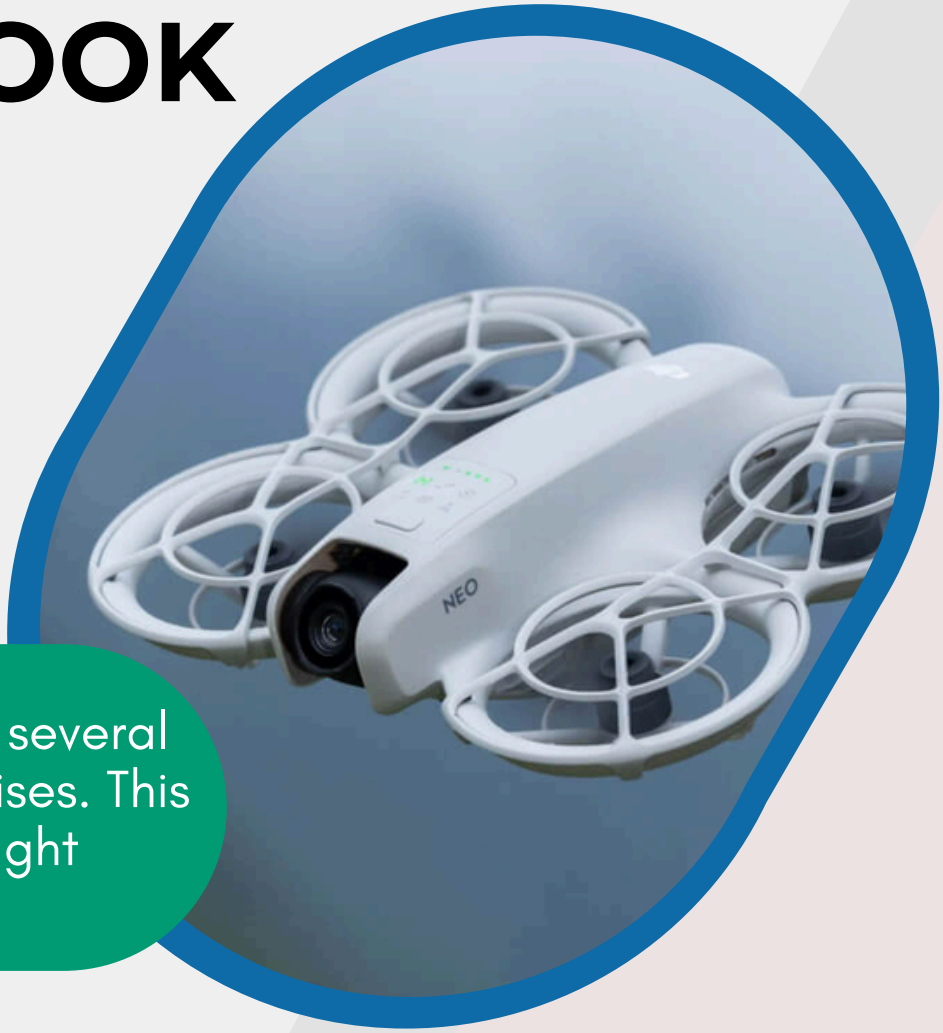
Class One Systems | Actionable Engineering Intelligence

FLIGHT TRAINING EXERCISES HANDBOOK



This handbook describes several UAS flight training exercises. This is for Module 5 of our Flight Training Programmes

Improve your UAS piloting skills with our essential flight activity handbook.

Introduction

Step into Unmanned Aerial Vehicles (UASs) training with our comprehensive handbook on flight exercises.

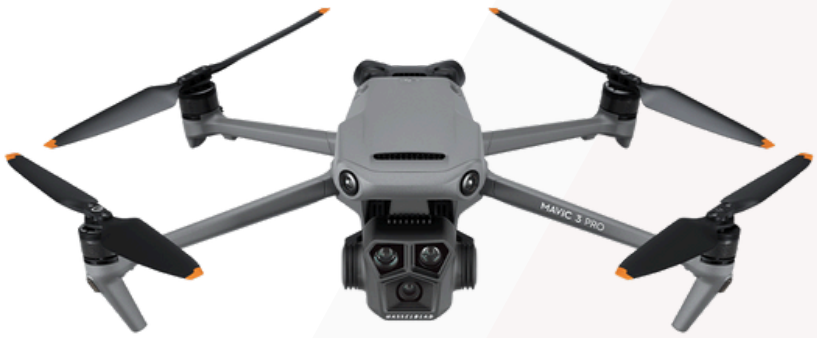
It is designed for aspiring pilots and seasoned operators alike, and is your gateway to honing essential skills, mastering advanced maneuvers, and ensuring safe, efficient operations in diverse environments.

This handbook, which is packed with practical drills, structured activities, and real-world scenarios, emphasises adherence to industry standards.

Whether navigating challenging terrains, performing aerial assessments, or exploring cutting-edge drone technologies, each exercise is crafted to improve your competence and confidence in UAS operations.

With clear instructions, this handbook transforms each flight training into an engaging and rewarding experience, preparing you to soar to new heights in both technical expertise and innovative problem-solving.

Let's take flight!



Basic flight skills

- Using the joysticks on the controller to start the drone, fly upwards, descend, rotate 360 degrees left and right, fly the drone forward, backwards, left, right, landing on the landing pad and shutting down the propellers.
- Push both joysticks in wards 45 degrees and hold till the propellers on the UAS start and then release.
- Using the Left Joystick, push forward to engage UAS upward thrust. The UAS will ascend straight till you reach the highlighted area, then release. Push the joystick backwards to descend the UAS to the highlighted area and release.
- With the UAS hovering, push the left joystick to the left. This will engage rotating the UAS in that direction (left), whilst the UAS hovers. Hold the stick leftwards until the UAS has rotated 360 degrees and then release.
- Then push the left stick to the right, to rotate the UAS 360 degrees in the right direction and release.
- Using the Right Joystick, push forward and the UAS will move towards the highlighted area then release. Pull the joystick backwards and the UAS will fly backwards towards you (notice the UAS is facing backwards). When you reach the highlighted area, release and the UAS will hover.
- Push the joystick to the right and the UAS will fly sideways to the right to the highlighted area and release.
- Push the joystick to the left and the UAS will fly sideways to the left to the highlighted area and release.
- Finally, return the UAS to the landing pad. You would need to descend so you can see the outline of the landing pad. Position the UAS over the landing pad and land. Push both joysticks inwards and hold to power down the UAS.
- The student will gain familiarity with using the left joystick to control ascent/descent and orientation whilst the right joystick controls motion.
- Using Line of Sight.

Shooting skills

- Here switching to Live Feed. The object is to take photos.
- Press C key to switch to live feed. Follow the instructions to see how to capture live feed.
- Camera rotates as the UAS rotates. Pushing the left stick, right or left will rotate the drone in the direction.
- Rotate the camera upwards or downwards whilst the UAS hovers by using the Gimble on the left-hand side.
- Next the pilot will move for a better position. Rotate the camera up to point to the pilot.

- Not operational on the link but using the shutter button on the top right-hand side of the controller will allow you to take photos in reality.
- In the simulator use the Keyboard H – Shutter and L – Record.
- Using the H Key, take a photo of the pilot.
- Next using the L Key, record the pilot for 5 seconds. You can move the UAS around whilst recording.

Flight modes

- Switch flight mode using the V Key on the keyboard.
- Switch to A Mode, press the V Key and you will the instrument panel showing A. Next switch to P Mode.
- P Mode (Positioning) – allows the UAS to fly precisely and auto brake when controls are released and or objects come within the collision zone.
- Fly the UAS to the Right to reach the highlighted area. UAS will auto brake. Next, fly the UAS to the left to the highlighted area.
- Switch to S Mode and press the V Key.
- S Mode (Sport) – will allow the UAS to hover at a specified location and brake automatically. The UAS will fly faster so fly with caution.
- Fly the UAS to the Right to the highlighted area and then fly to the Left to the highlighted area.
- Switch to A Mode and press the V Key.
- A Mode (Attitude) – the GPS function is unavailable and attitude stabilization is on. Most new UASs no longer have this feature. The UAS is difficult to control as it will not hover in one place and will not auto brake when the controls are released.
- Fly the UAS to the light beam and try to hover inside it.

Hovering skills

- There are seven levels in this section. All are to be done in A Mode, at a height of 1mtr. The trainee can use P Mode to start. The object is to hover over the specified targets for some time.
- Single Target
- Multiple Target
- Fixed Orientation Hovering
- Four Direction Hovering
- Single Target with wind
- Multiple Target with wind
- Four Directions with wind.

The trainee with gain confidence with joystick controls.

Flight route skills

There are **eight levels** in this section. All to be done in A Mode, but the user can engage P Mode. The objective is to follow the route highlighted in blue. As you follow the route, the blue lines turn green. There is a timer. Once completed, the programme will highlight the route you took in playback.

- Rectangular Overhead
- Rectangular Route – ground view
- Square Overhead
- Square Route – ground view
- Round Route Overhead
- Ring Route – ground view
- 8 Shape Route Overhead
- 8 Shape Route – ground view

The trainee will be able to gain confidence in using the joysticks while flying.

UTC Power grid inspection test

1**Preparation**

The trainer will ask What is required for preparation for the flight. Responses such as ensuring the controller is set to P Mode, unfolding and locking UAS arms into place, GPS Support, the Remote controller is switched on then powering up the UAS, checking that the batteries are fully charged, opening the DJI Pilot app and checking the UAS status. You may need to calibrate the compass for long-distance missions.

Route Test

- Fly the UAS through A-B-C-D facing forward. Flight mode should be A Mode with a height of 2m.
- Change the POV by using the C Key and use the left gimble to adjust the camera view. Using the map and the camera view, follow the course.
- Return to home point and land, and power off.

Hover Test

- Here, spin/rotate the UAS at a constant speed in the hover area.
- Flight mode should be A Mode with a flight height of less than 3m.
- C Key to switch POV and Left Gimble to pan the camera up and down.

Multi-Dimensional Operation Test

There is a video here to illustrate what is required.

- Take off from point A fly to point B, and return. Fly at a constant speed.
- Repeat the process 4 times and land on point A.
- Whilst performing this operation, change the UAS orientation each time it returns to point A(forward, backwards, left and right respectively).
- Fly in P Mode and use POV.

BVR Operation Test

- Take off from point A, switch the view to FPV and fly through the frame. Be careful of the height of the frame.
- Find and take a photo of all 6 QR Codes with a shooting distance of less than 2m. Use the mouse to zoom in on the QR by clicking the cross point and scrolling in. Pull down on the right joystick to return to normal view. Use the H key to take a photo.
- Fly back through the frame in FPV
- Land at point A
- Set in P Mode
- Complete inside of 12mins.

End of Operation

- Evaluation: Verbal questions on ending mission, such as powering off the controller and UAS, removing batteries, folding in arms and securing etc.

UTC Public Safety test

This is to test the user's awareness of the surroundings in a controlled environment. It's a combination of questions and flight activities in A Mode.

- Preparation for flight - Questions, such as setting up the UAS, battery check, DJI Pilot app, etc.
- Hover Test - Done in A Mode at a height of no less than 3m, the candidate must spin the UAS once at a control speed, whilst hovering in an area. There is a video demo.
- Operation Test - Done in A Mode at a height of 2m, the candidate will be required to fly the UAS from A to B to C to D, facing forward. There is a video demo.
- Try using Line of Sight.
- You can use the POV - and use the map to follow the line course or use the gimble to angle the camera to see the path.

Public Arena

a. There are 5 vehicles lettered A to E

A – Police – 88888
B – Jeep – YS567
C – Mini Van – 6S77V
D – Nissan 350Z – 003J7
E – Pick Up – 33946

b. There are 5 vehicles numbered 1 to 5

1 – Nissan Infiniti – 4P323
2 – RV – 0V0E0
3 – Chevy SUV – PD666
4 – Corvette – 99732
5 – Dump Truck – DJ188

Internal audit test

Here the candidate will be assessed on UAS technical skills in both P & A Mode.

- Preparation – The user will be asked what is required before you start your mission, such as unpacking UAS, powering up units, etc
- Take Off & Landing – There is a short video clip. The user is required to throttle up slowly to an altitude of 2m and hover. Then return to home plate and land.
- Rectangular Flight – Here the candidate can change the Point of View, using the C Key on the keyboard. Flying from A to B to C to D, flying facing forward. The user will fly at a height of 2m and must use a Horizontal and Vertical Camera view to maintain accuracy. They can use the map view.
- Circle – Here the candidate can change the Point of View. Candidate to fly at a height of 2m and done in P Mode only. Use the table as a reference point.
- Hover Test – Here the candidate can change the Point of View. Candidate to hover backwards for 5 secs, then forward for 5 secs, then leftward for 5 secs and finally rightward for 5 secs in P Mode then repeat in A Mode for 3 secs. Carry the UAS to the edge of the circle to hover. Set the flight view to flat so you can see the circle.
- End of Mission – The candidate will be asked how the mission ends. Power down the controller and UAS, pack away, etc.

Free flights

There are seven free flights in this section. They can be done in the flight mode(s) of your choosing. The objective is to improve control of the device in a multi-influence setting. These flights are great for developing the skill of using the drone camera for not just images/video but also for navigation. Also great for learning to blend flight modes.

1) Farm 2) Hanger 3) City 4) Island 5) Mountain 6) Forest 7) Custom scenario

The pilot will be able to gain confidence in using modes and the camera as part of flight control.

Entertainment module

Select Entertainment from the menu on the main screen then select the UAS and select Flight Mode.

In this section, you have a Time Trial, Tunnel Run and Bubble Race

- **Time Trial** – Fly along designated flight paths and fly through every checkpoint. Complete the course as fast as possible to score the most points. Fly in either A Mode, P Mode or S Mode.
- **Tunnel Run** – Pass through energy rings to get points and gain more time. Fly fast to rank higher.

Bubble Race – Fly along the path to collect as many bubbles as possible.

Search and rescue

A hiker is lost in the woods. You start from where his car is parked and try to find him by looking for clues.

- Start the UAS and take off. Climb to a high enough altitude. Change the POV, adjust the camera view and rotate the drone whilst hovering to look for clues. You can use the mouse to zoom the camera in, by clicking on the screen (you will see a green +). The camera on the simulator is Zenmuse Z30 which features 30x optical zoom and 6x digital zoom. This is only available on the MATRICE 210 RTK UAS. Fly this UAS in Drone FPV or Remote-Control View and use the mouse to zoom in.
- Fly around and look for clues like smoke, temporary shelter, food etc.
- You will experience interference and signal loss.

Real-life practical exercises

Some practical exercises you can do to home in on your skills, providing you have a UAS of any make. These exercises will allow you to get better and more skilled in dual joystick control. It will make you become a safer Pilot and better prepared for different emergency scenarios. You will become a professional UAS operator.

In these exercises, you will be using your controller, where the configuration is Left Stick controlling up/down/yaw and Right Stick controlling forward/backward/left/right. Done mostly in P Mode for safer control, auto braking and hovering. If you have an older UAS with A (ATTI) Mode, you can try some of these when you feel confident.

NIST standard flight activities

Group 1

- **Position hold** - Maintain a fixed position in the air for a specified duration.
- **Traverse** - Fly a straight path from one point to another.
- **Rotate hold** - Hold a fixed orientation while rotating around a central point.
- **Descend and climb** - Ascend and descend to specific altitudes accurately.
- **Accurate land** - Land the UAS precisely on a designated spot.
- **Visual acuity test** - Identify and focus on specific visual targets (e.g., color, thermal, or hazmat labels).
- **Obstacle avoidance** - Navigate around obstacles without contact.
- **Sensor test** - Use onboard sensors (e.g., cameras, thermal imagers) to perform specific tasks.
- **Simulated search and rescue** - Conduct a search pattern to locate a target.
- **Emergency procedures** - Execute emergency landing or return-to-home procedures.

Group 2

- **Payload drop** - Accurately release a payload at a specific location.
- **Precision hover** - Hover precisely over a moving target.
- **Multi-waypoint navigation** - Fly a pre-programmed route with multiple waypoints.
- **Formation flight** - Fly in coordination with other UASs.
- **Inspect Infrastructure** - Perform detailed inspections of infrastructure like bridges or power lines.
- **Map generation** - Create a 3D map of a specified area using onboard sensors.
- **Communications relay** - Act as a relay point for communication signals.
- **Live stream video** - Stream live video footage to a ground station.
- **Weather resistance test** - Operate in various weather conditions to test resilience.
- **Dynamic mission re-tasking** - Adapt to changing mission parameters and objectives in real-time.

Entertainment module

- **Observation before mission flight:** Hover your UAS to eye level for 10 to 15 seconds. Observe and listen for any abnormal noises. If something doesn't sound right, land UAS, power down and have the unit serviced by a qualified technician.
- **Hover and Yaw**: for UAS movement, you have Thrust, Yaw, Pitch and Roll. Yaw is when you rotate the UAS on one axis. The left stick will allow you to rotate either left or right depending on the direction you push the stick.
- **Target Practice:** Here you want to create a couple of landing targets about 3m apart. Start with 2. Take off from point A and bring the UAS to eye level and hover. Then fly the UAS to point B, Hover and then land. Return to point A and power down.
- **Fly in a Square pattern with No YAW:** Here you want to create a square box with landing points A, B, C & D about 3m apart. Bring the UAS to eye level above point A. If the front of the drone is facing you at point A, fly at a safe and consistent speed to point B and hover there. If B was behind A, this would mean flying backwards. If C is to the right of B, fly the UAS sideways to C and hover. Then fly towards point D and hover. Obviously, to complete the square, fly sideways to the left to point A, hover and land and power down. Gaining experience of using the right joystick.
- **Fly in a Circular pattern at eye level:** This is a bit difficult but try to maintain a constant speed. Use your right thumb to control the right joystick and maintain a control diameter. Then try in the opposite direction.
- **Fly away from, back to and land at eye level:** This introduces UAS rotation. Bring the UAS to eye level and hover. Yaw the camera 180 degrees so it is pointing away from you. Fly the UAS, 3m, away from you by moving it forward facing. Then stop and hover. Yaw the camera 180 degrees so that the camera is facing you. Fly the UAS back to you, flying forward. Stop, hover and land. This allows hand-eye coordination and perception and directional awareness.
- **Fly in a Square pattern with Yaw at eye level.** Once again, bring the UAS to eye level. Using 4 markers (corners of the square about 3m apart), yaw the UAS to point it to the first corner marker and fly towards it and hover. Then yaw the UAS to the next marker fly towards it and hover. Then yaw the UAS to the next corner marker and fly towards it and hover and then yaw the camera facing you and fly the UAS towards you and hover and land. You can increase the distance or try it faster.
- **Fly at a Maximum altitude of 400ft / 120m.** Once you are in a safe clear area or field, set the height on the controller or app to 400ft then fly the UAS to that height. Once the height is achieved the drone will automatically brake and hover. Yaw the UAS and land.
- **Bird Eye View or Top-Down View**: Here bring the UAS at eye level and using the gimble controller wheels on your controller tilt the camera on the UAS 90 degrees downwards. Your controller's POV screen should show the ground. Then adjust the camera upwards. You can do this at different heights.

Entertainment module

- **Orbit Effect or Point of Interest:** This is where the UAS is circling an object or a point of interest. You will be using Yaw and movement controls together. Bring the UAS to eye level slowly and hover. Let the camera focus on you and fly the UAS around you keeping you in the frame. Or for easier control, using the DJI App, select yourself as the Point of Interest (POI) and the UAS will lock onto you as the target. As you fly the UAS, it will focus on you or the selected POI.
- **Return to Home**: On your controller set the home point, which is the location from where the UAS will take off and check the height above sea level. Fly the UAS about 5m away from you and stop. Press the return to home button on the controller and the UAS will return to the point of take off and land. This is useful when want the UAS to return. On the smart controller, when the UAS battery reaches a low level, the UAS will engage a return-to-home warning.
- **DRONIE:** This is a fun exercise. Bring the UAS to eye level and hover with the camera facing towards you. Now fly the UAS away from you, backwards keeping you in the frame, at a constant speed. As you are carrying out this action, increase the height of the UAS as it is moving backwards. Ensure you are kept in the frame. Then return the UAS forward to you, hover and then land.
- **Fly close to objects**: When doing this action, you would need to disable or switch off the object collision sensor and fly slowly and cautiously.
- **Tripod Mode (T Mode):** This allows you to fly the UAS slow so that you can take stable photos or videos.
- **Fly without GPS:** This is difficult. Flying indoors. Hovering will be difficult as the UAS won't stay still (Atti Mode).