

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

Test Director

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

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

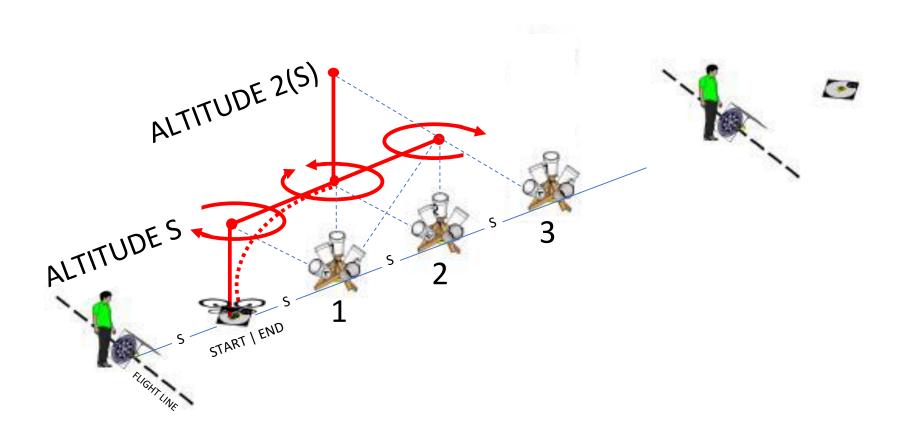
Area required 6 x spacing long (9m-30ft) x 6 x spacing wide (9m-30ft) x 2.6 x spacing high (4m-13ft)



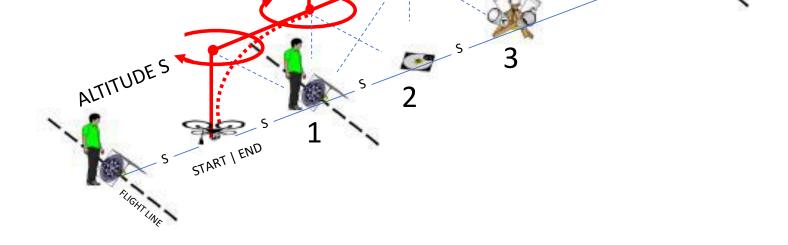


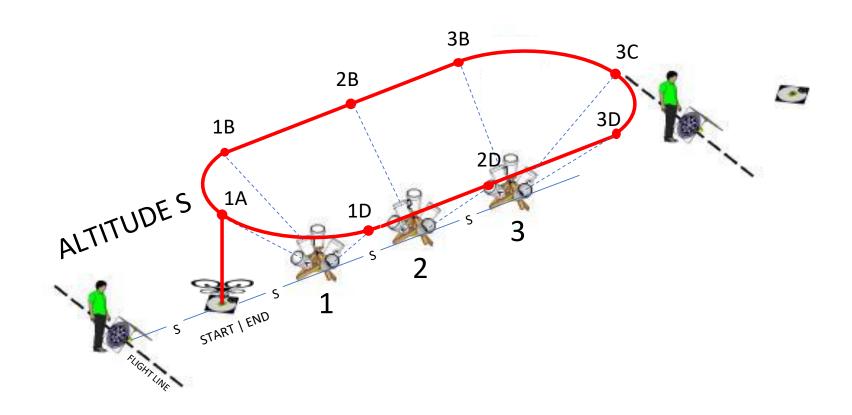
Position (MAN/PAY 1)

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



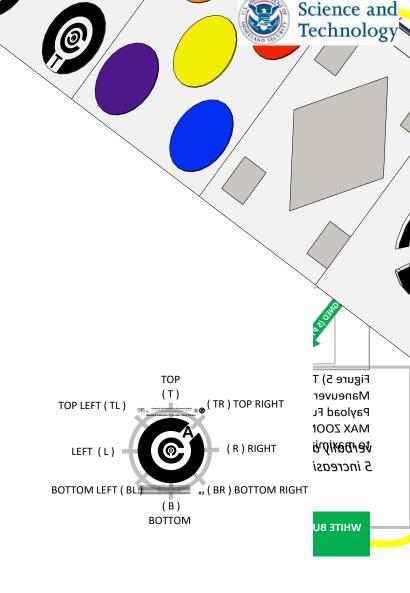
to guide alignment and a visual acuity target with increasingly small Concentric Cs gaps to identify the correct (1 of 8) orientations.

inscri

Versio

Func

the a





CAPIURE UNLY UNE IMAGE OF EACH BUCKEY CHRUB ALIGNED IN AGES 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

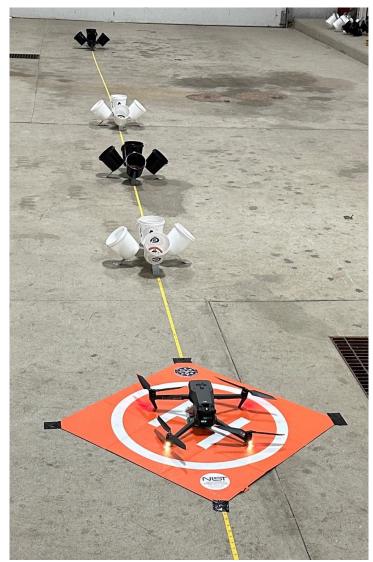
TOP

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

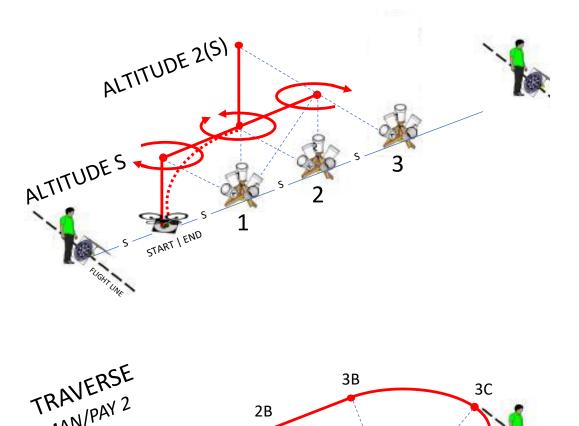
Area required 10 x spacing long (15m-50ft) x 6 x spacing wide (9m-30ft) x 2.6 x spacing high (4m-13ft)

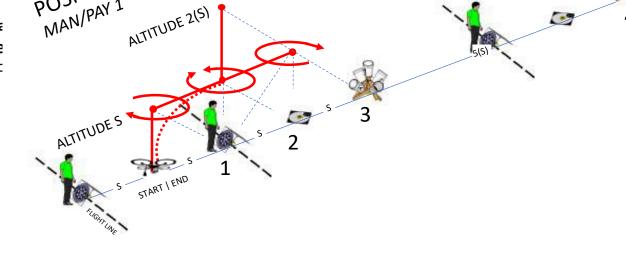


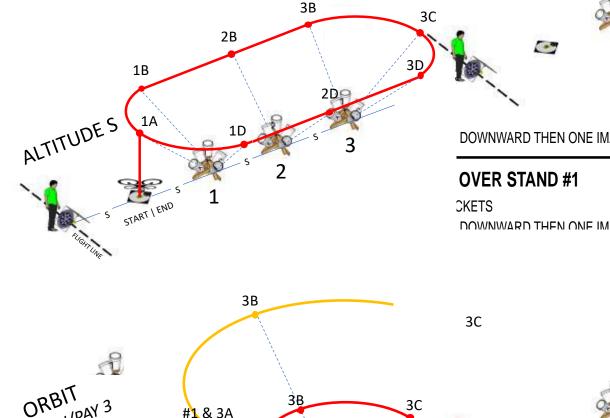
Test Methods for Evalua Safety | Capabilitie RobotTestMethc

Position (MAN/PAY 1)

Open Test Lane







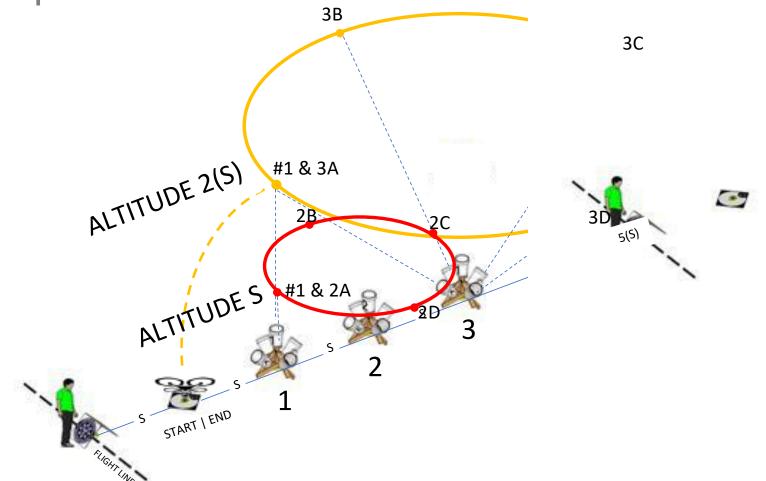
LIDAY 3

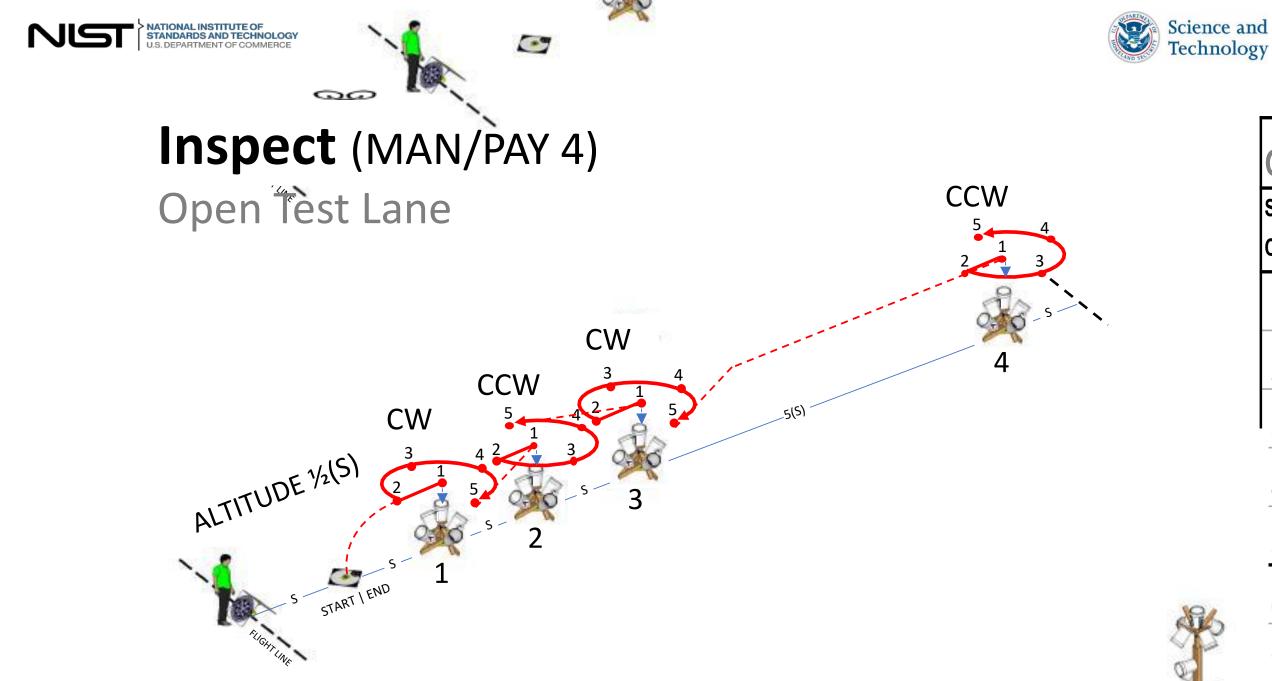




Orbit (MAN/PAY 3)

Open Test Lane







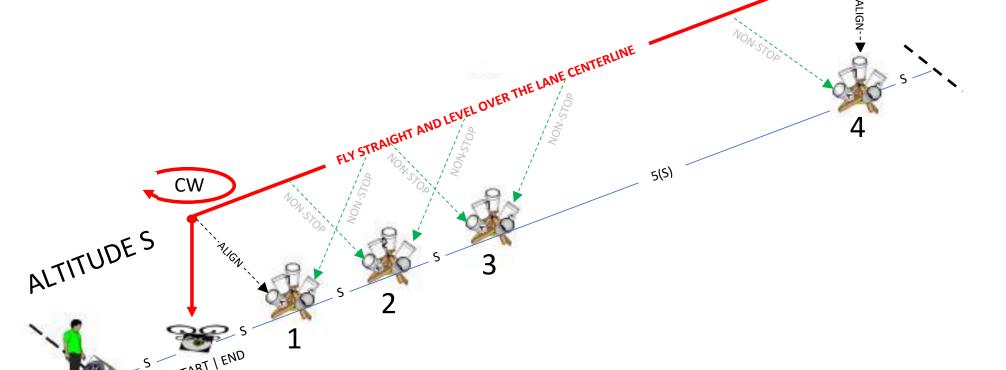




CCW

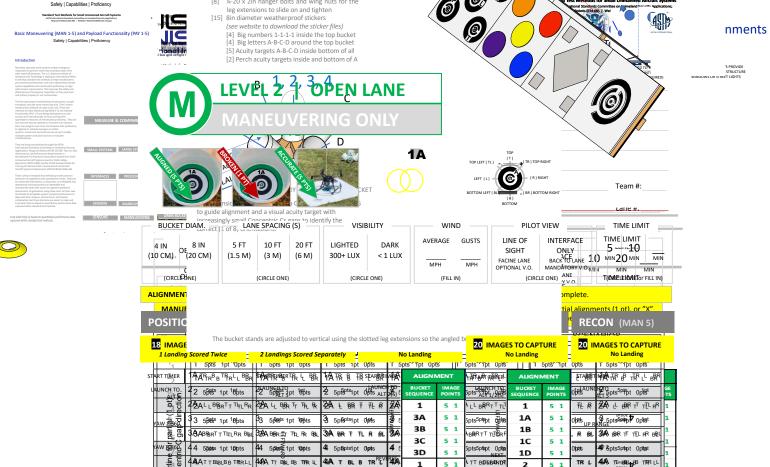
Recon (MAN/PAY 5)

Open Test Lane



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TR L 4A TUPSBELLE TRR LL 1 5 1 2 33 55pbs 1pt16pbts **3A** 5 1 | 33 5p5nets1pt10mpts 33 5pfapts1pt 0fpfts 5pts5p**t**spt @∰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 BBRTANDA 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 BUSAABRTTE 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
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



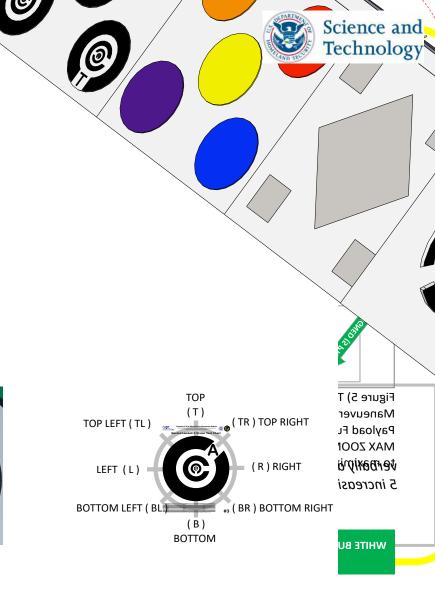
to guide alignment and a visual acuity target with increasingly small Concentric Cs gaps to identify the correct (1 of 8) orientations.

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	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

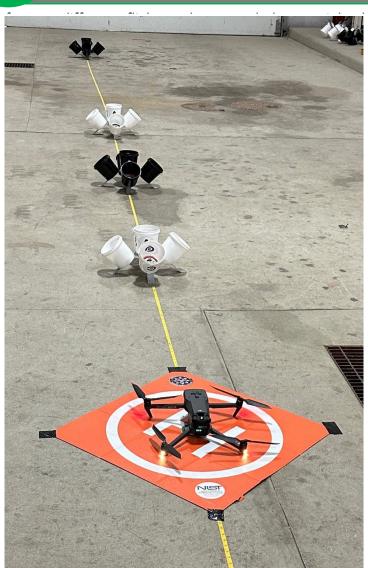
FRONT 1A





Level 3 Open Lane





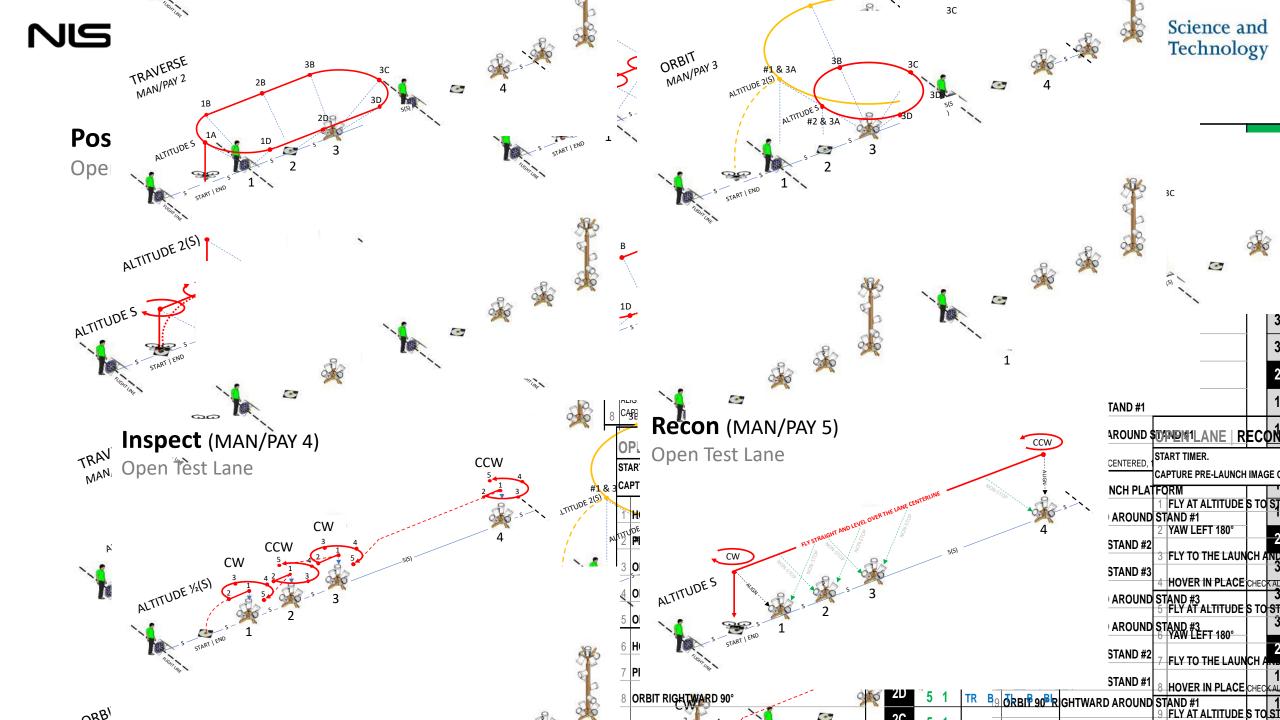


Level 3 Open Lane Setup

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)

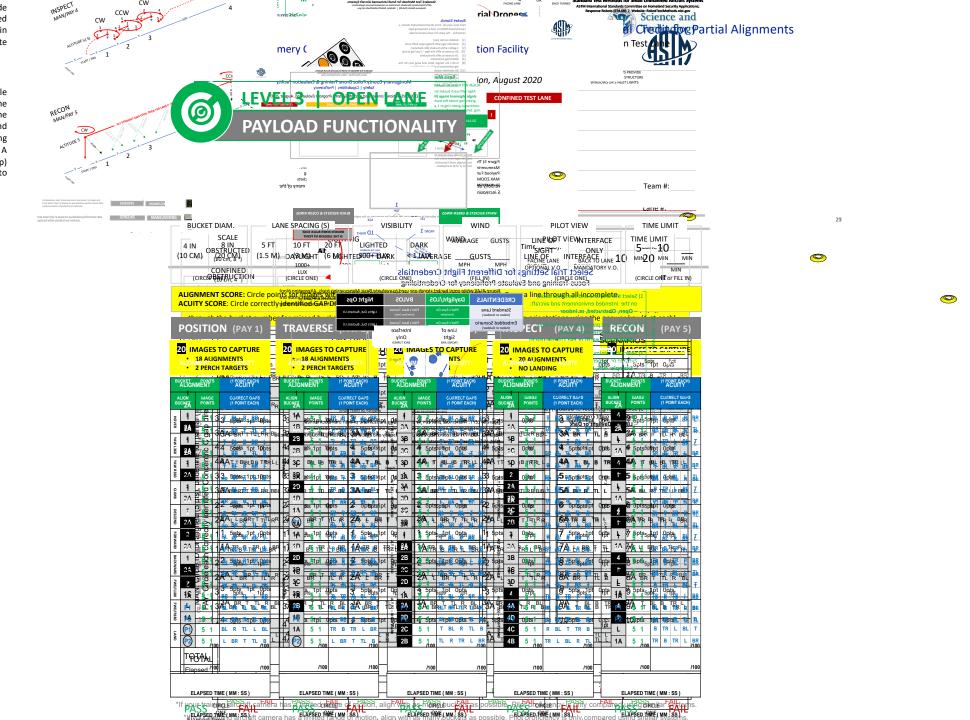


on the top and all sides. The drone flies at altitude each omni bucket stand to align with the designated in tasks start on top then rotate around the objects in wise and counter clockwise directions. Accurate cluded.

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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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



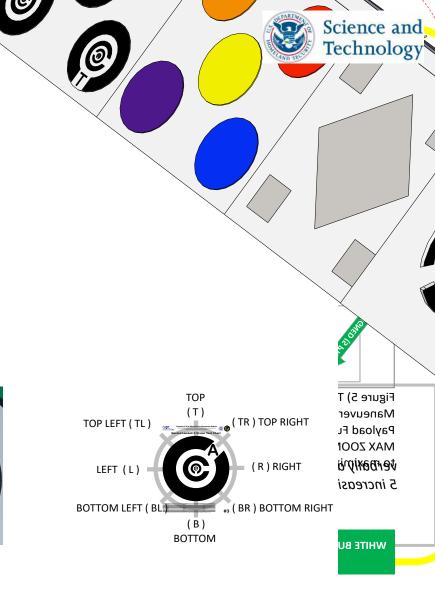
to guide alignment and a visual acuity target with increasingly small Concentric Cs gaps to identify the correct (1 of 8) orientations.

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Version 202

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

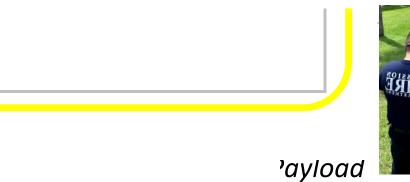
to guide alignment and a visu increasingly small Concentric correct (1 of 8) orientations.

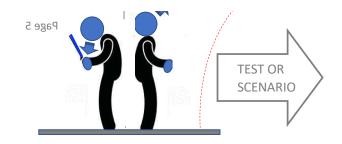
rapidos pilot Proctor.

arion gighterface OS).

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

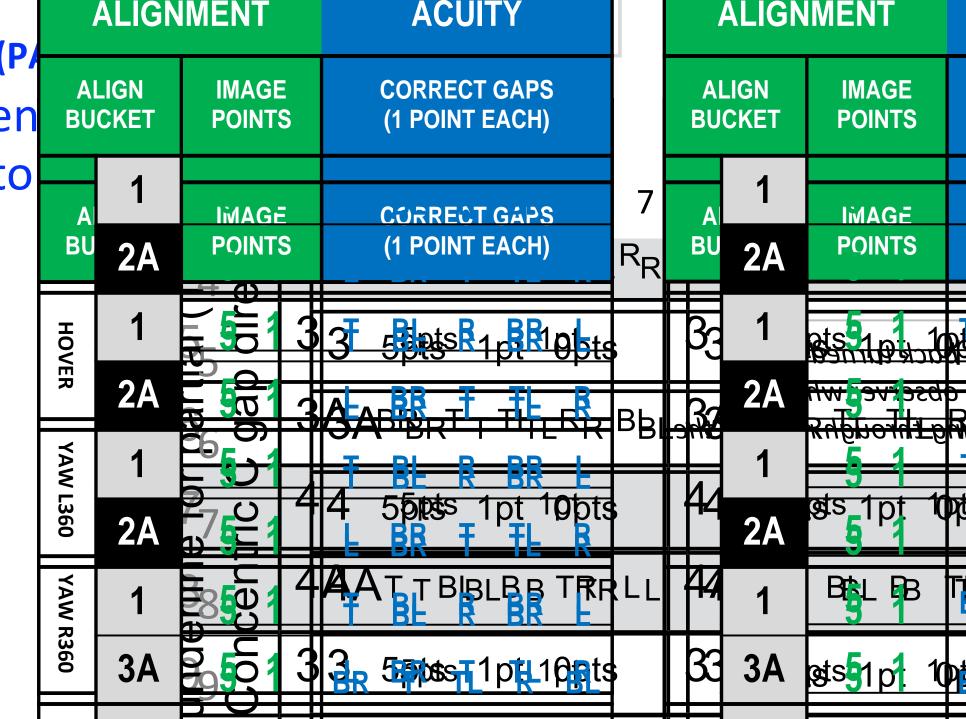






otni gn'
to soliq sh'
Select Trial Settings for Differ

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)

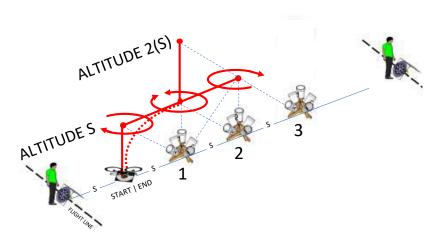
Flight Paths - Position, Traverse, Orbit 10-minute time limit for each Flight Path

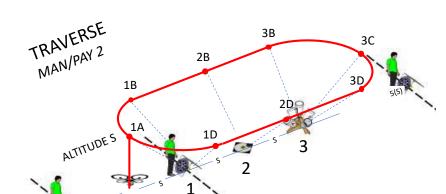
This provides the training necessary for the Large Platform's mission set

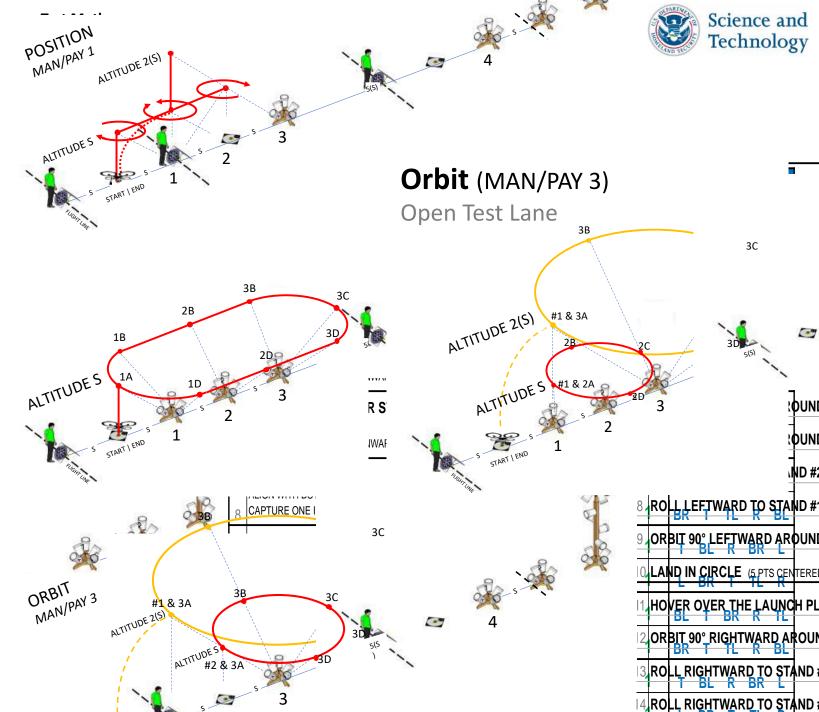


Position (MAN/PAY 1)

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 some time district common time to prepare the next to a life to the final use and after the proposed district common to prepare the next to a life to the final use and after the proposed district common to prepare the next to a life to the final use and after the proposed district common to prepare the next to a life to the final use and after the proposed district common to prepare the next to a life to the final use and after the proposed district common to prepare the next to a life to the final use and after the proposed district common to prepare the next to a life to the final use and after the proposed district common to prepare the next to a life to the final use and after the proposed district common to prepare the next to a life to the final use and after the proposed district common to prepare the next to a life to the final use and after the proposed district common to prepare the next to a life to the final use and after the proposed district common to prepare the next to a life to the final use and after the proposed district common to prepare the next to a life to the final use and after the proposed district common to the proposed district

- 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 going last in the matter personal season as the control of the personal activities and the Proctor can take whether are the proctor personal activities and the Proctor can take whether are the proctor personal activities and the Proctor can take whether are the proctor personal activities and the Proctor personal

Pilot Person 1
Proctor Person 2
VO Person 3

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

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 in scaring always have one person getting their objective in scaring always have one person getting their objective in scaring always have one person getting their objective in scaring always have one person getting their objective in scaring always have one person getting their objective in scaring and in scaring always have one person getting their objective in scaring and in sca

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

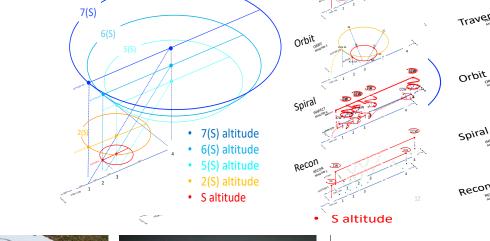
The average of your last five trials is an excellent measure control of the aircraft.

The average of your last five trials is an excellent measure of your proficiency on the aircraft and interface year, and interface year, and interface year.

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.





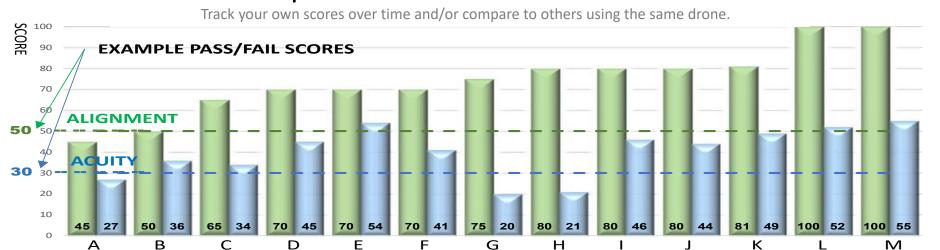
Shown with all white bucket stands for Basic Maneuvering (MAN).



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

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Separate Scores for ALIGNMENT and ACUITY

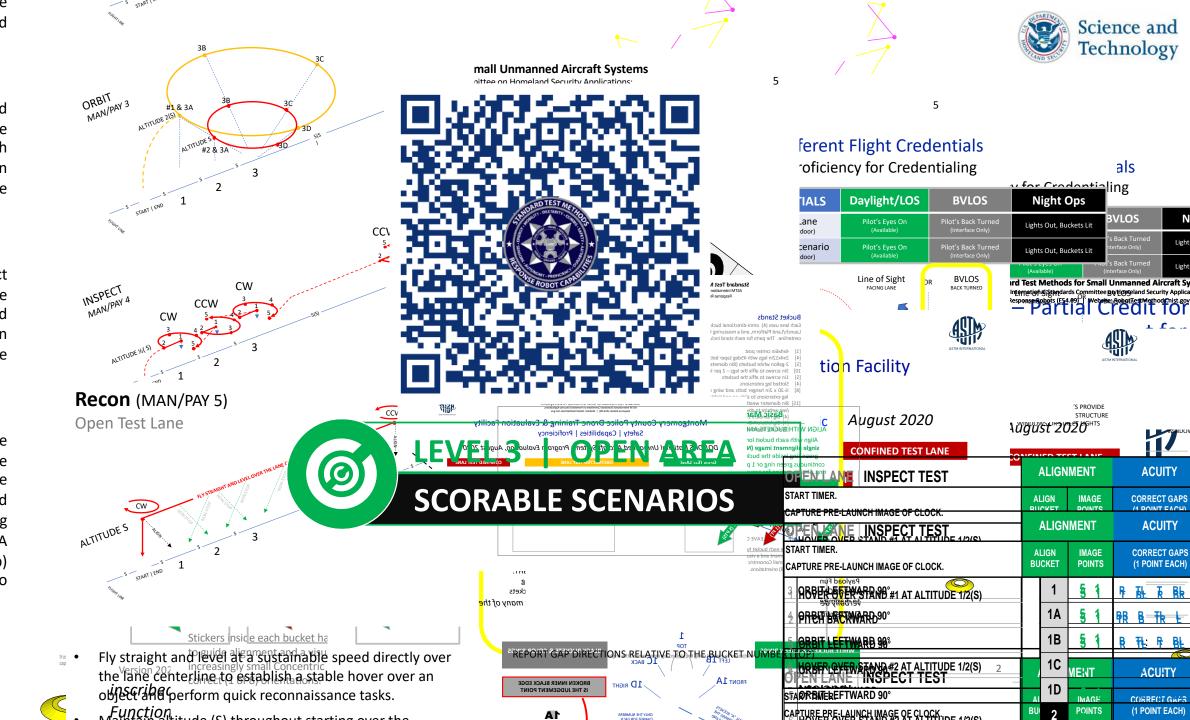


or any ground

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

cts to inspect 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

OPEN

Day and Night Trials

REMOTE PILOT TRAINING - CANADIAN POLICE COLLEGE, ONTARIO, CANADA

VEHICLE INSPECTION

THUT DAUNY

ORBIT RIGHT

ORBIT RIGHT

ORBIT R

STOP TIMER.

CONCURRENT OBJECTIVES FOR 3 TEAMS TO FLY

D ALTITUDE AND RADIUS

< 10 FT



IADA

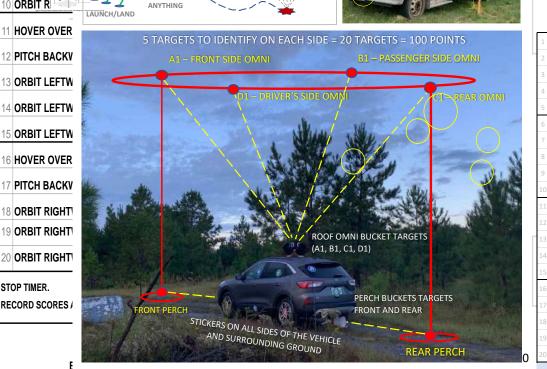




Teams concurrently fly separate objectives set up at safe distances and/or altitudes apart (with a clearly designated and safe return path).

WIDE AREA SEARCH

- 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.



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RECORD SCORES AND

9 OKBIT KIGHTWA ORBIT RIGHTWAI

STOP TIMER.

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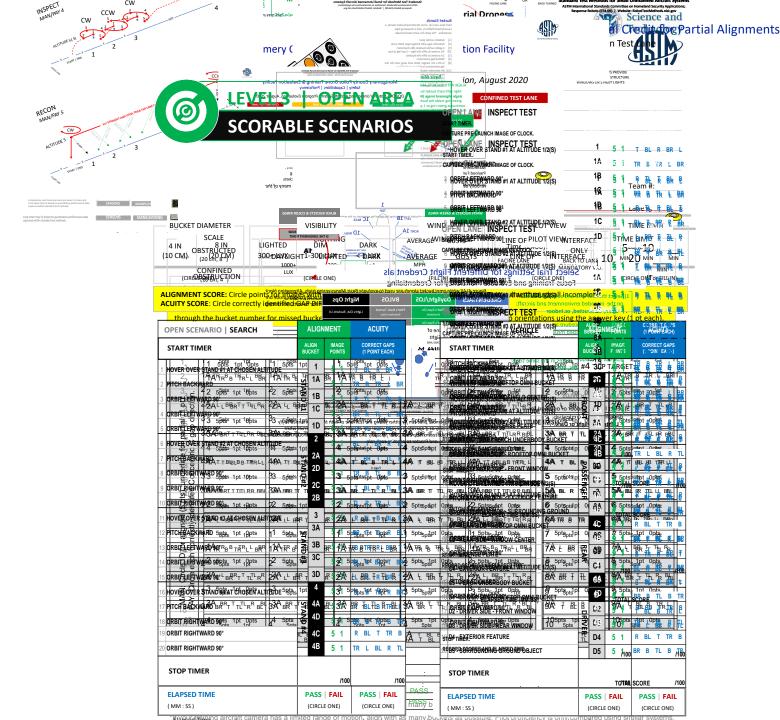
ELA

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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Level 4 Obstructed Environments





ndard Test Methods for Small Unmanned Aircraft Systems

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

Version: 2020B2

cted Test Lanes and Related Scenarios

CHECKRIDE SCORESHEET

fmaneuvers to align with *Dual Bucket Rails* in the test lanes or as embedded scoring tasks in imbered bucket pair is performed in order to complete 20 bucket alignments and identify

ment with the PERPENDICULAR BUCKETS is succes on, and altitude long enough to verify a complete y inscribed ring (1 point). The acuity targets inside t pointing, zooming, and exposure control to measu e treng can main ain the STRUCTED ring at the bottom of the

PAYLOAD FUNCTIONALITY and identifications to their

ons as possible (1 point each). The pilot declares all alignments and identifications to their Video of the trial or captured images can be used after the trial to analyze performance, to increased image resolution.

FOR ALL TESTS ARE THE SAME (10 POSITIONS = 20 BUCKET ALIGNMENTS)

EVERSE – FORWARD – LAND

LAUNCH - 1 2 3 4 - 3 2 1 - 2 3 4 - LAND



ASTM International Standards Committee for Homeland Security Applications:

NATIONAL INSTITUTE OF STANDARDS AND RESPONSEY Robots (E54.09) Website: Robot I est Methods nist gov U.S. DEPARTMENT OF COMMERCE Safety | Capabilities | Proficiency

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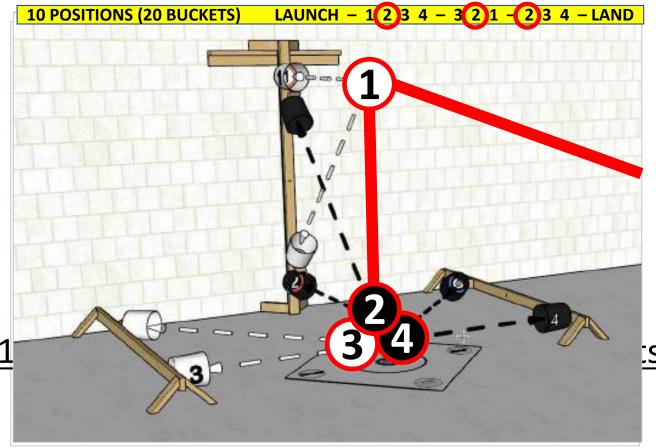
CH TEST

BACK 24 | Pereh (PAY 6)

drone lands 2 m (6 ft) from the wall guided by dual bucket alignments in various ntations. A single perch measures the sigld of view of arangependent pan-tilt-zoom

era. Others may need to re-launch, rotate, and land to identify2alltontongets/incorderched

TOP VIEW FENCE | OBSTACLE



PERCH TEST

The drone lands 2 m (6 ft) orientations. A single per camera. Others may need **TOP VIEW**



NATIONAL ASTIM International Standards Committee for Homeland Security Application Standards And THE Estador Security Application Standards And THE Estador Security Application Standards And THE Estador Security Application Standards And THE STANDARDS AND THE ESTADOR SECURITY Application Standards Committee for Homeland Security Application Security


BACK 24

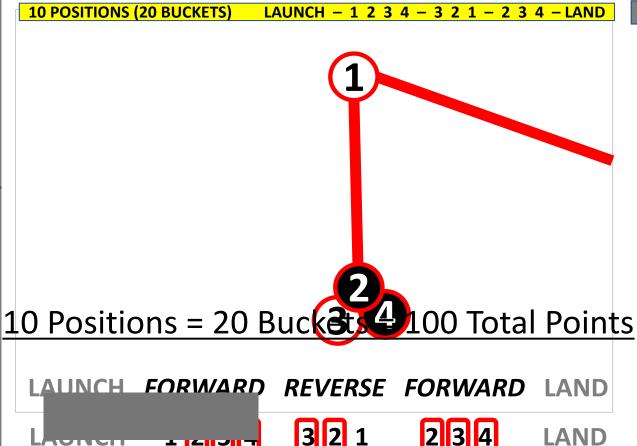
Perch (PAY 6)

ne drone lands 2 m (6 ft) from the wall guided by dual bucket alignments in various rientations. A single perch measures in Sield of the family and the targets in order.

TOP VIEW

WALL | FENCE | OBSTACLE

L1



PERCH TEST

The drone lands 2 m (6 ft) from orientations. A single perch recamera. Others may need to

VALL | FENCE | OBSTACLE



ALL TEST

ERCH TEST





BACK 24

KHWUIIU (PAT O)

he drone lands 2 m (6 ft) from the wall guigeα by quai pucket alignments in various rientations. A single perch measure chose du com a consepence pan-tilt-zoom amera. Others may need to re-launch, rotate, and land to identify all the targets in order.

TOP VIEW

LICH TEST

WALL | FENCE | OBSTACLE



10 POSITIONS (20 BUCKETS) LAUNCH - 1 2 3 4 - 3 2 1 - 2 3 4 - LAND **10 POSITIONS (20 BUCKETS)** LAUNCH - 1 2 3 4 - 3 2 1 - 2 3 4 - LAND



PERCH TEST

The drone lands 2 m (6 ft) from orientations. A single perch m camera. Others may need to r **TOP VIEW**

FENCE | OBSTACLE WALL



L TEST





BACK 24

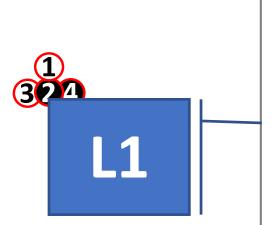
Peley (PAY 9)

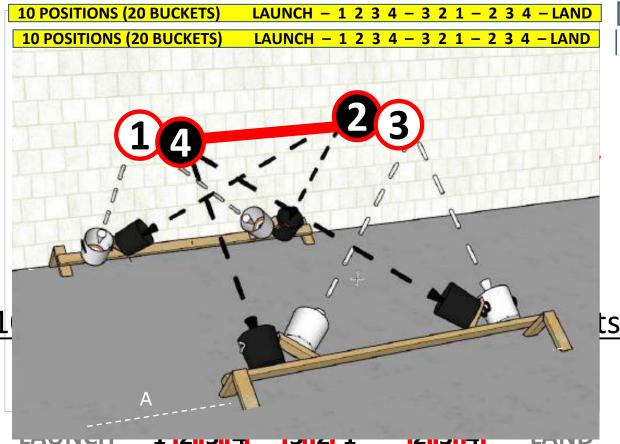
he drone lands 2 m (6 ft) from the wall guided by dual bucket alignments in various rientations. A single perch measure of the state of a state of the pan-tilt-zoom amera. Others may need to re-launch, rotate, and land to identify all the targets in order.

TOP VIEW
FENCE | OBSTACLE

ERCH TEST

VALL TEST





PERCH TEST

The drone lands 2 m (6 ft) from orientations. A single perch recamera. Others may need to

VALL | FENCE | OBSTACLE



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RCH TEST

TOP VIEW

FENCE | OBSTACLE

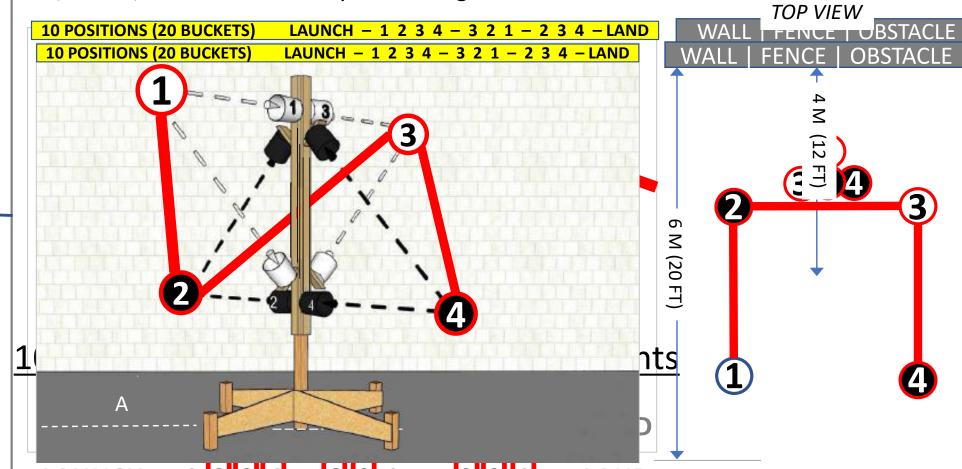
BACK 24 | **Post** (PAY 10)

drone lands 2 m (6 ft) from the wall guided by dual bucket alignments in various entations. A single perch measure commentations. A single perch measure comments and a single perchange of the single perchang

nera. Others may need to re-launch, rotate, and land to identify all the targets in order.

PERCH TEST

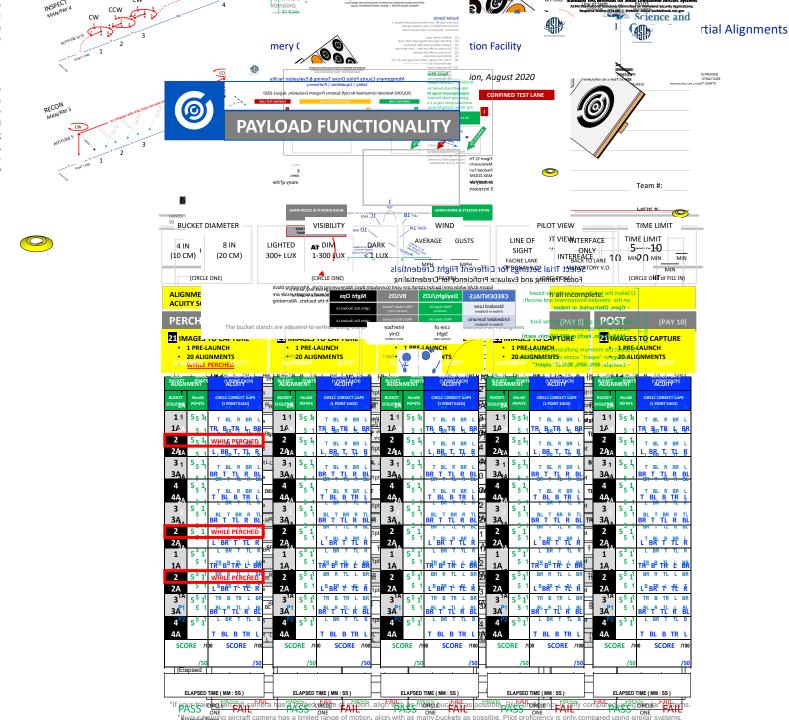
The drone lands 2 m (6 f orientations. A single per camera. Others may nee



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.

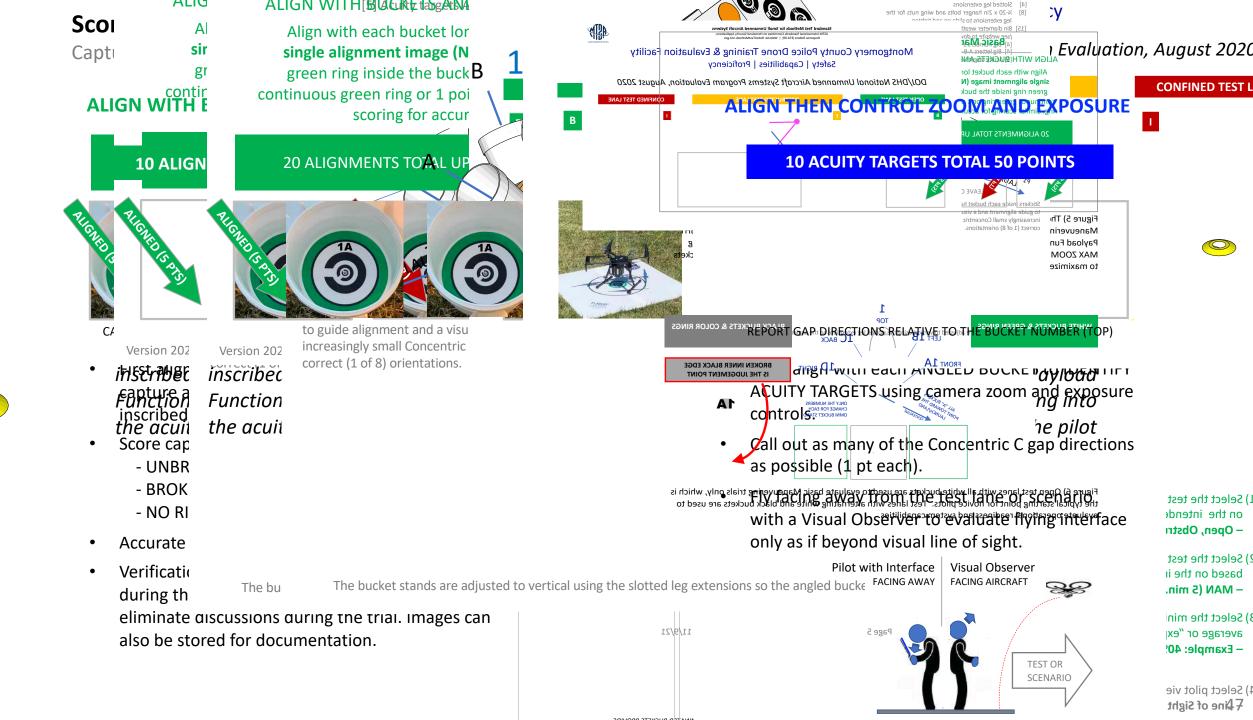
PAY 5)

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 the objects in different orientations and at an angle. A ters 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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ALIGNMENT ACUI ALIGNMENT ACUITY d Functionality Trials (PA vering (MAN) then iden **ALIGN IMAGE CORRECT GAPS ALIGN IMAGE CORRECT BUCKET POINTS** (1 POINT EACH) **BUCKET** (1 POINT E **POINTS** possible to score up to CIRCLE CORREC **IMAGE** CIRCLE CORRECT GAPS **IMAGE** BU BU **POINTS POINTS** (1 POINT EACH) R_R SEQI (1 POINT E SEQ **2A 2A** 5₅ 4 554 BR BL TL BR BB **2A 2A** BRTR VHILE PERCHED 2 2A 2 2A BB_R T BR T BR BL BL **3A 3A** B₿I BR 4 2A BL **2A** 5aks 1nt 1Ants



Test Methods for Evaluating Aerial Drones Safety | Capabilities | Proficiency

RobotTestMethods.nist.gov









Standard Test Methods for Small Unmanned Aircraft System

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

Obstructed Test Lane and Related Ope

Standard Test Methods for Small Unmanned Aircraft Systems

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



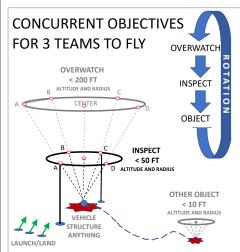


Obstructed Vehicle Inspection Scenarios

Day and Night Trials

USE SETS OF 5 "INLINE" DUAL BUCKET RAILS

DISTRIBUTED THROUGHOUT THE SCENARIO













Obstructed Search Scenarios

Day and Night Trials

START TIMER (CAPTURE CLOC

PERPENDICULAR BUCKET

ANGLED BUCKET: CALL OL

PERPENDICULAR BUCKET

10 ANGLED BUCKET: CALL OL

11 PERPENDICULAR BUCKET

2 ANGLED BUCKET: CALL OL

13 PERPENDICULAR BUCKET

4 ANGLED BUCKET: CALL OU

5 PERPENDICULAR BUCKET

16 ANGLED BUCKET: CALL OU

17 PERPENDICULAR BUCKET:

18 ANGLED BUCKET: CALL OU

19 PERPENDICULAR BUCKET

20 ANGLED BUCKET: CALL OU

STOP TIMER (CAPTURE CLOCK

USE SETS OF 5 "OFFSET" DUAL BUCKET RAILS

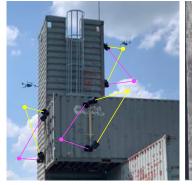
HORIZONTALS DISTRIBUTED WITH OBJECTS OF INTEREST







VERTICALS IN ELEVATED WINDOWS AND ON STRUCTURES







- 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.

START TIMER (CAPT)

PERPENDICULAR

ANGLED BUCKET

PERPENDICULAR

ANGLED BUCKET

PERPENDICULAR

ANGLED BUCKET

7 PERPENDICULAR

ANGLED BUCKET

9 PERPENDICULAR

10 ANGLED BUCKET

1 PERPENDICULAR

12 ANGLED BUCKET

13 PERPENDICULAR

4 ANGLED BUCKET

L5 PERPENDICULAR

L6 ANGLED BUCKET

17 PERPENDICULAR

18 ANGLED BUCKET

19 PERPENDICULAR

20 ANGLED BUCKET

STOP TIMER (CAPTU

n the top and all sides. The drone flies at altitude ASTM Information Standard Committee on Formation Security Applications;
Response Robots (E44,09) | Website: RobotTestMethods nist gov
Science and ach omni bucket stand to align with the designated tasks start on top then rotate around the objects in ırtial Alignments rise and counter clockwise directions. Accurate mery (tion Facility luded. Pilot LAST Name Pilot FIRST Name ing straight and level down range to establish stable in open space to perform reconnaissance tasks. The (P) Pilot Organization de (S) at a sustainable speed directly over the lane with designated buckets and the landing at each end **SCORABLE SCENARIOS** Drone Make down range reconnaissance tasks include looking ne objects in different orientations and at an angle. A Drone Model ers a total distance of 80(S) with moving (non-stop) **Facility Location** ne angled buckets along the centerline helping to from the intended path and encourage consistency. Date (YYYY/MM/DD) Team #: PROCTOR NAME цапе #: BUCKET DIAMETER TIME LIMIT A l' TMORS OT VIEWNTERFACE TIME LIMIT AVERAGE GUSTS LINE OF 4 IN LIGHTED AT DIM 5----10 SIGHT (10 CM) (20 CM) 300+ LUX 1-300 LUX 1 LUX INTEREACE AND 10 MIN MIN MIN FACINE LANE .o.vynota@ellect Trial.Sete(Mgg9for Different Flight Credentials (CIRCLE ONE) (CIRCLE ONE) (CIRCLE WILL OF FILL IN) Folks Traffiling and Evaluate Proficiently Folk Credentialing Standard Test Methods to ate Basic Maneuvering tripls. Afternating black Night Ops CREDENTIALS Daylight/LOS Response Robots (E54
Standard Test Method WW) Standard Test Methods for Small Unmanned Aircraft Systems International Standards Committee for Homeland Security Applica Response Robots (E54.09) Website: RobotTestMethods.nist.gov Standard Lane PERCH TEST The bucket stands are adjusted to ver The perpertages 2 m (6 ft) from the PERCH TEST The drone lands 2 m (6 ft) from the wall guided by dual bucket alignments in various orientationse Ausingle-genthro orientations. A single perch measures the field of view of an independent pan-tilt-zoom camerienOthers Analygheed domedauras camera. Others may need to re-launch, rotate, and land to identify all the targets in order camera_P Others may need to re-lau WALL | FEN TOP VIEW TACLE
WALL | FENCE | OBSTACLE TOP VIEW 2 50 s 50 s tTPo 10t 1₁ 10 Positions = 20 Bucket 4100 Total Points LAUNCH FORWARD REVERSE FORWARD LAND LAUNCH WALL TEST LAND The drone flies within 2-3 m (6-10 ft) of the wall align with buckets and identify features upward tasks inside elevated windows and doors. align with t TOP VIEW and identify features upward and downward. This approxima WALL | FENCE | OBSTACLE task WALL | FENCE | OBSTACLE OWS and 明明有有限即 WART TELTE TEL ANGLED BUCKET: CALL OUT ACUITY GAP DIRECTIONS ANGLED BUCKET: CALL OUT ACUITY GAP DIRECTIONS TO A BLBIR BL TR BE 10 5 1 0 WHILE PERCHED 5 1 0 WHILE PERCHEL PERPENDICULAR BUCKET: ALIGN AND CAPTURE IMAG ANGLED BUCKET: CALL OUT ACUITY GAP DIRECTIONS STOP TIMER STOP TIMER RECORD SCORES AND ELAPSED TIME. RECORD SCORES AND ELAPSED TIME. ELAPSED TIME (MM:SS) ELAPSED TIME (MM:SS)



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S PROVIDE STRUCTURE T LIGHTS



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Science and Technology



Level 5 Confined Environments





rd Test Methods for Small Unmanned Aircraft Systems

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

Version: 2020B2

ed Test Lanes and Related Scenarios

CHECKRIDE SCORESHEET

ineuvers to align with *Dual Bucket Rails* in the test lanes or as embedded scoring tasks in

ered bucket pair is performed in order to complete ucket alignments and identify e de De La Sintain GONFINED

nt with the PERPENDICULAR BUCKETS is successf **(6)**

and altitude long enough to verify a complete

scribed ring (1 point). The acuity targets inside the

nting, zooming, and exposure control to measure vis

PAYLOAD FUNCTIONALITY

as possible (1 point each). The pilot declares all alignments and identifications to their eo of the trial or captured images can be used after the trial to analyze performance,

increased image resolution.

ALL TESTS ARE THE SAME (10 POSITIONS = 20 BUCKET ALIGNMENTS)

ERSE – FORWARD – LAND

LAUNCH - 1 2 3 4 - 3 2 1 - 2 3 4 - LAND

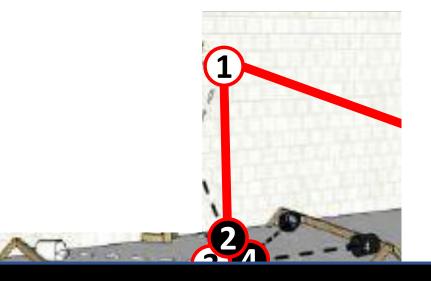




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Confin

IDDLE INDOOR ALTITUDE

1 M (3 FT)

Confined Test Lanes and Scorable In

ASTM International Standards Comm Response Robots (E54.09) | W

Confined Scenario: Struct

Safety I Capabil

BACK 24 Perch (PAY 6) **PERCH TEST** The drone lands 2 m (6 ft) from the wall guided by dual bucket alignments in various orientations. A single perch measures in Sield Wew of an Sepender pan-tilt-zoom \mathbb{N}_{a} amera. Others may need to re-launch, rotate, and land to identify all the targets in order. TOP VIEW 10 POSITIONS (20 BUCKETS) LAUNCH - 1 2 3 4 - 3 2 1 - 2 3 4 - LAND WALL | FENCE | OBSTACLE

The drone flies within 2-3 m (6-10 ft) of the wall at 45 degrees from

align with buckets and identify features upward and downward. This approximates in pection

WALL TEST

TOP VIEW WALL | FENCE | OBSTACLE

10 Positions = 20 Bucket 100 Total Points

LAUNCH FORWARD REVERSE FORWARD LAND

The drone lands 2 m (6 ft) from the wall grided by Lipal

orientations. A single perch measures the field of view camera. Others may need to re-launch, rotate, and land

TOP VIEW

PERCH 1EST

| FENCE | OBSTACLE

tasks inside elevated windows and deors. Land within 2-3 m (6-10 ft) of a wall in the trong flies within 2-3 m (6-10 ft) of the wall by the align with buckets and identify features upward and do align with buckets and identify features upward and do align with buckets and identify features upward and do align with buckets and identify features upward and do align with buckets and identify features upward and do align with buckets and identify features upward and do align with buckets and identify features upward and do align with buckets and identify features upward and do align with buckets and identify features upward and do align with buckets and identify features upward and do align with buckets and identify features upward and do align with buckets and identify features upward and do align with buckets and identify features upward and do align with buckets and identify features upward and do align with buckets and identify features upward and do align with buckets and identify features upward and do align with buckets and identify features upward and do align with buckets and identify features upward and align with align with align with align with a second
LAND

While perched, inspect ver all and horizontal object

features upward, downward, leftward and rightward.

WALL TEST

10 POSITIONS (20 BUCKE

CALL OUT 12 ANGLED BY

Launch and land repeatedly if necessary to score at

10 POSITIONS (20 BUCK

PERPENDICULAR BUCKET: A

ANGLED BUCKET: CALL OUT

PERPENDICULAR BUCKET: A

4 ANGLED BUCKET: CALL OUT

PERPENDICULAR BUCKET: A

6 ANGLED BUCKET: CALL OUT

PERPENDICULAR BUCKET: A

8 ANGLED BUCKET: CALL OUT

BACK 24

PEICH (PAY b)

The drone lands 2 m (6 ft) from the wall guided by dual bucket alignments in various orientations. A single perch measures in Sield of Grandepender pan-tilt-zoom camera. Others may need to re-launch, rotate, and land to identify all the targets in order.

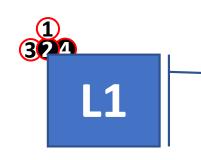
10 POSITIONS (20 BUCKETS)

10 POSITIONS (20 BUCKETS)

TOP VIEW

FLINCH TEST

WALL | FENCE | OBSTACLE



PERCH TEST

The drone lands 2 m (6 ft) from the wall griced by Ep orientations. A single perch measures the field of view camera. Others may need to re-launch, rotate, and la

Jaicty

TOP VIEW

FENCE | OBSTACLE



L TEST

The drone flies within 2-3 m (6-10 ft) of the wall at 45 degrees from fo align with buckets and identify features upward and downward. This approximates in pection asks inside elevated windows and deors. Land within 2-3 m (6-10 ft) of a wall in trong the within 2-3 m (6-10 ft) of the wall by

TOP VIEW

WALL | FENCE | OBSTACLE

TOP VIEW WALL | FENCE | OBSTACLE

align with buckets and identify features upward and constraint of the positions of the selevated windows and doors.

• While perched, inspect ver (1) I and horizontal object 10 POSITIONS (20 BUCKETS) LAUNCH = 1 2 3 4 - 3 2 1 - 2 3 4 - LAND WALL | FENCE OBSTACLE ard and rightward.

LAUNCH - 1 2 3 4 - 3 2 1 - 2 3 4 - LAND

LAUNCH - 1 2 3 4 - 3 2 1 - 2 3 4 - LAND

. TEST

10 POSITIONS (20 BUC

10 POSITIONS (20 BU)

12 ANGLED B

BACK 24 **RCH TEST** e drone lands 2 m (6 ft) from the wall guided by dual bucket alignments in various entations. A single perch measure la sield la Claude de la commentations. A single perch measure la sield la commentation de la nera. Others may need to re-launch, rotate, and land to identify all the targets in order. TOP VIEW ALL | FENCE | OBSTACLE

Perch (PAY 6)

10 POSITIONS (20 BUCKETS)

The drone lands 2 m (6 ft) from the wall grice orientations. A single perch measures the field camera. Others may need to re-launch, rotate

TOP VIEW

WALL TEST

FENCE | OBSTACLE

10 POSITIONS (20 BUCKETS) LAUNCH - 1 2 3 4 - 3 2 1 - 2 3 4 - LAND

LL TEST

e drone flies within 2-3 m (6-10 ft) of the wall at 45 degree n with buckets and identify features upward and downward. This approximates inspection

ks inside <mark>elevated windows and</mark> deors. Land within 2-3 m (6-10 ft) of a wall in the trong flies within 2-3 m (6-10 ft) or the wa

align with buckets and identify features upward to a stacles on the positions to a supposition of the stacks and identify features upward and constant to a supposition of the suppositi

While perched, inspect ver land horizontal object wall | FENCE | OBSTACLE

TOP VIEW

ALL | FENCE | OBSTACLE

10 POSITION

10 POSITION

BACK 24

Perch (PAY 6)

PERCH TEST The drone lands 2 m (6 ft) from the wall guided by dual bucket alignments in various

orientations. A single perch measure les it is it is to be a single perch measure les its indicate of a single camera. Others may need to re-launch, rotate, and land to identify all the targets in order.

10 POSITIONS (20 BUCKETS)

TOP VIEW

| FENCE | OBSTACLE

10 POSITIONS (20 BUCKETS) LAUNCH - 1 2 3 4 - 3 2 1 - 2 3 4 - LAND nts **LAUNCH LAND**

WALL TEST

The drone flies within 2-3 m (6-10 ft) of the wall at 45 degrees align with buckets and identify features upward and downward. This approximates inspection tasks inside elevated windows and deors. Land within 2-3 m (6-10 ft) of a wall in front lies within 2-3 m (6-10 ft) of the wall a

WALL | FENCE | OBSTACLE



While perched, inspect ver land horizontal object features upward, downward, leftward and rightward.

The drone lands 2 m (6 ft) from the wall gaided by orientations. A single perch measures the field of camera. Others may need to re-launch, rotate, ar

TOP VIEW

WALL FENCE | OBSTACLE

WALL TEST

align with buckets and identify features upward a align with buckets and identify features upward a align with buckets and identify features upward a align with buckets and identify features upward a align with buckets and identify features upward a light with buckets.

10 POSITIONS (2

10 POSITIONS (2

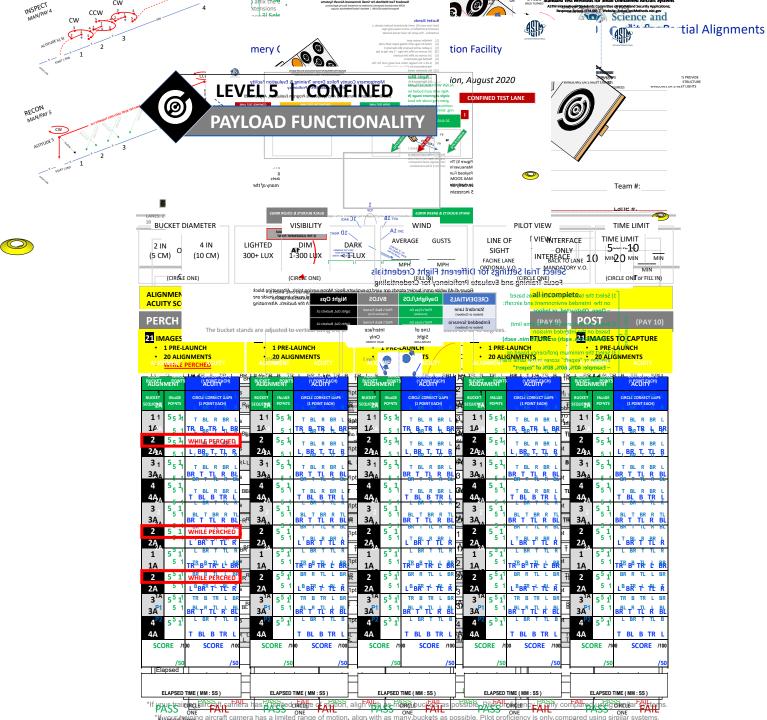
12 ANGLED B

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

PAY 5)

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





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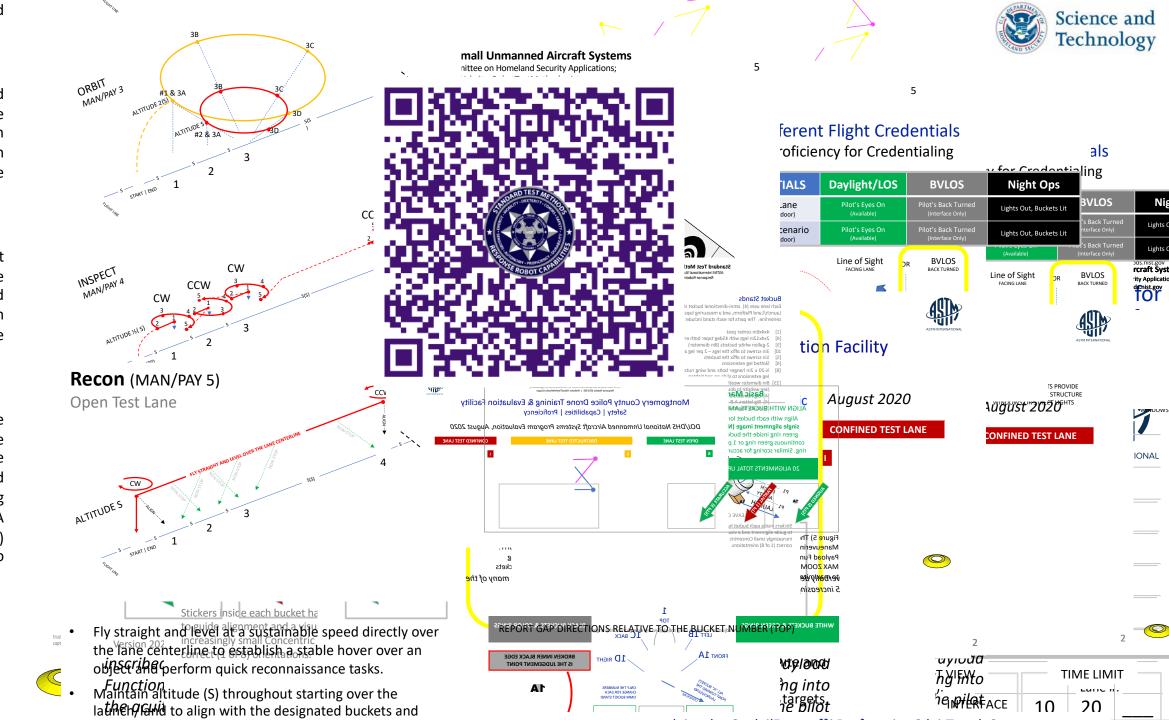


ALIGNMENT ACUI ALIGNMENT ACUITY d Functionality Trials (PA vering (MAN) then iden **ALIGN IMAGE CORRECT GAPS ALIGN IMAGE CORRECT BUCKET POINTS** (1 POINT EACH) **BUCKET** (1 POINT E **POINTS** possible to score up to CIRCLE CORREC **IMAGE** CIRCLE CORRECT GAPS **IMAGE** BU BU **POINTS POINTS** (1 POINT EACH) R_R SEQI (1 POINT E SEQ **2A 2A** 5₅ 4 554 BR BL TL BR BB **2A 2A** BRTR VHILE PERCHED 2 2A 2 2A BB_R T BR T BR BL BL **3A 3A** B₿I BR 4 2A BL **2A** 5aks 1nt 1Ants

altitudes around I four sides. The titude (S) in both bit starts with an eradius before re not included.

bjects to inspect of flies at altitude the designated and the objects in ctions. Accurate

o establish stable sance tasks. The tly over the lane ding at each end include looking and at an angle. A noving (non-stop) erline helping to age consistency.



BACK 24

Perch (PAY 6)

Obstructed Test Lane

L1

L2

Land within 2-3 m (6-10 ft) of a wall in front of th aircraft with ground obstacles on both sides.

- While perched, inspect vertical and horizontal ob features upward, downward, leftward and rightw
- Launch and land repeatedly if necessary to score buckets in the sequence.
- Measure the field of view of the drone while per with independent pan-tilt-zoom cameras.

Payload Functionality Trials (PAY):

- Align with the PERPENDICULAR BUCKETS first and capture an image of the inscribed rings that can I to score up to 50 alignment points after the trial.
- Align with the ANGLED BUCKETS second to ident many acuity target gaps as possible to score up to acuity points. Call out the gap directions to the P

BACK 24C opfine of Room-to-Room Labyrinth

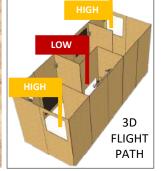
Searchtasks with 1 m (3ft) minimum clearances

USE SETS OF 5 "INLINE" DUAL BUCKET RAILS

HORIZONTALS FOR LEFTWARD/RIGHTWARD INSPECTIONS







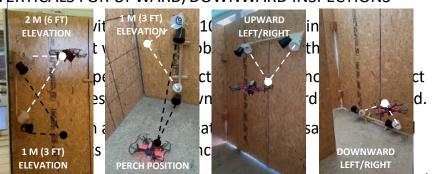
VERTICALS FOR UPWARD/DOWNWARD INSPECTIONS

L2

L3

L4

L1



- Measure the field of view of the grone while perched Fabriciateid dependerropan-sidazdoscenario avith inspect
- tasks that can be replicated to track and compare scores. Payload Functionality Irials (PAY). Self-stamdinighptlywbbdPcortbertwalls EdefineT1.2 not (4nft)

switchback halliwaysewith a blackbet tangschiling over toged at 2.4mg(8ft)u bits insidera 6mm(20ft) shippeing container.

Align with the ANGLED BUCKETS second to identify as square access "windows" measuring 1m (3ft) square provide entry/exit and interior high/low pass throughs. acuity points. Call out the gap directions to the Proctor.

OBSTRUCTED

PERPENDICULAR BUCKET:

ANGLED BUCKET: CALL OU

PERPENDICULAR BUCKET:

ANGLED BUCKET: CALL OU'

PERPENDICULAR BUCKET:

ANGLED BUCKET: CALL OU'

PERPENDICULAR BUCKET:

ANGLED BUCKET: CALL OU

ANGLED BUCKET: CALL OU

ANGLED BUCKET: CALL OU'

ANGLED BUCKET: CALL OU

ANGLED BUCKET: CALL OU

PERPENDICULAR BUCKET:

O ANGLED BUCKET: CALL OU

L3

L4

on the top and all sides. The drone flies at altitude ASTI Intelligibility Sizina Committee of Honeland Security Applications;
Response Robbits (ESA.09) | Websile: Robbits estated and Security Applications;
Science and each omni bucket stand to align with the designated n tasks start on top then rotate around the objects in tial Alignments wise and counter clockwise directions. Accurate mery (tion Facility icluded. PAY 5) ion, August 2020 Montgomery County Police Drone Training & Evaluation Facility lying straight and level down range to establish stable DOJ/DHS National Unmanned Aircraft Systems Program Evaluation, August 2020 CONFINED TEST LANE ts in open space to perform reconnaissance tasks. The tude (S) at a sustainable speed directly over the lane with designated buckets and the landing at each end down range reconnaissance tasks include looking the objects in different orientations and at an angle. A vers a total distance of 80(S) with moving (non-stop) the angled buckets along the centerline helping to Payload Fun MAX ZOOM from the intended path and encourage consistency. many of the 1erbetlyide Team #: Latte #: BU TIME LIMIT T VIEWNTERFACE TIME LIMIT 2 IN 5----10 0 (5 CM) INTERFACE ANE 10 MINO MIN MIN Select Trial Settings for Different Flight Credentials (or FILL IN) Focus Training and Evaluate Proficiency for Credentialing Standard Test Methods for te.Basic.Maneuvering.tgipls...Alternating block CREDENTIALS Daylight/LOS Night Ops Response Robots (E54.09 Standard Test Methods for Small Unmanned Aircraft Systems International Standards Committee for Homeland Security Applica Response Robots (E54.09) Website: RobotTestMethods.nist.gov Standard Lane PERCH TEST The bucket stands are adjusted to ve The perpertages 2 m (6 ft) from the PERCH TEST The drone lands 2 m (6 ft) from the wall guided by dual bucket alignments in various orientationse Asingle-penthros orientations. A single perch measures the field of view of an independent pan-tilt-zoom cameren Others Arangheed dome-laure the field of sind later the determination camera. Others may need to re-launch, rotate, and land to identify all the targets in order. camerap Others may need to re-lau WALL | FEN TOP VIEW TACLE
WALL | FENCE | OBSTACLE TOP VIEW 31 58 50 St TRodet 10 Positions = 20 Bucket 4100 Total Points LAUNCH FORWARD REVERSE FORWARD LAND LAUNCH 1 2 3 4 WALL TEST LAND The drone flies within 2-3 m (6-10 ft) of the wall align with buckets and identify features upward The drone files within 2-3 m (6-10 ft) of the wall at 45 de tasks inside elevated windows and doors. align with t TOP VIEW and identify features upward and downward. This approxima TOP VIEW WALL | FENCE | OBSTACLE task WALL | FENCE | OBSTACLE OWS and DOOR AR RUCKET - ALIGN AND CAPTURE IMAGE 明明有有限 BRT TELTE TER I ANGLED BUCKET: CALL OUT ACUITY GAP DIRECTIONS ANGLED BUCKET: CALL OUT ACUITY GAP DIRECTIONS TO A BLBIR BL TR BE 10 5 1 0 WHILE PERCHED 5 1 0 WHILE PERCHEL PERPENDICULAR BUCKET: ALIGN AND CAPTURE IMAG ANGLED BUCKET: CALL OUT ACUITY GAP DIRECTIONS ANGLED BUCKET: CALL OUT ACUITY GAP DIRECTIONS STOP TIMER STOP TIMER RECORD SCORES AND ELAPSED TIME. RECORD SCORES AND ELAPSED TIME. ELAPSED TIME (MM:SS) ELAPSED TIME (MM:SS)

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Select the Appropriate Platform for the Mission

- Open Environment/Over Watch Missions Larger Platform with High Definition Zoom and Thermal Cameras
- Open to Obstructed Environments Medium Platform with Good Zoom and Thermal Cameras
- Obstructed to Confined Environments Medium/Small Platform Prop Guarded
- Confined Environments Small platform Prop Guarded



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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

Adam Jacoff

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



Sponsor:

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