



Designation: F3470 – 20

Standard Guide for A-UGV Capabilities¹

This standard is issued under the fixed designation F3470; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide categorizes the autonomous capabilities of an automatic through autonomous-unmanned ground vehicle (A-UGV) based on the following list of capability categories:

- (a) *Goal Navigation: Pre-Programmed*;
- (b) *Goal Navigation: In situ*;
- (c) *Localization*;
- (d) *Docking—Infrastructure Dependence*;
- (e) *Obstacle Avoidance*—Types of objects that can be avoided and are within the A-UGV envelope, and types of objects that can be avoided and are outside of the A-UGV envelope;
- (f) *Changing Contour Area or Envelope*;
- (g) *Changing Payload*;
- (h) *Impaired Communication Behavior*;
- (i) *Lost Communication Behavior*;
- (j) *Environmental Conditions*;
- (k) *Fleet Makeup*—Fleet Task Assignment, Information Sharing/Updating, Fleet Navigation Coordination, and Fleet Task Coordination.

1.2 This guide provides a basis for A-UGV manufacturers and users to compare the intended task to the A-UGV capability. This guide does not purport to cover all relevant capabilities or categories that an A-UGV can perform. Instead, this guide provides a method for defining A-UGV capabilities and limits of A-UGV capabilities within specified categories listed in 1.1.

1.3 One or more capabilities may be used to define the A-UGV capability and not all categories are required to be used for defining the capability of an A-UGV.

1.4 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 material dimensions or quantities that are readily available to avoid excessive fabrication costs of test apparatuses while maintaining repeatability and reproducibility of the test method results.

¹ This guide is under the jurisdiction of ASTM Committee F45 on Driverless Automatic Guided Industrial Vehicles and is the direct responsibility of Subcommittee F45.91 on Terminology.

Current edition approved Aug. 1, 2020. Published September 2020. DOI: 10.1520/F3470-20.

These values given in parentheses are provided for information only and are not considered standard.

1.5 *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.*

1.6 *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.*

2. Referenced Documents

2.1 ASTM Standards:²

- F3200 Terminology for Driverless Automatic Guided Industrial Vehicles
- F3218 Practice for Documenting Environmental Conditions for Utilization with A-UGV Test Methods
- F3244 Test Method for Navigation: Defined Area
- F3265 Test Method for Grid-Video Obstacle Measurement
- F3327 Practice for Recording the A-UGV Test Configuration
- F3381 Practice for Describing Stationary Obstacles Utilized within A-UGV Test Methods

2.2 Other Standards:

- ANSI/ITSDF B56.5-2019 Safety Standard for Driverless, Automatic Guided Industrial Vehicles and Automated Functions of Manned Industrial Vehicles³
- ANSI/RIA 15.08 Safety Standard for Industrial Mobile Robots and Mobile Manipulators³
- EN 60529 Degrees of Protection Provided by Enclosures (IP Code)⁴
- BS EN 60529:1992 Degrees of Protection Provided by Enclosures (IP Code)⁴

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.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

⁴ Available from European Committee for Standardization (CEN), Avenue Marnix 17, B-1000, Brussels, Belgium, <http://www.cen.eu>.

IEC 60509:1989 Degrees of Protection Provided by Enclosures (IP Code)⁵

2.3 *ASTM Adjuncts:*
Capabilities Report⁶

3. Terminology

3.1 Many terms used within this document are defined as in Terminology F3200. The following terms and definitions are used within this document and are not defined within Terminology F3200.

3.2 Definitions:

3.2.1 *capability, adj*—ability of an A-UGV (operating independently or within a fleet of A-UGVs) to perform a specified task.

3.2.2 *category, n*—a division of capabilities for an A-UGV (operating independently or within a fleet of A-UGVs) regarded as having particular shared characteristics.

3.2.3 *docking, v*—arrival and act of stopping at a position relative to another object.

3.2.4 *forcibly unlocalized, n*—an A-UGV that has been picked up and moved to another location (kidnapped) or is intentionally programmed that it is in the wrong location (for example, both a wildly-off position and an aliased position such as one aisle off).

3.2.5 *positioning, v*—arrival and act of stopping at a position relative to an absolute position in an environment.

4. Summary of Guide

4.1 The guide provides a list and description (see 5.4) of automatic through autonomous capabilities for industrial A-UGVs as compared to categories. Each category contains a set of capabilities, shown along the vertical axis of the example test report (see Section 9, Fig. 1), in which the guide-user can state, positively or negatively, the existence of a capability for an A-UGV.

5. Significance and Use

5.1 This guide is intended to be used by manufacturers and users of A-UGVs: (1) to fully define capabilities of their A-UGV(s) or (2) to allow the standard requestor to describe the A-UGV capabilities required for the requested A-UGV to align with assigned task(s). A-UGVs that are covered within ASTM Committee F45 are industrial vehicles that, for example, can be automatic guided vehicles through mobile robots, can be pre-programmed-through-autonomously controlled, can operate indoors or outdoors in infinitely diverse environmental conditions and therefore, with infinitely diverse functionality. To fully describe and measure the usefulness of these vehicles, functionality can be divided into categories where associated capabilities can be independently measured. This guide there-

fore provides a decomposition of many, perhaps not all, categories and capabilities that are typical of current A-UGVs globally marketed.

5.2 Capability Categories:

5.2.1 *Goal Navigation: Pre-Programmed*—Capabilities are the various abilities of the A-UGV to navigate a series of externally-defined waypoints on the way to a final goal.

5.2.2 *Goal Navigation: In situ*—Capabilities are the various abilities of the A-UGV to navigate to a final goal by using the A-UGV system's internal logic to determine the route.

5.2.3 *Localization*—Capabilities are the various abilities of the A-UGV to determine its pose within an environment map.

5.2.4 *Docking*—Capabilities are the various abilities of the A-UGV to stop at a position relative to another object or an absolute position in an environment.

5.2.4.1 *Infrastructure Dependence*—Sub-category describing the need of the A-UGV to rely on features in the environment for Goal Navigation: Pre-Programmed, Goal Navigation: In-Situ, Localization, or Docking.

5.2.5 *Obstacle Avoidance: Single Vehicle*—Capabilities are the various abilities of the A-UGV not to collide with an obstacle(s).

5.2.5.1 *Types of objects that can be avoided and are within the A-UGV envelope*—Describe the types of objects that can be avoided, as in 5.2.6, and are within the A-UGV envelope.

5.2.5.2 *Types of objects that can be avoided and are outside of the A-UGV envelope*—Describe the types of objects that the A-UGV can avoid, as in 5.2.6, and that are outside of the A-UGV envelope.

5.2.6 *Changing Contour Area or Envelope*—the A-UGV can change contour area or envelope using stock settings or while operating and stopped or moving.

5.2.7 *Changing Payload*—The A-UGV can transport fixed or moving payload(s) at 100 % rated weight and speed.

5.2.8 *Impaired Communication Behavior*—A-UGV action(s) when communication is disrupted.

5.2.9 *Lost Communication Behavior*—A-UGV action(s) when communication stops.

5.2.10 *Environmental Conditions*—Capabilities are the various abilities of the A-UGV to overcome environmental conditions. Section 5.4 provides example standards referencing ingress protection (IP) rating and examples referenced within Practice F3218-18 that affect mobility where other environmental conditions may also affect A-UGV capabilities (for example, electrical interference, humidity, etc.).

5.3 Fleet Categories:

5.3.1 Fleets of A-UGVs are defined in Terminology F3200 as a coordinated collection of vehicles. The following sections related to fleets provide descriptions of the capability categories that a single A-UGV has as one of the vehicles within a fleet.

5.3.2 *Fleet Makeup*—The A-UGV type as compared to the fleet: homogeneous (the same type and configuration as vehicles within the fleet), or heterogeneous (different type or configuration as vehicles within the fleet).

5.3.2.1 *Fleet Task Assignment*—Tasks can be given individually to the A-UGV or collectively to the A-UGV and the other vehicles within the fleet.

⁵ Available from International Electrotechnical Commission (IEC), 3, rue de Varembe, 1st floor, P.O. Box 131, CH-1211, Geneva 20, Switzerland, <https://www.iec.ch>.

⁶ Available from ASTM International Headquarters. Order Adjunct No. ADJF3470-EA. Original adjunct produced in 2020. Adjunct last revised in 2020.