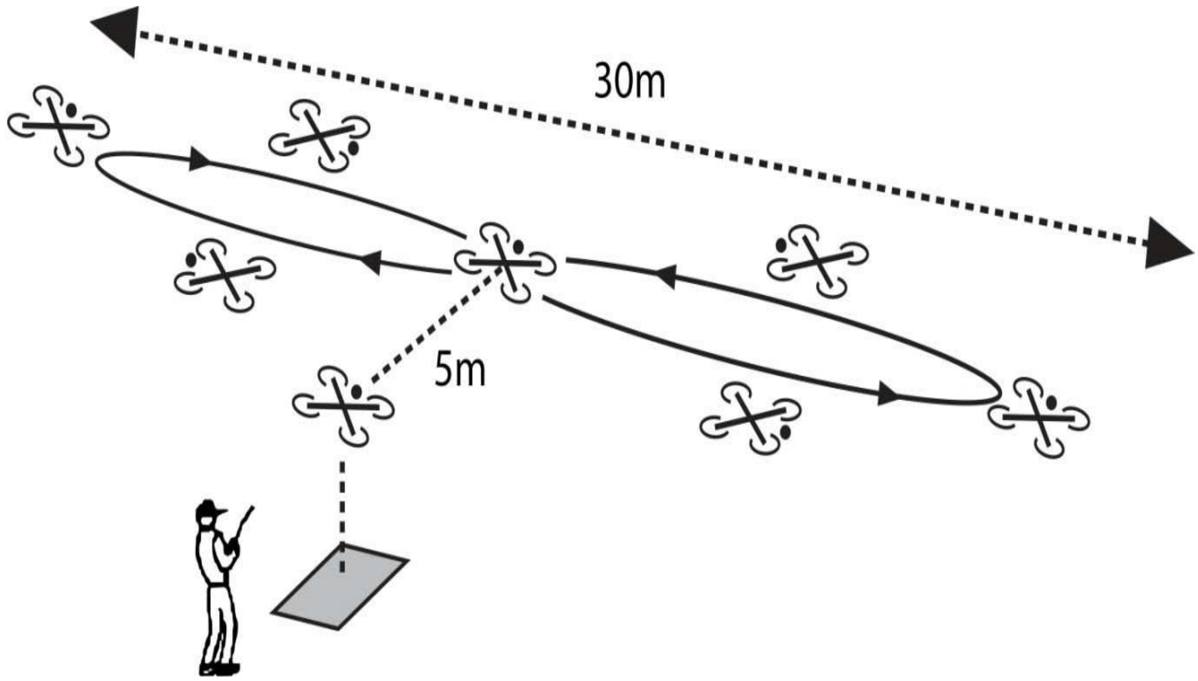
The pilot should fly this manoeuvre at a safe height above eye level, but should not fly at such a height that the model cannot be clearly seen by both the pilot and yourself. Between ten and fifteen feet is the correct height band for this part of the test and the model **must** hover through the lazy eights, not fly through them. The pilot must be clear about the height at which they wish to fly before they take-off and you should discuss this with them in the pre-flight briefing.

Having ensured that it is safe to start the manoeuvre, the pilot then takes the model off, rises smoothly to the flight level previously selected and hovers forwards for approximately 5 metres, stopping over the centre marker and hovering for about five seconds.

The pilot then turns the model 90 degrees, either left or right and, at the same time, slowly moves off forward at about a **walking pace** (but still in the hover). It is not required that the 90 degrees turn is completed before the model accelerates; the turn and acceleration may be one smooth manoeuvre although the pilot may treat them as separate manoeuvres if they wish.

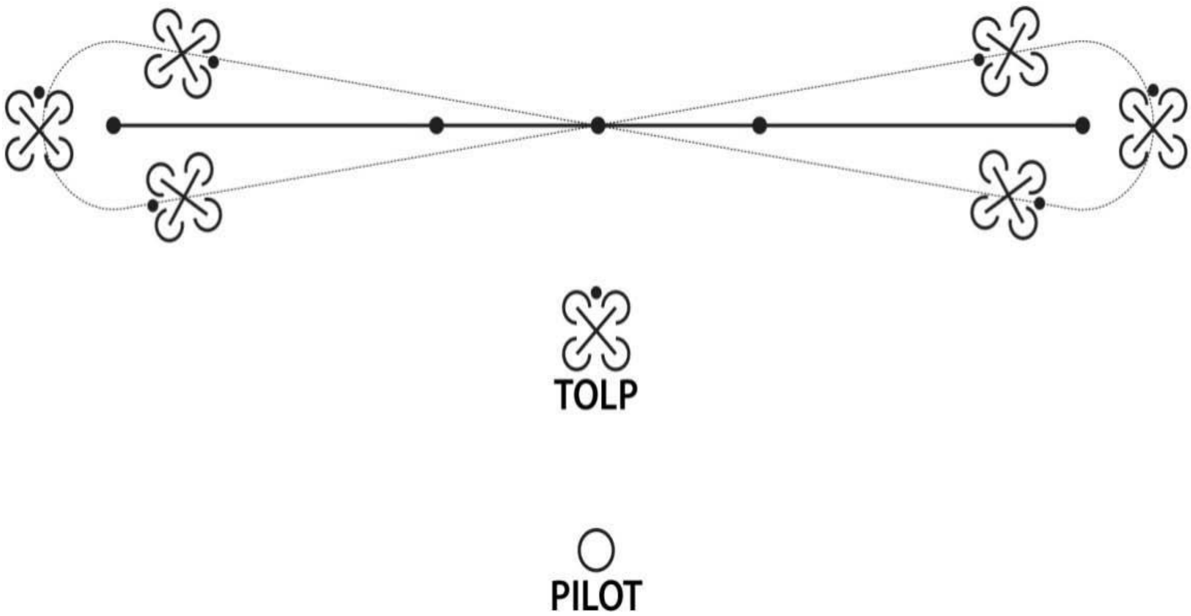
The pilot moves away at his chosen height for about fifteen metres where they begin a turn the model smoothly through 180 degrees, flying forward in the hover all the time, and bringing the model back across in front of them. Without hesitation, the model continues at the same speed in the new direction until it has flown past the pilot for a further fifteen metres to his opposite side. At this point he smoothly executes another 180 degrees turn, causing the model to be now moving in the same direction as the first leg, again hovering across in front of the pilot.

The model does not stop at this point but it then repeats the events of the first lazy eight until two full eights have almost been completed and the model is near or over the centre ground marker.



During the lazy eights, you will be looking for a safe controlled flight throughout. The candidate should not lose or gain height significantly on the turns and should hover in a straight line between the turns with only sufficient drift on the model to prevent it from moving either further away or, more dangerously, closer to oneself during each leg of the manoeuvre. The **overall** length of each eight should be at least thirty metres and the model must be sideways on to the pilot each time it passes across their front.

Some allowance can be made for a strong or gusty wind but the basic points of the manoeuvre must still be demonstrated.



At no time during the manoeuvre should the model be flying sideways. Throughout all the turns and straight flight, it must be flying forward in the hover and not 'crabbing' sideways.

The turns should be made by use of cyclic and rudder co-ordinated correctly, and must **not** be half pirouettes at the end of each leg. The flight pattern should be as the diagram in the MFNZ Multirotor Certification Appendix document (below) and not deviate significantly from it. The pilot should be equally competent to the left and to the right when flying this manoeuvre. If any significant difference in their flying skills shows up here, then you should seriously consider whether they show the degree of competence necessary. It should be borne in mind that the manoeuvres in the test have been made reasonably simple, so that a high degree of control can be demanded.

(i) After the two 'lazy eights', bring the multirotor to a halt side-ways on over the centre marker. Turn the model until the rear of the model is facing the pilot and hover for about five seconds. From this point fly the model to a landing on the original take off point.

At this point the model should be approaching the area of the centre marker, still at the chosen manoeuvre height, and the pilot should aim to smoothly decelerate the model to a stop in front of and sideways onto oneself. The model is then turned to the heading it had before the lazy eights were started and hovered for about five seconds. At this point it should be over the centre marker, about five metres in front of the TOLP and hovering at the standard height.

The model is now flown to a landing at the original take-off point. The path taken is entirely at the discretion of the pilot and you should take the opportunity to watch carefully for a smooth well-thought-out and safe manoeuvre.

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

Remember that electric models must be assumed to be ‘live’ until the flight battery has been disconnected and the handling of the aircraft by the candidate must reflect this during retrieval and in the pits area.

(j) Complete post flight checks as required by the MFNZ Safety Codes.

These are clearly set out in the MFNZ Members manual and MFNZ Multirotor Certification Appendix document (below), but you should pay attention to the correct Rx off, Tx off sequence and ensure that the frequency control system in use is cleared correctly.

The Questions (basic)

The candidate must answer correctly a minimum of **five** of the **Mandatory Questions** (**Annex I**, **questions 1-15**; attached to this document) on safety matters, based on the MFNZ Safety Code for general flying and local flying rules.

The candidate must **also** answer correctly a minimum of **five** questions from the **General** and **Specific Discipline Questions** (**Annex I, questions 16-29 and 45-56**; attached to this document) on safety matters, based on the MFNZ Safety Code for general flying and local flying rules.

It is suggested that the 'questions' are asked before the flying test.

Prior to the 'flying test' the examiner should also ask a minimum of three 'Local site/club Rules'.

Such questions should query the maximum altitude models can fly over the flying site as well as the boundaries of the site together with site 'etiquette' and pilot safety.

Remember, the Proficiency 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 safety questions they should not pass.

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 questions you ask are to be BASED on the MFNZ Safety Code; 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? Why operating transmitters should not be taken out when retrieving models from an active flying area? Or why should models not be flight taxied in or out of the pits area?

Advanced Multirotor (AM)

The Advanced Test

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

The pre-flight checks are laid out clearly in the MFNZ Multirotor Certification Appendix document. The candidate should also go through the pre-flying session checks, laid out in the MFNZ Members Manual. 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 multirotor for flight.

A tidy flight box and a neat ground layout makes a good impression and is to be expected from Advanced 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 candidate’s performance and this is one that may influence a real ‘borderline’ case.

Pay 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 off 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.

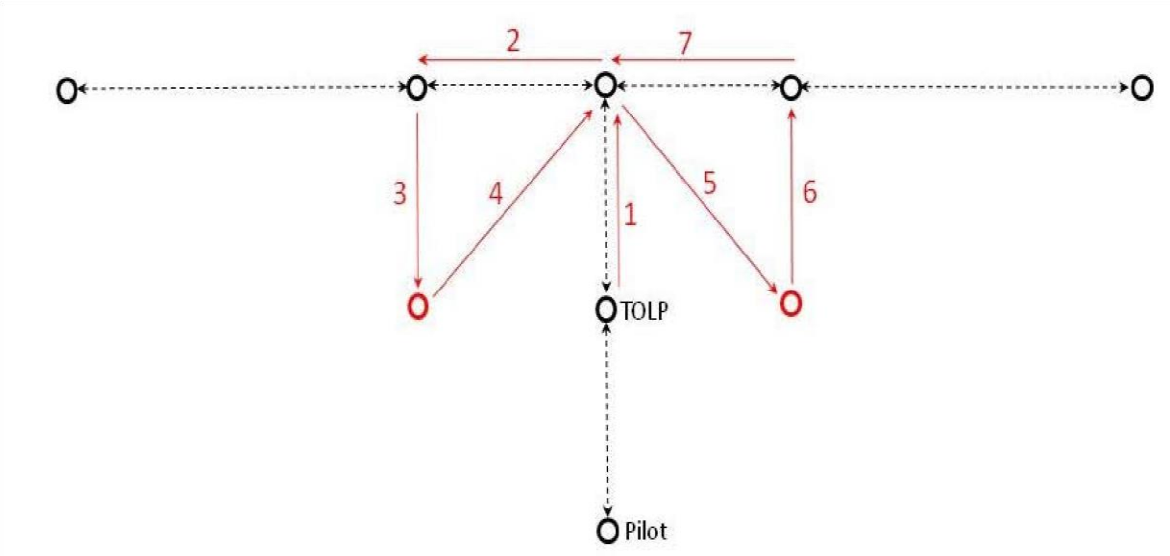
(4) The model then hovers diagonally forward and to the right to a position over the centre marker where it is held and hovered for about 5 seconds.

(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 multirotor 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 at a height of approximately 10 feet 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 15 feet 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 15 feet until the model is once again at a height of approximately 10 feet 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 approximately 10 feet, 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 pilot's 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 two feet high. After again checking for obstacles and obstructions the pilot then climbs out at an angle greater than 45 degrees 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.

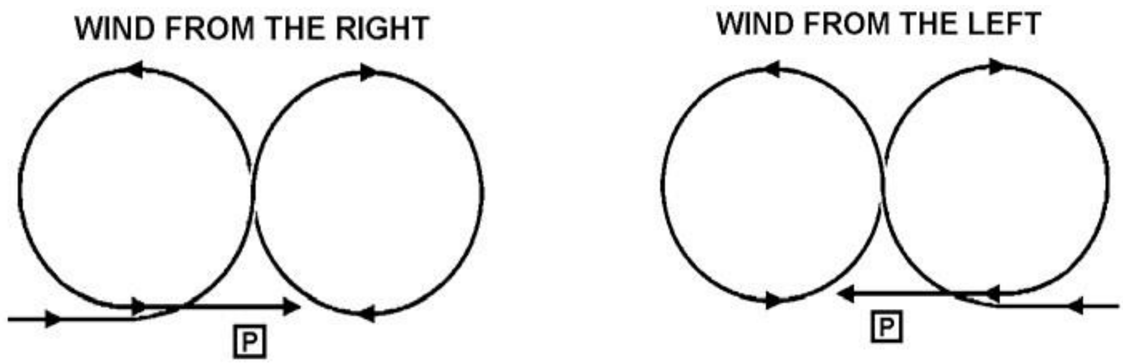
(g) Fly a right hand rectangular circuit.

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 flight line 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 pilot's 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) 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 approximately 10 feet. 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 its 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 must draw your own conclusions. Throttle is typically required always for a multirotor to manoeuvre, 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.

N.B. See Appendix 5 for guidance on completing this manoeuvre.

(k) Perform an approach at 45 degree 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 degrees, 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 degrees descent.

After landing, the candidate should shut down the motors 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 MFNZ Safety Codes.

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

The Questions (advanced)

The candidate must answer correctly a minimum of **five** of the **Mandatory Questions** (**Annex I**, **questions 1-15**; attached to this document) on safety matters, based on the MFNZ Safety Code for general flying and local flying rules.

The candidate must **also** answer correctly a minimum of **eight** questions from the **General** and **Specific Discipline Questions** (**Annex I, questions 16-29 and 45-56**; attached to this document) on safety matters, based on the MFNZ Safety Code for general flying and local flying rules.

It is suggested that the 'questions' are asked before the flying test.

Prior to the 'flying test' the examiner should also ask a minimum of three 'Local site/club Rules'.

Such questions should query the maximum altitude models can fly over the flying site as well as the boundaries of the site together with site 'etiquette' and pilot safety.

Remember, the Proficiency 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 safety questions they should not pass.

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 questions you ask are to be BASED on the MFNZ Safety Code; 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? Why operating transmitters should not be taken out when retrieving models from an active flying area? Or why should models not be flight taxied in or out of the pits area?

Appendix 1 Examiners and Candidates Basic 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 MFNZ Members Manual

Local site rules (if applicable) Safety Code for General Flying ☐

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 may do for them as the test progresses ☐

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

6 Clearly identify the take-off / landing point and agree with the candidate the required hovering times that he will be flying and you will be being looking for. ☐

Appendix 2 Examiners and Candidates Advanced 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 MFNZ Members Manual

Local site rules (if applicable) ☐

Safety Code for General Flying

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 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 Does the candidate understand how you expect to see the model positioned about 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 be looking for. ☐

Appendix 3

Basic CERTIFICATE MULTIROTOR (MR) Examiners Test Flight Check List

CandidatesName	**MFNZNumber**	**Date**	**Signature**
Examiner's Name	**MFNZNumber**	**Date**	**Signature**

	FLIGHT TASK	**COMMENTS**
(a)	Carry out pre-flight checks as required by the MFNZ Safety Codes.	
(b)	Take off and hover tail in over the take off point, with the multirotor at 10 feet, for about twenty seconds and then land.	
(c)	Take off and hover for about five seconds then hover the multirotor slowly forwards for approximately five metres, stop, and hover for about five seconds.	
(d)	Hover the multirotor slowly sideways for approximately five metres, stop, and hover for about five seconds	
(e)	Hover the multirotor slowly sideways in the opposite direction for approximately ten metres (five metres past its original position in front of the pilot), stop, and hover for about five seconds.	
(f)	Hover the multirotor slowly sideways in the first direction to bring it back to its original position in front of the pilot, stop, and hover for about five seconds.	
(g)	Fly slowly backwards, bringing the multirotor back to its original position over the take off point, stop, hover for about five seconds and land.	
(h)	Take off and hover forward for about five metres, stopping over the centre ground marker and hover for about five seconds. Turn 90 degrees either left or right and fly forward to perform two 'lazy eights', each at least 30 metres in length. Each time the multirotor passes in front of the pilot it must be sideways on to the pilot and throughout the manoeuvre the model must be flying forward, not sideways.	
(i)	At the conclusion of the 'lazy eights', bring the multirotor to a halt above the centre ground marker, turn the model tail in to the pilot and hover for about five seconds. Then fly to the original take off point, and land.	
(j)	Complete post-flight checks as required by the MFNZ 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 MFNZ Safety Codes and local flying rules.		

Appendix 4

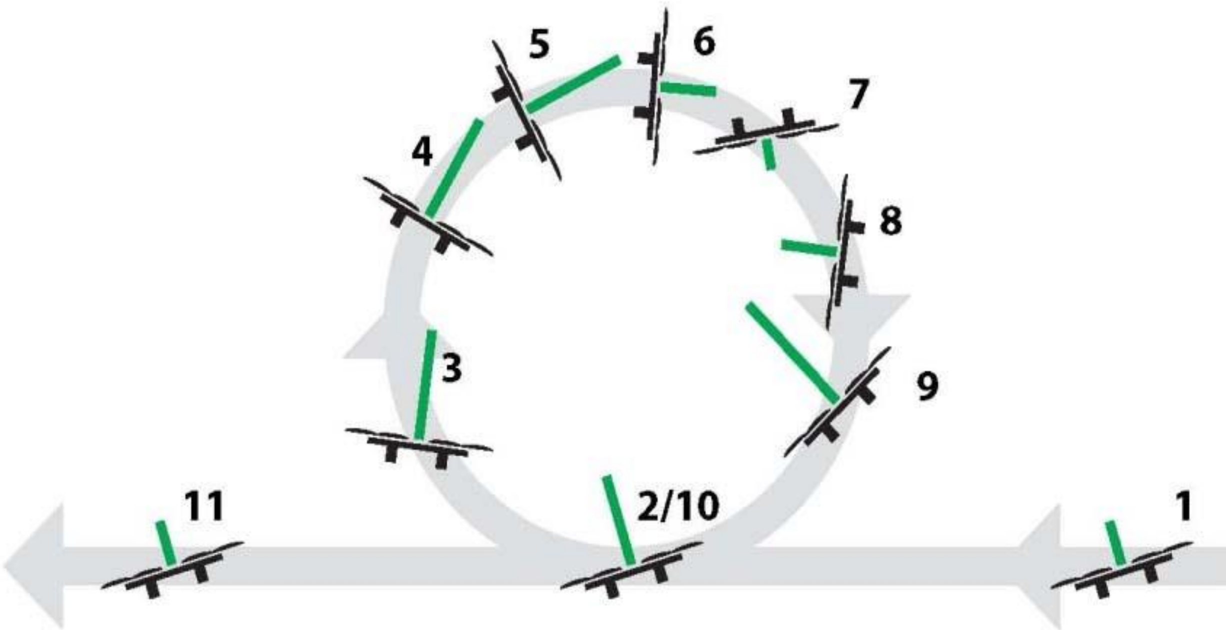
Advanced CERTIFICATE MULTIROTOR (AM) Examiners Test Flight Check List

CandidatesName	**MFNZNumber**	**Date**	**Signature**
Examiner's Name	**MFNZNumber**	**Date**	**Signature**

	FLIGHT TASK	**COMMENTS**
(a)	Carry out pre-flight checks as required by the MFNZ 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 45° to the vertical, landing within a predetermined two metre square	
(l)	Complete post-flight checks as required by the MFNZ Safety Codes	
Answer five questions from the list of mandatory questions on legal aspects of model aircraft flying.		
Answer satisfactorily a minimum of eight questions on safety matters based on the MFNZ Safety Codes for General Flying and Model Flying Displays and local flying rules.		

Appendix 5

Multirotor Loop for Fixed Pitch Multirotors



Technique

- Approach with a nice steady throttle to maintain a constant height, but flying forwards with enough speed to begin the loop.
- In the first quarter of the loop throttle is used to start the multirotor around a circular path, with only a small amount of elevator to maintain shape.
- In the second quarter of the loop, between 4 and 6 the multirotor will rotate to a little under 90 degrees. During these stages throttle is used to essentially drive the multirotor over the top part of the loop.
- In the third quarter of the loop the multirotor is rotated a full 180 degrees while using between 10-25% throttle. At no point, should the throttle be allowed to drop to zero or control can and will be lost.
- In the final quarter of the loop the focus is on using throttle to catch the multirotor while using elevator to finish the shape of the circle and fly out.
- Aim to continue to carry the same speed on exit.

Appendix 7

NB: This is a rough guide that should be adapted to suit your own multirotor

Multirotor 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 / 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 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 being 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 flybar-less 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. For a multirotor 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 multirotors of all formats and sizes could be fitted with none or all 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 / 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.

Multirotor Pre & Post Flight Checks

(A) Checks before daily flying session.

- Check that all rotor blades are in good condition with no damage and securely attached to the motors or blade grips.
- Check for loose or missing nuts and bolts.
- Check all ball links for slop and change as necessary.

- Check there is no backlash in the drive system apart from gear backlash, which should not be excessive.
- Check that servos are secure.
- Check that the receiver aerial is secure and in good condition with no chafing or damage.
- Check that the flight controller is secure and that all aerials including GPS are secure and orientated in the correct direction.
- Check all transmitter switches are in the right positions.

(B) Checks before and after each flight.

- If the multirotor suffers damage or a heavy landing, recheck all (A) above.
- Check all controls before starting especially for binding links or slowing servos.
- Check for vibration and eliminate before flight.
- Check that all wiring is secure and cannot become entangled with any moving or rotating part, especially the receiver aerial.
- Before starting insure all switches are in the correct position for take-off and the correct flight mode selected before **EVERY** flight.
- 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)
- 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 ensure 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 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. Thus,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 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 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 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 multirotor with too much gyro gain will oscillate in the air, where as too little will create a model that rocks or drifts excessively.

A multirotor that appears to "toilet bowl" (drifting around in a circle) typically requires compass recalibration

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, multirotors 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 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. GPS 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 multirotor, 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, whereas 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:

Multirotors 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 multirotor self-stabilises and goes in to a slow decent and **RTH** (return to home), in this mode the multirotor 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 multirotors 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 multirotor. 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.