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Standard Practice for Recording the A-UGV Test Configuration¹

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1. Scope

1.1 This practice describes a means to record the Automatic, Automated, or Autonomous – Uncrewed Ground Vehicle (A-UGV) configuration when testing. The practice provides a method for recording A-UGV hardware and software control parameters and describes high-level capabilities, such as used for A-UGV safety and navigation.

1.2 This practice: contextualizes the A-UGV configuration during a test, including the identification and adjustment of main configuration parameters; provides the proper context for test results; provides a basis for comparison of the test circumstances across different vehicles or tests, or both; and allows a test to be recreated.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are not precise mathematical conversions to imperial units. They are close approximate equivalents for the purpose of specifying A-UGV characteristics while maintaining repeatability and reproducibility of the test method results. These values given in parentheses are provided for information only and are not considered standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

¹ This practice is under the jurisdiction of ASTM Committee F45 on Robotics, Automation, and Autonomous Systems and is the direct responsibility of Subcommittee F45.91 on Terminology.

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2. Referenced Documents

2.1 ASTM Standards:²

F3200 Terminology for Robotics, Automation, and Autonomous Systems

3. Terminology

3.1 Terms used within this practice refer to Terminology F3200.

4. Summary of Practice

4.1 This practice describes a method for recording the A-UGV test configuration when performing tests described in A-UGV test methods. A-UGVs have a series of hardware and software parameters that vary the vehicle functionality, for example:

4.1.1 Different A-UGVs may perform differently dependent upon their hardware setup and software capabilities and settings; or

4.1.2 The same A-UGV may perform differently dependent upon its hardware setup and software settings.

4.2 Main configuration parameters are, for example:

4.2.1 *Hardware*—A-UGV weight, size, wheelbase, drive/steer method, load carry or pull method, sensors, and onboard equipment (for example, roller tables or robot arms); and

4.2.2 *Software*—Control and monitor software, firmware versions, and software settings for maximum accelerations and velocities, preferred paths, and restricted areas, among many other possible hardware and software configuration parameters.

4.3 *High Level Capabilities*—For example, obstacle avoidance, path planning, localization method, and safety.

4.4 This practice also contextualizes test results of a test method by identifying main configuration parameters as requested prior to the test method. A-UGV configuration is reported using a standard method, defined in this practice,

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

which includes the documentation of the context for test results. For example, the result of a timed test could be dependent upon varying speed constraints: an A-UGV having a speed constraint of 1.5 m/s as compared to a speed constraint of 2.0 m/s. As such, comparing two A-UGV configurations could allude to which parameters affect vehicle performance.

5. Significance and Use

5.1 The significance of the information to be recorded in a test report allows for A-UGV performance to be contextualized with A-UGV configuration.

5.2 Limitations of the practice are that not all A-UGVs have the same capabilities or configuration parameters. For example, for capabilities, a vehicle that remaps during navigation versus another vehicle that uses a static map may behave differently in repeated runs of an obstacle avoidance test. For configuration, a vehicle that remaps during navigation may have varying times that obstacles remain in the map for test recreation.

5.3 The environment map used by the A-UGV, developed through localization including any landmarks, shall be saved as used on the A-UGV and should be saved and provided as a human-readable layout on or off the A-UGV (see [Appendix X1](#) showing a sample layout drawing).

5.4 The main A-UGV hardware parameters shall be recorded as follows:

- 5.4.1 Make and model;
- 5.4.2 Part number;
- 5.4.3 Serial number;
- 5.4.4 Hardware revision number (if any);
- 5.4.5 Number of drive/steer wheels;
- 5.4.6 Steering type;
- 5.4.7 A-UGV Type—For example, fork, tugger, unit load, cart; and
- 5.4.8 Loaded/unloaded.

5.5 The main A-UGV software parameters shall be recorded as follows:

- 5.5.1 All applicable software and firmware versions;
- 5.5.2 *Velocity*—Translation and rotation, minimum/maximum;
- 5.5.3 *Acceleration*—Translation and rotation, minimum/maximum; and
- 5.5.4 *Stand-off Distances*—Safety sensor thresholds, obstacle avoidance thresholds.

5.6 The context for the test shall be recorded by providing detailed answers to the following questions:

5.6.1 When are the various software configurations used during the test? For example, two software versions may be required as follows: Use configuration A for straight aisles and configuration B for turns.

5.6.2 What other hardware and software parameters/settings are required to recreate the A-UGV behavior (that is, attached debug, settings, or other files)?

5.6.3 What is the A-UGV layout that is saved and used on the vehicle and, if possible, saved and provided as a human-readable version?

5.6.4 Are there constraints that the requestor has placed on the A-UGV? Examples may include the following:

5.6.4.1 *Generic Test Environment*—For example, outdoors or indoors, day or night, defined or undefined test areas?

5.6.4.2 Velocity and acceleration that are below the maximum capability?

5.6.4.3 Clearances between the A-UGV and an obstacle during obstacle avoidance maneuvering?

5.6.4.4 Negative obstacle measurement capability enabled?

5.6.4.5 Choose its own path or is required to use a preferred path?

5.7 Higher-level categories of A-UGV capabilities shall be recorded as follows:

5.7.1 *Localization Method*—For example, natural features, reflective markers, tape on ground, matrix barcodes/visual fiducial system, lights in ceiling.

5.7.2 *Safety-rated Equipment*—For example, scanning lasers and their make and model numbers; other functions of safety sensors.

5.7.3 *Other Sensors Used*—For example, cameras, including their make and model numbers, and image processing software used for path planning.

5.7.4 *Added Equipment for A-UGV Testing*—For example, cameras, including their make and model numbers, and image processing software used for capturing docking performance.

6. Procedure

6.1 When conducting the Committee F45 test methods, the test requestor can choose the A-UGV configuration to be recorded as described in Section 4. The test requestor can elect and apply any of the configuration methods and parameters to the A-UGV-under-test included herein and record the levels as described in Section 7.

6.2 A-UGV configuration may be changed prior to a test. At any time after the start of a test, as instructed by the test supervisor, the A-UGV configuration shall not be manually changed by any person. In the event that the A-UGV configuration automatically changes during a test, the test requestor shall inform the test supervisor of such occurrence(s) prior to the test and the occurrence(s) shall be noted on the test report.

7. Report

7.1 A test report is required for recording the A-UGV configuration. The test report shall include the following features:

7.1.1 A photograph or detailed drawing showing the hardware configuration of the A-UGV to be tested;

7.1.2 A hardcopy or electronic file of the software configuration of the A-UGV to be tested; and

7.1.3 Any additional A-UGV features or important notes, or both, that may cause A-UGV performance variation.

7.1.4 The test report (see example in [Fig. X1.1](#)) shall be filled out. In the situation where a particular configuration parameter is not known, it shall be noted as such using “Unknown.”

NOTE 1—The implementation of a test report is not standardized. As such, the resulting test reports can be different while conforming to this specification. [Fig. 1](#) provides an illustration of a blank test report for this practice.