

Sensing & Radio Comms

Aerial Test Methods

Version 2021A

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AND FLIGHT PATH ANIMATIONS](#)



Online Only Meeting
February 3, 2021
10:00am – 2:00pm EST

Sub Committee Chair

Adam Jacoff

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

Committee Chair:

Phil Mattson

Science and Technology Directorate
U.S. Department of Homeland Security

Internet
RobotTestMethods.nist.gov

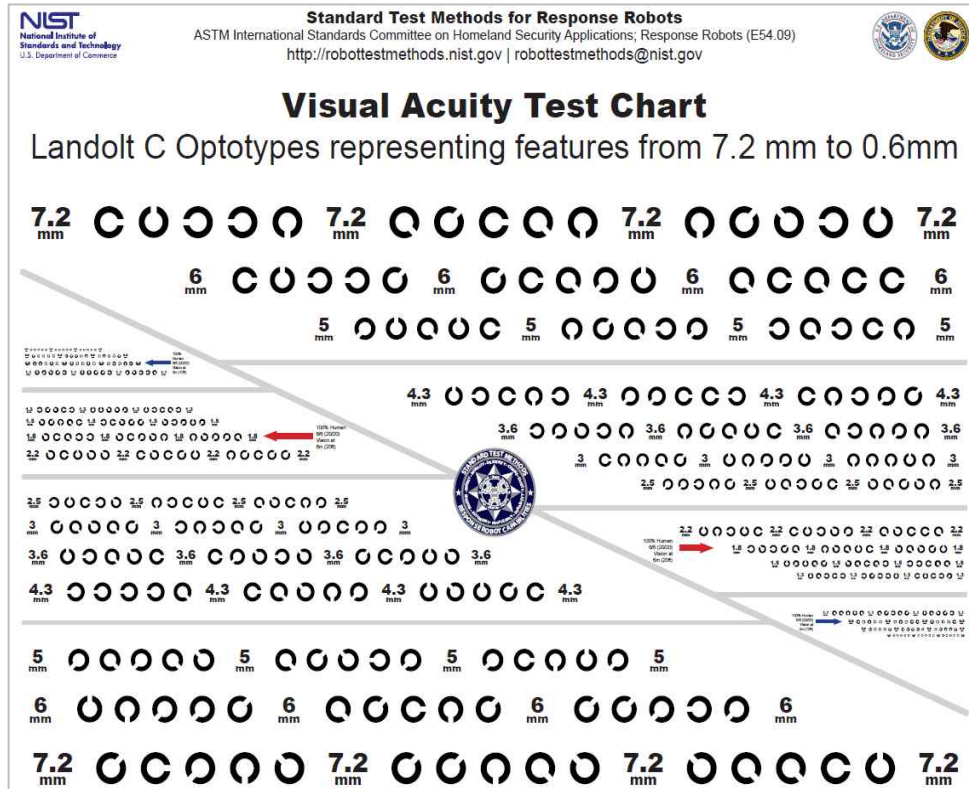


Email
RobotTestMethods@nist.gov

Aerial Sensing: Visual Acuity Test

ASTM E2566-2017

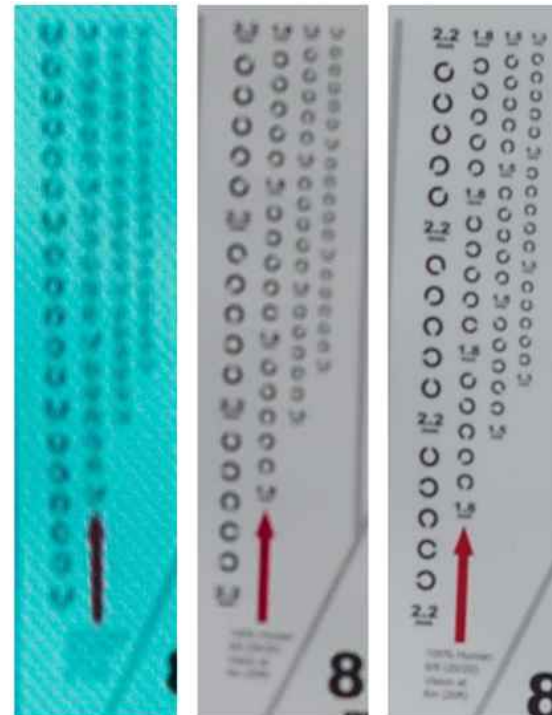
MORE CONTINUOUS TARGETS



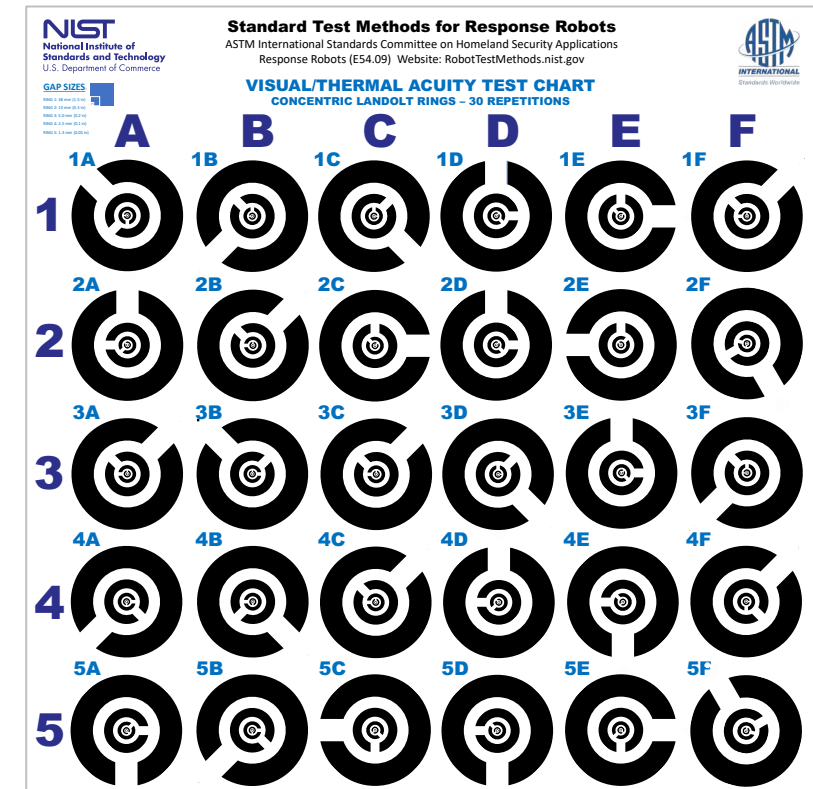
DIFFERENT LEVELS OF ACUITY

Interface Streamed Recovered

LIVE BETTER BEST



5 DEEP CONCENTRIC C TARGETS



Aerial Sensing: Color Acuity Test

COLOR DOTS

ASTM WK54755

ROTATING HAZMAT LABELS

NIST
National Institute of
Standards and Technology
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Standard Test Methods for Response Robots
ASTM International Standards Committee on Homeland Security Applications
Response Robots (E54.09) | <http://RobotTestMethods.nist.gov>

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COLOR ACUITY TEST CHART
6 RANDOM HAZMAT LABEL COLORS - 30 REPETITIONS
Colors as specified in 49 CFR (Code of Federal Regulations) 172.401(f)

Colors:
Red #E85C3D
Orange #FF8C00
Yellow #FFD700
Green #3CB371
Blue #1E90FF
Black #000000

	A	B	C	D	E	F
1	1A	1B	1C	1D	1E	1F
2	2A	2B	2C	2D	2E	2F
3	3A	3B	3C	3D	3E	3F
4	4A	4B	4C	4D	4E	4F
5	5A	5B	5C	5D	5E	5F

NIST
National Institute of
Standards and Technology
U.S. Department of Commerce

Standard Test Methods for Response Robots
ASTM International Standards Committee on Homeland Security Applications
Response Robots (E54.09) | <http://RobotTestMethods.nist.gov>

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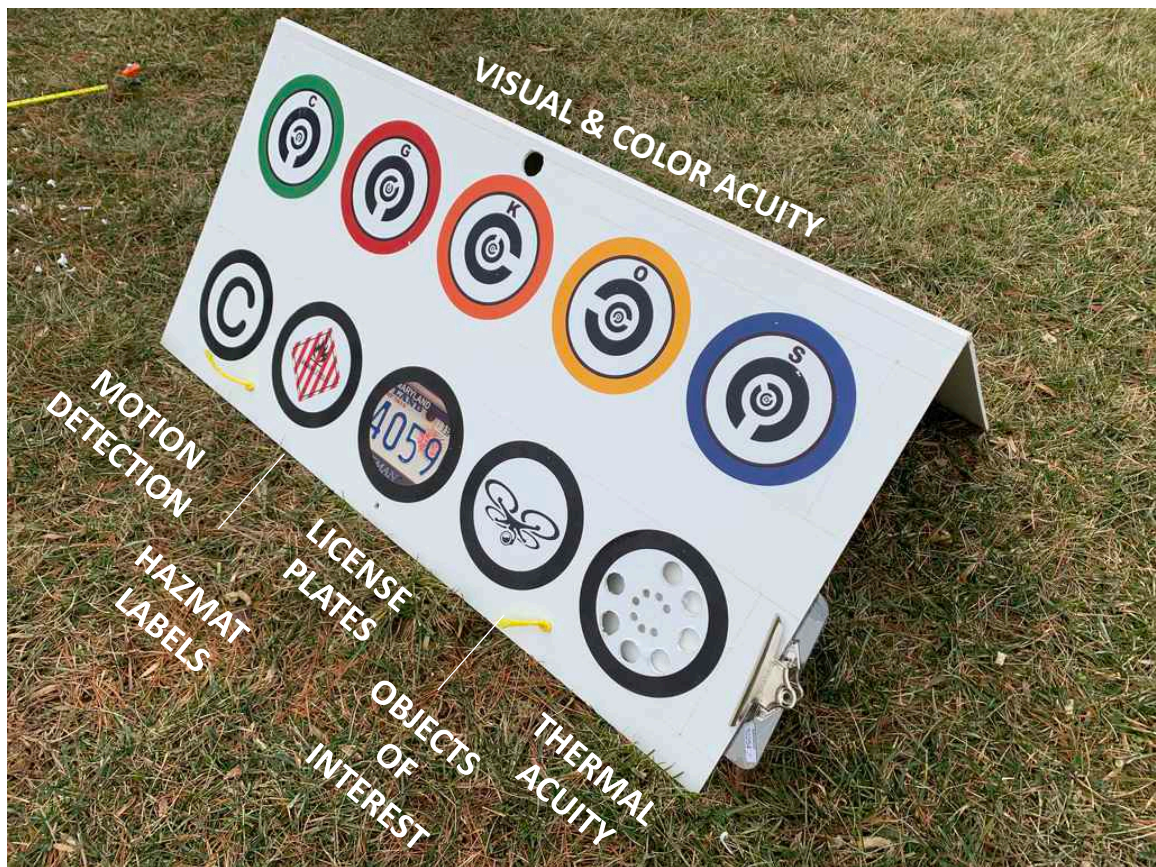
HAZARDOUS MATERIAL LABEL TEST CHART
30 RANDOM, RANDOMLY ORIENTED 100 MM (4 IN) LABELS

	A	B	C	D	E	F
1	1A	1B	1C	1D	1E	1F
2	2A	2B	2C	2D	2E	2F
3	3A	3B	3C	3D	3E	3F
4	4A	4B	4C	4D	4E	4F
5	5A	5B	5C	5D	5E	5F

Aerial Sensing: Point and Zoom Camera Test

ASTM WK33261

Visual, Color, Motion, Thermal, and Operationally Significant Objects



LICENSE
PLATES

OBJECTS OF
INTEREST

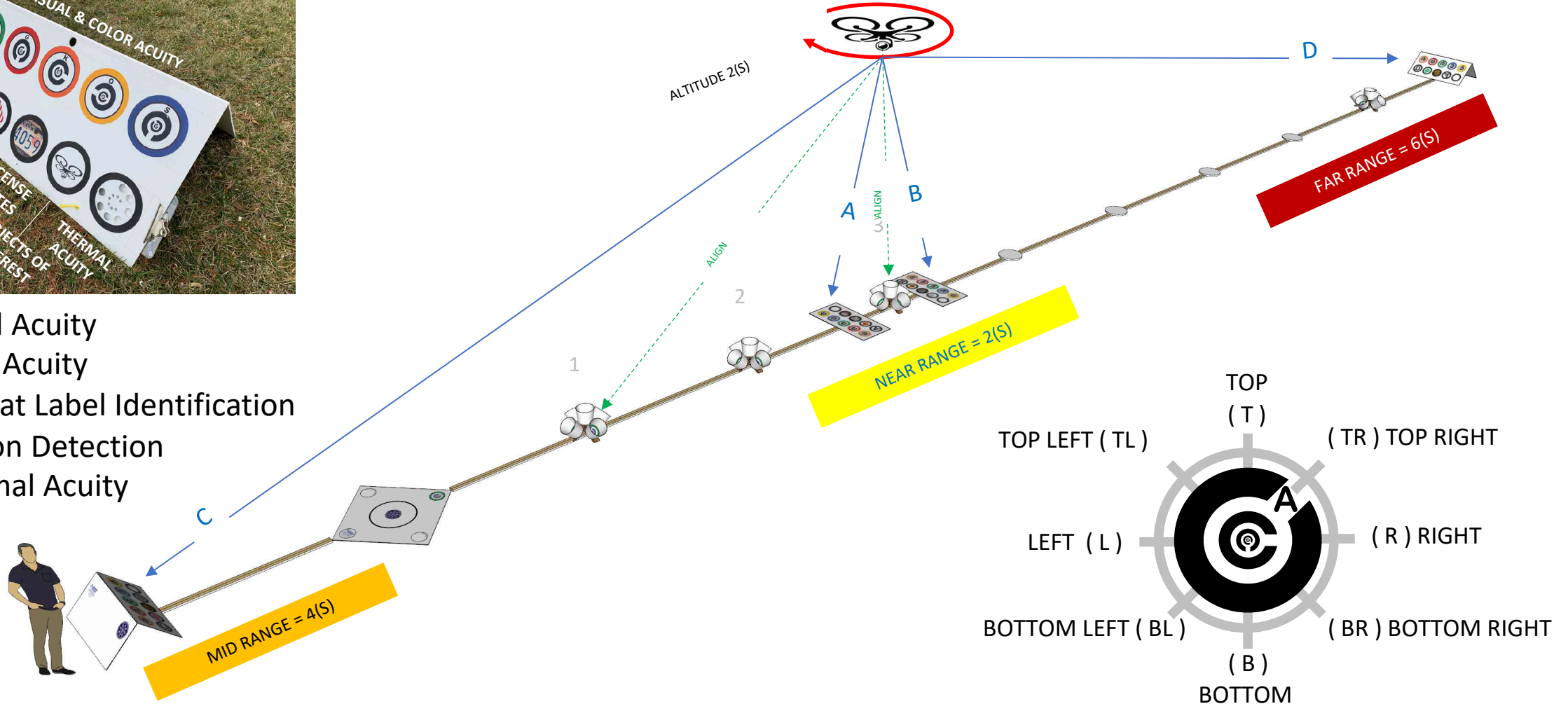
THERMAL
HAND WARMER

Aerial Sensing: Point and Zoom Camera Test

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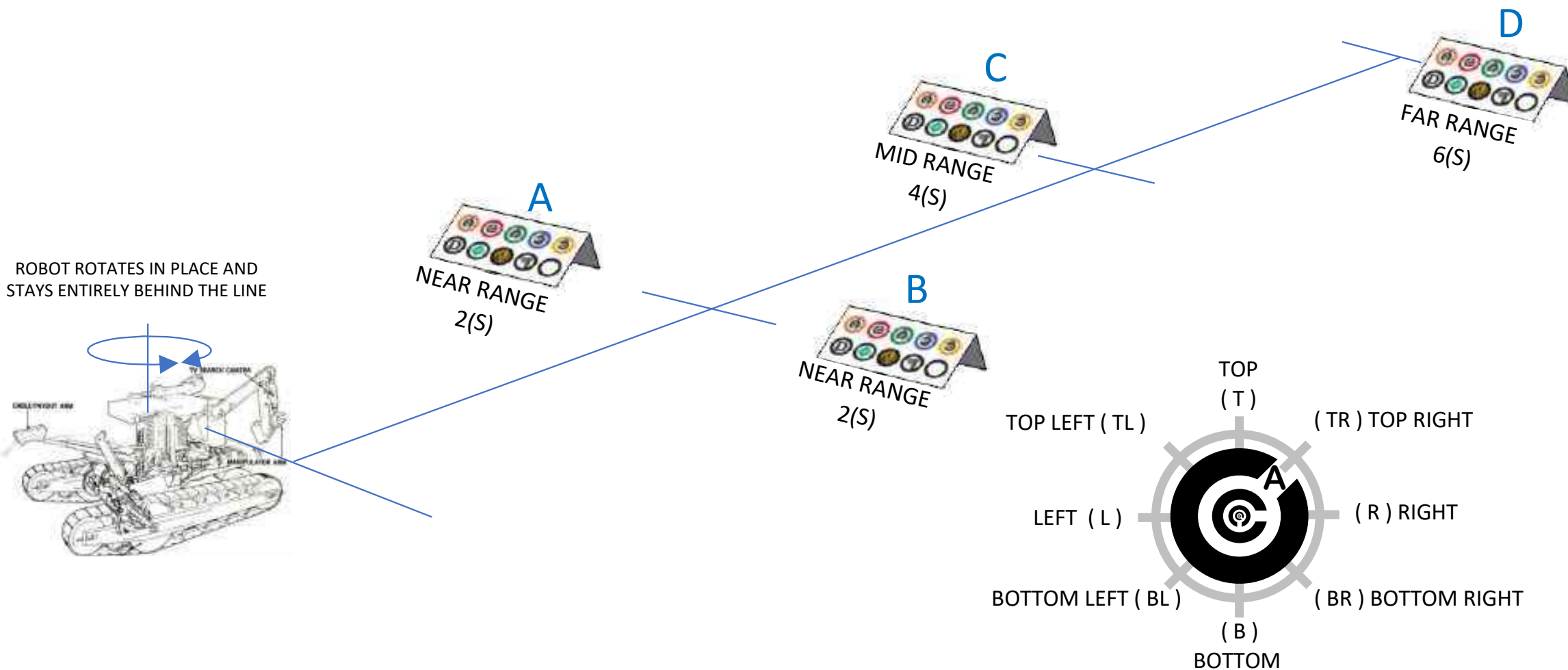


1. Visual Acuity
2. Color Acuity
3. Hazmat Label Identification
4. Motion Detection
5. Thermal Acuity



Ground Sensing: Point and Zoom Camera Test

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Aerial Sensing: Point and Zoom Camera Test

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[WATCH MOVIE OF ASSEMBLY PROCESS HERE](#)



Thermal acuity circular hole patterns. The large holes are 1 inch diameter and small holes are 1/2 inch diameter. One of the 8 directions is missing, like the gap on the visual acuity targets. There is a sticker template to drill through in the Disk Insert file.

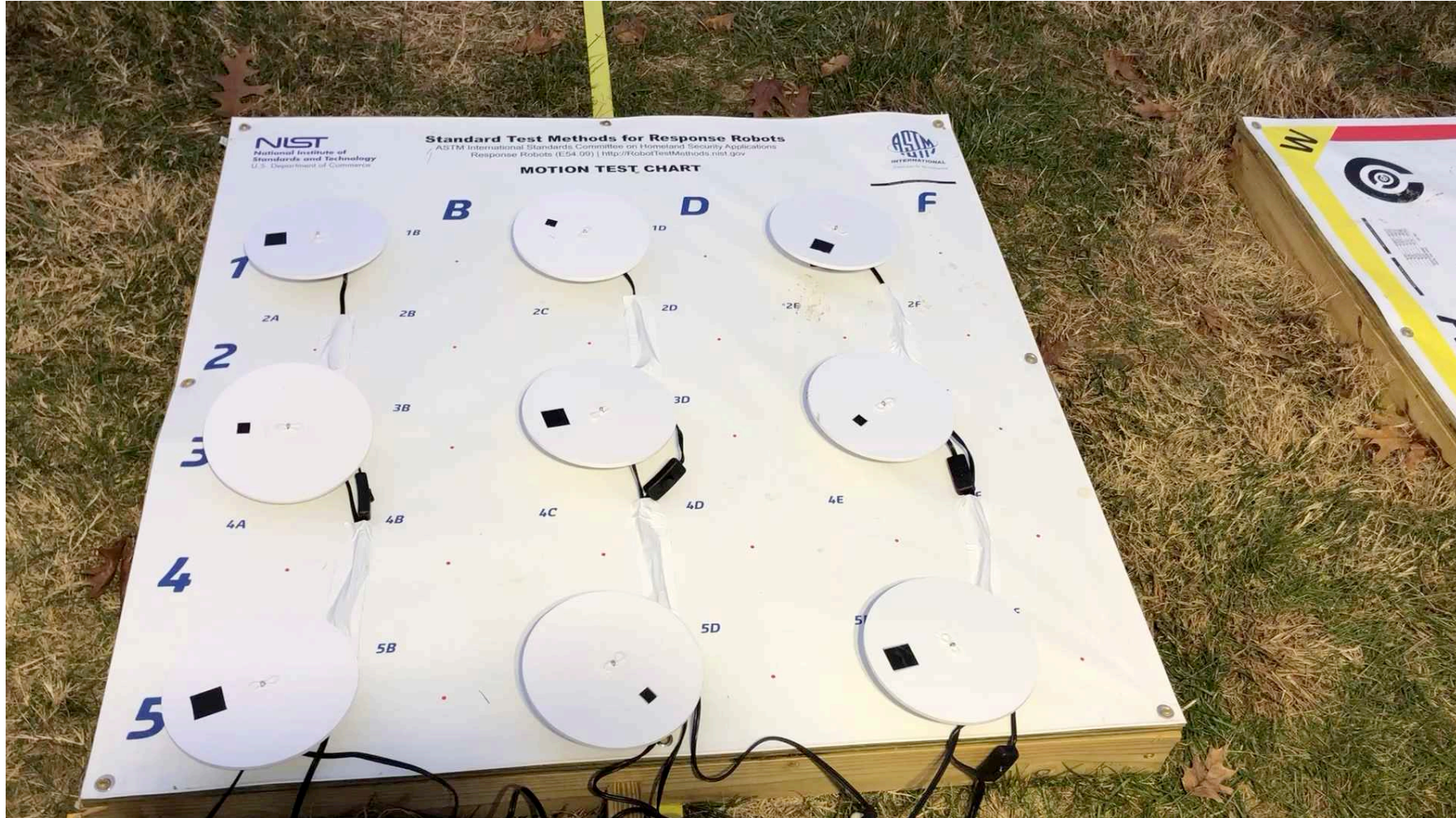


A simpler approach is to fold a hand warmer into roughly a line and staple it to the panel vertical, horizontal, or diagonal



Aerial Sensing: Motion Detection

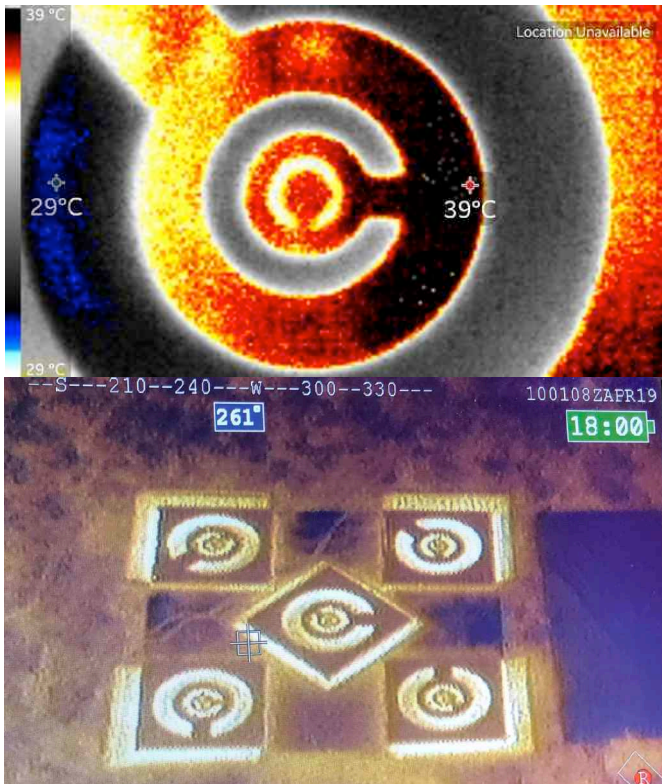
ASTM WK _____



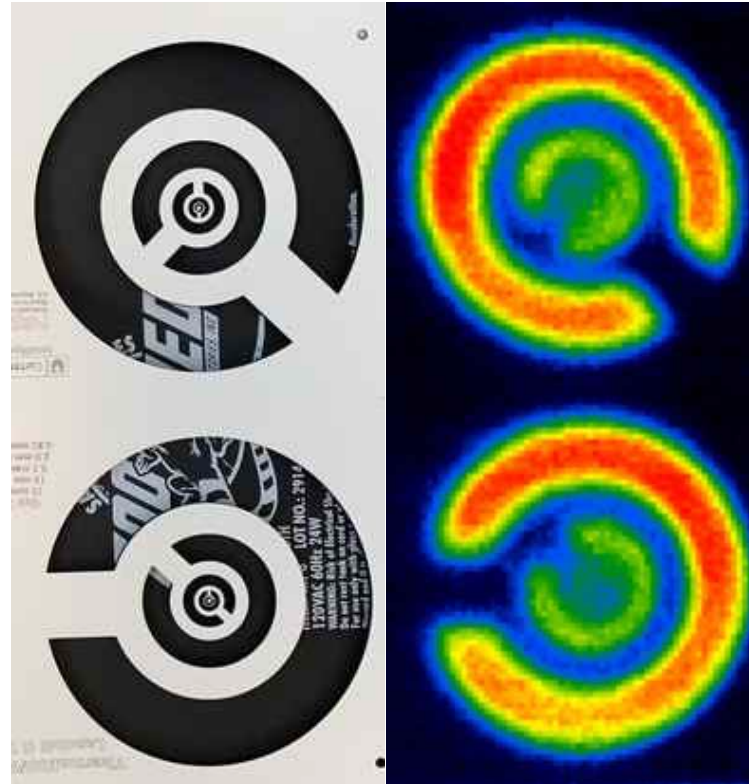
Aerial Sensing: Thermal Image Acuity

ASTM WK57967

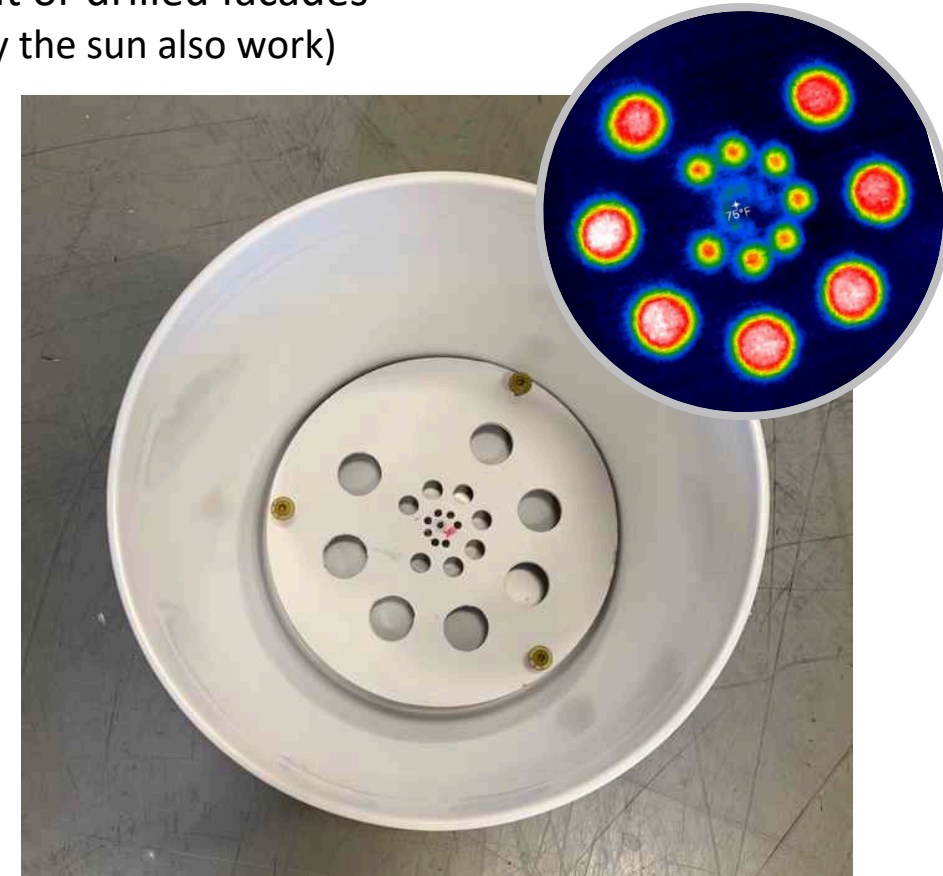
Heated reptile pads or hand warmers behind laser cut or drilled facades
(Indoor or outdoor use – typical sticker targets warmed by the sun also work)



An array of Concentric C thermal targets placed throughout a scenario (needs power).



Concentric Cs laser cut into MDF with a reptile heater. A metal backing helps diffuse the heat.



Drill Holes (1in, 1/2in, 1/4in) through plastic disks with hand warmers heating a metal disk backing.

Aerial Sensing: Video Latency

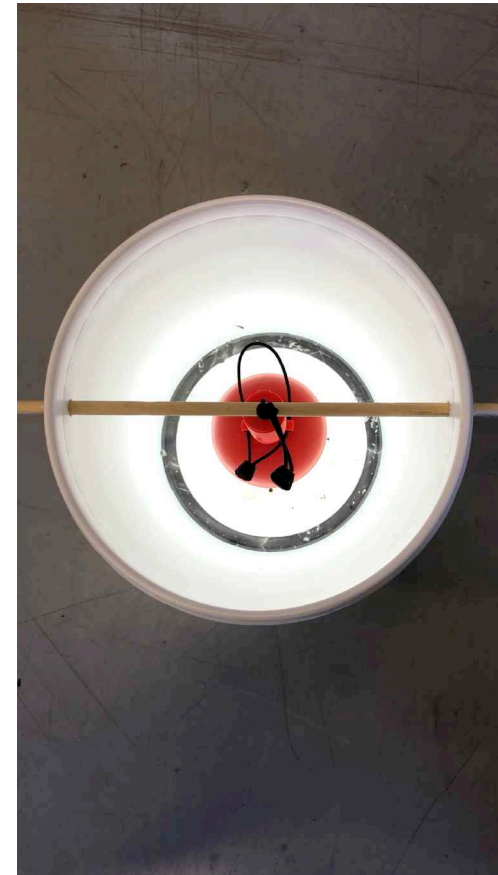
ASTM WK46478

Latency test with flashing “SOS” beacon or other light

High speed camera video (240 fps) captures flash in field AND flash on display views simultaneously.



Count the frames
between flashes



Aerial Sensing: Remote Latency and Packet Loss

ASTM WK46478

COMPUTER READABLE CODES
SYNCRONIZED AT BOTH ENDS

HUMAN READABLE CLOCKS
SYNCRONIZED AT BOTH ENDS

UP RANGE WITH OCU
(VIDEO CAPTURE WITH INTERFACE)

UP RANGE WITH OCU
(VIDEO CAPTURE WITH INTERFACE)



DOWN RANGE WITH ROBOT
(VIEWED THROUGH INTERFACE)

DOWN RANGE WITH ROBOT
(VIEWED THROUGH INTERFACE)

Aerial Sensing: Audio Acuity (2-Way)

ASTM WK60783

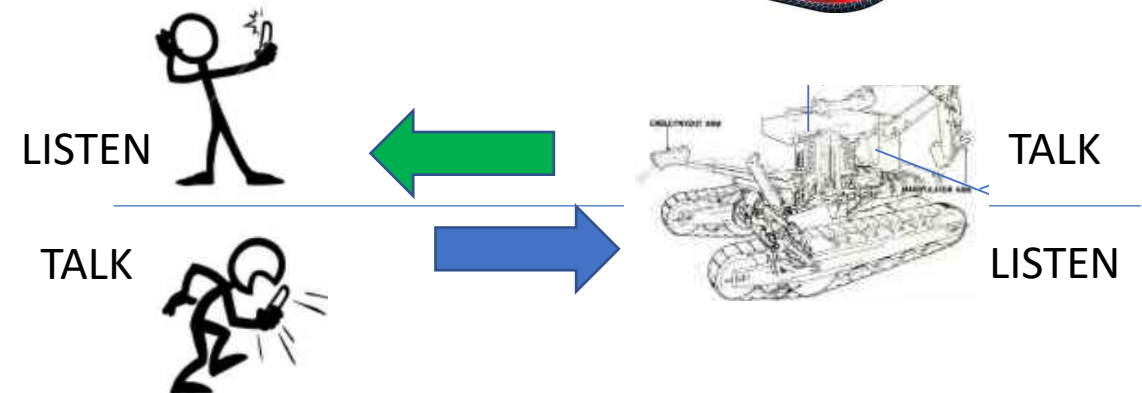
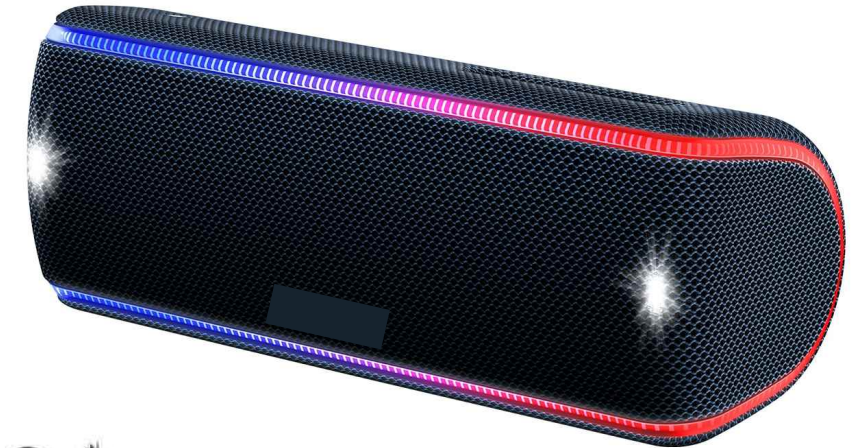
Alpha-numeric list read by a computer voice

Loudness set to 75-80 dB

AUDIO ACUITY TEST1.

0 MISSES IN 2 LINES ALLOWED. 0 IN 10 NUMBERS.
1 MISS IN 3 LINES ALLOWED. 1 IN 15 NUMBERS.
2 MISSES IN 5 LINES ALLOWED. 2 IN 25 NUMBERS.
3 MISSES IN 6 LINES ALLOWED. 3 IN 30 NUMBERS.

A!	1.	2.	3.	4.	5.	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
B!	6.	2.	3.	5.	4.	<u>6</u>	<u>2</u>	<u>3</u>	<u>5</u>	<u>4</u>
C!	2.	5.	9.	8.	7.	<u>2</u>	<u>5</u>	<u>9</u>	<u>8</u>	<u>7</u>
D!	7.	2.	8.	9.	5.	<u>7</u>	<u>2</u>	<u>8</u>	<u>8</u>	<u>5</u>
E!	3.	4.	9.	1.	0.	<u>3</u>	<u>4</u>	<u>9</u>	<u>1</u>	<u>0</u>
F!	5.	8.	0.	2.	9.	<u>5</u>	<u>8</u>	<u>0</u>	<u>2</u>	<u>9</u>
G!	6.	9.	7.	3.	8.	<u>6</u>	<u>9</u>	<u>7</u>	<u>3</u>	<u>8</u>
H!	2.	0.	5.	2.	7.	<u>2</u>	<u>0</u>	<u>5</u>	<u>2</u>	<u>7</u>
I!	3.	5.	2.	8.	9.	---	---	---	---	---
J!	7.	2.	6.	1.	6.	---	---	---	---	---
K!	8.	3.	3.	4.	5.	---	---	---	---	---



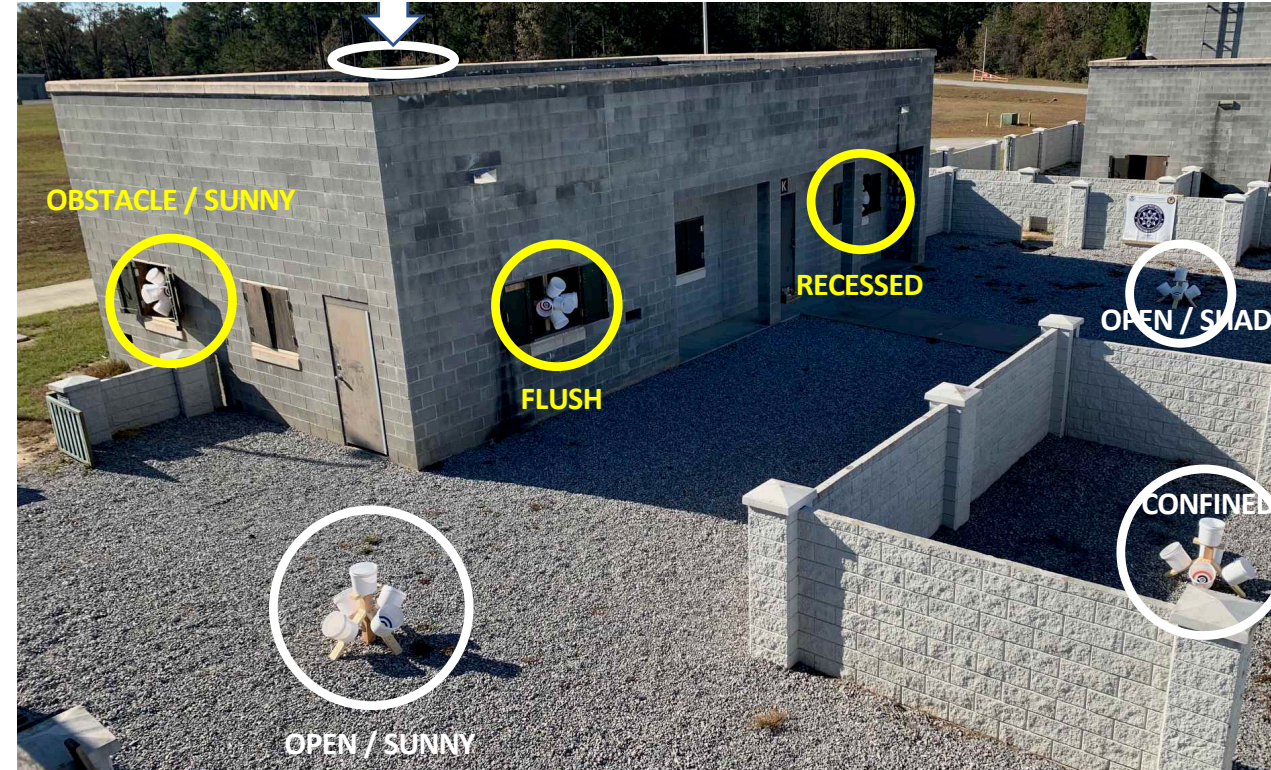
Aerial Sensing: 3D Range Imagers and Scanners

ASTM WK _____

Resolution



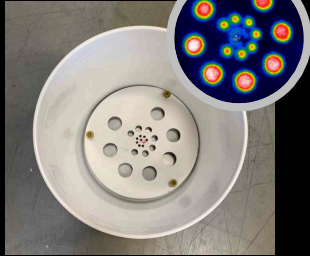
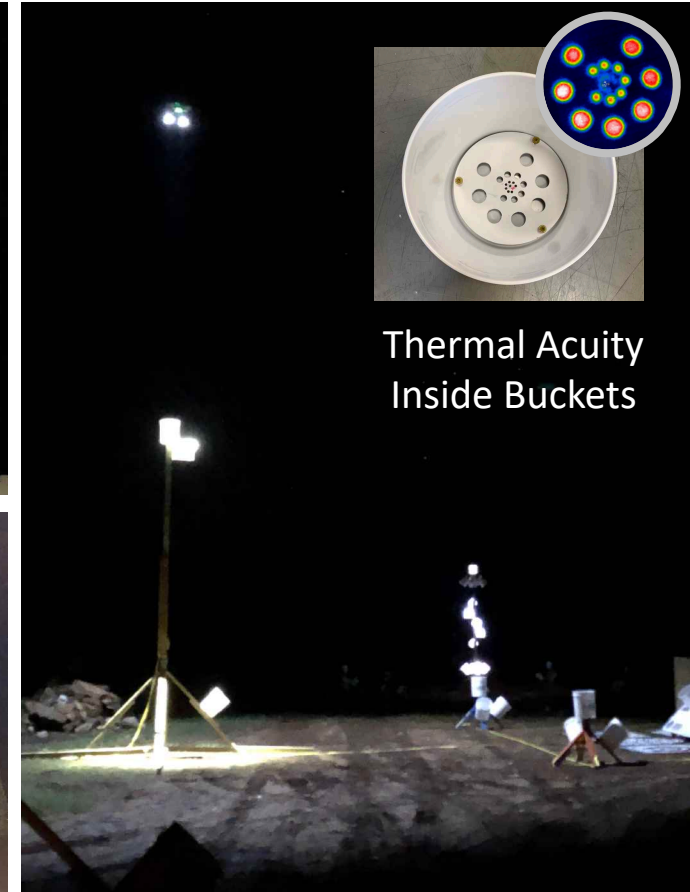
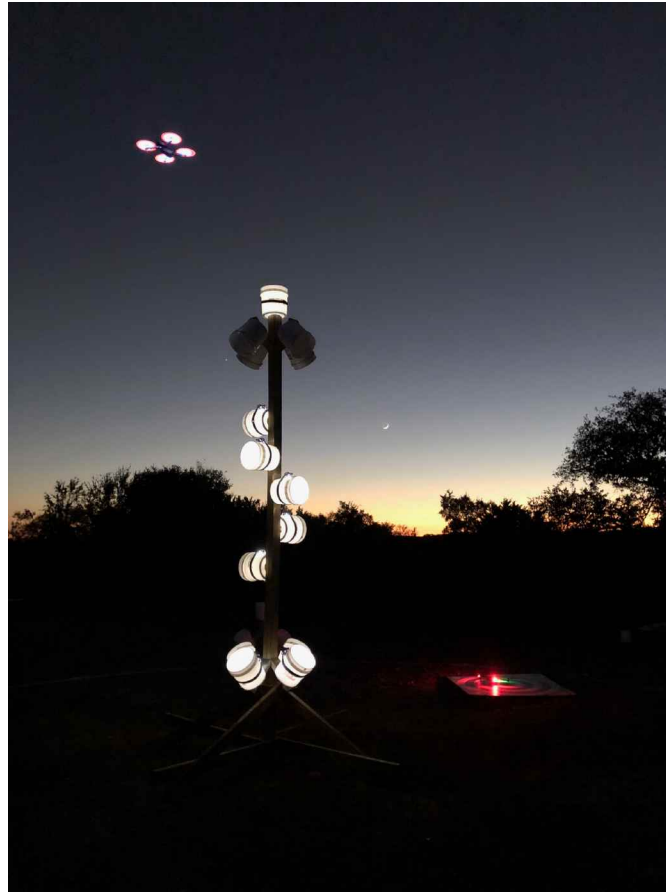
Mapping



Aerial Sensing: Light Emissions

ASTM WK _____

WHITE OR RED HEADLAMPS
WRAPPED AROUND BUCKETS POINTED INWARD



Thermal Acuity
Inside Buckets

Position accuracy for range to target
using lighted buckets (red or white)

Inspect objects of interest
using lighted buckets (red or white)

Identify objects
lighted from the aircraft

Measure additional
sensor capabilities

Aerial Sensing: Combined Sensor Crates (aka "Victim" Crates)

WK _____



LIGHTED CRATES



CENTER DEXTERITY PIPE TASKS
(BLOCKS VIEWS WHEN NOT CENTERED.
BUT IS USED ONLY TO DETERMINE ROBOT
DEXTERITY CONFIGURATION MULTIPLIERS)



HAZMAT LABEL
IDENTIFICATION
(x2)

VISUAL/COLOR
ACUITY
(x2)



MOTION
DETECTION
(x2)

THERMAL IMAGE
RESOLUTION
(x2)

PROXIMITY SAMPLING
MAGNETS IN CORNERS
AND CENTER (x5)

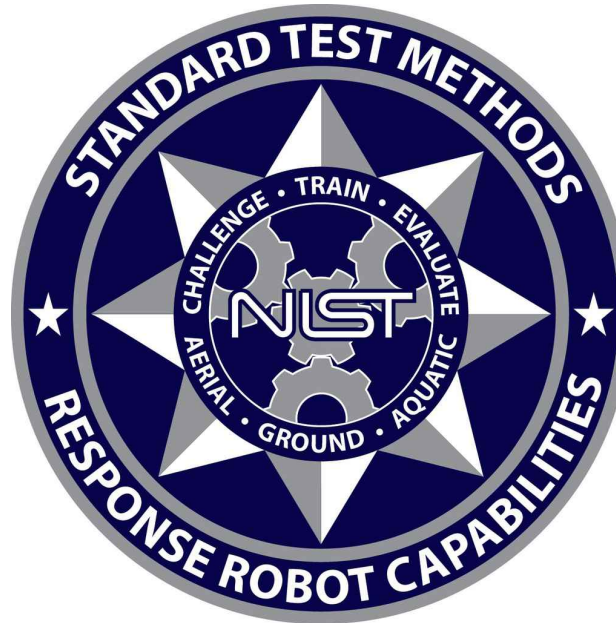
Aerial Configuration: Noise Emissions

WK _____

- Conducted during a practice Recon test flying straight and level toward/away from the microphone S distance from the landing (on the A-frame)

Aerial Radio Comms Range Tests

Aerial Test Methods



Test Director:

Adam Jacoff

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

Sponsor:

Phil Mattson

Science and Technology Directorate
U.S. Department of Homeland Security

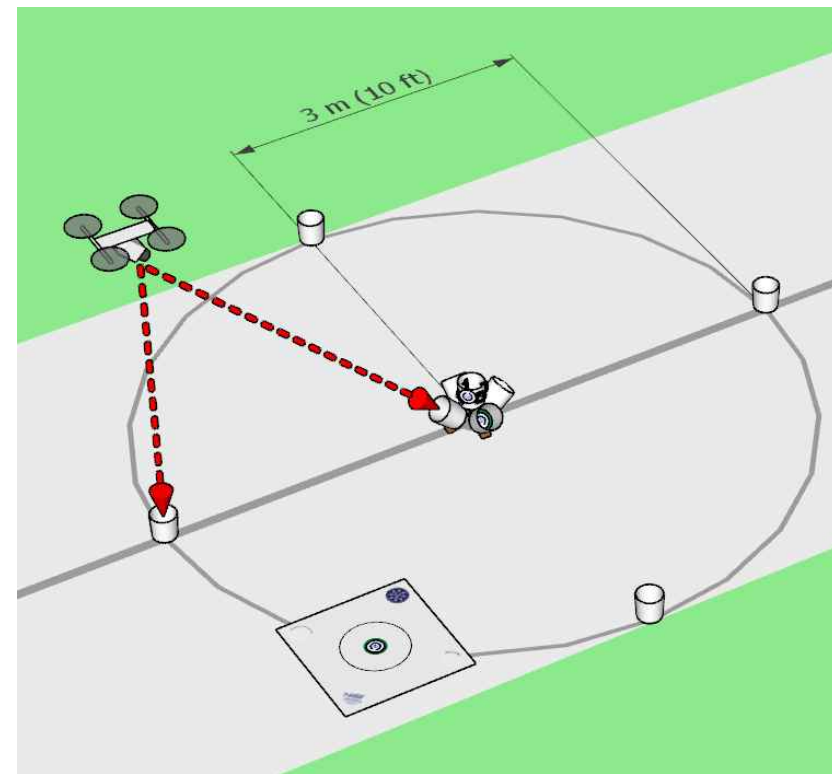
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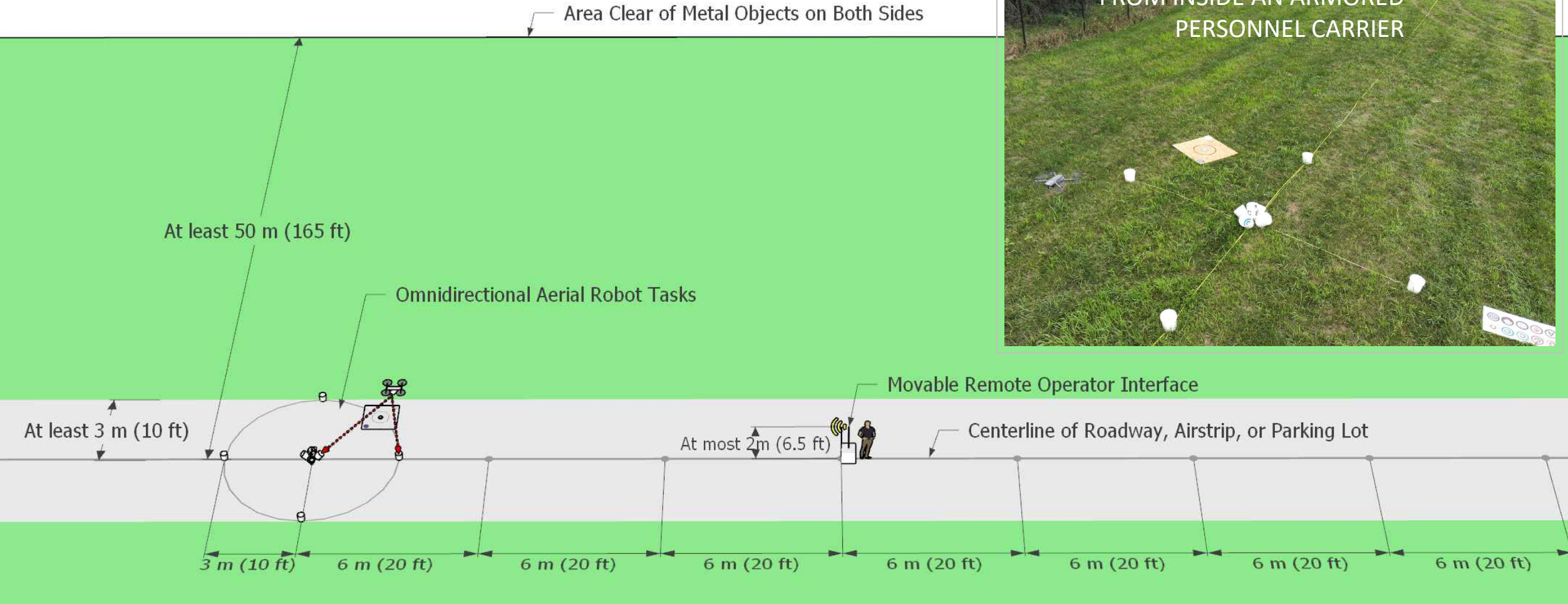
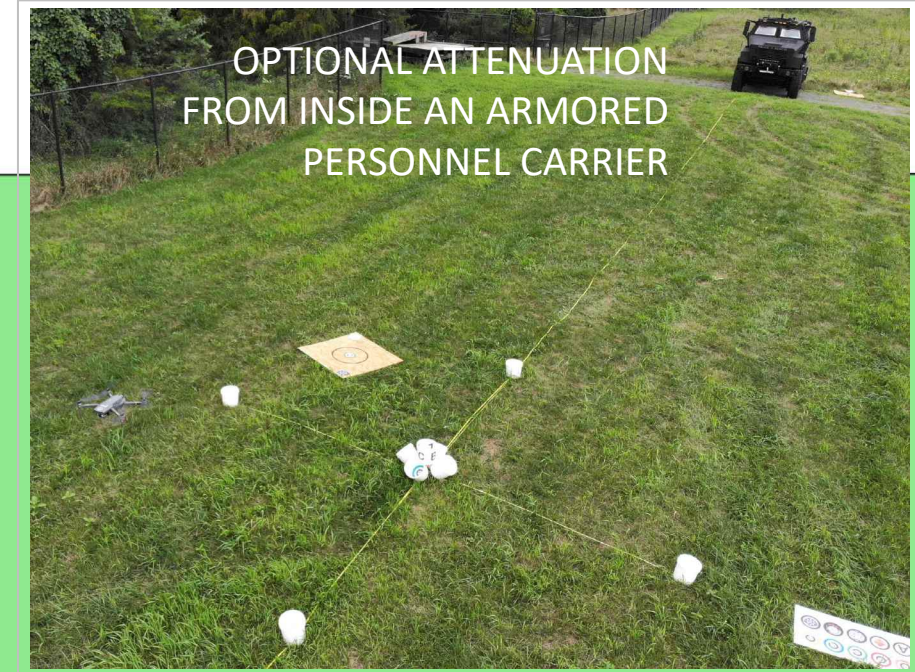
Aerial Radio Comms: Line-of-Sight Range

ASTM WK _____



Aerial Radio Comms: Line-of-Sight Range

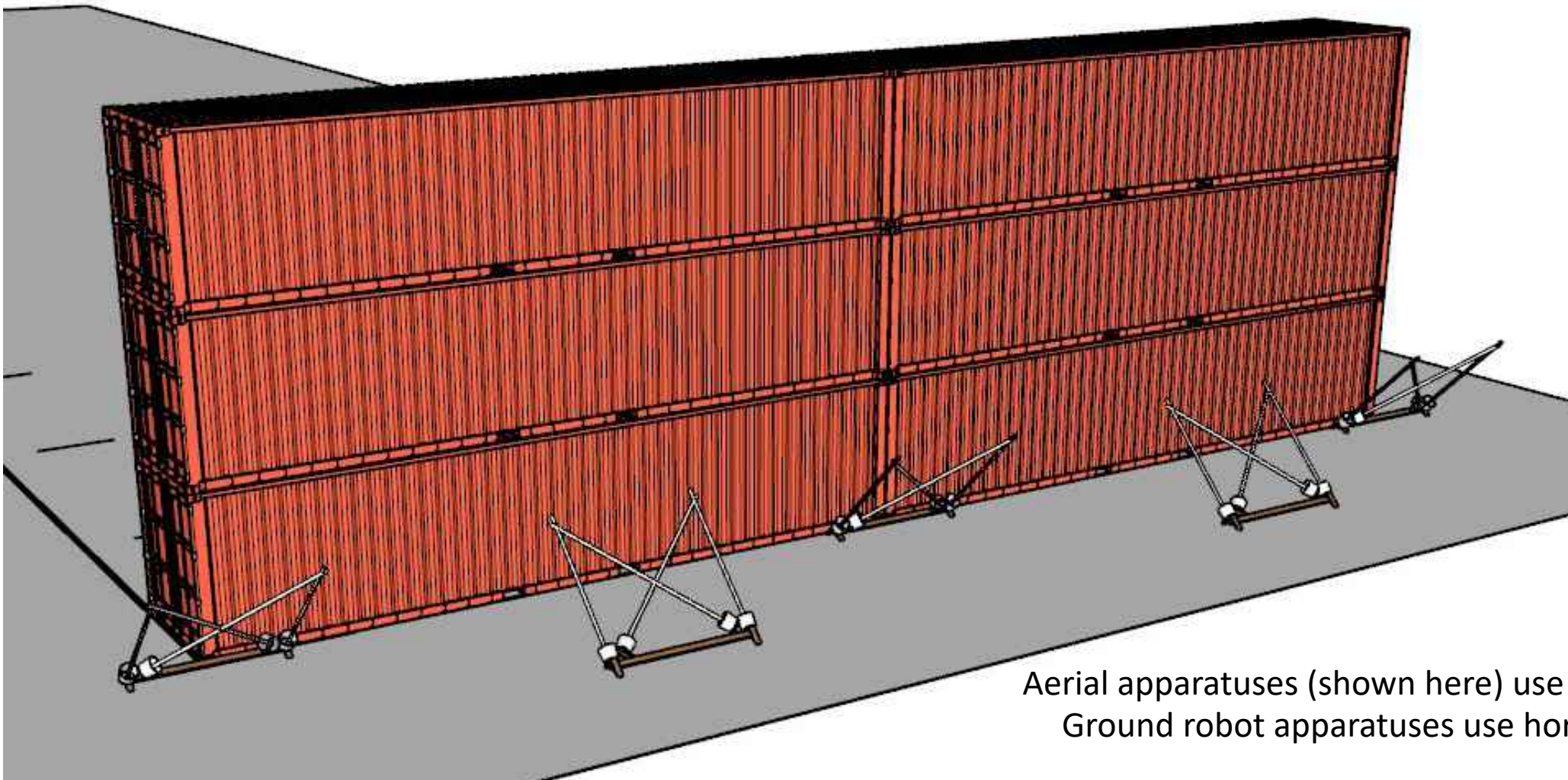
ASTM WK _____



Aerial Radio Comms: Non-Line-of-Sight Range

OPERATOR STATION UP RANGE
HALF THE LINE-OF-SIGHT MAX RANGE

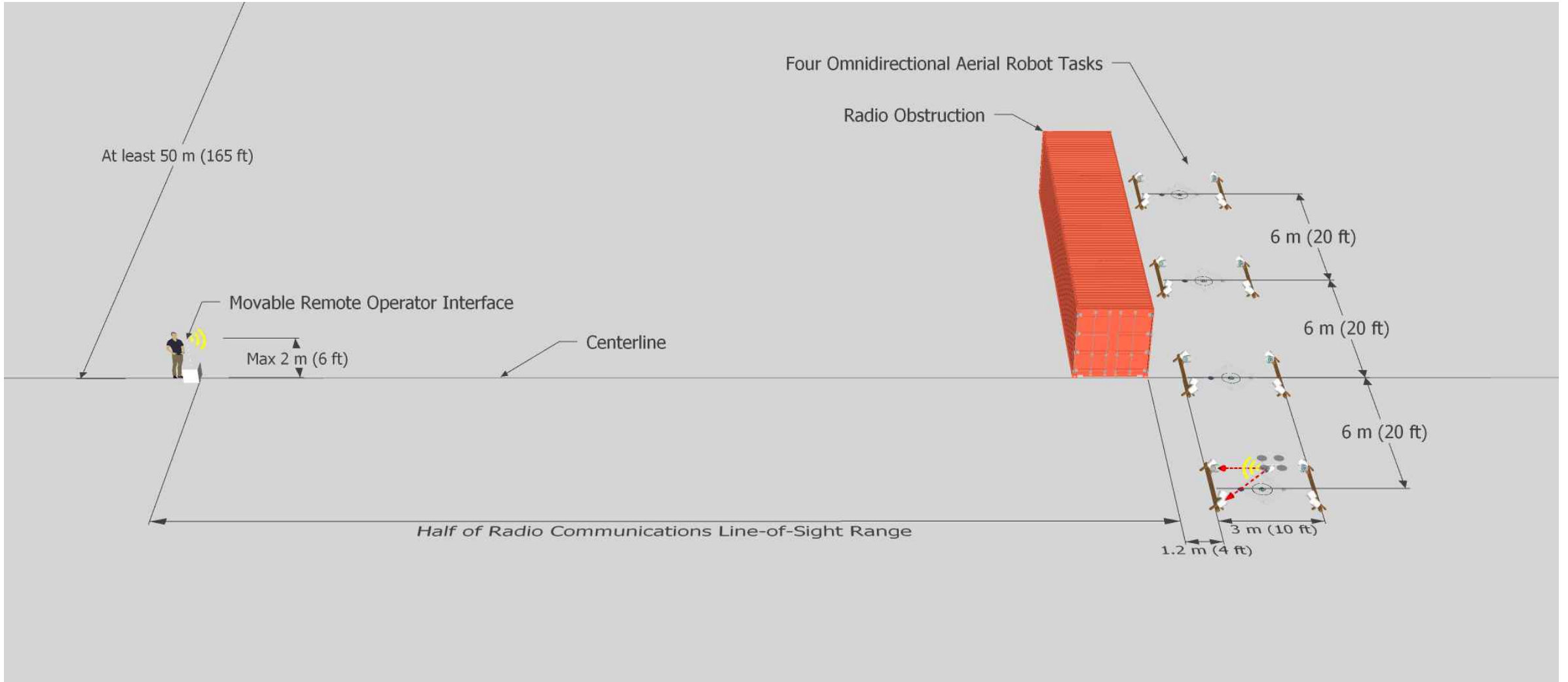
ASTM WK _____



Aerial apparatuses (shown here) use angled buckets.
Ground robot apparatuses use horizontal buckets.

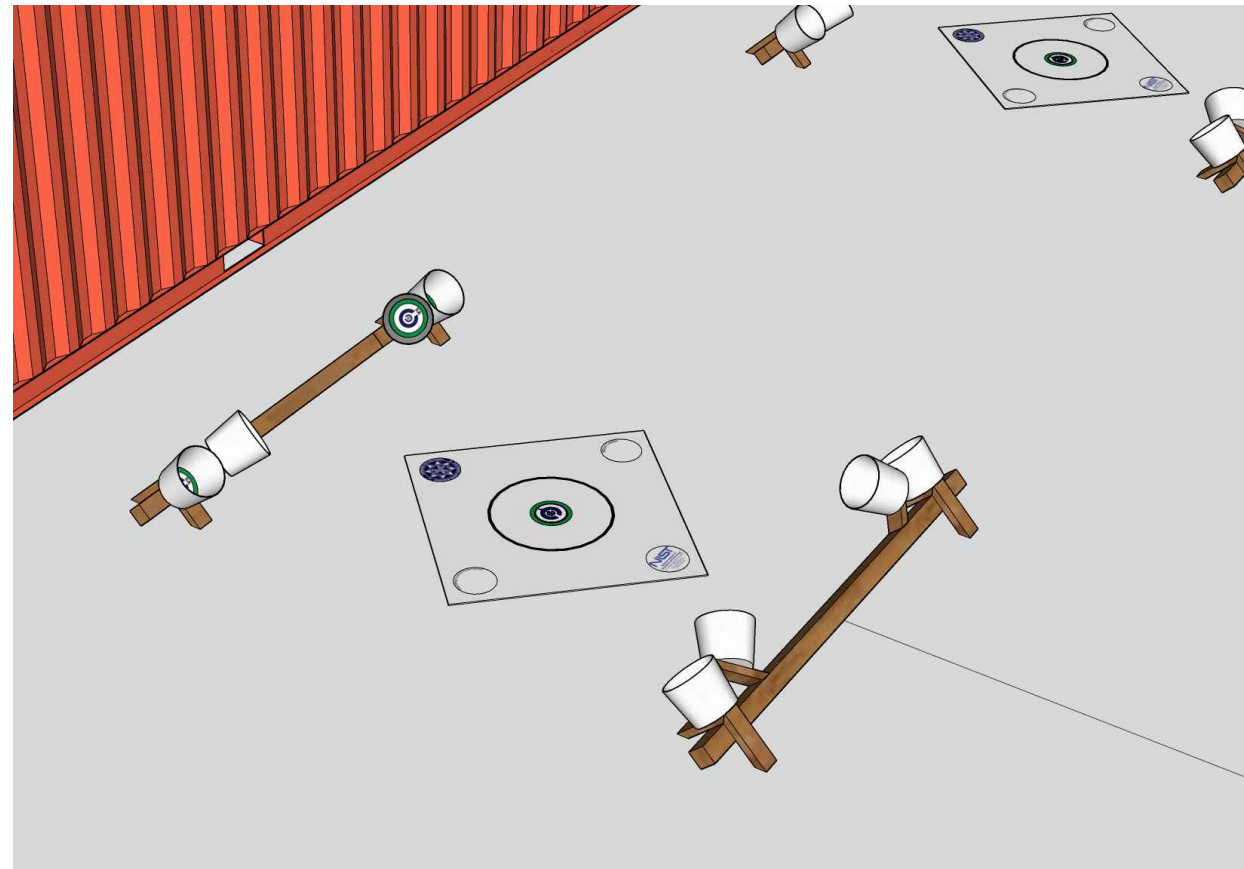
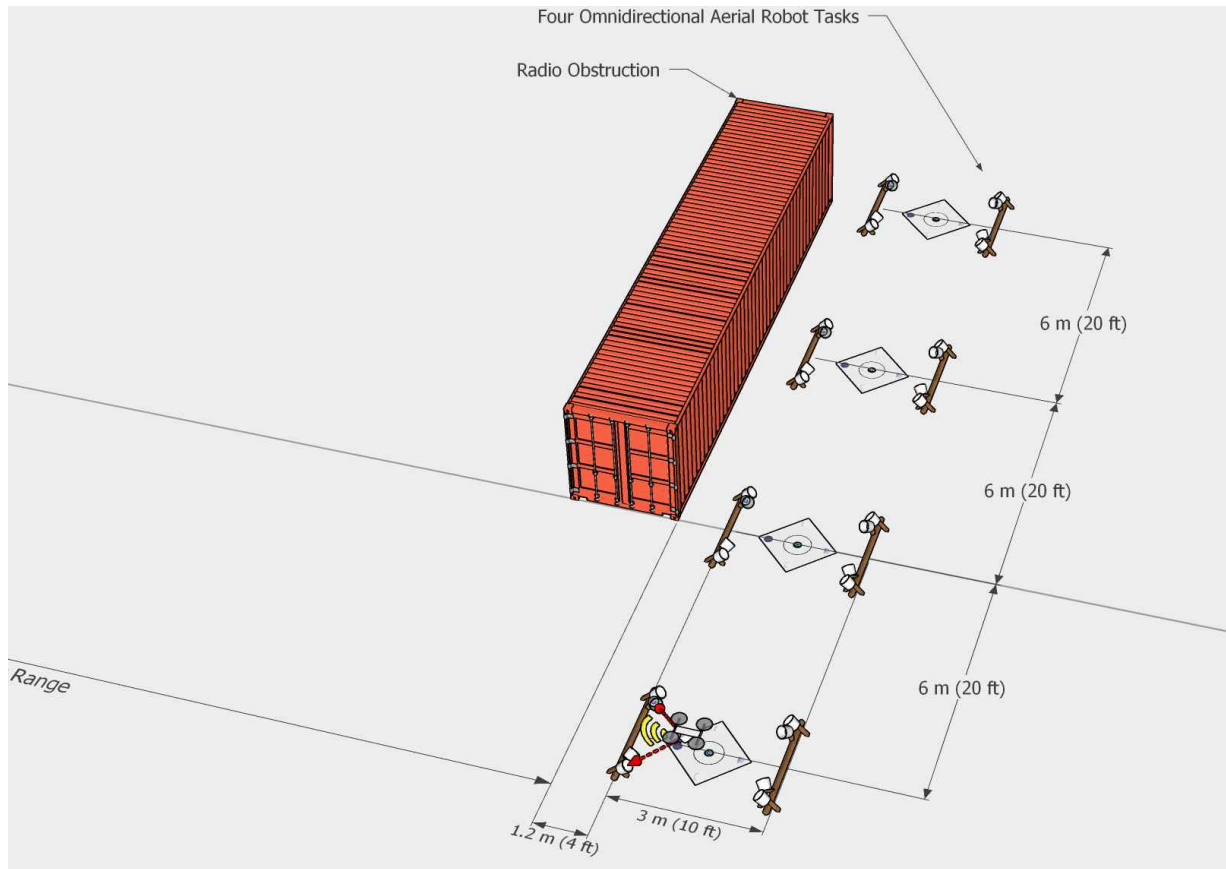
Aerial Radio Comms: Non-Line-of-Sight Range

ASTM WK _____



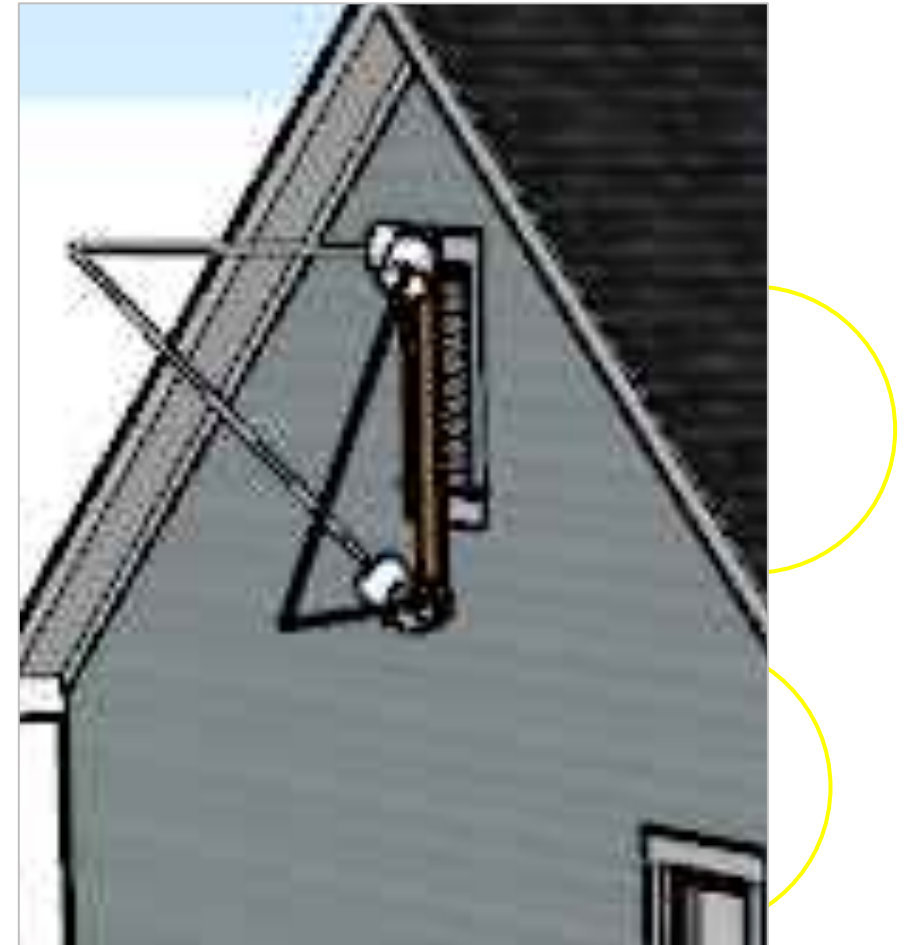
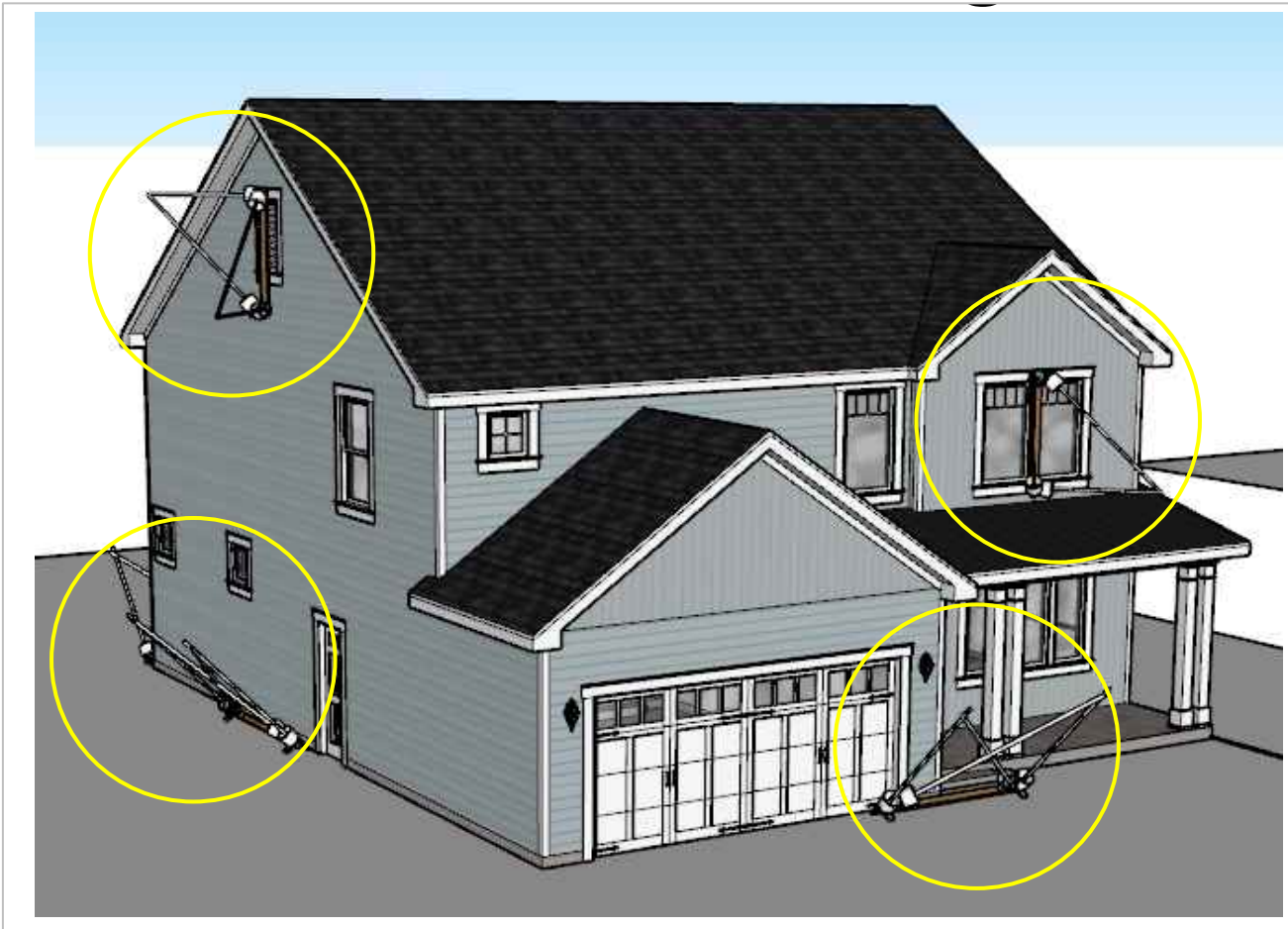
Aerial Radio Comms: Non-Line-of-Sight Range

ASTM WK _____



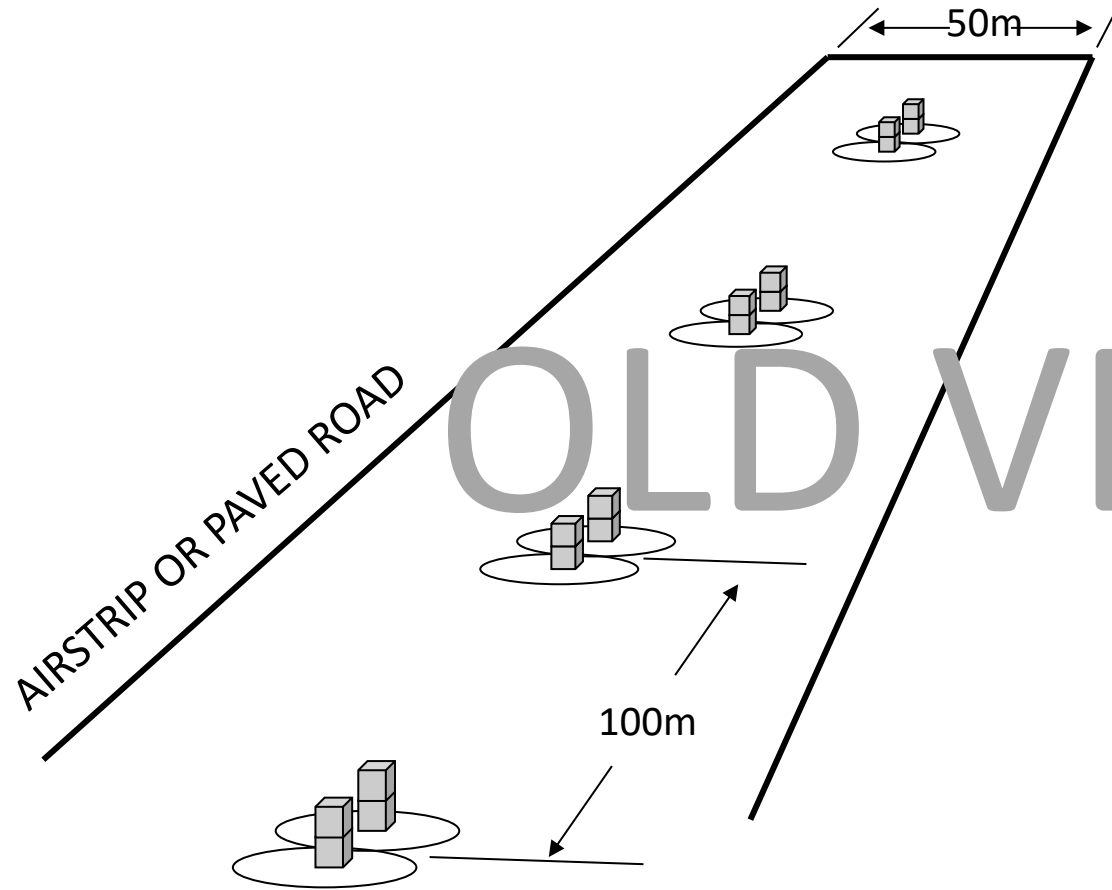
Aerial Radio Comms: Non-Line-of-Sight Range

ASTM WK _____



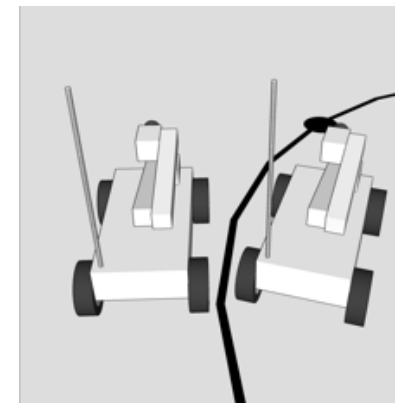
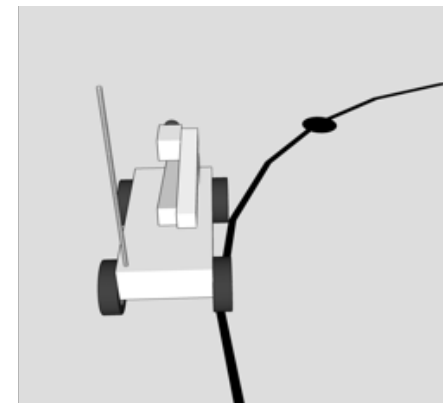
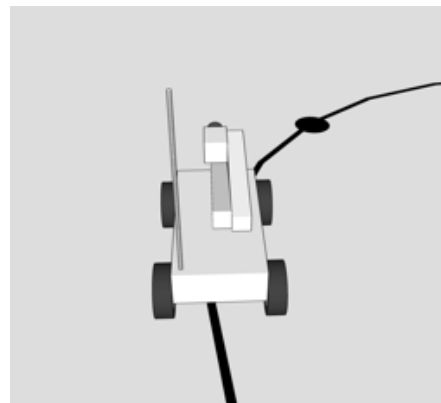
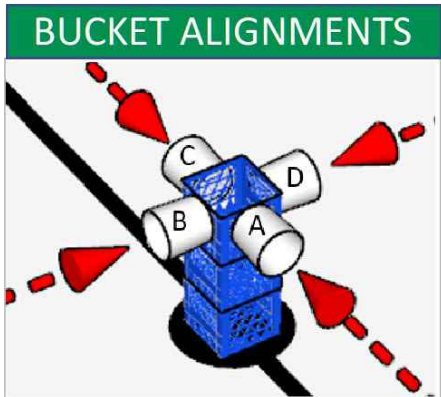
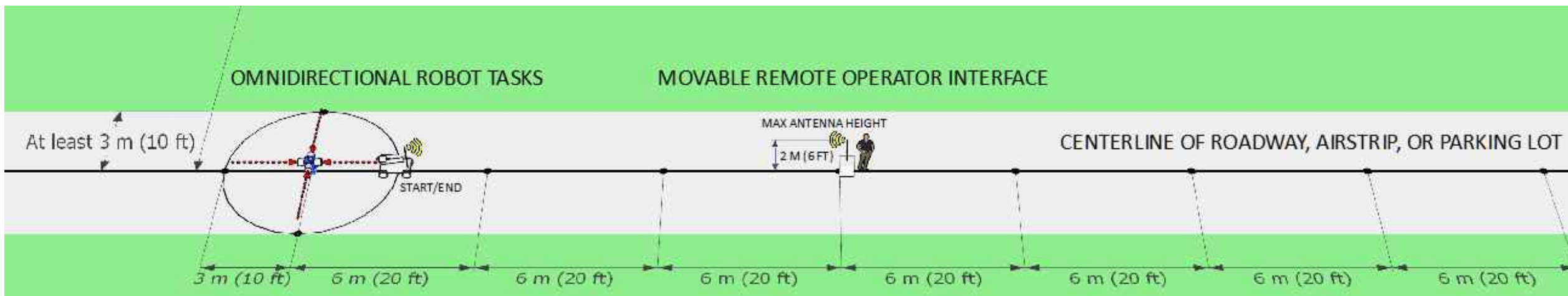
Radio Comms: Line-of-Sight Range

ASTM E2854-2013



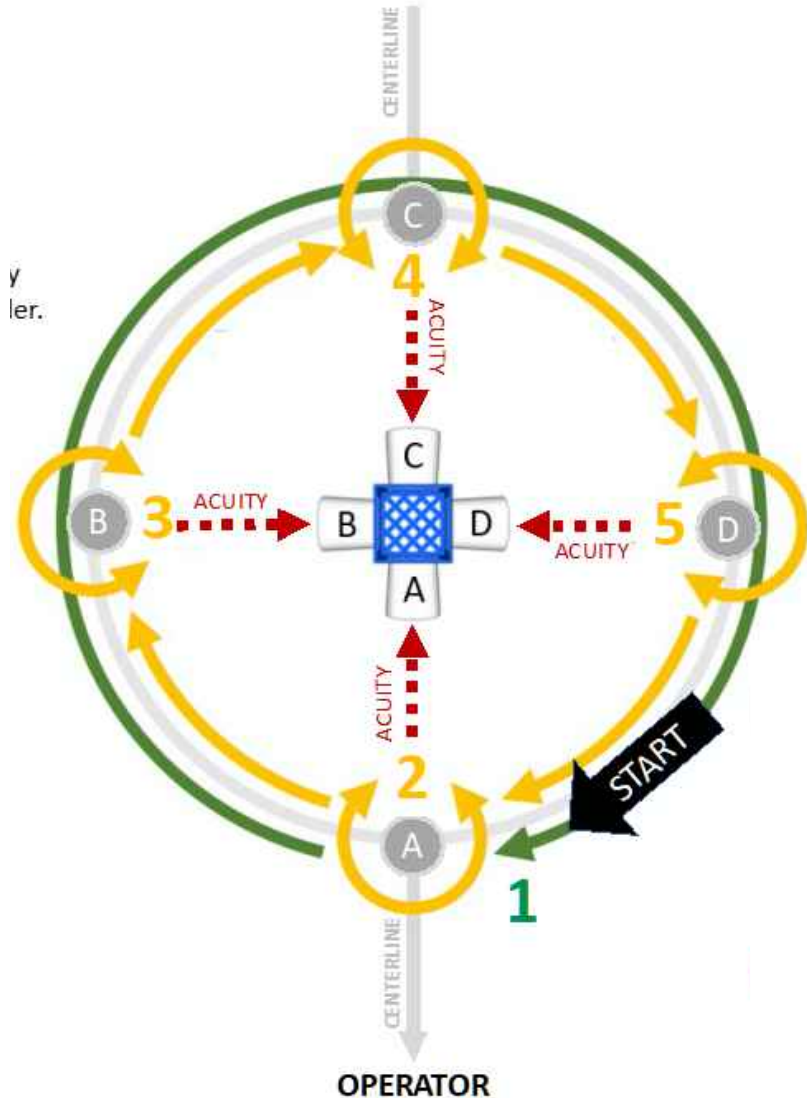
Radio Comms: Line-of-Sight Range

ASTM E2854-2020

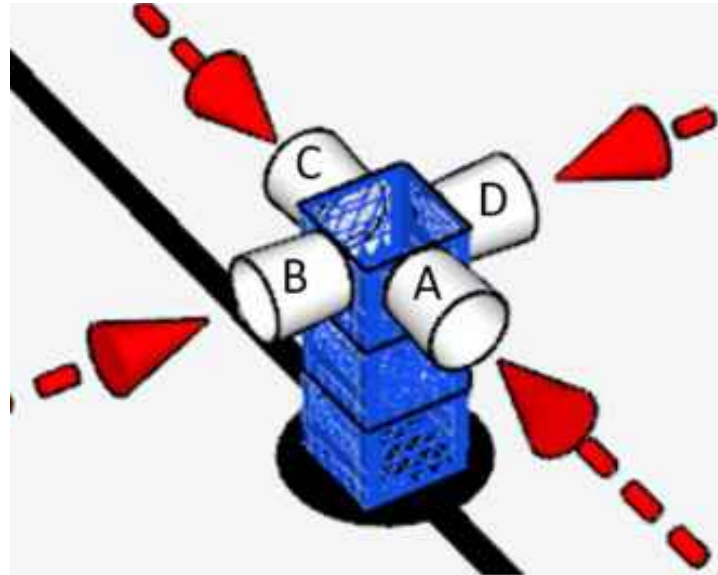


Radio Comms: Line-of-Sight Range

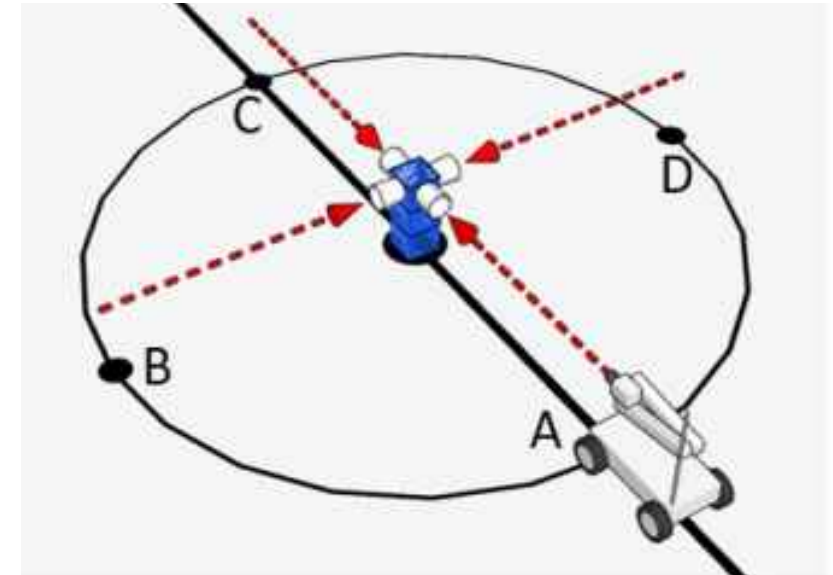
ASTM E2854-2020



PERPENDICULAR BUCKETS



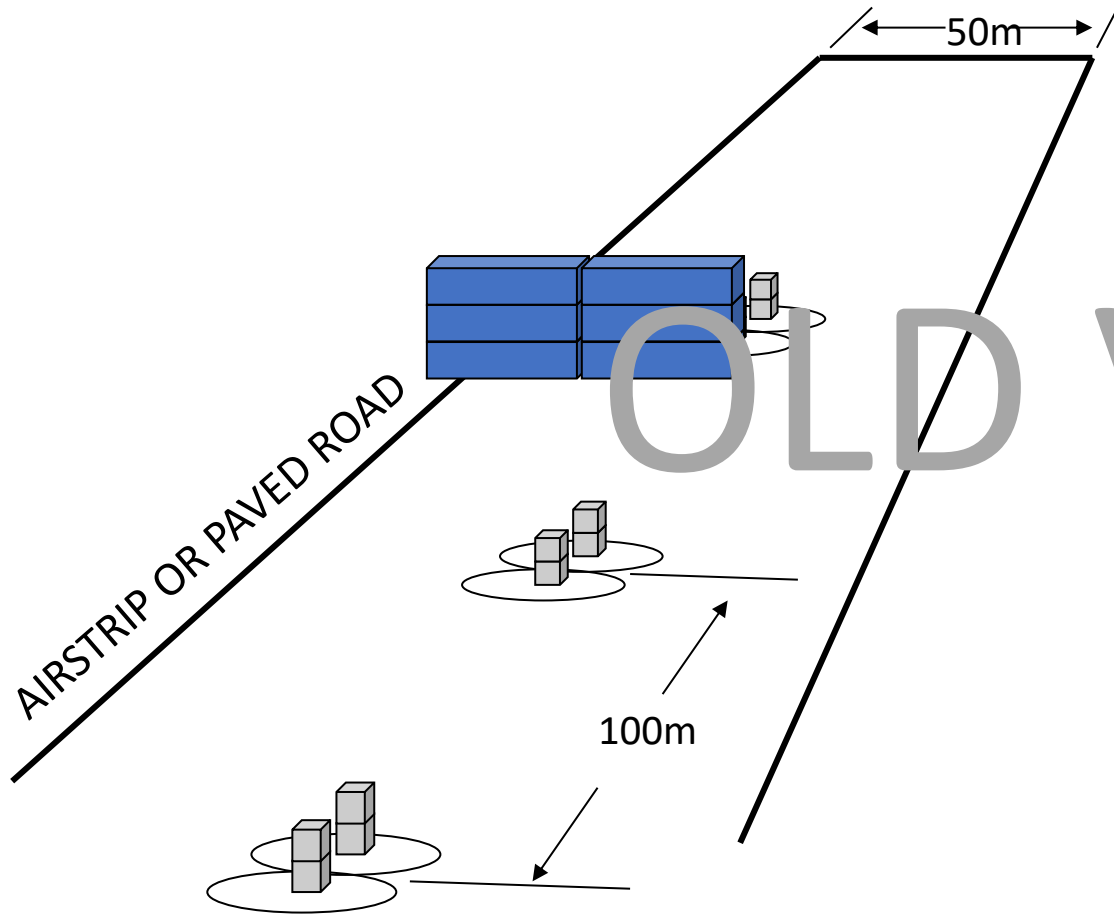
BUCKET IDENTIFICATION POSITION



Maneuvering Tasks (5 points) and Visual Acuity Tasks (20 Points)

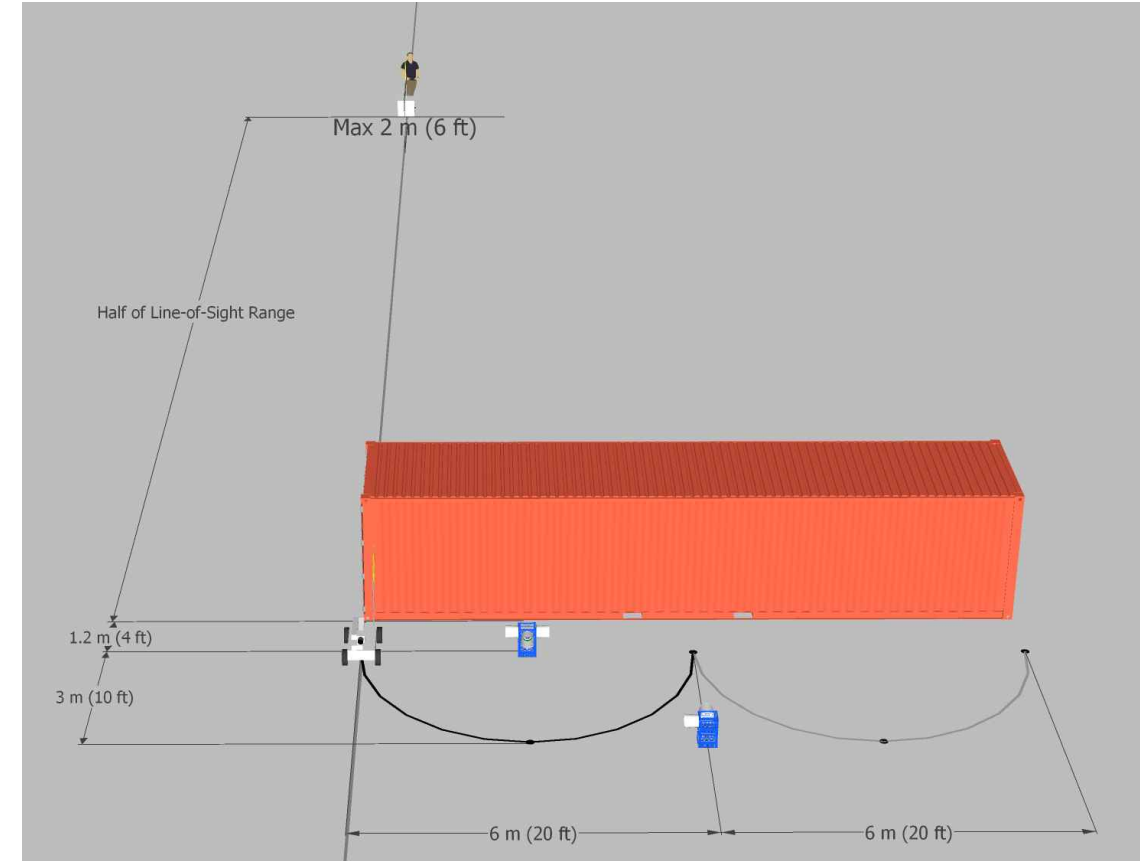
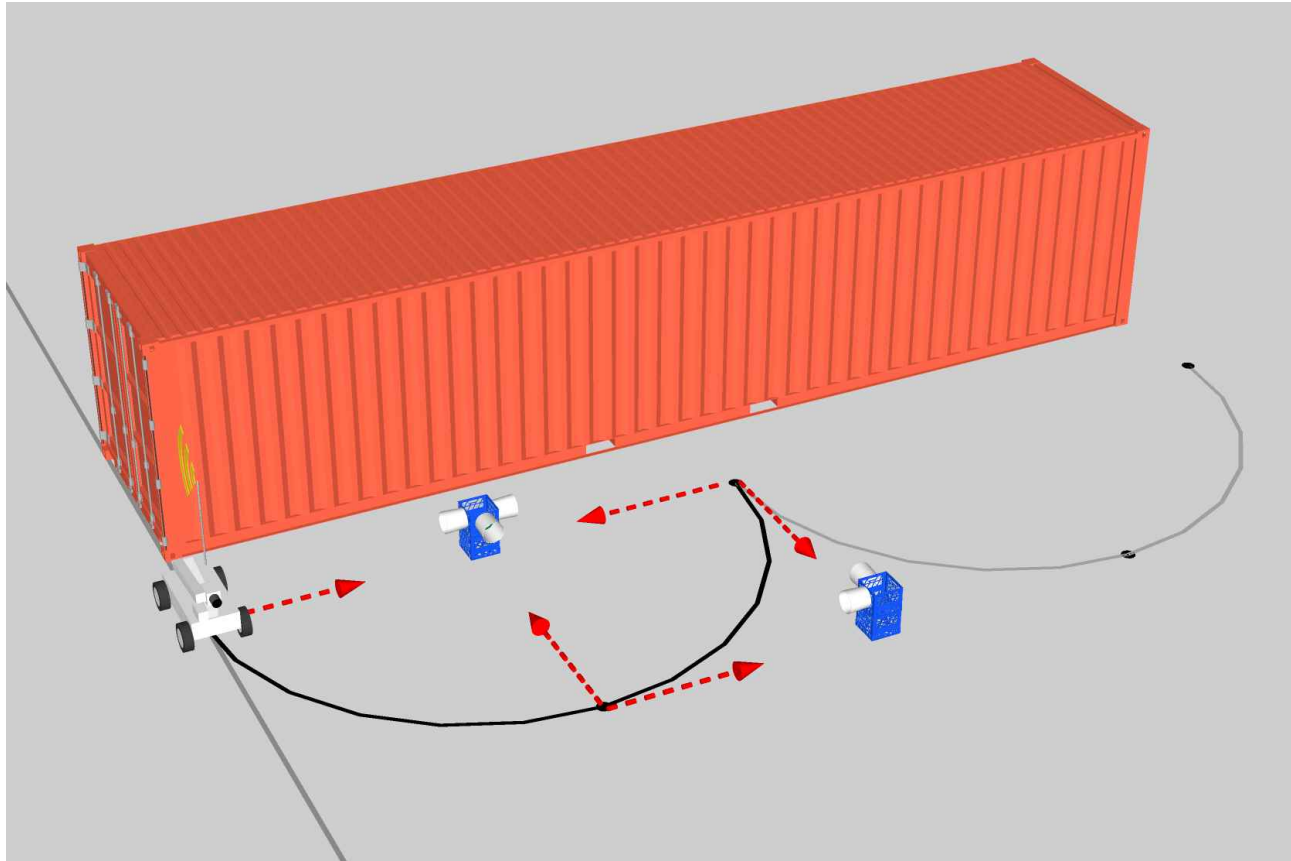
Radio Comms: Non-Line-of-Sight Range

ASTM E2855-2013



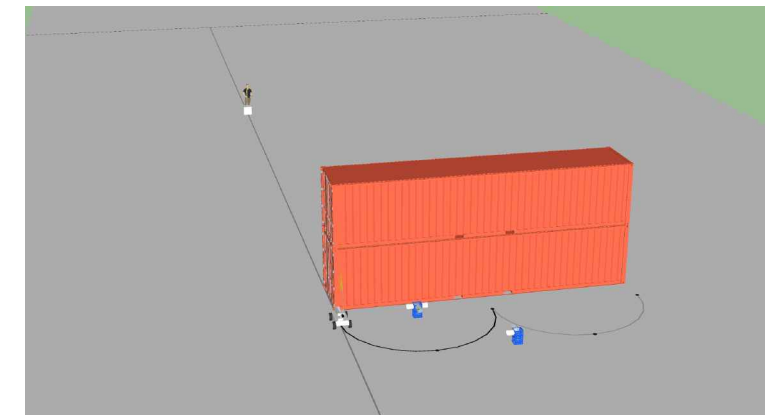
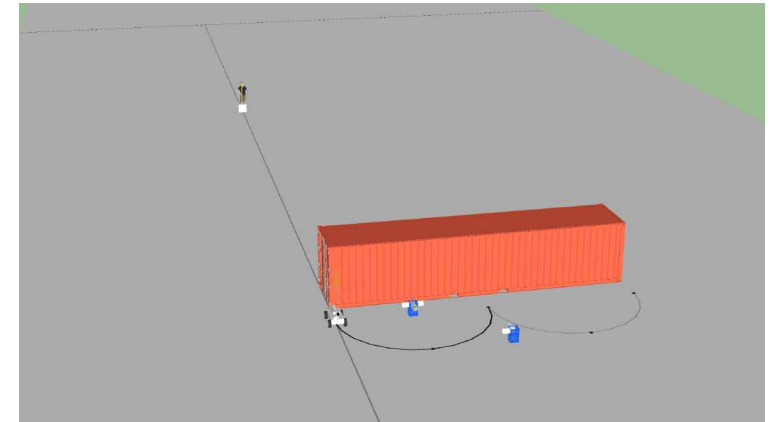
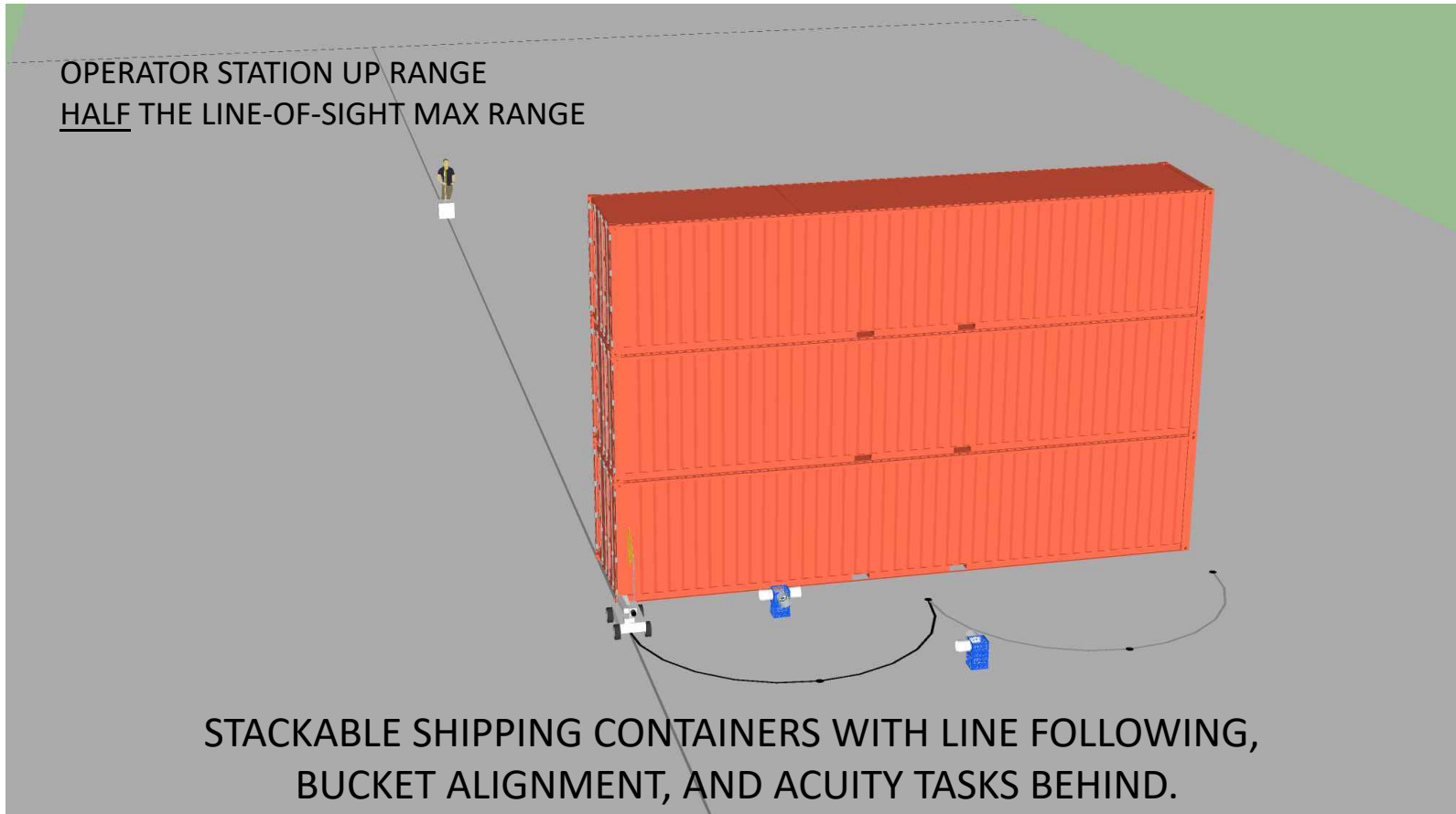
Radio Comms: Non-Line-of-Sight Range

ASTM E2855-2021



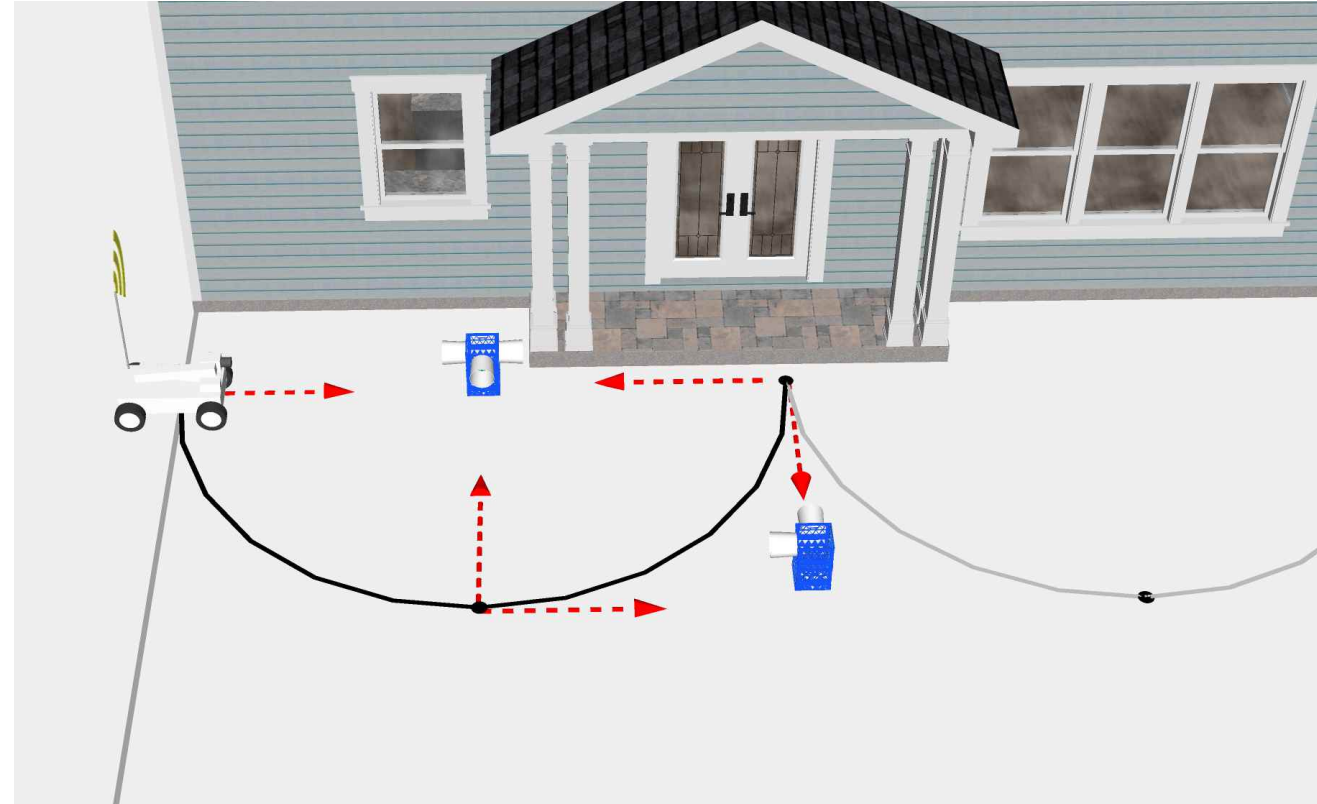
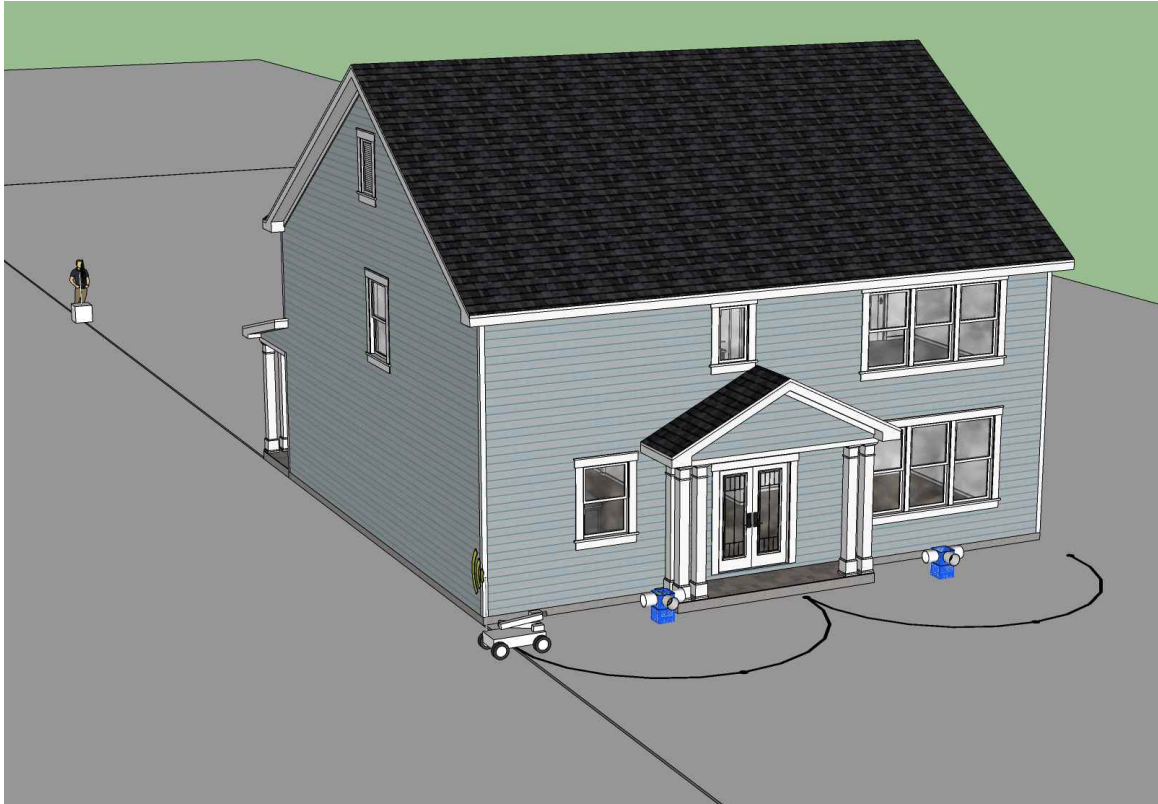
Radio Comms: Non-Line-of-Sight Range

ASTM E2855-2021



Radio Comms: Non-Line-of-Sight Range

ASTM E2855-2021





Sub Committee Chair:

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