Designation: F3218 – 25

Standard Practice for Documenting Environmental Conditions for Utilization with Robotic, Automatic, or Autonomous System Test Methods[1]

This standard is issued under the fixed designation F3218; 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 practice describes "System" as a robotic, automatic, or autonomous system (for example, robot arm; automatic machine; automatic, automated, or autonomous – uncrewed ground vehicle (A-UGV)). When conducting test methods, it is important to consider the role that the environmental conditions play in the system performance. Various systems are designed to be operated both indoors and outdoors under conditions specified by the manufacturer. Likewise, end users of the system will be operating them in a variety of environmental conditions. When conducting and replicating F45 test methods by system manufacturers and users, it is important to specify and document the environmental conditions under which the system is to be tested as there will be variations in vehicle performance caused by the conditions, especially when comparing and replicating sets of test results. It is also important to consider changes in environmental conditions during the course of operations (for example, transitions between conditions). As such, environmental conditions specified in this practice are static, dynamic, or transitional, or combinations thereof; with the system stationary or in motion. This practice provides brief introduction to the following list of environmental conditions that can affect performance of the system: Lighting, External Sensor Emission, Temperature, Humidity, Electrical Interference, Air Quality, Ground Surface, and Boundaries. This practice then breaks down each condition into sub-categories so that the user can document the various aspects associated with the category prior to system tests defined in ASTM F45 Test Methods E1274, F3200, and F3244. It is recommended that salient environment conditions be documented when conducting F45 test methods.

1.2 The environmental conditions listed in 1.1 to be documented for system(s) being tested are described and parameterized in Section 4 and allow a basis for performance comparison in test methods. The approach is to divide the list of environmental conditions into sub-conditions that represent the various aspects of the major category (for example, sunlight within ambient lighting). Where necessary, this practice also provides guidelines (for example, lighting direction) to document environmental conditions in an existing environment.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are not precise mathematical conversion 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. 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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E1155M Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers (Metric) (Withdrawn 2023)[3]

E1274 Test Method for Measuring Pavement Roughness Using a Profilograph

F3200 Terminology for Robotics, Automation, and Autonomous Systems

[1] This practice is under the jurisdiction of ASTM Committee F45 on Robotics, Automation, and Autonomous Systems and is the direct responsibility of Subcommittee F45.01 on Environmental Conditions and Effects.

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

[3] The last approved version of this historical standard is referenced on www.astm.org.

F3244 Test Method for Navigation: Defined Area

2.2 *Other Standards:*

ANSI/ITSDF B56.5 Safety Standard for Driverless, Automatic Guided Industrial Vehicles and Automated Functions of Manned Industrial Vehicles – section 8.11.2 describes Hazardous Zones[4]

ANSI B101.3 Test Method for Measuring Wet DCOF of Common Hard-Surface Floor Materials – specifies use of a BOT-3000 drag-sled meter

ISO 14644-1 Cleanrooms and Associated Controlled Environments – Part 1: Classification of Air Cleanliness by Particle Concentration[5]

BS 667 Illuminance Meters – Requirements and Test Methods

BS EN 12895 Industrial Trucks – Electromagnetic Compatibility – Emissions and Immunity[6]

MIL-STD-462 Measurement of Electromagnetic Interference Characteristics[7]

ISO 15469 Spatial distribution of daylight – CIE standard general sky – defines a set of outdoor daylight conditions linking sunlight and skylight for theoretical and practical purposes

IEC TR 61000-4-1 Electromagnetic Compatibility (EMC) – Part 4-1: Testing and Measurement Techniques – Overview of Immunity Tests[8]

IEC 61000–6 Electromagnetic Compatibility (EMC) – Part 6: Generic Standards[8]

UL 3100 Automated Mobile Platforms (AMPs)[9]

3. Terminology

3.1 Generic terminology for this practice are referenced in Terminology F3200.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *between area, n*—the area of the apparatus that is between different environmental conditions in a transitional environment (see *transitional*).

3.2.2 *change time, n*—amount of time to change from one environmental condition to another (only applies to dynamic environments).

3.2.3 *dynamic, adj*—when the environment changes over time within the test apparatus during a test.

3.2.3.1 *Discussion*—The amount of time it takes for the environment to change is called change time (see *change time*).

3.2.4 *emitter, n*—external radiation sources that can affect the system performance, for example: multiple time-of-flight cameras, fork-lift pedestrian lights, structured light sensor, light detection and ranging sensors (LIDAR).

3.2.5 *transition distance, n*—amount of distance to change from one environmental condition to another, that is, the length of the between area (see *between area*).

3.2.6 *transitional, adj*—when the environment significantly differs in different areas within the test apparatus.

3.2.6.1 *Discussion*—The area between the different environmental conditions is called the between area (see *between area*).

4. Significance and Use

4.1 This section provides a description of the environmental conditions listed in Section 1 and describes the sub-conditions within each condition. Examples provided for many of the conditions and sub-conditions are provided as guidance only. Each of the conditions described should be evaluated and documented as set forth in Sections 5, 6, and 7.

4.2 *Environmental Consistency: Static, Dynamic, Transitional:*

4.2.1 Static is when the environment is similar throughout the test apparatus. For example, there are minor fluctuations in temperature throughout the apparatus as shown in Fig. 1 and Fig. 2. Dynamic is when the environment significantly differs within the test apparatus. For example, when the temperature changes between repetitions as shown in Fig. 3. Transitional is when the environment significantly differs in different areas within the test apparatus as shown in Fig. 4. The intent here is to not give specific guidance, but to provide a high-level classification of a particular set of environmental conditions. If environment consistency is dynamic or transitional, or both, a report form (see Section 7) for each unique set of environmental conditions should be completed.

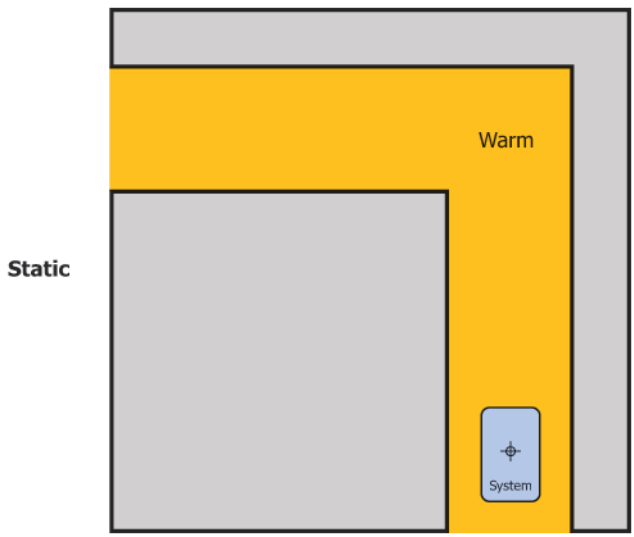

FIG. 1 Example of Static Environment using Temperature

[4] Available from American National Standards Institute (ANSI), 1180 Avenue of the Americas, 10th Floor, New York, NY 10036, http://www.ansi.org.

[5] 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.

[6] Available from British Standards Institution (BSI), 389 Chiswick High Rd., London W4 4AL, U.K., http://www.bsigroup.com.

[7] Available from U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Washington, DC 20401-0001, http://www.access.gpo.gov.

[8] Available from International Electrotechnical Commission (IEC), 3, rue de Varembé, 1st Floor, P.O. Box 131, CH-1211, Geneva 20, Switzerland, http://www.iec.ch.

[9] Available from Underwriters Laboratories (UL), 2600 N.W. Lake Rd., Camas, WA 98607-8542, http://www.ul.com.