

Test Methods for Evaluating Aerial Drones Safety | Capabilities | Proficiency RobotTestMethods.nist.gov



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



Adam Jacoff

Intelligent Systems Division
National Institute of Standards and Technology
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



USAGE GUIDE or a
A thick black mar
rings inside bucket

targets inside. Successful al altitude long enough to veri proficiency/Safety Checkrid equires a single image image is captured of evaluate positive aircraft control in quick and extended and extended

10 minutes (5 minutes each)

POS I

evaluate ght maneuve O Alignment Points orientations, and altitudes alc positive aircraft control at all maneuvers including climb, simultaneously align with two laltitude. The aircraft then lar chassis or any ground contact w

1/PAY 1)

TRAVERSE (MAN/PAY 2)

to identify a de (S) to corthe omr

designated time limit. V camera pointing and zo <u>color, t</u>hermal, hazmat la resulting in an end-of-tri from the intended fligh apparatus, ground, or sa





alignments and accompte landings within the designated time limit. Visual aculty targets evaluate camera pointing and zooming capabilities along with color, thermal, hazmat labels, or other objects. Faults resulting in an end-of-trial include extreme deviations

POSITION (MANL
POSITI

Z

a in

BASIC

Dilot

Org:

Email:

Zip Code:

Make:

CAPTURE O

CAPTURE

POSITION

1 LAI

2 YAN 3 YAN

CLI

PIT





with one requires inside the alignmen designate camera p color, the

resulting in an end-of-trial include extreme deviations

tude. Simultaneously align with two buckets in each position the least one least the nathern with at least one le nough to CAPTURE ONE IMAGE OF EACH BUCKET showing the nathorn with at least one le nough to CAPTURE one land centered on the nathorn with at least one le nough to CAPTURE one land centered on the nathorn than land centered on the nathorn than land centered on the nathorn than land centered on the nathern with at least one le nathern wi hough to CAPTURE ONE IMAGE OF EACH BUCKET showing the leg in nough to CAPTURE ONE IMAGE on the platform with at least one leg in nscribed ring. Then land centered on the platform with at least one leg in nscribed ring. Then land centered on the platform with at least one leg in the 12 in radius circle. the 12 in radius circle.

BASIC

Pilot:

Org:

Email:

Zip Code:

Make:

CAPTURE O

CAPTURE POSITION

> 1 LAI 2 YA



Level 1 Open Lane Setup

Using 10cm(4in) Buckets;

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

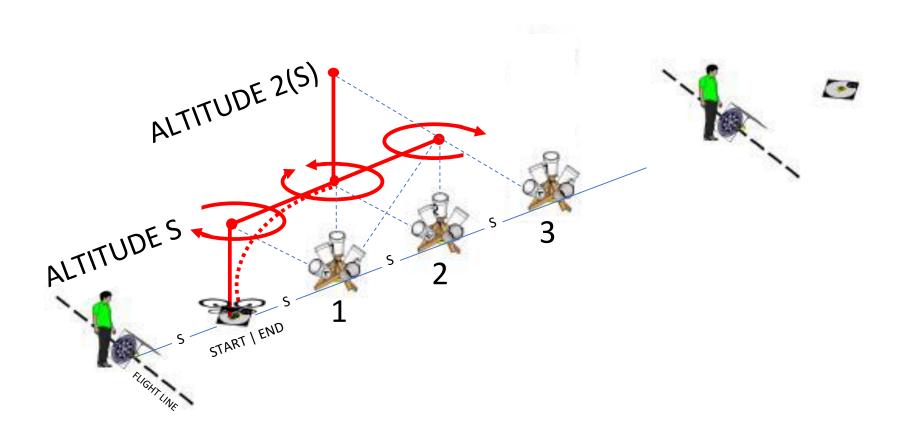
Area required 6 x spacing long (9m-30ft) x 6 x spacing wide (9m-30ft) x 2.6 x spacing high (4m-13ft)



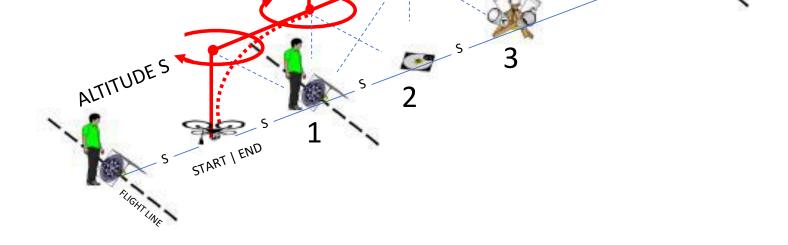


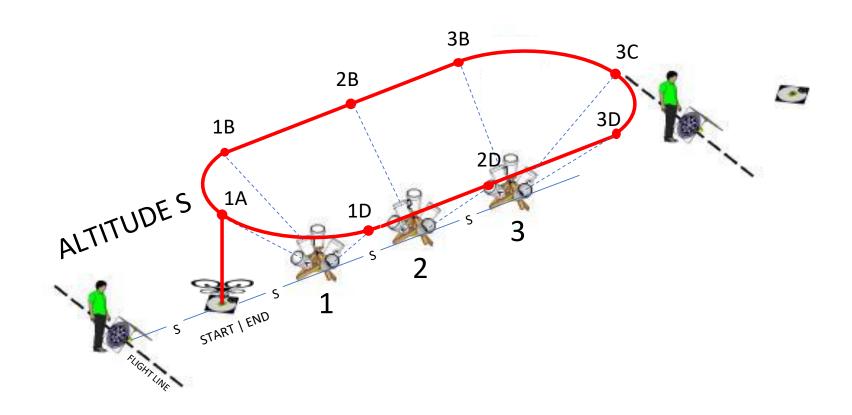
Position (MAN/PAY 1)

Open Test Lane













NATIONAL INSTITUTE OBIN diameter weatherproof stickers
STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMPLETE Website to download the stickers for Evaluating Aerial Drones

Safety | Capabilities | Proficiency leg extensions to shae on and tighten

- [4] Big numbers 1-1-1-1 inside the top bucket
- [4] Big letters A-B-C-D around the top bucket
- [5] Acuity targets A-B-C-D inside bottom of all
- [2] Perch acuity targets inside and bottom of A

Scoring

Capture in 1, 2, 3, 4

ALIGN WITH BUCKETS AND LAND ACURATELY

20 ALIGNMENTS TOTAL UP TO 100 POINTS



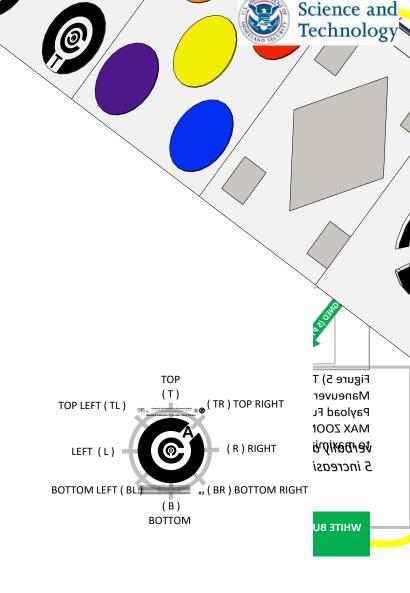
to guide alignment and a visual acuity target with increasingly small Concentric Cs gaps to identify the correct (1 of 8) orientations.

inscri

Versio

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CAPIURE UNLY UNE IMAGE OF EACH BUCKEY CHRUB ALIGNED INAGES AND LANDINGS

g the answer key (1 pt each).

1pt & 1pt

POSIT	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	&	3 A
5	DESCEND VERTICALLY OVER STAND #1 TO ALIGN WITH	1	&	2A
6	PITCH FORWARD OVER STAND #2 TO ALIGN WITH	2	&	3 A
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°	L	&	1A

LAND IN CIRCLE (ONE OR MORE LEGS) – WORTH 2 POINTS





10

POST I/PAY 1)

Evaluate ght maneuve orientations, and altitudes alc positive aircraft control at all maneuvers Evicusing OPEN Test Lane simultaneously align with two l altitude. The craft than auvering Trials

Evaluate dropes flying sidewalditional pilot workload. to identif s as if along a drone fli de (S) to c@5 minutes (5 minutes each) the ornin ands to align

ed on the books or a contact within a 30 cm (12 in) radius circle.

ORBIT (MAN/PAY 3)

Evaluate drones flying circular flight paths at different altitue objects while looking inward to identify features on all four drone orbits at altitude 2(S) in both directions then altitude directions to align with the designated buckets. Each orbit sta initial downward bucket alignment to check the radi proceeding leftward and rightward. Accurate landings are not

INSPE (PAY 4)

Evaluate ying in closer proximity around objects detailed to on the top and all sides. The drone flies

designated time iimit. Visua camera pointing and zoomi <u>color, t</u>hermal, hazmat label: resulting in an end-of-trial in from the intended flight p chassis or any found contact when open area maneuvering around apparatus, ground, or safety TRAVERSE (MIAN/PEROZ) nd objects using all 5 flight paths with

ALIGNED

1A

ALIGNE

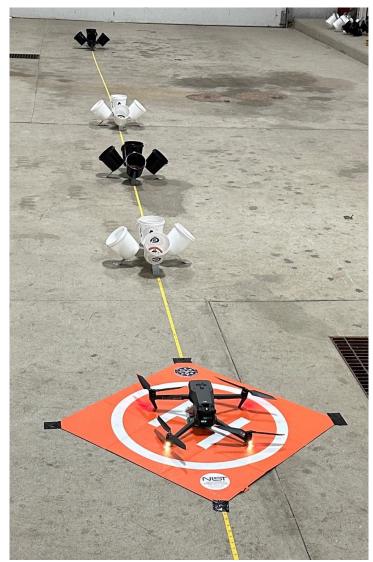
TOP

HANDLE



Level 2 Open Lane







Level 2 Open Lane Setup

Using 10cm(4in) Buckets;

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

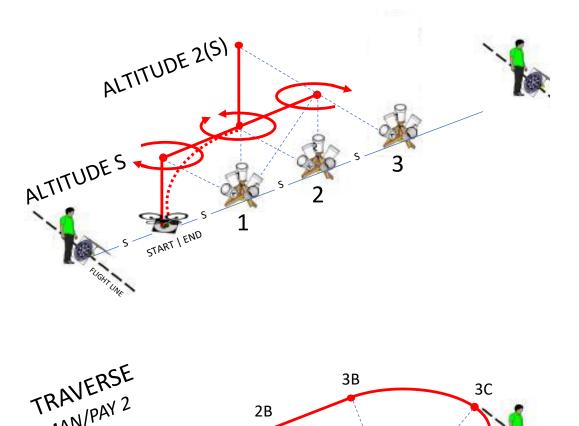
Area required 10 x spacing long (15m-50ft) x 6 x spacing wide (9m-30ft) x 2.6 x spacing high (4m-13ft)

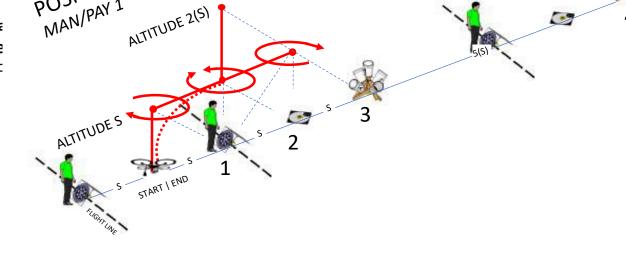


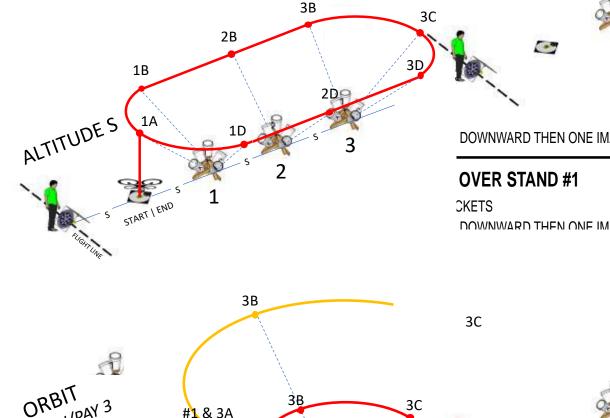
Test Methods for Evalua Safety | Capabilitie RobotTestMethc

Position (MAN/PAY 1)

Open Test Lane







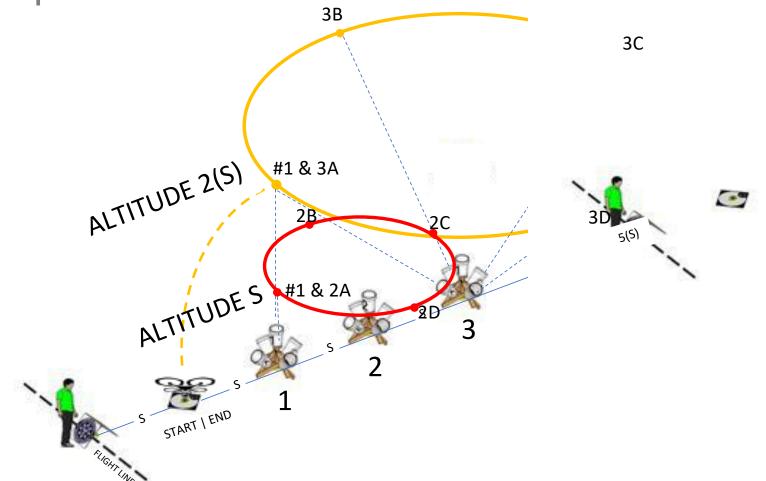
LIDAY 3

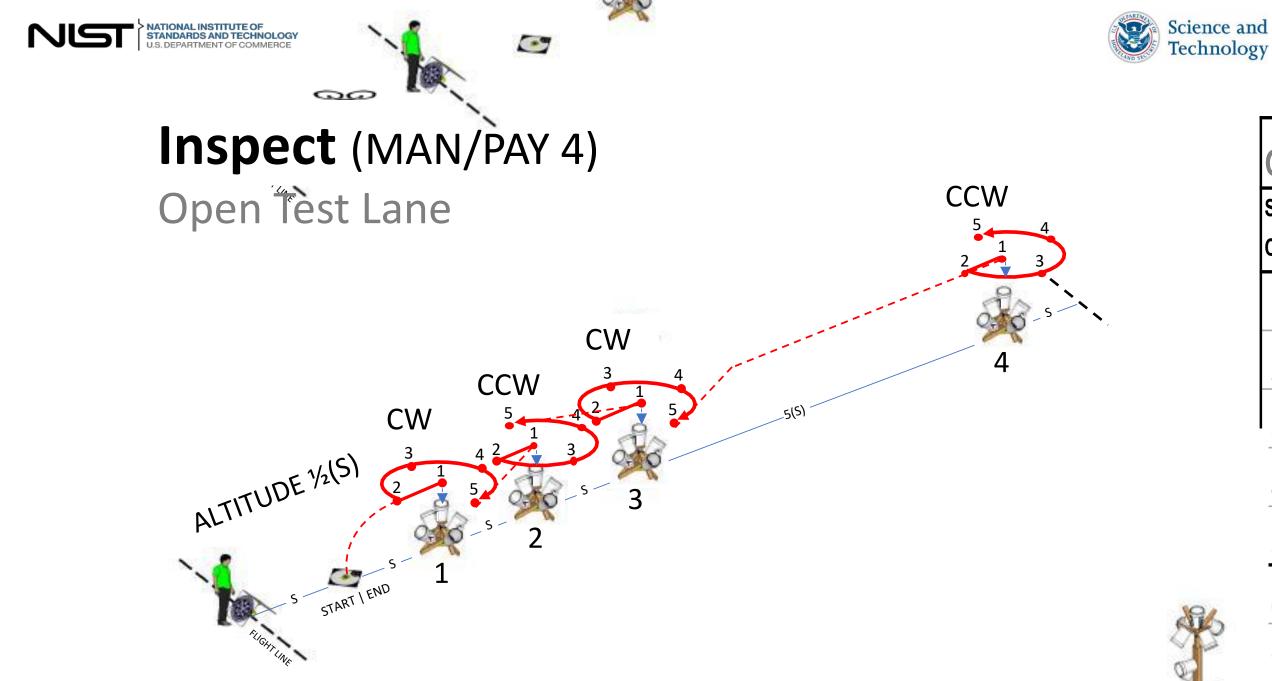




Orbit (MAN/PAY 3)

Open Test Lane







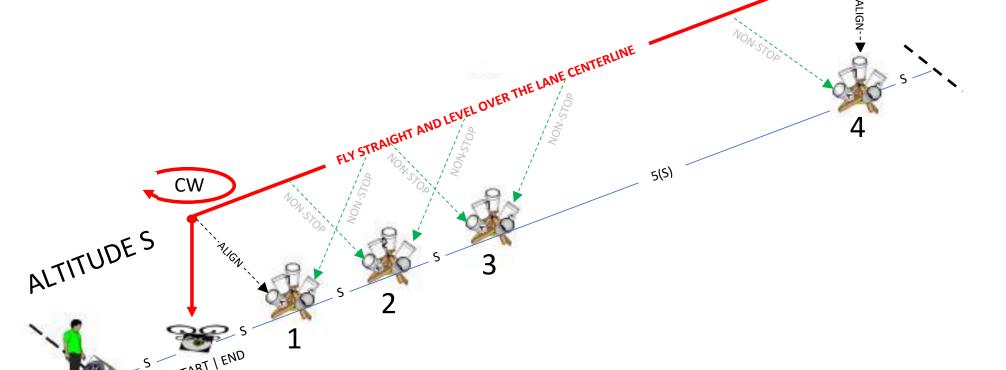




CCW

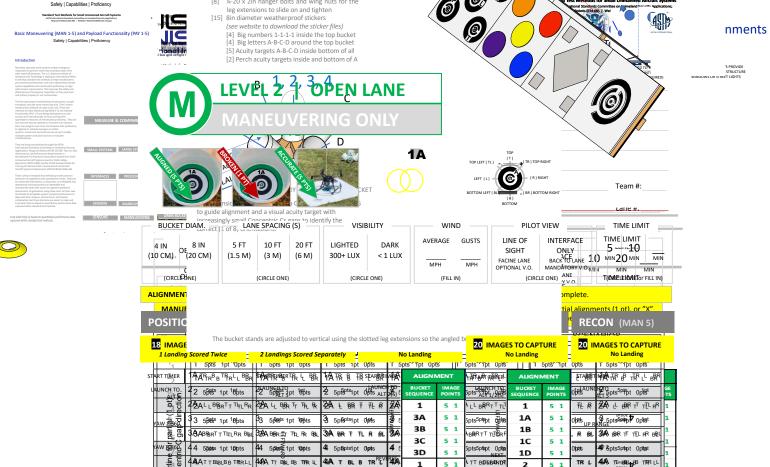
Recon (MAN/PAY 5)

Open Test Lane



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CAP



23

TR L 4A TUPSBELLE TRR LL 1 5 1 2 33 55pbs 1pt16pbts **3A** 5 1 | 33 5p5nets1pt10mpts 33 5pfapts1pt 0fpfts 5pts5p**ts**pt @∰ott 2A 5 5pts5ptsot Optet 3D 5 1 2D . L BLL 55AA, BBLR TLLLBBL 3.AA.ABRBRT THILRR BBL B3%A BBR TITL RR BBL B3AA. BR T TL R BL B\$AA. NBBRTT TOSE **3C** 5 1 2C 5 MANU pt 10pts 6 5pts5ptspt 0ptst 2 5ptspts1pt Oppts 5pts5pflspt 0pt **3B** 5 1 2B 2AALLBARTTTTLRR 2AALLUNG TTTLR 2A L BR T TLTBAZA L LERR BOTH THE BETTER L BEER LL BBIRTAINTH 1 5 1 3 5pts_{5p}tspt Opts 7 5pts_{5p}tpt 0ptst 1 5pts 1pt 10pts 5pts 1pt Opts 1 5pts_{bts}1pt Qpts 2A 5 1 ЗА 1.AA+7.RBB+7.RRLLBR 1.1AA+7.RB+7.RLBR 1.1AA+7.RB+7.RLBR 2B 5 1 TRRBB TRE 3B 11-16 **77**Α΄ L 1876 Τ 11-16 2C 5 1 3C 5pts 5pts 7 Opts 5pts_{5pts}1pt 0pts 2 5pts_{bts}1pt 0pts 2D AACLBRATTULR 2AAL ARTULR 2AAL ARTUR R BL 8A BR T TL R BL 1 5 1 5pts 1pt Opts ვ³ 5pts_{pts}1pt Opts Spts_{5pts}t Opts 5pts_{5pt}st Opt 2A 5 1 4A AABRTTTLR BUSAABRTTTLR BUSAABRT TE BE 2D 5 1 BBRTT 1 4D 5 1 2C 5 1 4C 5 1 2B 5 1 4B 5 1 /100 /100 /100 /100 Elapsed ELAPSED TIME ELAPSED TIME ELAPSED TIME ELAPSED TIME Time RASS FAIL PASS FAIL FAIL PASS F

NATIONAL INSTITUTE OBIN diameter weatherproof stickers
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U.S. DEPARTMENT OF COMPLETE Website to download the stickers for Evaluating Aerial Drones

Safety | Capabilities | Proficiency leg extensions to shae on and tighten

- [4] Big numbers 1-1-1-1 inside the top bucket
- [4] Big letters A-B-C-D around the top bucket
- [5] Acuity targets A-B-C-D inside bottom of all
- [2] Perch acuity targets inside and bottom of A

Scoring

Capture in

1, 2, 3, 4

ALIGN WITH BUCKETS AND LAND ACURATELY

20 ALIGNMENTS TOTAL UP TO 100 POINTS



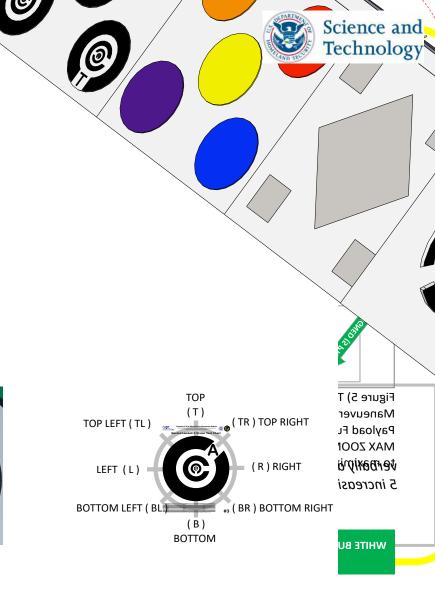
to guide alignment and a visual acuity target with increasingly small Concentric Cs gaps to identify the correct (1 of 8) orientations.

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İ			 		
	1		1 5pts 1pt 0pts		1 5pts 1pt 0
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Ļ	AUNCH TO.	2	2 5pts 1pt 1pts		2 5pts 1pt 16
	1-pt) ectic	2	ALLBBRTTTELRR		L BR T
	AVA TERES	3	3 55 Pets 1pt 10 pts	Ţ	3 5 fets 1 pt 10
	garl gar	3	ABBRT T TITLRR BBL		BOR TT THE P
	WW BEED IN	_	4 55pts 1pt 10pts	ł	14 5 ptsts 1 pt 10
	edine cent	_	AATTBIBLBBTRRLL	Ł	144A TT BBL BB 7
	<u> </u>				



the omr ands to align also lands ed on the platform with the chassis or a contact within a 30 cm (12 in) radius circle.

ORB T (MEANE PAY B) OPEN Test Lane

Evaluate drones flying circular flight paths at different altitude objects while poking in way deather different altitude drone orbits a altitude 2(S) in both directions then altitude directions to all in with the designated buckets. Each orbit star while initial down, and buckentaugring about a landings are not proceeding leftward and rightward. Accurate landings are not ground objects using all 5 flight paths.

Evaluate (pay 4) 25 minutes (5 minutes each) ying in closer proximity around objects detailed to on the top1200 Alignmenth& drone-Amuty Points 1/2(S) all around each omni bucket stand to align with the buckets. Inspection tasks start on top then rotate around the alternating clockwise and counter clockwise directions.

RECON (MAN/PAY 5)

landings are not included.

Evaluate drones flying straight and level down range to estal hovers over objects in open space to perform reconnaissance drone flies at altitude (S) at a sustainable speed directly over centerline to align with designated buckets and the landing a of the down range reconnaissance tasks inclu

ALIGNED

1A

LEFT 1B

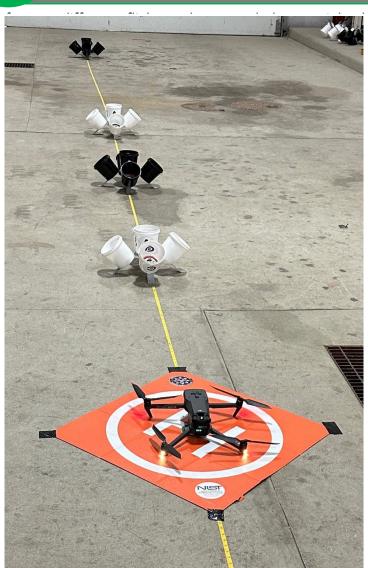
FRONT 1A





Level 3 Open Lane





Choose Appropriate Lane Spacing Based on Optics and Safety

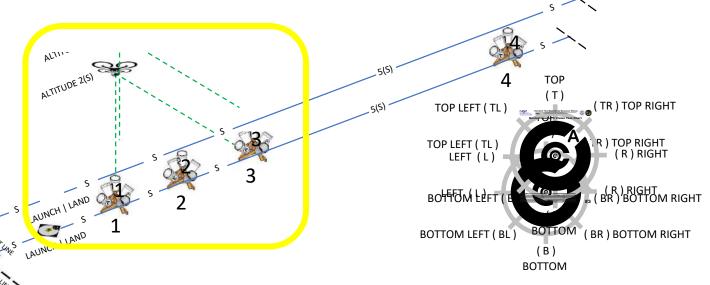
ASTM International Standards Committee on Homeland Security Applications; Response Robots (E54.09) | Website: RobotTestMethods.nist.gov

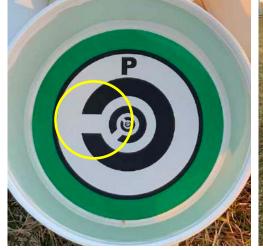
ALWAYS:

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

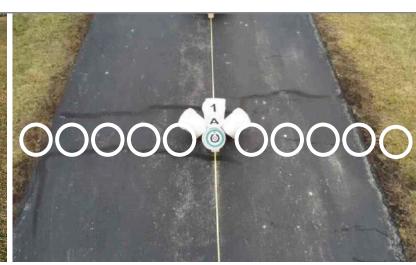
INDOORS:

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









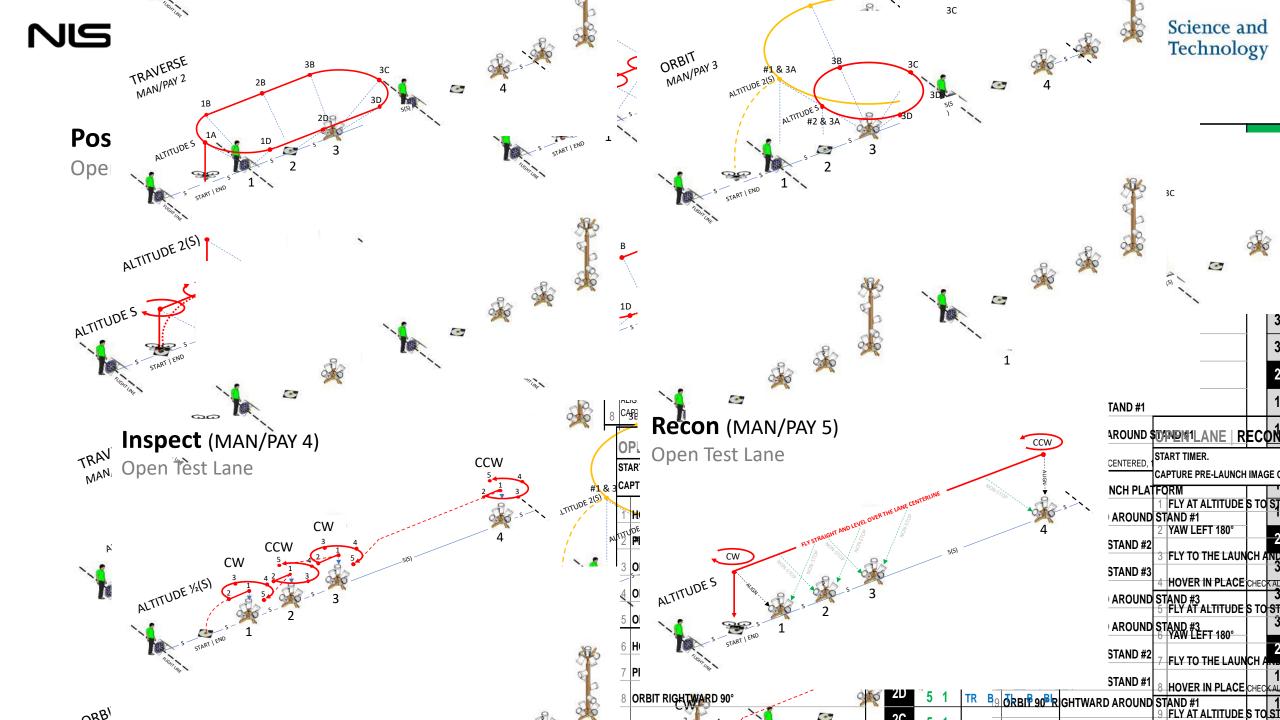


Level 3 Open Lane Setup

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)

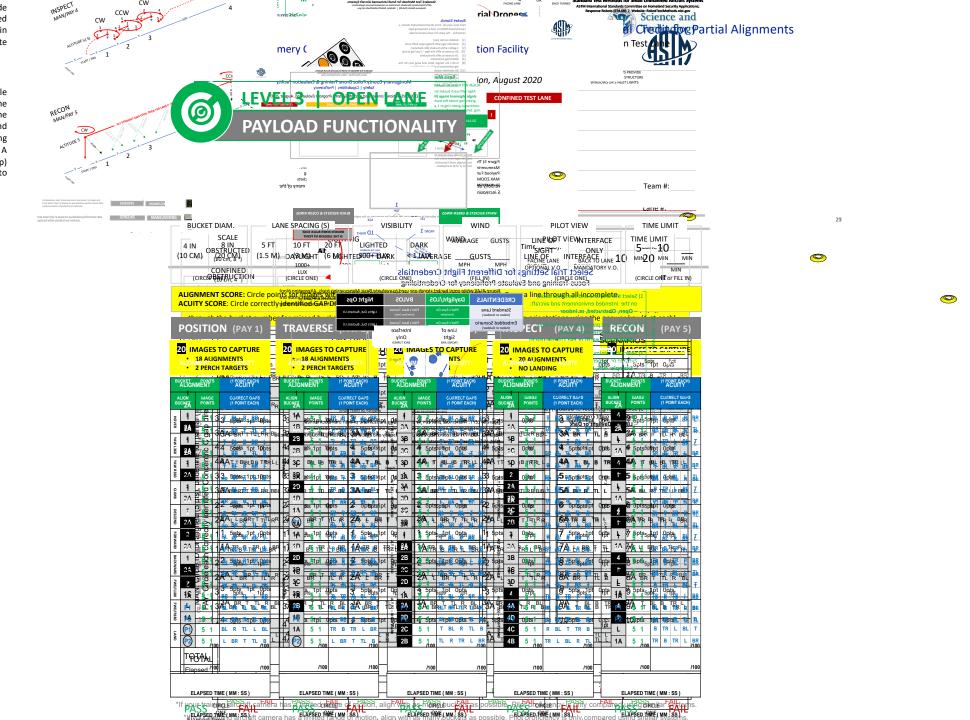


on the top and all sides. The drone flies at altitude each omni bucket stand to align with the designated in tasks start on top then rotate around the objects in wise and counter clockwise directions. Accurate cluded.

PAY 5)

ying straight and level down range to establish stable is in open space to perform reconnaissance tasks. The ude (S) at a sustainable speed directly over the lane with designated buckets and the landing at each end down range reconnaissance tasks include looking he objects in different orientations and at an angle. A ers a total distance of 80(S) with moving (non-stop) the angled buckets along the centerline helping to from the intended path and encourage consistency.





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U.S. DEPARTMENT OF COMPLETE Website to download the stickers for Evaluating Aerial Drones

Safety | Capabilities | Proficiency leg extensions to shae on and tighten

- [4] Big numbers 1-1-1-1 inside the top bucket
- [4] Big letters A-B-C-D around the top bucket
- [5] Acuity targets A-B-C-D inside bottom of all
- [2] Perch acuity targets inside and bottom of A

Scoring

Capture in

1, 2, 3, 4

ALIGN WITH BUCKETS AND LAND ACURATELY

20 ALIGNMENTS TOTAL UP TO 100 POINTS



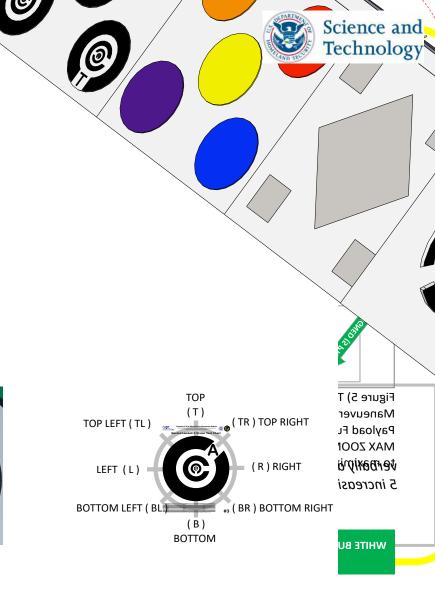
to guide alignment and a visual acuity target with increasingly small Concentric Cs gaps to identify the correct (1 of 8) orientations.

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Version 202

Align wither on Function of the three or zoo yourself, alt

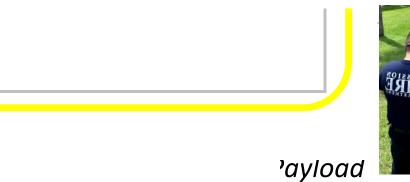
to guide alignment and a visu increasingly small Concentric correct (1 of 8) orientations.

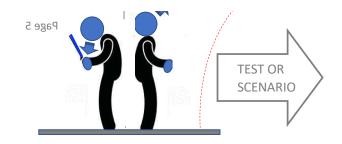
rapidos pilot Proctor.

arion gighterface OS).

The bucket stands are adjusted to vertical using the slotted leg extensions so the angled buckets are at 45 degrees.

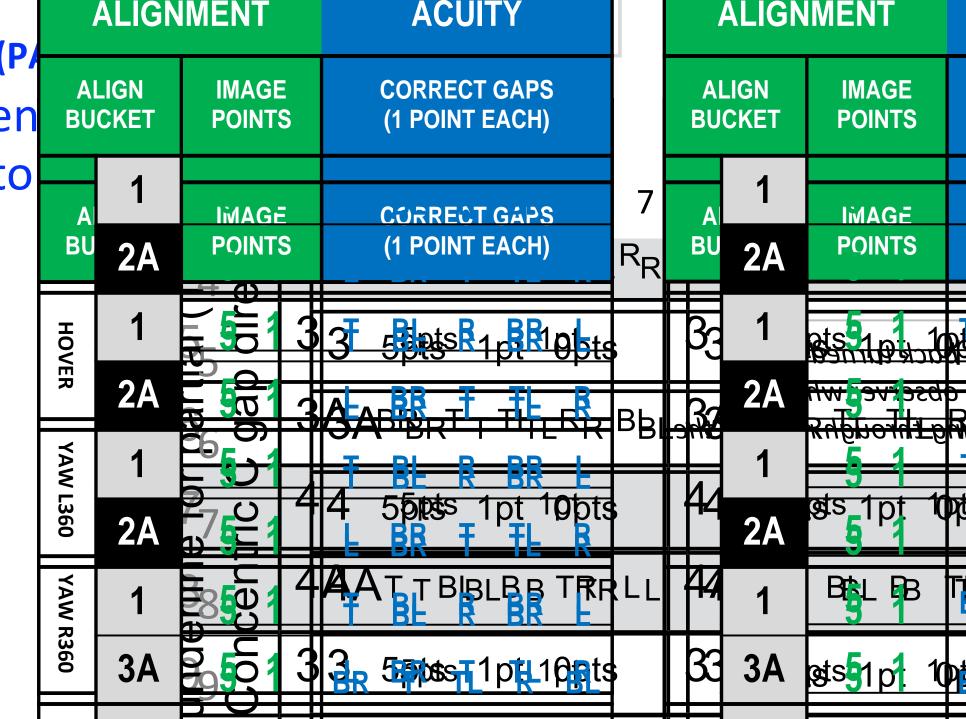






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to soliq sh'
Select Trial Settings for Differ

tionality Trials (PA (MAN) then iden le to score up to





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)

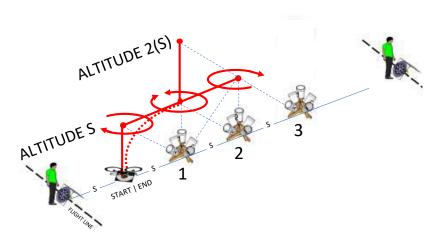
Flight Paths - Position, Traverse, Orbit 10-minute time limit for each Flight Path

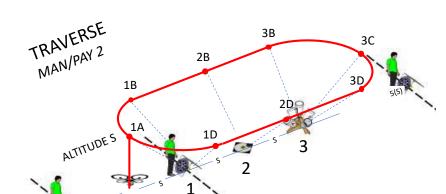
This provides the training necessary for the Large Platform's mission set

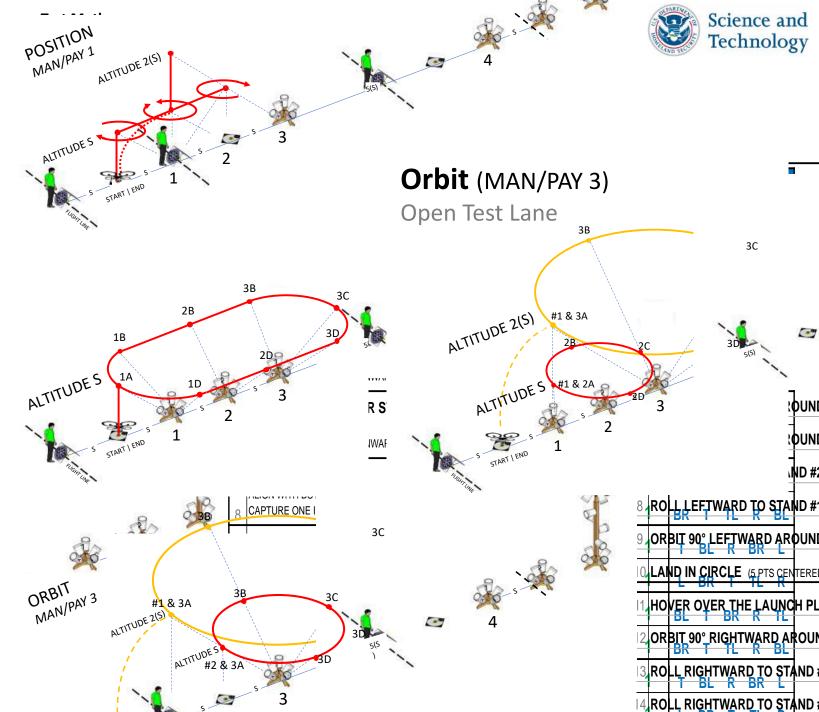


Position (MAN/PAY 1)

Open Test Lane









ALL ARE OFF



Teams Rotate Through Each Role

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

TEAM ROTATIONS





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 on the same time.

between each rotation to prepare the next of the same time as a same time.

between each rotation to prepare the next of the same time as a same time.

- 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

The order is different with the VO role noing last in the matter because as soon as the order in Antons all 5 tests in 2 hours. aircraft lands, the VO can leady their aircraft is pliot the perturbation of the process away and the Proctor can take Viet the County of the Process of the Proces

Pilot Person 1
Proctor Person 2
VO Person 3

2nd SHIFT (5-10 minutes)
Pilot Person 3
Proctor Person 1
VO Person 2

 3rd SHIFT (10-15 minutes)

 Pilot
 Person 2

 Proctor
 Person 3

 VO
 Person 1

4th SHIFT (15-20 minutes
ALL ARE OFF

Measument Proctor

Completent With every bucket in the sequence and land accurately according to the procedure. The Four person teams always have one person getting their objective sequing Alliapints possible for your ais tables. Without making mistakes work too, but require some time between each rotation to prepare the next aircraft.

Score! Por complete trials, track your scores over time.

Maintain control of the aircraft.

The average of your last five trials is an excellent measure can out each intention of movement before doing so. of your proficiency on the aircraft and interface year gap.

PROCTOR

Efficiency (Optional) Fascomplete trials with maximum scores for a particular wineraft, the elapsed time can help identify the most efficient systems and techniques. Time limited trials can be used across multiple tests to maintain Maintain sight with the aircraft and surroundings. a schedule and similarly satisfied novices and ment to confirm.

· Call out corrections and warnings as necessary.



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

CENTERLINE
MEASURING TAPE



• 7(S) altitude

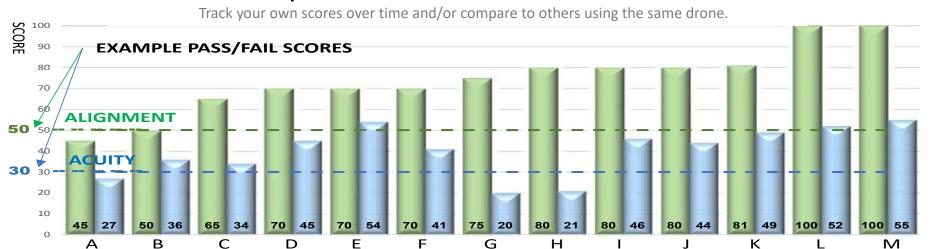
• 2(S) altitude

S altitude

6(S) altitude5(S) altitude

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

Separate Scores for ALIGNMENT and ACUITY



36

Trave

Orbit

Spiral

S altitude



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Level 3 Open Lane Proctoring

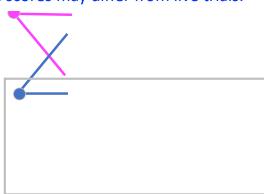
ALIGN WITH BULLIKIE Hasgeting Align with each bucket lor single alignment image (N green ring inside the buck **OPEN TEST LANE** continuous green ring or 1 poi scoring for accur **20 ALIGNMENTS TOTAL UF** to guide alignment and a visu increasingly small Concentric Version 202 correct (1 of 8) orientations. insa**nse**d Fun**Etiloc**i the time b Scor рс The bucket stands are adjusted to vertical using the slotted leg extensions so the angled buckets are at 45 degrees. 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.

Safety | Canabilities | Proficiency

Align with each bucket long enough to verify the DOJ/DHS Nation inscribed ring and declare as many of the 5 Concentric C gap directions as possible to score 1 point each. Use video or zoomed in images after the trial to score yourself, although scores may differ from live trials.



August 2020

CONFINED TEST LANE

Select Trial Setti

Focus Training an

est lane and scenarios based nded environment and aircraft structed, or Indoor

est procedure and time limit e intended mission:

iin. each) or PAY (10 min. each

'expert' scores in the same tria

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MARIORAN regcontrols. hie Gigopt ²roctor.

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ginterface OS).

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TEST OR

SCENARIO

ninimum proficiency based on

40%, 60%, 80% of "expert"

he one but stands to align with the designated buckets. The drone sliso lands in a sound the platform with the chassis or any ground contact within a 30 cm (12 in) radius circle.

DRBIT (MAN/PAY 3)

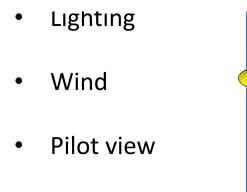
evaluate drones flying circular flight paths at different altitudes around objects while looking inward to identify features on all four sides. The drone orbits at altitude 2(S) in both directions then altitude (S) in both directions to align with the designated buckets. Each orbit starts with an initial downward bucket alignment to check the radius before proceeding leftward and rightward. Accurate landings are not included.

NSPECT (MAN/PAY 4)

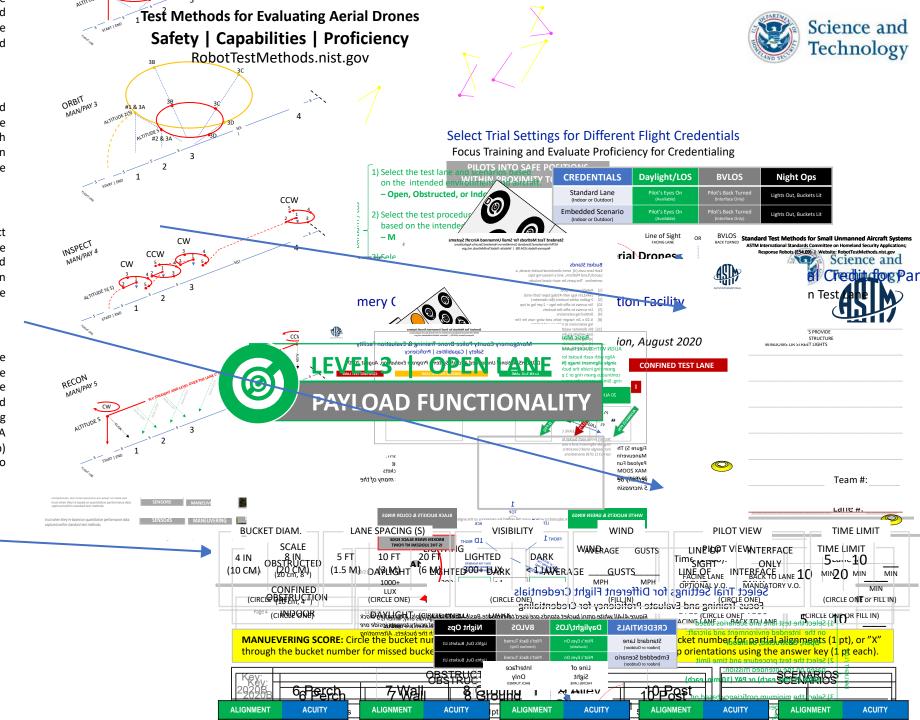
Evaluate drones flying in closer proximity around objects to inspect detailed features on the top and all sides. The drone flies at altitude L/2(S) all around each omni bucket stand to align with the designated buckets. Inspection tasks start on top then rotate around the objects in alternating clockwise and counter clockwise directions. Accurate andings are not included.

RECON (MAN/PAY 5)

Evaluate drones flying straight and level down range to establish stable anovers over objects in open space to perform reconnaissance tasks. The drone flies at altitude (S) at a sustainable speed directly over the lane tenterline to align with designated buckets and the landing at each end of the lane. The down range reconnaissance tasks include looking traight down on the objects in different orientations and at an angle. A complete trial covers a total distance of 80(S) with moving (non-stop) dignments over the angled buckets along the centerline helping to dentify deviations from the intended path and encourage consistency.



Time limit





Review scoring guidance.

Reminders to help understand mistakes

White and black bucket shading

Circle ALIGNMENT points from images.

Circle ACUITY points from answer key.

Separate totals for ALIGNMENT and ACUITY points (100 points each).

Any organization can select their ownpassing score and elapsed time.

yourself, although scores may differ from live trials Test Methods for Evaluating Aerial Drones Safety Capabilities | Proficiency RobotTestMethods.nist.gov

Fly straight and level at a sustainable speed directly over the lane centerline to establish a stable hover over an obless and perform quick reconnaissance tasks.

- Function faintain altitude (S) throughout starting over the lath€h¶GHid to align with the designated buckets and the landing at each end of the lane.
- Capture a single image inside each bucket and the landing target for scoring alignments after the trial.
- Accurate landings are not included in this test
- A complete trial totals a distance of 80(S)
- The bucket stands are adjusted to vertical using th **Basic Maneuvering Trials (MAN):** Complete 5 laps with 20 bucket alignments to score up to 100 alignment points.

Payload Functionality Trials (PAY): Same as Basic

gaps as possible to score up to

FAIL

DECLARE EACH CONCENTRIC C FOR **SCORE DURING** THE TRIAL

(with a

as if

(CIRCLE ONE OR FILL IN)

Science and

Technology

(PAY 5)

entric C gap directions (1 pt each)

CL RECON

	• NO LANDING																				
ENT	ACUITY	Ā	ALIGNMENT			Т	ACUITY				ALIGNMENT				ıτ	ACUITY					
IMAGE POINTS	CORRECT GAPS (1 POINT EACH)			LIGN			CORRECT GAPS (1 POINT EACH)				ALIGN BUCKET		IMAGE POINTS		CORRECT GAPS (1 POINT EACH)						
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5 1	BR T TL R BL		LT 1/2	1A	5	1	TR B	TR	L	BR		LAP	Þ	5	1	BR	Ι	BL	L	Ι	
5 1	B TR R BL T		S) – LEF	1B	5	1	R TL	. т	BL	В		P 1	L	5	1	В	TR	L	BL	1	
5 1	BL R BL T BR		ALT 1/2(S) - LEFTWARE	1C	5	1	BR R	TL	L	BR			1A	5	1	TR	В	TR	L	В	
5 1	L TL R BR T			1D	5	1	B TL	R	BL	Т			4	5	1	TL	В	TR	R	В	
5 1	T BL R BR L		Ą	2	5	1	BL T	BR	R	크		IAP 2	Þ	5	1	BR	I	BL	L	1	
5 1	BR T TL R BL		ALT1/2(S) - RIGHTWARD	2A	5	1	L BF	т я	TL	R			L	5	1	В	TR	L	BL		
5 1	L TL R BR T)-RIGI	2D	5	1	TR B	TL	В	BL			1A	5	1	TR	В	TR	L	В	
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5 1	B TR R BL T		0	2B	5	1	TL R	TR	L	BR	2		Þ	5	1	BR	Ι	BL	L	I	
5 1	T BL R BR L		_	3	5	1	R TL	В	BL	R		Р3	L	5	1	В	TR	L	BL	ŀ	
5 1	L BR T TL R		UT 1/2	3A	5	1	BR T	TL	R	BL			1A	5	1	TR	В	TR	L	В	
5 1	TL R TR L BR		(S) -LE	3B	5	1	в тя	R	BL	Т			4	5	1	TL	В	TR	R	В	
5 1	T BL R TL B		ALT 1/2(S) - LEFTWARD	3C	5	1	BL R	BL	т	BR		LAP	Þ	5	1	BR	Ι	BL	L	I	
5 1	TR B TL B BL		0	3D	5	1	L TL	R	BR	Т		4	L	5	1	В	TR	L	BL		
5 1	T BL R BR L	1	Þ	4	5	1	TL B	TR	R	BR			1A	5	1	TR	В	TR	L	В	
5 1	L BR T TL R		ALT 1/2(S) – RIGHTWARD	4A	5	1	T BL	. в	TR	П			4	5	1	TL	В	TR	R	В	
5 1	TR B TL B BL		5) – RIG	4D	5	1	BR B	TL	В	TR		LAP	Þ	5	1	BR	I	BL	L	1	
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		Ī																			
PSED TI	ME (MM : SS)		ELAPSED TIME (MM : SS)									ELAPSED TIME (MM: SS)									

ng into ach).

Verify your score after the trial using captured video, although scores

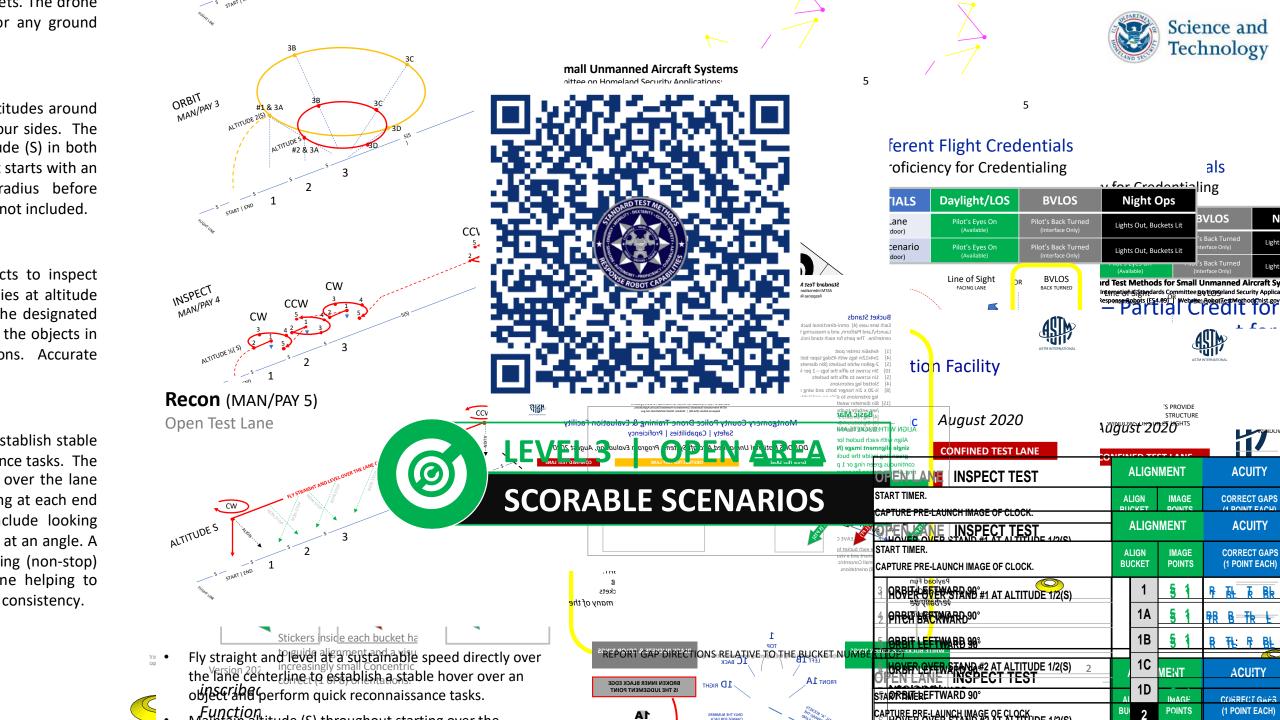
PASS CIRCLE FAIL

ets. The arone or any ground

itudes around our sides. The ide (S) in both starts with an radius before not included.

ies at altitude he designated the objects in ons. Accurate

stablish stable nce tasks. The over the lane ng at each end clude looking at an angle. A ing (non-stop) ne helping to consistency.



Open Area Search

SEQUENCE DOWN RAN

20 FT

Day and Night Trials

REMOTE PILOT TRAINING - CANADIAN POLICE COLLEGE, ONTARIO, CANADA

CONCURRENT OBJECTIVES

OPEN FOR 3 TEAMS TO FLY



IADA





HOVER OVER

THUT DAUNY

ORBIT RIGHT

ORBIT RIGHT

ORBIT R

VEHICLE INSPECTION

PITCH BACKV ORBIT LEFTW

ORBIT LEFTW

ORBIT LEFTW

HOVER OVER

PITCH BACKV ORBIT RIGHT ORBIT RIGHT ORBIT RIGHT STOP TIMER. RECORD SCORES /

PERCH BUCKETS TARGETS RONT AND REAR STICKERS ON ALL SIDES OF THE VEHICLE AND SURROUNDING GROUND **REAR PERCH**

20 FORWARD

OTHER OBJECT < 10 FT

ALTITUDE AND RADIU

D ALTITUDE AND RADIUS

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.

ORBIT RIGHTWAI ORBIT RIGHTWAI STOP TIMER.

RECORD SCORES AND

ORBIT RIGHTWAR ORBIT RIGHTWAF

STOP TIMER.

RECORD SCORES AND

9 OKBIT KIGHTWA

ORBIT RIGHTWAI

STOP TIMER.

RECORD SCORES AND

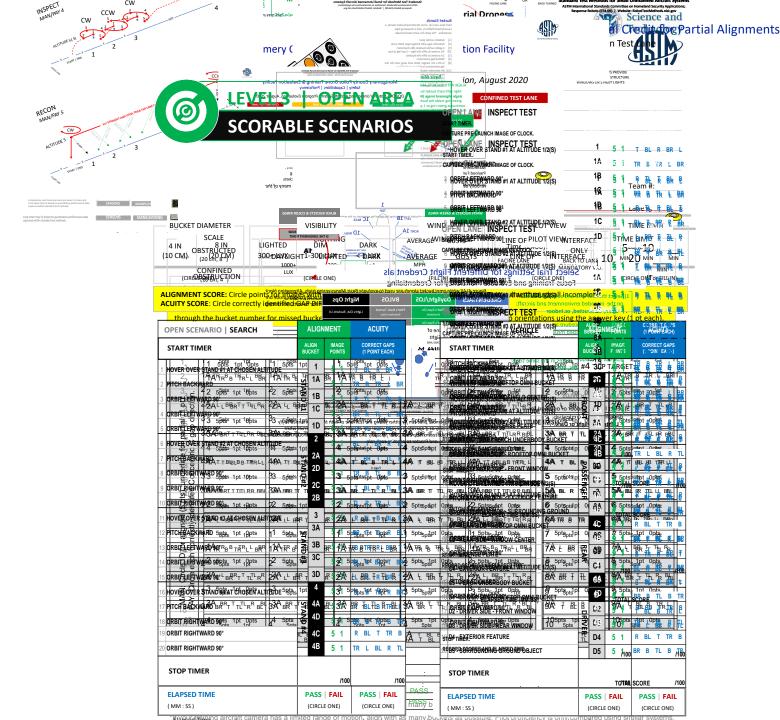
ELA

on the top and all sides. The drone flies at altitude each omni bucket stand to align with the designated in tasks start on top then rotate around the objects in wise and counter clockwise directions. Accurate cluded.

PAY 5)

ying straight and level down range to establish stable is in open space to perform reconnaissance tasks. The ude (S) at a sustainable speed directly over the lane with designated buckets and the landing at each end down range reconnaissance tasks include looking he objects in different orientations and at an angle. A ers a total distance of 80(S) with moving (non-stop) the angled buckets along the centerline helping to from the intended path and encourage consistency.





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9



Test Methods for Evaluating Aerial Drones Safety | Capabilities | Proficiency RobotTestMethods.nist.gov

Science and Technology



Level 1-3 Review

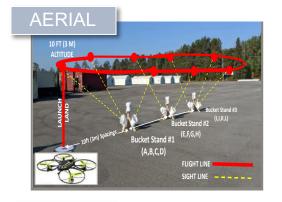
Standards Enable Credentialing of Proctors and Remote Pilots

Safety | Capabilities | Proffice are extended to accommodate the orbit radius of forward flying systems.

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 to the limited surfaces ensure the top bucket is points for similar elapsed times or calculate and compare the scoring rate as points per minute for different elapsed times







These test methods are primarily intended for vertical takeoff and landing systems with an

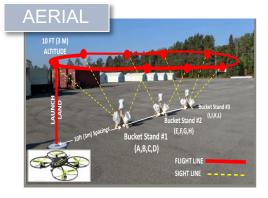
Standards Enable Credentialing of Proctors and Remote Pilots

Safety | Capabilities | Profice per extended to accommodate the orbit radius of forward flying systems.

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.

Bucket stands on a level surfaces ensure the top bucket is vertical and the angled buckets are 45 degrees.







These test methods are primarily intended for vertical takeoff and landing systems with an

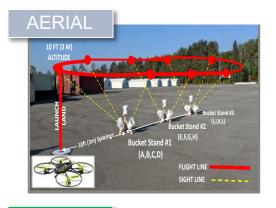
Standards Enable Credentialing of Proctors and Remote Pilots

Safety | Capabilities | Proffice recycled to accommodate the orbit radius of forward flying systems.

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

Bucket stands on a level surfaces ensure the top bucket is vertical and the angled buckets are 45 degrees.







rir scoring tasks in the reaction Test Lane will one or targets inside. Successful al altitude long enough to veri Procession to veri encyt Safety Checkride quires a single procession of the control of the image is captured of each tale positive aircraft control in quicke the books and the books are the b pointing, zo ming, and external recreational pilots material labels, or other ob alignments parusing the first 2 of 5 flight paths. any of the designated ti 10 minutes (5 minutes each) **POST** camera point ght maneuv 40 Alignment Points Evaluate 1 orientations, and altitudes alc color, thermal positive aircraft control at all

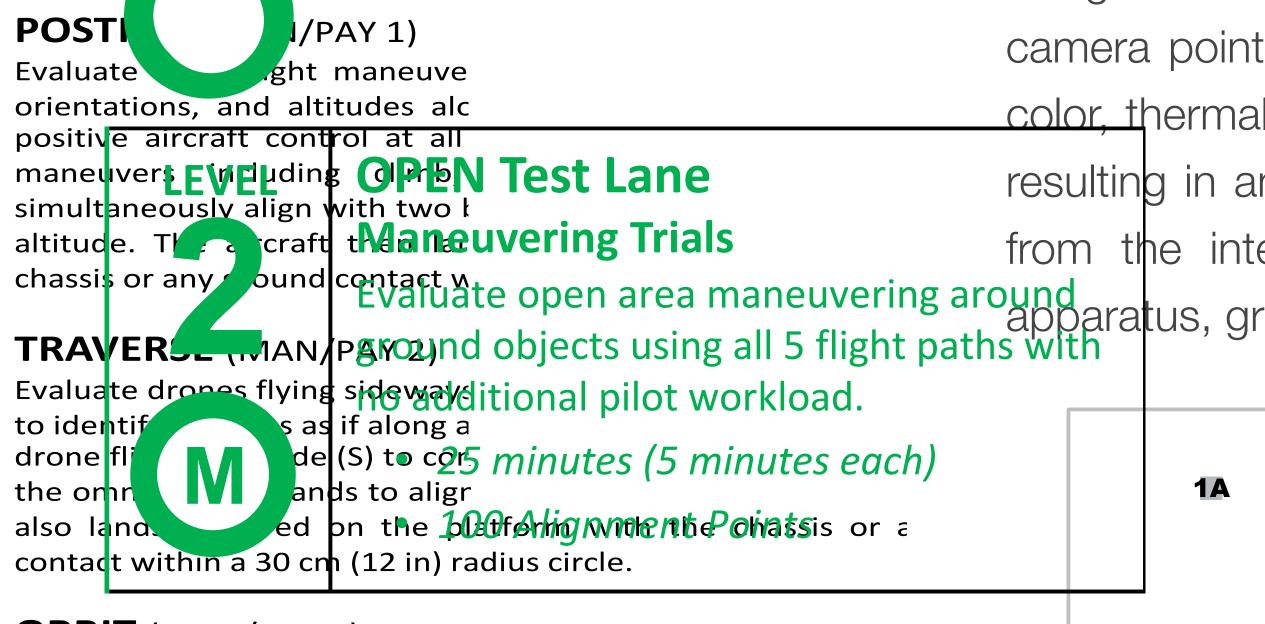
resulting in ar

from the inte

maneuvers including climb,

simultaneously align with two k

altitude. The aircraft then lar



ORBIT (MAN/PAY 3)

Evaluate drones flying circular flight paths at different altituous objects while looking inward to identify features on all four

the omr also land ed on the platform with the chassis or a contact within a 30 cm (12 in) radius circle.

1A

ORB T (MENTERAY B)OPEN Test Lane

Evaluate drones flying circular flight paths at different altitude objects while poking in way deather difficulties in way deather different altitude. It is altitude open area maneuvering while direct ons to all n with the designated buckets. Each orbit star while initial down and buckentage in ground objects using all 5 flight paths.

ALIGNED

Evaluate (5 minutes each) ying in closer proximity around objects on the top1a0 Alignmenth drope Ariety Points

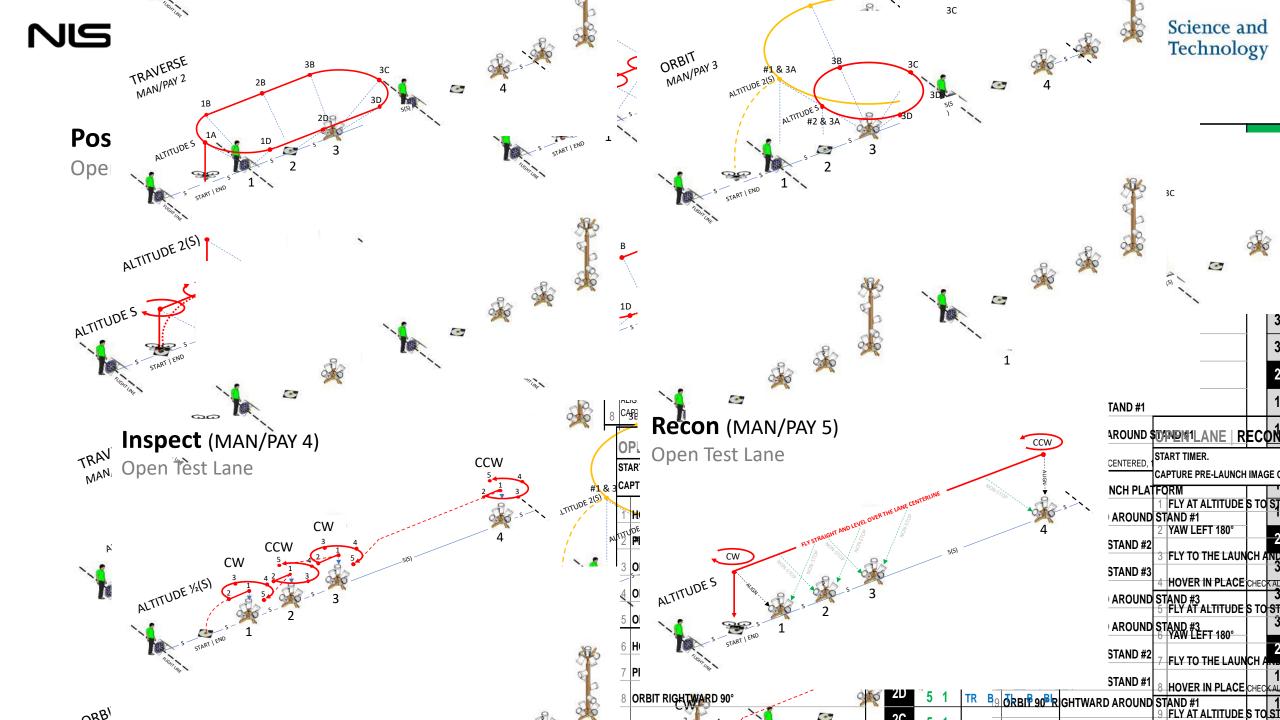
1/2(S) all around each omni bucket stand to align with the buckets. Inspection tasks start on top then rotate around the

alternating clockwise and counter clockwise directions

landings are not included.

LEFT

FRONT 1A



Choose Appropriate Lang Spacing Based on Optics and Safety

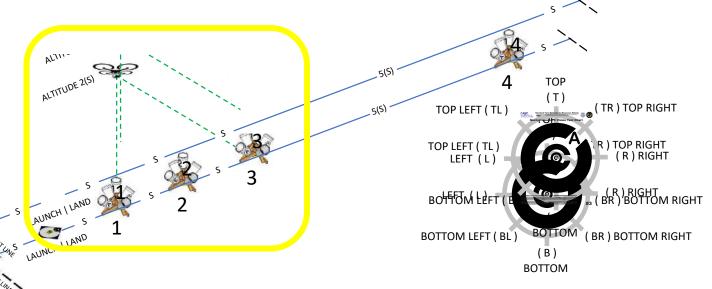
ASTM International Etandricks Gormaittee on Homeland Security Applications;
Response Robots (E54.09) | Website: RobotTestMethods.nist.gov

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





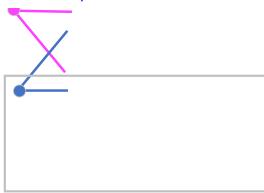




ALIGN WITH BULLIKIE Hasgeting Align with each bucket lor single alignment image (N green ring inside the buck **OPEN TEST LANE** continuous green ring or 1 poi scoring for accur **20 ALIGNMENTS TOTAL UF** to guide alignment and a visu increasingly small Concentric Version 202 correct (1 of 8) orientations. insa**nse**d Fun**Etiloc**i the time b Scor рс

Safety | Canabilities | Proficiency

Align with each bucket long enough to verify the DOJ/DHS Nation inscribed ring and declare as many of the 5 Concentric C gap directions as possible to score 1 point each. Use video or zoomed in images after the trial to score yourself, although scores may differ from live trials.



August 2020

CONFINED TEST LANE

est lane and scenarios based nded environment and aircraft structed, or Indoor

Focus Training an

Select Trial Setti

est procedure and time limit e intended mission:

iin. each) or PAY (10 min. each

ninimum proficiency based on 'expert' scores in the same tria

40%, 60%, 80% of "expert"

53

MARIORAN

regcontrols. hie Gigopt

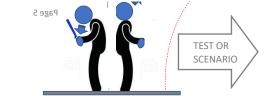
²roctor.

วลห่ดูเ ginterface OS).

38

The bucket stands are adjusted to vertical using the slotted leg extensions so the angled buckets are at 45 degrees.

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.



WHITEBOARD IN

PILOT & AIRCRA

Basic Maneuvering (MAN 1-5) and Test Methods, for Evaluating Aerial Drones

Safety | Capabilities Safety | Capabilities | Proficiency | Capabilities | Capabilities | Proficiency | Capabilities | Capabil

RobotTestMeth of Sandwister goods and related operational scenarios with t Methods for Response Robots lards Committee on Homeland Security Applications;

> t Methods for Response Robots lards Committee on Homeland Security Applications;

54.09) | Website: RobotTestMethods.nist.gov

POINTS

Open Test Lane and Related Operational Scenarios

Functionality (PAY 1-5) are being replicated across the country and internationally to focus training with **MEASURE & COMPARE** mantitative measures of remote pilot proficiency. They are their own progress over time and compare their proficiency to regional or national averages on similar multiple systems and pilots to train or evaluate

SMALL SYSTEMS LARGE DRONES

They are being standardized through the ASTM Applications; Response Robots (ASTM E54.09). They are also referenced as Job Performance Requirements in Unmanned Aircraft Systems Used For Public Safety

Introduction

Remotely operated aerial systems enable emergency

responders to perform extremely hazardous tasks from safer stand-off distances. The U.S. National Institute of

to develop standard test methods to help manufacturers. stem capabilities and remote pilot proficiency to align

with mission requirements. This improves the safety and

everybody onto the same measuring stick. That's where standard test methods can play a key role. These test

methods for Basic Maneuvering (MAN 1-5) and Payload

and protect property in our communities The first step toward credentialing remote pilots is to get

SCALABLE TEST LANES (ALTITUDE = SPACING)

Position

(MAN 1 | PAY 1)

Science and

Technology

Standard Test Methods fo

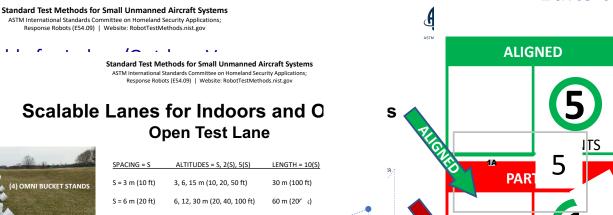
ASTM International Standards Co

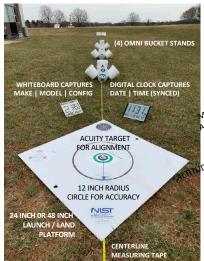
Response Robots (E54.09)

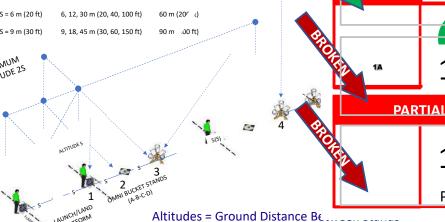
Standard Test Methods for Small U ASTM International Standards Committee or Response Robots (E54.09) | Website:

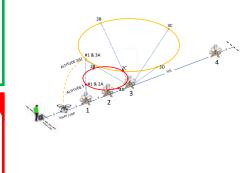
Edits to the Forms – Partial Cr

Open Test











Test Methods for Evaluating Aerial Drones Safety | Capabilities | Proficiency RobotTestMethods.nist.gov



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



Adam Jacoff

Intelligent Systems Division National Institute of Standards and Technology U.S. Department of Commerce



Sponsor.

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



