Extreme Environment Marking & Labeling Compliance Report: ASTM D7932-14 & Industry-Wide Validation

Polyfuze® Polymer Fusion Label Technology

Introduction & Industry-Specific Applications: This report provides a comprehensive analysis of Polyfuze's Polymer Fusion Marking & Labeling Technology and its compliance with ASTM D7932-14. It details the durability, performance, and industry-wide validation of these solutions across multiple regulated industries.

Introduction & Industry-Specific Applications
Testing was conducted by Assured Testing at the request of an industry partner manufacturing medical waste bins, with findings applicable to various industries requiring ASTM D7932-14 compliance.

ASTM D7932-14 establishes performance criteria for markings and labels used in extreme distribution environments, ensuring they withstand harsh conditions such as exposure to chemicals, abrasion, moisture, and temperature extremes. This report outlines how Polymer Fusion Markings & Labels not only meet but exceed these durability standards, providing a permanent, compliant solution across multiple industries.

Each industry section below highlights key challenges that traditional markings and labels face, followed by how Polymer Fusion technology resolves these issues through superior adhesion, resistance, and compliance. Readers should reference the section(s) most relevant to their industry to understand how this technology enhances safety, regulatory compliance, asset tracking, and long-term cost efficiency.

Industry-Specific Labeling Challenges & Solutions

1. Hazardous Materials & Chemical Packaging

- ***Compliance:*** DOT, OSHA, GHS
- ***Applications:*** Industrial chemical drums, hazardous waste containers
- ***Challenges:*** Chemical exposure, solvents, abrasion
- ***Solution:*** Polymer fusion labels resist solvents, acids, and extreme conditions.

2. Medical & Pharmaceutical Waste Containers

- ***Compliance:*** FDA, OSHA, Biohazard Regulations
- ***Applications:*** Sharps containers, biohazard disposal
- ***Challenges:*** High heat, sterilization, chemical exposure
- ***Solution:*** Polymer fusion labels remain intact through autoclave sterilization and chemical contact.

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3. Industrial & Manufacturing Chemicals

- ***Compliance:*** OSHA, EPA Labeling Requirements
- ***Applications:*** Battery acid containers, industrial paints
- ***Challenges:*** Industrial solvents, extreme temperatures
- ***Solution:*** Polymer fusion labels permanently fuse to HDPE/PP and withstand industrial stress.

4. Oil & Gas (Fuel, Lubricant, and Drilling Containers)

- ***Compliance:*** DOT, API Petroleum Standards
- ***Applications:*** Fuel storage tanks, lubricant drums
- ***Challenges:*** Harsh outdoor conditions, fluctuating temperatures
- ***Solution:*** Polymer fusion labels endure UV exposure, petroleum contact, and extreme temperatures.

5. Waste Management & Recycling

- ***Compliance:*** EPA, DOT, Municipal Waste Regulations
- ***Applications:*** Waste bins, hazardous material disposal
- ***Challenges:*** UV exposure, moisture, physical handling
- ***Solution:*** Polymer fusion labels are UV-stable, moisture-resistant, and durable.

6. Returnable & Reusable Transport Packaging (IBCs, Dunnage, Bulk Containers)

- ***Compliance:*** Track & Trace, Asset Identification Regulations
- ***Applications:*** Intermediate Bulk Containers (IBCs), reusable dunnage
- ***Challenges:*** Labels must withstand multiple reuse cycles
- ***Solution:*** Polymer fusion labels permanently embed into surfaces, preventing peeling and fading.

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Performance Data

Executive Summary: This report provides a comprehensive analysis of Polyfuze's Polymer Fusion Marking & Labeling Technology and its compliance with ASTM D7932-14. It details the durability, performance, and industry-wide validation of these solutions across multiple regulated industries.

External Referenced Standards:

Volvo STD 423-0015
MIL-STD-810G
ASTM D7932-14
ASTM D3611
ASTM D4332

Water Jet:

Test Name	Test Specs	Surface	Result
Water Jet	Water Jet (122°F @ 1740psi)	HDPE, PP Test Plaques	*Exceeded performance criteria*

Part Washer:

Test Name	Test Specs	Surface	Result
Part Washer	250 Cycles @ 120°F	HDPE, PP Test Plaques	*Exceeded performance criteria*

High Temperature:

Test Name	Test Specs	Surface	Result
High Temperature	95-120ºF for 24hrs for 7 Days	HDPE, PP Test Plaques	*Exceeded performance criteria*

Low Temperature:

Test Name	Test Specs	Surface	Result
Low Temperature	-60ºF for 72hrs	HDPE, PP Test Plaques	*Exceeded performance criteria*

Rainfall:

Test Name	Test Specs	Surface	Result
Rainfall	40MPH raindrops for 40min	HDPE, PP Test Plaques	*Exceeded performance criteria*

Salt Fog, Salt Spray:

Test Name	Test Specs	Surface	Result
Salt Fog, Salt Spray	5% salt solution at 95ºF	HDPE, PP Test Plaques	*Exceeded performance criteria*

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Performance Data Cont.

Blowing Dust:

Test Name	Test Specs	Surface	Result
Blowing Dust	Blown dust @ 2mph for 6hrs	HDPE, PP Test Plaques	*Exceeded performance criteria*

Humidity:

Test Name	Test Specs	Surface	Result
Humidity	80ºF, 95-100% humidity 45 days	HDPE, PP Test Plaques	*Exceeded performance criteria*

Freeze / Thaw, Temperature Cycling:

Test Name	Test Specs	Surface	Result
Temperature Cycling	3 cycles 77ºF, 95% RH to 18ºF	HDPE, PP Test Plaques	*Exceeded performance criteria*

Accelerated Aging, Thermal Testing:

Test Name	Test Specs	Surface	Result
Aging, Thermal	150ºF, 80% humidity, 96hrs	HDPE, PP Test Plaques	*Exceeded performance criteria*

Solar Radiation, Xenon Exposure:

Test Name	Test Specs	Surface	Result
Solar, Xenon	(56) 24 hour cycles	HDPE, PP Test Plaques	*Exceeded performance criteria*

Abrasion Resistance, Desert:

Test Name	Test Specs	Surface	Result
Abrasion, Desert	500g @ 60rpm at 60 °C ± 2	HDPE, PP Test Plaques	*Exceeded performance criteria*

Abrasion Resistance, Room Temperature:

Test Name	Test Specs	Surface	Result
Abrasion, Room Temp.	500g @ 60rpm at room temp.	HDPE, PP Test Plaques	*Exceeded performance criteria*

Abrasion Resistance, Cryogenic:

Test Name	Test Specs	Surface	Result
Abrasion, Cryogenic	500g @ 60rpm at -55 °C ± 3	HDPE, PP Test Plaques	*Exceeded performance criteria*

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Performance Data Cont.

Chemical Resistance Testing:

Test Name	Test Specs	Surface	Result
Deionized Water	8hr. exposure, max 24hr dry	HDPE, PP Test Plaques	*Exceeded performance criteria*
5% Salt Water	8hr. exposure, max 24hr dry	HDPE, PP Test Plaques	*Exceeded performance criteria*
Windex	8hr. exposure, max 24hr dry	HDPE, PP Test Plaques	*Exceeded performance criteria*
Betco AF67 Bathroom Cleaner	8hr. exposure, max 24hr dry	HDPE, PP Test Plaques	*Exceeded performance criteria*
99% Isopropyl Alcohol	8hr. exposure, max 24hr dry	HDPE, PP Test Plaques	*Exceeded performance criteria*
Dot 3 Brake Fluid	8hr. exposure, max 24hr dry	HDPE, PP Test Plaques	*Exceeded performance criteria*
#2 Diesel Fuel	8hr. exposure, max 24hr dry	HDPE, PP Test Plaques	*Exceeded performance criteria*
Nitric Acid - Ph 1.0±0.2	8hr. exposure, max 24hr dry	HDPE, PP Test Plaques	*Exceeded performance criteria*
HCL - Ph 1.0 ± 0.2	8hr. exposure, max 24hr dry	HDPE, PP Test Plaques	*Exceeded performance criteria*
Sodium Hydroxide - Ph 12 ± 0.2 @ 5.25%	8hr. exposure, max 24hr dry	HDPE, PP Test Plaques	*Exceeded performance criteria*
Sodium Hypochlorite - 5%	8hr. exposure, max 24hr dry	HDPE, PP Test Plaques	*Exceeded performance criteria*
Quaternary Ammonium 200 ppm	8hr. exposure, max 24hr dry	HDPE, PP Test Plaques	*Exceeded performance criteria*

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Test Criteria:

Water Jet:
Volvo STD 423-0015. Water at 122 °F sprayed 4 inches from the substrate at approximately 1740psi and 4 gallons/minute. Using a manual power washer wand for 30 seconds sweeping across the sample at a rate of 1 wand sweep per second.

Part Washer:
One cycle will consist of an ECOLAB cleaning solution at 120 °F sprayed 15 inches at a 45 degree angle from the substrate at line pressure of 45psi and flow rate of 5 gallons/minute for 45 seconds. Immediately followed by a 10 second fresh water rinse at 160 °F. The substrate will then cool to room temperature before the next cycle. Test will conclude after 250 cycles or part failure.

High Temperature:
ASTM D7932-14, Section 11.6, as described in MIL-STD-810G, Method 501.6, Procedure I, Storage, Table 501.5-III for seven (7)-24 hour cycles (168 hours). Cycling of sample occurred at 95-120ºF for 24hrs for total of 7 Days.

Low Temperature:
ASTM D7932-14, Section 11.7, as described in MIL-STD-810G, Method 502.6, Procedure I, Storage, Design Type C3, -60º F for 72hrs.

Rainfall:
ASTM D7932-14, Section 11.8, as described in MIL-STD-810G, Method 506.6, Procedure II, Exaggerated Rain, Exposure duration will be 40mph for 40 minutes.

Salt Fog, Salt Spray:
ASTM D7932-14, Section 11.9, as described in MIL-STD-810G, Method 509.6, using a 5% ± 1% salt solution for four (4)-24 hour cycles, one cycle consists 24 hours salt spray, then 24 hours of drying time.

Blowing Dust:
ASTM D7932-14, Section 11.10, as described in MIL-STD-810G, Method 510.6, Procedure I. Dust particles were blown at 2mph for a total of 6hrs.

Humidity:
ASTM D7932-14, Section 11.11, as described in MIL-STD-80G, Method 507.6, Cycle B1, exposure duration will be 45 days (1080hours) at 80ºF cycling, 95-100% humidity.

Freeze / Thaw, Temperature Cycling:
ASTM D7932-14, Section 11.12, as described in MIL-STD-810G Method 524.1, Procedure III, Rapid Temperature Change, exposure duration will be 3 cycles at 77ºF, 95% humidity for 1hr to 18ºF for 1hr.

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Test Criteria Cont.:

Accelerated Aging, Thermal Testing:
ASTM D7932-14, Section 11.13, as described in ASTM D3611, exposure to 150ºF at 80% humidity for 96 hours.

Solar Radiation, Xenon Exposure:
ASTM D7932-14, Section 11.15, as described in MIL-STD-810G, Method 5056, Procedure II, duration will be (56) 24 hour cycles, (1344hours) each cycle will consist of 20 hours of light and 4 hours of darkness.

Abrasion Resistance, Desert:
ASTM D7932-14, Section 11.5.1, followed by abrasion testing to be performed as described in Table 1 of ASTM D4332, for 24 hours, Sample conditioned at 60 °C ± 2 (140 °F ± 4) RH 15% ± 2 with a 500g weight on a wheel moving at 60rpm.

Abrasion Resistance, Room Temperature:
ASTM D7932-14, Section 11.5, to be performed as described in ASTM G195. Sample conditioned at room temp with a 500g weight on a wheel moving at 60rpm.

Abrasion Resistance, Cryogenic:
ASTM D7932-14, Section 11.5.1 followed by abrasion testing to be performed as described in Table 1 of ASTM D4332, for 24 hours. Sample conditioned at -55 °C ± 3 (-67 °F ± 6) with a 500g weight on a wheel moving at 60rpm.

Chemical Resistance Testing:
ASTM D7932-14, Sections 11.14-11.14.3, as described in MIL-STD 810G, Method 504.2, P procedure II, eight (8) hour exposure and max 24hr drying time.

FDA 510(k) Durability Requirement:
600 Wash Cycles. Wash Temperature - 140°F-160°F for approximately 50 seconds, Rinse Temperature 180°F-195°F for approximately 36 seconds, Dry Temperature 180°F-200°F for approximately 80 seconds. Chemical in Wash Tank: 250ppm of free chlorine; using ZEP FS Z-Chlor (#2443)

Conclusion & Final Validation Statement:

Industries requiring ASTM D7932-14 compliance need marking and labeling solutions that endure extreme environments. Polyfuze Polymer Fusion Markings & Labels offer the most durable, permanent, and compliant solution available, eliminating the risks of adhesive-based labels that degrade over time.

For further details or compliance inquiries, contact Polyfuze Graphics Corporation.