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Standard Test Method for Rotary Stretch Wrapper Method for Determining the Readability of Passive RFID Transponders on Homogenous Palletized or Unitized Loads[1]

This standard is issued under the fixed designation D7580/D7580M; 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 test method quantitatively evaluates the readability of radio frequency identification (RFID) tagged unitized load in a simulated stretch wrapper read point scenario.

1.2 This test method is intended for use in laboratory settings that simulate, as closely as is practicable, the distribution environment of the product being tested or within the actual distribution environment itself.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the 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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D996 Terminology of Packaging and Distribution Environments

D4332 Practice for Conditioning Containers, Packages, or Packaging Components for Testing

E337 Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures)

3. Terminology

3.1 *Definitions*—Terms and definitions used in these test methods may be found in Terminology D996.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *firmware*—a series of programmable instructions, stored in read-only memory (ROM), which controls the capabilities of an interrogator.

3.2.2 *material handling base*—a generalized term referring to any apparatus used to facilitate assembling, mechanical handling, transporting, or storing of a unitized load (for example, pallets, slip-sheets or skids).

3.2.3 *Radio Frequency Identification (RFID)*—a wireless data communication technology that uses radio waves to transfer data from one source to another.

3.2.4 *RF*—the energy used by RFID systems to activate transponders and wirelessly transfer information.

3.2.5 *RF inhibiting*—a substance or material that causes a significant reduction in the effectiveness of radio waves that reach an RFID transponder.

3.2.6 *software*—an array of logic, displayed as an application, used to access and control a device.

4. Summary of Test Method

4.1 This test method is used to determine the read performance of an RF system inclusive of the reader, antennae, and transponders with a unitized load of RF tagged unit case loads. The test is conducted with the unitized load being stretch wrapped by an automated rotary stretch wrapping machine while the unitized load is subjected to a stationary RF field, provided by surrounding RF antennae.

5. Significance and Use

5.1 This test method is intended to be used as a means to verify the readability of RFID tagged unitized loads.

5.2 This test method simulates an RF read point at stage of unitizing a load using a stretch wrapper. Reading RF tags on a stretch wrapper is beneficial because the dynamic rotary motion of the unitized load within the stationary RF field increases the likelihood of successful reads.

[1] This test method is under the jurisdiction of ASTM Committee D10 on Packaging and is the direct responsibility of Subcommittee D10.17 on Auto-ID Applications.

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[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.

5.3 This test method is intended for systems used exclusively within the United States. Additional test standards from ISO or other standards bodies may apply to internationally handled goods, and may include additional test scenarios not outlined in this document.

6. Interferences

6.1 RFID systems are subject to interference from metal, water, and ambient RF energy. If significant levels of any of these interferences are present in the immediate testing area, the observed read performance will be affected. Due to uncontrolled variation in testing facilities, numerical values for interference cannot be stated. Possible sources of interference shall be documented in the final report.

6.1.1 Documentation of interference shall include information regarding, material, size, and location relative to interrogator antenna.

6.2 If significant levels of interference are unavoidable, testing shall be conducted in such a manner that interferences remain unchanged throughout testing.

7. Atmospheric Conditions

7.1 Testing shall be conducted at Standard Conditioning Atmosphere, 23 ± 1°C (73.4 ± 2°F) and 50 ± 2 % relative humidity unless otherwise noted as per 13.1.1.

7.2 The exact measurement of temperature and relative humidity of the testing atmosphere shall be made as close to the specimen being exposed as is possible. (See Test Method E337 for a detailed description of methods.) The temperature and relative humidity indicated at the control point may not be representative of conditions elsewhere in the conditioned space due to local effects or deficiency in air circulation. Tolerances at the controller usually must be smaller than those at the specimen.

8. Apparatus

8.1 *Material Handling Equipment.* The equipment used to move the unit load. This equipment may consist of a manual or electronic pallet jack, fork truck, or clamp truck.

8.2 *Stretch Wrapper*—Any machinery used to automatically unitize a load using a stretch film.

8.3 *RFID System:*

8.3.1 *Interrogator*—A manufactured device that communicates with RFID transponders by means of antennae, and communicated transponder information to the host computer.

8.3.2 *Interrogator Antenna*—A manufactured device that emits RF energy to transponders and receives information from transponders in the form of reflected RF energy.

8.3.3 *Transponder*—Amicrochip with a small conductive antenna that receives RF energy from the interrogator antenna and reflects the information on the microchip back to the interrogator antenna in the form of RF energy.

8.3.4 *Host Computer*—Any computer with the proper software to communicate with and operate the RFID interrogator.

9. Test Specimen

9.1 Each unitized load shall be comprised of a specified quantity of loaded containers, representative of a production run unitized load.

9.2 Each loaded container shall consist of a representative production run package, or components of an assembled packaging system, to include primary, secondary, and/or tertiary packaging up through the shipping case level.

9.3 An RFID transponder specimen shall be a randomly selected transponder from an RFID transponder inventory.

10. Conditioning

10.1 Test specimens shall be conditioned at the standard conditioning atmosphere of 23 ± 2°C (73.4 ± 3.6°F) for a minimum of 24 h prior to testing (see Practice D4332) unless otherwise noted as per 13.1.1.

11. Procedure

Test Method for Time Based Stretch Wrapper Testing

11.1 *Assembling the Palletized Load:*

11.1.1 Affix a single RFID container transponder to each of the containers to be assembled into the unitized load.

11.1.1.1 The location at which transponders are affixed to unit case loads shall represent, as closely as possible, the placement of the transponder in a production scenario.

11.1.2 Record the EPC number of each container transponder, visually, on the container to which it is attached so that the performance of individual transponders can be associated with the relative position of the container within the unitized load.

11.1.3 Assemble the tagged containers into a unitized load that is consistent with a production run load with respect to stacking pattern, number of tiers, number of containers, container orientation, and material handling base (pallet, skid platform, and so forth).

11.2 Assemble the RFID system.

11.2.1 The location and quantity of the interrogator antennae shall be documented and held constant throughout testing.

NOTE 1—The configuration of the interrogator antennae is a critical variable affecting the readability of unitized loads.

11.3 Place the unitized load in the center of the stretch wrapper platen.

NOTE 2—Attachment of stretch film to the unitized load is not necessary.

11.4 Set the stretch wrapper to continuously rotate at 12 ± 1 rpm. Start the stretch wrapper.

11.5 Turn the interrogator on and allow it to run for 10 s before turning it off.

11.6 Record the following information by either saving a test file or recording the information manually from the RF system software:

11.6.1 The total number of container transponders read.

11.6.2 The EPC number of each container transponder read.

11.6.3 The number of reads accumulated for each container transponder.

11.7 Repeat steps 11.4 through 11.6 thirty (30) times to enhance statistical validity.

Test Method for Cycle Based Stretch Wrapper Testing

11.8 *Assembling the Palletized Load:*

11.8.1 Affix a single RFID container transponder to each of the containers to be assembled into the unitized load.

11.8.1.1 The location at which transponders are affixed to unit case loads shall represent, as closely as possible, the placement of the transponder in a production scenario.

11.8.2 Record the EPC number of each container transponder, visually, on the container to which it is attached so that the performance of individual transponders can be associated with the relative position of the container within the unitized load.

11.8.3 Assemble the tagged containers into a unitized load that is consistent with a production run load with respect to stacking pattern, number of tiers, number of containers, container orientation, and pallet movement apparatus (pallet, slip sheet, and so forth).

11.9 Assemble the RFID system.

11.9.1 The location and quantity of the interrogator antennae shall be documented and held constant throughout testing.

NOTE 3—The configuration of the interrogator antennae is a critical variable affecting the readability of unitized loads.

11.10 Place the unitized load in the center of the stretch wrapper platen and attach the end of the stretch film to the unitized load.

11.11 Begin the stretch wrapper wrap cycle and simultaneously turn the interrogator on so that it begins reading.

NOTE 4—Results can be affected by the speed of rotation, the up and down speed of stretch wrapper carriage, and the total number of rotations occurring during the wrap cycle. These variables shall be documented and held constant throughout testing.

11.12 At the moment when the stretch wrapper platen comes to rest, turn the interrogator off.

11.13 Record the following information by either saving a test file or recording the information manually from the RF system software:

11.13.1 The total number of container transponders read.

11.13.2 The EPC number of each container transponder read.

11.13.3 The number of reads accumulated for each container transponder.

11.14 Remove the stretch film from the unitized load.

11.15 Repeat steps 11.11 through 11.14 thirty (30) times to enhance statistical validity.

12. Interpretation of Results

12.1 Case transponders reading three or more times in a single trial are denoted as "passed."

12.2 Case transponders reading less than three times in a single trial are denoted as "failed."

12.3 If all case transponders in a unitized load pass, the unitized load is considered RFD transparent.

12.4 If any case transponder fails, the unitized load is considered RF inhibiting.

13. Report

13.1 Report the following information:

13.1.1 A statement that the test was conducted in compliance with these test methods or a description of any deviation(s) from these test methods.

13.1.2 Identification of the RFID system including:

13.1.2.1 Identification of the make, model and firmware version of the interrogator.

13.1.2.2 Identification of the make and model of the interrogator antenna.

13.1.2.3 Identification of the make and model of the transponder.

13.1.2.4 Identification of the make, model and software version (where applicable) of the host computer.

13.1.2.5 All relevant reader settings where available (that is, power setting, reader operation mode).

13.1.3 Description of the unitized load.

13.1.3.1 Description of the product, internal packaging, shipping container, and closure system, where applicable.

13.1.4 Description of antennae configuration including:

13.1.4.1 Number of antennae used.

13.1.4.2 Location of each antenna.

13.1.4.3 Photograph or illustration of antennae configuration.

13.1.5 The temperature and humidity conditioning prior to testing.

13.2 *Graphical Representation:*

13.2.1 A visual representation of the read performance of each case in the palletized load shall be developed. The diagram will include an over head view representing each of the loaded containers, separated by layer.

13.2.2 Data shall be included on the figure to denote the following information about each loaded container:

13.2.2.1 Whether or not the container was passed in all trials,

NOTE 5— If the container is only detected in some of the trials, information should be included to indicate the percentage of trials in which the case was detected.

13.2.2.2 The average number of reads per container per trial, and

13.2.2.3 The approximate position of the RFID tag applied to each loaded container.

14. Precision and Bias

14.1 *Precision*—Based on replicate testing in one laboratory using Avery Dennison AD220 transponders and an Impinj Speedway reader, the pooled standard deviation of time based testing was 12.6 reads per tag per trial, with an average of 307 reads per trial. The pooled standard deviation of cycle based testing was 28.4 reads per tag per trial, with an average of 2282 reads per trial. These estimates of within-laboratory repeatability may vary with other equipment, transponders, product loads, test conditions, and so forth.

14.2 *Bias*—The procedures in this test method have no bias because there are no accepted reference materials or procedures.

15. Keywords

15.1 packaging; radio frequency identification (RFID); stretch wrapper; transponder; unitized load