



Pocket Guide for Aerial Drones





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

Website RobotTestMethods.nist.gov



RobotTestMethods@nist.gov

Version 2023D

VEHICLE INSPECTION

BUILDING EXTERIOR SEARCH 21 ERIOR SEARCHercis

WIDE AREA SEARCH

URBAN AREA SEARCH

Figure 9) LEFT: An Open Test Land With the Miles

stands for the Payload Functionality variant of the tests a single Proctor helping teams of piers and the visual correctly. RIGHT: A 6 m (20 ft) lane spacing set up to be

Scenario: Wide Area Search

ne Open Test Lane evaluates flight paths to identify of

VIN NUMBER, INTERIOR TO THE VI bucket stands from the Open Test Lane. There are atures to icentify for a to

scores for pilots and arcraft that can reliably perform t visual/thermal acuity features, across-altravailable acuit minutes to remain within one battery charge and to ma pilots. Time thatted trials also enable direct compariso scores using singlar aircraft and trial times are directly ent a boraft can be used to compresse care rall sco



Scoring

[5] Acuity targets A-B-C-D inside bottom of all

[2] Perch acuity targets inside and bottom of A

Capture in

B 1, 2, 3, 4

ALIGN WITH BUCKETS AND LAND ACURATELY

20 ALIGNMENTS TOTAL UP TO 100 POINTS

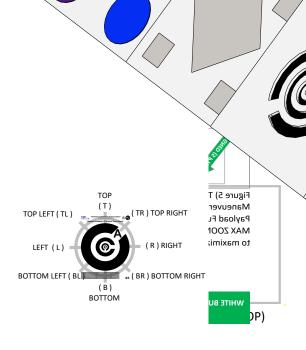




- Align with each bucket to capture at SINGLE IMAGE of the inscribed alignment ring. Only the first image is scored.
- Score captured images as:
 - UNBROKEN RINGS (5 points)
 - BROKEN RINGS (1 point)
 - NO RINGS (0 points, strike through line)
- Score accurate landings as:
 - CENTERED (5 pts) with the aircraft center point inside the 60 cm (24 in) diameter circle.
 - OFFSETT(12 pts): withdatdeastsomeopropellering the slotted leg extensions so the angled buckets are at 45 degrees.

 motor inside the circle.
- Verification of captured alignment images can be during the trial when obvious or after the trial to eliminate discussions during the trial. Images can also be stored for documentation.





Y ACUITY re controls.

ric C gap Proctor.

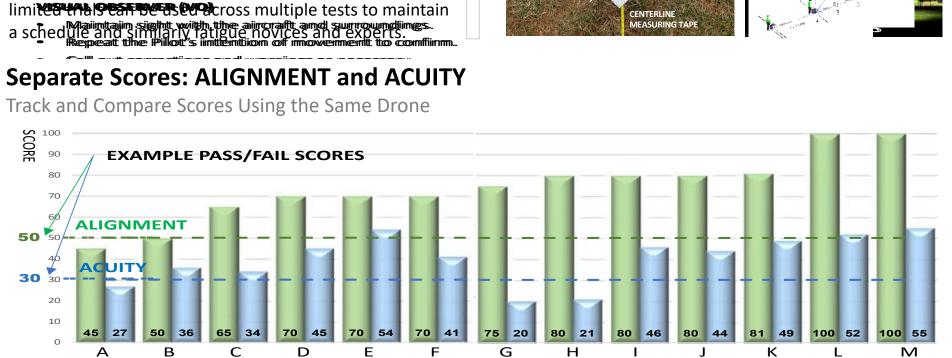
១ariQ₁ ខ្លែរូក្រាំរួម្ខុំrface OS).

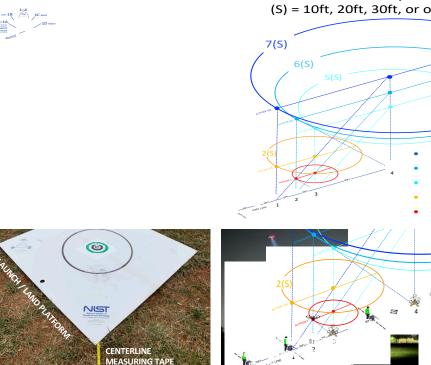




4

11/9/21





5 Different Orbits in Every Lan

Teams Rotate Through Each Role

Each Pilot flies a 5-minute trial with help from others.

A 3-4 person team completes all 5 tests in 2 hours.



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

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

PILOT

- Maintain control of the aircraft.
- Call out each intention of movement be ng so
- Call out each bucket alignment and acu https://doi.org///
 https://doi.org/10.1006/pdf.

PROCTOR

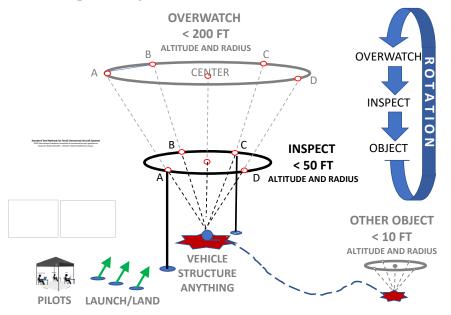
- Fill in the form header.
- Read the test procedures to the Pilot.
- Confirm, record, and attest to scoring after the trial.

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.

Teams Sequence Through Scenarios

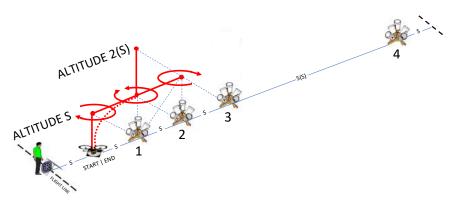
Each Pilot flies a 15-minute scenario, sequencing through 3 objectives for 5 minutes each.



- This scenario mechanization enables embedded bucket scoring tasks to be performed similarly by all participating Pilots. So the results are comparable within the same scenario layout. Additional tactics can be overlayed onto these scenarios at your facility.
- Up to 3 teams concurrently fly different scenario objectives from safe distances and altitudes apart.
- Teams move as necessary to maintain sight lines with their aircraft and communications with other teams.
 The overwatch team leads communications.
- Scenarios restart every 20 minutes with a different rotation of Pilot, Proctor, and VO.

Position (MAN/PAY 1)

Open Test Lane

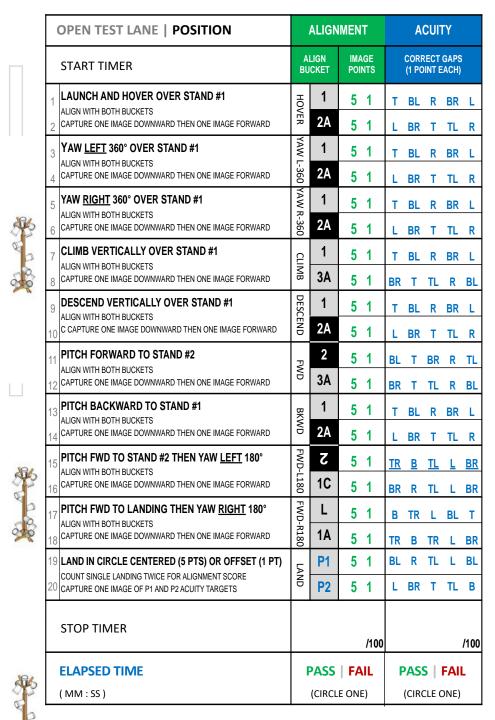


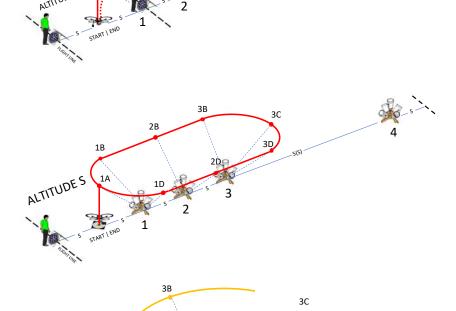
- Demonstrate positive aircraft control using basic flight TRN Proneuvers between designated hover positions, orientations, and altitudes along the lane centerline.
- Perform a series of maneuvers including climb,

 descend, yaw, pitch, and roll to simultaneously align

 with downward and forward buckets in each position.
- Land accurately on the platform with the chassis CENTERED (5 pts) within the 60 cm (24 in) diameter circle, or OFFSET (1 pt) at least one motor in the circle.
- Alignment Points: Capture a SINGLE IMAGE of each MAN alignment with 20 buckets and accurate landings to score up to 100 alignment points.
- Acuity Points: While aligned with each bucket, identify as many acuity target gaps as possible to core ប្រើ to 100 acuity points.

CCM



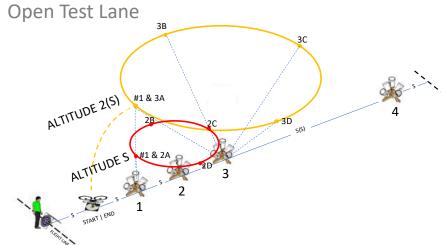


- Fly sideways parallel to objects while looking forward to dentify features as if along a road, truck, bus willding features as if along a road, truck, bus willding features as if along a road, truck bus 4
- Maintain altitude State throughout to complete two laps in both directions around the first three omni stands.
- Land accurately on the platform with the chassis CENTERED (5 pts) within the 60 cm (24 in) diameter circle, or OFFSET (1 pt) at least one motor in the two circle.
- Alignment Points: Capture a SINGLE IMAGE of each alignment ring throughout 2 laps with 20 buckets and warment landings to score up to 100 alignment points.
- Acuity Points: White stigged with each bucket, identify as many acuity to reet gaps as possible to score up to 100 we with points.

OPEN TEST LANE TRAVERSE		ALIGNMENT				ACUITY						
START TIMER		LIGN ICKET		AGE INTS				ECT GAPS INT EACH)				
1 HOVER OVER THE LAUNCH AT ALTITUDE S		1A	5	1	TR	В	TR	L	BR			
2 ORBIT 90° LEFTWARD AROUND STAND #1		1B	5	1	R	TL	т	BL	В			
3 ROLL LEFTWARD TO STAND #2		2B	5	1	TL	R	TR	L	BR			
4 ROLL LEFTWARD TO STAND #3	ALT S	3B	5	1	В	TR	R	BL	т			
5 ORBIT 90° LEFTWARD AROUND STAND #3	1	3C	5	1	BL	R	BL	Т	BR			
6 ORBIT 90° LEFTWARD AROUND STAND #3	LEFTWARD	3D	5	1	L	TL	R	BR	т			
7 ROLL LEFTWARD TO STAND #2	Įΰ	2D	5	1	TR	В	TL	В	BL			
8 ROLL LEFTWARD TO STAND #1		1D	5	1	В	TL	R	BL	Т			
9 ORBIT 90° LEFTWARD AROUND STAND #1		1A	5	1	TR	В	TR	L	BR			
0 LAND IN CIRCLE (5 PTS CENTERED, 1 PT OFFSET)		P1	5	1	BL	R	TL	L	BL			
11 HOVER OVER THE LAUNCH PLATFORM		1A	5	1	TR	В	TR	L	BR			
12 ORBIT 90° RIGHTWARD AROUND STAND #1		1D	5	1	В	TL	R	BL	т			
3 ROLL RIGHTWARD TO STAND #2		2D	5	1	TR	В	TL	В	BL			
14 ROLL RIGHTWARD TO STAND #3	ALT S	3D	5	1	L	TL	R	BR	Т			
15 ORBIT 90° RIGHTWARD AROUND STAND #3	- RIGI	3C	5	1	BL	R	BL	Т	BR			
16 ORBIT 90° RIGHTWARD AROUND STAND #3	RIGHTWARD	3B	5	1	В	TR	R	BL	т			
17 ROLL RIGHTWARD TO STAND #2	RD	2B	5	1	TL	R	TR	L	BR			
18 ROLL RIGHTWARD TO STAND #1		1B	5	1	R	TL	т	BL	В			
ORBIT 90° RIGHTWARD AROUND STAND #1		1A	5	1	TR	В	TR	L	BR			
LAND IN CIRCLE (5 PTS CENTERED, 1 PT OFFSET)		P2	5	1	L	BR	Т	TL	В			
CTOD TIMED												
STOP TIMER				/100					/100			
ELAPSED TIME		PASS	F#	AIL	F	PASS FAIL						
(MM : SS)		(CIRCL	E ON	E)		(CIR	CLE C	NE)				

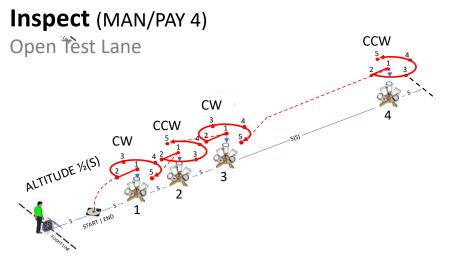


Orbit (MAN/PAY 3)



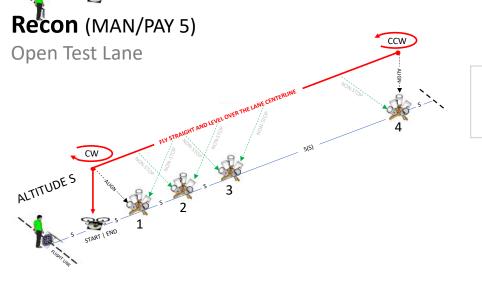
- Orbit an object at an equal altitude and radius while looking inward to identify features on four sides.
- Each orbit includes 5 bucket alignments: 1 downward radius check plus 4 angled buckets all around.
- Start aligned over omni stand #1 at altitude 2(S) to set the orbit radius around omni stand #3. Orbit both directions ending at the start point.
- Descend over omni stand #1 to altitude S to set the orbit radius around omni stand #2. Orbit both directions. Accurate landings are not included.
- Alignment Points: Capture a SINGLE IMAGE of each alignment ring throughout 4 orbits (leftward and rightward at each altitude) with 20 buckets to score up to 100 alignment points.
- Acuity Points: While aligned with each bucket, identify
 as many acuity target gaps as possible to score up to
 100 acuity points.

OPEN TEST LANE ORBIT	ļ	ALIGN	MENT	ACUITY					
START TIMER		IGN CKET	IMAGE POINTS	CORRECT GAPS (1 POINT EACH)					
1 ALIGN OVER STAND #1 AT ALT 2(S) CHECK RADIUS	A	1	5 1	T BL R BR L					
2 ALIGN WITH BUCKET 3A CHECKALTITUDE	ALT 2(S) -	3A	5 1	BR T TL R BL					
3 ORBIT LEFTWARD 90°	-LEF	3B	5 1	B TR R BL T					
4 ORBIT LEFTWARD 90°	LEFTWARD	3C	5 1	BL R BL T BF					
5 ORBIT LEFTWARD 90°	D	3D	5 1	L TL R BR T					
6 ALIGN OVER STAND #1 AT ALT 2(S) CHECK RADIUS	ALT	1	5 1	T BL R BR L					
7 ALIGN WITH BUCKET 3A CHECKALTITUDE	2(S)	3A	5 1	BR T TL R BL					
8 ORBIT RIGHTWARD 90°	– RIGI	3D	5 1	L TL R BR T					
9 ORBIT RIGHTWARD 90°	-RIGHTWARD	3C	5 1	BL R BL T BR					
10 ORBIT RIGHTWARD 90°	8	3B	5 1	B TR R BL T					
11 ALIGN OVER STAND #1 AT ALT S CHECK RADIUS		1	5 1	T BL R BR L					
12 ALIGN WITH BUCKET 2A CHECKALTITUDE	ALT S	2A	5 1	L BR T TL R					
13 ORBIT LEFTWARD 90°	- LEFT	2B	5 1	TL R TR L B					
14 ORBIT LEFTWARD 90°	LEFTWARD	2C	5 1	T BL R TL B					
15 ORBIT LEFTWARD 90°		2D	5 1	TR B TL B BI					
16 ALIGN OVER STAND #1 AT ALT S CHECK RADIUS		1	5 1	T BL R BR L					
17 ALIGN WITH BUCKET 2A CHECKALTITUDE	ALT S –	2A	5 1	L BR T TL R					
18 ORBIT RIGHTWARD 90°	- RIGH	2D	5 1	TR B TL B BI					
19 ORBIT RIGHTWARD 90°	RIGHTWARD	2C	5 1	T BL R TL B					
20 ORBIT RIGHTWARD 90°	Ď	2B	5 1	TL R TR L BF					
STOP TIMER			/100	/10					
ELAPSED TIME	F	PASS	FAIL	PASS FAIL					
(MM : SS)		(CIRCL	E ONE)	(CIRCLE ONE)					



- Fly around objects in close proximity to inspect detailed features on the top and all four sides.
- Maintain altitude 1/2(S) throughout starting on top
 of each omni stand then rotate around all four omni
 bucket stands in alternating clockwise (A-B-C-D) and
 counter clockwise (A-D-C-B) directions.
- · Accurate landings are not included.
- Alignment Points: Capture a SINGLE IMAGE of each alignment ring throughout 4 omni stands with 20 buckets to score up to 100 alignment points.
- Acuity Points: While aligned with each bucket, identify as many acuity target gaps as possible to score up to 100 acuity points.

OPEN TEST LANE INSPECT	A	LIGN	IMENT	ACUITY					
START TIMER	ALI BUC		IMAGE POINTS	CORRECT GAPS (1 POINT EACH)					
1 HOVER OVER STAND #1 AT ALTITUDE 1/2(S)	Ą	1	5 1	T BL R BR L					
2 PITCH BACKWARD	ALT ½(S) –	1A	5 1	TR B TR L BR					
3 ORBIT LEFTWARD 90°		1B	5 1	R TL T BL B					
4 ORBIT LEFTWARD 90°	LEFTWARD	1C	5 1	BR R TL L BR					
5 ORBIT LEFTWARD 90°	D	1D	5 1	B TL R BL T					
6 HOVER OVER STAND #2 AT ALTITUDE 1/2(S)	AL.	2	5 1	BL T BR R TL					
7 PITCH BACKWARD	ALT %(S) — RIGHTWARD	2A	5 1	L BR T TL R					
8 ORBIT RIGHTWARD 90°	– RIGF	2D	5 1	TR B TL B BL					
9 ORBIT RIGHTWARD 90°	1TWAI	2C	5 1	T BL R TL B					
10 ORBIT RIGHTWARD 90°	RD	2B	5 1	TL R TR L BR					
11 HOVER OVER STAND #3 AT ALTITUDE 1/2(S)	Þ	3	5 1	R TL B BL R					
12 PITCH BACKWARD	ALT ½(S) — LEFTWARD	3A	5 1	BR T TL R BL					
13 ORBIT LEFTWARD 90°) – LEF	3B	5 1	B TR R BL T					
14 ORBIT LEFTWARD 90°	TWAR	3C	5 1	BL R BL T BR					
15 ORBIT LEFTWARD 90°	Ď	3D	5 1	L TL R BR T					
16 HOVER OVER STAND #4 AT ALTITUDE 1/2(S)	ALT	4	5 1	TL B TR R BR					
17 PITCH BACKWARD		4A	5 1	T BL B TR L					
18 ORBIT RIGHTWARD 90°	– RIGI	4D	5 1	BR B TL B TR					
19 ORBIT RIGHTWARD 90°	RIGHTWARD	4C	5 1	R BL T TR B					
20 ORBIT RIGHTWARD 90°	RD	4B	5 1	TR L BL R TL					
STOP TIMER									
STOT HIVILIN			/100	/100					
ELAPSED TIME	P/	ASS	FAIL	PASS FAIL					
(MM : SS)	(0	CIRCLE	E ONE)	(CIRCLE ONE)					

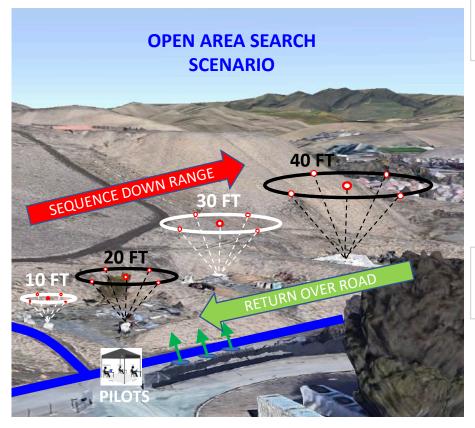


- Fly straight and level at a sustainable speed directly over the lane centerline to establish a stable hover over an object and perform quick reconnaissance tasks.
- Maintain altitude (S) throughout starting over the launch/land platform to align with the designated targets at both ends of the lane.
- A complete trial totals a distance of 80(S).
- Accurate landings are not included.
- Alignment Points: Capture a SINGLE IMAGE of each alignment ring throughout 5 laps with 20 buckets to score up to 100 alignment points.
- Acuity Points: While aligned with each bucket, identify as many acuity target gaps as possible to score up to 100 acuity points.

	OPEN TEST LANE RECON		ALIGN	IMEN	T	ACUITY							
	START TIMER	ALIGN IMAGE BUCKET POINTS			CORRECT GAPS (1 POINT EACH)								
1	FLY AT ALTITUDE S TO STAND #4		4	5	1	TL	В	TR	R	BR			
2	YAW LEFT 180°	LAP	Þ	5	1	<u>BR</u>	I	<u>BL</u>	L	<u>TL</u>			
3	FLY TO THE LAUNCH AND YAW RIGHT 180°	P 1	L	5	1	В	TR	L	BL	Т			
4	HOVER IN PLACE CHECK ALTITUDE S		1A	5	1	TR	В	TR	L	BR			
5	FLY AT ALTITUDE S TO STAND #4		4	5	1	TL	В	TR	R	BR			
6	YAW LEFT 180°	LAP	Þ	5	1	<u>BR</u>	I	<u>BL</u>	L	<u>TL</u>			
7	FLY TO THE LAUNCH AND YAW RIGHT 180°	P 2	L	5	1	В	TR	L	BL	Т			
8	HOVER IN PLACE CHECK ALTITUDE S	ĺ	1A	5	1	TR	В	TR	L	BR			
9	FLY AT ALTITUDE S TO STAND #4		4	5	1	TL	В	TR	R	BR			
10	YAW LEFT 180°	LAP	Þ	5	1	BR	I	BL	L	ΤL			
11	FLY TO THE LAUNCH AND YAW RIGHT 180°	ü	L	5	1	В	TR	L	BL	Т			
12	HOVER IN PLACE CHECK ALTITUDE S		1A	5	1	TR	В	TR	L	BR			
13	FLY AT ALTITUDE S TO STAND #4		4	5	1	TL	В	TR	R	BR			
14	YAW LEFT 180°	LAP	Þ	5	1	BR	I	BL	L	ΤL			
15	FLY TO THE LAUNCH AND YAW RIGHT 180°	4	L	5	1	В	TR	L	BL	Т			
16	HOVER IN PLACE CHECK ALTITUDE S		1A	5	1	TR	В	TR	L	BR			
17	FLY AT ALTITUDE S TO STAND #4		4	5	1	TL	В	TR	R	BR			
18	YAW LEFT 180°	LĄΡ	Þ	5	1	BR	I	BL	L	TL			
19	FLY TO THE LAUNCH AND YAW RIGHT 180°	P 5	L	5	1	В	TR	L	BL	T			
20	HOVER IN PLACE CHECK ALTITUDE S		1A	5	1	TR	В	TR	L	BR			
	CTOD TIMED						-						
	STOP TIMER				/100					/100			
	ELAPSED TIME	PASS FAIL					PASS FAIL						
	(MM : SS)	(CIRCLE ONE)					(CIRCLE ONE)						

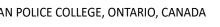
Open Area Search Scenarios

Day and Night Trials

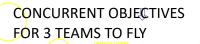


- Teams concurrently fly separate objectives set up at safe distances and/or altitudes apart (with a clearly designated and safe return path).
- Each pilot flies for 15 minutes across 3 different objectives for 5 minutes each. Teams move as necessary to maintain sight lines and communication.
- Scenarios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

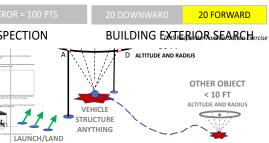
OPEN SCENARIO SEARCH		ALIGN	IMENT		Α	CUI	CUITY					
START TIMER		LIGN CKET	IMAGE POINTS		CORF (1 PC	GAPS ACH)						
1 HOVER OVER STAND #1 AT CHOSEN ALTITUDE		1	5 1	т	BL	R	BR	L				
2 PITCH BACKWARD	된	1A	5 1	TR	В	TR	L	BR				
3 ORBIT LEFTWARD 90°	LEFTWARD	1B	5 1	R	TL	Т	BL	В				
4 ORBIT LEFTWARD 90°		1C	5 1	BR	R	TL	L	BR				
5 ORBIT LEFTWARD 90°		1D	5 1	В	TL	R	BL	Т				
6 HOVER OVER STAND #2 AT CHOSEN ALTITUDE		2	5 1	BL	т	BR	R	TL				
7 PITCH BACKWARD	RIG	2A	5 1	L	BR	Т	TL	R				
8 ORBIT RIGHTWARD 90°	RIGHTWARD	2D	5 1	TR	В	TL	В	BL				
9 ORBIT RIGHTWARD 90°	RD	2C	5 1	т	BL	R	TL	В				
10 ORBIT RIGHTWARD 90°		2B	5 1	TL	R	TR	L	BR				
11 HOVER OVER STAND #3 AT CHOSEN ALTITUDE		3	5 1	R	TL	В	BL	R				
12 PITCH BACKWARD		3A	5 1	BR	Т	TL	R	BL				
13 ORBIT LEFTWARD 90°	_EFTWARD	3B	5 1	В	TR	R	BL	Т				
14 ORBIT LEFTWARD 90°	R	3C	5 1	BL	R	BL	Т	BR				
15 ORBIT LEFTWARD 90°		3D	5 1	L	TL	R	BR	т				
16 HOVER OVER STAND #4 AT CHOSEN ALTITUDE		4	5 1	TL	В	TR	R	BR				
17 PITCH BACKWARD	R _C	4A	5 1	т	BL	В	TR	L				
18 ORBIT RIGHTWARD 90°	RIGHTWARD	4D	5 1	BR	В	TL	В	TR				
19 ORBIT RIGHTWARD 90°	ARD	4C	5 1	R	BL	Т	TR	В				
20 ORBIT RIGHTWARD 90°		4B	5 1	TR	L	BL	R	TL				
STOR TIMER												
STOP TIMER			/100					/100				
ELAPSED TIME	Р	ASS	FAIL		PAS	S	FAIL					
(MM : SS)		CIRCLE	-				E ONE)					



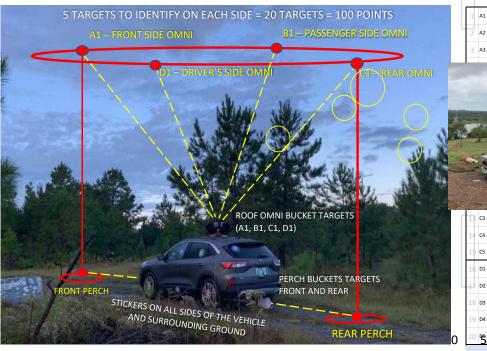
IADA











STABLE METER SAN AND AND AND AND AND AND AND AND AND A		<u> </u>	5	1_	_B_	His.	. R.	.Pl	Ŀ		
CARTURE PRE-LAUNCH MAGE OF PENGELE MAYER BATERWARK DO 1/2 AT ALTITUDE 1/2(S)	BUCKETONMENTS					(1 ACCUITY					
HOVER OVER STAND #1 AT ALTITUDE 1/2(S)	Al BU	CSE	MA FOI	NGE N'i S		C⊜RF († ³'0	RECT (
PITCH BACKWARD PRESENTATION OF THE PROPERTY O	#4	4 TOI	P TA	RGE	T:	Б	ΙK		ÞΚ		
S ORBIT LEFTWARD 90°		Â	1	1	R	靴	F	融	B		
ORBIT LEFTWARD 90° ORBIT LEFTWAR)[) 10	2	1	BR 報	R	最	B	BR BR		
ORBIT LEFTWARD 90°		33	3	1	B	社	R	朝			
HOVER OVER STAND #2 AT ALTITUDE 1/2(S) ORBIT RIGHT CAR DIGGENSE PLATE PITCH BACKWARD	FRONT	3(3)	2	1	野野	Į	擊	DOM:	載		
7 PITCH BACKWARD \$1000000000000000000000000000000000000		2A 4G	25	1	L	BR	T FR	TL	R		
CORDISCHICHT WARD 99SED TIME. OBT PASSEMULE STOE - ROOFTOP OMNI BUCKET		–9n− B	5	100	TR TR	R L	TI BL	R R	RI TL		
ORBIT RIGHTWARD 90°	P,	3822	5	1	Ţ	BL BR	R	TL BIR	B		
ORBIT RIGHTWARD 90°T CHEYERASTER (SEPTEMENT MENTAL	PASSENGER	EI3	5	OTAL	TL SCC	R R	TR TR	L	BR /100		
HOVER OVER STAND#3 AT ALTITUDE 1/2(S)	GER	47.4	55	1	B	J.	В	服	R		
2 PITCH BACKWARD ORBIT PRESENTATE BURE SURROUNDING GROUND		3A 450)	55	1	BR	Į	程	R	BL 棘		
1 - FRONT SIZE - F	ickots	С	5	1	R	BL	Ť	TR	B		
1 - FROM TSDE - PROFITOR ONNESDOCETY OF BY Should only be compared using similar systems. 2 - FROM CENTER	ickets	36	5	1	船	R	亂	Ę	解		
3-FROM PRETINEENSEAR DAPE®	REAF	扬	5	1	В	Ŧk	R	BR	Ŧ		
RECORDING COPPRISON THE MAPS RETITUDE 1/2(S)		C4	5	/100	BL	R	₫R	R	/ 100		
7-PESCHEASKWABERBODY BUCKET		6/5	15	1.	Ī	₽Ŀ	R	ВR	‡		
SOUR DELOCATION OF PROPERTY OF THE PROPERTY OF	1	D	1	OTAL	BR SCO	RE	TL	В	TR		
BREENIG TWORE PRONT WINDOW	9	92	15	1	R	BŁ	B	ŦŖ	В		
2 OS TORIVER SIDE AREAR WILLOW	RINE	403	5	1	FR	F	BF	R	Æ		
TO DAMENTERIOR FEATURE		D4	5	1	R	BL	Т	TR	В		
FECOSO SCRREGUNDING CREDUNC OBJECT		D5	5	<mark>/</mark> 100	BR	В	TL	В	/ <mark>18</mark> 0		
5-RE/ 1-DM STOP TIMER											
2-DRI ELAPSED TIME (MM:SS)	TO/1AP					SCORE			/100		
3-DRI 4-DRI ELAPSED TIME	P	ASS	FA	IL		PAS	SS FAIL				
_{5-DRI} (MM:SS)	(CIRCLE	ONE)	(CIRCLE ONE)						