Designation: D7932 – 14

Standard Specification for Printed, Pressure-Sensitive Adhesive Labels for Use in Extreme Distribution Environments[1]

This standard is issued under the fixed designation D7932; 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 specification provides a standard means to test and measure performance characteristics of printed, pressure-sensitive adhesive labels for containers, particularly containers to be used in extreme distribution environments (for example, hazardous materials labels, aerospace, military containers). For the purposes of this specification, an extreme distribution environment is one in which it can be reasonably expected to experience direct exposure to deteriorating chemicals, weather, elevated/cold temperatures, and other environmental and physical elements for an extended period of time.

1.2 *Units*—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.

1.3 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A666 Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar

D374 Test Methods for Thickness of Solid Electrical Insulation (Withdrawn 2013)[3]

D975 Specification for Diesel Fuel Oils

D996 Terminology of Packaging and Distribution Environments

D1000 Test Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications

D3611 Practice for Accelerated Aging of Pressure-Sensitive Tapes

D3951 Practice for Commercial Packaging

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

D4814 Specification for Automotive Spark-Ignition Engine Fuel

D6210 Specification for Fully-Formulated Glycol Base Engine Coolant for Heavy-Duty Engines

D6252/D6252M Test Method for Peel Adhesion of Pressure-Sensitive Label Stocks at a 90° Angle

G195 Guide for Conducting Wear Tests Using a Rotary Platform Abraser

2.2 *Department of Defense Standards:*[4]

MIL-STD-810 Environmental Engineering Considerations and Laboratory Tests

MIL-STD-2073 Standard Practice for Military Packaging

MIL-DTL-83133 Turbine Fuel, Aviation, Kerosene Type, JP-8 (NATO F-34), NATO F-35, and JP-8+100 (NATO F-37)

2.3 *Society of Automotive Engineers Standards:*[5]

SAE J183 Engine Oil Performance and Engine Service Classification

SAE J300 Engine Oil Classification

2.4 *Other:*

ISO/IEC 15415 Information Technology – Automatic Identification and Data Capture Techniques – Bar Code Print Quality Test Specification – Two Dimensional Symbols[6]

ISO/IEC 15416 Information Technology – Automatic Identification and Data Capture Techniques – Bar Code Print Quality Test Specification – Linear Symbols[6]

[1] This specification is under the jurisdiction of ASTM Committee D10 on Packaging and is the direct responsibility of Subcommittee D10.14 on Tape and Labels.

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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.

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

[4] Copies of these documents are available online at http://quicksearch.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4/D, Philadelphia, PA 19111-5094.

[5] Copies of these documents are available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001.

[6] Copies of these documents are available at www.iso.org or www.ansi.org or from the American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036.

ISO/IEC 15426-1 Information Technology – Automatic Identification and Data Capture Techniques – Bar Code Verifier Conformance Specification – Part 1: Linear Symbols[6]

ISO/IEC 15426-2 Information Technology – Automatic Identification and Data Capture Techniques – Bar Code Verifier Conformance Specification – Part 2: Two-Dimensional Symbols[6]

ANSI MH10.8.1 Linear Bar Code & 2-Dimensional Symbols[7]

ANSI/ASQC Z1.4 Sampling Procedures and Tables for Inspection by Attributes[8]

3. Terminology

3.1 General definitions for packing and distribution environments are found in Terminology D996.

3.2 *Definitions:*

3.2.1 *porous*—possessing or full of pores or openings that permit solids, liquids, or gases to permeate or penetrate an outer surface or membrane.

3.2.2 *non-porous*—possessing a non-permeable outer surface or membrane that does not permit solids, liquids, or gases to penetrate an outer surface or membrane.

3.2.3 *printed, pressure-sensitive adhesive label*—the combination of a release liner, pressure-sensitive adhesive, and facestock (face material) which has been printed with an image.

3.2.4 *label sample*—used to describe a facestock and its pressure-sensitive adhesive while still adhered to its release liner only.

3.2.5 *test surface panel*—used to describe the solid material surface onto which the label samples are adhered for the purpose of testing (see 4.2).

3.2.6 *label test specimen*—used to describe a test surface panel with a label sample applied by way of its pressure-sensitive adhesive.

4. Significance and Use

4.1 Degradation of pressure-sensitive adhesive labels due to environmental and physical factors is a common occurrence during transportation and storage. This specification provides minimum performance requirements for printed, pressure-sensitive labels for use in extreme distribution environments. In addition, standard laboratory test methods are provided to simulate exposure to various conditions and measure associated degradation of required performance characteristics. The data from these methods can be used as acceptance criteria between a supplier and customer.

4.2 The test methods described in this specification are performed on standard stainless steel test surface panels (see 10.3). Substitution of panels representative of the proposed substrates for the standard stainless steel panel is acceptable for this procedure.

NOTE 1—Test surface panels other than specified stainless steel panels may not meet the minimum requirements of Tables 2 and 3.

4.3 Type I labels are intended for use on container outer surfaces where direct contact with physical and environmental factors is unavoidable. Material strength and resistance to abrasion, sunlight, rain, extreme temperatures, chemicals, and other deteriorating environmental elements are required. Type I labels may be used on porous surfaces (Class 1) or non-porous surfaces (Class 2).

4.4 Type II labels are intended for use on inner containers where there will be a physical barrier to outside elements, such as an overpack. Since not all barriers are hermetically sealed, material strength and resistance to abrasion, extreme temperatures, and other deteriorating environmental elements are required. Type II labels may be used on porous surfaces (Class 1) or non-porous surfaces (Class 2).

4.5 Type III labels are intended for applications not covered by Type I or II labels. The performance requirements and testing shall be tailored by the customer. Type III labels may be used on porous surfaces (Class 1) or non-porous surfaces (Class 2).

5. Classifications

5.1 *Type:*

5.1.1 *Type I*—Heavy Duty.

5.1.2 *Type II*—Medium Duty.

5.1.3 *Type III*—Custom requirements.

5.2 *Classes:*

5.2.1 *Class 1*—For use on porous surfaces.

5.2.2 *Class 2*—For use on non-porous surfaces.

6. Ordering Information

6.1 *The inquiry or order shall include the following:*

6.1.1 ASTM designation and date of issue.

6.1.2 Type and Class required (see Section 5).

6.1.3 *For Type III Labels*—Required tests from Table 1 and minimum performance criteria for each.

6.1.4 Label form (for example, in sheets, rolls, etc.).

6.1.5 Individual label size.

TABLE 1 Minimum Number of Test Samples

Test Method	Minimum Number of Test Samples		Reference Paragraph
	Type I	Type II	
Print Quality	5	5	11.2
Peel Adhesion	5	5	11.3
Thickness	5	5	11.4
Abrasion	15	15	11.5
High Temperature	5	5	11.6
Low Temperature	5	5	11.7
Rain	5	Not Required	11.8
Salt Fog	5	Not Required	11.9
Blowing Dust	5	Not Required	11.10
Humidity	5	5	11.11
Freeze and Thaw	5	5	11.12
Accelerated Aging	5	5	11.13
Contamination by Fluids	40	Not Required	11.14

[7] A copy of this document is available at www.mhi.org or from the Material Handling Industry, 8720 Red Oak Boulevard, Suite 201, Charlotte, NC 28217-3992.

[8] A copy of this document is available from American Society for Quality (ASQ), 600 North Plankinton Ave., Milwaukee, WI 53203.

6.1.6 Printing requirements, as necessary.

6.1.7 When testing and inspection certification is required (see Section 13).

6.1.8 Report requirements, as necessary (see Section 12).

6.1.9 Packing and marking requirements (see Section 15).

7. Physuical Properties

7.1 All labels shall comply with the requirements listed in Table 2 and Table 3 when tested in accordance with Section 11.

8. Workmanship, Finish, and Appearance

8.1 All labels shall be uniformly constructed and free from defects that impair the usefulness of the label for the purpose intended (see Section 4). The label adhesive coating shall be uniform, covering entirely the adhesive side of the label and shall be mounted on a release liner. The adhesive shall be pressure-sensitive, water insoluble, and shall require no moisture, heat, or other preparation prior to, or after, application to clean, dry surfaces. The labels shall be furnished in the form of individual labels, sheets, rolls, or as specified by the customer. The label edges shall be clean, straight, unbroken, and shall display no excessive bleeding of adhesive. The finished product shall conform to the levels of quality established herein.

TABLE 2 Physical Property Requirements

Property	Units	Type I		Type II	
		Class 1	Class 2	Class 1	Class 2
Thickness, max	(mm)	0.22	0.22	0.22	0.22
	(mils)	8.5	8.5	8.5	8.5
Initial Adhesion, min	(N/100 mm)	66	66	55	55
	(oz/in.)	60	60	50	50
Abrasion resistance, minimum cycles to failure:					
At low temperature (-67° F)		500	500	100	100
At ambient temperature (73.4° F)		500	500	100	100
At high temperature (140° F)		500	500	100	100
Post-eposure adhesion, min:					
High temperature	(N/100 mm)	66	66	55	55
	(oz/in.)	60	60	50	50
Low temperature	(N/100 mm)	66	66	55	55
	(oz/in.)	60	60	50	50
Rain	(N/100 mm)	66	66	N/A	N/A
	(oz/in.)	60	60	N/A	N/A
Salt fog	(N/100 mm)	66	66	N/A	N/A
	(oz/in.)	60	60	N/A	N/A
Blowing dust	(N/100 mm)	66	66	N/A	N/A
	(oz/in.)	60	60	N/A	N/A
Humidity	(N/100 mm)	66	66	55	55
	(oz/in.)	60	60	50	50
Freeze and thaw	(N/100 mm)	66	66	55	55
	(oz/in.)	60	60	50	50
Accelerated aging	(N/100 mm)	66	66	55	55
	(oz/in.)	60	60	50	50
Contamination by Fluids	(N/100 mm)	See Table 3		N/A	N/A
	(oz/in.)	See Table 3		N/A	N/A

TABLE 3 Contamination by Fluids Requirements

Test Chemical	Specification	Number of Test Samples Type I	Minimum Adhesion to Stainless Steel
Water, distilled		5	55 N/100 mm (50 oz/in.)
Engine oil: SAE 15W-40, API CI-4, CI-4 Plus, or CJ-4	SAE J300 SAE J183	5	55 N/100 mm (50 oz/in.)
Gasoline (Petrol), unleaded, Anti-knock Index 87, min	ASTM D4814	5	38 N/100 mm (35 oz/in.)
Turbine Fuel JP-8	MIL-DTL-83133	5	38 N/100 mm (35 oz/in.)
Diesel fuel, Grade No. 1-D S15 or 2-D S15	ASTM D975	5	38 N/100 mm (35 oz/in.)
Automatic Transmission Fluid	Dexron VI	5	38 N/100 mm (35 oz/in.)
Coolant Type III-FF or IV-FF	ASTM D6210	5	38 N/100 mm (35 oz/in.)
Brake fluid, DOT 3, 4, or 5	FMVSS 116 49 CFR 571.116	5	38 N/100 mm (35 oz/in.)

9. Acceptance Criteria

9.1 *First Article of Manufacture*—When a product is first manufactured in a plant, it shall be tested and inspected to determine compliance with all examinations and tests of this specification by an independent laboratory. First article of manufacture examinations need only be repeated when there is a change in materials or processes.

9.2 Unless otherwise specified, the number of label test samples shall be as specified in Table 1, with an acceptable quality limit (AQL) of 4.0 % in accordance with ANSI/ASQC Z1.4.

10. Procedures

10.1 Unless otherwise specified, prior to label application, each label sample and test surface panel shall be conditioned in the standard conditioning atmosphere described in Practice D4332 for a minimum of 24 h.

10.2 Each requirement shall be tested in accordance with the test methods listed in Section 11. The total test quantities shall follow sequential testing as described in Figs. 1 and 2 for Type I and Type II labels, respectively. Unless otherwise noted in the applicable test method, tests shall be conducted in the standard conditioning atmosphere described in Practice D4332.

10.3 *Test Surface*—Except for abrasion resistance, each test sequence, unless otherwise specified by the customer, shall be conducted on panels of stainless steel 302 or 304 in accordance

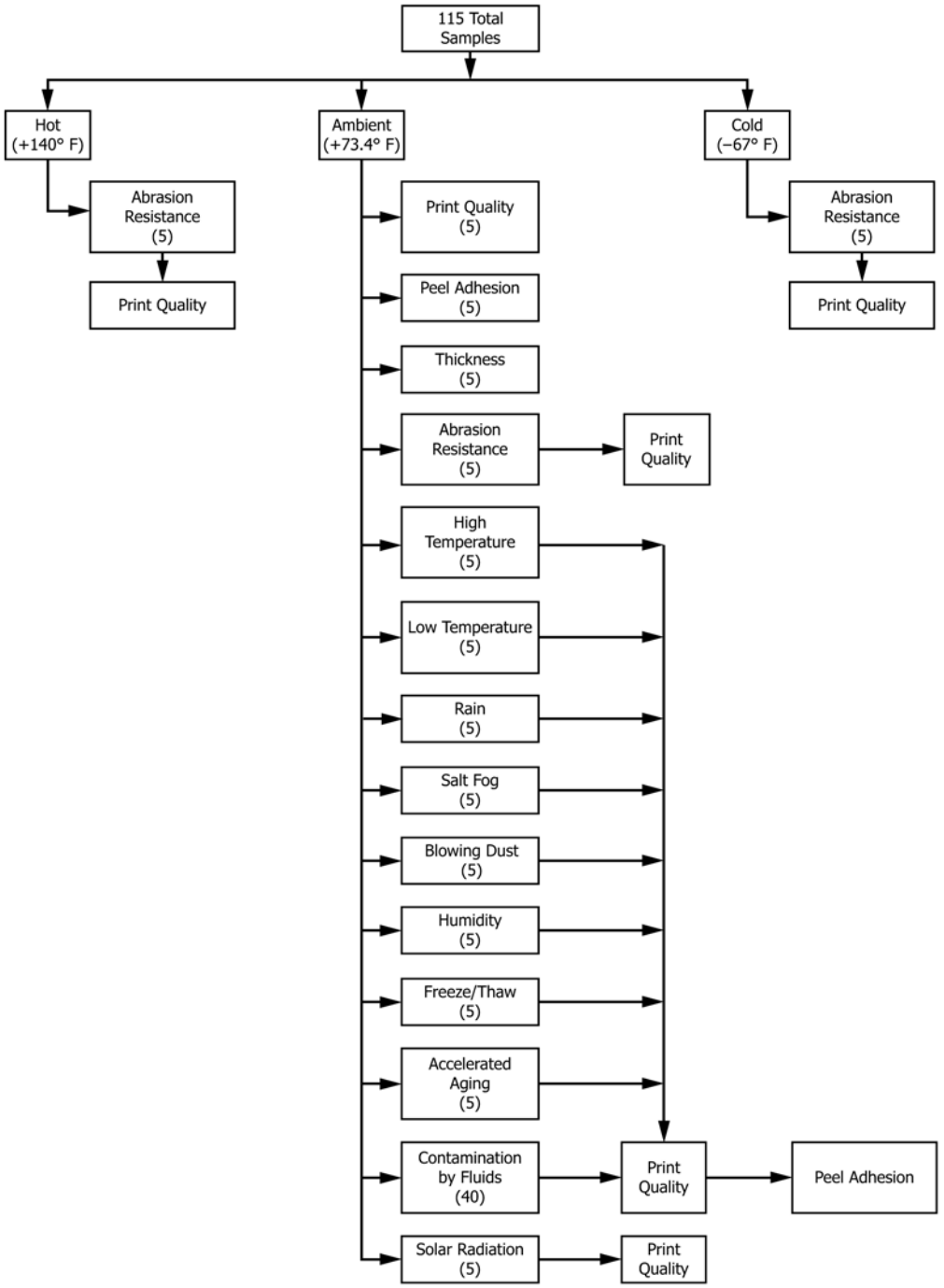

FIG. 1 Type I Test Sequence

with Specification A666 having a bright-annealed finish. The stainless steel surface roughness height shall be 2.0 ± 0.2-µin. or 50 ± 5-nm arithmetical average deviation from the mean line. All test surface panels, regardless of material, shall be a minimum 2 by 5-in. and no less than 0.032-in. thick or 50 by 125-mm and no less than 1.1-mm thick. Any panels showing stains, discoloration, numerous scratches, or other surface imperfections are not acceptable.

10.4 *Test Surface Panel Preparation—*

10.4.1 Stainless steel and other non-porous test surface panels shall be prepared as specified in Test Method D6252/D6252M.

10.4.2 If used for testing, wooden test surface panels shall be lightly sanded using at least 220 grit sandpaper to provide a smooth test surface. A clean surgical sponge, gauze, or tissue free of lint shall be used to clean all residue before label sample adhesion.

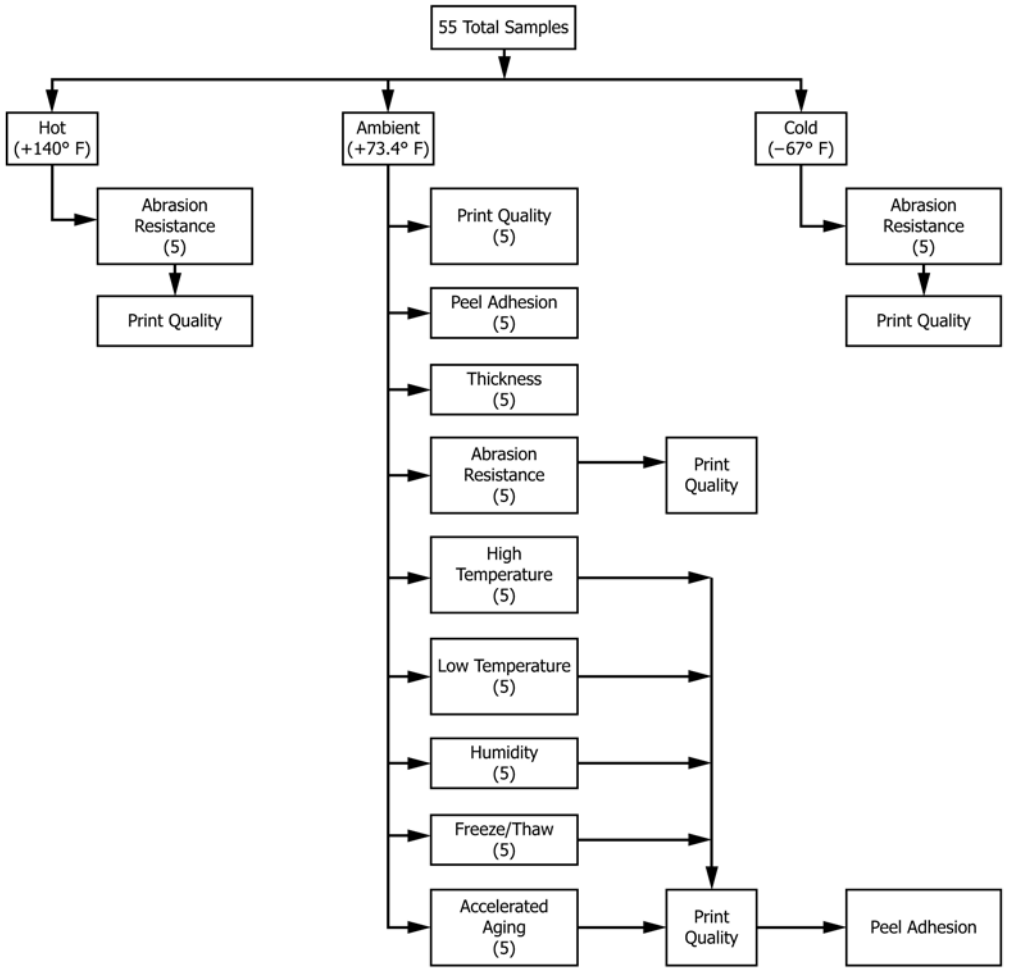

FIG. 2 Type II Test Sequence

10.4.3 All other porous test surface panels used for testing shall be cleaned of any residue using a clean surgical sponge, gauze, or tissue free of lint before label sample adhesion.

10.4.4 Label samples shall be applied to test surface panels as specified in Test Method D6252/D6252M.

10.5 *Label Marking*—Prior to application, each label sample shall be printed with, at a minimum, the word "Sample," the label manufacturer, and the label stock or model number. In addition to the human-readable printing, each label sample shall have a linear or 2-dimensional barcode, as specified by the customer, encoded with the same minimum information. Linear and 2-dimensional barcodes shall be encoded in accordance with ANSI MHI MH10.8.1. The method of printing shall be representative of the intended method to be used by the customer.

NOTE 2—Label facestock (face material) will react differently to varying types of thermal transfer printer ribbons. Use of incompatible thermal transfer ribbons and label facestock may result in decreased performance during the testing specified within this specification. It is the responsibility of the party performing the testing specified herein to ensure that all label samples are printed in a method approved by the label manufacturer.

10.6 *Evaluation of Results*—Within 3 h following completion of 11.6 – 11.14, all label test specimens shall be examined for print quality and peel adhesion in accordance with 11.2 and 11.3, for compliance with minimum requirements of Tables 2 and 3. Within 3 h following completion of 11.5 and 11.15, the label test specimen shall be examined for compliance with print quality in accordance with 11.2 only.

10.7 *Blotting*—If necessary to protect test equipment, moist or contaminated label test specimens may be blotted dry before examination in accordance with 11.2. Lay the label test specimen face up on a flat surface and place a piece of absorbent surgical gauze, sponge, or tissue on top. Suitable material shall be absorbent and lint-free. Using the hand roller described in Test Method D6252/D6252M, remove excess moisture and contaminants by rolling over the absorbent material once in each direction. Take care not to increase the mass of the roller or apply any additional pressure onto the label test specimen as this may affect the results of the peel adhesion test.

11. Test Methods

11.1 *Responsibility for Inspection*—Unless otherwise specified in the contract or purchase order, the manufacturer is responsible for the performance of all inspection requirements as specified herein.

11.2 *Print Quality*—The print quality test shall be performed on each label sample after conditioning, prior to any additional testing, to obtain baseline results. The test shall be repeated on each label sample immediately following completion (within 3 h) of exposure to conditions specified in 11.5 – 11.15. A commercial bar code reader or scanner in accordance with ISO/IEC 15426-1 for linear symbols and ISO/IEC 15426-2 for 2-dimensional symbols shall be used to test barcode print quality. Print quality shall be assessed in accordance with ISO/IEC 15416 for linear symbols or ISO/IEC 15415 for 2-dimensional symbols. Minimum acceptable print quality for baseline scans shall be 2.5 (Grade B) for both linear and 2-dimensional barcodes. Minimum acceptable print quality following any test method shall be 1.5 (Grade C) for both linear and 2-dimensional barcodes. Aperture, light, and angle shall be as required by the size and format of the printed barcode image.

11.3 *Peel Adhesion*—The peel adhesion test shall be performed on five samples after conditioning, prior to any additional testing to obtain baseline results. In addition, the peel adhesion test shall be performed on each label sample immediately following completion (within 3 h) of exposure to conditions specified in 11.6 – 11.14, and corresponding print quality test. Perform the peel adhesion test as described in Test Method D6252/D6252M.

11.4 *Thickness*—Thickness shall be measured using Method C of Test Method D374 as modified in Test Method D1000. Measure the thickness of the label and release liner, and the release liner only; then subtract to obtain the label thickness only.

11.5 *Abrasion Resistance*—Exposure to abrasion shall be conducted as specified in Guide G195. Label samples shall be attached to the test plates such that maximum barcode printed area will be in the abrasion path. Label samples do not have to be adhered to test plates using adhesive for the purposes of this test. Label samples shall be abraded at a speed of 60 cycles/min using the CS-10 or CS-10F abrading wheel and a 500 g weight on each wheel. Vacuum level shall be set to 100 %. Duration shall be 500 cycles for Type I and 100 cycles for Type II labels. Following completion, label samples shall meet the minimum print quality requirements of 11.2.

11.5.1 *Hot and Cold Conditioning*—For the purpose of determining abrasion resistance at hot and cold atmospheric conditions, label samples shall be conditioned in the desert and cryogenic conditioning atmospheres, respectively, described in Table 1 of Practice D4332 for a period of not less than 24 h before testing. The abrasion shall be conducted in standard atmospheric conditions as soon as possible after removal of the label sample from the desert or cryogenic conditioning atmosphere. The maximum permissible time from conditioning chamber removal to start of abrasion shall be 3 min.

11.6 *High Temperature*—Exposure to high temperature shall be conducted in accordance with MIL-STD-810, Method 501.5, Procedure I, Storage. The temperature cycle shall be in accordance with induced conditions of Table 501.5-III and the exposure duration shall be seven 24-h cycles.

11.7 *Low Temperature*—Exposure to low temperature shall be conducted in accordance with MIL-STD-810, Method 502.5, Procedure I, Storage. The temperature shall be in accordance with Design Type C3, Severe Cold, and the exposure duration shall be 4 h. A ramp up and ramp down time of ½ h each, independent of 4 h test time, shall be used to transition the label test specimen from ambient to cold and again from cold to ambient.

11.8 *Rain*—Exposure to rain shall be conducted in accordance with MIL-STD-810, Method 506.5, Procedure II, Exaggerated Rain. Label test specimen standoff distance shall be a maximum of 19 in. (48 cm) and exposure duration shall be 40 min. The label test specimen shall be positioned in the vertical Y-direction and rain spray shall be in the horizontal X-direction to avoid pooling effects.

11.9 *Salt Fog*—Exposure to salt fog shall be conducted in accordance with MIL-STD-810, Method 509.5. A 5 ± 1 % salt solution shall be used. The label test specimen shall be exposed to alternating 24-h periods of salt fog exposure and drying conditions for four 24-h cycles.

11.10 *Blowing Dust*—Exposure to blowing dust shall be conducted in accordance with MIL-STD-810, Method 510.5, Procedure I.

11.11 *Humidity*—Exposure to humidity shall be performed in accordance with MIL-STD-810, Method 507.5, induced constant high humidity Cycle B1. Exposure duration shall be 45 days.

11.12 *Freeze/Thaw*—Exposure to a freeze/thaw cycle shall be conducted in accordance with MIL-STD-810, Method 524, Procedure III, Rapid Temperature Change. The temperature range shall be from a minimum of –14°F to at least 72°F. The exposure shall consist of three cycles and shall begin and finish in the warm condition.

11.13 *Accelerated Aging*—Exposure to accelerated aging conditions shall be conducted in accordance with Practice D3611. The label test specimen shall be exposed to an environment of 66°C (150°F) and 80 % relative humidity for a period of 96 h (4 days).

11.14 *Contamination by Fluids*—Exposure to contamination by fluids (chemical resistance) shall be conducted in accordance with MIL-STD-810, Method 504.1, Procedure II. The application method shall be by immersion only.

11.14.1 The contamination sequence shall be as follows: 1 h immersion time, visual inspection, 7 h immersion time, drying time not to exceed 24 h, examination in accordance with 11.2 and 11.3 (see 10.6).

11.14.2 Test chemicals and respective adhesion requirements shall be as described in Table 3.

11.14.3 Several test chemicals, such as gasoline, may partially or fully evaporate before completion of 8 h immersion time. In this case do not refill or reapply any additional test chemical to the label test sample and allow sequence to proceed as specified in 11.14.1.

11.15 *Solar Radiation*—Exposure to solar radiation (sunshine) shall be conducted in accordance with MIL-STD-810,

Method 505.5, Procedure II. Exposure duration shall be fifty-six 24-hour cycles. The label test specimen shall be examined and photographed after every 10 cycles to document any changes. A solar test system utilizing xenon arc or metal halide bulbs with proper filters is recommended to meet the spectral irradiance requirements.

12. Report

12.1 Report fully all the steps taken. At a minimum, the report should include:

12.1.1 Reference to this specification.

12.1.2 Description of product (for example, manufacturer, backing material, adhesive, batch/lot number(s), etc.) and shipping unit.

12.1.3 Test plan.

12.1.4 Assurance levels and rationale.

12.1.5 Number of samples tested.

12.1.6 Conditioning used.

12.1.7 Acceptance criteria.

12.1.8 Variation from recommended procedures.

12.2 *Military Shipments*—In addition to 12.1.2 – 12.1.8, the complete report shall include the following:

12.2.1 Party, other than contractor, performing testing.

12.2.2 Testing facility used, other than contractor's.

12.2.3 Government representative witnessing testing.

13. Certification

13.1 When specified in the purchase order or contract (see 6.1.7) the purchaser shall be furnished with a certification stating that the samples representing each lot of labels have been tested and inspected as directed in this specification and the requirements have been met.

14. Rejection

14.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection shall be reported to the producer or supplier promptly in writing.

15. Preparation for Delivery

15.1 Unless otherwise specified in the purchase order or contract (see 6.1.9), labels shall be packaged and packed in accordance with Practice D3951. Such packaging shall ensure arrival at destination in satisfactory conditions and shall be acceptable to the carrier used at the lowest rate.

15.2 *Military Shipments*—When specified (see 6.1.9) shipments to the Department of Defense shall be packaged and packed in accordance with MIL-STD-2073 at the levels specified in the purchase order or contract.

16. Keywords

16.1 labels; pressure-sensitive adhesives; shipping containers; distribution environments