

Aerial Drone Tests and Scorable Scenarios for Evaluating System Capabilities and Remote Pilot Proficiency in Level 3 Open, Level 4 Obstructed, and Level 5 Confined Environments

Developed by the National Institute of Standards and Technology



Test Director

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U.S. Department of Commerce

Sponsor:

Systems Engineering & Standards Division
Science and Technology Directorate
U.S. Department of Homeland Security

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Level 1 - 3 Open Environments

LEVEL

1



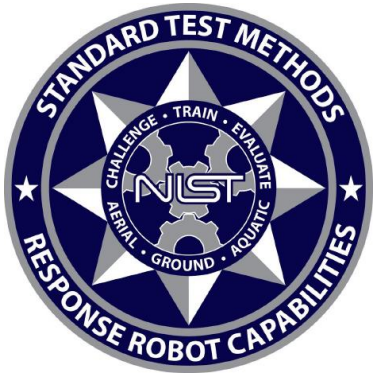
OPEN Test Lane

Basic Proficiency/Safety Checkride

Evaluate positive aircraft control in quick trials for novices and recreational pilots using the first 2 of 5 flight paths.

- *10 minutes (5 minutes each)*
- *40 Alignment Points*





 **LEVEL 1 | OPEN LANE**
BASIC PROFICIENCY

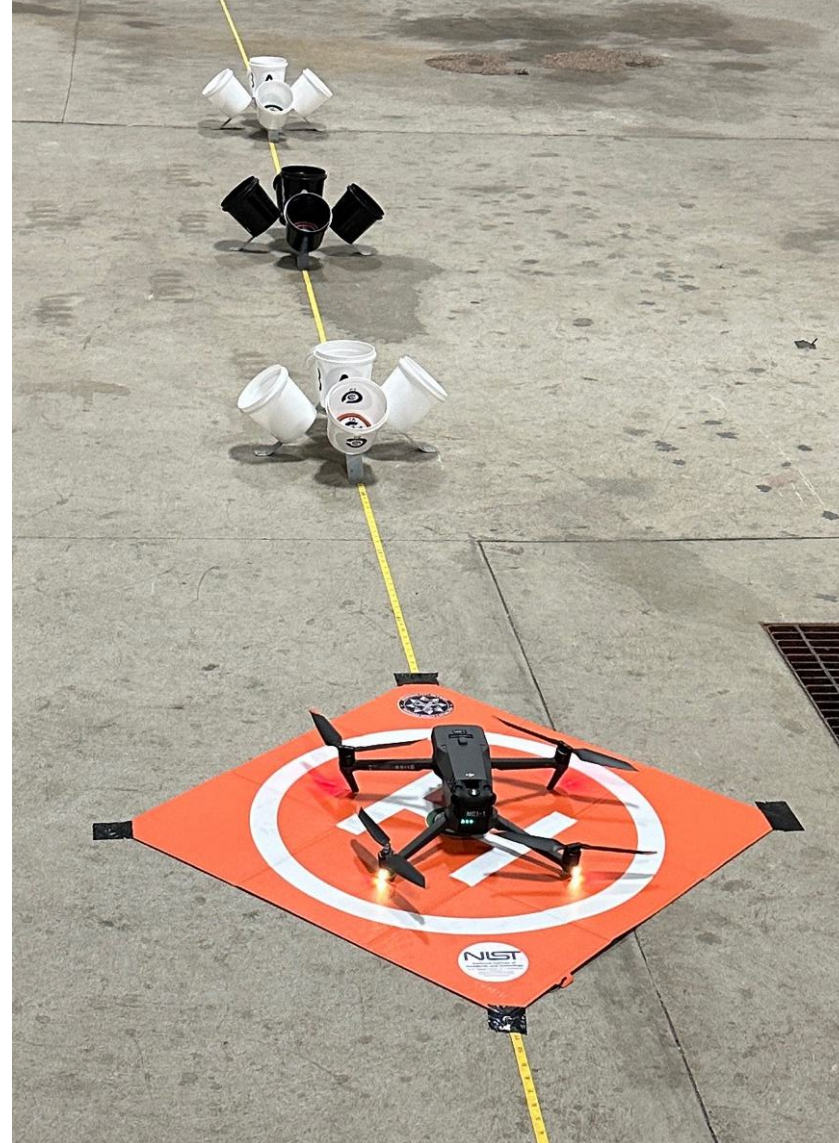


Omni Stand



Level 1 Open Lane

 **LEVEL 1 | OPEN LANE**
BASIC PROFICIENCY





Level 1 Open Lane Setup

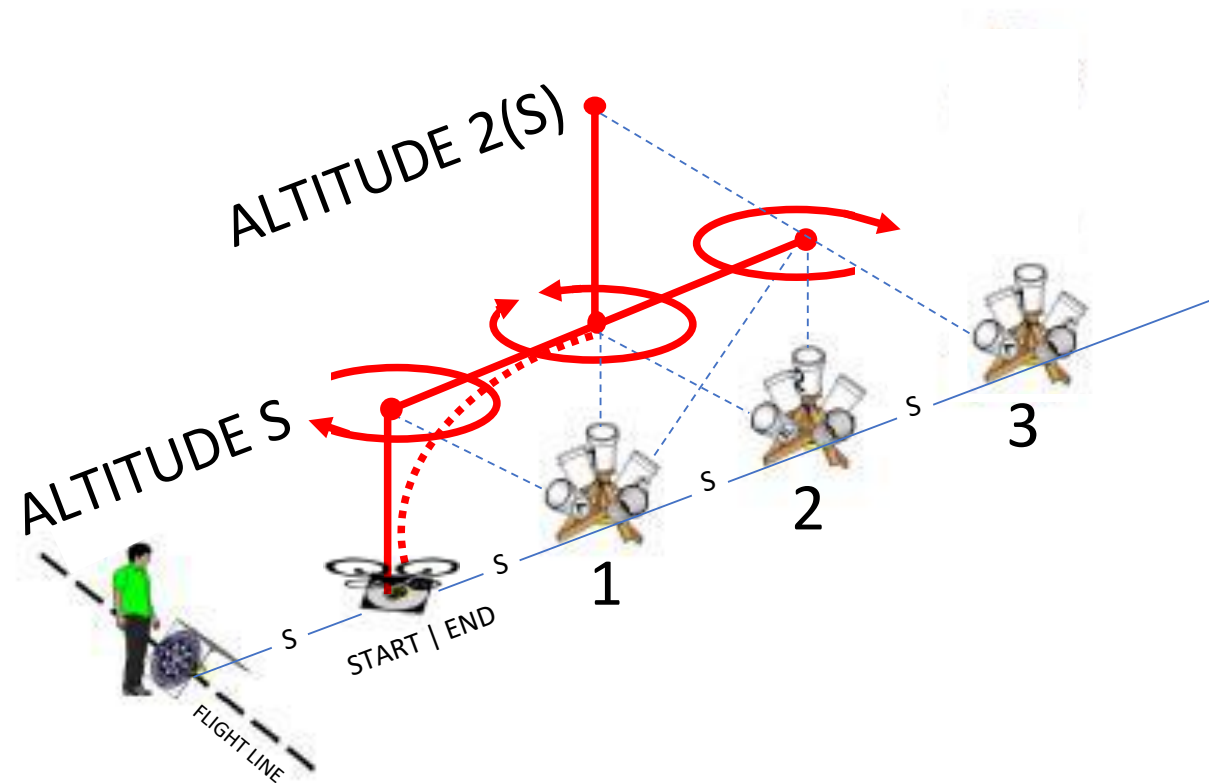
Using 10cm(4in) Buckets;

- Open Stands 1, 2, and 3 with a 1.5m(5ft) spacing

Area required 6 x spacing long (9m-30ft) x 6 x spacing wide (9m-30ft) x 2.6 x spacing high (4m-13ft)

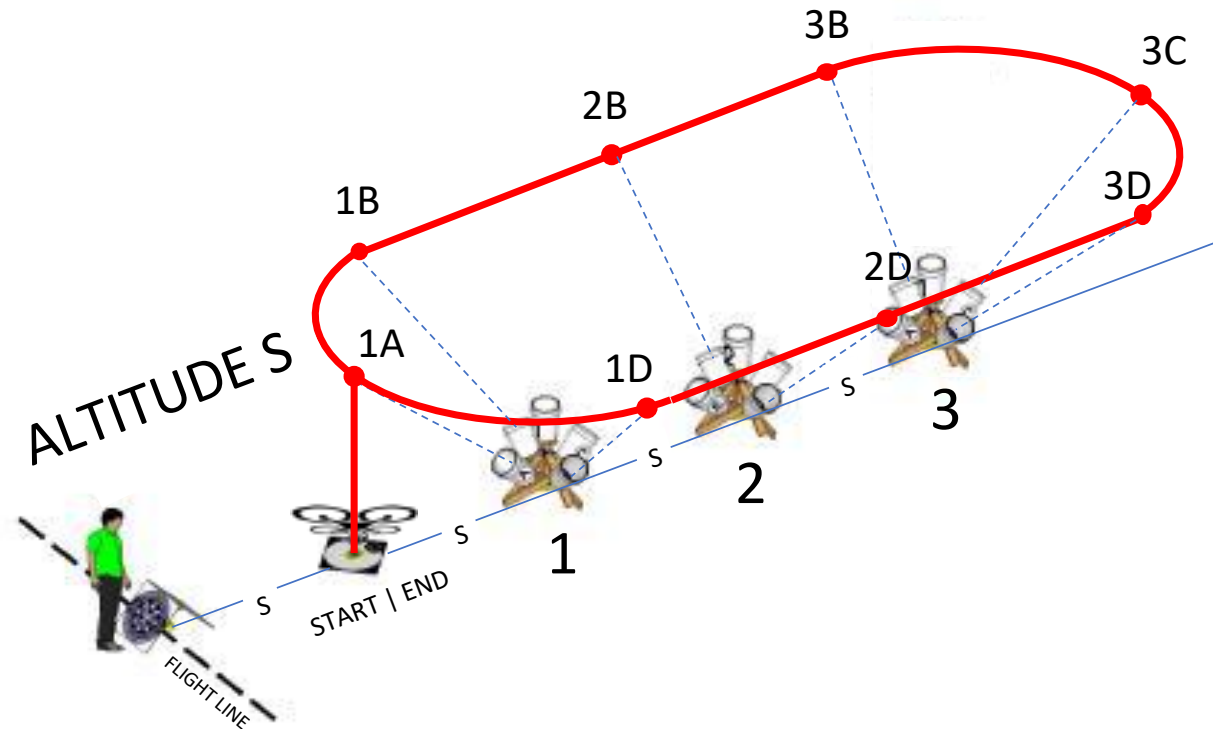
Position (MAN/PAY 1)

Open Test Lane



Traverse (MAN/PAY 2)

Open Test Lane



VERSION 2023A

LEVEL 1 | OPEN LANE BASIC PROFICIENCY



Pilot LAST Name _____

Pilot FIRST Name _____

Pilot Organization _____

Drone Make _____

Drone Model _____

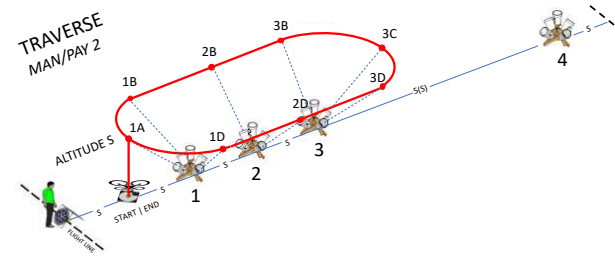
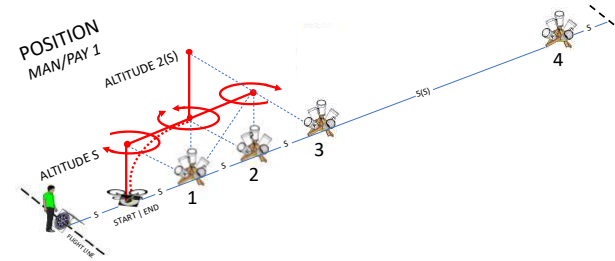
Facility Location _____

Date (YYYY/MM/DD) _____ Team #: _____

PROCTOR NAME _____

BUCKET DIAM.		LANE SPACING (S)			VISIBILITY		WIND		PILOT VIEW		TIME LIMIT	
4 IN (10 CM)	8 IN (20 CM)	5 FT (1.5 M)	10 FT (3 M)	20 FT (6 M)	LIGHTED 300+ LUX	DARK < 1 LUX	AVERAGE MPH	GUSTS MPH	LINE OF SIGHT FACINE LANE OPTIONAL V.O.	INTERFACE ONLY BACK TO LANE MANDATORY V.O.	5 MIN	10 MIN
(CIRCLE ONE)		(CIRCLE ONE)			(CIRCLE ONE)		(FILL IN)		(CIRCLE ONE)		(CIRCLE ONE or FILL IN)	

ALIGNMENT SCORE: Circle bucket identifiers for images with UNBROKEN RINGS. Strike through all BROKEN RINGS and incomplete buckets.



CAPTURE ONLY ONE IMAGE OF EACH BUCKET – CIRCLE ALIGNED IMAGES AND LANDINGS

CAPTURE PRE-LAUNCH CLOCK IMAGE – LAUNCH TIME (HH:MM:SS)	:	:
POSITION TEST – FLYING ALONG CENTERLINE		
CIRCLE ALIGNED		
1 LAUNCH AND HOVER OVER STAND #1 TO ALIGN WITH	1	2A
2 YAW LEFTWARD 360° OVER STAND #1 TO ALIGN WITH	1	2A
3 YAW RIGHTWARD 360° OVER STAND #1 TO ALIGN WITH	1	2A
4 CLIMB VERTICALLY OVER STAND #1 TO ALIGN WITH	1	3A
5 DESCEND VERTICALLY OVER STAND #1 TO ALIGN WITH	1	2A
6 PITCH FORWARD OVER STAND #2 TO ALIGN WITH	2	3A
7 PITCH BACKWARD OVER STAND #1 TO ALIGN WITH	1	2A
8 PITCH FORWARD OVER STAND #2 THEN YAW LEFT 180°	2	1C
9 PITCH FORWARD OVER LANDING THEN YAW RIGHT 180°	1	1A
10 LAND IN CIRCLE (ONE OR MORE LEGS) – WORTH 2 POINTS	1pt	1pt
TRAVERSE TEST – FLYING LEFTWARD		
CIRCLE ALIGNED		
11 HOVER OVER THE LAUNCH PLATFORM TO ALIGN WITH	1A	
12 ORBIT 90° LEFTWARD AROUND STAND #1 TO ALIGN WITH	1B	
13 ROLL LEFTWARD TO STAND #2 TO ALIGN WITH	2B	
14 ROLL LEFTWARD TO STAND #3 TO ALIGN WITH	3B	
15 ORBIT 90° LEFTWARD AROUND STAND #3 TO ALIGN WITH	3C	
16 ORBIT 90° LEFTWARD AROUND STAND #3 TO ALIGN WITH	3D	
17 ROLL LEFTWARD TO STAND #2 TO ALIGN WITH	2D	
18 ROLL LEFTWARD TO STAND #1 TO ALIGN WITH	1D	
19 ORBIT 90° LEFTWARD AROUND STAND #1 TO ALIGN WITH	1A	
20 LAND IN CIRCLE (ONE OR MORE LEGS) – WORTH 1 POINT	1pt	
TRAVERSE TEST – FLYING RIGHTWARD		
CIRCLE ALIGNED		
21 HOVER OVER THE LAUNCH PLATFORM TO ALIGN WITH	1A	
22 ORBIT 90° RIGHTWARD AROUND STAND #1 TO ALIGN WITH	1D	
23 ROLL RIGHTWARD TO STAND #2 TO ALIGN WITH	2D	
24 ROLL RIGHTWARD TO STAND #3 TO ALIGN WITH	3D	
25 ORBIT 90° RIGHTWARD AROUND STAND #3 TO ALIGN WITH	3C	
26 ORBIT 90° RIGHTWARD AROUND STAND #3 TO ALIGN WITH	3B	
27 ROLL RIGHTWARD TO STAND #2 TO ALIGN WITH	2B	
28 ROLL RIGHTWARD TO STAND #1 TO ALIGN WITH	1B	
29 ORBIT 90° RIGHTWARD AROUND STAND #1 TO ALIGN WITH	1A	
30 LAND IN CIRCLE (ONE OR MORE LEGS) – WORTH 1 POINT	1pt	
CAPTURE CLOCK IMAGE AFTER LANDING – LAND TIME (HH:MM:SS)	:	:
STOP THE TIMER OR CALCULATE RESULT – ELAPSED TIME (MM:SS)	:	:
/ 40 MINIMUM PASSING SCORE – TOTAL SCORE (POINTS)		
CIRCLE ONE: FAIL (SCORE TIME SAFETY) OR PASS		

Scoring Alignment Points

Capture images of alignment rings to verify

ALIGN WITH BUCKETS AND LAND ACURATELY

20 ALIGNMENTS TOTAL UP TO 100 POINTS



- Align with each bucket to capture a SINGLE IMAGE of the inscribed alignment ring. Only the first image is scored.
- Score captured images as:
 - UNBROKEN RINGS (5 points)
 - BROKEN RINGS (1 point)
 - NO RINGS (0 points, strike through line)
- Score accurate landings as:
 - CENTERED (5 pts) with the aircraft center point inside the 60 cm (24 in) diameter circle.
 - OFFSET (1 pts) with at least one propeller motor inside the circle.
- Verification of captured alignment images can be during the trial when obvious or after the trial to eliminate discussions during the trial. Images can also be stored for documentation.

POSITION TEST – FLYING ALONG CENTERLINE		CIRCLE ALIGNED
1	LAUNCH AND HOVER OVER STAND #1 TO ALIGN WITH	1 & 2A
2	YAW <u>LEFTWARD</u> 360° OVER STAND #1 TO ALIGN WITH	1 & 2A
3	YAW <u>RIGHTWARD</u> 360° OVER STAND #1 ALIGN WITH	1 & 2A
4	CLIMB VERTICALLY OVER STAND #1 TO ALIGN WITH	1 & 3A
5	DESCEND VERTICALLY OVER STAND #1 TO ALIGN WITH	1 & 2A
6	PITCH FORWARD OVER STAND #2 TO ALIGN WITH	2 & 3A
7	PITCH BACKWARD OVER STAND #1 TO ALIGN WITH	1 & 2A
8	PITCH FORWARD OVER STAND #2 THEN YAW <u>LEFT</u> 180°	2 & 1C
9	PITCH FORWARD OVER LANDING THEN YAW <u>RIGHT</u> 180°	L & 1A
10	LAND IN CIRCLE (ONE OR MORE LEGS) – WORTH 2 POINTS	1pt & 1pt

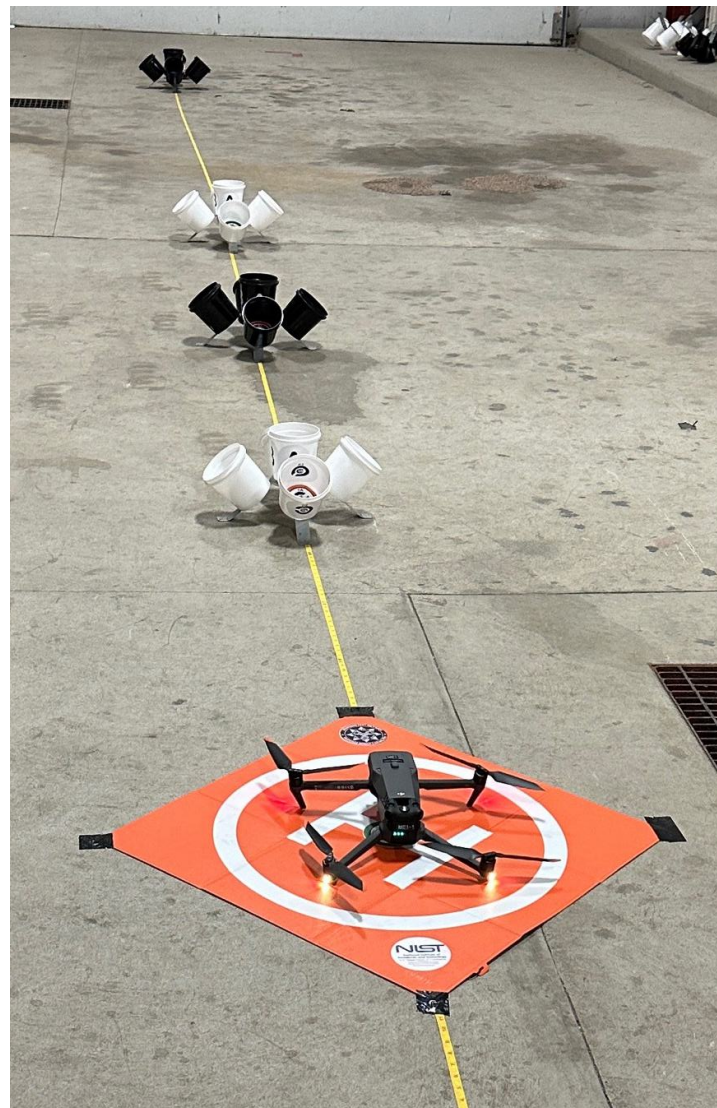
<p>LEVEL 2 M</p>	<p>OPEN Test Lane Maneuvering Trials</p> <p>Evaluate open area maneuvering around ground objects using all 5 flight paths with no additional pilot workload.</p> <ul style="list-style-type: none">• <i>25 minutes (5 minutes each)</i>• <i>100 Alignment Points</i>
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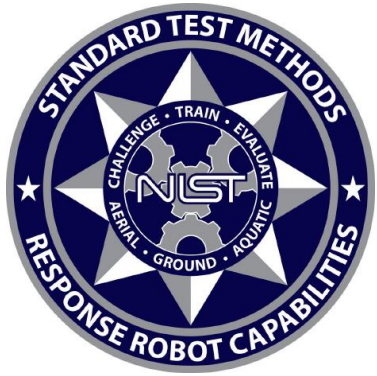




Level 2 Open Lane

M LEVEL 2 | OPEN LANE
MANEUVERING ONLY





Level 2 Open Lane Setup

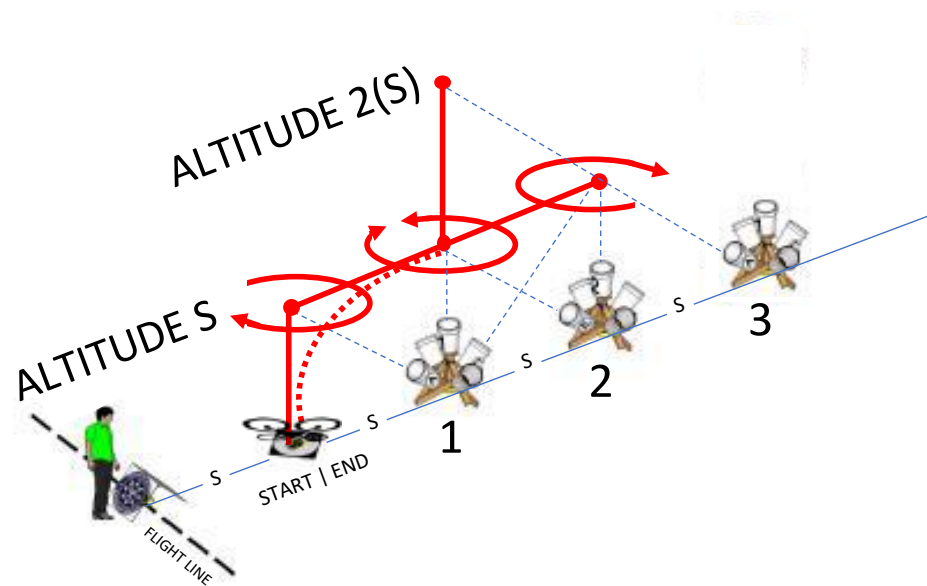
Using 10cm(4in) Buckets;

- Open Stands 1, 2, 3, and 4 with a 1.5m(5ft) spacing

Area required 10 x spacing long (15m-50ft) x 6 x spacing wide (9m-30ft) x 2.6 x spacing high (4m-13ft)

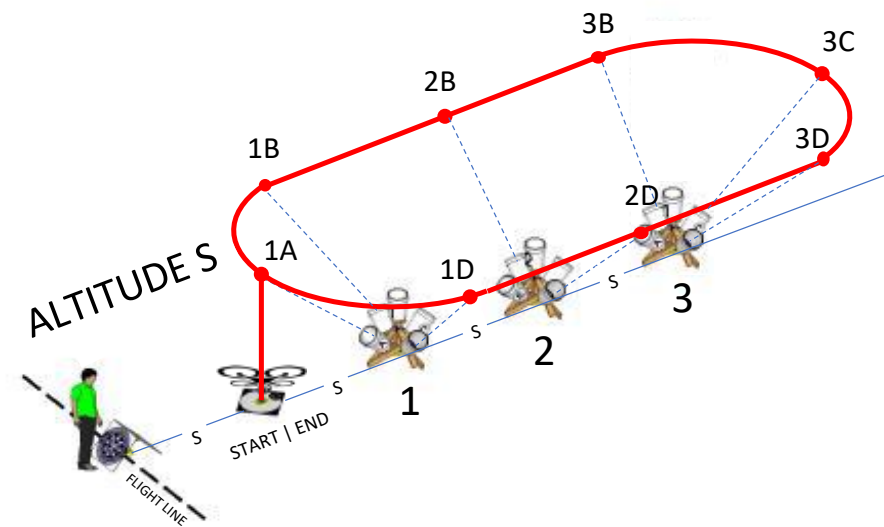
Position (MAN/PAY 1)

Open Test Lane



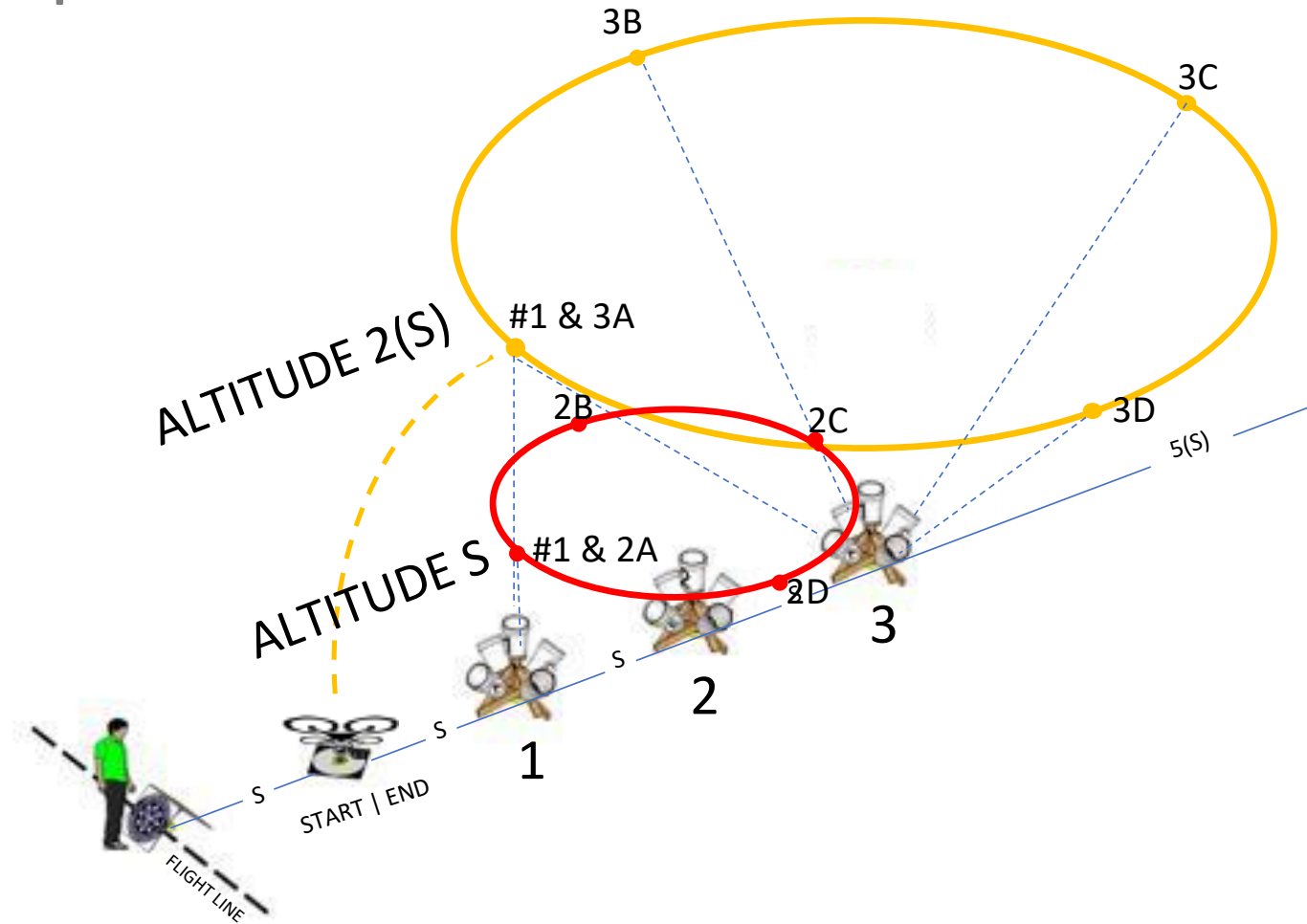
Traverse (MAN/PAY 2)

Open Test Lane



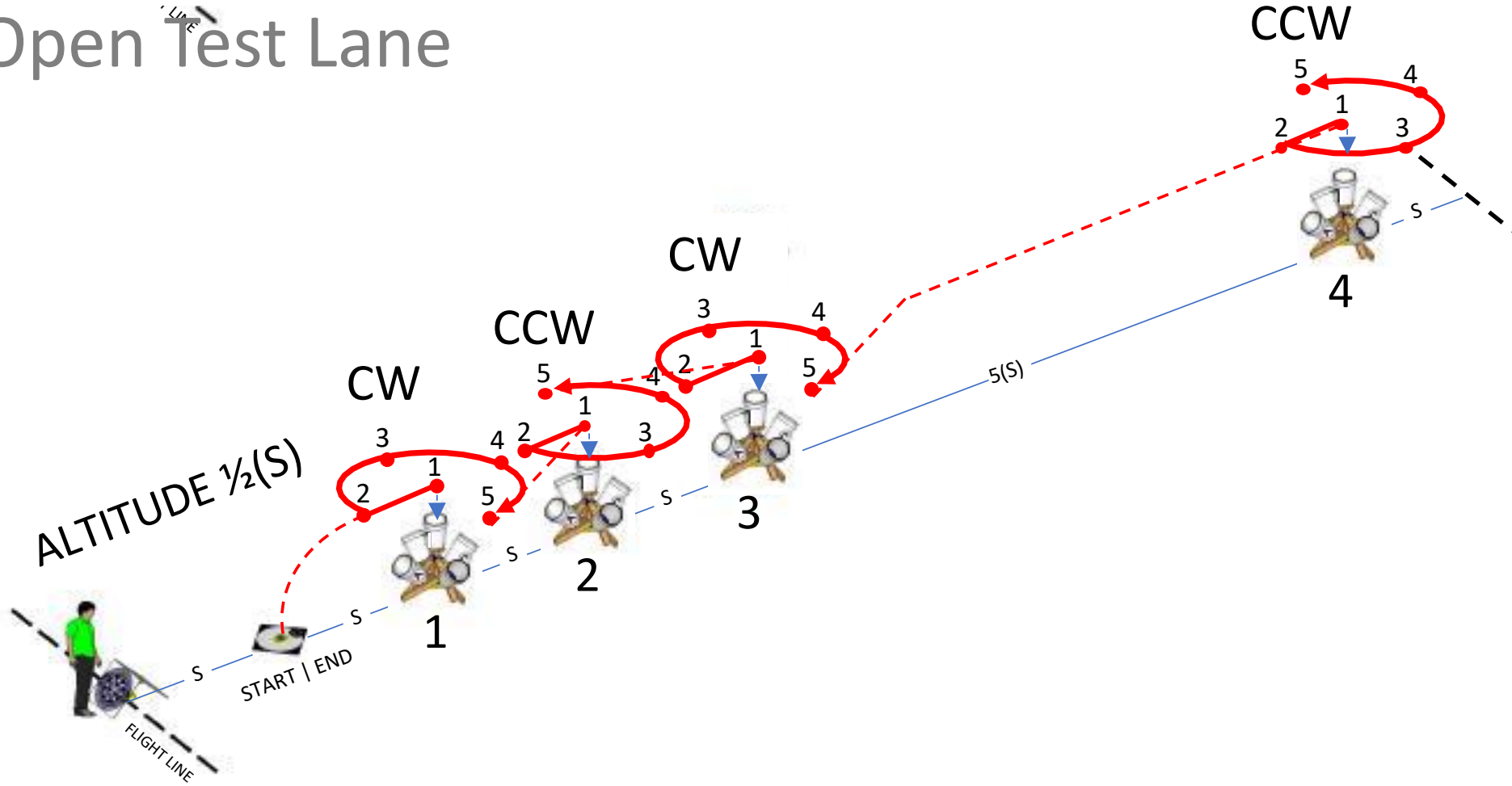
Orbit (MAN/PAY 3)

Open Test Lane



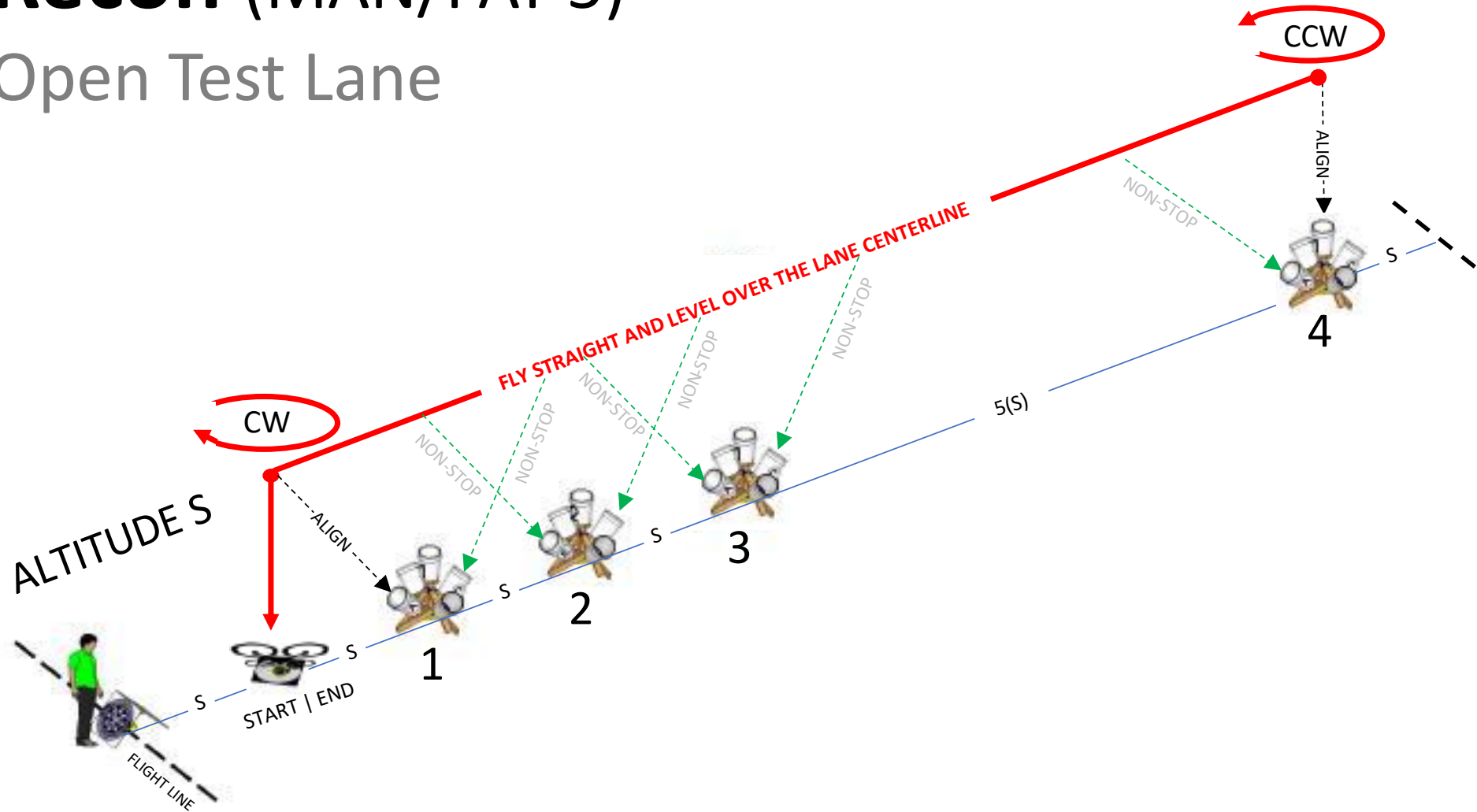
Inspect (MAN/PAY 4)

Open Test Lane



Recon (MAN/PAY 5)

Open Test Lane



VERSION 2023A

M **LEVEL 2 | OPEN LANE**
MANEUVERING ONLY



Pilot LAST Name _____
 Pilot FIRST Name _____
 Pilot Organization _____
 Drone Make _____
 Drone Model _____
 Facility Location _____
 Date (YYYY/MM/DD) _____ Team #: _____

PROCTOR NAME _____

BUCKET DIAM.		LANE SPACING (S)			VISIBILITY		WIND		PILOT VIEW		TIME LIMIT	
4 IN (10 CM)	8 IN (20 CM)	5 FT (1.5 M)	10 FT (3 M)	20 FT (6 M)	LIGHTED 300+ LUX	DARK < 1 LUX	AVERAGE MPH	GUSTS MPH	LINE OF SIGHT FACINE LANE OPTIONAL V.O.	INTERFACE ONLY BACK TO LANE MANDATORY V.O.	5 MIN	10 MIN
(CIRCLE ONE)		(CIRCLE ONE)			(CIRCLE ONE)		(FILL IN)		(CIRCLE ONE)		(CIRCLE ONE OR FILL IN)	

ALIGNMENT SCORE: Circle points for images with UNBROKEN RINGS (5 pts) or BROKEN RINGS (1 pt). Draw a line through all incomplete.

POSITION (MAN 1)	TRAVERSE (MAN 2)	ORBIT (MAN 3)	INSPECT (MAN 4)	RECON (MAN 5)
18 IMAGES TO CAPTURE <i>1 Landing Scored Twice</i>	18 IMAGES TO CAPTURE <i>2 Landings Scored Separately</i>	20 IMAGES TO CAPTURE <i>No Landing</i>	20 IMAGES TO CAPTURE <i>No Landing</i>	20 IMAGES TO CAPTURE <i>No Landing</i>

	ALIGNMENT		ALIGNMENT		ALIGNMENT		ALIGNMENT		ALIGNMENT				
START TIMER	BUCKET SEQUENCE	IMAGE POINTS	START TIMER	BUCKET SEQUENCE	IMAGE POINTS	START TIMER	BUCKET SEQUENCE	IMAGE POINTS	START TIMER	BUCKET SEQUENCE	IMAGE POINTS		
LAUNCH TO ALT S	1	5 1	LAUNCH TO ALT S	1A	5 1	LAUNCH TO ALT 2(S)	1	5 1	LAUNCH TO ALT S	4	5 1		
YAW L-360	2A	5 1	LEFTWARD	1B	5 1	LEFTWARD	3A	5 1	UP RANGE	UPSIDE DOWN	7	5 1	
	1	5 1		2B	5 1		3B	5 1		L	5 1		
YAW R-360	2A	5 1		3B	5 1		REVERSE	3C	5 1	LAP 2	1A	5 1	
	1	5 1		3C	5 1			3D	5 1		4	5 1	
CLIMB	2A	5 1	3D	5 1	RIGHTWARD	1	5 1	UP RANGE	UPSIDE DOWN	7	5 1		
	1	5 1	2D	5 1		3A	5 1		L	5 1			
DESCEND	3A	5 1	1D	5 1	RIGHTWARD	3D	5 1	LAP 3	1A	5 1			
	2A	5 1	1A	5 1		3C	5 1		4	5 1			
FORWARD	2A	5 1	LAND	○	DESCEND TO ALT S	3B	5 1	UP RANGE	UPSIDE DOWN	7	5 1		
	2	5 1	LAUNCH TO ALT S	1A	1	5 1	2B		5 1	L	5 1		
BACKWARD	3A	5 1	RIGHTWARD	1D	5 1	LEFTWARD	2A	5 1	LAP 4	1A	5 1		
	1	5 1		2D	5 1		2B	5 1		4	5 1		
FORWARD & YAW L-180	UPSIDE DOWN	7		3C	5 1		RIGHTWARD	2C	5 1	UP RANGE	UPSIDE DOWN	7	5 1
	1C	5 1		3B	5 1			2D	5 1		L	5 1	
FORWARD & YAW R-180	L	5 1	2B	5 1	REVERSE	1	5 1	LAP 5	1A	5 1			
	1A	5 1	1B	5 1		2A	5 1		4	5 1			
LAND	○	5 1	1A	5 1	RIGHTWARD	2D	5 1	UP RANGE	UPSIDE DOWN	7	5 1		
	COUNTS DOUBLE	5 1	LAND	○		2C	5 1		4C	5 1	L	5 1	
END TIMER			END TIMER		END TIMER	2B	5 1	END TIMER	4B	5 1	END TIMER		
	/100			/100		/100			/100		/100		
	ELAPSED TIME			ELAPSED TIME		ELAPSED TIME			ELAPSED TIME		ELAPSED TIME		

PASS FAIL (CIRCLE ONE) PASS FAIL (CIRCLE ONE) PASS FAIL (CIRCLE ONE) PASS FAIL (CIRCLE ONE) PASS FAIL (CIRCLE ONE)

Scoring Alignment Points

Capture images of alignment rings to verify

ALIGN WITH BUCKETS AND LAND ACURATELY

20 ALIGNMENTS TOTAL UP TO 100 POINTS



- Align with each bucket to capture a SINGLE IMAGE of the inscribed alignment ring. Only the first image is scored.
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 - BROKEN RINGS (1 point)
 - NO RINGS (0 points, strike through line)
- Score accurate landings as:
 - CENTERED (5 pts) with the aircraft center point inside the 60 cm (24 in) diameter circle.
 - OFFSET (1 pts) with at least one propeller motor inside the circle.
- Verification of captured alignment images can be during the trial when obvious or after the trial to eliminate discussions during the trial. Images can also be stored for documentation.

START TIMER

ALIGNMENT

LAUNCH TO
ALT S

**BUCKET
SEQUENCE**

**IMAGE
POINTS**

1

5 1

2A

5 1

YAW L-360

1

5 1

2A

5 1

YAW R-360

1

5 1

2A

5 1

LEVEL

3



OPEN Test Lane

Payload Functionality Trials

Evaluate open area maneuvering while controlling zoom and exposure to identify ground objects using all 5 flight paths.

- *25 minutes (5 minutes each)*
- *100 Alignment & 100 Acuity Points*

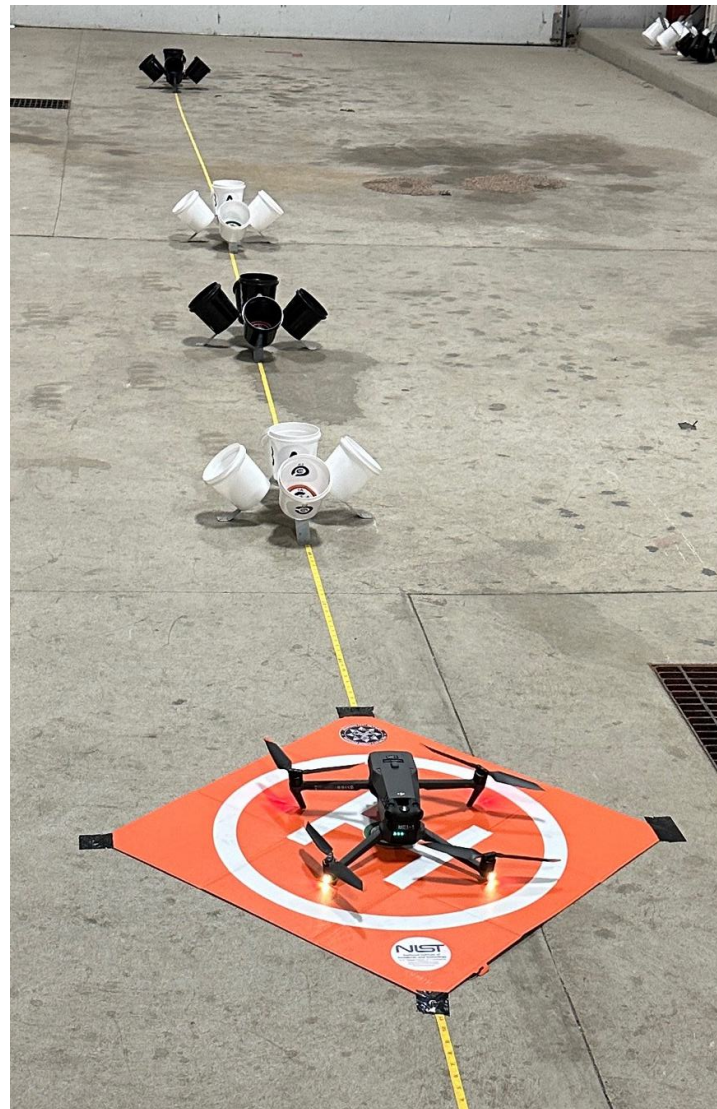




Level 3 Open Lane



LEVEL 3 | OPEN LANE PAYLOAD FUNCTIONALITY



Choose Appropriate Lane Spacing Based on Optics and Safety

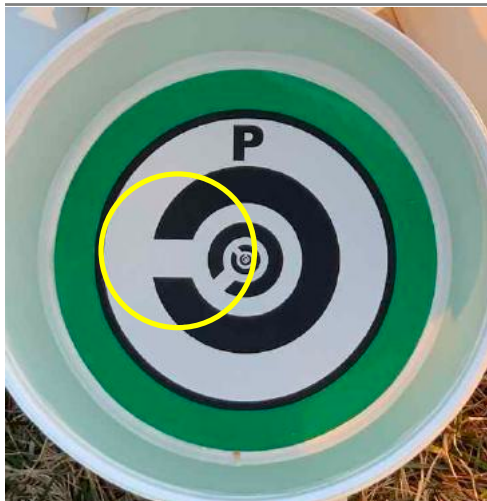
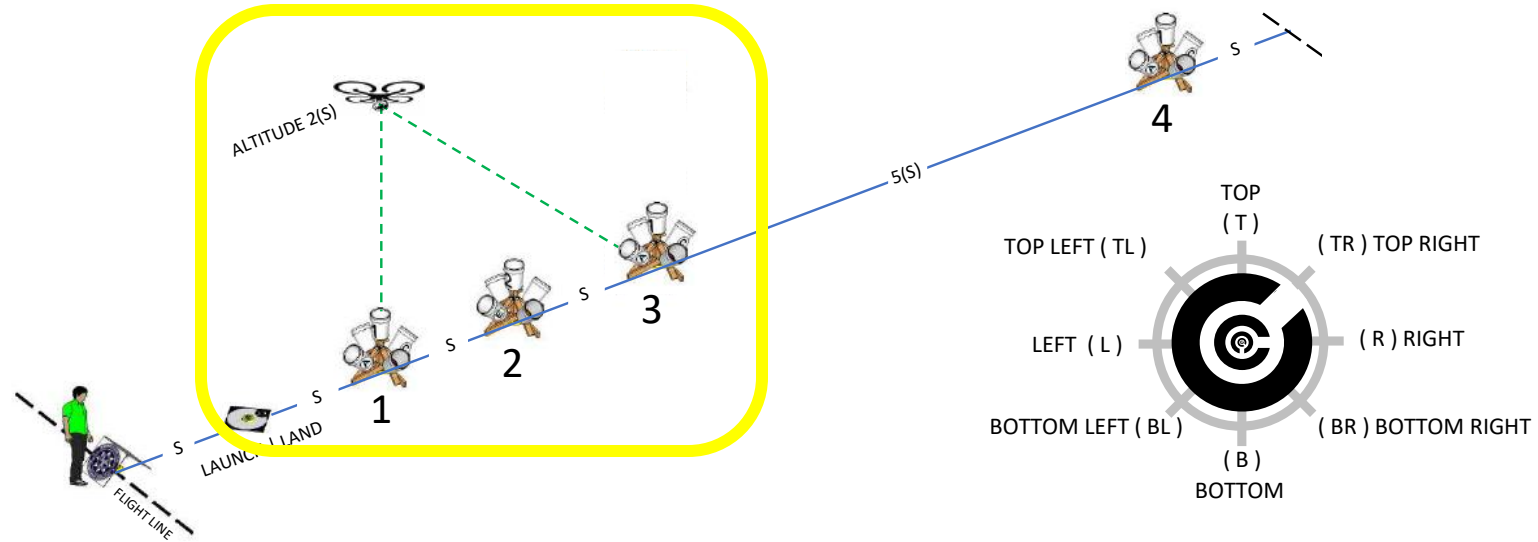
Open Test Lane

ALWAYS:

- Acuity from $2(S)$ so the targets must be visible

INDOORS:

- Lane Length = $10(S)$
 - Lane Width = $6(S)$
 - Elevation = $2(S)$
- PLUS SAFETY MARGIN





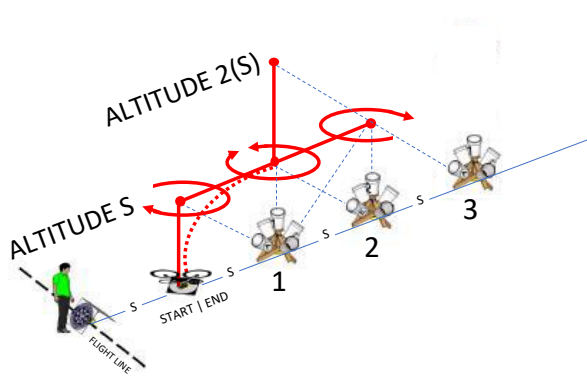
Level 3 Open Lane Setup

Using 10cm(4in) Buckets;

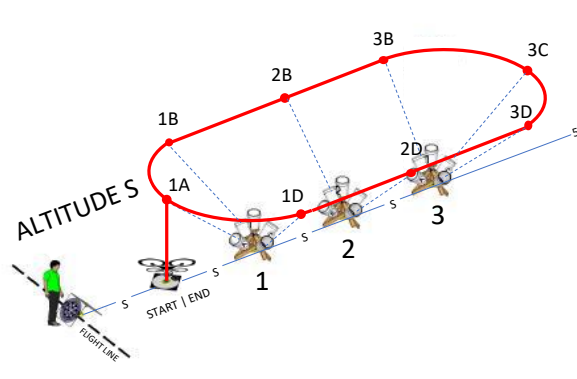
- Open Stands 1, 2, 3, and 4 with a 1.5m(5ft) spacing

Area required 10 x spacing long (15m-50ft) x 6 x spacing wide (9m-30ft) x 2.6 x spacing high (4m-13ft)

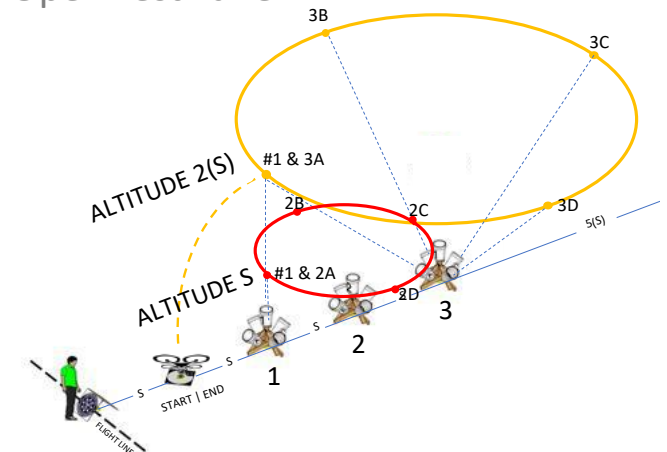
Position (MAN/PAY 1)
Open Test Lane



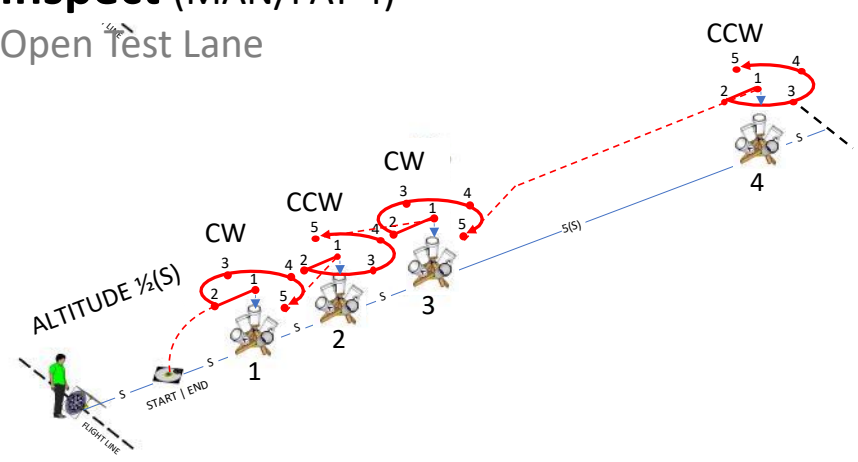
Traverse (MAN/PAY 2)
Open Test Lane



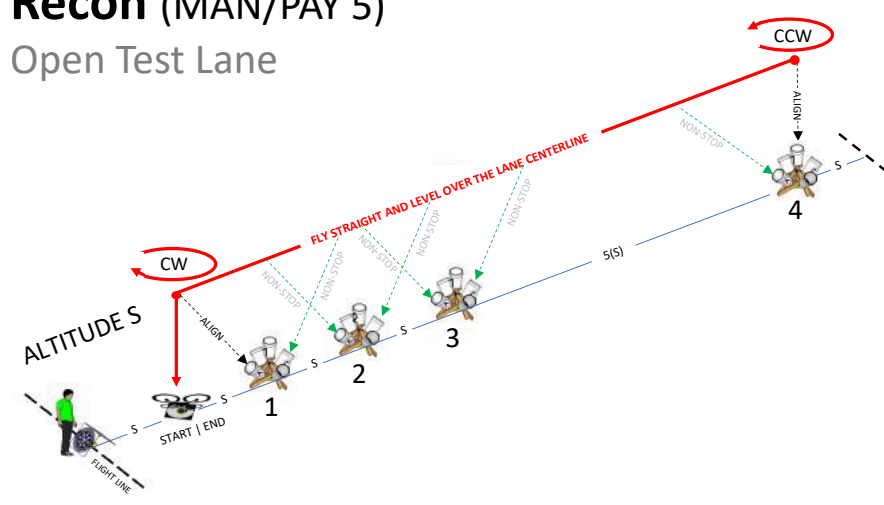
Orbit (MAN/PAY 3)
Open Test Lane



Inspect (MAN/PAY 4)
Open Test Lane



Recon (MAN/PAY 5)
Open Test Lane



VERSION 2023A

LEVEL 3 | OPEN LANE PAYLOAD FUNCTIONALITY



Pilot LAST Name _____

Pilot FIRST Name _____

Pilot Organization _____

Drone Make _____

Drone Model _____

Facility Location _____

Date (YYYY/MM/DD) _____ Team #: _____

PROCTOR NAME _____

BUCKET DIAM.		LANE SPACING (S)			VISIBILITY		WIND		PILOT VIEW		TIME LIMIT	
4 IN (10 CM)	8 IN (20 CM)	5 FT (1.5 M)	10 FT (3 M)	20 FT (6 M)	LIGHTED 300+ LUX	DARK < 1 LUX	AVERAGE MPH	GUSTS MPH	LINE OF SIGHT FACINE LANE OPTIONAL V.O.	INTERFACE ONLY BACK TO LANE MANDATORY V.O.	5 MIN	10 MIN
(CIRCLE ONE)		(CIRCLE ONE)			(CIRCLE ONE)		(FILL IN)		(CIRCLE ONE)		(CIRCLE ONE or FILL IN)	

ALIGNMENT SCORE: Circle points for images with UNBROKEN RINGS (5 pts) or BROKEN RINGS (1 pt). Draw a line through all incomplete.
ACUITY SCORE: Circle correctly identified GAP DIRECTIONS in the answer key (1 point each).

POSITION (PAY 1)	TRAVERSE (PAY 2)	ORBIT (PAY 3)	INSPECT (PAY 4)	RECON (PAY 5)																																																																																																																																																																																																																																																																																																																																																																											
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Scoring Alignment Points

Capture images of alignment rings to verify

ALIGN WITH BUCKETS AND LAND ACURATELY

20 ALIGNMENTS TOTAL UP TO 100 POINTS



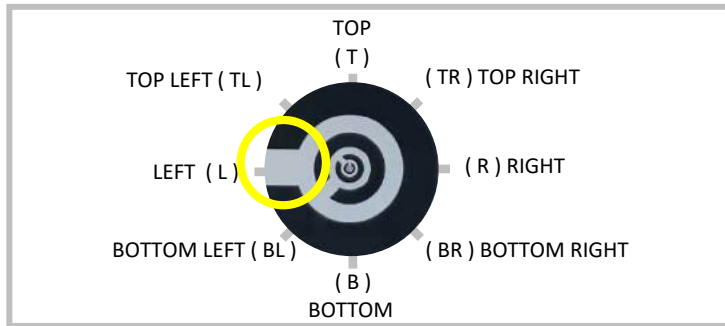
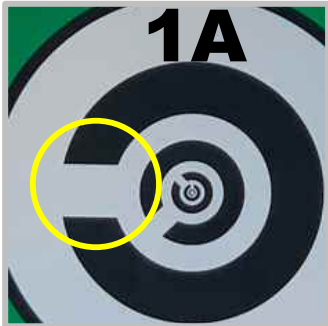
- Align with each bucket to capture a SINGLE IMAGE of the inscribed alignment ring. Only the first image is scored.
- Score captured images as:
 - UNBROKEN RINGS (5 points)
 - BROKEN RINGS (1 point)
 - NO RINGS (0 points, strike through line)
- Score accurate landings as:
 - CENTERED (5 pts) with the aircraft center point inside the 60 cm (24 in) diameter circle.
 - OFFSET (1 pts) with at least one propeller motor inside the circle.
- Verification of captured alignment images can be during the trial when obvious or after the trial to eliminate discussions during the trial. Images can also be stored for documentation.

Scoring Acuity Points

Identify increasingly small visual acuity targets

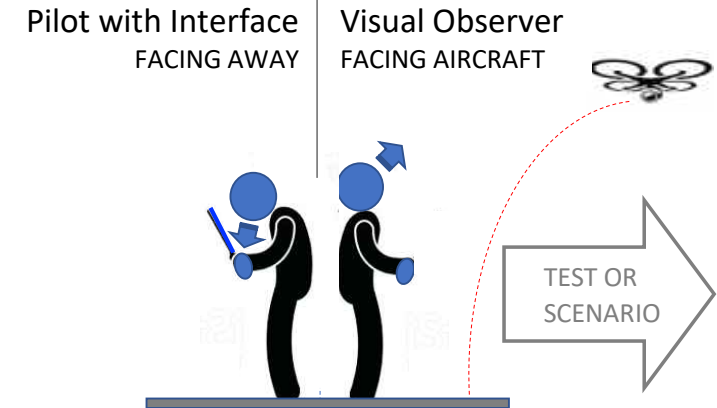
ALIGN THEN CONTROL ZOOM AND EXPOSURE

20 TARGETS TOTAL UP TO 100 POINTS



REPORT GAP DIRECTIONS RELATIVE TO THE BUCKET NUMBER (TOP)

- While aligned with each bucket, IDENTIFY ACUITY TARGETS using camera zoom and exposure controls.
- Verbally call out as many of the Concentric C gap directions as possible (1 pt each) with a Proctor.
- Fly facing away from the test lane or scenario (with a Visual Observer) to evaluate flying interface only as if beyond visual line of sight (BVLOS).



ALIGNMENT		ACUITY					
ALIGN BUCKET	IMAGE POINTS	CORRECT GAPS (1 POINT EACH)					
HOVER	1	5 1	T	BL	R	BR	L
	2A	5 1	L	BR	T	TL	R
YAW L360	1	5 1	T	BL	R	BR	L
	2A	5 1	L	BR	T	TL	R
YAW R360	1	5 1	T	BL	R	BR	L
	2A	5 1	L	BR	T	TL	R



Level 3 Open Lanes for Large Platforms

Using 10cm(4in) Buckets

- Open Stands 1-3 with a 6m(20ft) spacing

Area required 7 x spacing long (42m-140ft) x 6 x spacing wide (36m-120ft) x 2.5 x spacing high (15m-50ft)

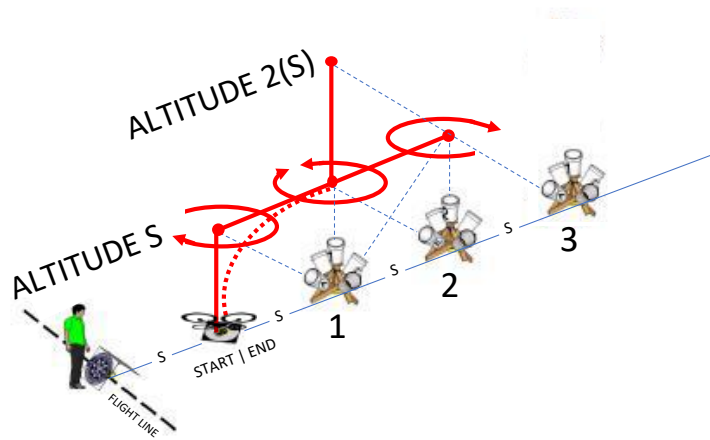
Flight Paths - Position, Traverse, Orbit

10-minute time limit for each Flight Path

This provides the training necessary for the Large Platform's mission set

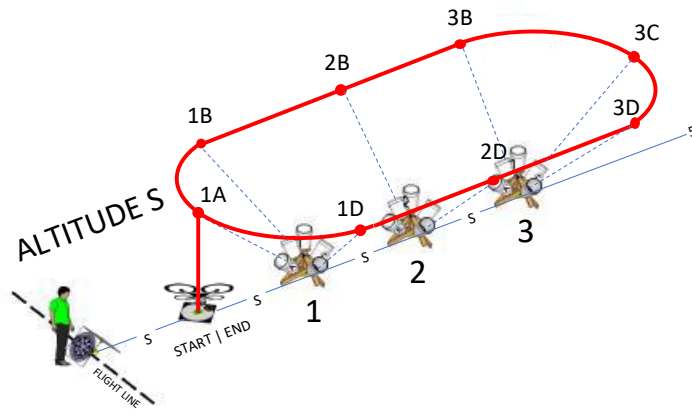
Position (MAN/PAY 1)

Open Test Lane



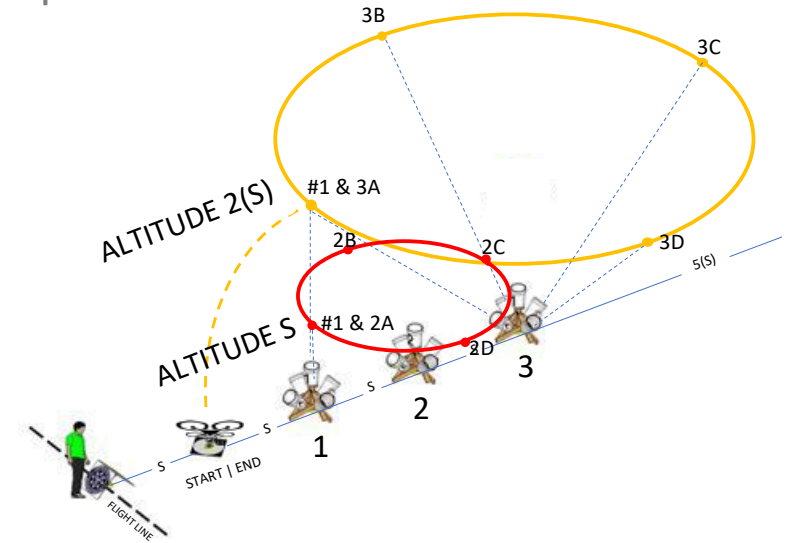
Traverse (MAN/PAY 2)

Open Test Lane



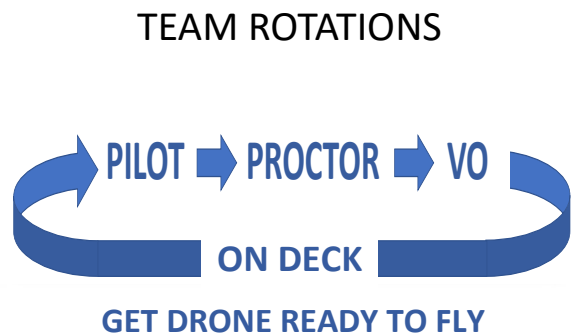
Orbit (MAN/PAY 3)

Open Test Lane



Teams Rotate Through Each Role

Each Pilot flies a 5-minute trial with help from other team members.
A 3-4 person team completes all 5 tests in 2 hours.



Four person teams always have one person getting their aircraft ready to launch right after the previous lands.

Three person teams work too, but require some time between each rotation to prepare the next aircraft.

PILOT

- Maintain control of the aircraft.
- Call out each intention of movement before doing so.
- Call out each bucket alignment and acuity target gap.

PROCTOR

- Fill in the form header.
- Read the test procedures to the Pilot.
- Confirm, record, and attest to scoring after the trial.

VISUAL OBSERVER (VO)

- Maintain sight with the aircraft and surroundings.
- Repeat the Pilot's intention of movement to confirm.
- Call out corrections and warnings as necessary.

Test Lane Uses

- Platform Evaluations – Compare platform capabilities
- Operator Training and Certification
- Evaluate the Platform or Operator in Degraded Environmental Conditions
- Evaluate Platform Readiness – after firmware updates, repairs, and addition of accessories ensure readiness prior to returning the platform to service

Metrics to Track Over Time

Measure System Capabilities and Pilot Proficiency

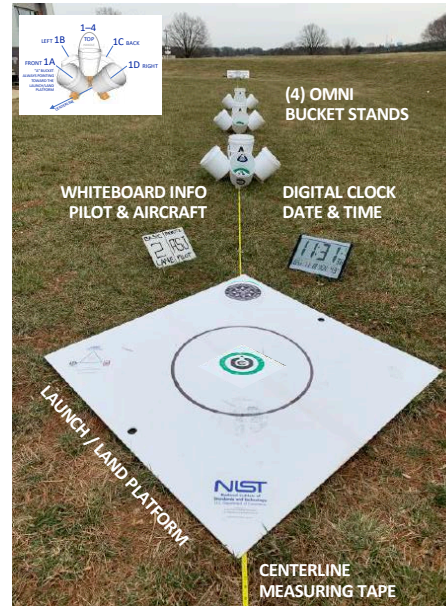
Completeness: Align with every bucket in the sequence and land accurately according to the procedure. The objective is scoring ALL points possible for your aircraft without making mistakes.

Score: For complete trials, track your scores over time. The average of your last five trials is an excellent measure of your proficiency on the aircraft and interface used.

Efficiency (Optional): For complete trials with maximum scores for a particular aircraft, the elapsed time can help identify the most efficient systems and techniques. Time limited trials can be used across multiple tests to maintain a schedule and similarly fatigue novices and experts.

Day and Night Operations

Evaluate using repeatable hovers and orbits



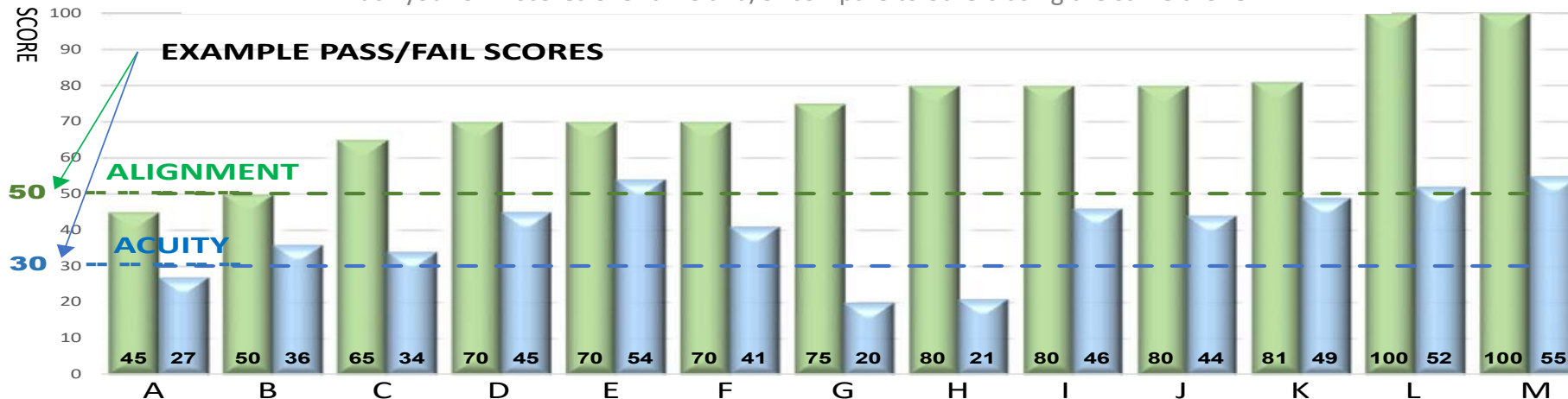
Shown with all white bucket stands for Basic Maneuvering (MAN).



Alternating black and white buckets stands for Payload Functionality (PAY).

Separate Scores for ALIGNMENT and ACUITY

Track your own scores over time and/or compare to others using the same drone.





Level 3 Open Lane Proctoring

Scoring Alignment Points

Capture images of alignment rings to verify

ALIGN WITH BUCKETS AND LAND ACURATELY

20 ALIGNMENTS TOTAL UP TO 100 POINTS



- Align with each bucket to capture a SINGLE IMAGE of the inscribed alignment ring. Only the first image is scored.
- Score captured images as:
 - UNBROKEN RINGS (5 points)
 - BROKEN RINGS (1 point)
 - NO RINGS (0 points, strike through line)
- Score accurate landings as:
 - CENTERED (5 pts) with the aircraft center point inside the 60 cm (24 in) diameter circle.
 - OFFSET (1 pts) with at least one propeller motor inside the circle.
- Verification of captured alignment images can be during the trial when obvious or after the trial to eliminate discussions during the trial. Images can also be stored for documentation.

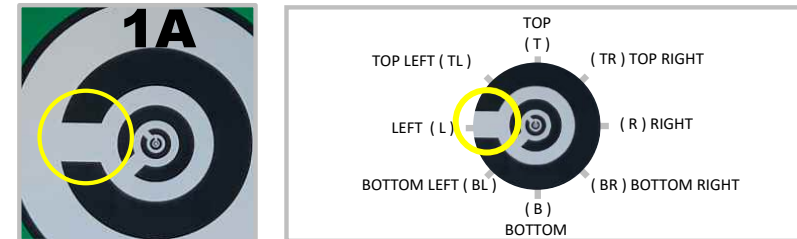
4

Scoring Acuity Points

Identify increasingly small visual acuity targets

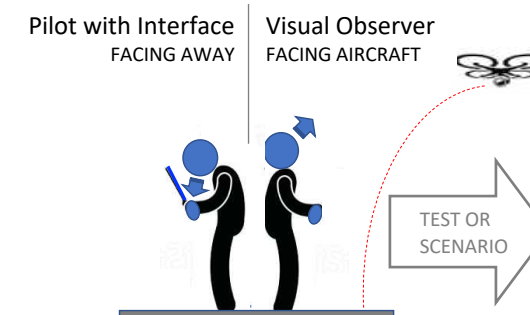
ALIGN THEN CONTROL ZOOM AND EXPOSURE

20 TARGETS TOTAL UP TO 100 POINTS



REPORT GAP DIRECTIONS RELATIVE TO THE BUCKET NUMBER (TOP)

- While aligned with each bucket, IDENTIFY ACUITY TARGETS using camera zoom and exposure controls.
- Verbally call out as many of the Concentric C gap directions as possible (1 pt each) with a Proctor.
- Fly facing away from the test lane or scenario (with a Visual Observer) to evaluate flying interface only as if beyond visual line of sight (BVLOS).



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Level 3 Open Lane

Payload Functionality Trials

• Fill in the header information completely!

• **PROCTOR ATTESTATION**
(The Proctor's printed name)

• Bucket Size


• Lane Spacing

• Lighting


• Wind

• Pilot view


• Time limit



Test Methods for Evaluating Aerial Drones
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VERSION 2023A




Science and Technology




LEVEL 3 | OPEN LANE


PAYLOAD FUNCTIONALITY




ALIGNED (5 PTS)

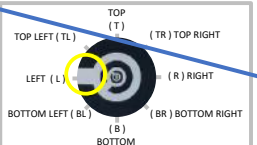


BROKEN (1 PNT)



ACCURATE (5 PTS)





Pilot LAST Name _____

Pilot FIRST Name _____

Pilot Organization _____

Drone Make _____

Drone Model _____

Facility Location _____

Date (YYYY/MM/DD) _____ Team #: _____

PROCTOR NAME _____

BUCKET DIAM.		LANE SPACING (S)			VISIBILITY		WIND		PILOT VIEW		TIME LIMIT		
4 IN (10 CM)	8 IN (20 CM)	5 FT (1.5 M)	10 FT (3 M)	20 FT (6 M)	LIGHTED 300+ LUX	DARK < 1 LUX	AVERAGE _____ MPH	GUSTS _____ MPH	LINE OF SIGHT FACINE LANE OPTIONAL V.O.	INTERFACE ONLY BACK TO LANE MANDATORY V.O.	5 MIN	10 MIN	_____ MIN
(CIRCLE ONE)		(CIRCLE ONE)			(CIRCLE ONE)		(FILL IN)		(CIRCLE ONE)		(CIRCLE ONE or FILL IN)		

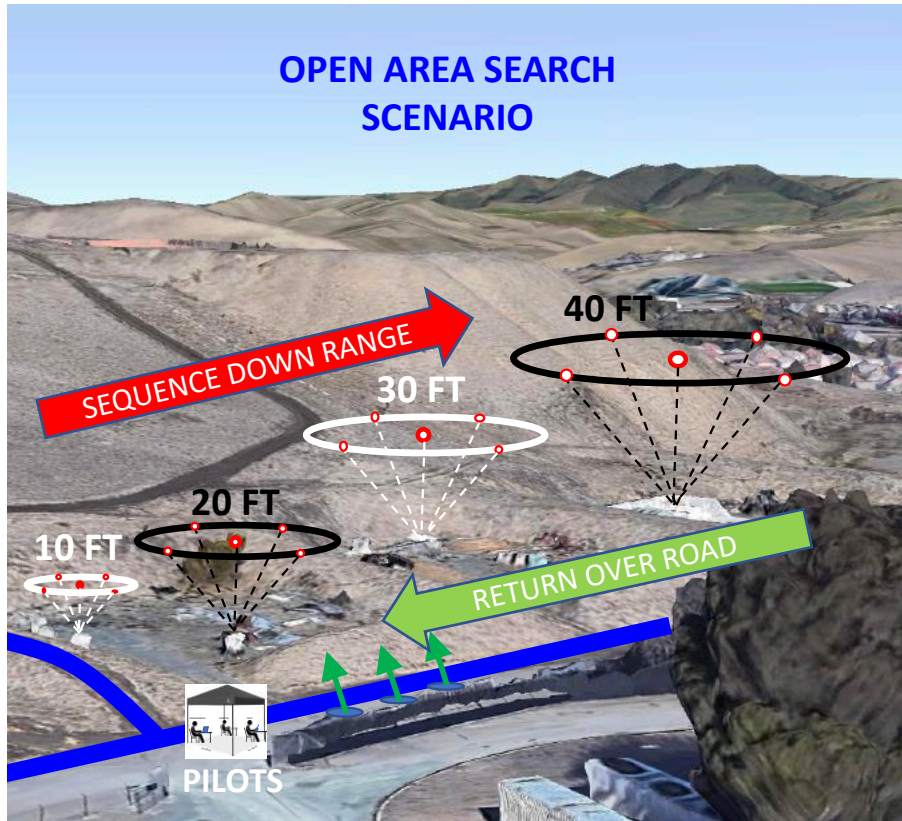


LEVEL 3 | OPEN AREA

SCORABLE SCENARIOS

Open Area Search Scenarios

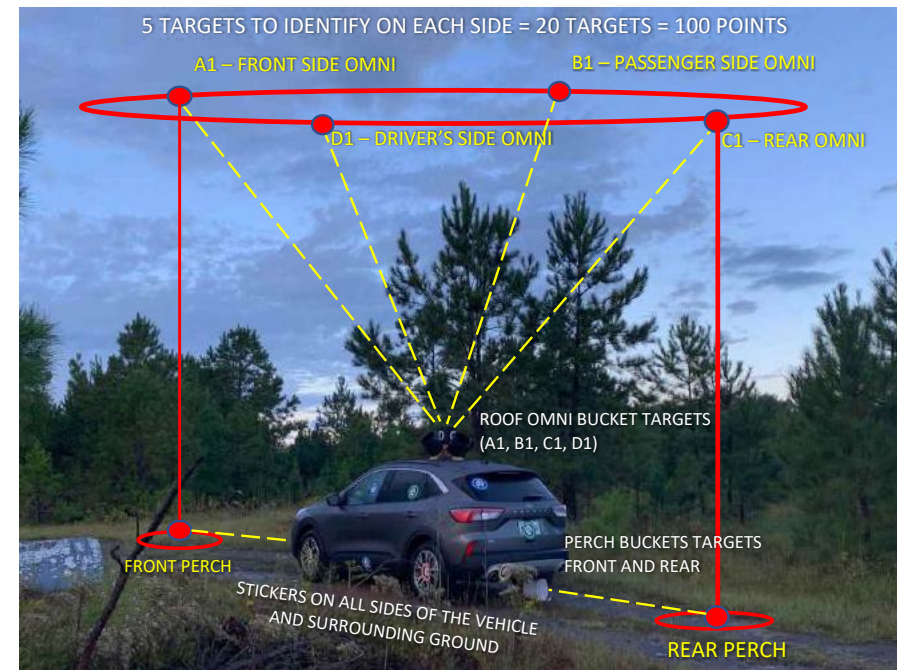
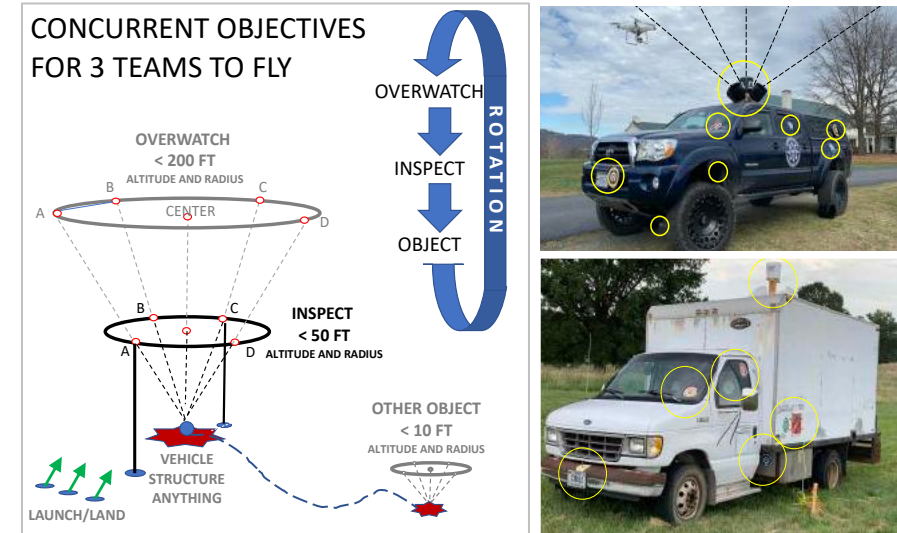
Day and Night Trials



- Teams concurrently fly separate objectives set up at safe distances and/or altitudes apart (with a clearly designated and safe return path).
- Each pilot flies for 15 minutes across 3 different objectives for 5 minutes each. Teams move as necessary to maintain sight lines and communication.
- Scenarios restart with a different rotation of Pilot, Proctor, and VO.

Open Vehicle Identification Scenarios

Day and Night Trials



LEVEL 3 | OPEN AREA SCORABLE SCENARIOS



Pilot LAST Name _____

Pilot FIRST Name _____

Pilot Organization _____

Drone Make _____

Drone Model _____

Facility Location _____

Date (YYYY/MM/DD) _____ Team #: _____

PROCTOR NAME _____

BUCKET DIAMETER 4 IN (10 CM) (CIRCLE ONE) 8 IN (20 CM) (CIRCLE ONE)		VISIBILITY LIGHTED 300+ LUX (CIRCLE ONE) DIM 1-300 LUX (CIRCLE ONE) DARK < 1 LUX (CIRCLE ONE)	WIND AVERAGE _____ MPH (FILL IN) GUSTS _____ MPH (FILL IN)	PILOT VIEW LINE OF SIGHT (CIRCLE ONE) FACINE LANE OPTIONAL V.O. INTERFACE ONLY (CIRCLE ONE) BACK TO LANE MANDATORY V.O.	TIME LIMIT 5 MIN (CIRCLE ONE or FILL IN) 10 MIN (CIRCLE ONE or FILL IN)
--	--	---	---	--	--

ALIGNMENT SCORE: Circle points for images with UNBROKEN RINGS (5 pts) or BROKEN RINGS (1 pt). Draw a line through all incomplete.
ACUITY SCORE: Circle correctly identified GAP DIRECTIONS in the answer key (1 pt each).

OPEN SCENARIO SEARCH		ALIGNMENT		ACUITY	
START TIMER		ALIGN BUCKET	IMAGE POINTS	CORRECT GAPS (1 POINT EACH)	
1	HOVER OVER STAND #1 AT CHOSEN ALTITUDE	1	5 1	T	BL R BR L
		1A	5 1	TR	B TR L BR
2	PITCH BACKWARD	1B	5 1	R	TL T BL B
3	ORBIT LEFTWARD 90°	1C	5 1	BR	R TL L BR
4	ORBIT LEFTWARD 90°	1D	5 1	B	TL R BL T
5	ORBIT LEFTWARD 90°				
6	HOVER OVER STAND #2 AT CHOSEN ALTITUDE	2	5 1	BL	T BR R TL
7	PITCH BACKWARD	2A	5 1	L	BR T TL R
8	ORBIT RIGHTWARD 90°	2D	5 1	TR	B TL B BL
9	ORBIT RIGHTWARD 90°	2C	5 1	T	BL R TL B
10	ORBIT RIGHTWARD 90°	2B	5 1	TL	R TR L BR
11	HOVER OVER STAND #3 AT CHOSEN ALTITUDE	3	5 1	R	TL B BL R
12	PITCH BACKWARD	3A	5 1	BR	T TL R BL
13	ORBIT LEFTWARD 90°	3B	5 1	B	TR R BL T
14	ORBIT LEFTWARD 90°	3C	5 1	BL	R BL T BR
15	ORBIT LEFTWARD 90°	3D	5 1	L	TL R BR T
16	HOVER OVER STAND #4 AT CHOSEN ALTITUDE	4	5 1	TL	B TR R BR
17	PITCH BACKWARD	4A	5 1	T	BL B TR L
18	ORBIT RIGHTWARD 90°	4D	5 1	BR	B TL B TR
19	ORBIT RIGHTWARD 90°	4C	5 1	R	BL T TR B
20	ORBIT RIGHTWARD 90°	4B	5 1	TR	L BL R TL
STOP TIMER			/100		/100
ELAPSED TIME (MM : SS)		PASS FAIL (CIRCLE ONE)		PASS FAIL (CIRCLE ONE)	

OPEN SCENARIO VEHICLE		ALIGNMENT		ACUITY	
START TIMER		ALIGN BUCKET	IMAGE POINTS	CORRECT GAPS (1 POINT EACH)	
ALIGN OVER OMNI BUCKET - START TIMER		#4 TOP TARGET:			
1	A1 - FRONT SIDE - ROOFTOP OMNI BUCKET	A	5 1	T	BL B TR L
2	A2 - FRONT SIDE - WINDSHIELD CENTER	A2	5 1	TR	B TR L BR
3	A3 - FRONT SIDE - VIN #	A3	5 1	R	TL T BL B
4	A4 - FRONT SIDE - LICENSE PLATE	A4	5 1	BR	R TL L BR
5	A5 - FRONT SIDE - PERCH UNDERBODY BUCKET	A5	5 1	B	TL R BL T
6	B1 - PASSENGER SIDE - ROOFTOP OMNI BUCKET	B	5 1	TR	L BL R TL
7	B2 - PASSENGER SIDE - FRONT WINDOW	B2	5 1	L	BR T TL R
8	B3 - PASSENGER SIDE - REAR WINDOW	B3	5 1	TL	R TR L BR
9	B4 - PASSENGER SIDE - EXTERIOR FEATURE	B4	5 1	T	BL R TL B
10	B5 - PASSENGER SIDE - SURROUNDING GROUND	B5	5 1	TR	B TL B BL
11	C1 - REAR SIDE - ROOFTOP OMNI BUCKET	C	5 1	R	BL T TR B
12	C2 - REAR SIDE - WINDOW CENTER	C2	5 1	BR	T TL R BL
13	C3 - LICENSE PLATE	C3	5 1	B	TR R BL T
14	C4 - EXTERIOR FEATURE	C4	5 1	BL	R BL T BR
15	C5 - PERCH UNDERBODY BUCKET	C5	5 1	L	TL R BR T
16	D1 - DRIVER SIDE - ROOFTOP OMNI BUCKET	D	5 1	BR	B TL B TR
17	D2 - DRIVER SIDE - FRONT WINDOW	D2	5 1	T	BL B TR L
18	D3 - DRIVER SIDE - REAR WINDOW	D3	5 1	TR	L BL R TL
19	D4 - EXTERIOR FEATURE	D4	5 1	R	BL T TR B
20	D5 - SURROUNDING GROUND OBJECT	D5	5 1	BR	B TL B TR
STOP TIMER			/100		/100
ELAPSED TIME (MM : SS)		PASS FAIL (CIRCLE ONE)		PASS FAIL (CIRCLE ONE)	



Level 1-3 Review

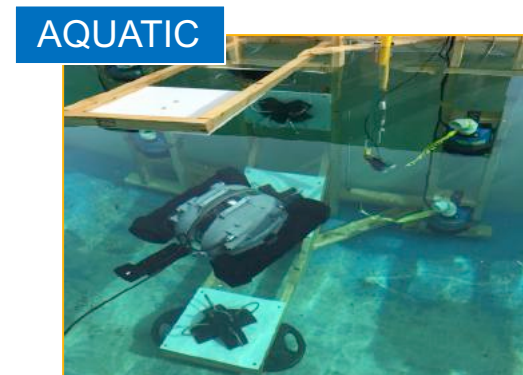
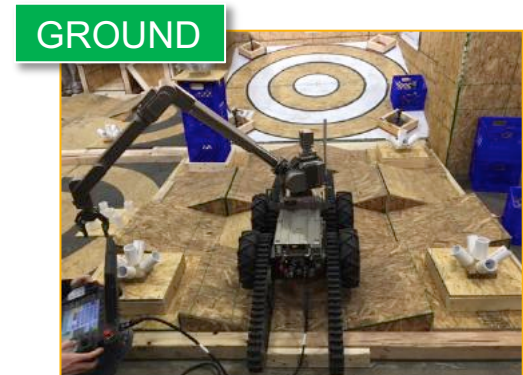
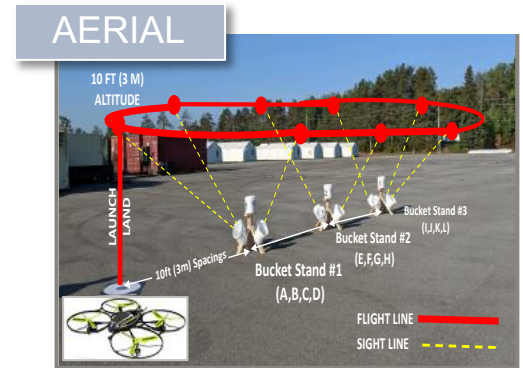
Standards Enable Credentialing of Proctors and Remote Pilots

Safety | Capabilities | Proficiency

NIST Develops and Validates Test Methods

- **Apparatus** that can be reproducible by others.
- **Procedures** that are repeatable to conduct test trials.
- **Performance Metrics** that are quantitative and can be compared over time, across locations and internationally
- **Evaluate Systems** using expert pilots conducting complete trials
- **Operator proficiency** is compared with similar systems on the same lane spacing in similar environmental conditions with either complete or time limited trials

Compare time limited trials that are incomplete by total points for similar elapsed times or calculate and compare the scoring rate as points per minute for different elapsed times

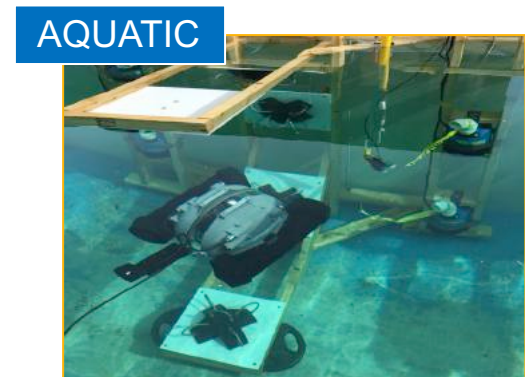
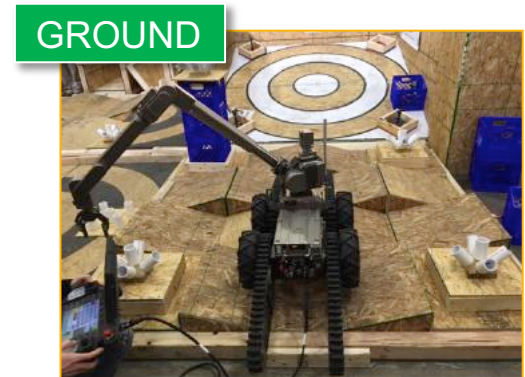
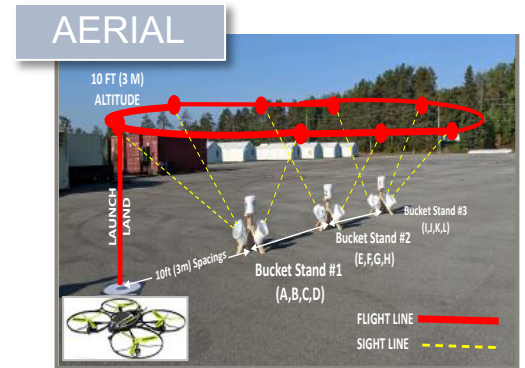


Standards Enable Credentialing of Proctors and Remote Pilots

Safety | Capabilities | Proficiency

When conducting evaluations with these Test Methods the results should only be compared to similar environmental conditions.

Night or dark trials can be conducted with white or red headlamps illuminating the white buckets or only using the lights and sensors onboard the drone.

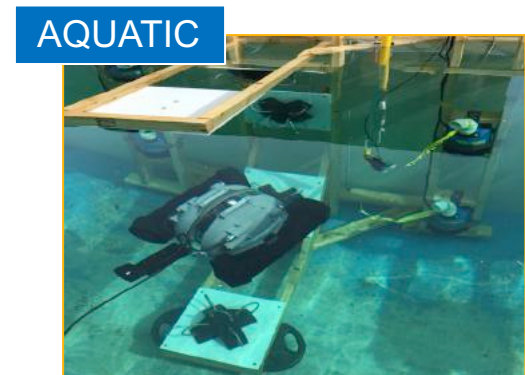
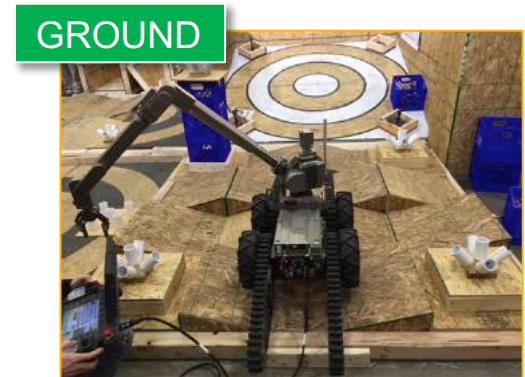
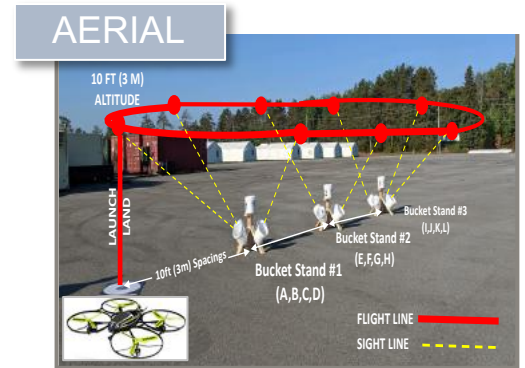


Standards Enable Credentialing of Proctors and Remote Pilots

Safety | Capabilities | Proficiency

When Credentialing operators an organization can;

- Set their own pass/fail scoring threshold
- Adopt a pass/fail scoring threshold set by a regional or national association with which the organization collaborates
- Adopt a pass/fail scoring threshold set by a similar organization



LEVEL

1



OPEN Test Lane

Basic Proficiency/Safety Checkride

Evaluate positive aircraft control in quick trials for novices and recreational pilots using the first 2 of 5 flight paths.

- ***10 minutes (5 minutes each)***
- ***40 Alignment Points***

LEVEL

2



OPEN Test Lane

Maneuvering Trials

Evaluate open area maneuvering around ground objects using all 5 flight paths with no additional pilot workload.

- *25 minutes (5 minutes each)*
- *100 Alignment Points*

LEVEL

3



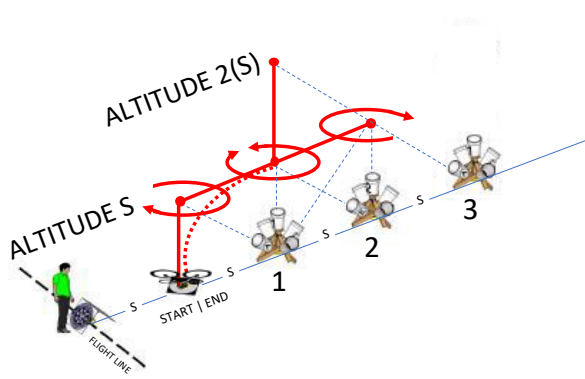
OPEN Test Lane

Payload Functionality Trials

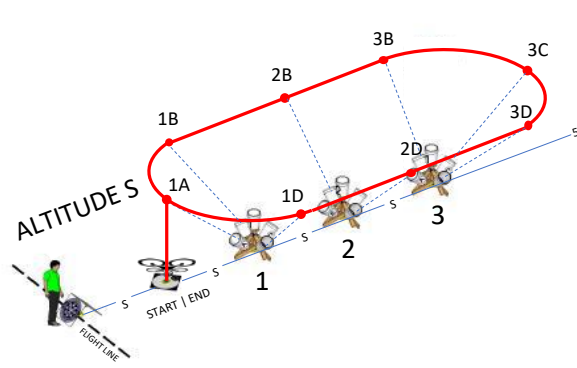
Evaluate open area maneuvering while controlling zoom and exposure to identify ground objects using all 5 flight paths.

- *25 minutes (5 minutes each)*
- *100 Alignment & 100 Acuity Points*

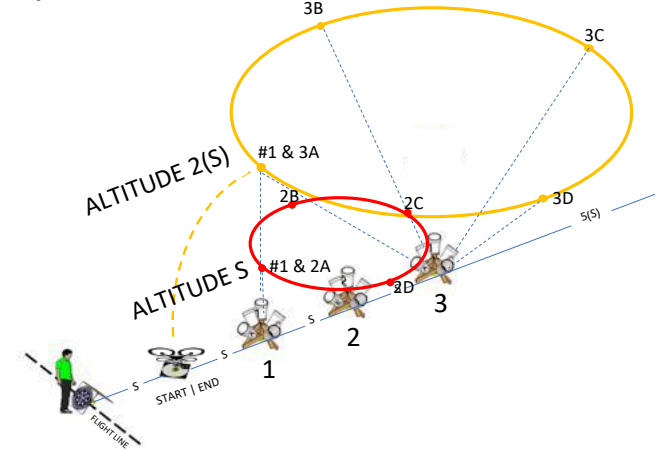
Position (MAN/PAY 1)
Open Test Lane



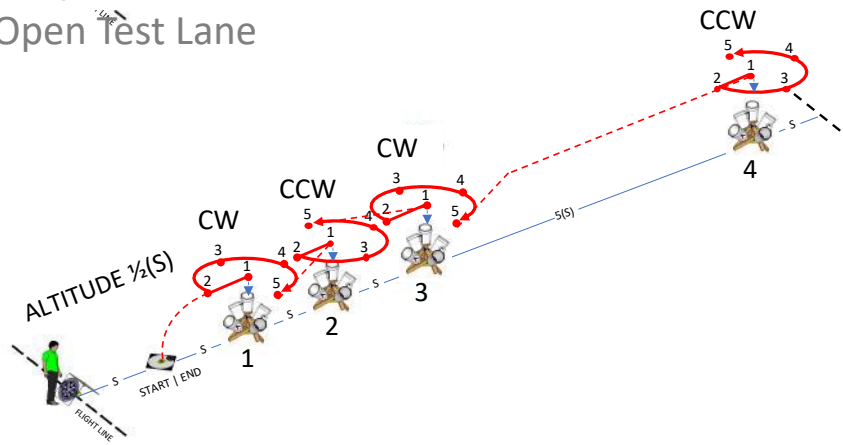
Traverse (MAN/PAY 2)
Open Test Lane



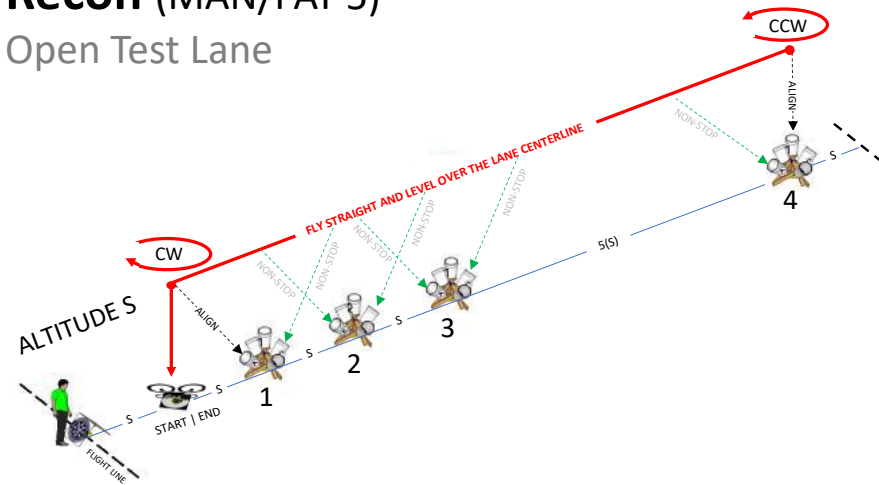
Orbit (MAN/PAY 3)
Open Test Lane



Inspect (MAN/PAY 4)
Open Test Lane



Recon (MAN/PAY 5)
Open Test Lane



Choose Appropriate Lane Spacing Based on Optics and Safety

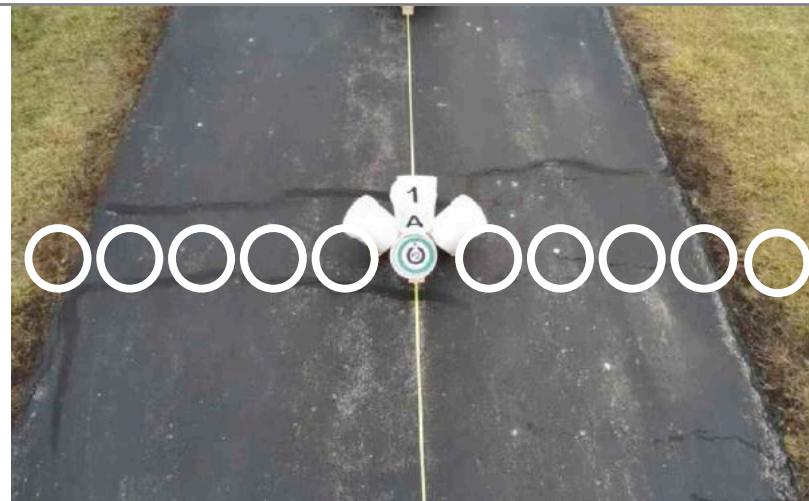
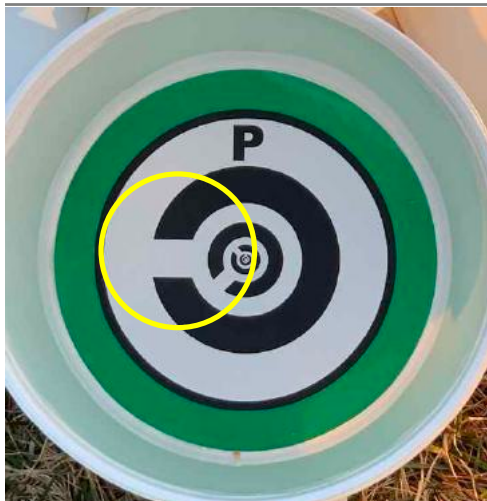
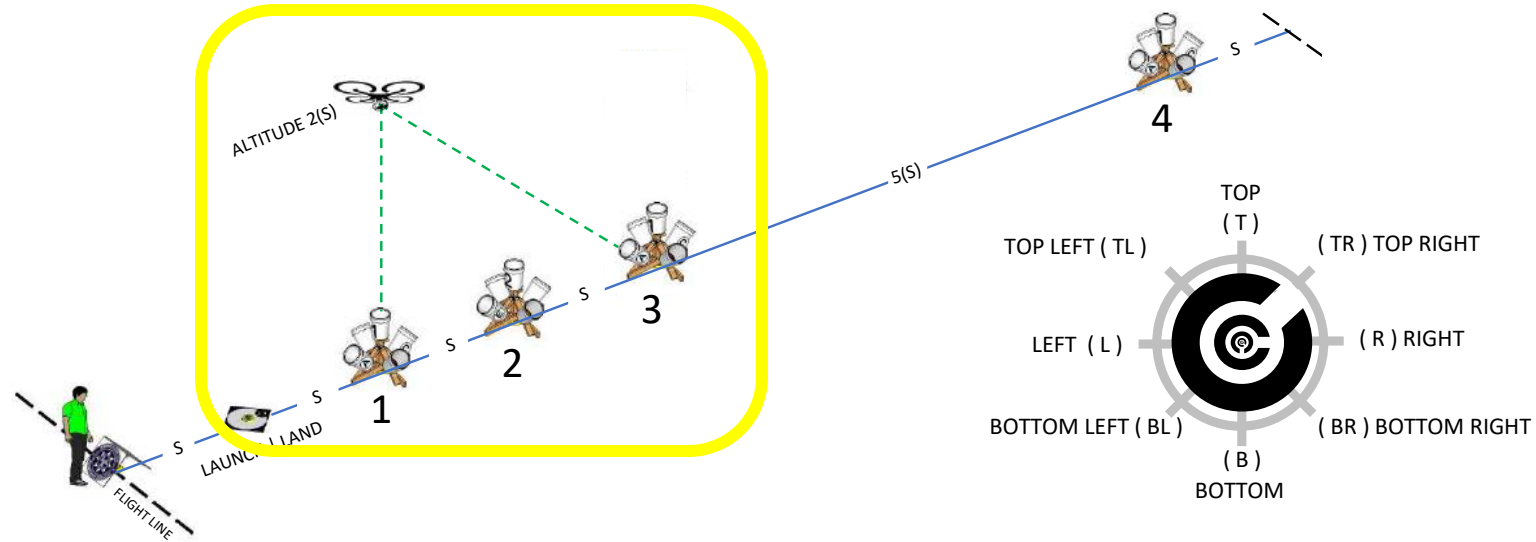
Open Test Lane

ALWAYS:

- Acuity from $2(S)$ so the targets must be visible

INDOORS:

- Lane Length = $10(S)$
- Lane Width = $6(S)$
- Elevation = $2(S)$
PLUS SAFETY MARGIN



Scoring Alignment Points

Capture images of alignment rings to verify

ALIGN WITH BUCKETS AND LAND ACURATELY

20 ALIGNMENTS TOTAL UP TO 100 POINTS



- Align with each bucket to capture a SINGLE IMAGE of the inscribed alignment ring. Only the first image is scored.
- Score captured images as:
 - UNBROKEN RINGS (5 points)
 - BROKEN RINGS (1 point)
 - NO RINGS (0 points, strike through line)
- Score accurate landings as:
 - CENTERED (5 pts) with the aircraft center point inside the 60 cm (24 in) diameter circle.
 - OFFSET (1 pts) with at least one propeller motor inside the circle.
- Verification of captured alignment images can be during the trial when obvious or after the trial to eliminate discussions during the trial. Images can also be stored for documentation.

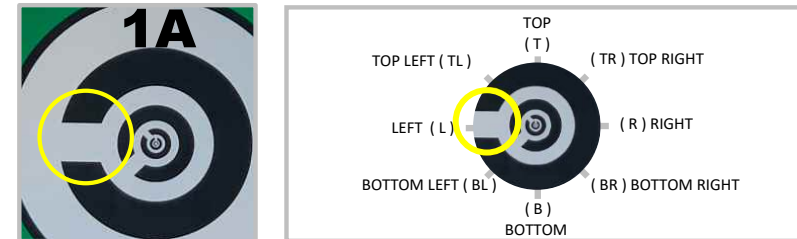
4

Scoring Acuity Points

Identify increasingly small visual acuity targets

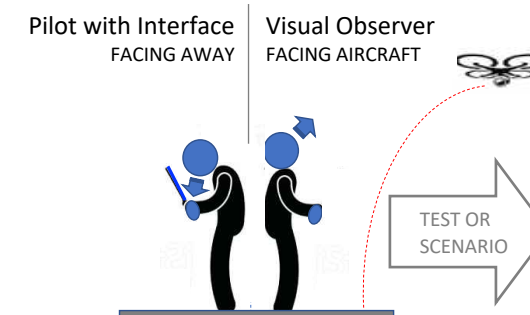
ALIGN THEN CONTROL ZOOM AND EXPOSURE

20 TARGETS TOTAL UP TO 100 POINTS



REPORT GAP DIRECTIONS RELATIVE TO THE BUCKET NUMBER (TOP)

- While aligned with each bucket, IDENTIFY ACUITY TARGETS using camera zoom and exposure controls.
- Verbally call out as many of the Concentric C gap directions as possible (1 pt each) with a Proctor.
- Fly facing away from the test lane or scenario (with a Visual Observer) to evaluate flying interface only as if beyond visual line of sight (BVLOS).

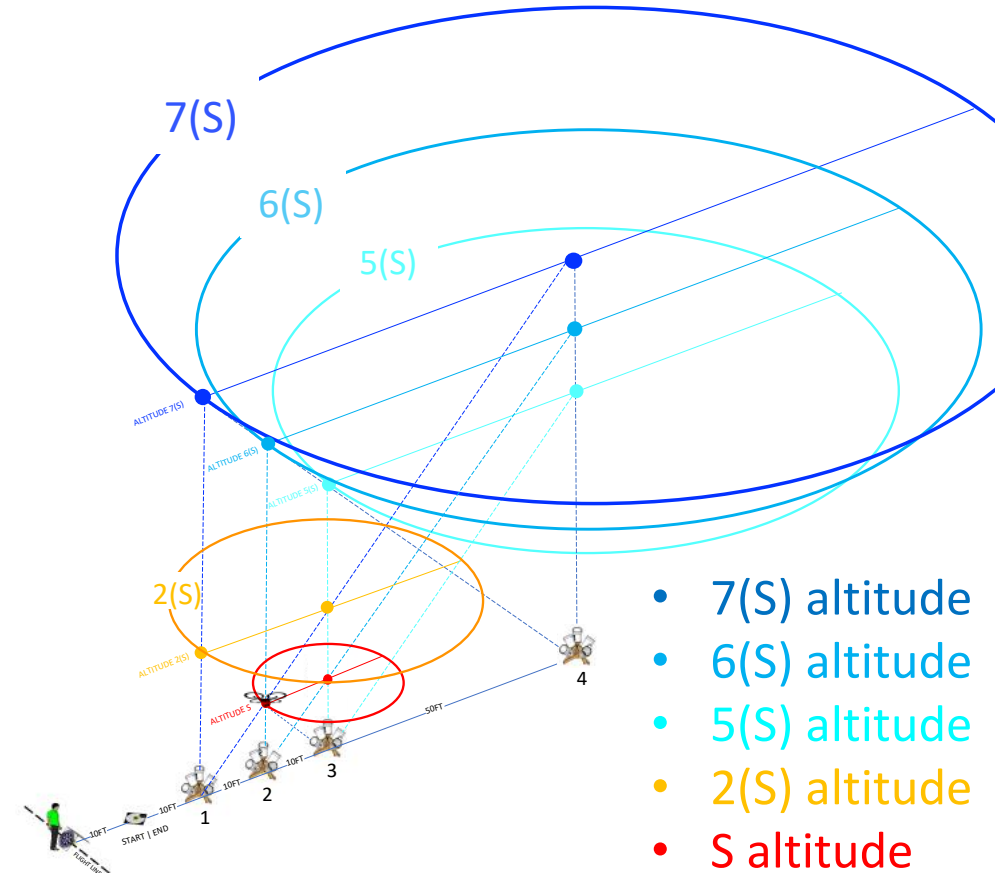
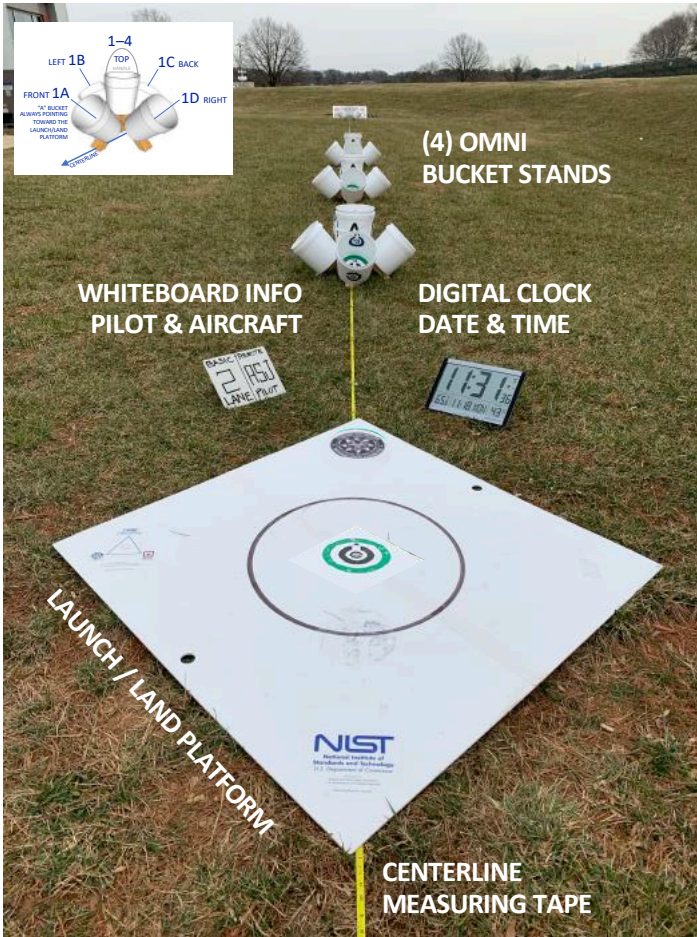


53

Same Lane Supports Other Flight Paths

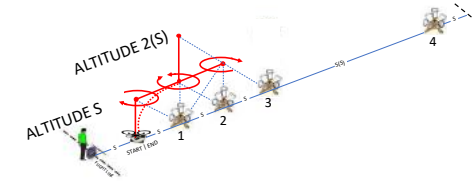
Open Test Lane

5 Different Orbits in Every Lane Spacing
(S) = 10ft, 20ft, 30ft, or other

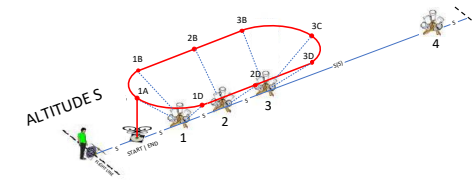


- 7(S) altitude
- 6(S) altitude
- 5(S) altitude
- 2(S) altitude
- S altitude

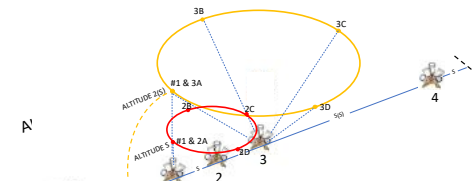
POSITION
MAN/PAY 1



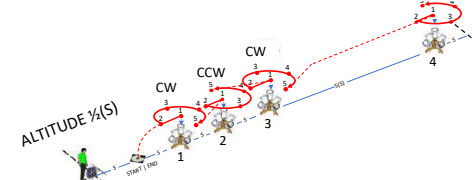
TRAVERSE
MAN/PAY 2



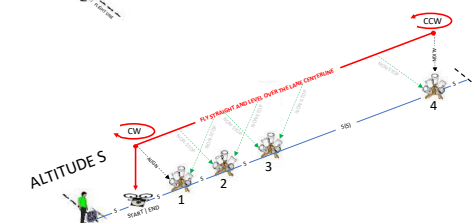
ORBIT
MAN/PAY 3



INSPECT
MAN/PAY 4



RECON
MAN/PAY 5



Aerial Drone Tests and Scorable Scenarios for Evaluating System Capabilities and Remote Pilot Proficiency in Level 3 Open, Level 4 Obstructed, and Level 5 Confined Environments

Developed by the National Institute of Standards and Technology



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