Standard Test Methods to Evaluate
Small Unmanned Aircraft System Capabilities and Operator Proficiency for Emergency Response Applications

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# Project Overview

AERIAL

GROUND

AQUATIC

Objective

Develop the measurements and standards infrastructure necessary to quantitatively evaluate robot capabilities and operator proficiency.

Outcomes:

Test methods, performance metrics, and data collection tools to help manufacturers apply emerging technologies toward essential robot tasks and improve product reliability.

Impacts:

Emergency responders use quantitative data to compare, purchase, train, and deploy robotic systems to perform extremely hazardous missions from safer standoff distances.
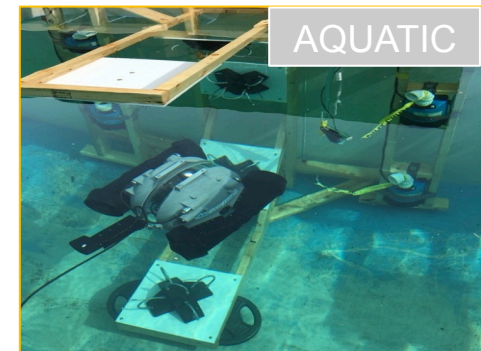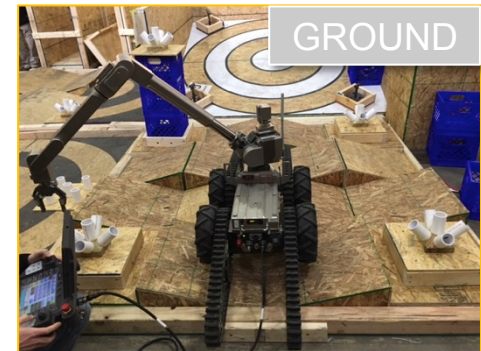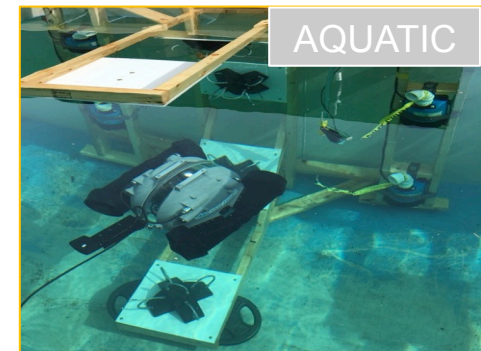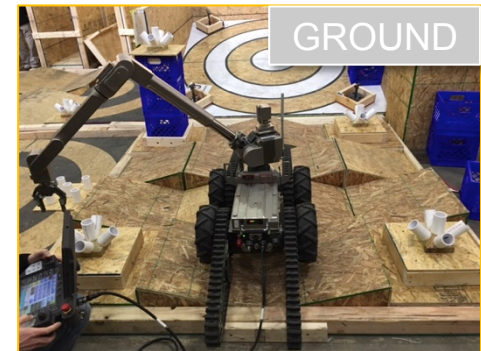
For more information:
Email: RobotTestMethods@nist.gov | https://RobotTestMethods.nist.gov

Project Approach

- **Develop** suites of test methods, performance metrics, and data collection tools for Maneuvering, Mobility, Dexterity Sensing, Energy, Comms, Durability, Safety, Autonomy, and Operator Proficiency.

- *Measure* combinations of capabilities and emerging technologies.

- *Inspire* innovation using tests to communicate operational needs.

- *Guide* purchasing and deployment decisions with objective robot capabilities data.

- *Focus* training with repeatable tasks and measure operator proficiency.

- *Identify* gaps in equipment and/or training through local, regional, or national averages.

REPEAT

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Test Methods for sUAS
Safety | Capabilities | Proficiency

Up to 25kg (55 lbs) with Vertical Launch and Landing
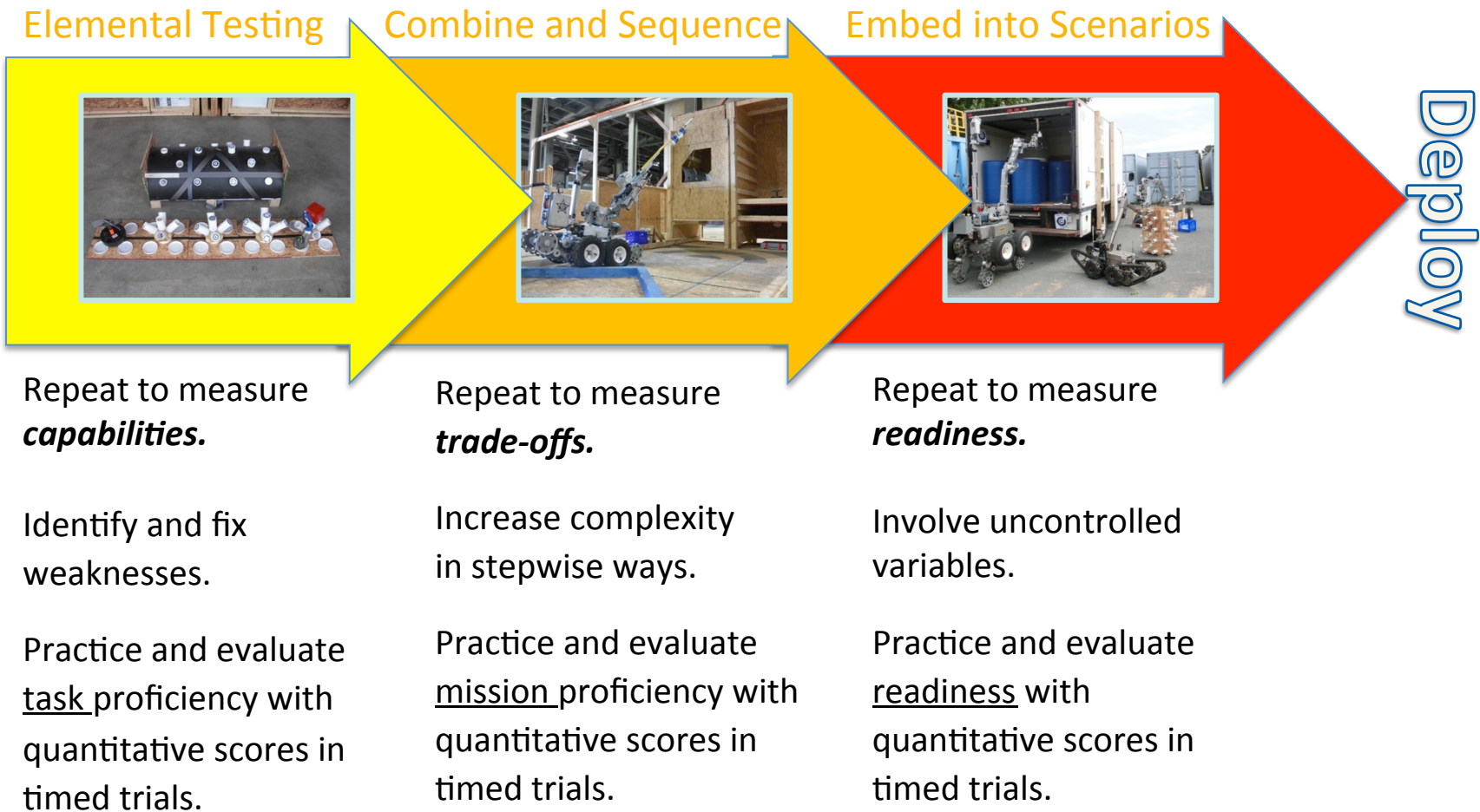*(Potentially based on <u>Impact Forces</u> rather than weight.)*

Implementing Standard Test Methods
Safety | Capabilities | Proficiency

Elemental Testing → **Combine and Sequence** → **Embed into Scenarios** → **Deploy**

Repeat to measure
capabilities.

Identify and fix
weaknesses.

Practice and evaluate
task proficiency with
quantitative scores in
timed trials.

Repeat to measure
trade-offs.

Increase complexity
in stepwise ways.

Practice and evaluate
mission proficiency with
quantitative scores in
timed trials.

Repeat to measure
readiness.

Involve uncontrolled
variables.

Practice and evaluate
readiness with
quantitative scores in
timed trials.

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List of Test Methods Under Development
Safety | Capabilities | Proficiency

Airframe
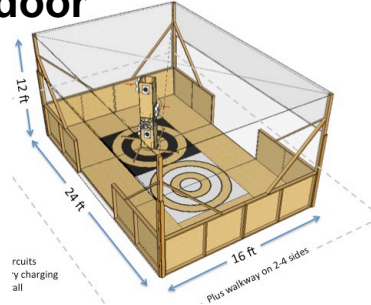
Impact Forces

Lights and Sirens

Prop Guards

Comms

Lost Comms Behaviors

Line of Sight Range

Beyond Line of Sight

Structure Penetration

Interference

Energy

Lost Power Behaviors

Endurance Range

Endurance Dwell

Indoor

Outdoor

Embedded

Sensors

Visual Acuity

Color Acuity

Thermal Acuity

System Latency

Dynamic Range

Camera Pointing

Maneuvering

Pose Agilities

Inspect Targets

Center in Obstacles

Land/Perch

Deliver Payload

Awareness

Point/Zoom Cameras

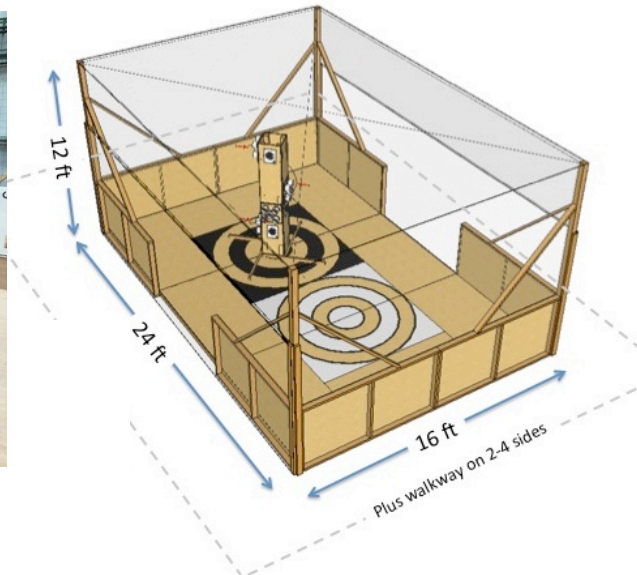**Map Area (Stitched Images)**

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Enclosed Practice/Test Environments
Safety | Capabilities | Proficiency

- Limit safety issues to quickly implement a standards-based approach.

- All testing is in netted enclosures (outside tents when GPS is involved).

- Users train indoors (tennis or basketball court) to avoid practice in the National Airspace.
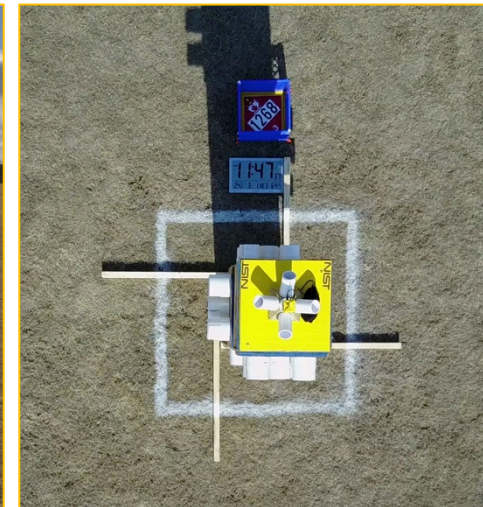
Outdoor Test Methods
Safety | Capabilities | Proficiency

- Hold Position and Orientation

- Point and Zoom Cameras (optical, thermal)

- Inspect Targets (downward, spiral, omnidirectional)

- Endurance (with and without max payload)

- Map Area with Stitched Images

Embedding into Training Scenarios
Safety | Capabilities | Proficiency

- Hold Position and Orientation

- Point and Zoom Cameras (optical, thermal)

- Inspect Targets (downward, spiral, omnidirectional)

- Endurance (with and without max payload)
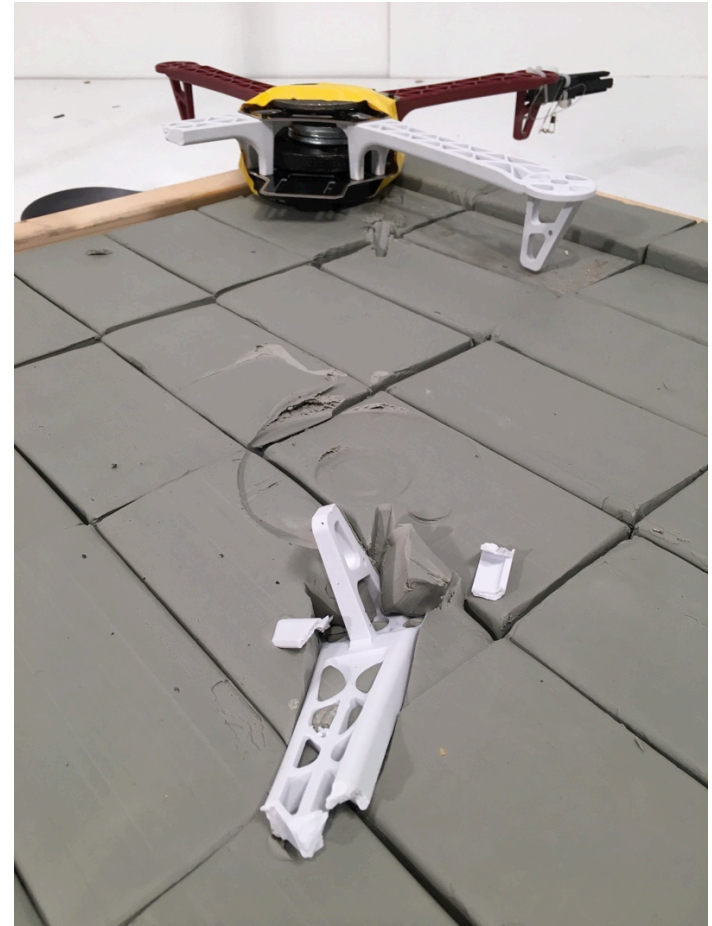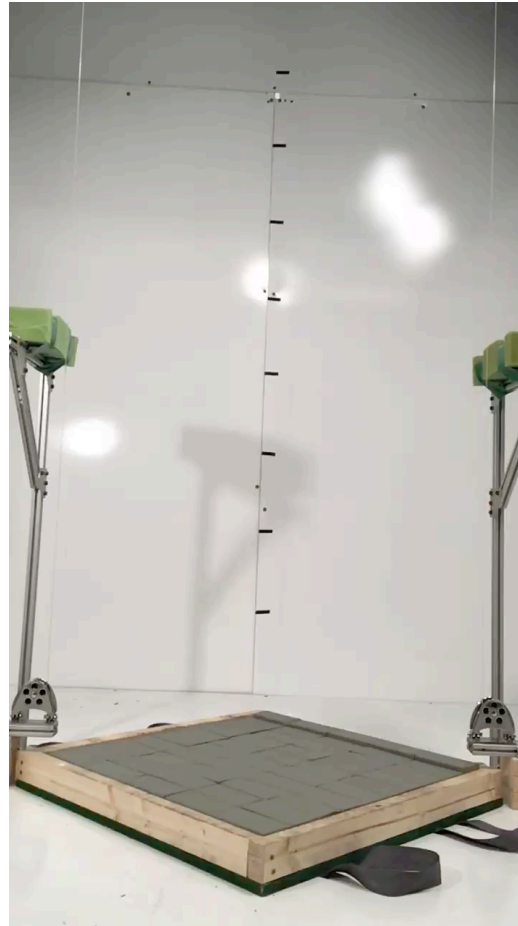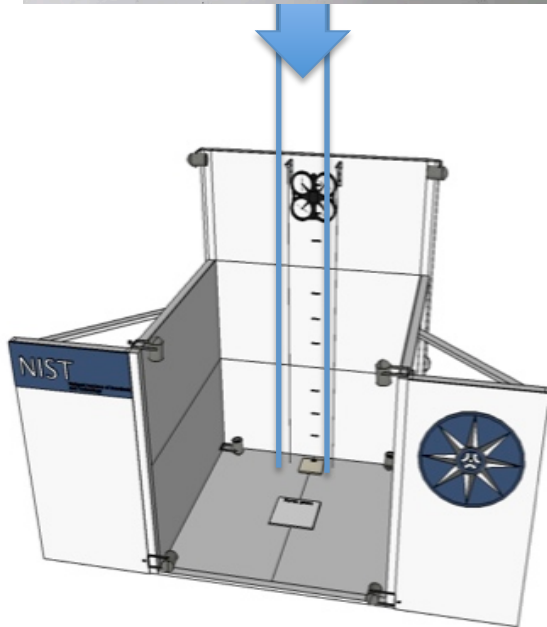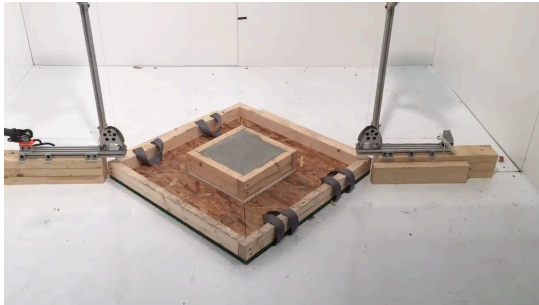
- Map Area with Stitched Images

Impact Forces Test Method
Safety | Capabilities | Proficiency

A Model for Standards Collaboration
Safety | Capabilities | Proficiency

Standard Test Methods to Evaluate Robots and Operators

Equipment Standards for Robots in Specific Missions

Use the Standards to Purchase, Train, and Assess Readiness

Deploy

- Measure robot capabilities and reliability in statistically significant trials.

- Compile and disseminate data.

- Fill gaps in tests.

- Define mission specific suites of ASTM standard test methods.

- Set thresholds to guide purchases and acceptance testing.

- Set thresholds to guide operator proficiency.

- Self evaluate to meet specified thresholds in time limited trials.

- Measure strengths and practice weaknesses.

- Learn how emerging technologies may help.

- Identify gaps in tests.
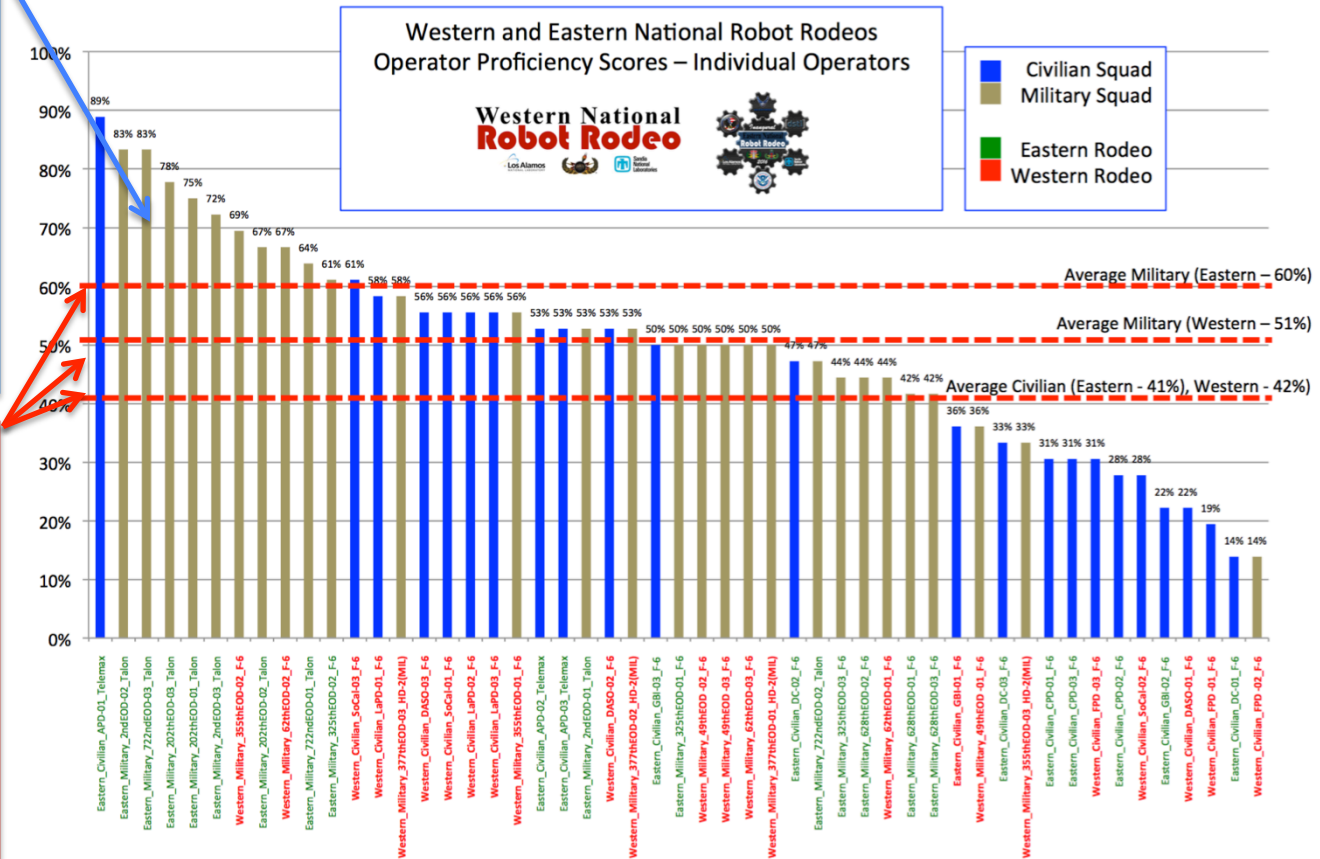
Capture Quantitative Data, Then Select Thresholds
Safety | Capabilities | Proficiency

Develop standard test methods and collect robot capability and reliability data with "expert" operators

Select standard test methods and set thresholds to define readiness for mission essential tasks (or adopt user averages)

Western and Eastern National Robot Rodeos
Operator Proficiency Scores – Individual Operators

Western National Robot Rodeo

Legend:
- Civilian Squad (blue)
- Military Squad (tan)
- Eastern Rodeo (green)
- Western Rodeo (red)

Average Military (Eastern – 60%)
Average Military (Western – 51%)
Average Civilian (Eastern - 41%), Western - 42%)

Concurrent Validation Sites
Safety | Capabilities | Proficiency

- NIST, Gaithersburg, MD (National Capital Region)

- Southwest Research Institute, San Antonio, TX

- Austin Fire Dept. Austin TX

- Disaster City, College Station, TX

- UK Atomic Energy Authority, Oxfordshire, UK

- Japan Atomic Energy Agency, Fukushima/Naraha, Japan

- York County, VA Department of Fire and Life Safety

As a Result of the
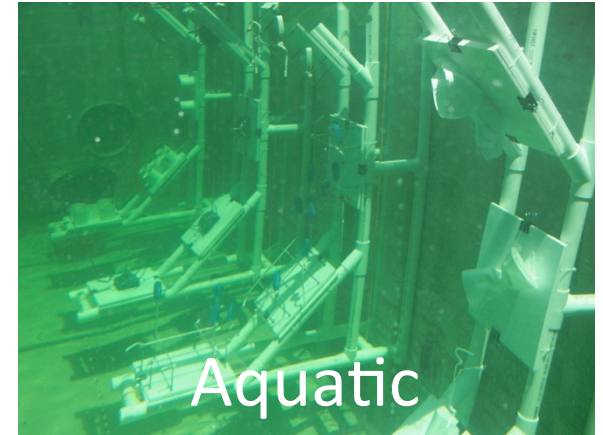TEXAS UAS SUMMIT
Austin, TX
March 29-31, 2016

Upcoming Test Method Validation Events:

- Event: UAS Summit, Charlottesville, VA March 1, 2017

- Event: AUVSI Conference, Dallas, TX May 8-11, 2017

- Event: ASTM E54.09 Meeting, Toronto, Canada June 12-16, 2017
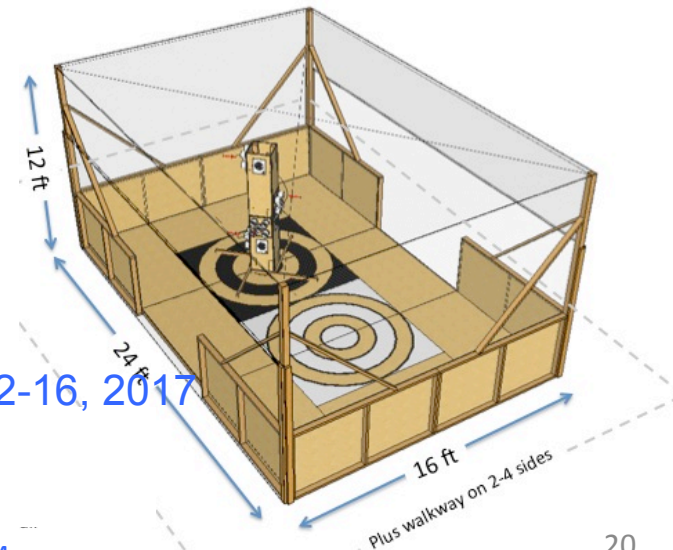
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