Designation: ~~F3200 – 22~~ F3200 – 22a

Standard Terminology for ~~Driverless Automatic Guided Industrial Vehicles~~Robotics, Automation, and Autonomous Systems[1]

This standard is issued under the fixed designation F3200; 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 terminology covers terms associated with ~~unmanned (that is, driverless), ground (that is, land-based and in continuous contact with the ground), industrial vehicles.~~ robotic, automation, and autonomous systems. By providing a common and consistent lexicon, the purpose of this terminology is to facilitate communication between individuals who may be involved in the research, design, deployment, and use of ~~unmanned ground vehicles,~~ robotic, automation, and autonomous systems, including but not limited to, for manufacturing, distribution, security, healthcare, response, etc. The terminology ~~covers~~ covers, but is not limited to, terms used in performance test methods of for example: robot arms, automatic guided vehicles (AGVs), autonomous mobile robots, and all other ~~driverless, ground vehicles. In addition, with increasingly intelligent vehicle systems with onboard equipment, robotics industry terms that are used in associated test methods and descriptions are also included.~~automatic or autonomous industrial systems.

1.2 For the terminology to be harmonious with the practices in the field, definitions have been drawn from the literature or other public sources when possible. When no definition is available, is similar but requires change for use within standards produced by Committee F45, or in dispute, a consensus-based approach will be used to resolve definitions and add them to the lexicon. The development of this terminology is taking place in close coordination with corresponding efforts in all Committee F45 subcommittees to ensure comprehensive and consistent coverage.

1.3 *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.*

1.4 *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]

F3244 Test Method for Navigation: Defined Area

F3499 Test Method for Confirming the Docking Performance of A-UGVs

2.2 *ANSI/ITSDF Standard:*[3]

ANSI/ITSDF B56.5 Safety Standard for Driverless, Automatic Guided Industrial Vehicles and Automated Functions of Manned Industrial Vehicles

---

[1] This terminology 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.

Current edition approved ~~Feb. 1, 2022~~Dec. 1, 2022. Published ~~February 2022~~January 2023. Originally approved in 2016. Last previous edition approved in ~~2020~~2022 as ~~F3200 – 20a.~~F3200 – 22. DOI: ~~10.1520/F3200-22.~~10.1520/F3200-22A.

[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 Industrial Truck Standards Development Foundation, 1750 K St., NW, Suite 460, Washington, DC 20006, http://www.itsdf.org.

2.3 *ISO ~~Standard:~~Standards:*[4]
ISO 8373 Robots and Robotic ~~Devices—Vocabulary~~Devices – Vocabulary
ISO 12100 Safety of machinery – General principles for design – Risk assessment and risk reduction

3. Terminology

3.1 Terminology is delineated into multiple sub-sections of terms and definitions beginning with general definitions that may be useful across all robotic, automation, and autonomous systems areas. Following are sub-sections for specific areas within robotic, automation, and autonomous systems areas. Each F45 standard includes a statement in the Terminology section referencing the sub-section(s) and term(s) within this standard. F45 standards may include terminology from one or more sections. For example, A-UGV terms within A-UGV-specific Test Methods F3244 and F3499 include terms within General and A-UGV Definition sections.

3.2 *General Definitions:*

~~**A-UGV envelope,** *n*—A-UGV contour area plus clearance.~~

~~**A-UGV operator,** *n*—person responsible for initiating and monitoring vehicle operation.~~

~~**A-UGV system, A-UGVS,** *n*—A-unmanned ground vehicle and all associated components, equipment, software, and communications necessary to make a fully functional system.~~

~~**A-UGV technician,** *n*—person(s) responsible for executing the test procedures under supervision of the test supervisor.~~

~~**A-unmanned ground vehicle, A-UGV,** *n*—automatic, automated or autonomous vehicle that operates while in contact with the ground without a human operator.~~

~~**Ackermann steer,** *n*—kinematic configuration for vehicles with pairs of wheels in which the front or rear wheels are pivoted to achieve steering.~~

~~Discussion—~~
~~The pivot angles of each wheel within the pivoted set are calculated such that each wheel's axle intersects a common point. This common point serves as the instantaneous center of the vehicle's turning circle.~~

adaptive control, *n*—control scheme whereby the control system parameters are adjusted from conditions detected during the process.

aisle, *n*—in a facility, the passageway between locations where temporary or permanent obstructions may exist.

~~**aisle, guidepath clearance,** *n*—minimum distance between fixed structures along the vehicle guide path or objects intentionally positioned in a designated area along the vehicle guidepath and the rigid parts of the vehicle, the load, and trailers if towed.~~
~~**ANSI/ITSDF B56.5**~~

ambient temperature, *n*—temperature of the atmosphere surrounding equipment.

ampere-hour capacity, *n*—amount of electrical energy that can be delivered from an energy storage unit at a specified discharge rate under specified conditions.

authorized person, *n*—trained or qualified personnel approved or assigned to perform a specific duty or duties.

[4] Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, http://www.iso.org.

automatic data capture, *n*—identification and direct collection of data into a computer system or other micro-processor-controlled device without using a keyboard (for example, technologies that support the function are: barcode, radio frequency data communication, radio frequency identification, and other emerging technologies).

DISCUSSION—
Other similar terms are *automatic data collection* or *automatic identification*.

axis of motion, *n*—axis along which the ~~vehicle moves in translation or around which the vehicle moves in rotation.~~robotic joint or A-UGV moves.

barcode, *n*—system of printed patterns that represent alphanumeric data that are able to be ~~optically read.~~read optically.

barcode reader, *n*—device used to read a barcode.

benchmarking, *v*—measurement process that can be used for comparison against best industry practices or established goals, operating targets, and performance expectations.

braking, *v*—any ~~controlled~~processor or ~~emergency means~~actuator used to slow or stop the ~~vehicle.~~robotic system (for example, robot, A-UGV). ~~ANSI/ITSDF B56.5~~

bumper, physical, *n*—surface designed to absorb or withstand impact.

clearance, *n*—additional margin, beyond the contour area, that is defined for uninterrupted A-UGV operation. See Fig. 1.

collision prevention, *n*—use of sensors to detect the presence of obstacles and, through the use of integrated controls, prevent a collision from occurring; *see* **obstacle avoidance**.

commissioning, *v*—sequence of actions of setting up and checking the ~~A-UGVS~~ robotic system (for example, robot, A-UGV) followed by the verification of the ~~A-UGV~~ robotic system functions after installation.

DISCUSSION—
Sometimes called acceptance.

configuration, *n*—all hardware, software, and settings needed to operate the ~~A-UGV~~ robotic system (for example, robot, A-UGV) as specified.

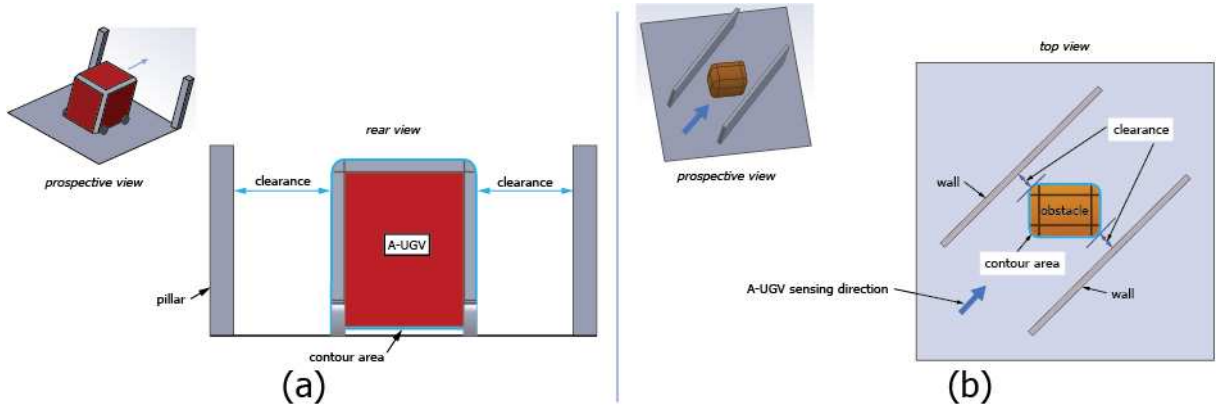

FIG. 1 Contour area and Clearance
(a) Between an A-UGV and Infrastructure and
(b) Between an Obstacle and Infrastructure

contour area, *n*—area that includes the physical boundaries of the obstacle or A-UGV and its payload, onboard equipment, or trailer, or combinations thereof.

controls and **control system,** *n*—hardware and software required to operate ~~A-UGVs~~ the robotic system (for example, robot, A-UGV) and communicate with the environment (equipment and users).

cycle, single, *n*—single execution of a task program.

DISCUSSION—
A repetition may contain one or more cycles; *see* **repetition**.

cycle time, *n*—time required to perform ~~the~~a cycle.

defined areas, *n*—space constrained by test method boundaries for ~~A-unmanned ground vehicle (A-UGV)~~ robotic system (for example, robot, A-UGV) operation.

~~**differential steer,** *n*—kinematic configuration for vehicles with two drive wheels in which steering is achieved solely via varying wheel speeds and the wheels are not able to pivot; *see* **skid steer**.~~

distance accuracy, *n*—difference between a command distance and the attained distance over a set of points.

~~**dock,** *n*—target location where the A-UGV interacts with another object.~~

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

drift, *n*—movement from the designated hold point because of the system's inability to maintain a fixed position.

echo, *n*—time elapsed between signal emission and reception that is used to determine target position in a sensor.

emergency ~~stop,~~ stop (E-stop), *n*—~~vehicle stop, not part of~~function which is intended to:
~~normal operation, that requires operator action to restart; also known as E-stop.~~—avert arising or reduce existing hazards to persons, damage to maochinery or to work in progress, and
—be initiated by a single human action. **ISO 12100**

environment map or **environment model,** *n*—map or model that describes an environment with its distinguishable features. **ISO 8373**

DISCUSSION—
Examples are grid map, geometrical map, topological map, and so forth.

exteroceptive sensor or **external state sensor,** *n*—~~mobile platform~~ robotic system (for example, robot, A-UGV) sensor intended to measure the state of a ~~vehicle's~~system's environment or interaction of the ~~vehicle~~system with its environment.

DISCUSSION—
Examples are global positioning system (GPS), vision sensor, distance sensor, force sensor, tactile sensor, and acoustic sensor.

~~**fleet,** *n*—coordinated collection of vehicles.~~

globalization, *n*—ability of the ~~A-UGV~~ robotic system (for example, robot, A-UGV) to articulate its pose within a specified reference frame.

human-machine interaction, HMI, *n*—information and action exchanges between human and ~~A-UGV~~ robotic system (for example, robot, A-UGV) to perform a task by means of a user interface.

impairment(s), *n*—an object, feature, or quality of the situation that is utilized to disrupt intended ~~A-UGV~~ robotic system (for example, robot, A-UGV) operation, such as the inclusion of obstacles or communication failures during task performance.

infrastructure, *n*—the parts and features of the facility and its environment that are not intended to be moved or changed (for example, walls, hills, doorways).

integration, *n*—act of combining ~~an A-UGV~~ a robotic system (for example, robot, A-UGV) with other software or hardware, or both.

intended ~~path,~~path/trajectory, *n*—heading of a ~~vehicle~~ robot or A-UGV at a given instant in time dictated by the control logic, recognizing that the heading is a dynamic property and can change at any instant in time depending on conditions in the operating environment (for example, the decision ~~to allow~~ for a ~~vehicle to pass another vehicle or~~ robot to change goals or an A-UGV to navigate around an obstacle); *see* **path ~~deviation, guidepath.~~deviation.** ~~ANSI/ITSDF B56.5~~

interlock, *v*,*n*—method to limit or prevent the operation of machine functions under specified ~~conditions.~~conditions of the system.

joystick, *n*—manually controlled input device whose variable positions and orientations or applied forces are measured and result in commands to the ~~vehicle~~robotic control system.

~~**landmark,** *n*—artificial or natural object identifiable on the environment map used for localization of the A-UGV.~~

~~**layout,** *n*—graphical representation of the environment and A-UGV functional space.~~

~~**load, rated,** *n*—load stated by the manufacturer that can be applied to the A-UGV under defined operating conditions.~~

load-bearing surface, *n*—actual area of material in contact with and supporting a unit load.

~~**localization,** *n*—ability of the A-UGV to articulate its pose within an environment map.~~

~~**main direction of travel,** *n*—forward movement of the vehicle, including turns, unless otherwise specified and agreed to by the user and system supplier.~~

~~ANSI/ITSDF B56.5~~

~~**manipulator,** *n*—automatically controlled, reprogrammable, multipurpose device, programmable in multiple axes that can be either fixed in place or mobile for use in industrial automation applications.~~

manual mode, manual control, manual operation, *n*—operating mode in which the complete ~~vehicle~~ robotic system (for example, robot, A-UGV) is under control of an operator.

manufacturer, *n*—company or organization responsible for the vehicle system to be installed and integrated into the environment where it will be operating.

mapping or **map building** or **map generation,** *n*—constructing the environment map to describe the environment with its geometrical and detectable features, landmarks, and obstacles. **ISO 8373**

master-slave control, *n*—control method in which the motion of a primary device (master) is reproduced on secondary devices (slaves). **ISO 8373**

DISCUSSION—
Master-slave control is typically used for manual control.

maximum force or **maximum thrust,** *n*—force (thrust), excluding any inertial effect, that can be continuously applied ~~by or to the mobile platform~~ without causing any permanent ~~damage to the vehicle.~~damage.

maximum moment or **maximum torque,** *n*—moment (torque) excluding any inertial effect that can be continuously applied ~~by or to the mobile platform~~ without causing any permanent ~~damage to the vehicle.~~damage.

~~**natural features,** *n*—features in the environment that were not specifically installed to assist in A-UGV navigation; *see* **navigation aids**.~~

~~**navigation,** *n*—deciding on and controlling the direction of travel derived from localization and the environment map; *see* **simultaneous localization and mapping (SLAM)**, **localization**.~~

~~DISCUSSION—~~
~~Navigation can include path planning for location-to-location travel and complete area coverage.~~

~~**navigation aids,** *n*—features in the environment that were specifically installed to assist in A-UGV navigation (for example, guide tape, reflectors); *see* **natural features**.~~

non-contact sensing device, *n*—device used to sense the presence, location, or other characteristics of objects without physical contact.

non-restricted area, *n*—area in which the ~~A-UGV~~ robotic system (for example, robot, A-UGV) may operate and is shared with personnel.

normal operating conditions, *n*—range of conditions that can influence ~~vehicle~~ robotic system (for example, robot, A-UGV) performance (such as electrical supply instability, electromagnetic fields) within which the performance of the ~~vehicle~~ robotic system specified by the manufacturer is valid.

DISCUSSION—
This could also include environmental conditions, for example, temperature and humidity.

object, *n*—anything in the environment that is not infrastructure.

object detection, *n*—use of sensors to identify the presence of an object.

obstacle, *n*—static or moving object that obstructs the intended movement.

obstacle avoidance, *n*—autonomously avoiding impact with obstacles (for example, stopping, driving around).

~~**omni-directional A-UGV,** *n*—an A-UGV that is capable of rotational and linear movement in any direction.~~

operator control unit (OCU), *n*—device linked (wireless or wired) to the control system with which a ~~vehicle~~ robotic system (for example, robot, A-UGV) can be programmed or ~~moved.~~moved; *see* **pendant.**

operating mode or **operational mode,** *n*—state of the ~~A-UGV~~ control system.

operator, *n*—person designated to start, monitor, and stop the intended operation of ~~an A-UGV or A-UGVS.~~a robotic system (for example, robot, A-UGV).

path deviation, *n*—measurement derived from the ~~vehicle~~ robotic system (for example, robot, A-UGV) control logic and guidance reference information that enables the ~~vehicle~~ robotic system to know whether it is wandering off the current intended path such that, when specified deviation tolerances are exceeded, appropriate action can be taken; *see* **intended path**.

path velocity fluctuation, *n*—difference between the minimum and maximum velocities along the complete path that result from traversing a given command path with a given command velocity and not from external interferences.
ISO 8373

path velocity repeatability, *n*—closeness of agreement of the velocities attained for a given command path velocity.
ISO 8373

pendant, *n*—*see* **operator control unit (OCU)**.

pose, *n*—position and orientation.

positioning, *v*—~~A-UGV(s)~~ arriving and stopping at a pose relative to a reference frame.

processor monitor, *n*—hardware device that ensures that the software program in the computer is being executed. **ANSI/ITSDF B56.5**

proprioceptive sensor or **internal state sensor,** *n*—~~mobile platform~~ robotic system (for example, robot, A-UGV) sensor intended to measure the ~~vehicle's~~system's internal state(s).

DISCUSSION—
Examples are encoder, potentiometer, tachometer generator, inertial sensor such as accelerometer, and gyroscope.

qualified person, *n*—person who, by possession of a recognized degree or certificate of professional standing or extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter and work. **ANSI/ITSDF B56.5**

radio controlled, *adj*—means by which a material-handling device or piece of equipment is controlled by receiving commands via radio frequencies sent to an onboard receiver and allows the equipment or device to be controlled remotely.

rated capacity, *n*—~~load, its position, and the vehicle speed,~~ the operating limit of a robotic system (for example, robot, A-UGV), as established by the manufacturer, at which design and performance can be expected. ~~**ANSI/ITSDF B56.5**~~

rated speed, *n*—speed, as established by the manufacturer, at which design performance can be expected.
ANSI/ITSDF B56.5

repetition, *n*—performance of a task.

reprogrammable, *adj*—designed so that the programmed motions or auxiliary functions can be changed without physical alteration. **ISO 8373**

restricted area, *n*—area in which the ~~A-UGV~~ robotic system (for example, robot, A-UGV) may operate in and from which unauthorized personnel are prohibited.