Engineering and Technical Services for Joint Group on Pollution Prevention (JG-PP) Projects

Joint Test Report
J-95-OC-005-R

Validation of Low-VOC Inks and Self-Adhesive Labels as Alternatives to Solvent-Based Ink Stenciling for Identification Marking

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LIST OF ACRONYMS

A/E	Aramid Epoxy Laminate
AL	Aluminum Substrate
ASTM	American Standard Test
CAR	Chemical Agent Resistance
CBA	Cost Benefit Analysis
C/E	Carbon Epoxy Laminate
CTC	Concurrent Technologies Corporation
DC	Direct Current
DoD	Department of Defense
EPA	Environmental Protection Agency
ESOH	Environmental Safety And Occupational Health
ESTCP	Environmental Security Technology Certification Program
FED STD	Federal Standard
GC	Gas Chromatography
GD	Chemical Agent GD
G/E	Glass Epoxy Laminate
HAP	Hazardous Air Pollutant
HazMat	Hazardous Material
HD	Chemical Agent HD
IR	Infrared
JASPPA	Joint Acquisition Sustainment Pollution Prevention Activity
JG-PP	Joint Group on Pollution Prevention
JLC	Joint Logistics Command
JTP	Joint Test Protocol
JTR	Joint Test Report
LM	Lockheed Martin
MEK	Methyl Ethyl Ketone
MS	Mass Spectroscopy
NADEP	Naval Aviation Depot
NASA	National Aeronautics and Space Administration
NDCEE	National Defense Center for Environmenal Excellence
NR	Neoprene Rubber
OEM	Original Equipment Manufacuter
PAR	Potential Alternatives Report
SR	Silicon Rubber
SS	Stainless Steel
TTP	Thermal Transfer Printable
UV	Ultraviolet
VOC	Volatile Organic Chemical

PREFACE

This report was prepared by Concurrent Technologies Corporation (*CTC*) through the National Defense Center for Environmental Excellence (NDCEE) under Contract Number DAAE30-98-C-1050. This report was prepared on behalf of and under guidance provided by the Joint Group on Pollution Prevention (JG-PP) through the Joint Acquisition Sustainment Pollution Prevention Activity (JASPPA). The structure, format, and depth of technical content of the report were determined by the JASPPA, government contractors, and other government technical representatives in response to the specific needs of this project.

We wish to thank the participants involved in the creation of this document for their invaluable contributions.

This Joint Test Report (JTR) documents the results of testing performed in accordance with the *Joint Test Protocol (LM-P-1-2) for Validation of Alternatives to Solvent-Based Ink Stenciling for Identification Marking*, dated March 11, 1997. This JTR will be made available as a reference for future pollution prevention endeavors by other U.S. Department of Defense (DoD), National Aeronautics and Space Administration (NASA), and industry organizations to minimize duplication of effort.

EXECUTIVE SUMMARY

As part of the Joint Group on Pollution Prevention (JG-PP) Identification Marking project, validation testing was performed on material alternatives to inks and paints containing volatile organic compounds (VOCs), such as methyl ethyl ketone and toluene, that are used for identification marking (i.e., stenciling, stamping, and silk screening). The alternatives tested include three ultraviolet (UV)-curable inks, six waterborne inks, and ten self-adhesive computer-printable labels. These alternatives are described in the *Potential Alternatives Report, LM-A-1-1, for Alternatives to Solvent-Based Ink Stenciling for Identification Marking*, dated July 16, 1998.

In preparation for testing, the technical representatives from Lockheed Martin (LM) Missiles and Fire Control (previously Electronics and Missiles) and LM Information Systems Companies in Orlando, Florida, and government technical representatives from affected defense systems reached consensus on the critical technical and performance requirements that alternative marking materials must satisfy to be used for selected applications at these LM facilities. These requirements are documented in *Joint Test Protocol, LM-P-1-2, for Validation of Alternatives to Solvent-Based Ink Stenciling for Identification Marking*, dated March 11, 1997. Requirements were defined in three grades: Grade A (exterior applications, such as external surfaces of vehicles, radar systems, missiles, portable systems, targeting systems, and electronic support equipment), Grade B (interior applications, such as instrument panels, test equipment, cabinets and internal electronic components), and Grade C (general purpose applications for items where loss or removal of the marking is not critical). This Joint Test Report documents the common and extended (program-specific) validation testing results.

The results of common testing show that five of the nine alternative inks and all ten self-adhesive labels met Grade C application requirements for at least one substrate. In addition, two alternative inks (DPI #311 and Willmark #44) and all self-adhesive labels were validated for Grade A and Grade B applications for at least one substrate. Extended test results are used by individual facilities to deselect alternatives that do not meet performance requirements. Please refer to Tables 77 through 82 for a summary of all pass/fail results for the inks and self-adhesive labels.

The testing results show that the performance of stenciling inks depends strongly on the substrate to which the ink or label is applied. For example, Nor-Cote 80 was the only ink to exhibit acceptable abrasion resistance on glass/epoxy panels. Virtually all inks applied to glass/epoxy panels failed tape adhesion tests. The adhesion failures are believed to result from the surface properties of the glass/epoxy panels; the extremely smooth surface of the panels appeared to inhibit ink adhesion.

Similarly, the adhesive strengths of the self-adhesive labels were dependent on the substrates to which they were applied. Several of the blank labels (Brady B-437; Brady B-652; Critchley clear, metallized, and white polyester; and Tyton 900 labels on silicone rubber, and the Brady B-652 and Critchley clear polyester labels on neoprene rubber) exhibited unacceptably low adhesion on these smooth surfaces throughout testing (based on the requirement of a minimum adhesive strength of 16 ounces per inch width).

Performance of alternative inks was more closely correlated to substrate type than was label performance. For example, when one ink failed adhesion and abrasion on the glass/epoxy substrate, all inks failed. Labels, although showing low adhesion on smooth substrates such as neoprene rubber, glass/epoxy, or silicon rubber, did not all fail adhesion on these substrates. Adhesion failure for a label on one substrate did not indicate adhesion failure on other substrates.

The results of the validation testing will be leveraged for Environmental Security Technology Certification Program (ESTCP) demonstrations at a U.S. Navy depot and U.S. Army depots.

1. INTRODUCTION

The Joint Logistics Commanders (JLC) and Headquarters National Aeronautics and Space Administration (NASA) co-chartered the Joint Group on Pollution Prevention (JG-PP) to coordinate joint service/agency activities affecting pollution prevention issues identified during system and component acquisition and sustainment processes. The primary objectives of the JG-PP are to:

- Reduce or eliminate the use of hazardous materials (HazMats) or hazardous processes at manufacturing, remanufacturing, and sustainment locations
- Avoid duplication of effort in actions required to reduce or eliminate HazMats through joint service cooperation and technology sharing.

JG-PP projects typically involve at least one original equipment manufacturer (OEM) producing multiple systems for more than one of the Services and NASA, as well as at least one facility, such as a Department of Defense (DoD) depot, maintaining one or more of the systems. JG-PP technical representatives for each project begin by selecting at least one target HazMat for reduction or elimination. This target HazMat(s) is a material used in production or sustainment processes that is known to create environmental and/or worker health concerns. Project participants then identify alternative technologies or materials for evaluation. The HazMats targeted for replacement during this project were Methyl Ethyl Ketone (MEK) and Toluene found in stenciling inks and paints.

A Joint Test Protocol (JTP) that contains the critical requirements and tests necessary to qualify potential alternatives to selected target HazMats and processes for a particular application is written for each project. The required tests used for validating low VOC alternatives during this project are documented in *Joint Test Protocol, LM-P-1-2, for Validation of Alternatives to Solvent-Based Ink Stenciling for Identification Marking*, dated March 11, 1997, hereafter referred to as JTP. The tests are summarized in Section 2.

During each project, the participating technical representatives select candidate alternatives that will be tested in accordance with the JTP. The candidate alternatives for this project, and the process by which they were selected for testing, are documented in *Potential Alternatives Report, LM-A-1-2, for Validation of Alternatives to Solvent-Based Ink Stenciling for Identification Marking*, dated July 16, 1998, hereafter referred to as PAR. The nine alternate inks and ten label systems selected for validation are listed below.

- UV Curable 80 Series Ink
- UV Curable MSK-Series Ink
- UV Curable UV3004
- AERO No. 6565 Ink
- CS7-56 Water Base Ink
- Waterborne DPI #311 Ink
- Waterborne WB 2040M Ink

- Waterborne WB82 Ink
- Waterborne Willmark #44 Ink
- Ink Jet printable Brady B-107 Matte White Label Stock
- Thermal transfer printable Brady B-423 Glossy White Polyester
- Thermal transfer printable Brady B-437 Label Stock
- Laser printable Brady B-652 High Temperature Label Stock
- Laser printable Brady B-747 Lasertab Markers
- Thermal transfer printable Critchley Clear Polyester
- Thermal transfer printable Critchley White Polyester
- Thermal transfer printable Critchley Metallized Polyester
- Thermal transfer printable Tyton 822
- Thermal transfer printable Tyton 900

Details for these alternatives can be found in Section 3.

A Cost Benefit Analysis (CBA) was performed to determine the economic impact of implementing alternative inks and self-adhesive labels. Changes in equipment, material, labor, utility, safety, regulatory, and environmental costs are included in CBA calculations. The CBA, performed at two Lockheed Martin companies and four sustainment community facilities, showed a potential cost avoidance of $1 million per year. Additional benefits of implementation include decreased hazardous waste and enhanced regulatory compliance due to reduced VOC and HAP emissions.

After project participants define the tests to be performed and the alternatives to be tested, testing is executed. This Joint Test Report (JTR) documents the results of the testing, describes any test modifications made during the execution of testing, and identifies technically acceptable alternatives to the baseline process. Any test procedure modifications documented in this JTR have been agreed upon by the project technical stakeholders.

Technical representatives from Lockheed Martin (LM) Missiles and Fire Control (previously Electronics & Missiles) and LM Information Systems Companies in Orlando, Florida, the affected DoD and NASA programs, the sustainment community, and other government organizations participated in this project. The project participants were led by the Joint Acquisition Sustainment Pollution Prevention Activity (JASPPA), the working-level government managers tasked with executing JG-PP projects.

For this project, participants identified volatile organic compounds (VOCs), such as methyl ethyl ketone (MEK) and toluene, as found in ink and paint formulations as the target HazMats to be eliminated or reduced. The targeted process was identification marking by stenciling, stamping, and silk screening. Table 1 summarizes the target HazMat, current material and process, current specifications, affected programs, and candidate parts/substrates.

Table 1. Lockheed Martin Identification Marking Target HazMat Summary

Target HazMats	VOCs (e.g., MEK and toluene)	
Current Material	Paint and two-part epoxy ink	
Current Process	Stenciling, stamping, and silk screening for identification marking	
Current Specifications	MIL-STD-130 MIL-STD-129 MIL-HDBK-454 Rqmt 67 MIL-M-81531 MIL-M-87958	MIL-PRF-61002 MIL-I-43553 MIS-20238 MIS-19916 MIS-22043
Affected Programs	Air Force: AC-130 Gunship LLL-TV, Airborne IRST, F-22 MLD, JASSM, LANTIRN, WCMD Army: COFT, Comanche, Hellfire II, JAVELIN, Longbow FCR, Longbow Missile, MPIM/SRAW, Patriot, TADS/PNVS, TDT Navy: AEGIS DAC, AN/AAS-38, CASS, DDG51 Machinery Control Systems, F-14 IRST, JASSM Marine Corps: Predator	
Candidate Parts/ Substrates	Components for a broad spectrum of applications such as electronics cabinets and cabinet parts; aluminum, steel, and stainless steel sheet and parts; and nonmetallics, painted metal surfaces, and elastomers	

This JTR will be made available as a reference for future pollution prevention efforts by other DoD, NASA, and commercial users to minimize duplication of effort. Additionally, this JTR will be leveraged to identify acceptable alternatives for Environmental Security Technology Certification Program (ESTCP) demonstrations at NADEP Jacksonville, Florida and Tobyhanna Army Depot, Pennsylvania. The ESTCP is a DoD program managed by the Office of the Deputy Undersecretary of Defense for Environmental Security. The ESTCP demonstrates and validates laboratory-proven technologies that target the DoD's most urgent environmental needs. These technologies provide a return on investment through reduced environmental, safety, and occupational health (ESOH) risks; cost savings; and improved efficiency. The new technologies typically have broad application to both the DoD Sustainment Community and industry.

2. TESTING REQUIREMENTS

A joint group led by JASPPA and consisting of technical representatives from LM Missiles and Fire Control Company, LM Information Systems Company, the affected DoD defense system programs, the sustainment community, and other government organizations identified engineering, performance, and operational impact (supportability) requirements for ink and paint stenciling. This group then reached consensus on tests with procedures, methodologies, and acceptance criteria to qualify alternatives against these technical requirements. Failure in any single test does not necessarily disqualify a candidate alternative for use in all possible application grades.

The test requirements for identification marking alternatives were divided into three application grades based upon performance requirements. The three grades were designated as A, B, and C in the JTP. The grades were defined as:

- **Grade A:** The marking must be able to withstand extremes in environmental conditions; this application grade represents the most severe set of performance conditions a unit might be expected to encounter. These markings would typically be found on the exterior of a product that was expected to be used outdoors.
- **Grade B:** The marking must be able to withstand typical operating environments of electronic equipment. These markings would typically be found on products that are used in an indoor, protected environment.
- **Grade C:** There is no significant consequence if the marking is removed in the future after the purpose for the original marking is fulfilled. Furthermore, the loss of the marking does not impact safety or preclude continued operational performance. Materials meeting the Grade C requirements are expected to be commercial off-the-shelf labels. Examples of such labels include bag-and-tag applications and labels for re-marking vendor-supplied parts.

For Grade A, B, and C categories, common and extended testing requirements were identified by the project participants for validating alternatives to ink and paint stenciling. Common tests are required by all affected programs that are listed in Table 1. Extended tests are required by at least one of the programs, but not all.

The identified common and extended tests are listed in Table 2 and Table 3, respectively. Each of the tests is identified with one or more of the application grades described above and also identified with alternative stenciling inks (tests for “Ink on Part”) and self-adhesive labels (tests for “Ink on Label” and “Label on Part”). The listings in Table 2 and Table 3 include acceptance criteria and the references, if any, used for developing the tests. Each of the tests is fully described in the JTP.

Table 2. Common Engineering, Performance, and Testing Requirements for Identification Marking Applications

Performance Requirement	JTP Sections	Acceptance Criteria	Variations of Test	Grade A	Grade B	Grade C	Applicability			Reference(s)
							Ink on Part	Ink on Label	Label on Part	
Abrasion (Scrub) Resistance	3.1.1 3.2.1	Legibility	--	X	X	X	X	X		MIL-M-81531 (May 2, 1967)
Adhesion	3.1.2 3.2.2	Legibility	--	X	X	X	X	X		ASTM D 3359-92a (May 15, 1992)
	3.3.1	Average pull value of 16 ounces per linear inch	--	X	X	X			X	ASTM D 3330-90 (June 29, 1990)
Chemical Resistance	3.1.3 3.2.3 3.3.2	Adhesion and/or legibility Inspect visually for any effects	Soak in:							ASTM D 896-92 (July 15, 1992)
			- Isopropyl alcohol	X	X	X	X	X	X	
			- Deionized water	X	X	X	X	X	X	
			- Engine oil 21SAE20 W	X	X	X	X	X	X	
			- Terpene-based solvent	X	X		X	X	X	MIL-I-43553B (June 23, 1994)
Legibility	3.1.8 3.2.6	Visually discernible printing with 20/20 corrected vision	--	X	X	X	X	X		None

(Table 2 continued on next page)

Table 2. Common Engineering, Performance, and Testing Requirements for Identification Marking Applications (continued)

Performance Requirement	JTP Sections	Acceptance Criteria	Variations of Test	Grade A	Grade B	Grade C	Applicability			Reference(s)
							Ink on Part	Ink on Label	Label on Part	
Salt Spray Resistance	3.1.9 3.2.7 3.3.6	Adhesion and/or legibility; No effects on the label Corrosion no worse than control specimen	48-hour exposure 168-hour exposure	X X			X X	X X	X X	ASTM B 117-94 (February 15, 1994)
Temperature Exposure and Thermal Shock Resistance	3.1.10 3.2.8 3.3.7	Adhesion and/or legibility	Low-temperature exposure High-temperature exposure Thermal shock	X X X	X X X	X X X	X X X	X X X	X X X	MIL-M-87958 (October 12, 1990)
UV Light/ Condensation	3.1.11 3.2.9 3.3.8	Adhesion and/or legibility; Label stays on test specimen	--	X	X		X	X	X	ASTM G 53-91 (September 15, 1991)

Table 3. Extended Performance and Testing Requirements for Identification Marking Applications

Performance Requirement	JTP Sections	Acceptance Criteria	Variations of Test	Grade A	Grade B	Grade C	Applicability			Reference(s)
							Ink on Part	Ink on Label	Label on Part	
Adhesion (Program-specific parts)	3.3.1	Average pull value of 16 ounces per linear inch	--	(*)	(*)	(*)			X	ASTM D 3330-90 (June 29, 1990)
Chemical Resistance (Program-specific requirement)	3.1.3 3.2.3 3.3.2	Adhesion and/or legibility Inspect visually for any effects	Soak in:	(*)	(*)	(*)				ASTM D 896-92 (May 15, 1992)
			- Coolanol				X	X	X	
			- PAO				X	X	X	
			- Hydraulic fluid (MIL-H-5606)				X	X	X	
			- Lubricating oil (MIL-L-23699)				X	X	X	
			- Skydrol				X	X	X	
			- JP5 (MIL-T-5624)				X	X	X	
			- DS2				X	X	X	
Corrosivity	3.1.4 3.3.3	No visible signs of corrosion		X	X	X	X		X	ASTM D 3310-90 (March 30, 1990)
DC Electrical Resistance	3.1.5 3.3.4	Resistance ≥ 10^{12} ohms		X	X	X	X		X	ASTM D 257-92 (December 1992)
Fungus Resistance	3.1.6 3.2.4	Adhesion and/or legibility		X	X		X	X		MIL-STD-810E, Method 508 (July 14, 1989) MIL-HDBK-454 Guide-line 4 (April 28, 1995)

(*) Dependent on program-specific requirements.

(Table 3 continued on next page)

Table 3. Extended Performance and Testing Requirements for Identification Marking Applications (continued)

Performance Requirement	JTP Sections	Acceptance Criteria	Variations of Test	Grade A	Grade B	Grade C	Applicability			Reference(s)
							Ink on Part	Ink on Label	Label on Part	
IR Reflectance	3.1.7 3.2.5 3.3.5	450-500 nm ≤ 8% reflectance 500-600 nm ≤ 10% reflectance 600-2700 nm ≤ 8% reflectance	Aircraft	X			X	X	X	MIL-C-85295B (October 22, 1990)
		Refer to JTP Sections 3.1.7, 3.2.5, and 3.3.5	Ground Support Equipment	X			X	X	X	MIL-C-46168D (May 21, 1993)
Temperature Exposure and Thermal Shock Resistance (Program-specific parts)	3.3.7	Adhesion	Low-temperature exposure	(*)	(*)	(*)			X	MIL-M-87958 (October 12, 1990)
			High-temperature exposure	(*)	(*)	(*)			X	
			Thermal shock	(*)	(*)	(*)			X	

(*) Dependent on program-specific requirements.

The technical representatives also agreed to the sequence in which the tests would be performed. Tests were conducted in a manner that eliminated duplication and maximized use of each test specimen. For example, where possible, more than one test was performed on each specimen. The amount and type of tests that were run on any one specimen were determined by the destructiveness of the test.

The testing was performed in two sequential phases, with the phases defined by the technical representatives. After the completion of each phase, the technical representatives jointly determined which candidate alternatives to eliminate and which to test further. This testing strategy is represented in Figure 1, Figure 2, and Table 4. During Phase I testing, inks and blank labels were tested for adhesion on the designated substrates while inks and printed labels were tested for legibility. After review of the Phase I data, the technical representatives made the determination as to whether a candidate would proceed into Phase II testing. This decision was based not only upon the performance of an alternative during adhesion and legibility but also upon ease of application and additional information obtained during the preparation of test panels. This performance may include preparation and handling of the alternative, ease of clean-up, sagging of the applied stencil, additional curing requirements, or the need to use an alternate method of marking. At the end of Phase I, several inks were removed from further testing because they failed adhesion on more than one substrate and could not be applied using a spray gun. Figure 1 below shows the process for testing and approving alternatives during Phase I of the validation.

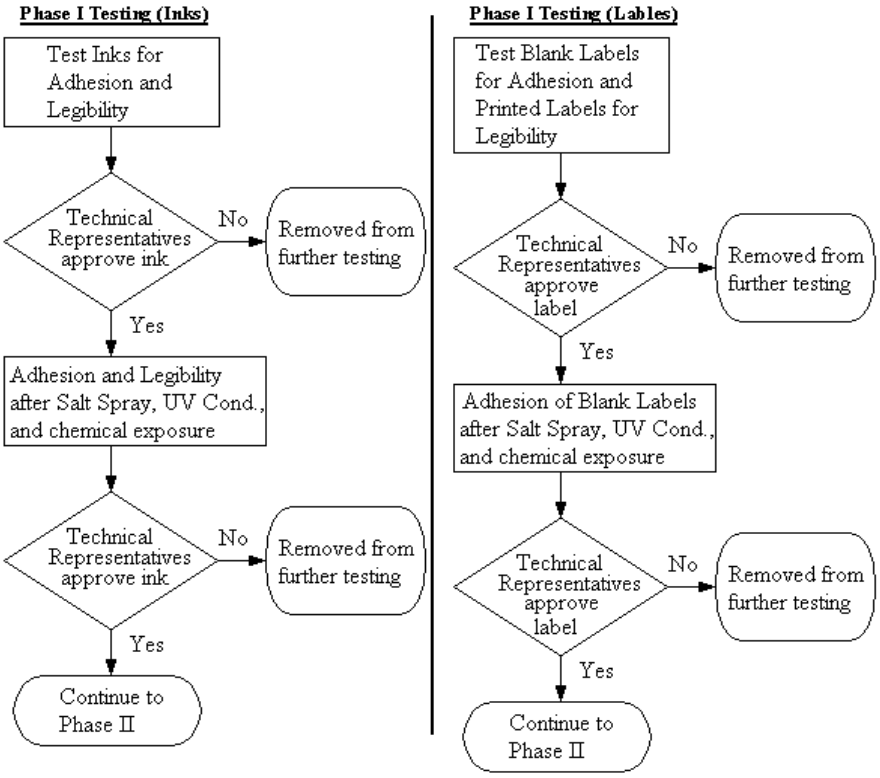


Figure 1. Test Flow for Phase I

During Phase II testing, printed labels were evaluated for adhesion and legibility after exposure to Salt Spray, UV Condensation, and exposure to common chemicals. Testing for exposure to common chemicals (chemical resistance) included those solutions listed under both common and extended requirements. The extended testing also included measuring adhesion and legibility after chemical exposure on the surface of project specific parts used in Lockheed Martin facilities. Refer to Figure 2 below for the process for testing and approving alternatives during Phase II of the validation.

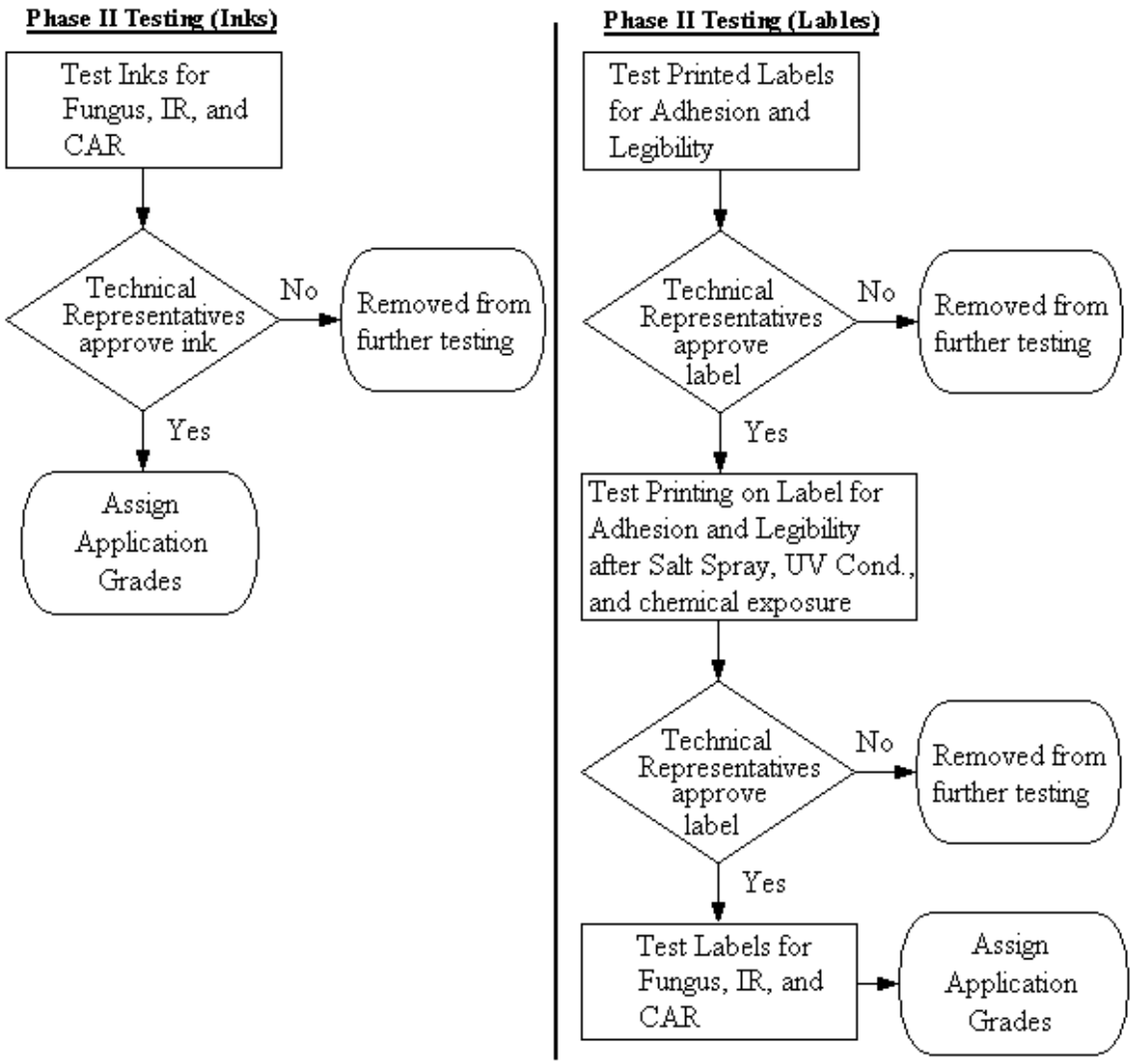


Figure 2. Decision Tree for Phase II Testing of Alternatives

The test parameters conducted during each part of each phase of testing are listed in Table 4.

Table 4. Description of Test Strategy Phases and Parts

Phase	Part	Description
I	A	Legibility and adhesion testing for alternative inks and the baseline ink, and adhesion testing for blank self-adhesive labels.
	B	All common (with the exception of legibility and adhesion testing) and extended testing (with the exception of fungus, infrared (IR) reflectance, and chemical agent resistance (CAR) testing) for alternative inks, the baseline ink, and blank self-adhesive labels.
II	C	Fungus, IR reflectance, and CAR testing for alternative inks. Part C was performed concurrently with Part F.
	D	Legibility and adhesion testing for printed self-adhesive labels.
	E	Common (with the exception of legibility and adhesion testing) and extended (with the exception of fungus, IR reflectance, and CAR testing) testing for printed self-adhesive labels.
	F	Fungus, IR reflectance, and CAR testing for printed self-adhesive labels.

Deviations from the JTP are described in Section 2.1. Tests performed in addition to the JTP tests are described in Section 2.2.

2.1 Deviations from JTP

Modifications to the JTP that were necessary during test execution are described below. The technical representatives approved these modifications.

Cleanliness measurements – Section 3 of the JTP requires that the cleanliness of each test panel be measured with an Omegameter before stenciling or labeling. To reduce costs and the time required for test execution, only 5% of the total number of test panels was evaluated for cleanliness before stenciling or labeling. The test panels were randomly selected from each of the substrate types.

SR panel preparation – Based on previous experience with the Patriot program at LM, silicone rubber (SR) substrates were cured at 204ºC (400ºF) for 4 hours prior to scuffing to enhance adhesion properties. This curing was not specified in the JTP.

ID Marking application – Identification markings are typically applied using stenciling with paint or ink, stamping, or silk screening. The method for applying markings onto substrates used for validation testing was not detailed in the JTP. Stenciling with a spray gun through a brass stencil was the preferred method due to ease of applying the marking, however, some ink alternatives were not easily sprayed. In those instances were spray stenciling was not acceptable, brush stenciling or stamping was attempted. For all alternative inks that were stamped, the inability to apply even pressure over the entire surface of the 4.25-inch by

5.25-inch stamp required to make the marking specified in the JTP caused portions of the imprint to be illegible. Therefore, during screening, legibility results were based on the inspection of that portion of the stamped impression that was visible. In addition, a second, smaller (1.25-inch by 2.25-inch) stamp with 10-point type was used to verify that the ink could be clearly stamped. Information on the preparation of test specimens can be found in Section 5 for each alternative.

Blank label adhesion testing – The labels were subjected to adhesion testing in accordance with JTP Section 3.3.1, which requires testing in accordance with Method A of ASTM D 3330-90. This test method requires applying the label to the panel and doubling back the free end of the tape for approximately one inch at a 180º angle. The label must be pulled back at least one inch past the edge of the panel to allow the upper jaws of the adhesion tester to grasp the label without hitting the panel. However, the short length of the labels made it impossible to exactly follow this test procedure; when the label is pulled back this far, less than two inches remain on the panel. Therefore, a testing fixture was designed and built by LM to perform the blank label adhesion tests (refer to Figure 3 and Figure 4). One end of the fixture was securely attached to the free 1-inch long end of the label, while the other end of the fixture fit securely in the adhesion tester's upper jaws. This test fixture was used for the test panels (as shown in Figure 4), as well as on the Javelin Launch Tube sections tested (as shown in Figure 5).

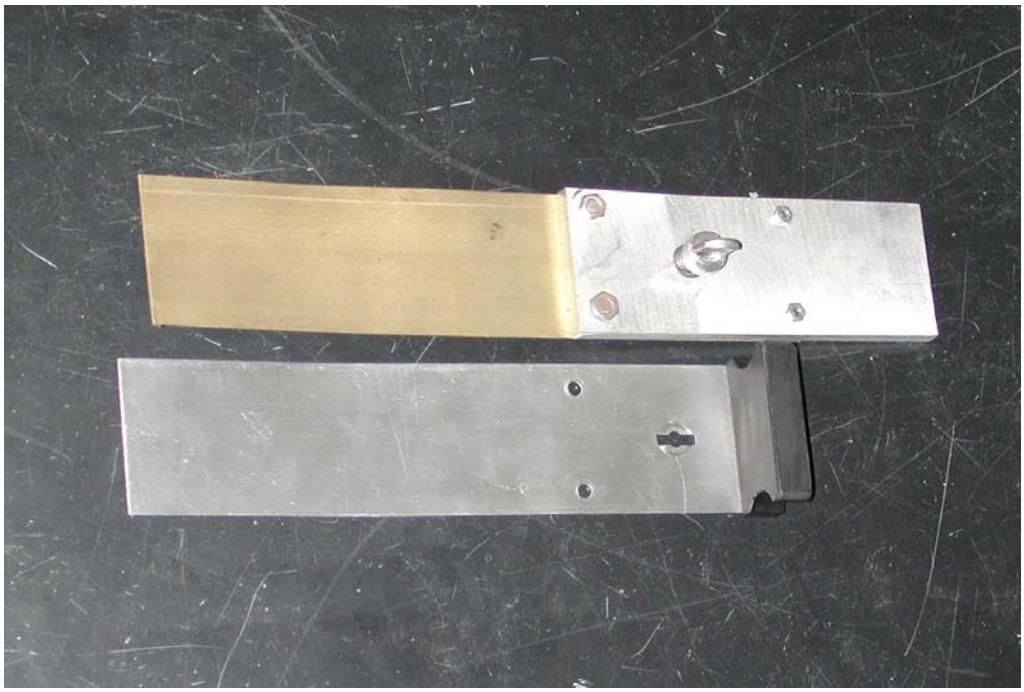


Figure 3. Test Fixture for Gripping Labels

The label fits into a groove on the underside of the top half of the fixture, and is held in place by attaching the bottom half of the fixture to the upper half. The right end of the upper half of the test fixture fits into the upper (moving) grips of the Instron test machine (refer to Figure 4).

Figure 4. The Label Holding Fixture in Use

The panel is held by the bottom jaws of the Instron test machine, and the top of the label holding fixture is held in the upper (moving) jaws of the Instron. This 180 degree peel test is approximately 40% complete.

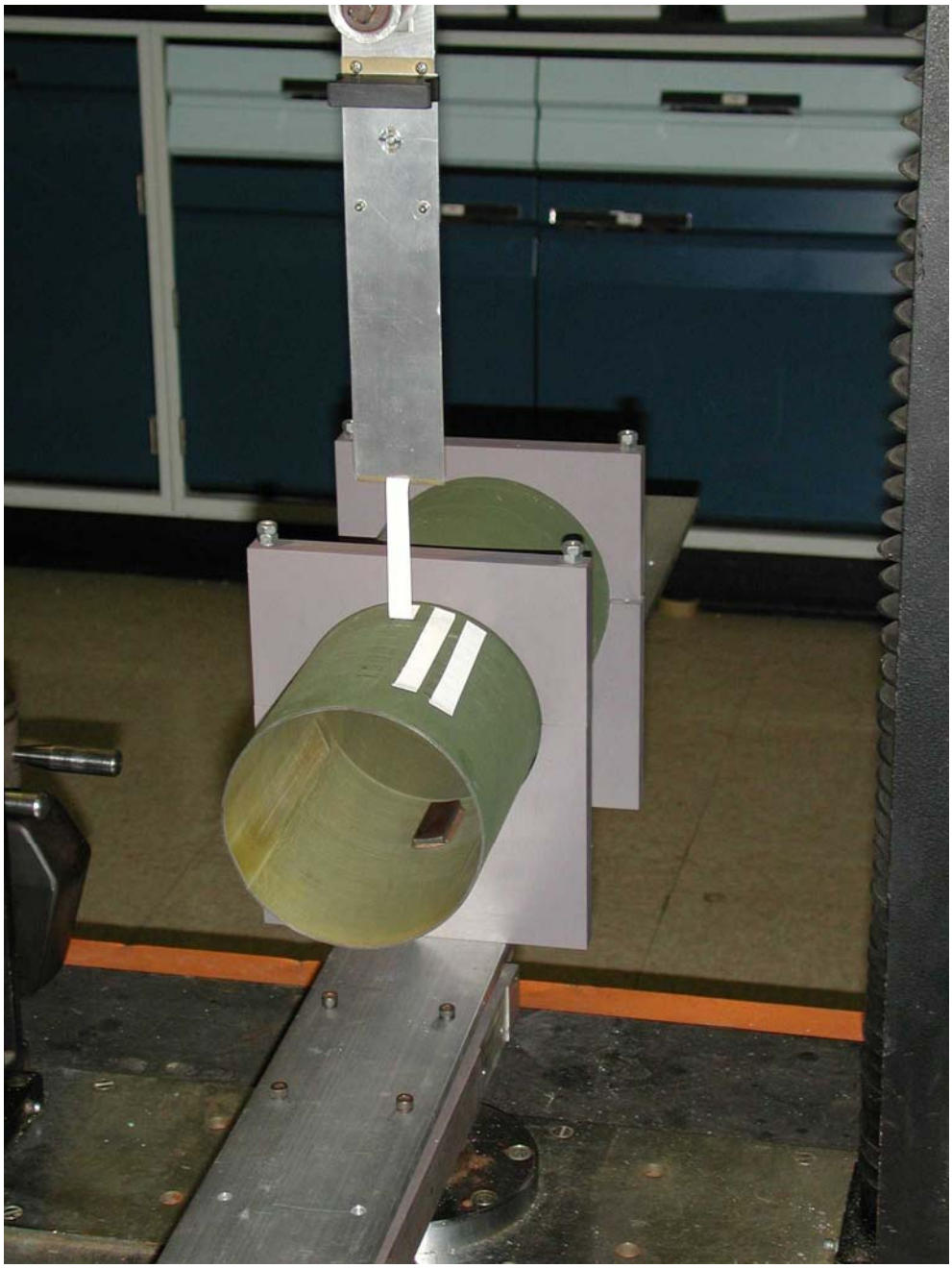


Figure 5. Javelin Launch Tube in Test Fixture
The labels on the launch tube are attached to the upper jaws of the Instron test machine using a custom-designed label holding fixture.

Corrosivity – The JTP requires that test specimens be placed into a glass jar, and then the uncovered glass jar be placed into a larger glass jar and a lid be screwed onto the larger jar. A glass jar with an opening large enough to accommodate the smaller glass jar could not be identified. Therefore, test specimens were placed in a polymethylpentene jar, which was then placed into a galvanized can, and then a lid was screwed onto the can.

Salt Spray Resistance – For blank labels, the JTP requires testing for adhesion after 48 hours of salt spray exposure, and examining the effects after 168 hours of salt spray exposure. However, because the labels performed so well during the testing, the adhesion testing was not performed until after 168 hours of exposure. Therefore, blank label adhesion results reported in this JTR are for 168 hours of salt spray exposure.

2.2 Tests Performed in Addition to Tests Defined in JTP

Section 2.2.1 and Section 2.2.2 describe testing performed in addition to the JTP testing. Section 2.2.1, Chemical Agent Resistance (CAR) Testing, was required by Tobyhanna Army Depot, which is one of the demonstration facilities. The CAR Testing is not required by representatives of the defense systems manufactured at LM. Section 2.2.2, Gas Chromatography/Mass Spectrometry (GC/MS), was required by the LM stakeholders to determine one ink's naphtha content.

2.2.1 Supplemental Test: Chemical Agent Resistance Testing (Agents HD and GD)

Test Description

This test measures the tendency of an alternative marking material to retain Agents HD and GD using the current Army-approved procedure for determining chemical agent resistance. The method uses gas chromatography as a mode of separation, collection, and detection of GD and HD on alternative inks and printed labels.

To prepare panels for testing, a grease pencil and a circular guide were used to draw a 5 cm^2 circular area on the CARC coated test panel. A microliter syringe was used to apply 50 µl of either CASARM grade GD or CASARM grade HD to that area. A glass cover slip was placed over the area of agent application to minimize evaporation of the agent. After 30 minutes, the panel was rinsed with 50 ml of isopropanol, allowed to air dry (approx. 45 sec.) and then placed in the test apparatus which was maintained at 25°C.

To conduct the test, five separate test cells are placed into a temperature controlled plexiglass box (approx. 0.5m x 0.5m x 1 m). The temperature is controlled by passing heated dry nitrogen through the box at a flow rate of 5L/minute. The dry nitrogen was pre-heated with a Miller-Nelson HCS401 temperature and humidity controller. Final temperature control was provided by a YSI model 72 proportional temperature controller. The temperature measured in the box was always within 0.05°C of the 25°C

target temperature. The five separate test cells, permitted the simultaneous evaluation of five CARC panels; usually four test panels and a control panel. Each panel was clamped into a two piece metal test cell, held in place with gas-tight O rings. Dry nitrogen (200 ml/min) was drawn through the test cell, across the contaminated area of the CARC panel, and through an impinger using a Tylan mass flow controller. For GD, the impinger was filled with 20 ml of iso-octane (2,2,4-trimethylpentane) and sample was collected for 6 hours. For HD, 20 ml of n-decane was used and sample was collected for 22 hours. After sample collection, the contents of the impinger were transferred to a 25 m1 volumetric flask. The impinger was rinsed twice with 2-3 ml of solvent (iso-octane for GD samples and decane for HD samples). Rinses were added to the volumetric flask which was made up to 25 m1. A 1 ml portion was then transferred to a GC vial and analyzed by GC-MS.

A Finnigan-MAT GCQ ion-trap mass spectrometer, equipped with a 25 meter MS-5 capillary column with helium as the carrier gas was used for the analysis. 1 ul samples were introduced onto the GC column in splitless mode using an AST 2000 autosampler, and an injector temperature of 280°°C. For GD, the GC column was temperature programmed from an initial temperature of 50°C, which was held for 2 minutes, then ramped at 5°C/minute to a final temperature of 100°C. Mass spectra were acquired in electron impact mode over the mass range 50-200. Under these conditions GD eluted as a pair of completely resolved diastereomeric enantiomers, with retention times of 9.56 and 10.04 minutes. Quantitation of GD was performed using integrated peak areas of the relevant portion of the reconstructed ion chromatograms for the ion at m/z 99. For HD, the GC column was temperature programmed from an initial temperature of 50°C, ramped at 10°C/minute to 120°C, and ramped again at 25°C/minute to a final temperature of 200°C. Mass spectra were acquired in electron impact mode over the mass range 50-150. Under these conditions HD had a retention time of 8.15 mm. Quantitation of HD was performed using integrated peak areas of the relevant portion of the reconstructed ion chromatograms for the ion at m/z 109.

Dilute standards of either GD or HD were prepared (GD in iso-octane and HD in decane) and used to construct a standard response curve. The slope, intercept and correlation coefficient of the standard response curves were calculated using the linear regression analysis function contained in an EXCEL spreadsheet. The slope and intercept of the standard response curve were used to calculate the concentration of GD or HD in each impinger solution. The total amount of GD or HD (in ug) off-gassing from the CARC panel was calculated by multiplying the concentration in the impinger solution (ug/ml) by the volume of the impinger solution (25m1).

Rationale

MIL-C-46168D (*Chemical Agent Resistant Aliphatic Polyurethane Coating*, issued May 21, 1993) requires this test for Agents HD and GD. Tobyhanna Army Depot, a demonstration facility for this project, requires that marking materials used on exterior and interior surfaces resist retention of Agents HD and GD. This test will be performed in accordance with the current Army-approved procedure. Only alternatives that passed the DS2 resistance test will be subjected to this test.

Test Methodology

	Agent HD	**Agent GD**
Parameters	None specified	None specified
Number and Type of Test Coupons	4 SS2 [3-inch by 3-inch stainless steel 302 (ASTM-A-240)]	4 SS2 [3-inch by 3-inch stainless steel 302 (ASTM-A-240)]
Trials Per Test Coupon	1	1
Acceptance Criteria	Desorb 180 micrograms (μg) maximum	Desorb 40 μg maximum

Unique Equipment and Instrumentation

- Fume hood.
- Temperature controlled plexiglass box with gas flow, temperature and humidity control.
- Impingers.
- Gas Chromatograph.

Data Analysis

- One color photograph of each exposed coupon shall be taken after the test.
- Report the amount of desorption of the chemical agent.

2.2.2 Gas Chromatography/Mass Spectrometry (GC/MS) Testing

Test Description

Gas chromatography/mass spectrometry (GC/MS) was performed on one alternative stenciling ink (DPI #311) to determine its naphtha content; naphtha was identified as an ingredient on the ink's Material Safety Data Sheet (MSDS), but the quantity was not specified.

Determine the constituents using U.S. Environmental Protection Agency (EPA) Method 8260B (*Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)*, Revision 2, dated December 1996).

> *Test summary*: Introduce ink sample into the gas chromatograph by purge-and-trap or another appropriate method. The ink is fed into a capillary column that is temperature-programmed to separate the constituents, which are then detected by a mass spectrometer interfaced with a gas chromatograph. Identify constituents by comparing the resulting mass spectra with standard (reference) spectra.

Rationale

The LM stakeholders required this test to determine the content of the naphtha contained in DPI #311. This information was not available from the vendor.

Test Methodology

Parameters	None specified
Number and Type of Samples	Analyze one ink sample (DPI #311)
Acceptance Criteria	None specified

Unique Equipment

- GC/MS equipment

Data Analysis and Reporting

- Report identified constituents.

3. ALTERNATIVES TESTED

The PAR contains descriptions of alternatives considered for testing and documents the selection of alternatives for testing. The alternative inks, as specified in the PAR, are listed in Table 5. The self-adhesive label alternatives are listed in Table 6.

Table 5. Baseline Ink and Alternative Inks Tested

Technology	Alternative	Vendor	Additional Information for Alternative Tested
Baseline Solventborne Ink	ACMI #6051 Ink	American Coding and Marking Ink Co.	Lot 990326 (black) and lot 990326 (white), with catalyst Lot 990224, thinned as required with ACMI #6051 thinner, Lot 990504
UV-Curable Ink	80 Series UV Curable Ink	Nor-Cote International	Phase I Screening: Product 80-1019, Lot 990302103 (black) and Product 80-1046, Lot 990304106 (white) Phase I Common and Extended: Product 80-1019, Lot 990302103 (black), thinned with Nor-Cote 80-070 thinner, Lot 990527117
	MSK-Series UV Curable Ink	Nor-Cote International	Product MSK-1019, Lot 990301105 (black) and Product MSK-1046, Lot 990305110 (white)
	UV3004	Polychem Corporation	Product UV-3004-14, Lot 151 (black) and Product UV-3004-240, Lot 195 (white)
Waterborne Ink	AERO No. 6565	Specialty Ink Company, Inc.	No lot information on label, thinned with AERO No. 6565 thinner as required
	CS7-56 Water Base Ink	Chemsong	Lot #A, thinned with water as required
	DPI #311 (referred to in the PAR as Permanent Opaque #311)	Dell Marking Systems, Inc.	Product DPI-311, Lot 014823 (black) and Lot 001524 (white)
	WB 2040M	Polychem Corporation	Product WB 2040M-Black, Lot 007848915 and Product WB 2040M-White, Lot 007848911
	WB82	Gem Gravure Company, Inc.	Product Black 20 Lot #125 and Product White 00, Lot 142
	Willmark #44	Willard Marking Devices Corporation	No lot information on bottle, thinned with Willmark Thinner E (no lot information)

Table 6. Self-adhesive Labels Tested

Technology	Alternative	Vendor	Additional Information for Alternative Tested
Self-Adhesive Labels	Brady B-107 Matte White Polyester (referred to in the PAR as Brady XB-107 Matte White Polyester; the name changed, but the material is the same)	W.H. Brady Company	Phase I testing: XB107/194727 Phase II testing: Product JET-26-107-25SH, Lot ANY00
	Brady B-423 Thermal Transfer Printable Glossy White Polyester Label Stock	W.H. Brady Company	Phase I testing: Lot 803-1Y-129408-1 Phase II testing: Product THT-21-423, Lot ABA00
	B-437 Thermal Transfer Printable Label Stock (referred to in the PAR as Brady XB-437 Thermal Transfer Printable Label Stock; the name changed, but the material is the same)	W.H. Brady Company	Phase I testing: B437/195007 Phase II testing: Product THT-21-437W, Lot RDR00
	Brady B-652 Printable High Temperature Label Stock	W.H. Brady Company	Phase I testing: B652/93/194728 Phase II testing: Product LAT-28-652, Lot 544229
	Brady B-652 Printable High Temperature Label Stock Brady B-747 Lasertab Markers	W.H. Brady Company	Phase I testing: B747/93WH/194729 Phase II testing: Product LAT-28-747-25SH, Lot RDB00
	Critchley Clear Polyester (TTP200CL-10) [referred to in the PAR as Critchley Clear Polyester (CR-100-CP); the name changed, but the material is the same]	Tyco Electronics (formerly Critchley, Inc.)	Phase I testing: Product TTP200CL-10 Phase II testing: Product TTP200CL-10, ID 3376-43E6
	Critchley Metallized Thermal Transfer (CR-104-MP)	Tyco Electronics	Phase I testing: Product TTP200MP-10 Phase II testing: Product TTP200MP-10, ID 3317-43E6

(Table 6 continued on next page)

Table 6. Self-adhesive Labels Tested (Continued)

Technology	Alternative	Vendor	Additional Information for Alternative Tested
Self-Adhesive Labels	Critchley White Polyester Film (CR-119-WP2.5)	Tyco Electronics	Phase I testing: Product TTP200WE-10 Phase II testing: Product TTP200WE-10, ID 3318-43E6
	Tyton 822	Hellermann Tyton	Phase I testing: Product C11-82207, Lot 26131 Phase II testing: Product C11-82207, Lot 28982
	Tyton 900	Hellermann Tyton	Phase I testing: Product C11-90008, Lot 26119 Phase II testing: Product C11-90008, Lot 28983

The baseline solventborne ink was found to contain 4-10% Methyl Isobutyl Ketone and 4-10% xylenes. MSDS information for the alternate inks indicates the presence of solvents such as propylene glycol, 2-butoxy ethanol, propylene glycol, 1,2,4-trimethyl benzene, cellusolve acetate, and others. A summary of the solvents present in each alternate ink can be found in Table 7 below. Additional information concerning the alternatives can be found in the PAR and in Appendix A.

Table 7. Identified Hazardous Constituents in Ink Alternatives

Alternate Ink	Constituent	CAS #	Percentage (wt%)
ACMI #6051 Ink Baseline Ink	Methyl Isobutyl Ketone Xylene	108-10- 1330-20-7	4-10 4-10
80 Series U.V. Curable Ink	Acrylated oligomers	N.P.	45-67
	N-Vinyl-2-pyrrolidone	88-12-0	6-26
	Acrylated monomers	N.P.	15-26
MSK-Series U.V. Curable Ink	Acrylated oligomers	N.P.	20-55
	n-Vinyl-2-pyrrolidone	88-12-0	12-25
	Acrylated monomers	N.P.	8-20
UV 3004	Cycloaliphatic epoxy	286-87-0	30-40
	Caprolactone polyol	37625-56-2	30-40
	Polycaprolactone triol Oxabuyclo [4.1.0.] heptane-3-carboxylic acid 7-oxabuyclo [4.1.0]	37625-56-2	5-15
	(3,4-Epoxycyclohexylmethyl)-3,4-epoxycyclohexylcarboxylate	2386-87-0	1-3
	Carbon black	1333-86-4	15-25
AERO No. 6565 INK	Ethylene glycol	107-21-1	18
CS7-56	Ammonium hydroxide	1336-21-6	N.P.
Film III Dense Black Ink	Ammonium hydroxide	1336-21-6	4.1
	n-propanol	71-23-8	5.5
Permanent Opaque #311	Propylene glycol ether	107-98-2	1 to 5
	1,2,4-trimethylbenzene	95-63-6	< 1
WB 2040M	Ammonia	7664-41-7	N.P.
	Propylene glycol	57-55-6	N.P.
	Dimethylethanolamine	108-01-0	N.P.
	2-Butoxyethanol	111-76-2	N.P.
Willmark #44	Cellusolve acetate	111-15-9	9
WB82 (Gem Gravure)	Confidential, trade-secret information		N.P.

N.P. = Not provided

4. TESTING BACKGROUND

All testing was performed in accordance with the JTP unless otherwise stated in this JTR. LM Missiles and Fire Control performed the majority of the testing summarized in this JTR, with the exceptions shown in Table 8.

Table 8. Testing Facilities

Testing	Facility
CAR and IR Reflectance	Army Research Laboratory, Aberdeen Proving Grounds, Maryland
DC Electrical Resistance and Color Matching (for IR Reflectance)	NDCEE/*CTC*, Johnstown, Pennsylvania
Fungus Resistance	Wyle Laboratories, Huntsville, Alabama
GC/MS	Kennedy Space Center, Florida
UV Light/Condensation	Atlas Weathering, Miami, Florida
All test specimen preparation and all other common and extended testing	LM Missiles and Fire Control, Orlando, Florida

Table 9 summarizes the substrates used for testing that are described in the JTP and referenced in this JTR. Text in italics in Table 9 is specific information concerning the substrate preparation that was not contained in the JTP. These clarifications to substrate descriptions do not modify the requirements of the JTP, but the additional information will enhance the ability of other facilities to reproduce the results contained in this JTR.

Table 9. Test Panel Specimen Codes and Substrate Descriptions

Panel Specimen Code	Substrate Descriptions (*)
AL1a	Aluminum alloy 2024, (QQ-A-250/4), cleaned, chromate conversion coated, primed *with MIL-P-23377 (to a dry film thickness of 0.8-1.2 mils), room-temperature cured for 1 to 24 hours,* topcoated *with MIL-C-46168 (to a dry film thickness of 1.8 mils minimum), room temperature cured for 15 minutes, and cured at 60ºC (140ºF) for 30 minutes*. AL1a was used for ink, blank label, and printed label tests.
AL1b	Aluminum alloy 2024, (QQ-A-250/4), cleaned, chromate conversion coated, primed *with MIL-P-23377 (to a dry film thickness of 0.8-1.2 mils), room-temperature cured for 1 to 24 hours,* topcoated *with MIL-C-53039 (to a dry film thickness of 1.8 mils minimum), room-temperature cured for 4 days, and cured at 104ºC (220ºF) for 3 days*. AL1b was used for blank label tests only.

(*) Text in italics is specific information concerning the substrate preparation that was not contained in the JTP.

(Table 9 continued on next page)

Table 9. Test Panel Specimen Codes and Substrate Descriptions (continued)

Panel Specimen Code	Substrate Descriptions (*)
AL1c	Aluminum alloy 2024, (QQ-A-250/4), cleaned, chromate conversion coated, primed *with MIL-P-23377 (to a dry film thickness of 0.8-1.2 mils), room-temperature cured for 1 to 24 hours,* topcoated *with MIL-C-85285 (to a dry film thickness of 1.8 to 2.4 mils minimum), room-temperature cured for at least 1 hour, and cured at 54ºC (130ºF) for 12 hours minimum*. AL1c was used for blank label tests only.
AL1d	Aluminum alloy 2024, (QQ-A-250/4), cleaned, chromate conversion coated, primed *with MIL-P-85582 (to a dry film thickness of 0.6-0.9 mils), room-temperature cured for 1 to 18 hours,* topcoated *with MIL-C-85285 (to a dry film thickness of 1.8 to 2.4 mils minimum), room-temperature cured for at least 1 hour, and cured at 54ºC (130ºF) for 12 hours minimum*. AL1d was used for blank label tests only.
AL1e	Aluminum alloy 2024, (QQ-A-250/4), cleaned, chromate conversion coated, primed *with MIL-P-85582 (to a dry film thickness of 0.6-0.9 mils), room-temperature cured for 1 to 18 hours,* topcoated *with MIL-C-22750 (to a dry film thickness of 0.8-2.0 mils), room-temperature cured for at least 20 minutes, and cured at 54ºC (130ºF) for 20 minutes minimum*. AL1e was used for blank label tests only.
AL2	Aluminum alloy, 6061-T6, (QQ-A-250/11), cleaned and chromate conversion coated *in accordance with MIL-C-5541*.
SS	Stainless steel 302, (ASTM-A-240), cleaned.
NR	Neoprene rubber, (AMS 3208), scuff to remove mold release or other foreign coating, and clean by wiping with acetone per O-A-51.
SR	Silicone rubber, (AMS 3347), *cured at 204ºC (400ºF) for 4 hours*, scuff to remove mold release or other foreign coating, and clean by wiping with acetone per O-A-51.
G/E	Glass/epoxy laminate, either custom fabricated in a suitable laboratory or purchased from a material supplier *[custom fabricated with DuPont N4000-6 epoxy prepreg and cured in a press for 90 minutes at approximately 250 psi and 182ºC (360ºF)]*, and cleaned by solvent wiping with alcohol per TT-I-735A.

(*) Text in italics is specific information concerning the substrate preparation that was not contained in the JTP.

(Table9 continued on next page)

Table 9. Test Panel Specimen Codes and Substrate Descriptions (continued)

Panel Specimen Code	Substrate Descriptions (*)
C/E	Carbon/epoxy laminate, either custom fabricated in a suitable laboratory facility or purchased from a material supplier *[custom fabricated with Fiberite MXG7620-2534 prepreg and vacuum bagged and cured in an autoclave at 100 psi and 93ºC (200ºF) for 4 hours]*, and cleaned by solvent wiping with acetone per O-A-51.
A/E	Aramid/epoxy laminate, (MIL-S-13949/15), unclad, either custom fabricated in a suitable laboratory facility or purchased from a material supplier *[custom fabricated with DuPont N4500-6T Thermount epoxy prepreg and cured in a press for 90 minutes at approximately 300 psi and 182ºC (360ºF)]*, cleaned by solvent wiping with acetone per O-A-51.

(*) Text in italics is specific information concerning the substrate preparation that was not contained in the JTP.

Black and white inks were used for testing. The black inks were used to stencil the AL1a, AL2, SS, SR, G/E, and A/E panels. The white inks were used on the NR and C/E panels to provide contrast with the black substrate.

Prior to Phase I screening, both the NR panels and the AL1e panels failed to meet the JTP cleanliness criterion of a maximum of 1.56 μg per square centimeter (cm^2) ionic contamination. Multiple trials with various cleaning solvents and with surface abrasion techniques (for NR panels) failed to resolve the problem. It is suspected that trace levels of ionic additives in the neoprene and the MIL-C-22750 were responsible for the slightly high resistivity measurements that were obtained for these two panel types. Subsequent ink and label adhesion results showed no evidence of substrate-induced adhesion failures for samples prepared from these panels. This failure to meet JTP cleanliness criteria occurred again prior to Phase I common and extended testing where both the AL1a and NR panels failed. The slightly high resistivity measurements obtained for these two panel types was attributed to trace levels of ionic additives in the neoprene and the MIL-C-46168. Again, subsequent ink and label adhesion results showed no evidence of substrate-induced adhesion failures for samples prepared from these panels. No panels failed to meet the cleanliness criterion during Phase II testing. Test panel cleanliness results are summarized in Appendix B.

5. TEST RESULTS: ALTERNATIVE INKS

Test results for the baseline ink and alternative inks are contained in this Section. MSK-Series UV Curable Ink, UV3004, WB 2040M, and WB82 were removed from consideration after initial screening tests. Table 10 summarizes the application grades (A, B, and/or C) for which each alternative ink met all common requirements on the individual substrate types.

Table 10. Alternative Inks and Application Grades

Technology	Alternative	Substrate[1]							
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E
Baseline Ink	ACMI #6051 Ink	A, B, C	NT	NT	NT	NT	A, B, C	NT	NT
UV-Curable Ink	80 Series UV Curable Ink	C	None	None	None	None	None	C	None
	MSK-Series UV Curable Ink[2]	None	None	None	None	None	None	None	None
	UV3004[2]	None	None	None	None	NT	None	None	None
Waterborne Ink	AERO No. 6565	C	None	None	None	NT	None	None	None
	CS7-56 Water Base Ink	C	None	None	None	NT	None	None	None
	DPI #311	A, B, C	A, B, C	A, B, C	C	NT	None	A, B, C	None
	WB 2040M[2]	None	None	None	None	NT	None	None	None
	WB82[2]	None	None	None	None	NT	None	None	None
	Willmark #44	A, B, C	C	C	C	NT	None	C	C

[1] Only common results are summarized in this table.
[2] Removed from consideration after initial screening tests.
NT – Not tested.

Section 5.1 through Section 5.10 contain details about test results for the baseline and alternative inks. Unless otherwise noted in the following Sections, no discoloration, wrinkling, corrosion, or other negative characteristics were observed. For example, during salt spray resistance testing, no visual evidence of substrate corrosion was noted for any of the test panels. Additional information concerning the fluids used for chemical resistance testing is contained in Appendix C.

5.1 Baseline: ACMI #6051 Ink (American Coding and Marking Ink Co.)

The ACMI #6051 Ink, a baseline ink containing 4–10% methyl isobutyl ketone and 4–10% xylene, was applied by spraying through a brass stencil. Results of common and extended testing are shown in Table 11 and Table 12, respectively. ACMI #6051 Ink met all common performance requirements.

ACMI #6051 Ink met all extended performance requirements for those tests performed and substrates required to be tested. Only a portion of IR Reflectance testing (JTP Section 3.1.7) was performed, because green ink was not available that could closely match the FED-STD-595B colors required. The JTP only required testing of the baseline ink on AL1 substrates, but the DC Electrical

Resistance testing was performed on G/E substrates instead, due to the nature of the test and of the AL1 substrate. Additionally, the CAR testing was performed on the SS substrate due to the requirements of the test. This ink exhibited acceptable chemical agent resistance when tested with the chemical agents HD and GD.

Table 11. Baseline (ACMI #6051 Ink) Screening and Common Results

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E
Screening									
3.1.8 Legibility	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.2 Adhesion	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
Common									
3.1.1 Abrasion (Scrub) Resistance	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.3 Chemical Resistance									
Isopropyl alcohol	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
Deionized water	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
Engine oil 21SAE20W	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
Flux/solder float, then terpene-based solvent	A, B	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.9 Salt Spray Resistance									
48-Hour Test	A	Pass	NR	NR	NR	NR	NR	NR	NR
168-Hour Test	A	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.10 Temperature Exposure and Thermal Shock Resistance									
-48ºC (-55ºF)	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
118ºC (244ºF)	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
Thermal Shock	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.11 UV Light/Condensation	A, B	Pass	NR	NR	NR	NR	NR	NR	NR

NR – Not required.

Table 12. Baseline (ACMI #6051 Ink) Extended Results

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E
Screening									
3.1.8 Legibility	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.2 Adhesion	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
Extended									
3.1.3 Chemical Resistance									
Coolanol	PS	Pass	NR	NR	NR	NR	NR	NR	NR
PAO	PS	Pass	NR	NR	NR	NR	NR	NR	NR
Hydraulic fluid (MIL-H-5606)	PS	Pass	NR	NR	NR	NR	NR	NR	NR
Lubricating oil (MIL-L-23699)	PS	Pass	NR	NR	NR	NR	NR	NR	NR
Skydrol	PS	Pass	NR	NR	NR	NR	NR	NR	NR
JP5 (MIL-T-5624)	PS	Pass	NR	NR	NR	NR	NR	NR	NR
DS2	PS	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.4 Corrosivity									
54°C (130ºF)	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
71°C (160ºF)	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
118°C (244ºF)	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.5 DC Electrical Resistance	A, B, C	NR	NR	NR	NR	NR	Pass	NR	NR
3.1.6 Fungus Resistance	A, B	5A[1]	NR	NR	NR	NR	NR	NR	NR
3.1.7 IR Reflectance									
FED-STD-595B # 34094 (Green 383)	A	NP[2]	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B #34095 (Field Green)	A	NP[2]	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B # 37030 (Black)	A	Pass[3]	NR	NR	NR	NR	NR	NR	NR

[1]Rating of 5A over entire specimen – no removal of ink. See Appendix E for complete results.
[2] Green ACMI #6051 Ink that could closely match FED-STD-595B #34094 or #34095 was not available for this test.
[3] Color matching test results are contained in Appendix D.
NP – Not performed.
NR – Not required.

(Table 12 continued on next page)

Table 12. Baseline (ACMI #6051 Ink) Extended Results (continued)

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E
Supplemental Test (JTR Section 2.2.1): CAR									
Agent HD	A, B	NR	NR	Pass	NR	NR	NR	NR	NR
Agent GD	A, B	NR	NR	Pass	NR	NR	NR	NR	NR

[1]Rating of 5A over entire specimen – no removal of ink. See Appendix E for complete results.
[2] Green ACMI #6051 Ink that could closely match FED-STD-595B #34094 or #34095 was not available for this test.
[3] Color matching test results are contained in Appendix D.
NP – Not performed.
NR – Not required.

5.2 80 Series UV Curable Ink (Nor-Cote International)

During Phase I Screening, 80 Series UV Curable Ink could not be applied by spray stenciling due to its high viscosity. Attempts to stencil the ink using a brush were also only marginally successful. This ink was successfully applied by stamping for the initial legibility and adhesion testing. For all alternative inks that were stamped, the inability to apply even pressure over the entire surface of the 4.25-inch by 5.25-inch stamp required to make the marking specified in the JTP caused portions of the imprint to be illegible. Therefore, during screening, legibility results were based on the inspection of that portion of the stamped impression that was visible. In addition, a second, smaller (1.25-inch by 2.25-inch) stamp with 10-point type was used to verify that the ink could be clearly stamped.

For the remainder of testing, this ink was thinned in accordance with the manufacturer's directions, and the ink was applied by spray stenciling.

Common and extended testing results for 80 Series UV Curable Ink are shown in Table 13 and Table 14, respectively. 80 Series UV Curable Ink met Grade C common performance requirements on AL1a and C/E substrates. This ink failed adhesion testing after chemical exposure (JTP Section 3.1.3) for other substrate types.

80 Series UV Curable Ink did not meet Grade A and Grade B common performance requirements for any substrate type due to its failure of chemical resistance testing (JTP Section 3.1.3) in the solder float/terpene-based solvent. If exposure to the solder float/terpene-based solvent can be avoided, 80 Series UV Curable Ink may also be suitable for Grade A and Grade B applications for AL1a and C/E substrates.

80 Series UV Curable Ink met Grade A, Grade B, and Grade C extended performance requirements on C/E and A/E substrates. This ink passed adhesion testing after chemical exposure (JTP Section 3.1.3) for AL1a, C/E, and A/E substrates, but failed adhesion testing after chemical exposure for other substrate types. 80 Series UV Curable Ink in Field Green (FED-STD-595B #34095) failed IR reflectance (JTP Section 3.1.7) when compared to aircraft requirements. 80 Series UV Curable Ink in Green 383 (FED-STD-595B #34094) failed IR reflectance when compared to ground support equipment requirements. 80 Series UV Curable Ink in black passed IR reflectance when compared to ground support equipment requirements.

80 Series UV Curable Ink exhibited acceptable chemical agent resistance when tested with the chemical agents HD and GD.

Table 13. 80 Series UV Curable Ink Screening and Common Testing Results

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	**AL2**	**SS**	**NR**	**SR**	**G/E**	**C/E**	**A/E**
Screening									
3.1.8 Legibility	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.2 Adhesion	A, B, C	Pass	Pass	Pass	Pass[1]	Pass[1]	Pass	Pass	Pass
Common									
3.1.1 Abrasion (Scrub) Resistance	A, B, C	Pass	Pass	Pass	**Fail**	**Fail**	Pass	Pass[2]	Pass[2]
3.1.3 Chemical Resistance									
Isopropyl alcohol	A, B, C	Pass[2]	**Fail**	**Fail**	**Fail**	Pass[2]	**Fail**	Pass	Pass
Deionized water	A, B, C	Pass	Pass	Pass	Pass	Pass[2]	**Fail**	Pass	Pass
Engine oil 21SAE20W	A, B, C	Pass	**Fail**	Pass[2]	Pass	Pass	**Fail**	Pass	**Fail**
Flux/solder float, then terpene-based solvent	A, B	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***
3.1.9 Salt Spray Resistance									
48-Hour Test	A	Pass	Pass[2]	NR	NR	NR	Pass[2]	NR	NR
168-Hour Test	A	Pass	Pass[2]	NR	NR	NR	Pass	NR	NR
3.1.10 Temperature Exposure and Thermal Shock Resistance									
-48ºC (-55ºF)	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
118ºC (244ºF)	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
Thermal Shock	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.11 UV Light/Condensation	A, B	Pass[3]	NR	NR	NR	NR	NR	NR	NR

[1] Visible ink removal. Marking remained legible.
[2] Visible ink removal but still legible.
[3] Failure on two of three coupons between paint and substrate (no failure between ink and paint).
NR – Not required.
* No test – Ink removed by solvent.

Table 14. 80 Series UV Curable Ink Extended Testing Results

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	**AL2**	**SS**	**NR**	**SR**	**G/E**	**C/E**	**A/E**
Screening									
3.1.8 Legibility	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.2 Adhesion	A, B, C	Pass	Pass	Pass	Pass[1]	Pass[1]	Pass	Pass	Pass
Extended									
3.1.3 Chemical Resistance									
Coolanol	PS	Pass	Pass	Pass	Pass	Pass[2]	Pass[2]	Pass	Pass
PAO	PS	Pass	**Fail**	**Fail**	Pass	**Fail**	**Fail**	Pass	Pass
Hydraulic fluid (MIL-H-5606)	PS	Pass	**Fail**	Pass[2]	Pass	**Fail**	Pass[2]	Pass	Pass[2]
Lubricating oil (MIL-L-23699)	PS	Pass	**Fail**	Pass[2]	Pass	Pass[2]	Pass[2]	Pass	Pass
Skydrol	PS	Pass[2]	**Fail**	Pass[2]	**Fail***	**Fail**	**Fail**	Pass	Pass
JP5 (MIL-T-5624)	PS	Pass	Pass[2]	**Fail**	Pass	Pass[2]	**Fail***	Pass	Pass
DS2	PS	Pass[2]	**Fail**	**Fail**	Pass[2]	Pass[2]	Pass[2]	Pass[2]	Pass[2]
3.1.4 Corrosivity									
54°C (130ºF)	A, B, C	Pass	Pass	Pass	NR	NR	NR	NR	NR
71°C (160ºF)	A, B, C	Pass[3]	Pass	Pass	NR	NR	NR	NR	NR
118°C (244ºF)	A, B, C	Pass[3]	Pass	Pass	NR	NR	NR	NR	NR
3.1.5 DC Electrical Resistance	A, B, C	NR	NR	NR	NR	NR	Pass	NR	NR
3.1.6 Fungus Resistance	A, B	NR	5A/4A[4]	NR	NR	NR	NR	NR	NR

[1] Visible ink removal. Marking remained legible.
[2] Visible ink removal but still legible.
[3] Visual evidence of ink blistering.
[4] Rating of 5A over 2 sections of the specimen and 4A over the third section. See Appendix E for complete results.
NR – Not required.
PS – Dependent on program-specific requirements.
* No test – Ink removed by solvent.

(Table 14 continued on next page)

Table 14. 80 Series UV Curable Ink Extended Testing Results (continued)

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E
3.1.7 IR Reflectance									
FED-STD-595B # 34094 (Green 383)	A	**Fail**	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B #34095 (Field Green)	A	**Fail**	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B # 37030 (Black)	A	Pass	NR	NR	NR	NR	NR	NR	NR
Supplemental Test (JTR Section 2.2.1): CAR									
Agent HD	A, B	NR	NR	Pass	NR	NR	NR	NR	NR
Agent GD	A, B	NR	NR	Pass	NR	NR	NR	NR	NR

[1] Visible ink removal. Marking remained legible.
[2] Visible ink removal but still legible.
[3] Visual evidence of ink blistering.
[4] Rating of 5A over 2 sections of the specimen and 4A over the third section. See Appendix E for complete results.
NR – Not required.
PS – Dependent on program-specific requirements.
* No test – Ink removed by solvent.

5.3 MSK-Series UV Curable Ink (Nor-Cote International)

MSK-Series UV Curable Ink could not be applied by spray stenciling due to its high viscosity. Attempts to stencil the ink using a brush were also only marginally successful. This ink was successfully applied by stamping for the legibility and adhesion testing. For all alternative inks that were stamped, the inability to apply even pressure over the entire surface of the 4.25-inch by 5.25-inch stamp required to make the marking specified in the JTP caused portions of the imprint to be illegible. Therefore, during screening, legibility results were based on the inspection of that portion of the stamped impression that was initially visible. In addition, a second, smaller (1.25-inch by 2.25-inch) stamp with 10-point type was used to verify that the ink could be clearly stamped.

Screening results are shown in Table 15. After screening, the technical representatives agreed to remove this ink from consideration because it failed adhesion testing on SS and SR substrates. The other alternatives that continued testing either passed adhesion testing on all substrates or failed only the G/E substrate.

Table 15. MSK-Series UV Curable Ink Screening Testing Results

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	**AL2**	**SS**	**NR**	**SR**	**G/E**	**C/E**	**A/E**
Screening									
3.1.8 Legibility	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.2 Adhesion	A, B, C	Pass	Pass	**Fail**	Pass[1]	**Fail**	Pass	Pass	Pass

[1] Visible ink removal. Marking remained legible.
NR – Not required.

5.4 UV3004 (Polychem Corporation)

UV3004 could not be applied by spray stenciling due to its low viscosity, which resulted in rapid slump of the applied ink and an illegible marking. Attempts to stencil the ink using a brush were also only marginally successful. The ink was then successfully applied by stamping for the legibility and adhesion testing. For all alternative inks that were stamped, the inability to apply even pressure over the entire surface of the 4.25-inch by 5.25-inch stamp required to make the marking specified in the JTP caused portions of the imprint to be illegible. Therefore, during screening, legibility results were based on the inspection of that portion of the stamped impression that was initially visible. In addition, a second, smaller (1.25-inch by 2.25-inch) stamp with 10-point type was used to verify that the ink could be clearly stamped.

UV3004 had to be cured immediately after stamping to maintain legibility; any deviation of the panel surface from horizontal resulted in rapid ink slumping, particularly for the non-porous substrates (i.e., AL2, SS, G/E, and A/E).

G/E panels used for the screening tests had a very smooth, resin-rich surface. UV3004 was applied to both as-received and sanded glass/epoxy surfaces. Adhesion properties of the ink did not appear to be improved by the sanding.

Screening results are shown in Table 16. After screening, the technical representatives agreed to remove this ink from consideration because it failed adhesion testing on NR and G/E substrates. The other alternatives tested that continued testing either passed the adhesion testing on all substrates or failed only on the G/E substrate. Additionally, this ink was removed from consideration because of the ink sagging that occurred after application and prior to curing.

Table 16. UV3004 Screening Testing Results

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	**AL2**	**SS**	**NR**	**SR**	**G/E**	**C/E**	**A/E**
Screening									
3.1.8 Legibility	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.2 Adhesion	A, B, C	Pass	Pass	Pass	**Fail**	NR	**Fail**	Pass	Pass

NR – Not required.

5.5 AERO No. 6565 (Specialty Ink Company, Inc.)

AERO No. 6565 was applied by spraying through a brass stencil. Common and extended testing results are shown in Table 17 and Table 18, respectively.

AERO No. 6565 met Grade C common requirements on AL1a substrates. It failed adhesion testing after chemical exposure (JTP Section 3.1.3) for the other substrate types.

AERO No. 6565 did not meet Grade A and Grade B requirements for any substrate type due to its failure of chemical resistance testing (JTP Section 3.1.3) in a solder float/terpene-based solvent. If exposure to a solder float/terpene-based solvent can be avoided, AERO No. 6565 may also be suitable for Grade A and Grade B applications on AL1a substrates. Note that AERO No. 6565 failed the 48-hour salt spray corrosion resistance test (JTP Section 3.1.9) on G/E substrates, where legibility and adhesion are required, so this may limit the acceptance for Grade A applications.

As shown in Table 17, AERO No. 6565 met Grade A, Grade B, and Grade C extended performance requirements on AL1a and A/E substrates. It failed adhesion testing after chemical exposure testing (JTP Section 3.1.3) for the other substrate types. Only a portion of IR Reflectance testing (JTP Section 3.1.7) was performed, because green ink was not available that could closely match the FED-STD-595B colors required. AERO No. 6565 in black passed IR reflectance when compared to ground support equipment requirements.

AERO No. 6565 ink exhibited acceptable chemical agent resistance when tested with the chemical agents HD and GD.

Table 17. AERO No. 6565 Screening and Common Testing Results

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E
Screening									
3.1.8 Legibility	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.2 Adhesion	A, B, C	Pass	Pass	Pass	Pass	NR	**Fail**	Pass	Pass
Common									
3.1.1 Abrasion (Scrub) Resistance	A, B, C	Pass	Pass	Pass	**Fail**	NR	**Fail**	Pass	Pass
3.1.3 Chemical Resistance									
Isopropyl alcohol	A, B, C	Pass[1]	**Fail**	**Fail**	Pass[1]	NR	**Fail**	**Fail**	**Fail**
Deionized water	A, B, C	Pass	Pass	Pass	Pass[1]	NR	**Fail**	Pass	Pass
Engine oil 21SAE20W	A, B, C	Pass	Pass	Pass	**Fail**	NR	**Fail**	Pass	Pass
Flux/solder float, then terpene-based solvent	A, B	**Fail***	**Fail***	**Fail***	**Fail***	NR	**Fail***	**Fail***	**Fail***
3.1.9 Salt Spray Resistance									
48-Hour Test	A	Pass	Pass	NR	NR	NR	**Fail**	NR	NR
168-Hour Test	A	Pass	Pass	NR	NR	NR	Pass	NR	NR
3.1.10 Temperature Exposure and Thermal Shock Resistance									
-48ºC (-55ºF)	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
118ºC (244ºF)	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
Thermal Shock	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.11 UV Light/Condensation	A, B	Pass	NR	NR	NR	NR	NR	NR	NR

NR – Not required.
[1] Visible ink removal but still legible.
* No test – Ink removed by solvent.

Table 18. AERO No. 6565 Extended Testing Results

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E
Screening									
3.1.8 Legibility	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.2 Adhesion	A, B, C	Pass	Pass	Pass	Pass	NR	**Fail**	Pass	Pass
Extended									
3.1.3 Chemical Resistance									
Coolanol	PS	Pass	Pass	Pass	**Fail***	NR	**Fail**	Pass	Pass
PAO	PS	Pass	Pass	Pass	Pass	NR	**Fail**	Pass	Pass
Hydraulic fluid (MIL-H-5606)	PS	Pass	Pass	Pass	Pass[1]	NR	**Fail**	Pass	Pass[1]
Lubricating oil (MIL-L-23699)	PS	Pass[1]	Pass	Pass	Pass	NR	**Fail**	Pass	Pass
Skydrol	PS	Pass	**Fail***	**Fail***	Pass	NR	**Fail**	**Fail***	Pass[1]
JP5 (MIL-T-5624)	PS	Pass	Pass	Pass	Pass	NR	**Fail**	Pass	Pass
DS2	PS	Pass[1]	**Fail**	Pass[1]	Pass[1]	NR	**Fail**	Pass[1]	Pass[1]
3.1.4 Corrosivity									
54°C (130ºF)	A, B, C	Pass	Pass	Pass	NR	NR	NR	NR	NR
71°C (160ºF)	A, B, C	Pass	Pass	Pass[2]	NR	NR	NR	NR	NR
118°C (244ºF)	A, B, C	Pass	Pass	Pass[2]	NR	NR	NR	NR	NR
3.1.5 DC Electrical Resistance	A, B, C	NR	NR	NR	NR	NR	Pass	NR	NR
3.1.6 Fungus Resistance	A, B	NR	5A[3]	NR	NR	NR	NR	NR	NR

[1] Visible ink removal but still legible.
[2] Visual evidence of ink blistering.
[3] Rating of 5A over entire specimen – no removal of ink. See Appendix E for complete results.
[4] The standard green AERO No. 6565 Ink did not match FED-STD-595B #34094 or #34095 (custom colors were not available from the vendor).
[5] Refer to Appendix D for color matching testing results.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.
* No test – Ink removed by solvent.

(Table 18 continued on next page)

Table 18. AERO No. 6565 Extended Testing Results (continued)

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E
3.1.7 IR Reflectance									
FED-STD-595B # 34094 (Green 383)	A	NP[4,5]	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B #34095 (Field Green)	A	NP[4,5]	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B # 37030 (Black)	A	Pass[5]	NR	NR	NR	NR	NR	NR	NR
Supplemental Test (JTR Section 2.2.1): CAR									
Agent HD	A, B	NR	NR	Pass	NR	NR	NR	NR	NR
Agent GD	A, B	NR	NR	Pass	NR	NR	NR	NR	NR

[1] Visible ink removal but still legible.
[2] Visual evidence of ink blistering.
[3] Rating of 5A over entire specimen – no removal of ink. See Appendix E for complete results.
[4] The standard green AERO No. 6565 Ink did not match FED-STD-595B #34094 or #34095 (custom colors were not available from the vendor).
[5] Refer to Appendix D for color matching testing results.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.
* No test – Ink removed by solvent.

5.6 CS7-56 Water Base Ink

CS7-56 Water Base Ink was applied by stamping for Phase I screening. For all alternative inks that were stamped, the inability to apply even pressure over the entire surface of the 4.25-inch by 5.25-inch stamp required to make the marking specified in the JTP caused portions of the imprint to be illegible. Therefore, this ink was applied to the panels using a small (1.25-inch by 2.25-inch) rubber stamp with 10-point type. Subsequent tests that were performed on a limited number of panels (one SS, one AL2, one G/E, one A/E, and one NR panel) verified that the material could be successfully applied by spray stenciling. Panels prepared by both stamping and by stenciling met the adhesion requirements of JTP Section 3.1.2.

Common and extended testing results are shown in Table 19 and Table 20, respectively.

CS7-56 Water Base Ink met Grade C performance requirements on AL1a substrates. This ink failed adhesion testing after chemical exposure (JTP Section 3.1.3) for the other substrate types.

CS7-56 Water Base Ink did not meet Grade A and Grade B requirements for any substrate type due to its failure of chemical resistance testing (JTP Section 3.1.3) with a solder float/terpene-based solvent. If exposure to the solder float/terpene-based solvent can be avoided, CS7-56 Water Base Ink may also be suitable for Grade A and Grade B applications on AL1a substrates. Note that CS7-56 Water Base Ink failed the 48-hour salt spray corrosion resistance test (JTP Section 3.1.9) on G/E substrates, where legibility and adhesion are required, so this may limit the acceptance for Grade A applications.

As shown in Table 20, CS7-56 Water Base Ink met extended performance requirements on AL1a, NR, and A/E substrates. This ink failed the DC Electrical Resistance test on G/E substrates, so applications where a short circuit may occur between electronic components should be avoided. Other failures occurred during adhesion testing after chemical exposure (JTP Section 3.1.3) for the other substrate types. Only a portion of IR Reflectance testing (JTP Section 3.1.7) was performed, because green ink was not available. CS7-56 Water Base Ink in black passed IR reflectance when compared to ground support equipment requirements.

CS7-56 Water Base Ink exhibited acceptable chemical agent resistance when tested with the chemical agents HD and GD.

Table 19. CS7-56 Water Base Ink Screening and Common Testing Results

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	**AL2**	**SS**	**NR**	**SR**	**G/E**	**C/E**	**A/E**
Screening									
3.1.8 Legibility	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.2 Adhesion	A, B, C	Pass	Pass	Pass	Pass[1]	NR	Pass	Pass	Pass
Common									
3.1.1 Abrasion (Scrub) Resistance	A, B, C	Pass	Pass	Pass	**Fail**	NR	**Fail**	Pass	Pass
3.1.3 Chemical Resistance									
Isopropyl alcohol	A, B, C	Pass[2]	**Fail**	**Fail**	**Fail**	NR	**Fail**	**Fail**	**Fail**
Deionized water	A, B, C	Pass	Pass	Pass	Pass[2]	NR	**Fail**	Pass	Pass
Engine oil 21SAE20W	A, B, C	Pass	Pass	Pass	**Fail**	NR	**Fail**	Pass	Pass
Flux/solder float, then terpene-based solvent	A, B	**Fail***	**Fail***	**Fail***	**Fail***	NR	**Fail***	**Fail***	**Fail***
3.1.9 Salt Spray Resistance									
48-Hour Test	A	Pass	Pass	NR	NR	NR	**Fail**	NR	NR
168-Hour Test	A	Pass	Pass[2]	NR	NR	NR	Pass	NR	NR
3.1.10 Temperature Exposure and Thermal Shock Resistance									
-48ºC (-55ºF)	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
118ºC (244ºF)	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
Thermal Shock	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.11 UV Light/Condensation	A, B	Pass	NR	NR	NR	NR	NR	NR	NR

[1] Visible ink removal. Marking remained legible.
[2] Visible ink removal but still legible.
NR – Not required.
* No test – Ink removed by solvent.

Table 20. CS7-56 Water Base Ink Extended Testing Results

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E
Screening									
3.1.8 Legibility	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.2 Adhesion	A, B, C	Pass	Pass	Pass	Pass[1]	NR	Pass	Pass	Pass
Extended									
3.1.3 Chemical Resistance									
Coolanol	PS	Pass	Pass	Pass	Pass	NR	**Fail**	Pass	Pass
PAO	PS	Pass	Pass	Pass	Pass	NR	**Fail**	Pass	Pass
Hydraulic fluid (MIL-H-5606)	PS	Pass	Pass	Pass	Pass[2]	NR	**Fail**	Pass	Pass[2]
Lubricating oil (MIL-L-23699)	PS	Pass	Pass[2]	Pass[2]	Pass[2]	NR	**Fail**	Pass[2]	Pass[2]
Skydrol	PS	Pass	**Fail**	**Fail**	Pass	NR	**Fail***	**Fail***	Pass[2]
JP5 (MIL-T-5624)	PS	Pass	Pass	Pass	Pass	NR	Pass[2]	Pass	Pass
DS2	PS	Pass[2]	**Fail***	Pass[2]	Pass[2]	NR	**Fail**	**Fail**	Pass[2]
3.1.4 Corrosivity									
54°C (130ºF)	A, B, C	Pass	Pass	Pass	NR	NR	NR	NR	NR
71°C (160ºF)	A, B, C	Pass	Pass	Pass	NR	NR	NR	NR	NR
118°C (244ºF)	A, B, C	Pass	Pass	Pass	NR	NR	NR	NR	NR
3.1.5 DC Electrical Resistance	A, B, C	NR	NR	NR	NR	NR	**Fail**	NR	NR
3.1.6 Fungus Resistance	A, B	NR	5A[3]	NR	NR	NR	NR	NR	NR

[1] Visible ink removal. Marking remained legible.
[2] Visible ink removal but still legible.
[3] Rating of 5A over entire test specimen – no removal of ink. See Appendix E for complete test results.
[4] Green CS7-56 Water Base Ink is not available (green is not a standard color and custom colors were not available from the vendor).
[5] Refer to Appendix D for color matching testing results.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.
* No test – Ink removed by solvent.

(Table 20 continued on next page)

Table 20. CS7-56 Water Base Ink Extended Testing Results (continued)

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E
3.1.7 IR Reflectance									
FED-STD-595B # 34094 (Green 383)	A	NP[4]	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B #34095 (Field Green)	A	NP[4]	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B # 37030 (Black)	A	Pass[5]	NR	NR	NR	NR	NR	NR	NR
Supplemental Test (JTR Section 2.2.1): CAR									
Agent HD	A, B	NR	NR	Pass	NR	NR	NR	NR	NR
Agent GD	A, B	NR	NR	Pass	NR	NR	NR	NR	NR

[1] Visible ink removal. Marking remained legible.
[2] Visible ink removal but still legible.
[3] Rating of 5A over entire test specimen – no removal of ink. See Appendix E for complete test results.
[4] Green CS7-56 Water Base Ink is not available (green is not a standard color and custom colors were not available from the vendor).
[5] Refer to Appendix D for color matching testing results.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.
* No test – Ink removed by solvent.

5.7 DPI #311 (Dell Marking Systems, Inc.)

DPI #311 ink was applied by spraying through a brass stencil. Common and extended testing results are shown in Table 21 and Table 22, respectively.

DPI #311 met Grade C common performance requirements on AL1a, AL2, SS, NR, and C/E substrates. It also met Grade A and Grade B common performance requirements on AL1a, AL2, SS, and C/E substrates. This ink failed adhesion testing after chemical exposure testing (JTP Section 3.1.3) for the other substrate types. Note that DPI #311 ink failed the 48-hour salt spray corrosion resistance test (JTP Section 3.1.9) on G/E substrates, where legibility and adhesion are required, so this may limit the acceptance for Grade A applications.

As shown in Table 22, DPI #311 ink met Grade A, Grade B, and Grade C extended performance requirements for AL1a, AL2, SS, and NR substrates. This ink failed adhesion testing after chemical exposure (JTP Section 3.1.3) for the other substrate types. Only a portion of IR Reflectance testing (JTP Section 3.1.7) was performed, because green ink was not available that could closely match the FED-STD-595B colors required. DPI #311 ink in black passed IR reflectance when compared to ground support equipment requirements.

DPI #311 ink exhibited acceptable chemical agent resistance when tested with the chemical agents HD and GD.

Additionally, GC/MS testing in accordance with Section 2.2.2 was used to determine the naphtha content of this ink. This testing was conducted to identify the major constituents found in this alternative. The major peaks corresponded to the following constituents:

- Total xylenes
- Trimethylbenzenes
- Other alkyl substituted benzenes
- Various substituted siloxanes.

Table 21. DPI #311 Screening and Common Testing Results

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E
Screening									
3.1.8 Legibility	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.2 Adhesion	A, B, C	Pass	Pass	Pass	Pass	NR	Pass[1]	Pass	Pass
Common									
3.1.1 Abrasion (Scrub) Resistance	A, B, C	Pass	Pass	Pass	Pass[2]	NR	**Fail**	Pass	Pass[2]
3.1.3 Chemical Resistance									
Isopropyl alcohol	A, B, C	Pass	Pass	Pass	Pass	NR	**Fail**	Pass[2]	**Fail**
Deionized water	A, B, C	Pass	Pass	Pass	Pass[2]	NR	**Fail**	Pass	Pass
Engine oil 21SAE20W	A, B, C	Pass	Pass	Pass	Pass	NR	**Fail**	Pass	Pass
Flux/solder float, then terpene-based solvent	A, B	Pass	Pass	Pass	**Fail***	NR	Pass	Pass	**Fail***
3.1.9 Salt Spray Resistance									
48-Hour Test	A	Pass	Pass	NR	NR	NR	**Fail**	NR	NR
168-Hour Test	A	Pass	Pass	NR	NR	NR	Pass	NR	NR
3.1.10 Temperature Exposure and Thermal Shock Resistance									
-48ºC (-55ºF)	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
118ºC (244ºF)	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
Thermal Shock	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.11 UV Light/Condensation	A, B	Pass	NR	NR	NR	NR	NR	NR	NR

[1] Visible ink removal. Marking remained legible.
[2] Visible ink removal but still legible.
NR – Not required.
* No test – Ink removed by solvent.

Table 22. DPI #311 Extended Testing Results

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E
Screening									
3.1.8 Legibility	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.2 Adhesion	A, B, C	Pass	Pass	Pass	Pass	NR	Pass[1]	Pass	Pass
Extended									
3.1.3 Chemical Resistance									
Coolanol	PS	Pass	Pass	Pass	Pass	NR	**Fail**	Pass	Pass
PAO	PS	Pass	Pass	Pass	Pass	NR	**Fail**	Pass	Pass
Hydraulic fluid (MIL-H-5606)	PS	Pass	Pass	Pass	Pass[2]	NR	**Fail**	Pass	Pass[2]
Lubricating oil (MIL-L-23699)	PS	Pass	Pass	Pass	Pass	NR	**Fail**	Pass	Pass[2]
Skydrol	PS	Pass	Pass	Pass	Pass	NR	**Fail***	**Fail***	**Fail***
JP5 (MIL-T-5624)	PS	Pass	Pass	Pass	Pass	NR	**Fail**	Pass	Pass
DS2	PS	Pass	Pass	Pass[2]	Pass	NR	**Fail**	Pass	Pass
3.1.4 Corrosivity									
54°C (130ºF)	A, B, C	Pass	Pass	Pass	NR	NR	NR	NR	NR
71°C (160ºF)	A, B, C	Pass	Pass	Pass	NR	NR	NR	NR	NR
118°C (244ºF)	A, B, C	Pass	Pass	Pass	NR	NR	NR	NR	NR
3.1.5 DC Electrical Resistance	A, B, C	NR	NR	NR	NR	NR	Pass	NR	NR
3.1.6 Fungus Resistance	A, B	NR	5A[3]	NR	NR	NR	NR	NR	NR

[1] Visible ink removal. Marking remained legible.
[2] Visible ink removal but still legible.
[3] Rating of 5A over entire specimen – no removal of ink. See Appendix E for complete test results.
[4] The standard green DPI #311 ink did not match FED-STD-595B #34094 or #34095 (custom colors were not available from this vendor).
[5] Refer to Appendix D for color matching testing results.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.
* No test – Ink removed by solvent.

(Table 22 continued on next page)

Table 22. DPI #311 Extended Testing Results (continued)

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E
3.1.7 IR Reflectance									
FED-STD-595B # 34094 (Green 383)	A	NP[4,5]	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B #34095 (Field Green)	A	NP[4,5]	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B # 37030 (Black)	A	Pass[5]	NR	NR	NR	NR	NR	NR	NR
Supplemental Test (JTR Section 2.2.1): CAR									
Agent HD	A, B	NR	NR	Pass	NR	NR	NR	NR	NR
Agent GD	A, B	NR	NR	Pass	NR	NR	NR	NR	NR

[1] Visible ink removal. Marking remained legible.
[2] Visible ink removal but still legible.
[3] Rating of 5A over entire specimen – no removal of ink. See Appendix E for complete test results.
[4] The standard green DPI #311 ink did not match FED-STD-595B #34094 or #34095 (custom colors were not available from this vendor).
[5] Refer to Appendix D for color matching testing results.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.
* No test – Ink removed by solvent.

5.8 WB 2040M (Polychem Corporation)

WB 2040M was applied by spraying through a brass stencil. The screening results are shown in Table 23. After screening, the technical representatives agreed to remove this ink from consideration because it failed adhesion testing on NR and G/E substrates. The other alternatives tested that continued with testing either passed adhesion testing on all substrates or failed only on the G/E substrate.

Table 23. WB 2040M Screening Testing Results

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	**AL2**	**SS**	**NR**	**SR**	**G/E**	**C/E**	**A/E**
Screening									
3.1.8 Legibility	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.2 Adhesion	A, B, C	Pass	Pass	Pass[1]	**Fail**	NR	**Fail**	Pass	Pass

[1] Visible ink removal. Marking remained legible.
NR – Not required.

5.9 WB82 (Gem Gravure Company, Inc.)

WB82 was applied by stamping and by spraying through a brass stencil. The screening test results are shown in Table 24. After screening, the technical representatives agreed to remove this ink from consideration because it failed adhesion testing on the G/E substrate and only had marginal performance on the NR substrate. The other alternatives that continued with testing either passed adhesion testing on all substrates or failed only on the G/E substrate.

Table 24. WB82 Screening Testing Results

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	**AL2**	**SS**	**NR**	**SR**	**G/E**	**C/E**	**A/E**
Screening									
3.1.8 Legibility	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.2 Adhesion – stenciling	A, B, C	Pass	Pass	Pass	Pass[1]	NR	**Fail**	Pass	Pass
3.1.2 Adhesion – stamping		Pass	Pass	Pass	Pass	NR	**Fail**	Pass	Pass

[1] Visible ink removal. Marking remained legible.
NR – Not required.

5.10 Willmark #44 (Willard Marking Devices Corporation)

During screening, Willmark #44 could not be applied by spray stenciling due to its high viscosity. Attempts to stencil the ink using a brush were also only marginally successful. This ink was successfully applied by stamping for the legibility and adhesion testing. For all alternative inks that were stamped, the inability to apply even pressure over the entire surface of the 4.25-inch by 5.25-inch stamp required to make the marking specified in the JTP caused portions of the imprint to be illegible. Therefore, during screening, legibility results were based on the inspection of that portion of the stamped impression that was visible. In addition, a second, smaller (1.25-inch by 2.25-inch) stamp with 10-point type was used to verify that the ink could be clearly stamped.

During screening, Willmark #44 failed adhesion testing on G/E substrates. G/E panels used in screening had a very smooth, resin-rich surface. Willmark #44 was applied to both as-received and sanded glass/epoxy surfaces. Adhesion properties of the ink did not appear to be improved by the sanding.

For the remainder of testing, this ink was thinned per the manufacturer's directions and applied by spray stenciling.

Common and extended testing results are shown in Table 25 and Table 26, respectively.

Willmark #44 met Grade A, Grade B, and Grade C common performance requirements on AL1a substrates. It failed on the other substrates during adhesion (JTP Section 3.1.2), abrasion (JTP Section 3.1.1), and/or chemical resistance (JTP Section 3.1.3) testing.

As shown in Table 26, Willmark #44 met extended performance requirements on AL1a substrates. This ink failed adhesion testing after chemical exposure (JTP Section 3.1.3) for the other substrate types. Only a portion of IR Reflectance testing (JTP Section 3.1.7) was performed, because green ink was not available that could closely match the FED-STD-595B colors required. Willmark #44 ink in black passed IR reflectance when compared to ground support equipment requirements.

Willmark #44 ink exhibited acceptable chemical agent resistance when tested with the chemical agent HD but failed testing with agent GD.

Table 25. Willmark #44 Screening and Common Testing Results

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E
Screening									
3.1.8 Legibility	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.2 Adhesion	A, B, C	Pass	Pass	Pass	Pass	NR	**Fail**	Pass	Pass
Common									
3.1.1 Abrasion (Scrub) Resistance	A, B, C	Pass	Pass	Pass	Pass	NR	**Fail**	Pass	Pass
3.1.3 Chemical Resistance									
Isopropyl alcohol	A, B, C	Pass	Pass	Pass	Pass	NR	**Fail**	Pass	Pass
Deionized water	A, B, C	Pass	Pass	Pass	Pass[1]	NR	**Fail**	Pass	Pass
Engine oil 21SAE20W	A, B, C	Pass	Pass	Pass	Pass	NR	**Fail**	Pass	Pass
Flux/solder float, then terpene-based solvent	A, B	Pass	**Fail**	**Fail**	**Fail**	NR	**Fail**	**Fail**	**Fail**
3.1.9 Salt Spray Resistance									
48-Hour Test	A	Pass	Pass	NR	NR	NR	**Fail**	NR	NR
168-Hour Test	A	Pass	Pass	NR	NR	NR	Pass	NR	NR
3.1.10 Temperature Exposure and Thermal Shock Resistance									
-48ºC (-55ºF)	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
118ºC (244ºF)	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
Thermal Shock	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.11 UV Light/Condensation	A, B	Pass[2]	NR	NR	NR	NR	NR	NR	NR

[1] Visible ink removal but still legible.
[2] Failure on one of three coupons between paint and substrate (no failure between ink and paint).
NR – Not required.
* No test – Ink removed by solvent.

Table 26. Willmark #44 Extended Testing Results

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E
Screening									
3.1.8 Legibility	A, B, C	Pass	NR	NR	NR	NR	NR	NR	NR
3.1.2 Adhesion	A, B, C	Pass	Pass	Pass	Pass	NR	**Fail**	Pass	Pass
Extended									
3.1.3 Chemical Resistance									
Coolanol	PS	Pass	Pass	Pass	Pass	NR	**Fail**	Pass	Pass
PAO	PS	Pass	Pass	Pass	Pass	NR	**Fail**	Pass	Pass
Hydraulic fluid (MIL-H-5606)	PS	Pass	**Fail**	**Fail**	Pass	NR	**Fail**	Pass	**Fail**
Lubricating oil (MIL-L-23699)	PS	Pass	Pass[1]	**Fail**	Pass	NR	**Fail**	Pass[1]	**Fail**
Skydrol	PS	Pass	**Fail***	**Fail***	**Fail***	NR	**Fail***	**Fail***	**Fail***
JP5 (MIL-T-5624)	PS	Pass	Pass	**Fail**	Pass[1]	NR	Pass	Pass	**Fail**
DS2	PS	Pass	Pass	Pass	Pass	NR	**Fail**	Pass	Pass
3.1.4 Corrosivity									
54°C (130ºF)	A, B, C	Pass	Pass	Pass	NR	NR	NR	NR	NR
71°C (160ºF)	A, B, C	Pass	Pass	Pass	NR	NR	NR	NR	NR
118°C (244ºF)	A, B, C	Pass	Pass	Pass	NR	NR	NR	NR	NR
3.1.5 DC Electrical Resistance	A, B, C	NR	NR	NR	NR	NR	Pass	NR	NR
3.1.6 Fungus Resistance	A, B	NR	5A[2]	NR	NR	NR	NR	NR	NR

[1] Visible ink removal but still legible.
[2] Rating of 5A over entire specimen – no removal of ink from specimen. See Appendix E for the complete table of results.
[3] The special order green Willmark #44 did not match FED-STD-595B #34094 or #34095 (custom colors were not available from the vendor).
[4] Refer to Appendix D for the color matching testing results.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.
* No test – Ink removed by solvent.

(Table 26 continued on next page)

Table 26. Willmark #44 Extended Testing Results (continued)

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E
3.1.7 IR Reflectance									
FED-STD-595B # 34094 (Green 383)	A	NP[3,4]	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B #34095 (Field Green)	A	NP[3,4]	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B # 37030 (Black)	A	Pass[4]	NR	NR	NR	NR	NR	NR	NR
Supplemental Test (JTR Section 2.2.1): CAR									
Agent HD	A, B	NR	NR	Pass	NR	NR	NR	NR	NR
Agent GD	A, B	NR	NR	**Fail**	NR	NR	NR	NR	NR

[1] Visible ink removal but still legible.
[2] Rating of 5A over entire specimen – no removal of ink from specimen. See Appendix E for the complete table of results.
[3] The special order green Willmark #44 did not match FED-STD-595B #34094 or #34095 (custom colors were not available from the vendor).
[4] Refer to Appendix D for the color matching testing results.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.
* No test – Ink removed by solvent.

6. TEST RESULTS: SELF-ADHESIVE LABELS

The self-adhesive labels with the printer technology for which each is intended are listed in Table 27. Table 27 also summarizes the application grades (A, B, and/or C) for which each self-adhesive label metal all common requirements on the individual substrate types.

Section 6.1 through Section 6.10 contain details about the test results for the self-adhesive labels. Label tests were performed at least 24 hours but no more than 28 hours after label application. It should be noted that many of the labels took on high static charges when they were separated from the backing materials. In some cases, small amounts of nearby dust and lint were attracted to the label's adhesive. This should be considered if the labels are being considered for electrostatic discharge (ESD)-sensitive printed wiring boards.

Unless otherwise noted in the following sections, no discoloration, wrinkling, corrosion, or other negative characteristics were observed during testing. For example, during salt spray resistance testing, no visual evidence of substrate corrosion was noted for any of the test panels. Additional information concerning the fluids used for chemical resistance testing is contained in Appendix C.

Table 27. Self-Adhesive Labels and Application Grades

Name	Printer Technology	Substrate[1,2]											
		AL1a	AL1b	AL1c	AL1d	AL1e	AL2	SS	NR	SR	G/E	C/E	A/E
Brady B-107 Matte White Polyester	Ink Jet	C	A, B, C	A, B, C	A, B, C	A, B, C	C	C	C	None	C	C	C
Brady B-423 Thermal Transfer Printable Glossy White Polyester Label Stock	Thermal Transfer	C	A, B, C	A, B, C	A, B, C	A, B, C	C	C	None	C	C	C	C
Brady B-437 Thermal Transfer Printable Label Stock	Thermal Transfer	C	A, B, C	A, B, C	A, B, C	A, B, C	C	C	C	None	C	C	C
Brady B-652 Printable High Temperature Label Stock	Laser	C	A, B, C	A, B, C	A, B, C	A, B, C	A, B, C	A, B, C	None	None	None	A, B, C	A, B, C
Brady B-747 Lasertab Markers	Laser	C	A, B, C	A, B, C	A, B, C	A, B, C	C	C	C	None	C	C	C
Critchley Clear Polyester (TTP200CL-10)	Thermal Transfer	C	None	A, B, C	A, B, C	A, B, C	C	C	None	None	C	C	C
Critchley Metallized Thermal Transfer (CR-104-MP)	Thermal Transfer	C	A, B, C	A, B, C	A, B, C	A, B, C	C	C	C	None	C	C	C
Critchley White Polyester Film (CR-119-CP2.5)	Thermal Transfer	C	A, B, C	A, B, C	A, B, C	A, B, C	C	C	C	None	C	C	C
Tyton 822	Thermal Transfer	C	A, B, C	A, B, C	A, B, C	A, B, C	C	C	C	None	C	C	C
Tyton 900	Thermal Transfer	None	A, B, C	A, B, C	A, B, C	A, B, C	C	C	C	None	C	C	C

[1] Only common results for blank and printed labels are summarized in this table.
[2] If solder float/terpene-based solvent chemical exposure results are disregarded, all Application “C”s in this table change to Application “A, B, C”s.

6.1 Brady B-107 Matte White Polyester (W.H. Brady Company)

Screening, common, and extended testing results for blank Brady B-107 labels are shown in Table 28, Table 29, and Table 30, respectively. During screening, Brady B-107 failed only on SR substrates.

Table 28. Brady B-107 Screening Results: Blank Labels[1]

Substrate	JTP Section 3.3.1 Average Adhesion, Ounces/Inch Width (Standard Deviation in parentheses)	Pass/Fail
AL1a	36.9 (0.8)	Pass
AL1b	27.4 (4.3)	Pass
AL1c	36.3 (1.2)	Pass
AL1d	35.8 (1.4)	Pass
AL1e	80.6 (2.4)	Pass
AL2	49.3 (2.7)	Pass
SS	47.9 (2.3)	Pass
NR	38.1 (2.7)	Pass
SR	**10.9 (2.9)**	**Fail**
G/E	25.3 (2.2)	Pass
C/E	38.9 (1.2)	Pass
A/E	35.2 (4.2)	Pass

[1] Ink Jet Printable Matte White Polyester Label Stock (Refer to Table 6 for detailed description or specification of this label).
AL1a - MIL-P-23377/MIL-C-46168
AL1b - MIL-P-23377/MIL-C-53039
AL1c - MIL-P-23377/MIL-C-85285
AL1d - MIL-P-85582/MIL-C-85285
AL1e - MIL-P-85582/MIL-C-22750

As shown in Table 29, blank Brady B-107 labels met Grade C common performance requirements on all substrates except SR. Brady B-107 failed chemical resistance testing (JTP Section 3.3.2) for the solder flux/terpene-based solvent, which is a requirement for Grade A and Grade B applications. During this test, the blank label decomposed due to exposure to the elevated temperature of the solder bath. If exposure to solder flux can be avoided, this blank label may be considered for Grade A and Grade B applications on all but the SR substrate.

As shown in Table 30, blank Brady B-107 labels met the extended requirements on all but SR substrates for those tests performed. Brady B-107 also failed adhesion testing on a curved surface coated with MIL-C-46168 (JTP Section 3.3.1). Blank Brady B-107 labels were not available in the FED-STD-595B colors required for IR reflectance testing (JTP Section 3.3.5). Additionally, W.H. Brady Company representatives indicated that coloring the label stock would change the label's performance.

Table 29. Brady B-107 Common Testing Results: Blank Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E
Screening									
3.3.1 Adhesion (baseline adhesive strengths)[2]	A, B, C	36.9	49.3	47.9	38.1	**Fail 10.9**	25.3	38.9	35.2
Common									
3.3.2 Chemical Resistance									
Isopropyl alcohol[2]	A, B, C	38.7	70.8	62.8	42.5	**Fail 8.4**	27.6	52.2	44.3
Deionized water[2]	A, B, C	39.0	65.8	62.4	36.6	**Fail 12.9**	25.4	51.6	48.9
Engine oil 21SAE20W[2]	A, B, C	41.2	73.2	66.6	37.8	18.7	32.5	62.9	48.8
Flux/solder float, then terpene-based solvent	A, B	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***
3.3.6 Salt Spray Resistance									
48-Hour Test[2]	A	45.6	83.7	70.6	NR	NR	NR	NR	NR
168-Hour Test[2]	A	54.2	84.8	78.4	NR	NR	NR	NR	NR
3.3.7 Temperature Exposure and Thermal Shock Resistance									
-48ºC (-55ºF)[2]	A, B, C	43.2	NR	NR	NR	NR	NR	NR	NR
118ºC (244ºF)[2]	A, B, C	60.0	NR	NR	NR	NR	NR	NR	NR
Thermal Shock	A, B, C	46.0	NR	NR	NR	NR	NR	NR	NR
3.3.8 UV Light/Condensation[2]	A, B	48.7	NR	NR	NR	NR	NR	NR	NR

[1] Ink Jet Printable Matte White Polyester Label Stock (Refer to Table 6 for detailed description or specification of this label)
[2] Average adhesion in ounces per inch label width.
NR – Not required.
* Label destroyed during solder float; no adhesion test.

Table 30. Brady B-107 Extended Testing Results: Blank Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate								
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E	Other[4]
Screening										
3.3.1 Adhesion (baseline adhesive strengths)[2]	A, B, C	36.9	49.3	47.9	38.1	**Fail 10.9**	25.3	38.9	35.2	NR
Extended										
3.3.1 Adhesion (Program-specific parts)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	**Fail 12.1**
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	31.3
3.3.2 Chemical Resistance										
Coolanol[2]	PS	50.8	84.9	64.8	34.6	24.4	40.9	59.8	47.4	NR
PAO[2]	PS	59.9	85.3	67.4	33.6	21.2	37.2	59.4	45.0	NR
Hydraulic fluid (MIL-H-5606)[2]	PS	40.2	71.4	64.4	31.8	**Fail 4.7**	37.7	61.9	49.4	NR
Lubricating oil (MIL-L-23699)[2]	PS	40.3	81.7	66.8	31.8	**Fail 12.1**	30.4	63.0	50.0	NR
Skydrol[2]	PS	40.9	85.8	66.9	25.0	18.9	34.0	61.7	46.4	NR
JP5 (MIL-T-5624)[2]	PS	41.0	86.7	63.2	29.8	18.4	37.3	59.7	44.4	NR
DS2[2]	PS	42.8	90.8	69.9	40.0	20.3	41.6	64.8	56.0	NR
3.3.3 Corrosivity										
54°C (130ºF)[2]	A, B, C	45.9	82.3	81.0	NR	NR	NR	NR	NR	NR
71°C (160ºF)[2]	A, B, C	53.4	74.4	95.7	NR	NR	NR	NR	NR	NR
118°C (244ºF)[2]	A, B, C	59.0	70.0	51.2	NR	NR	NR	NR	NR	NR

[1] Ink Jet Printable Matte White Polyester Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Average adhesion in ounces per inch label width.
[3] Required FED-STD colors were not available. Vendor indicated that coloring the label stock would change the label's performance.
[4] Javelin Launch Tube for testing adhesion to curved surfaces.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.

(Table 30 continued on next page)

Table 30. Brady B-107 Extended Testing Results: Blank Labels (continued)[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate								
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E	Other[4]
3.3.4 DC Electrical Resistance	A, B, C	NR	NR	NR	NR	NR	Pass	Pass	Pass	NR
3.3.5 IR Reflectance										
FED-STD-595B # 34094 (Green 383)	A	NP[3]	NR	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B #34095 (Field Green)	A	NP[3]	NR	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B # 37030 (Black)	A	NP[3]	NR	NR	NR	NR	NR	NR	NR	NR
3.3.7 Temperature Exposure and Thermal Shock Resistance (program-specific parts)										
-48ºC (-55ºF)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	26.3
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	35.1
118ºC (244ºF)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	24.5
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	37.4
Thermal Shock										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	31.7
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	42.0

[1] Ink Jet Printable Matte White Polyester Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Average adhesion in ounces per inch label width.
[3] Required FED-STD colors were not available. Vendor indicated that coloring the label stock would change the label's performance.
[4] Javelin Launch Tube for testing adhesion to curved surfaces.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.

The common and extended testing results for printed Brady B-107 labels are shown in Table 31 and Table 32, respectively. During screening, the adhesion test results for the ink-jet-printed Brady B-107 were marginal; the label image was still legible at the conclusion of the test, but examination of the underside of the adhesive tape indicated that some of the ink had been removed from the label. Additionally, the ink easily smeared immediately after printing.

Printed Brady B-107 labels met Grade C common performance requirements. Similar to testing the blank Brady B-107 labels, the printed Brady B-107 labels failed chemical resistance testing (JTP Section 3.3.2) for the solder flux/terpene-based solvent, which is a requirement for Grade A and Grade B applications. During this test, the label thermally decomposed. If exposure to solder flux can be avoided, this printed label may be considered for Grade A and Grade B applications.

As shown in Table 31, printed Brady B-107 labels met the extended performance requirements, except for chemical agent resistance. Only a portion of IR Reflectance testing (JTP Section 3.2.5) was performed, because green printing ink was not available that could closely match the FED-STD-595B colors required. Brady B-107 labels printed with black ink passed IR reflectance when compared to ground support equipment requirements.

Printed Brady B-107 labels failed chemical agent resistance when tested with the chemical agents HD and GD.

Table 31. Brady B-107 Common Testing Results: Printed Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate
		AL1a
Screening		
3.2.2 Adhesion	A, B, C	Pass [2]
3.2.6 Legibility	A, B, C	Pass
Common		
3.2.1 Abrasion (Scrub) Resistance	A, B, C	Pass
3.2.3 Chemical Resistance		
Isopropyl alcohol	A, B, C	Pass
Deionized water	A, B, C	Pass
Engine oil 21SAE20W	A, B, C	Pass
Flux/solder float, then terpene-based solvent	A, B	**Fail[3]**
3.2.7 Salt Spray Resistance		
48-Hour Test	A	Pass
168-Hour Test	A	Pass
3.2.8 Temperature Exposure and Thermal Shock Resistance		
-48ºC (-55ºF)	A, B, C	Pass
118ºC (244ºF)	A, B, C	Pass
Thermal Shock	A, B, C	Pass
3.2.9 UV Light/Condensation	A, B	Pass

[1] Ink Jet Printable Matte White Polyester Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Some ink removed during tape test; sample still legible
[3] Label destroyed during solder float.

Table 32. Brady B-107 Extended Testing Results: Printed Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate	
		AL1a	SS
Screening			
3.2.2 Adhesion	A, B, C	Pass [2]	NR
3.2.6 Legibility	A, B, C	Pass	NR
Extended			
3.2.3 Chemical Resistance			
Coolanol	PS	Pass	NR
PAO	PS	Pass	NR
Hydraulic fluid (MIL-H-5606)	PS	Pass	NR
Lubricating oil (MIL-L-23699)	PS	Pass	NR
Skydrol	PS	Pass	NR
JP5 (MIL-T-5624)	PS	Pass	NR
DS2	PS	Pass[3]	NR
3.2.4 Fungus Resistance	A, B	5A/1A/2A[4]	NR
3.2.5 IR Reflectance			
FED-STD-595B # 34094 (Green 383)	A	NP[5]	NR
FED-STD-595B #34095 (Field Green)	A	NP[5]	NR
FED-STD-595B # 37030 (Black)	A	Pass[6]	NR
Supplemental Test (JTR Section 2.2.1): CAR			
Agent HD	A, B	NR	**Fail**
Agent GD	A, B	NR	**Fail**

[1] Ink Jet Printable Matte White Polyester Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Some ink removed during tape test; sample still legible
[3] Legible, but visible damage to ink by solvent.
[4] Rating ranging from 5A to 1A over test specimen. See Appendix E for complete results.
[5] Green HP 51629A Ink that could closely match FED-STD-595B #34094 or #34095 was not available.
[6] Refer to Appendix D for the color matching testing results.
NP – This test was not performed because the blank label did not meet the IR reflectance requirement (required FED-STD colors not available).
NR – Not required.
PS – Dependent on program-specific requirements.

6.2 Brady B-423 Thermal Transfer Printable Glossy White Polyester Label Stock (W.H. Brady Company)

Screening, common, and extended testing results for blank Brady B-423 labels are shown in Table 33, Table 34, and Table 35, respectively. During screening, blank Brady B-423 labels failed on NR substrates; however, during subsequent common

and extended testing, the adhesive strength was higher than that observed during screening. This increase in adhesive strength is believed to be a result of increased curing time (i.e., time between label application and adhesion testing).

Table 33. Brady B-423 Screening Results: Blank Labels[1]

Substrate	JTP Section 3.3.1 Average Adhesion, Ounces/Inch Width (Standard Deviation in parentheses)	Pass/Fail
AL1a	33.1 (10.5)	Pass
AL1b	39.7 (1.8)	Pass
AL1c	41.3 (1.4)	Pass
AL1d	40.1 (1.1)	Pass
AL1e	66.3 (5.2)	Pass
AL2	74.2 (6.6)	Pass
SS	63.7 (2.5)	Pass
NR	**1.4 (0.2)**	**Fail**
SR	18.2 (2.2)	Pass
G/E	23.8 (0.6)	Pass
C/E	43.0 (2.0)	Pass
A/E	42.9 (1.8)	Pass

[1] Thermal Transfer Printable Glossy White Polyester Label Stock (Refer to Table 6 for detailed description or specification of this label).
AL1a - MIL-P-23377/MIL-C-46168
AL1b - MIL-P-23377/MIL-C-53039
AL1c - MIL-P-23377/MIL-C-85285
AL1d - MIL-P-85582/MIL-C-85285
AL1e - MIL-P-85582/MIL-C-22750

As shown in Table 34, blank Brady B-423 labels met Grade C common performance requirements on AL1a, AL2, SS, SR, G/E, C/E, and A/E substrates. The only failure that occurred during common testing on the blank label was on the NR substrate during adhesion testing. Brady B-423 did not meet Grade A and Grade B requirements for any substrate due to its failure of chemical resistance testing (JTP Section 3.3.2) for the solder float/terpene-based solvent. During this test, the blank label decomposed due to exposure to the elevated temperature of the solder bath. If exposure to solder flux can be avoided, this blank label may also be suitable for Grade A and Grade B applications on all but NR substrates.

As shown in Table 35, blank Brady B-423 labels met extended requirements for Grade B and Grade C applications for AL1a, AL2, SS, G/E, C/E, and A/E substrates. It failed chemical resistance testing (JTP Section 3.3.2) on NR and SR substrates. Blank Brady B-423 labels also failed low-temperature exposure testing on a curved surface coated with MIL-C-46148 (JTP Section 3.3.7). Blank Brady B-423 labels were not available in the FED-STD-595B colors required for IR reflectance testing (JTP Section 3.3.5). Additionally, W.H. Brady Company

representatives indicated that coloring the label stock would change its performance requirements.

Table 34. Brady B-423 Common Testing Results: Blank Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E
Screening									
3.3.1 Adhesion (baseline adhesive strengths)[2]	A, B, C	33.1	74.2	63.7	**Fail 1.4**	18.2	23.8	43.0	42.9
Common									
3.3.2 Chemical Resistance									
Isopropyl alcohol[2]	A, B, C	36.5	92.6	77.3	21.1	18.0	40.7	68.8	42.4
Deionized water[2]	A, B, C	30.0	89.1	85.5	24.4	19.2	44.6	64.8	45.3
Engine oil 21SAE20W[2]	A, B, C	42.2	91.3	63.7	22.6	19.6	49.2	79.0	47.8
Flux/solder float, then terpene-based solvent	A, B	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***
3.3.6 Salt Spray Resistance									
48-Hour Test[2]	A	40.2	92.4	93.5	NR	NR	NR	NR	NR
168-Hour Test[2]	A	51.4	92.6	93.1	NR	NR	NR	NR	NR
3.3.7 Temperature Exposure and Thermal Shock Resistance									
-48ºC (-55ºF)[2]	A, B, C	39.6	NR	NR	NR	NR	NR	NR	NR
118ºC (244ºF)[2]	A, B, C	42.6	NR	NR	NR	NR	NR	NR	NR
Thermal Shock[2]	A, B, C	47.1	NR	NR	NR	NR	NR	NR	NR
3.3.8 UV Light/Condensation[2]	A, B	53.8	NR	NR	NR	NR	NR	NR	NR

[1] Thermal Transfer Printable Glossy White Polyester Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Average adhesion in ounces per inch label width.
NR – Not required.
* Label destroyed during solder float; no adhesion test.

Table 35. Brady B-423 Extended Testing Results: Blank Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate								
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E	Other[4]
Screening										
3.3.1 Adhesion (baseline adhesive strengths)[2]	A, B, C	33.1	74.2	63.7	**Fail 1.4**	18.2	23.8	43.0	42.9	NR
Extended										
3.3.1 Adhesion (Program-specific parts)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	22.2
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	24.3
3.3.2 Chemical Resistance										
Coolanol[2]	PS	34.2	89.2	76.4	20.0	19.8	43.8	82.4	47.9	NR
PAO[2]	PS	33.6	88.0	81.2	19.7	**Fail 10.7**	46.7	72.1	47.4	NR
Hydraulic fluid (MIL-H-5606)[2]	PS	35.6	92.8	93.3	**Fail 5.8**	**Fail 13.4**	52.7	89.2	46.2	NR
Lubricating oil (MIL-L-23699)[2]	PS	39.2	92.4	93.2	**Fail 12.0**	**Fail 10.2**	34.8	86.2	46.8	NR
Skydrol[2]	PS	24.3	88.8	87.6	20.0	**Fail 14.2**	49.1	85.0	44.7	NR
JP5 (MIL-T-5624)[2]	PS	31.0	92.0	79.6	**Fail 9.2**	**Fail 9.3**	51.7	83.0	46.4	NR
DS2[2]	PS	44.8	90.6	87.6	**Fail 10.5**	**Fail 15.2**	53.4	87.4	51.8	NR

[1] Thermal Transfer Printable Glossy White Polyester Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Average adhesion in ounces per inch label width.
[3] Required FED-STD colors were not available. Vendor indicated that coloring the label stock would change the label's performance.
[4] Javelin Launch Tube for testing adhesion to curved surfaces
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.

(Table 35 continued on next page)

Table 35. Brady B-423 Extended Testing Results: Blank Labels (continued)[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate								
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E	Other[4]
3.3.3 Corrosivity										
54°C (130ºF)[2]	A, B, C	57.6	92.2	86.9	NR	NR	NR	NR	NR	NR
71°C (160ºF)[2]	A, B, C	77.4	83.0	84.2	NR	NR	NR	NR	NR	NR
118°C (244ºF)[2]	A, B, C	40.5	60.0	50.2	NR	NR	NR	NR	NR	NR
3.3.4 DC Electrical Resistance	A, B, C	NR	NR	NR	NR	NR	Pass	Pass	Pass	NR
3.3.5 IR Reflectance										
FED-STD-595B # 34094 (Green 383)	A	NP[3]	NR	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B #34095 (Field Green)	A	NP[3]	NR	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B # 37030 (Black)	A	NP[3]	NR	NR	NR	NR	NR	NR	NR	NR
3.3.7 Temperature Exposure and Thermal Shock Resistance (program-specific parts)										
-48ºC (-55ºF)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	**Fail 13.2**
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	17.2
118ºC (244ºF)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	27.7
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	43.6
Thermal Shock										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	34.4
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	32.6

[1] Thermal Transfer Printable Glossy White Polyester Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Average adhesion in ounces per inch label width.
[3] Required FED-STD colors were not available. Vendor indicated that coloring the label stock would change the label's performance.
[4] Javelin Launch Tube for testing adhesion to curved surfaces
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.

Common and extended testing results for printed Brady B-423 labels are shown in Table 36 and Table 37, respectively.

Printed Brady B-423 labels met Grade C common performance requirements. Similar to testing the blank Brady B-423 labels, printed Brady B-423 labels failed chemical resistance testing (JTP Section 3.2.3) for the solder float/terpene-based solvent, which is a requirement for Grade A and Grade B applications. During this test, the label thermally decomposed. If exposure to solder flux can be avoided, this printed label may be considered for Grade A and Grade B applications.

As shown in Table 37, printed Brady B-423 labels met extended performance requirements for non-Army applications. Because this label failed chemical resistance testing (JTP Section 3.2.3) for DS2, it did not undergo CAR testing (Section 2.2.1). Only a portion of IR Reflectance testing (JTP Section 3.2.5) was performed, because green printing ribbon was not available that could closely match FED-STD-595B colors required. Brady B-423 labels printed with black ink failed IR reflectance when compared to ground support equipment requirements.

Table 36. Brady B-423 Common Testing Results: Printed Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate
		AL1a
Screening		
3.2.2 Adhesion	A, B, C	Pass
3.2.6 Legibility	A, B, C	Pass
Common		
3.2.1 Abrasion (Scrub) Resistance	A, B, C	Pass
3.2.3 Chemical Resistance		
Isopropyl alcohol	A, B, C	Pass
Deionized water	A, B, C	Pass
Engine oil 21SAE20W	A, B, C	Pass
Flux/solder float, then terpene-based solvent	A, B	**Fail[1]**
3.2.7 Salt Spray Resistance		
48-Hour Test	A	Pass
168-Hour Test	A	Pass
3.2.8 Temperature Exposure and Thermal Shock Resistance		
-48ºC (-55ºF)	A, B, C	Pass
118ºC (244ºF)	A, B, C	Pass
Thermal Shock	A, B, C	Pass
3.2.9 UV Light/Condensation	A, B	Pass

[1] Thermal Transfer Printable Glossy White Polyester Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Label destroyed during solder float.

Table 37. Brady B-423 Extended Testing Results: Printed Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate	
		AL1a	SS
Screening			
3.2.2 Adhesion	A, B, C	Pass	NR
3.2.6 Legibility	A, B, C	Pass	NR
Extended			
3.2.3 Chemical Resistance			
Coolanol	PS	Pass	NR
PAO	PS	Pass	NR
Hydraulic fluid (MIL-H-5606)	PS	Pass	NR
Lubricating oil (MIL-L-23699)	PS	Pass	NR
Skydrol	PS	Pass	NR
JP5 (MIL-T-5624)	PS	Pass	NR
DS2	PS	**Fail**[2]	NR
3.2.4 Fungus Resistance	A, B	5A[3]	NR
3.2.5 IR Reflectance			
FED-STD-595B # 34094 (Green 383)	A	NP[4]	NR
FED-STD-595B #34095 (Field Green)	A	NP[4]	NR
FED-STD-595B # 37030 (Black)	A	**Fail**[5]	NR
Supplemental Test (JTR Section 2.2.1): CAR			
Agent HD	A, B	NR	NP[6]
Agent GD	A, B	NR	NP[6]

[1] Thermal Transfer Printable Glossy White Polyester Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Ink completely removed by solvent.
[3] Rating of 5A over entire test specimen – no peeling or removal. See Appendix E for complete results.
[4] Green R6004 ribbon that could match FED-STD-595B #34094 or #34095 was not available.
[5] Refer to Appendix D for color matching testing results.
[6] The CAR test was not performed because this alternative failed the DS2 chemical resistance test.
NP – This test was not performed because the blank label did not meet the IR reflectance requirement (required FED-STD colors not available).
NR – Not required.
PS – Dependent on program-specific requirements.

6.3 Brady B-437 Thermal Transfer Printable Label Stock (W.H. Brady Company)

Screening, common, and extended test results for blank Brady B-437 labels are shown in Table 38, Table 39, and Table 40, respectively. During screening, Brady B-437 was the only blank label to exhibit acceptable adhesion on all of the evaluated substrates.

Table 38. Brady B-437 Screening Results: Blank Labels[1]

Substrate	JTP Section 3.3.1 Average Adhesion, Ounces/Inch Width (Standard Deviation in parentheses)	Pass/Fail
AL1a	45.0 (4.5)	Pass
AL1b	37.4 (11.3)	Pass
AL1c	51.1 (0.8)	Pass
AL1d	50.2 (1.1)	Pass
AL1e	95.4 (2.7)	Pass
AL2	63.8 (3.3)	Pass
SS	60.8 (1.7)	Pass
NR	41.1 (3.9)	Pass
SR	17.1 (2.0)	Pass
G/E	27.3 (1.1)	Pass
C/E	51.2 (1.5)	Pass
A/E	43.9 (1.1)	Pass

[1] Thermal Transfer Printable Label Stock (Refer to Table 6 for detailed description or specification of this label).
AL1a - MIL-P-23377/MIL-C-46168
AL1b - MIL-P-23377/MIL-C-53039
AL1c - MIL-P-23377/MIL-C-85285
AL1d - MIL-P-85582/MIL-C-85285
AL1e - MIL-P-85582/MIL-C-22750

As shown in Table 39, blank Brady B-437 labels met Grade C common performance requirements on all substrates except SR. This label failed chemical resistance testing (JTP Section 3.3.2) for engine oil on SR. Brady B-437 failed chemical resistance testing (JTP Section 3.3.2) for the solder flux/terpene-based solvent, which is a requirement for Grade A and Grade B applications. During this test, the blank label decomposed due to exposure to the elevated temperature of the solder bath. If exposure to solder flux can be avoided, this blank label may be considered for Grade A and Grade B applications on all but the SR substrate.

As shown in Table 40, blank Brady B-437 labels met the extended requirements on all but SR substrates. Blank Brady B-427 labels were not available in the FED-STD-595B colors required for IR reflectance testing (JTP Section 3.3.5). Additionally, W.H. Brady representatives indicated that coloring the label stock would change the label's performance.

Table 39. Brady B-437 Common Testing Results: Blank Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E
Screening									
3.3.1 Adhesion (baseline adhesive strengths)[2]	A, B, C	45.0	63.8	60.8	41.1	17.1	27.3	51.2	43.9
Common									
3.3.2 Chemical Resistance									
Isopropyl alcohol[2]	A, B, C	46.8	97.3	72.8	31.2	25.6	40.3	75.4	60.4
Deionized water[2]	A, B, C	55.2	83.4	72.2	36.4	22.3	31.7	74.2	54.2
Engine oil 21SAE20W[2]	A, B, C	50.8	102.5	75.0	37.1	**Fail 14.2**	32.7	81.7	63.6
Flux/solder float, then terpene-based solvent	A, B	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***
3.3.6 Salt Spray Resistance									
48-Hour Test[2]	A	56.0	97.5	91.6	NR	NR	NR	NR	NR
168-Hour Test[2]	A	51.6	97.2	101.2	NR	NR	NR	NR	NR
3.3.7 Temperature Exposure and Thermal Shock Resistance									
-48ºC (-55ºF)[2]	A, B, C	55.9	NR	NR	NR	NR	NR	NR	NR
118ºC (244ºF)[2]	A, B, C	70.8	NR	NR	NR	NR	NR	NR	NR
Thermal Shock	A, B, C	73.1	NR	NR	NR	NR	NR	NR	NR
3.3.8 UV Light/Condensation[2]	A, B	62.4	NR	NR	NR	NR	NR	NR	NR

[1] Thermal Transfer Printable Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Average adhesion in ounces per inch label width.
NR – Not required.
* Label destroyed during solder float; no adhesion test.

Table 40. Brady B-437 Extended Testing Results: Blank Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate								
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E	Other[4]
Screening										
3.3.1 Adhesion (baseline adhesive strengths)[2]	A, B, C	45.0	63.8	60.8	41.1	17.1	27.3	51.2	43.9	NR
Extended										
3.3.1 Adhesion (Program-specific parts)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	23.8
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	28.3
3.3.2 Chemical Resistance										
Coolanol[2]	PS	56.4	101.1	75.3	32.6	18.4	32.1	80.3	62.7	NR
PAO[2]	PS	55.8	99.7	78.6	34.8	**Fail 15.2**	33.2	79.4	68.0	NR
Hydraulic fluid (MIL-H-5606)[2]	PS	55.8	99.0	80.9	25.8	**Fail 10.6**	34.7	85.6	63.4	NR
Lubricating oil (MIL-L-23699)[2]	PS	57.0	99.4	89.2	36.2	**Fail 12.5**	41.2	88.8	63.8	NR
Skydrol[2]	PS	51.6	91.0	71.7	25.8	**Fail 15.0**	28.4	94.0	60.0	NR
JP5 (MIL-T-5624)[2]	PS	56.6	95.6	73.2	32.0	19.5	32.0	90.1	62.0	NR
DS2[2]	PS	32.9	67.5	62.1	61.6	**Fail 13.0**	26.8	54.6	57.3	NR

[1] Thermal Transfer Printable Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Average adhesion in ounces per inch label width.
[3] Required FED-STD colors were not available. Vendor indicated that coloring the label stock would change the label's performance.
[4] Javelin Launch Tube for testing adhesion to curved surfaces.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.

(Table 40 continued on next page)

Table 40. Brady B-437 Extended Testing Results: Blank Labels (continued)[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate								
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E	Other[4]
3.3.3 Corrosivity										
54°C (130ºF)[2]	A, B, C	63.8	93.8	95.2	NR	NR	NR	NR	NR	NR
71°C (160ºF)[2]	A, B, C	66.9	96.2	93.5	NR	NR	NR	NR	NR	NR
118°C (244ºF)[2]	A, B, C	68.0	93.0	58.1	NR	NR	NR	NR	NR	NR
3.3.4 DC Electrical Resistance	A, B, C	NR	NR	NR	NR	NR	Pass	Pass	Pass	NR
3.3.5 IR Reflectance										
FED-STD-595B # 34094 (Green 383)	A	NP[3]	NR	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B #34095 (Field Green)	A	NP[3]	NR	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B # 37030 (Black)	A	NP[3]	NR	NR	NR	NR	NR	NR	NR	NR
3.3.7 Temperature Exposure and Thermal Shock Resistance (program-specific parts)										
-48ºC (-55ºF)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	21.2
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	28.0
118ºC (244ºF)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	42.6
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	28.0
Thermal Shock										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	31.7
MIL-C-53039[1]	PS	NR	NR	NR	NR	NR	NR	NR	NR	48.8

[1] Thermal Transfer Printable Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Average adhesion in ounces per inch label width.
[3] Required FED-STD colors were not available. Vendor indicated that coloring the label stock would change the label's performance.
[4] Javelin Launch Tube for testing adhesion to curved surfaces.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.

The common and extended testing results for printed Brady B-437 labels are shown in Table 41 and Table 42, respectively.

Printed Brady B-437 labels met Grade C common performance requirements. Similar to testing blank Brady B-437 labels, the printed Brady B-437 labels failed chemical resistance testing (JTP Section 3.2.3) for the solder, flux/terpene-based solvent, which is a requirement for Grade A and Grade B applications. During this test, the label decomposed due to the elevated temperature of the solder bath. If exposure to solder flux can be avoided, this printed label may be considered for Grade A and Grade B applications.

As shown in Table 42, printed Brady B-437 labels met extended performance requirements. Only a portion of IR Reflectance testing (JTP Section 3.2.5) was performed, because green printing ink was not available that could closely match the FED-STD-595B colors required. Brady B-437 labels printed with black ink passed IR reflectance when compared to ground support equipment requirements.

Printed Brady B-437 failed chemical agent resistance when tested with the chemical agents HD and GD.

Table 41. Brady B-437 Common Testing Results: Printed Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate
		AL1a
Screening		
3.2.2 Adhesion	A, B, C	Pass
3.2.6 Legibility	A, B, C	Pass
Common		
3.2.1 Abrasion (Scrub) Resistance	A, B, C	Pass
3.2.3 Chemical Resistance		
Isopropyl alcohol	A, B, C	Pass
Deionized water	A, B, C	Pass
Engine oil 21SAE20W	A, B, C	Pass
Flux/solder float, then terpene-based solvent	A, B	**Fail[2]**
3.2.7 Salt Spray Resistance		
48-Hour Test	A	Pass
168-Hour Test	A	Pass
3.2.8 Temperature Exposure and Thermal Shock Resistance		
-48ºC (-55ºF)	A, B, C	Pass
118ºC (244ºF)	A, B, C	Pass
Thermal Shock	A, B, C	Pass
3.2.9 UV Light/Condensation	A, B	Pass

[1] Thermal Transfer Printable Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Label destroyed during solder float test.

Table 42. Brady B-437 Extended Testing Results: Printed Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate	
		AL1a	SS
Screening			
3.2.2 Adhesion	A, B, C	Pass	NR
3.2.6 Legibility	A, B, C	Pass	NR
Extended			
3.2.3 Chemical Resistance			
Coolanol	PS	Pass	NR
PAO	PS	Pass	NR
Hydraulic fluid (MIL-H-5606)	PS	Pass	NR
Lubricating oil (MIL-L-23699)	PS	Pass	NR
Skydrol	PS	Pass	NR
JP5 (MIL-T-5624)	PS	Pass	NR
DS2	PS	Pass[2]	NR
3.2.4 Fungus Resistance	A, B	5A[3]	NR
3.2.5 IR Reflectance			
FED-STD-595B # 34094 (Green 383)	A	NP[4]	NR
FED-STD-595B #34095 (Field Green)	A	NP[4]	NR
FED-STD-595B # 37030 (Black)	A	Pass[5]	NR
Supplemental Test (JTR Section 2.2.1): CAR			
Agent HD	A, B	NR	**Fail**
Agent GD	A, B	NR	**Fail[6]**

[1] Thermal Transfer Printable Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Legible, but visible damage to ink by solvent.
[3] Rating of 5A over the entire test specimen – no peeling or removal of specimen. See Appendix E for complete adhesion results.
[4] Green R4304 ribbon that could match FED-STD-595B #34094 or #34095 was not available.
[5] Refer to Appendix D for color matching testing results.
[6] Two of three test results exceeded minimum requirement.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.

6.4 Brady B-652 Printable High Temperature Label Stock (W.H. Brady Company)

Screening, common, and extended testing results for blank Brady B-652 labels are shown in Table 43, Table 44, and Table 45, respectively. During screening, blank Brady B-652 labels failed on NR, SR, and G/E substrates.

After screening, the technical representatives discussed removing this alternative from testing because it failed on three substrates. The other alternatives failed on fewer substrates. However, because the TADS program at LM has been

successfully using this label in the field, the technical representatives agreed to continue testing this label.

Table 43. Brady B-652 Screening Results: Blank Labels[1]

Substrate	JTP Section 3.3.1 Average Adhesion, Ounces/Inch Width (Standard Deviation in parentheses)	Pass/Fail
AL1a	41.6 (8.5)	Pass
AL1b	38.7 (2.8)	Pass
AL1c	44.3 (2.0)	Pass
AL1d	45.4 (6.1)	Pass
AL1e	117.1 (6.5)	Pass
AL2	69.2 (5.6)	Pass
SS	69.6 (2.7)	Pass
NR	**9.9 (1.9)**	**Fail**
SR	**4.5 (1.5)**	**Fail**
G/E	**14.4 (0.8)**	**Fail**
C/E	38.4 (1.3)	Pass
A/E	39.4 (3.4)	Pass

[1] Laser Printable High Temperature Label Stock (Refer to Table 6 for detailed description or specification of this label).
AL1a - MIL-P-23377/MIL-C-46168
AL1b - MIL-P-23377/MIL-C-53039
AL1c - MIL-P-23377/MIL-C-85285
AL1d - MIL-P-85582/MIL-C-85285
AL1e - MIL-P-85582/MIL-C-22750

As shown in Table 44 and Table 45, adhesive strength of blank Brady B-652 labels on the G/E substrate was higher in subsequent common and extended testing than in screening. This increase in adhesive strength is believed to result from increased curing time (i.e., the time between label application and adhesion testing).

Blank Brady B-652 labels met Grade A, Grade B, and Grade C common and extended performance requirements on AL1a, AL2, SS, C/E, and A/E substrates. This label failed adhesion testing (JTP Section 3.3.1) or chemical resistance testing (JTP Section 3.3.2) on the other substrates.

As shown in Table 45, black Brady B-652 labels met extended performance requirements on AL1a, AL2, SS, G/E, C/E, and A/E substrates. Blank Brady B-652 labels were not available in the FED-STD-595B colors required for JTP IR reflectance testing (JTP Section 3.3.5). Additionally, W.H. Brady Company representatives indicated that coloring the label stock would change the label's performance.

Table 44. Brady B-652 Common Testing Results: Blank Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E
Screening									
3.3.1 Adhesion (baseline adhesive strengths)[2]	A, B, C	41.6	69.2	69.6	**Fail 9.9**	**Fail 4.5**	**Fail 14.4**	38.4	39.4
Common									
3.3.2 Chemical Resistance									
Isopropyl alcohol[2]	A, B, C	53.3	93.2	75.8	**Fail 11.6**	**Fail 4.3**	37.5	87.4	51.4
Deionized water[2]	A, B, C	40.0	87.5	81.7	**Fail 13.6**	**Fail 9.8**	42.6	86.8	47.4
Engine oil 21SAE20W[2]	A, B, C	51.5	118.3	82.1	**Fail 14.3**	**Fail 8.4**	30.6	97.6	59.4
Flux/solder float, then terpene-based solvent	A, B	64.6	109.2	101.6	**Fail 12.5**	**Fail 6.2**	48.6	73.0	37.6
3.3.6 Salt Spray Resistance									
48-Hour Test[2]	A	50.8	107.6	107.4	NR	NR	NR	NR	NR
168-Hour Test[2]	A	60.2	113.2	123.2	NR	NR	NR	NR	NR
3.3.7 Temperature Exposure and Thermal Shock Resistance									
-48ºC (-55ºF)[2]	A, B, C	48.6	NR	NR	NR	NR	NR	NR	NR
118ºC (244ºF)[2]	A, B, C	73.0	NR	NR	NR	NR	NR	NR	NR
Thermal Shock	A, B, C	62.6	NR	NR	NR	NR	NR	NR	NR
3.3.8 UV Light/Condensation[2]	A, B	64.9	NR	NR	NR	NR	NR	NR	NR

[1] Laser Printable High Temperature Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Average adhesion in ounces per inch label width.
NR – Not required.

Table 45. Brady B-652 Extended Testing Results: Blank Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate								
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E	Other[4]
Screening										
3.3.1 Adhesion (baseline adhesive strengths)[2]	A, B, C	41.6	69.2	69.6	**Fail 9.9**	**Fail 4.5**	**Fail 14.4**	38.4	39.4	NR
Extended										
3.3.1 Adhesion (Program-specific parts)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	17.8
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	39.1
3.3.2 Chemical Resistance										
Coolanol[2]	PS	54.9	120.8	81.8	**Fail 14.6**	**Fail 13.8**	37.4	46.9	64.8	NR
PAO[2]	PS	55.8	102.6	81.5	**Fail 14.6**	**Fail 6.1**	44.6	47.6	58.6	NR
Hydraulic fluid (MIL-H-5606)[2]	PS	49.0	90.8	82.7	**Fail 11.4**	**Fail 6.8**	39.5	106.8	48.4	NR
Lubricating oil (MIL-L-23699)[2]	PS	54.2	87.3	83.6	**Fail 8.0**	**Fail 4.4**	30.3	106.3	61.6	NR
Skydrol[2]	PS	46.5	95.0	82.0	**Fail 15.6**	**Fail 3.6**	40.1	98.4	55.0	NR
JP5 (MIL-T-5624)[2]	PS	53.8	90.4	82.6	**Fail 12.9**	**Fail 3.6**	44.6	102.0	64.6	NR
DS2[2]	PS	47.6	90.0	82.6	**Fail 12.5**	**Fail 4.5**	38.2	104.4	47.6	NR

[1] Laser Printable High Temperature Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Average adhesion in ounces per inch label width.
[3] Required FED-STD colors were not available. Vendor indicated that coloring the label stock would change the label's performance.
[4] Javelin Launch Tube for testing adhesion to curved surfaces.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.

(Table 45 continued on next page)

Table 45. Brady B-652 Extended Testing Results: Blank Labels (continued)[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate								
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E	Other[4]
3.3.3 Corrosivity										
54°C (130ºF)[2]	A, B, C	85.6	133.8	134.3	NR	NR	NR	NR	NR	NR
71°C (160ºF)[2]	A, B, C	101.5	138.6	132.4	NR	NR	NR	NR	NR	NR
118°C (244ºF)[2]	A, B, C	82.4	110.4	111.6	NR	NR	NR	NR	NR	NR
3.3.4 DC Electrical Resistance	A, B, C	NR	NR	NR	NR	NR	Pass	Pass	Pass	NR
3.3.5 IR Reflectance										
FED-STD-595B # 34094 (Green 383)	A	NP[3]	NR	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B #34095 (Field Green)	A	NP[3]	NR	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B # 37030 (Black)	A	NP[3]	NR	NR	NR	NR	NR	NR	NR	NR
3.3.7 Temperature Exposure and Thermal Shock Resistance (program-specific parts)										
-48ºC (-55ºF)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	33.6
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	48.4
118ºC (244ºF)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	43.2
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	43.4
Thermal Shock										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	28.3
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	39.9

[1] Laser Printable High Temperature Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Average adhesion in ounces per inch label width.
[3] Required FED-STD colors were not available. Vendor indicated that coloring the label stock would change the label's performance.
[4] Javelin Launch Tube for testing adhesion to curved surfaces.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.

The results of screening tests of printed Brady B-652 labels are shown in Table 46 and discussed below. The results of Phase II screening of the printed labels show that Brady B-652 legibility is strongly influenced by the printer toner setting.

Table 46. Brady B-652 Common Testing Results: Printed Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate
		AL1a
Screening		
3.2.2 Adhesion	A, B, C	
Medium toner setting, As Printed		**Fail**
Medium toner setting, Polyester-Coated		**Fail** [2]
Medium toner setting, Polyurethane-coated		Pass [3]
Light toner setting, As Printed		Pass [4]
Light toner setting, Polyester-Coated		Pass [2]
Light toner setting, Polyurethane-coated		Pass [3]
3.2.6 Legibility	A, B, C	
Medium toner setting, As Printed		Pass[5]
Medium toner setting, Polyester-Coated		Pass[5]
Medium toner setting, Polyurethane-coated		Pass[5]
Light toner setting, As Printed		Pass
Light toner setting, Polyester-Coated		Pass
Light toner setting, Polyurethane-coated		Pass

[1] Laser Printable High Temperature Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Polyester tape peeled off in ink-rich areas; ink still legible.
[3] Polyurethane coating peeled off in ink-rich areas; ink still legible.
[4] Some ink removed during tape test; sample still legible
[5] Ink flaked off of the label with handling (refer to Figure 6).

The first printed Brady B-652 labels that were tested were printed using a mid-range toner setting (setting 5) on a Hewlett-Packard LaserJet III printer. The as-printed labels were initially legible, but the markings were very easily removed during normal handling operations (such as cutting the labels apart and smoothing down the labels during application to the substrate). Figure 6 shows a typical printed label after application to the substrate and before adhesion tests were performed.

Figure 6. Brady B-652 Label, As-printed with Medium Toner Setting, Showing Typical Damage from Handling

When a second set of printed labels was prepared using the lightest possible toner setting on the printer (setting 9), a significant improvement in the durability of the printing was noted. No loss of ink was noted during the handling operations. The first set of printed Brady B-652 labels (setting 5) failed to meet the requirements of the adhesion test, with significant removal of the ink noted (refer to Figure 7). The labels that were printed at the lightest toner setting (setting 9) had slight but visible ink loss during the adhesion test (Figure 8), but were still quite legible.

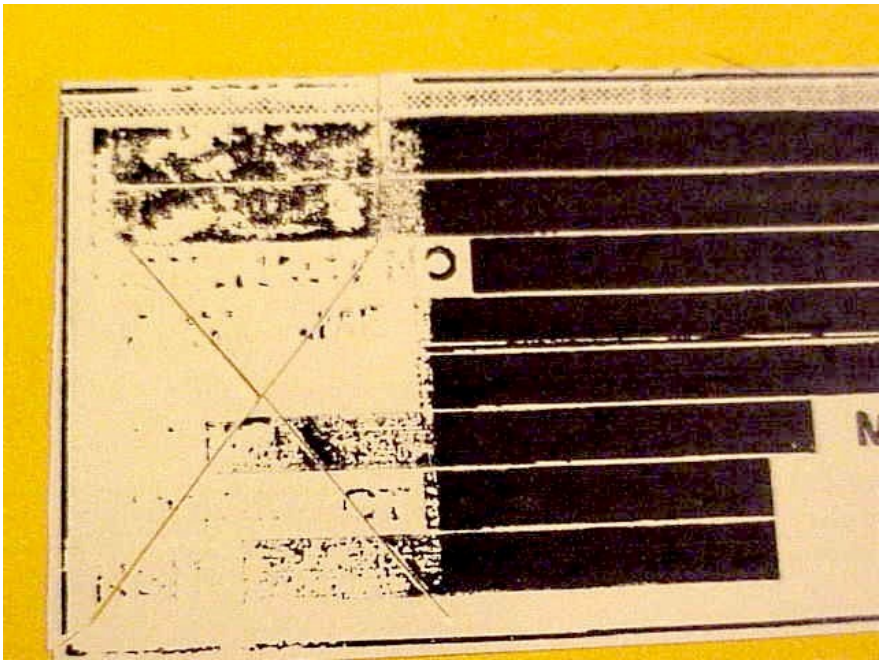


Figure 7. Brady B-652 Label Printed with Medium Toner Setting after Tape Adhesion Test (Significant Ink Removal is Apparent)

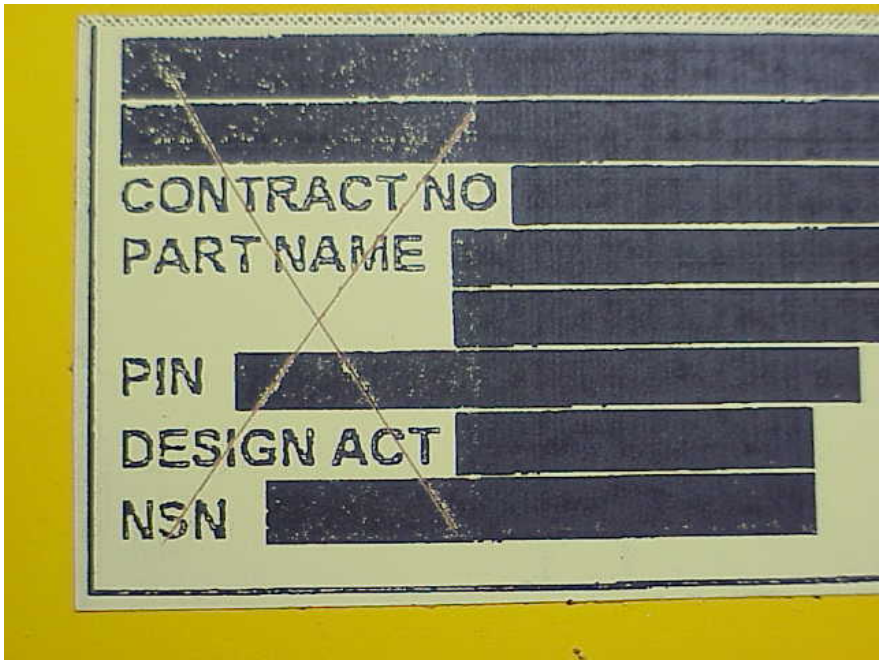


Figure 8. Brady B-652 Label Printed with Lightest Toner Setting after Adhesion Test (Slight Ink Removal is Apparent, but Sample Retains Legibility)

The blank Brady B-652 labels were also tested in accordance with JTP Section 3.2 with a clear polyester label over the black-background (top) label and with a polyurethane coating over the white-background (bottom) label. The polyurethane that was used was a Minwax commercial quick-drying formulation that conforms to ASTM D 4236-94 (*Standard Practice for Labeling Art Materials for Chronic Health Hazards*, approved 1994). The clear polyester label used was the Critchley Clear Polyester (TTP200CL-10) label discussed in Section 6.6. The coated specimens were tested for legibility and adhesion. Both the polyester- and the polyurethane-coated specimens showed visible signs of damage after the adhesion test. The polyester label appeared to adhere well to both the Brady B-652 label and to the ink on the label. However, in areas of high print density, the marginal adhesion of the ink to the label (particularly on the samples that were printed at the mid-range toner setting) resulted in failure at the Brady B-652-to-ink interface, and pieces of the clear polyester label were pulled off during the adhesion test. In the case of the labels that were printed at a mid-range toner setting, the underlying ink was almost completely removed along with the clear polyester label. The labels that were printed at the lightest toner setting showed little visible evidence of ink removal, but sections of the clear polyester label were removed during the test.

The polyurethane-coated specimen had considerable damage during the adhesion test, with significant loss of polyurethane due to failure at the polyurethane-to-ink interface in areas that had high print density. The ink, however, on both sets of labels (toner setting 5 and toner setting 9) remained on the underlying label and, in fact, exhibited much stronger adherence than it did prior to the application of the polyurethane. The polyurethane adhered well to areas of the Brady B-652 that had little ink.

Therefore, failure to use the lightest possible toner setting when printing on the Brady B-652 label results in markings that flake off during normal handling operations and that fail to meet JTP adhesion requirements. If the lightest toner setting is used, the samples can be handled with no visible damage, but visible ink removal is noted during the adhesion test. Clear polyester labels that are applied over the printing, while adhering well to the underlying label, are easily removed in ink-rich areas, as is the polyurethane coating.

After reviewing the screening results, the technical representatives agreed to continue testing the Brady B-652 label that is printed with the lightest possible toner setting. Therefore, during Phase II common and extended testing, Brady B-652 labels were tested as-printed and with protective coatings over the label. The black-background (top) label was sprayed with a polyurethane coating, and the white-background (bottom) label was covered with a Critchley Clear Polyester label. The common and extended testing results for printed Brady B-652 labels are shown in Table 47 and Table 48, respectively.

Printed Brady B-652 labels met Grade A, Grade B, and Grade C common performance requirements when polyurethane-coated. Uncoated and polyester-coated Brady B-652 labels met Grade C common performance requirements. Uncoated and polyester-coated Brady B-652 labels failed chemical resistance testing (JTP Section 3.2.3) for solder flux/terpene-based solvent, which is a requirement for Grade A and Grade B applications. During this test, the uncoated label stock survived solder float, but failed after terpene-based solvent exposure. The polyester-coated label stock failed because the polyester label decomposed due to exposure to the elevated temperature of the solder float. If exposure to solder flux and terpene-based solvent can be avoided, this printed label, either uncoated or coated, may be considered for Grade A and Grade B applications.

As shown in Table 48, printed Brady B-652 labels met extended performance requirements if polyester-coated or polyurethane-coated. Uncoated Brady B-652 labels failed chemical resistance testing (JTP Section 3.2.3) when exposed to Coolanol and Skydrol. Only a portion of IR Reflectance testing (JTP Section 3.2.5) was performed, because green printing ink was not available that could closely match the FED-STD-595B colors required. All Brady B-652 labels printed with black ink passed IR Reflectance when compared to ground support equipment requirements.

Polyester-coated printed Brady B-652 labels passed chemical agent resistance when tested with the chemical agents HD and GD. Uncoated and polyurethane-coated Brady B-652 labels failed chemical agent resistance when tested with the chemical agents HD and GD.

It should be noted that, although polyurethane-coated Brady B-652 performed well in tests, the polyurethane separated from the underlying ink during virtually all of the adhesion tests. The results from uncoated and polyurethane-coated Brady B-652 suggest that low ink cohesion, but sufficient adhesion between the label and ink to ensure that the marking remains legible.

Table 47. Brady B-652 Common Testing Results: Printed Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate		
		AL1a		
		Uncoated	Polyester-coated	Polyurethane-coated
Screening				
3.2.2 Adhesion (lightest toner setting)	A, B, C	Pass [2]	Pass [3]	Pass [4]
3.2.6 Legibility (lightest toner setting)	A, B, C	Pass	Pass	Pass
Common				
3.2.1 Abrasion (Scrub) Resistance	A, B, C	Pass	Pass	Pass
3.2.3 Chemical Resistance				
Isopropyl alcohol	A, B, C	Pass [2]	Pass	Pass [5]
Deionized water	A, B, C	Pass [2]	Pass	Pass [5]
Engine oil 21SAE20W	A, B, C	Pass [2]	Pass	Pass [5]
Flux/solder float, then terpene-based solvent	A, B	**Fail [6]**	**Fail [7]**	Pass
3.2.7 Salt Spray Resistance				
48-Hour Test	A	Pass	Pass	Pass
168-Hour Test	A	Pass	Pass	Pass
3.2.8 Temperature Exposure and Thermal Shock Resistance				
-48ºC (-55ºF)	A, B, C	Pass [2]	Pass	Pass [5]
118ºC (244ºF)	A, B, C	Pass	Pass	Pass [5]
Thermal Shock	A, B, C	Pass	Pass	Pass [5]
3.2.9 UV Light/Condensation	A, B	Pass [8]	Pass	Pass [8]

[1] Laser Printable High Temperature Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Some ink removed during tape test; sample still legible
[3] Polyester tape peeled off in ink-rich areas; ink still legible.
[4] Polyurethane coating peeled off in ink-rich areas; ink still legible.
[5] Polyurethane came off during tape test; ink survived.
[6] Label survived solder float but failed terpene solvent exposure.
[7] Polyester label destroyed during solder exposure.
[8] Slight loss of legibility after adhesion test.

Table 48. Brady B-652 Extended Testing Results: Printed Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate		
		AL1a		
		Uncoated	Polyester-coated	Polyurethane-coated
Screening				
3.2.2 Adhesion (lightest toner setting)	A, B, C	Pass [2]	Pass [3]	Pass [4]
3.2.6 Legibility (lightest toner setting)	A, B, C	Pass	Pass	Pass
Extended				
3.2.3 Chemical Resistance				
Coolanol	PS	**Fail** [5]	Pass	Pass [6]
PAO	PS	Pass [2]	Pass	Pass [6]
Hydraulic fluid (MIL-H-5606)	PS	Pass [2]	Pass	Pass [6]
Lubricating oil (MIL-L-23699)	PS	Pass	Pass	Pass [6]
Skydrol	PS	**Fail**	Pass	Pass [6]
JP5 (MIL-T-5624)	PS	Pass	Pass	Pass [6]
DS2	PS	Pass [2]	Pass	Pass [7]
3.2.4 Fungus Resistance	A, B	5A[8]	5A/4A[9]	5A/4A[9]
3.2.5 IR Reflectance				
FED-STD-595B # 34094 (Green 383)	A	NP[10]	NP[10]	NP[10]
FED-STD-595B #34095 (Field Green)	A	NP[10]	NP[10]	NP[10]
FED-STD-595B # 37030 (Black)	A	Pass[11]	Pass[11]	Pass[11]
		Substrate		
		SS		
Supplemental Test (JTR Section 2.2.1): CAR				
Agent HD	A, B	**Fail**	Pass	**Fail**
Agent GD	A, B	**Fail**	Pass	**Fail**

[1] Laser Printable High Temperature Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Some ink removed during tape test; sample still legible
[3] Polyester tape peeled off in ink-rich areas; ink still legible.
[4] Polyurethane coating peeled off in ink-rich areas; ink still legible.
[5] Passed legibility; failed adhesion.
[6] Polyurethane came off during tape test; ink survived.
[7] Polyurethane and some ink came off during tape test.
[8] Rating of 5A over entire specimen – no peeling or removal. See Appendix E for complete results.
[9] Rating of 4A and 5A over specimen – trace amounts of peeling. See Appendix E for complete results.
[10] Green LaserJet III Printer Ink that could match FED-STD-595B #34094 or #34095 was not available.
[11] Refer to Appendix D for color matching testing results.
NP –Not performed.
PS – Dependent on program-specific requirements.

6.5 Brady B-747 Lasertab Markers (W.H. Brady Company)

Screening, common, and extended testing results for blank Brady B-747 labels are shown in Table 49, Table 50, and Table 51, respectively. During screening, blank Brady B-747 labels failed only on SR substrates.

Table 49. Brady B-747 Screening Results: Blank Labels[1]

Substrate	JTP Section 3.3.1 Average Adhesion, Ounces/Inch Width (Standard Deviation in parentheses)	Pass/Fail
AL1a	39.2 (4.2)	Pass
AL1b	43.7 (1.4)	Pass
AL1c	46.4 (1.5)	Pass
AL1d	46.8 (2.0)	Pass
AL1e	83.0 (6.8)	Pass
AL2	59.6 (2.1)	Pass
SS	57.7 (2.5)	Pass
NR	22.8 (2.7)	Pass
SR	**9.5 (1.3)**	**Fail**
G/E	25.7 (3.0)	Pass
C/E	48.9 (1.5)	Pass
A/E	47.3 (3.5)	Pass

[1] Laser Printable Lasertab Markers (Refer to Table 6 for detailed description or specification of this label).
AL1a - MIL-P-23377/MIL-C-46168
AL1b - MIL-P-23377/MIL-C-53039
AL1c - MIL-P-23377/MIL-C-85285
AL1d - MIL-P-85582/MIL-C-85285
AL1e - MIL-P-85582/MIL-C-22750

Blank Brady B-747 labels met Grade C common performance requirements on all substrates except SR. Blank Brady B-747 labels failed chemical resistance testing (JTP Section 3.3.2) for the solder flux/terpene-based solvent, which is a requirement for Grade A and Grade B applications. During this test, the blank label decomposed due to exposure to the elevated temperature of the solder float. If exposure to solder flux can be avoided, this blank label may be considered for Grade A and Grade B applications on all but the SR substrate.

As shown in Table 51, blank Brady B-747 labels met Grade A, Grade B, and Grade C extended performance requirements on all but the SR substrate. Blank Brady B-747 labels were not available in the FED-STD-595B colors required for IR reflectance testing (JTP Section 3.3.5). Additionally, W.H. Brady Company representatives indicated that coloring the label stock would change the label's performance.

Table 50. Brady B-747 Common Testing Results: Blank Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E
Screening									
3.3.1 Adhesion (baseline adhesive strengths)[2]	A, B, C	39.2	59.6	57.7	22.8	**Fail 9.5**	25.7	48.9	47.3
Common									
3.3.2 Chemical Resistance									
Isopropyl alcohol[2]	A, B, C	52.4	84.6	66.3	34.3	18.2	42.2	70.0	58.4
Deionized water[2]	A, B, C	57.5	94.2	69.6	33.8	**Fail 12.1**	44.0	70.7	56.0
Engine oil 21SAE20W[2]	A, B, C	54.6	98.1	70.7	45.0	21.8	45.9	73.8	59.8
Flux/solder float, then terpene-based solvent	A, B	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***
3.3.6 Salt Spray Resistance									
48-Hour Test[2]	A	61.8	98.2	84.2	NR	NR	NR	NR	NR
168-Hour Test[2]	A	57.4	98.1	89.2	NR	NR	NR	NR	NR
3.3.7 Temperature Exposure and Thermal Shock Resistance									
-48ºC (-55ºF)[2]	A, B, C	61.9	NR	NR	NR	NR	NR	NR	NR
118ºC (244ºF)[2]	A, B, C	68.3	NR	NR	NR	NR	NR	NR	NR
Thermal Shock	A, B, C	70.5	NR	NR	NR	NR	NR	NR	NR
3.3.8 UV Light/Condensation[2]	A, B	83.4	NR	NR	NR	NR	NR	NR	NR

[1] Laser Printable Lasertab Markers (Refer to Table 6 for detailed description or specification of this label).
[2] Average adhesion in ounces per inch label width.
NR – Not required.
* Label destroyed during the solder float; no adhesion test.

Table 51. Brady B-747 Extended Testing Results: Blank Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate								
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E	Other[4]
Screening										
3.3.1 Adhesion (baseline adhesive strengths)[2]	A, B, C	39.2	59.6	57.7	22.8	**Fail 9.5**	25.7	48.9	47.3	NR
Extended										
3.3.1 Adhesion (Program-specific parts)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	20.1
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	35.5
3.3.2 Chemical Resistance										
Coolanol[2]	PS	56.2	90.4	75.1	33.8	20.0	49.9	73.7	70.0	NR
PAO[2]	PS	69.2	96.2	78.2	39.9	**Fail 7.9**	39.2	76.2	54.5	NR
Hydraulic fluid (MIL-H-5606)[2]	PS	62.2	97.9	81.0	33.6	**Fail 11.0**	39.6	76.7	55.6	NR
Lubricating oil (MIL-L-23699)[2]	PS	56.7	97.7	82.0	39.4	17.8	36.1	74.2	66.0	NR
Skydrol[2]	PS	58.5	94.1	78.6	35.8	21.0	33.8	72.3	55.0	NR
JP5 (MIL-T-5624z)[2]	PS	57.8	98.7	80.0	37.6	20.8	39.7	71.4	57.4	NR
DS2[2]	PS	44.8	68.7	52.9	59.9	**Fail 11.5**	28.2	50.7	55.0	NR
3.3.3 Corrosivity										
54°C (130ºF)[2]	A, B, C	77.2	94.4	93.3	NR	NR	NR	NR	NR	NR
71°C (160ºF)[2]	A, B, C	75.2	93.5	111.1	NR	NR	NR	NR	NR	NR
118°C (244ºF)[2]	A, B, C	61.9	76.2	56.5	NR	NR	NR	NR	NR	NR

[1] Laser Printable Lasertab Markers (Refer to Table 6 for detailed description or specification of this label).
[2] Average adhesion in ounces per inch label width.
[3] Required FED-STD-595B colors were not available. Vendor indicated that coloring the label stock would change the label's performance.
[4] Javelin Launch Tube for testing adhesion to curved surfaces.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.

(Table 51 continued on next page)

Table 51. Brady B-747 Extended Testing Results: Blank Labels (continued)[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate								
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E	Other[4]
3.3.4 DC Electrical Resistance	A, B, C	NR	NR	NR	NR	NR	Pass	Pass	Pass	NR
3.3.5 IR Reflectance										
FED-STD-595B # 34094 (Green 383)	A	NP[3]	NR	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B #34095 (Field Green)	A	NP[3]	NR	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B # 37030 (Black)	A	NP[3]	NR	NR	NR	NR	NR	NR	NR	NR
3.3.7 Temperature Exposure and Thermal Shock Resistance (program-specific parts)										
-48ºC (-55ºF)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	21.9
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	28.4
118ºC (244ºF)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	18.2
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	24.5
Thermal Shock										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	27.4
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	33.6

[1] Laser Printable Lasertab Markers (Refer to Table 6 for detailed description or specification of this label).
[2] Average adhesion in ounces per inch label width.
[3] Required FED-STD-595B colors were not available. Vendor indicated that coloring the label stock would change the label's performance.
[4] Javelin Launch Tube for testing adhesion to curved surfaces.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.

JTP Section 3.2 requires that labels that are laser printed be tested as-is, with a clear covering, and with a polyurethane coating. Because the printed labels performed well without the protective coatings, all testing was performed without these protective coatings. The common and extended testing results for printed Brady B-747 labels are shown in Table 52 and Table 53, respectively.

Printed Brady B-747 labels met Grade C common performance requirements. Similar to testing the blank Brady B-747 labels, the printed Brady B-747 labels failed chemical resistance testing (JTP Section 3.2.3) for the solder float/terpene-based solvent, which is a requirement for Grade A and Grade B applications. During this test, the label thermally decomposed. If exposure to solder flux can be avoided, this printed label may be considered for Grade A and Grade B applications.

As shown in Table 53, printed Brady B-747 labels met all extended performance requirements except chemical resistance (JTP Section 3.2.3) to Skydrol. Only a portion of IR Reflectance testing (JTP Section 3.2.5) was performed, because green printing ink was not available that could closely match the FED-STD-595B colors required. Brady B-747 labels printed with black ink passed IR Reflectance when compared to ground support equipment requirements. Printed Brady B-747 labels failed chemical agent resistance when tested with the chemical agents HD and GD.

Table 52. Brady B-747 Common Testing Results: Printed Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate
		AL1a
Screening		
3.2.2 Adhesion	A, B, C	Pass
3.2.6 Legibility	A, B, C	Pass
Common		
3.2.1 Abrasion (Scrub) Resistance	A, B, C	Pass
3.2.3 Chemical Resistance		
Isopropyl alcohol	A, B, C	Pass
Deionized water	A, B, C	Pass
Engine oil 21SAE20W	A, B, C	Pass
Flux/solder float, then terpene-based solvent	A, B	**Fail[2]**
3.2.7 Salt Spray Resistance		
48-Hour Test	A	Pass
168-Hour Test	A	Pass
3.2.8 Temperature Exposure and Thermal Shock Resistance		
-48ºC (-55ºF)	A, B, C	Pass
118ºC (244ºF)	A, B, C	Pass
Thermal Shock	A, B, C	Pass
3.2.9 UV Light/Condensation	A, B	Pass

[1] Laser Printable Lasertab Markers (Refer to Table 6 for detailed description or specification of this label).

[2] Label destroyed during solder float test.

Table 53. Brady B-747 Extended Testing Results: Printed Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate	
		AL1a	SS
Screening			
3.2.2 Adhesion	A, B, C	Pass	NR
3.2.6 Legibility	A, B, C	Pass	NR
Extended			
3.2.3 Chemical Resistance			
Coolanol	PS	Pass[2]	NR
PAO	PS	Pass[2]	NR
Hydraulic fluid (MIL-H-5606)	PS	Pass	NR
Lubricating oil (MIL-L-23699)	PS	Pass[2]	NR
Skydrol	PS	**Fail**	NR
JP5 (MIL-T-5624)	PS	Pass	NR
DS2	PS	Pass[2]	NR
3.2.4 Fungus Resistance	A, B	5A[3]	NR
3.2.5 IR Reflectance			
FED-STD-595B # 34094 (Green 383)	A	NP[4]	NR
FED-STD-595B #34095 (Field Green)	A	NP[4]	NR
FED-STD-595B # 37030 (Black)	A	Pass[5]	NR
Supplemental Test (JTR Section 2.2.1): CAR			
Agent HD	A, B	NR	**Fail**
Agent GD	A, B	NR	**Fail**

[1] Laser Printable Lasertab Markers (Refer to Table 6 for detailed description or specification of this label).
[2] Visible ink removal during adhesion test; sample still legible.
[3] Rating of 5A over entire specimen – no peeling or removal. See Appendix E for complete results.
[4] Green LaserJet III Printer Ink that could closely match FED-STD-595B #34094 or #34095 was not available.
[5] Refer to Appendix D for color matching testing results.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.

6.6 Critchley Clear Polyester (TTP200CL-10) (Tyco Electronics)[1]

Screening, common, and extended testing results for blank Critchley Clear Polyester labels are shown in Table 54, Table 55, and Table 56, respectively. During screening, blank Critchley Clear Polyester labels failed on both the SR and AL1b (MIL-P-23377/MIL-C-53039) substrates. The latter failure was thought to be a result of poor panel cleaning, because only one of the five test panels exhibited unacceptable results.

Table 54. Critchley Clear Polyester (TTP200CL-10) Screening Results: Blank Labels[1]

Substrate	JTP Section 3.3.1 Average Adhesion, Ounces/Inch Width (Standard Deviation in parentheses)	Pass/Fail
AL1a	39.9 (4.3)	Pass
AL1b	**15.5 (7.1)[2]**	**Fail**
AL1c	48.8 (2.7)	Pass
AL1d	49.2 (1.6)	Pass
AL1e	100.4 (2.7)	Pass
AL2	73.3 (4.8)	Pass
SS	64.9 (2.6)	Pass
NR	19.9 (2.5)	Pass
SR	**3.3 (0.9)**	**Fail**
G/E	19.2 (8.6)	Pass
C/E	51.1 (1.2)	Pass
A/E	44.9 (4.5)	Pass

[1] Thermal Transfer Printable Clear Polyester (TTP200CL-10) Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Average value rises to 18.2 oz/in width when results from one of the five panels (2.9 and 3.9 oz/in width) are discarded.
AL1a - MIL-P-23377/MIL-C-46168
AL1b - MIL-P-23377/MIL-C-53039
AL1c - MIL-P-23377/MIL-C-85285
AL1d - MIL-P-85582/MIL-C-85285
AL1e - MIL-P-85582/MIL-C-22750

As shown in Table 55, blank Critchley Clear Polyester labels met Grade C performance requirements on all substrates except NR and SR. Critchley Clear Polyester failed chemical resistance testing (JTP Section 3.3.2) for the solder flux/terpene-based solvent, which is a requirement for Grade A and Grade B applications. During this test, the blank label thermally decomposed due to exposure to the elevated temperature of the solder float. If exposure to solder flux can be avoided, this alternative may be considered for Grade A and Grade B applications on AL1a, AL2, SS, G/E, C/E, and A/E substrates.

Similarly, as shown in Table 56, blank Critchley Clear Polyester labels met Grade A, Grade B, and Grade C extended performance requirements on AL2, SS, G/E, C/E, and A/E substrates. This label met all extended performance requirements except IR Reflectance (JTP Section 3.3.5) on AL1a. This label failed chemical resistance testing (JTP Section 3.3.2) on NR and SR substrates. This label also failed low temperature exposure testing on a curved surface that was coated with MIL-C-46148 and MIL-C-53039 and thermal shock testing on a curved surface coated with MIL-C-46168 (JTP Section 3.3.7). For IR Reflectance testing, this clear label was applied over topcoats that matched the required FED-STD-595B colors. The blank Critchley Clear Polyester label applied over black (FED-STD-595B #37030) passed IR Reflectance when compared to ground support

equipment requirements. Two panels were evaluated for IR Reflectance of Critchley Clear Polyester label applied over Green 383 (FED-STD-595B #34094). Of these two panels, one exhibited unacceptable reflectance over the entire wavelength range while the other exhibited acceptable IR reflectance [wavelength greater than 690 nanometers (nm)] but unacceptable reflectance in the visual range, at wavelengths between 600 nm and 680 nm. Critchley Clear Polyester label applied over Green 383 (FED-STD-595B #34094) is thus considered to have failed IR Reflectance when compared to ground support equipment requirements. The blank Critchley Clear Polyester label applied over Field Green (FED-STD-595B #34095) was compared to aircraft IR reflectance requirements. This label exhibited appropriate reflectance in the 450-nm to 500-nm range, but failed between 500 nm and 2700 nm; thus the Critchley Clear Polyester label applied over Field Green is considered to have failed IR Reflectance when compared to aircraft requirements.

Table 55. Critchley Clear Polyester Common Testing Results: Blank Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E
Screening									
3.3.1 Adhesion (baseline adhesive strengths)[2]	A, B, C	39.9	73.3	64.9	19.9	**Fail 3.3**	19.2	51.1	44.9
Common									
3.3.2 Chemical Resistance									
Isopropyl alcohol[2]	A, B, C	36.3	69.3	63.8	**Fail 12.2**	**Fail 6.2**	27.2	68.0	54.2
Deionized water[2]	A, B, C	43.1	93.5	70.9	**Fail 13.8**	**Fail 5.8**	26.0	74.3	52.1
Engine oil 21SAE20W[2]	A, B, C	50.8	93.9	75.4	20.0	**Fail 10.6**	25.1	81.0	52.2
Flux/solder float, then terpene-based solvent	A, B	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***
3.3.6 Salt Spray Resistance									
48-Hour Test[2]	A	36.0	103.4	99.2	NR	NR	NR	NR	NR
168-Hour Test[2]	A	18.2	106.8	104.2	NR	NR	NR	NR	NR
3.3.7 Temperature Exposure and Thermal Shock Resistance									
-48ºC (-55ºF)[2]	A, B, C	51.2	NR	NR	NR	NR	NR	NR	NR
118ºC (244ºF)[2]	A, B, C	51.7	NR	NR	NR	NR	NR	NR	NR
Thermal Shock	A, B, C	32.7	NR	NR	NR	NR	NR	NR	NR
3.3.8 UV Light/Condensation[2]	A, B	51.3	NR	NR	NR	NR	NR	NR	NR

[1] Thermal Transfer Printable Clear Polyester (TTP200CL-10) Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Average adhesion in ounces per inch label width.
NR – Not required.
* Label destroyed during solder float; no adhesion test.

Table 56. Critchley Clear Polyester Extended Testing Results: Blank Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate								
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E	Other[3]
Screening										
3.3.1 Adhesion (baseline adhesive strengths)[2]	A, B, C	39.9	73.3	64.9	19.9	**Fail 3.3**	19.2	51.1	44.9	NR
Extended										
3.3.1 Adhesion (Program-specific parts)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	16.8
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	18.8
3.3.2 Chemical Resistance										
Coolanol[2]	PS	42.0	92.6	74.0	**Fail 10.4**	**Fail 9.4**	29.2	83.0	50.4	NR
PAO[2]	PS	47.5	93.4	72.0	**Fail 12.4**	**Fail 3.8**	29.1	84.3	53.9	NR
Hydraulic fluid (MIL-H-5606)[2]	PS	45.4	101.5	81.2	**Fail 12.4**	**Fail 2.8**	25.2	94.8	54.2	NR
Lubricating oil (MIL-L-23699)[2]	PS	47.3	100.4	79.0	16.9	**Fail 3.2**	26.2	91.9	55.2	NR
Skydrol[2]	PS	46.2	96.7	83.8	22.0	**Fail 13.4**	24.4	83.7	51.0	NR
JP5 (MIL-T-5624)[2]	PS	43.2	100.3	82.6	21.0	**Fail 13.1**	27.0	88.8	49.7	NR
DS2[2]	PS	44.3	88.6	80.2	**Fail 11.0**	**Fail 4.6**	33.2	84.1	54.6	NR

[1] Thermal Transfer Printable Clear Polyester (TTP200CL-10) Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Average adhesion in ounces per inch label width.
[3] Javelin Launch Tube for testing adhesion to curved surfaces.
NR – Not required.
PS – Dependent on program-specific requirements.

(Table 56 continued on next page)

Table 56. Critchley Clear Polyester Extended Testing Results: Blank Labels (continued)[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate								
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E	Other[3]
3.3.3 Corrosivity										
54°C (130ºF)[2]	A, B, C	59.6	103.0	100.6	NR	NR	NR	NR	NR	NR
71°C (160ºF)[2]	A, B, C	20.1	96.8	88.8	NR	NR	NR	NR	NR	NR
118°C (244ºF)[2]	A, B, C	39.5	104.8	104.6	NR	NR	NR	NR	NR	NR
3.3.4 DC Electrical Resistance	A, B, C	NR	NR	NR	NR	NR	Pass	Pass	Pass	NR
3.3.5 IR Reflectance										
FED-STD-595B # 34094 (Green 383)	A	**Fail**	NR	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B #34095 (Field Green)	A	**Fail**	NR	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B # 37030 (Black)	A	Pass	NR	NR	NR	NR	NR	NR	NR	NR
3.3.7 Temperature Exposure and Thermal Shock Resistance (program-specific parts)										
-48ºC (-55ºF)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	**Fail 12.5**
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	**Fail 14.6**
118ºC (244ºF)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	27.7
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	40.1
Thermal Shock										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	**Fail 9.0**
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	22.9

[1] Thermal Transfer Printable Clear Polyester (TTP200CL-10) Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Average adhesion in ounces per inch label width.
[3] Javelin Launch Tube for testing adhesion to curved surfaces.
NR – Not required.
PS – Dependent on program-specific requirements.

The common and extended testing results for printed Critchley Clear Polyester labels are shown in Table 57 and Table 58, respectively.

Printed Critchley Clear Polyester labels met Grade C common performance requirements. Similar to testing the blank Critchley Clear Polyester labels, the printed Critchley Clear Polyester labels failed chemical resistance testing (JTP Section 3.2.3) for the solder float/terpene-based solvent, which is a requirement for Grade A and Grade B applications. During this test, the label thermally decomposed. If exposure to solder flux can be avoided, this printed label may be considered for Grade A and Grade B applications.

As shown in Table 58, printed Critchley Clear Polyester labels met all extended performance requirements except chemical resistance (JTP Section 3.2.3) to Skydrol and DS2. Because this label failed DS2 testing, it did not undergo CAR testing (Section 2.2.1). Only a portion of IR Reflectance testing (JTP Section 3.2.5) was performed because green printing ribbon was not available that could closely match the FED-STD-595B colors required. The Critchley Clear Polyester label printed with black ink (FED-STD-595B #37030) passed IR Reflectance when compared to ground support equipment requirements.

Table 57. Critchley Clear Polyester Common Testing Results: Printed Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate
		AL1a
Screening		
3.2.2 Adhesion	A, B, C	Pass
3.2.6 Legibility	A, B, C	Pass
Common		
3.2.1 Abrasion (Scrub) Resistance	A, B, C	Pass
3.2.3 Chemical Resistance		
Isopropyl alcohol	A, B, C	Pass
Deionized water	A, B, C	Pass
Engine oil 21SAE20W	A, B, C	Pass
Flux/solder float, then terpene-based solvent	A, B	**Fail[2]**
3.2.7 Salt Spray Resistance		
48-Hour Test	A	Pass
168-Hour Test	A	Pass
3.2.8 Temperature Exposure and Thermal Shock Resistance		
-48ºC (-55ºF)	A, B, C	Pass
118ºC (244ºF)	A, B, C	Pass
Thermal Shock	A, B, C	Pass
3.2.9 UV Light/Condensation	A, B	Pass

[1] Thermal Transfer Printable Clear Polyester (TTP200CL-10) Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Label destroyed during solder float.

Table 58. Critchley Clear Polyester Extended Testing Results: Printed Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate	
		AL1a	SS
Screening			
3.2.2 Adhesion	A, B, C	Pass	NR
3.2.6 Legibility	A, B, C	Pass	NR
Extended			
3.2.3 Chemical Resistance			
Coolanol	PS	Pass	NR
PAO	PS	Pass	NR
Hydraulic fluid (MIL-H-5606)	PS	Pass	NR
Lubricating oil (MIL-L-23699)	PS	Pass	NR
Skydrol	PS	**Fail**	NR
JP5 (MIL-T-5624)	PS	Pass	NR
DS2	PS	**Fail[1]**	NR
3.2.4 Fungus Resistance	A, B	5A[2]	NR
3.2.5 IR Reflectance			
FED-STD-595B # 34094 (Green 383)	A	NP[3]	NR
FED-STD-595B #34095 (Field Green)	A	NP[3]	NR
FED-STD-595B # 37030 (Black)	A	Pass[4]	NR
Supplemental Test (JTR Section 2.2.1): CAR			
Agent HD	A, B	NR	NP[5]
Agent GD	A, B	NR	NP[5]

[1] Thermal Transfer Printable Clear Polyester (TTP200CL-10) Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Ink completely removed by solvent.
[3] Rating of 5A over entire specimen – no peeling or removal. See Appendix E for complete results.
[4] Green RHD TT Ribbon that could match FED-STD-595B #34094 or #34095 was not available.
[5] Refer to Appendix D for the color matching testing results.
[6] The CAR test was not performed because this alternative failed the DS2 chemical resistance test.
PS – Dependent on program-specific requirements.
NR – Not required.

6.7 Critchley Metallized Thermal Transfer (CR-104-MP) (Tyco Electronics)

Screening, common, and extended testing results for blank Critchley Metallized Thermal Transfer labels are shown in Table 59, Table 60, and Table 61, respectively. During screening, blank Critchley Metallized Thermal Transfer labels failed on SR substrates, but passed on all other substrates. Results showed an excessive range for AL1b substrates, which is believed to be a result of poor panel cleaning.

Table 59. Critchley Metallized Screening Results: Blank Labels[1]

Substrate	JTP Section 3.3.1 Average Adhesion, Ounces/Inch Width (Standard Deviation in parentheses)	Pass/Fail
AL1a	64.0 (17.5)	Pass
AL1b	20.4 (21.1)[2]	Pass
AL1c	65.9 (10.5)	Pass
AL1d	71.4 (1.0)	Pass
AL1e	87.2 (11.2)	Pass
AL2	82.8 (10.3)	Pass
SS	81.5 (2.0)	Pass
NR	18.7 (4.2)	Pass
SR	**3.5 (0.9)**	**Fail**
G/E	20.6 (13.3)	Pass
C/E	69.5 (1.2)	Pass
A/E	62.2 (5.8)	Pass

[1] Thermal Transfer Printable Metallized Polyester (CR-104-MP) Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Values show an excessive range. Insufficient cleaning prior to testing is expected.
AL1a - MIL-P-23377/MIL-C-46168
AL1b - MIL-P-23377/MIL-C-53039
AL1c - MIL-P-23377/MIL-C-85285
AL1d - MIL-P-85582/MIL-C-85285
AL1e - MIL-P-85582/MIL-C-22750

As shown in Table 60, blank Critchley Metallized Thermal Transfer labels met Grade C common performance requirements on all substrates except SR. Blank Critchley Metallized Thermal Transfer labels failed chemical resistance testing (JTP Section 3.3.2) for the solder flux/terpene-based solvent, which is a requirement for Grade A and Grade B applications. During this test, the blank label thermally decomposed due to the elevated temperature of the solder float. If exposure to solder flux can be avoided, this alternative may be considered for Grade A and Grade B applications on all substrates except SR.

Similarly, as shown in Table 61, blank Critchley Metallized Thermal Transfer labels met the extended requirements on all substrates except SR. This label also failed during high-temperature exposure testing on a curved surface coated with MIL-C-46168 and during thermal shock testing on a curved surface coated with MIL-C-46168 (JTP Section 3.3.7).

Table 60. Critchley Metallized Common Testing Results: Blank Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E
Screening									
3.3.1 Adhesion (baseline adhesive strengths)[2]	A, B, C	64.0	82.8	81.5	18.7	**Fail 3.5**	20.6	69.5	62.2
Common									
3.3.2 Chemical Resistance									
Isopropyl alcohol[2]	A, B, C	40.4	87.2	95.3	21.8	**Fail 8.1**	46.0	91.8	71.3
Deionized water[2]	A, B, C	22.9	87.4	80.0	23.4	**Fail 8.4**	58.8	84.4	67.0
Engine oil 21SAE20W[2]	A, B, C	45.3	85.8	73.8	23.9	17.0	54.6	94.8	68.4
Flux/solder float, then terpene-based solvent	A, B	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***
3.3.6 Salt Spray Resistance									
48-Hour Test[2]	A	42.1	88.0	92.1	NR	NR	NR	NR	NR
168-Hour Test[2]	A	55.9	83.2	102.3	NR	NR	NR	NR	NR
3.3.7 Temperature Exposure and Thermal Shock Resistance									
-48ºC (-55ºF)[2]	A, B, C	30.8	NR	NR	NR	NR	NR	NR	NR
118ºC (244ºF)[2]	A, B, C	63.6	NR	NR	NR	NR	NR	NR	NR
Thermal Shock	A, B, C	41.3	NR	NR	NR	NR	NR	NR	NR
3.3.8 UV Light/Condensation[2]	A, B	> 70**	NR	NR	NR	NR	NR	NR	NR

[1] Thermal Transfer Printable Metallized Polyester (CR-104-MP) Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Average adhesion in ounces per inch label width.
NR – Not required.
* Label destroyed during solder float; no adhesion test.
** Label tore during test.

Table 61. Critchley Metallized Extended Testing Results: Blank Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate								
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E	Other[4]
Screening										
3.3.1 Adhesion (baseline adhesive strengths)[2]	A, B, C	64.0	82.8	81.5	18.7	**Fail 3.5**	20.6	69.5	62.2	NR
Extended										
3.3.1 Adhesion (Program-specific parts)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	31.5
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	16.2
3.3.2 Chemical Resistance										
Coolanol[2]	PS	39.6	87.5	82.3	24.3	24.0	57.0	101.2	66.4	NR
PAO[2]	PS	31.4	87.4	97.9	27.6	**Fail 14.2**	65.0	103.6	67.0	NR
Hydraulic fluid (MIL-H-5606)[2]	PS	35.0	90.3	95.7	22.2	**Fail 9.1**	63.8	106.8	70.1	NR
Lubricating oil (MIL-L-23699)[2]	PS	43.2	88.2	95.6	24.1	**Fail 6.7**	71.9	103.6	68.2	NR
Skydrol[2]	PS	45.4	87.8	91.9	20.0	**Fail 11.8**	63.2	107.8	68.6	NR
JP5 (MIL-T-5624)[2]	PS	26.3	89.9	97.0	25.6	21.2	64.6	105.0	68.9	NR
DS2[2]	PS	40.8	92.2	94.8	25.3	16.8	67.6	109.0	69.3	NR
3.3.3 Corrosivity										
54°C (130ºF)[2]	A, B, C	> 60*	> 85*	> 90*	NR	NR	NR	NR	NR	NR
71°C (160ºF)[2]	A, B, C	> 50*	> 75*	> 70*	NR	NR	NR	NR	NR	NR
118°C (244ºF)[2]	A, B, C	> 50*	85.9	82.4	NR	NR	NR	NR	NR	NR

[1] Thermal Transfer Printable Metallized Polyester (CR-104-MP) Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Average adhesion in ounces per inch label width.
[3] Green Critchley Metallized Thermal Transfer labels that could match FED-STD-595B #34094 or #34095 were not available.
[4] Javelin Launch Tube for testing adhesion to curved surfaces.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.
* Label tore during test.

(Table 61 continued on next page)

Table 61. Critchley Metallized Extended Testing Results: Blank Labels (continued)[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate								
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E	Other[4]
3.3.4 DC Electrical Resistance	A, B, C	NR	NR	NR	NR	NR	Pass	Pass	Pass	NR
3.3.5 IR Reflectance										
FED-STD-595B # 34094 (Green 383)	A	NP[3]	NR	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B #34095 (Field Green)	A	NP[3]	NR	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B # 37030 (Black)	A	NP[3]	NR	NR	NR	NR	NR	NR	NR	NR
3.3.7 Temperature Exposure and Thermal Shock Resistance (program-specific parts)										
-48ºC (-55ºF)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	25.1
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	19.5
118ºC (244ºF)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	**Fail 14.5**
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	24.2
Thermal Shock										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	**Fail 12.0**
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	19.2

[1] Thermal Transfer Printable Metallized Polyester (CR-104-MP) Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Average adhesion in ounces per inch label width.
[3] Green Critchley Metallized Thermal Transfer labels that could match FED-STD-595B #34094 or #34095 were not available.
[4] Javelin Launch Tube for testing adhesion to curved surfaces.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.
* Label tore during test.

The common and extended testing results for printed Critchley Metallized Thermal Transfer labels are shown in Table 62 and Table 63, respectively.

Printed Critchley Metallized Thermal Transfer labels met Grade C common performance requirements. Similar to testing the blank Critchley Metallized Thermal Transfer labels, the printed Critchley Metallized Thermal Transfer labels failed chemical resistance testing (JTP Section 3.2.3) for the solder float/terpene-based solvent, which is a requirement for Grade A and Grade B applications. During this test, the label thermally decomposed due to the elevated temperature of the solder float. If exposure to solder flux can be avoided, this printed label may be considered for Grade A and Grade B applications.

As shown in Table 63, printed Critchley Metallized Thermal Transfer labels met all extended performance requirements except IR Reflectance (JTP Section 3.2.5) and chemical resistance (JTP Section 3.2.3) to Skydrol and DS2. Because this label failed DS2 testing, it did not undergo CAR testing (Section 2.2.1). Only a portion of IR Reflectance testing was performed because green printing ribbon was not available that could closely match the FED-STD-595B colors required. Critchley Metallized Thermal Transfer labels printed with black failed IR Reflectance when compared to ground support equipment requirements.

Table 62. Critchley Metallized Common Testing Results: Printed Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate
		AL1a
Screening		
3.2.2 Adhesion	A, B, C	Pass
3.2.6 Legibility	A, B, C	Pass
Common		
3.2.1 Abrasion (Scrub) Resistance	A, B, C	Pass
3.2.3 Chemical Resistance		
Isopropyl alcohol	A, B, C	Pass
Deionized water	A, B, C	Pass
Engine oil 21SAE20W	A, B, C	Pass
Flux/solder float, then terpene-based solvent	A, B	**Fail[2]**
3.2.7 Salt Spray Resistance		
48-Hour Test	A	Pass
168-Hour Test	A	Pass
3.2.8 Temperature Exposure and Thermal Shock Resistance		
-48ºC (-55ºF)	A, B, C	Pass
118ºC (244ºF)	A, B, C	Pass
Thermal Shock	A, B, C	Pass
3.2.9 UV Light/Condensation	A, B	Pass

[1] Thermal Transfer Printable Metallized Polyester (CR-104-MP) Label Stock (Refer to Table 6 for detailed description or specification of this label).

[2] Label destroyed during solder float.

Table 63. Critchley Metallized Extended Testing Results: Printed Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate	
		AL1a	SS
Screening			
3.2.2 Adhesion	A, B, C	Pass	NR
3.2.6 Legibility	A, B, C	Pass	NR
Extended			
3.2.3 Chemical Resistance			
Coolanol	PS	Pass	NR
PAO	PS	Pass	NR
Hydraulic fluid (MIL-H-5606)	PS	Pass	NR
Lubricating oil (MIL-L-23699)	PS	Pass	NR
Skydrol	PS	**Fail**	NR
JP5 (MIL-T-5624)	PS	Pass	NR
DS2	PS	**Fail**[2]	NR
3.2.4 Fungus Resistance	A, B	5A[3]	NR
3.2.5 IR Reflectance			
FED-STD-595B # 34094 (Green 383)	A	NP[4]	NR
FED-STD-595B #34095 (Field Green)	A	NP[4]	NR
FED-STD-595B # 37030 (Black)	A	**Fail**[5]	NR
Supplemental Test (JTR Section 2.2.1): CAR			
Agent HD	A, B	NR	NP[6]
Agent GD	A, B	NR	NP[6]

[1] Thermal Transfer Printable Metallized Polyester (CR-104-MP) Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Ink completely removed by solvent.
[3] Rating of 5A over entire specimen – no peeling or removal. See Appendix E for complete results.
[4] Green RHD TT Ribbon that could match FED-STD-595B #34094 or #34095 was not available.
[5] Refer to Appendix D for color matching testing results.
[6] The CAR test was not performed because this alternative failed the DS2 chemical resistance test.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.

6.8 Critchley White Polyester Film (CR-119-WP2.5) (Tyco Electronics)

Screening, common, and extended test results for blank Critchley White Polyester Film labels are shown in Table 64, Table 65, and Table 66, respectively. Critchley White Polyester Film passed on all substrates except SR. Results showed an excessive range for AL1b substrates. The wide range is believed to result from poor panel cleaning.

Table 64. Critchley White Polyester Film Screening Results: Blank Labels[1]

Substrate	JTP Section 3.3.1 Average Adhesion, Ounces/Inch Width (Standard Deviation in parentheses)	Pass/Fail
AL1a	35.5 (8.2)	Pass
AL1b	30.3 (18.1)[2]	Pass
AL1c	47.5 (1.1)	Pass
AL1d	41.3 (1.8)	Pass
AL1e	69.1 (5.9)	Pass
AL2	68.9 (5.5)	Pass
SS	64.1 (2.9)	Pass
NR	22.0 (2.8)	Pass
SR	**5.1 (1.7)**	**Fail**
G/E	25.1 (6.0)	Pass
C/E	48.4 (1.8)	Pass
A/E	43.6 (1.7)	Pass

[1] Thermal Transfer Printable Critchley White Polyester (CR-119-WP2.5) Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Values show an excessive range. Insufficient cleaning prior to testing is expected.
AL1a - MIL-P-23377/MIL-C-46168
AL1b - MIL-P-23377/MIL-C-53039
AL1c - MIL-P-23377/MIL-C-85285
AL1d - MIL-P-85582/MIL-C-85285
AL1e - MIL-P-85582/MIL-C-22750

As shown in Table 65, blank Critchley White Polyester Film labels met Grade C common performance requirements on all substrates except SR. Blank Critchley White Polyester Film labels failed chemical resistance testing (JTP Section 3.3.2) for the solder flux/terpene-based solvent, which is a requirement for Grade A and Grade B applications. During this test, the blank label decomposed due to exposure to the elevated temperature of the solder float. If exposure to solder flux can be avoided, this alternative may be considered for Grade A and Grade B applications on all substrates except SR.

Similarly, as shown in Table 66, blank Critchley White Polyester Film labels met the extended requirements on all substrates except SR. This label also failed during adhesion testing to a curved surface coated with MIL-C-46168 and MIL-C-53039 (JTP Section 3.3.1) and during low-temperature exposure testing when applied to a curved surface coated with MIL-C-46168 and MIL-C-53039 (JTP Section 3.3.7). For testing IR Reflectance, colored versions of the Critchley Polyester Film labels were used. Only a portion of IR Reflectance testing (JTP Section 3.3.5) was performed, because green labels that could closely match the FED-STD-595B colors required were not available. The black Critchley Polyester Film label (TTP400BK-10) failed IR Reflectance when compared to ground support equipment requirements.

Table 65. Critchley White Polyester Film Common Testing Results: Blank Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E
Screening									
3.3.1 Adhesion (baseline adhesive strengths)[2]	A, B, C	35.5	68.9	64.1	22.0	**Fail 5.1**	25.1	48.4	43.6
Common									
3.3.2 Chemical Resistance									
Isopropyl alcohol[2]	A, B, C	51.0	90.1	60.0	21.6	**Fail 8.6**	28.0	70.6	51.0
Deionized water[2]	A, B, C	50.8	86.6	59.2	17.9	**Fail 15.4**	26.9	69.6	49.6
Engine oil 21SAE20W[2]	A, B, C	55.2	95.4	70.2	22.2	**Fail 7.4**	27.4	76.4	50.2
Flux/solder float, then terpene-based solvent	A, B	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***
3.3.6 Salt Spray Resistance									
48-Hour Test[2]	A	46.6	97.1	86.8	NR	NR	NR	NR	NR
168-Hour Test[2]	A	59.0	98.1	95.8	NR	NR	NR	NR	NR
3.3.7 Temperature Exposure and Thermal Shock Resistance									
-48ºC (-55ºF)[2]	A, B, C	50.5	NR	NR	NR	NR	NR	NR	NR
118ºC (244ºF)[2]	A, B, C	57.4	NR	NR	NR	NR	NR	NR	NR
Thermal Shock	A, B, C	52.6	NR	NR	NR	NR	NR	NR	NR
3.3.8 UV Light/Condensation[2]	A, B	51.7	NR	NR	NR	NR	NR	NR	NR

[1] Thermal Transfer Printable Critchley White Polyester (CR-119-WP2.5) Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Average adhesion in ounces per inch label width.
NR – Not required.
* Label destroyed during solder float; no adhesion test.

Table 66. Critchley White Polyester Film Extended Testing Results: Blank Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate								
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E	Other[5]
Screening										
3.3.1 Adhesion (baseline adhesive strengths)[2]	A, B, C	35.5	68.9	64.1	22.0	**Fail 5.1**	25.1	48.4	43.6	NR
Extended										
3.3.1 Adhesion (Program-specific parts)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	**Fail 11.2**
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	**Fail 15.3**
3.3.2 Chemical Resistance										
Coolanol[2]	PS	28.6	94.8	72.0	23.3	23.4	29.8	83.2	45.8	NR
PAO[2]	PS	29.9	93.2	71.3	22.6	**Fail 10.4**	30.9	82.2	49.6	NR
Hydraulic fluid (MIL-H-5606)[2]	PS	37.8	83.7	76.3	18.4	**Fail 7.6**	32.0	91.2	52.5	NR
Lubricating oil (MIL-L-23699)[2]	PS	37.2	82.1	77.8	23.4	**Fail 7.2**	30.7	90.2	49.6	NR
Skydrol[2]	PS	54.2	89.0	72.2	20.6	23.7	31.7	91.4	48.5	NR
JP5 (MIL-T-5624)[2]	PS	37.2	94.3	79.0	20.3	**Fail 7.7**	30.8	92.0	51.6	NR
DS2[2]	PS	35.8	96.6	80.6	25.9	**Fail 9.2**	26.6	91.4	49.1	NR

[1] Thermal Transfer Printable Critchley White Polyester (CR-119-WP2.5) Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Average adhesion in ounces per inch label width.
[3] The standard Critchley TTP 400 GN-10 Green Polyester did not match FED-STD-595B #34094 or #34095.
[4] Refer to Appendix D for color matching testing results.
[5] Javelin Launch Tube for testing adhesion to curved surfaces.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.

(Table 66 continued on next page)

Table 66. Critchley White Polyester Film Extended Testing Results: Blank Labels (continued)[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate								
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E	Other[5]
3.3.3 Corrosivity										
54°C (130ºF)[2]	A, B, C	56.6	93.4	92.1	NR	NR	NR	NR	NR	NR
71°C (160ºF)[2]	A, B, C	61.9	88.4	72.7	NR	NR	NR	NR	NR	NR
118°C (244ºF)[2]	A, B, C	49.4	96.8	90.6	NR	NR	NR	NR	NR	NR
3.3.4 DC Electrical Resistance	A, B, C	NR	NR	NR	NR	NR	Pass	Pass	Pass	NR
3.3.5 IR Reflectance										
FED-STD-595B # 34094 (Green 383)	A	NP[3,4]	NR	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B #34095 (Field Green)	A	NP[3,4]	NR	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B # 37030 (Black) (TTP400BK-10)	A	**Fail**[4]	NR	NR	NR	NR	NR	NR	NR	NR
3.3.7 Temperature Exposure and Thermal Shock Resistance (program-specific parts)										
-48ºC (-55ºF)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	**Fail 15.3**
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	**Fail 12.9**
118ºC (244ºF)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	31.9
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	43.3
Thermal Shock										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	21.9
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	33.6

[1] Thermal Transfer Printable Critchley White Polyester (CR-119-WP2.5) Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Average adhesion in ounces per inch label width.
[3] The standard Critchley TTP 400 GN-10 Green Polyester did not match FED-STD-595B #34094 or #34095.
[4] Refer to Appendix D for color matching testing results.
[5] Javelin Launch Tube for testing adhesion to curved surfaces.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.

The common and extended testing results for printed Critchley White Polyester Film labels are shown in Table 67 and Table 68, respectively.

Printed Critchley White Polyester labels met Grade C common performance requirements. Similar to testing the blank Critchley White Polyester labels, the printed Critchley White Polyester labels failed chemical resistance testing (JTP Section 3.2.3) for the solder float/terpene-based solvent, which is a requirement for Grade A and Grade B applications. During this test, the label thermally decomposed. If exposure to solder flux can be avoided, this printed label may be considered for Grade A and Grade B applications.

As shown in Table 68, printed Critchley White Polyester labels met all extended performance requirements except chemical resistance (JTP Section 3.2.3) to Skydrol and DS2. Because this label failed DS2 testing, it did not undergo CAR testing (Section 2.2.1). Only a portion of IR Reflectance testing (JTP Section 3.2.5) was performed because green printing ribbon was not available that could closely match the FED-STD-595B colors required. Critchley White Polyester labels printed with black passed IR Reflectance when compared to ground support equipment requirements.

Table 67. Critchley White Polyester Film Common Testing Results: Printed Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate
		AL1a
Screening		
3.2.2 Adhesion	A, B, C	Pass
3.2.6 Legibility	A, B, C	Pass
Common		
3.2.1 Abrasion (Scrub) Resistance	A, B, C	Pass
3.2.3 Chemical Resistance		
Isopropyl alcohol	A, B, C	Pass
Deionized water	A, B, C	Pass
Engine oil 21SAE20W	A, B, C	Pass
Flux/solder float, then terpene-based solvent	A, B	**Fail[2]**
3.2.7 Salt Spray Resistance		
48-Hour Test	A	Pass
168-Hour Test	A	Pass
3.2.8 Temperature Exposure and Thermal Shock Resistance		
-48ºC (-55ºF)	A, B, C	Pass
118ºC (244ºF)	A, B, C	Pass
Thermal Shock	A, B, C	Pass
3.2.9 UV Light/Condensation	A, B	Pass[3]

[1] Thermal Transfer Printable Critchley White Polyester (CR-119-WP2.5) Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Label destroyed during solder float.
[3] Top label passed with no adhesion or legibility loss. Bottom label failed adhesion near scribe, but remained legible elsewhere.

Table 68. Critchley White Polyester Film Extended Testing Results: Printed Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate	
		AL1a	SS
Screening			
3.2.2 Adhesion	A, B, C	Pass	NR
3.2.6 Legibility	A, B, C	Pass	NR
Extended			
3.2.3 Chemical Resistance			
Coolanol	PS	Pass	NR
PAO	PS	Pass	NR
Hydraulic fluid (MIL-H-5606)	PS	Pass	NR
Lubricating oil (MIL-L-23699)	PS	Pass	NR
Skydrol	PS	**Fail**	NR
JP5 (MIL-T-5624)	PS	Pass	NR
DS2	PS	**Fail**[2]	NR
3.2.4 Fungus Resistance	A, B	5A/1A[3]	NR
3.2.5 IR Reflectance			
FED-STD-595B # 34094 (Green 383)	A	NP[4]	NR
FED-STD-595B #34095 (Field Green)	A	NP[4]	NR
FED-STD-595B # 37030 (Black)	A	Pass[5]	NR
Supplemental Test (JTR Section 2.2.1): CAR			
Agent HD	A, B	NR	NP[6]
Agent GD	A, B	NR	NP[6]

[1] Thermal Transfer Printable Critchley White Polyester (CR-119-WP2.5) Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Ink completely removed by solvent.
[3] Ratings of 5A and 1A in various areas of the specimen. See Appendix E for complete results.
[4] Green RHD Ribbon that could match FED-STD-595B #34094 or #34095 was not available.
[5] Refer to Appendix D for color matching testing results.
[6] The CAR test was not performed because this alternative failed the DS2 chemical resistance test.
NR – Not required.
PS – Dependent on program-specific requirements.

6.9 Tyton 822 (Hellermann Tyton)[1]

Screening, common, and extended results for blank Tyton 822 labels are shown in Table 69, Table 70, and Table 71, respectively. Blank Tyton 822 labels failed on SR substrates, but passed on all other substrates.

Table 69. Tyton 822 Screening Results: Blank Labels[1]

Substrate	JTP Section 3.3.1 Average Adhesion, Ounces/Inch Width (Standard Deviation in parentheses)	Pass/Fail
AL1a	39.6 (8.4)	Pass
AL1b	40.0 (6.0)	Pass
AL1c	42.1 (1.1)	Pass
AL1d	41.8 (0.6)	Pass
AL1e	82.4 (1.4)	Pass
AL2	86.7 (2.9)	Pass
SS	69.6 (3.8)	Pass
NR	35.5 (3.2)	Pass
SR	**13.5 (1.7)**	**Fail**
G/E	26.5 (2.1)	Pass
C/E	38.5 (1.0)	Pass
A/E	33.4 (1.3)	Pass

[1] Thermal Transfer Printable White Polyester Label Stock (Refer to Table 6 for detailed description or specification of this label).
AL1a - MIL-P-23377/MIL-C-46168
AL1b - MIL-P-23377/MIL-C-53039
AL1c - MIL-P-23377/MIL-C-85285
AL1d - MIL-P-85582/MIL-C-85285
AL1e - MIL-P-85582/MIL-C-22750

As shown in Table 70, blank Tyton 822 labels met Grade C common performance requirements on all substrates except SR, where the only failure was during screening. Blank Tyton 822 labels failed chemical resistance testing (JTP Section 3.3.2) for the solder flux/terpene-based solvent, which is a requirement for Grade A and Grade B applications. During this test, the blank label decomposed due to exposure to the elevated temperature of the solder float. If exposure to solder flux can be avoided, this alternative may be considered for Grade A and Grade B applications on all but SR substrates.

As shown in Table 71, blank Tyton 822 labels passed the extended performance requirements for all substrates tested. However, blank Tyton 822 labels failed high-temperature exposure testing on a curved surface coated with MIL-C-53039 (JTP Section 3.3.7). Blank Tyton 822 labels were not available in the FED-STD-595B colors required for IR reflectance testing (JTP Section 3.3.5).

Table 70. Tyton 822 Common Testing Results: Blank Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E
Screening									
3.3.1 Adhesion (baseline adhesive strengths)[2]	A, B, C	39.6	86.7	69.6	35.5	**Fail 13.5**	26.5	38.5	33.4
Common									
3.3.2 Chemical Resistance									
Isopropyl alcohol[2]	A, B, C	55.4	81.8	72.8	25.2	17.2	29.0	40.8	35.5
Deionized water[2]	A, B, C	55.2	82.2	70.3	25.1	17.0	30.0	41.6	34.2
Engine oil 21SAE20W[2]	A, B, C	59.5	81.3	62.1	26.8	33.0	34.2	46.8	35.8
Flux/solder float, then terpene-based solvent	A, B	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***	**Fail***
3.3.6 Salt Spray Resistance									
48-Hour Test[2]	A	82.6	86.5	85.6	NR	NR	NR	NR	NR
168-Hour Test[2]	A	79.5	85.8	86.2	NR	NR	NR	NR	NR
3.3.7 Temperature Exposure and Thermal Shock Resistance									
-48ºC (-55ºF)[2]	A, B, C	62.2	NR	NR	NR	NR	NR	NR	NR
118ºC (244ºF)[2]	A, B, C	71.8	NR	NR	NR	NR	NR	NR	NR
Thermal Shock	A, B, C	74.6	NR	NR	NR	NR	NR	NR	NR
3.3.8 UV Light/Condensation[2]	A, B	84.0	NR	NR	NR	NR	NR	NR	NR

[1] Thermal Transfer Printable White Polyester Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Average adhesion in ounces per inch label width.
NR – Not required.
* Label destroyed during solder float; no adhesion test.

Table 71. Tyton 822 Extended Testing Results: Blank Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate								
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E	Other[4]
Screening										
3.3.1 Adhesion (baseline adhesive strengths)[2]	A, B, C	39.6	86.7	69.6	35.5	**Fail 13.5**	26.5	38.5	33.4	NR
Extended										
3.3.1 Adhesion (Program-specific parts)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	26.9
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	21.4
3.3.2 Chemical Resistance										
Coolanol[2]	PS	62.8	82.1	68.9	27.0	19.2	34.2	40.2	35.3	NR
PAO[2]	PS	56.5	83.2	65.6	27.2	20.0	30.0	44.8	42.2	NR
Hydraulic fluid (MIL-H-5606)[2]	PS	64.0	84.2	65.8	26.6	24.1	36.6	45.6	43.8	NR
Lubricating oil (MIL-L-23699)[2]	PS	64.4	82.8	65.5	30.8	17.8	33.4	48.2	39.8	NR
Skydrol[2]	PS	60.2	79.0	65.2	25.8	17.8	33.6	41.2	40.0	NR
JP5 (MIL-T-5624)[2]	PS	60.7	75.2	72.6	28.2	23.1	32.0	45.6	37.9	NR
DS2[2]	PS	66.2	84.2	66.1	27.3	21.2	34.2	43.0	38.8	NR
3.3.3 Corrosivity										
54°C (130ºF)[2]	A, B, C	40.0	73.3	83.6	NR	NR	NR	NR	NR	NR
71°C (160ºF)[2]	A, B, C	52.3	79.6	66.9	NR	NR	NR	NR	NR	NR
118°C (244ºF)[2]	A, B, C	80.7	66.3	55.4	NR	NR	NR	NR	NR	NR
3.3.4 DC Electrical Resistance	A, B, C	NR	NR	NR	NR	NR	Pass	Pass	Pass	NR

[1] Thermal Transfer Printable White Polyester Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Average adhesion in ounces per inch label width.
[3] White is the only standard label stock color (minimum purchase of 25,000-50,000 labels for custom colors).
[4] Javelin Launch Tube for testing adhesion to curved surfaces.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.

(Table 71 continued on next page)

Table 71. Tyton 822 Extended Testing Results: Blank Labels (continued)[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate								
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E	Other[4]
3.3.5 IR Reflectance										
FED-STD-595B # 34094 (Green 383)	A	NP[3]	NR	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B #34095 (Field Green)	A	NP[3]	NR	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B # 37030 (Black)	A	NP[3]	NR	NR	NR	NR	NR	NR	NR	NR
3.3.7 Temperature Exposure and Thermal Shock Resistance (program-specific parts)										
-48ºC (-55ºF)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	24.7
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	18.3
118ºC (244ºF)										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	17.6
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	**Fail 15.4**
Thermal Shock										
MIL-C-46168[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	51.6
MIL-C-53039[2]	PS	NR	NR	NR	NR	NR	NR	NR	NR	61.9

[1] Thermal Transfer Printable White Polyester Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Average adhesion in ounces per inch label width.
[3] White is the only standard label stock color (minimum purchase of 25,000-50,000 labels for custom colors).
[4] Javelin Launch Tube for testing adhesion to curved surfaces.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.

The common and extended testing results for printed Tyton 822 labels are shown in Table 72 and Table 73, respectively.

Printed Tyton 822 labels met Grade C common performance requirements. Similar to testing the blank Tyton 822 labels, the printed Tyton 822 labels failed chemical resistance testing (JTP Section 3.2.3) for the solder float/terpene-based solvent, which is a requirement for Grade A and Grade B applications. During this test, the label thermally decomposed. If exposure to solder flux can be avoided, this printed label may be considered for Grade A and Grade B applications.

As shown in Table 73, printed Tyton 822 labels met all extended performance requirements except chemical resistance (JTP Section 3.2.3) to Skydrol and DS2. Because this label failed DS2 testing, it did not undergo CAR testing (Section 2.2.1). Only a portion of IR Reflectance testing (JTP Section 3.2.5) was performed because green printing ribbon was not available that could closely match the FED-STD-595B colors required. Tyton 822 labels printed in black failed IR Reflectance when compared to ground support equipment requirements.

Table 72. Tyton 822 Common Testing Results: Printed Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate
		AL1a
Screening		
3.2.2 Adhesion	A, B, C	Pass
3.2.6 Legibility	A, B, C	Pass
Common		
3.2.1 Abrasion (Scrub) Resistance	A, B, C	Pass
3.2.3 Chemical Resistance		
Isopropyl alcohol	A, B, C	Pass
Deionized water	A, B, C	Pass
Engine oil 21SAE20W	A, B, C	Pass
Flux/solder float, then terpene-based solvent	A, B	**Fail[1]**
3.2.7 Salt Spray Resistance		
48-Hour Test	A	Pass
168-Hour Test	A	Pass
3.2.8 Temperature Exposure and Thermal Shock Resistance		
-48ºC (-55ºF)	A, B, C	Pass
118ºC (244ºF)	A, B, C	Pass
Thermal Shock	A, B, C	Pass
3.2.9 UV Light/Condensation	A, B	Pass

[1] Thermal Transfer Printable White Polyester Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Label destroyed during solder float.

Table 73. Tyton 822 Extended Testing Results: Printed Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate	
		AL1a	SS
Screening			
3.2.2 Adhesion	A, B, C	Pass	NR
3.2.6 Legibility	A, B, C	Pass	NR
Extended			
3.2.3 Chemical Resistance			
Coolanol	PS	Pass	NR
PAO	PS	Pass	NR
Hydraulic fluid (MIL-H-5606)	PS	Pass	NR
Lubricating oil (MIL-L-23699)	PS	Pass	NR
Skydrol	PS	**Fail**	NR
JP5 (MIL-T-5624)	PS	Pass	NR
DS2	PS	**Fail**[2]	NR
3.2.4 Fungus Resistance	A, B	5A[3]	NR
3.2.5 IR Reflectance			
FED-STD-595B # 34094 (Green 383)	A	NP[4]	NR
FED-STD-595B #34095 (Field Green)	A	NP[4]	NR
FED-STD-595B # 37030 (Black)	A	**Fail**[5]	NR
Supplemental Test (JTR Section 2.2.1): CAR			
Agent HD	A, B	NR	NP[6]
Agent GD	A, B	NR	NP[6]

[1] Thermal Transfer Printable White Polyester Label Stock (Refer to Table 6 for detailed description or specification of this label).
[2] Ink completely removed by solvent.
[3] Rating of 5A over entire specimen – no peeling or removal. See Appendix E for complete results.
[4] Green TT822OUT Ribbon that could match FED-STD-595B #34094 or #34095 was not available.
[5] Refer to Appendix D for color matching testing results.
[6] The CAR test was not performed because this alternative failed the DS2 chemical resistance test.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.

6.10 Tyton 900 (Hellermann Tyton)

Screening, common, and extended testing results for blank Tyton 900 labels are shown in Table 74, Table 75, and Table 76, respectively. Blank Tyton 900 labels failed on SR substrates, but passed on all other substrates tested.

Table 74. Tyton 900 Screening Results: Blank Labels[1]

Substrate	JTP Section 3.3.1 Average Adhesion, Ounces/Inch Width (Standard Deviation in parentheses)	Pass/Fail
AL1a	55.7 (9.4)	Pass
AL1b	53.5 (5.0)	Pass
AL1c	65.8 (2.6)	Pass
AL1d	69.1 (3.9)	Pass
AL1e	94.2 (5.4)	Pass
AL2	85.3 (3.3)	Pass
SS	68.2 (1.4)	Pass
NR	23.3 (1.8)	Pass
SR	**13.7 (3.0)**	**Fail**
G/E	29.0 (1.3)	Pass
C/E	37.5 (0.5)	Pass
A/E	30.2 (1.0)	Pass

AL1a - MIL-P-23377/MIL-C-46168
AL1b - MIL-P-23377/MIL-C-53039
AL1c - MIL-P-23377/MIL-C-85285
AL1d - MIL-P-85582/MIL-C-85285
AL1e - MIL-P-85582/MIL-C-22750

As shown in Table 75, blank Tyton 900 labels met Grade C common performance requirements on all substrates except SR. Blank Tyton 900 labels failed chemical resistance testing (JTP Section 3.3.2) for solder flux/terpene-based solvent, which is a requirement for Grade A and Grade B applications. During this test, the blank label decomposed due to exposure to the elevated temperature of the solder float. If exposure to solder float can be avoided, this alternative may be considered as an alternative for Grade A and Grade B applications on all substrates except SR.

Similarly, as shown in Table 76, blank Tyton 900 labels passed the extended tests performed on all substrates except SR. Blank Tyton 900 labels were not available in the FED-STD-595B colors required for IR reflectance testing (JTP Section 3.3.5).

Table 75. Tyton 900 Common Testing Results: Blank Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate							
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E
Screening									
3.3.1 Adhesion (baseline adhesive strengths)[1]	A, B, C	55.7	85.3	68.2	23.3	**Fail 13.7**	29.0	37.5	30.2
Common									
3.3.2 Chemical Resistance									
Isopropyl alcohol[1]	A, B, C	63.9	> 85*	70.5	20.0	**Fail 10.1**	52.0	59.1	56.1
Deionized water[1]	A, B, C	72.6	> 85*	76.3	20.8	**Fail 5.2**	61.7	57.4	53.1
Engine oil 21SAE20W[1]	A, B, C	63.9	95.1	71.2	19.6	**Fail 8.4**	61.9	61.6	56.8
Flux/solder float, then terpene-based solvent	A, B	**Fail****	**Fail****	**Fail****	**Fail****	**Fail****	**Fail****	**Fail****	**Fail****
3.3.6 Salt Spray Resistance									
48-Hour Test[1]	A	73.2	61.0	79.5	NR	NR	NR	NR	NR
168-Hour Test[1]	A	73.2	97.0	63.2	NR	NR	NR	NR	NR
3.3.7 Temperature Exposure and Thermal Shock Resistance									
-48ºC (-55ºF)[1]	A, B, C	70.0	NR	NR	NR	NR	NR	NR	NR
118ºC (244ºF)[1]	A, B, C	100.4	NR	NR	NR	NR	NR	NR	NR
Thermal Shock	A, B, C	96.8	NR	NR	NR	NR	NR	NR	NR
3.3.8 UV Light/Condensation[1]	A, B	> 50*	NR	NR	NR	NR	NR	NR	NR

[1] Average adhesion in ounces per inch label width.
NR – Not required.
* Label tore during test.
** Label destroyed during solder float; no adhesion test.

Table 76. Tyton 900 Extended Testing Results: Blank Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate								
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E	Other[3]
Screening										
3.3.1 Adhesion (baseline adhesive strengths)[1]	A, B, C	55.7	85.3	68.2	23.3	**Fail 13.7**	29.0	37.5	30.2	NR
Extended										
3.3.1 Adhesion (Program-specific parts)										
MIL-C-46168[1]	PS	NR	NR	NR	NR	NR	NR	NR	NR	21.3
MIL-C-53039[1]	PS	NR	NR	NR	NR	NR	NR	NR	NR	32.3
3.3.2 Chemical Resistance										
Coolanol[1]	PS	69.4	> 95*	71.1	20.8	**Fail 11.9**	46.2	60.9	66.9	NR
PAO[1]	PS	65.5	> 95*	71.2	20.6	**Fail 7.4**	41.8	60.5	55.8	NR
Hydraulic fluid (MIL-H-5606)[1]	PS	71.6	> 85*	72.9	17.0	**Fail 4.2**	59.8	49.8	61.0	NR
Lubricating oil (MIL-L-23699)[1]	PS	70.1	> 90*	82.0	26.2	**Fail 5.4**	53.6	59.2	56.6	NR
Skydrol[1]	PS	56.1	> 75*	63.0	21.0	**Fail 15.8**	39.0	46.4	55.0	NR
JP5 (MIL-T-5624)[1]	PS	72.6	> 90*	>70*	20.6	**Fail 10.0**	67.8	46.8	65.4	NR
DS2[1]	PS	71.3	> 90*	81.0	20.4	**Fail 8.2**	69.4	62.3	58.6	NR

[1] Average adhesion in ounces per inch label width.
[2] White is the only standard label stock color (minimum purchase of 25,000-50,000 labels for custom colors).
[3] Javelin Launch Tube for testing adhesion to curved surfaces.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.
* Label tore during test.

(Table 76 continued on next page)

Table 76. Tyton 900 Extended Testing Results: Blank Labels (continued)[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate								
		AL1a	AL2	SS	NR	SR	G/E	C/E	A/E	Other[3]
3.3.3 Corrosivity										
54°C (130ºF)[1]	A, B, C	77.1	> 85*	> 90*	NR	NR	NR	NR	NR	NR
71°C (160ºF)[1]	A, B, C	> 64*	> 95*	> 80*	NR	NR	NR	NR	NR	NR
118°C (244ºF)[1]	A, B, C	> 64*	> 95*	82.3	NR	NR	NR	NR	NR	NR
3.3.4 DC Electrical Resistance	A, B, C	NR	NR	NR	NR	NR	Pass	Pass	Pass	NR
3.3.5 IR Reflectance										
FED-STD-595B # 34094 (Green 383)	A	NP[2]	NR	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B #34095 (Field Green)	A	NP[2]	NR	NR	NR	NR	NR	NR	NR	NR
FED-STD-595B # 37030 (Black)	A	NP[2]	NR	NR	NR	NR	NR	NR	NR	NR
3.3.7 Temperature Exposure and Thermal Shock Resistance (program-specific parts)										
-48ºC (-55ºF)										
MIL-C-46168[1]	PS	NR	NR	NR	NR	NR	NR	NR	NR	43.0
MIL-C-53039[1]	PS	NR	NR	NR	NR	NR	NR	NR	NR	37.9
118ºC (244ºF)										
MIL-C-46168[1]	PS	NR	NR	NR	NR	NR	NR	NR	NR	26.6
MIL-C-53039[1]	PS	NR	NR	NR	NR	NR	NR	NR	NR	39.7
Thermal Shock										
MIL-C-46168[1]	PS	NR	NR	NR	NR	NR	NR	NR	NR	28.7
MIL-C-53039[1]	PS	NR	NR	NR	NR	NR	NR	NR	NR	25.2

[1] Average adhesion in ounces per inch label width.
[2] White is the only standard label stock color (minimum purchase of 25,000-50,000 labels for custom colors).
[3] Javelin Launch Tube for testing adhesion to curved surfaces.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.
* Label tore during test.

The common and extended testing results for printed Tyton 900 labels are shown in Table 77 and Table 78, respectively.

Printed Tyton 900 labels did not meet Grade A, Grade B, or Grade C applications due to its failure during chemical resistance testing (JTP Section 3.2.3) for isopropyl alcohol and solder float/terpene-based solvent.

As shown in Table 78, printed Tyton 900 labels met all extended performance requirements except chemical resistance (JTP Section 3.2.3) to Skydrol and DS2. Because this label failed DS2 testing, it did not undergo CAR testing (Section 2.2.1). Only a portion of IR Reflectance testing (JTP Section 3.2.5) was performed because green printing ribbon was not available that could closely match the FED-STD-595B colors required. Tyton 900 labels printed in black passed IR Reflectance when compared to ground support equipment requirements.

Table 77. Tyton 900 Common Testing Results: Printed Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate
		AL1a
Screening		
3.2.2 Adhesion	A, B, C	Pass
3.2.6 Legibility	A, B, C	Pass
Common		
3.2.1 Abrasion (Scrub) Resistance	A, B, C	Pass
3.2.3 Chemical Resistance		
Isopropyl alcohol	A, B, C	**Fail[1]**
Deionized water	A, B, C	Pass
Engine oil 21SAE20W	A, B, C	Pass
Flux/solder float, then terpene-based solvent	A, B	**Fail[2]**
3.2.7 Salt Spray Resistance		
48-Hour Test	A	Pass
168-Hour Test	A	Pass
3.2.8 Temperature Exposure and Thermal Shock Resistance		
-48ºC (-55ºF)	A, B, C	Pass
118ºC (244ºF)	A, B, C	Pass
Thermal Shock	A, B, C	Pass
3.2.9 UV Light/Condensation	A, B	Pass

[1] Ink completely removed by solvent.
[2] Label destroyed during solder float.

Table 78. Tyton 900 Extended Testing Results: Printed Labels[1]

JTP Section Number and Test Name	Grade Reqmt	Substrate	
		AL1a	SS
Screening			
3.2.2 Adhesion	A, B, C	Pass	NR
3.2.6 Legibility	A, B, C	Pass	NR
Extended			
3.2.3 Chemical Resistance			
Coolanol	PS	Pass	NR
PAO	PS	Pass	NR
Hydraulic fluid (MIL-H-5606)	PS	Pass	NR
Lubricating oil (MIL-L-23699)	PS	Pass	NR
Skydrol	PS	**Fail**	NR
JP5 (MIL-T-5624)	PS	Pass	NR
DS2	PS	**Fail**[1]	NR
3.2.4 Fungus Resistance	A, B	1A/2A/5A[2]	NR
3.2.5 IR Reflectance			
FED-STD-595B # 34094 (Green 383)	A	NP[3]	NR
FED-STD-595B #34095 (Field Green)	A	NP[3]	NR
FED-STD-595B # 37030 (Black)	A	Pass[4]	NR
Supplemental Test (JTR Section 2.2.1): CAR			
Agent HD	A, B	NR	NP[5]
Agent GD	A, B	NR	NP[5]

[1] Ink completely removed by solvent.
[2] Various ratings over specimen. See Appendix E for complete results.
[3] Green TT900OUT Ribbon that could match FED-STD-595B #34094 or #34095 was not available.
[4] Refer to Appendix D for color matching testing results.
[5] The CAR test was not performed because this alternative failed the DS2 chemical resistance test.
NP – Not performed.
NR – Not required.
PS – Dependent on program-specific requirements.

7. SUMMARY AND RECOMMENDATIONS

During the Joint Group on Pollution Prevention (JG-PP) Identification Marking project, validation testing was performed on alternatives to inks and paints containing VOCs, such as MEK and toluene, that are used for stenciling, stamping, and silk screening. Alternatives tested included three UV-curable inks, six waterborne inks, and ten self-adhesive computer-printable labels.

Overall, the testing showed that the alternatives' performance was more dependent on the substrate type than on the test performed (e.g., chemical exposure). Alternative inks were more substrate-dependent than the self-adhesive labels.

Common testing results show that five alternative inks and all self-adhesive labels met Grade C application requirements for at least one substrate. In addition, two alternative inks and all self-adhesive labels were validated for Grade A and Grade B applications for at least one substrate. Please refer to Tables 78 through 83 for a summary of all Pass/Fail results for the inks and self-adhesive labels.

Navy testing that was performed on other identification marking alternatives is summarized in Appendix F. The results in Appendix F can be used in combination with the JTR for selecting identification marking alternative(s) to pursue at individual facilities.

A Cost Benefit Analysis (CBA) was previously performed as described in *Cost Benefit Analysis, LM-C-1-1, for Alternatives to Solvent-Based Ink and Paint Stenciling for Identification Marking*, dated July 28, 1998, to determine the economic impact of implementing alternative inks and self-adhesive labels. The CBA, which was previously performed at two Lockheed Martin companies and four Sustainment Community facilities, showed a potential cost avoidance of $1 million per year. Additional benefits of implementation include:

- Decreased VOC and HAP emissions
- Decreased hazardous waste
- Enhanced regulatory compliance
- Potential increased technical performance
- Reduced turnaround time.

Table 79. Screening and Common Results for the Inks

Alternative	Substrate	Screening Tests		Common Tests										
		3.1.8 Legibility	3.1.2 Adhesion	3.1.1 Abrasion Resistance	3.1.3 Chemical Resistance				3.1.9 Salt Spray Resistance		3.1.10 Temp. Exposure			3.1.11 UV Light/ Condensation
					Isopropanol	Deionized water	Engine oil (21SAE20W)	Flux/solder-terpene	48-hour	168-hour	-48°C	118°C	Thermal Shock	
Baseline (ACMI #6051 Ink)	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
80 Series UV Curable Ink	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	Pass	Pass	Pass	Pass	Pass
	AL2	NR	Pass	Pass	**Fail**	Pass	**Fail**	**Fail**	Pass	Pass	NR	NR	NR	NR
	SS	NR	Pass	Pass	**Fail**	Pass	Pass	**Fail**	NR	NR	NR	NR	NR	NR
	NR	NR	Pass	**Fail**	**Fail**	Pass	Pass	**Fail**	NR	NR	NR	NR	NR	NR
	SR	NR	Pass	**Fail**	Pass	Pass	Pass	**Fail**	NR	NR	NR	NR	NR	NR
	G/E	NR	Pass	Pass	**Fail**	**Fail**	**Fail**	**Fail**	Pass	Pass	NR	NR	NR	NR
	C/E	NR	Pass	Pass	Pass	Pass	Pass	**Fail**	NR	NR	NR	NR	NR	NR
	A/E	NR	Pass	Pass	Pass	Pass	Pass	**Fail**	NR	NR	NR	NR	NR	NR
AERO No. 6565	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	Pass	Pass	Pass	Pass	Pass
	AL2	NR	Pass	Pass	**Fail**	Pass	Pass	**Fail**	Pass	Pass	NR	NR	NR	NR
	SS	NR	Pass	Pass	**Fail**	Pass	Pass	**Fail**	NR	NR	NR	NR	NR	NR
	NR	NR	Pass	**Fail**	Pass	Pass	**Fail**	**Fail**	NR	NR	NR	NR	NR	NR
	G/E	NR	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**	Pass	NR	NR	NR	NR
	C/E	NR	Pass	Pass	**Fail**	Pass	Pass	**Fail**	NR	NR	NR	NR	NR	NR
	A/E	NR	Pass	Pass	**Fail**	Pass	Pass	**Fail**	NR	NR	NR	NR	NR	NR
CS7-56 Water Base Ink	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	Pass	Pass	Pass	Pass	Pass
	AL2	NR	Pass	Pass	**Fail**	Pass	Pass	**Fail**	Pass	Pass	NR	NR	NR	NR
	SS	NR	Pass	Pass	**Fail**	Pass	Pass	**Fail**	NR	NR	NR	NR	NR	NR
	NR	NR	Pass	**Fail**	**Fail**	Pass	**Fail**	**Fail**	NR	NR	NR	NR	NR	NR
	G/E	NR	Pass	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**	Pass	NR	NR	NR	NR
	C/E	NR	Pass	Pass	**Fail**	Pass	Pass	**Fail**	NR	NR	NR	NR	NR	NR
	A/E	NR	Pass	Pass	**Fail**	Pass	Pass	**Fail**	NR	NR	NR	NR	NR	NR
DPI #311	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
	AL2	NR	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	NR	NR	NR	NR
	SS	NR	Pass	Pass	Pass	Pass	Pass	Pass	NR	NR	NR	NR	NR	NR
	NR	NR	Pass	Pass	Pass	Pass	Pass	**Fail**	NR	NR	NR	NR	NR	NR
	G/E	NR	Pass	**Fail**	**Fail**	**Fail**	**Fail**	Pass	**Fail**	Pass	NR	NR	NR	NR
	C/E	NR	Pass	Pass	Pass	Pass	Pass	Pass	NR	NR	NR	NR	NR	NR
	A/E	NR	Pass	Pass	**Fail**	Pass	Pass	**Fail**	NR	NR	NR	NR	NR	NR

(Table 79 continued on next page)

Table 79. Screening and Common Results for the Inks (continued)

Alternative	Substrate	Screening Tests		Common Tests										
		3.1.8 Legibility	3.1.2 Adhesion	3.1.1 Abrasion Resistance	3.1.3 Chemical Resistance				3.1.9 Salt Spray Resistance		3.1.10 Temp. Exposure			3.1.11 UV Light/ Condensation
					Isopropanol	Deionized water	Engine oil (21SAE20W)	Flux/solder-terpene	48-hour	168-hour	-48°C	118°C	Thermal Shock	
Willmark #44	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
	AL2	NR	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	Pass	NR	NR	NR	NR
	SS	NR	Pass	Pass	Pass	Pass	Pass	**Fail**	NR	NR	NR	NR	NR	NR
	NR	NR	Pass	Pass	Pass	Pass	Pass	**Fail**	NR	NR	NR	NR	NR	NR
	G/E	NR	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**	Pass	NR	NR	NR	NR
	C/E	NR	Pass	Pass	Pass	Pass	Pass	**Fail**	NR	NR	NR	NR	NR	NR
	A/E	NR	Pass	Pass	Pass	Pass	Pass	**Fail**	NR	NR	NR	NR	NR	NR
MSK-Series UV Curable Ink	AL1a	Pass	Pass											
	AL2	NR	Pass											
	SS	NR	**Fail**											
	NR	NR	Pass											
	SR	NR	**Fail**											
	G/E	NR	Pass											
	C/E	NR	Pass											
	A/E	NR	Pass											
UV3004	AL1a	Pass	Pass											
	AL2	NR	Pass											
	SS	NR	Pass											
	NR	NR	**Fail**											
	G/E	NR	**Fail**											
	C/E	NR	Pass											
	A/E	NR	Pass											
WB 2040M	AL1a	Pass	Pass											
	AL2	NR	Pass											
	SS	NR	Pass											
	NR	NR	**Fail**											
	G/E	NR	**Fail**											
	C/E	NR	Pass											
	A/E	NR	Pass											
WB82	AL1a	Pass	Pass											
	AL2	NR	Pass											
	SS	NR	Pass											
	NR	NR	Pass											
	G/E	NR	**Fail**											
	C/E	NR	Pass											
	A/E	NR	Pass											

Table 80. Extended Results for Inks

Alternative	Substrate	Screening		Extended															
		3.1.8 Legibility	3.1.2 Adhesion	3.1.3 Chemical Resistance							3.1.4 Corrosivity			3.1.5 DC Elec. Resistance	3.1.7 IR Reflectance	(FED-STD-595B)		CAR Testing	
				Coolanol	PAO	Hydraulic Fluid (MIL-H-5606)	Lubricating oil (MIL-L-23699)	Skydrol	JP5 (MIL-T-5624)	DS2	54°C	71°C	118°C		#34094 (Green 383)	(Field Green)	#37030 (Black)	Agent HD	Agent GD
Baseline	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	NR	NP	NP	Pass	NR	NR
(ACMI#6051)	SS	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	Pass	Pass
	G/E	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	Pass	NR	NR	NR	NR	NR
80 Series UV	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	NR	**Fail**	**Fail**	Pass	NR	NR
Curable Ink	AL2	NR	Pass	Pass	**Fail**	**Fail**	**Fail**	**Fail**	Pass	**Fail**	Pass	Pass	Pass	NR	NR	NR	NR	NR	NR
	SS	NR	Pass	Pass	**Fail**	Pass	Pass	Pass	**Fail**	**Fail**	Pass	Pass	Pass	NR	NR	NR	NR	Pass	Pass
	NR	NR	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	SR	NR	Pass	Pass	**Fail**	**Fail**	Pass	**Fail**	Pass	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	G/E	NR	Pass	Pass	**Fail**	Pass	Pass	**Fail**	**Fail**	Pass	NR	NR	NR	Pass	NR	NR	NR	NR	NR
	C/E	NR	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	A/E	NR	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
AERO	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	NR	NP	NP	Pass	NR	NR
No. 6565	AL2	NR	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	**Fail**	Pass	Pass	Pass	NR	NR	NR	NR	NR	NR
	SS	NR	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	Pass	Pass	Pass	Pass	NR	NR	NR	NR	Pass	Pass
	NR	NR	Pass	**Fail**	Pass	Pass	Pass	Pass	Pass	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	G/E	NR	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**	NR	NR	NR	Pass	NR	NR	NR	NR	NR
	C/E	NR	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	A/E	NR	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
CS7-56	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	NR	NP	NP	Pass	NR	NR
Water Base	AL2	NR	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	**Fail**	Pass	Pass	Pass	NR	NR	NR	NR	NR	NR
	SS	NR	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	Pass	Pass	Pass	Pass	NR	NR	NR	NR	Pass	Pass
	NR	NR	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	G/E	NR	Pass	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**	Pass	**Fail**	NR	NR	NR	**Fail**	NR	NR	NR	NR	NR
	C/E	NR	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	**Fail**	NR	NR	NR	NR	NR	NR	NR	NR	NR
	A/E	NR	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
DPI #311	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	NR	NP	NP	Pass	NR	NR
	AL2	NR	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	NR	NR	NR	NR	NR	NR
	SS	NR	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	NR	NR	NR	NR	Pass	Pass
	NR	NR	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	G/E	NR	Pass	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**	NR	NR	NR	Pass	NR	NR	NR	NR	NR
	C/E	NR	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	A/E	NR	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR

(Table 80 continued on next page)

Table 80. Extended Results for Inks (continued)

Alternative	Substrate	Screening		Extended															
		3.1.8 Legibility	3.1.2 Adhesion	3.1.3 Chemical Resistance							3.1.4 Corrosivity			3.1.5 DC Elec. Resistance	3.1.7 IR Reflectance	(FED-STD-595B)		CAR Testing	
				Coolanol	PAO	Hydraulic Fluid (MIL-H-5606)	Lubricating oil (MIL-L-23699)	Skydrol	JP5 (MIL-T-5624)	DS2	54°C	71°C	118°C		#34094 (Green 383)	(Field Green)	#37030 (Black)	Agent HD	Agent GD
Willmark #44	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	NR	NP	NP	Pass	NR	NR
	AL2	NR	Pass	Pass	Pass	**Fail**	Pass	**Fail**	Pass	Pass	Pass	Pass	Pass	NR	NR	NR	NR	NR	NR
	SS	NR	Pass	Pass	Pass	**Fail**	**Fail**	**Fail**	**Fail**	Pass	Pass	Pass	Pass	NR	NR	NR	NR	Pass	**Fail**
	NR	NR	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	G/E	NR	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**	Pass	**Fail**	NR	NR	NR	Pass	NR	NR	NR	NR	NR
	C/E	NR	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	A/E	NR	Pass	Pass	Pass	**Fail**	**Fail**	**Fail**	**Fail**	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table 81. Screening and Common Results for Blank Labels

Alternative	Substrate	Screening	Common Tests									
		3.3.1 Adhesion	3.3.2 Chemical Resistance				3.3.6 Salt Spray Resistance		3.3.7 Temp. Exposure			3.3.8 UV Light/ Condensation
			Isopropanol	Deionized water	Engine oil (21SAE20W)	Flux/solder-terpene	48-hour	168-hour	-48°C	118°C	Thermal Shock	
Brady B-107 Matte White Polyester	AL1a	Pass (36.9)	Pass (38.7)	Pass (39.0)	Pass (41.2)	**Fail**	Pass (45.6)	Pass (54.2)	Pass (43.2)	Pass (60.0)	Pass (46.0)	Pass (48.7)
	AL2	Pass (49.3)	Pass (70.8)	Pass (65.8)	Pass (73.2)	**Fail**	Pass (83.7)	Pass (84.8)	NR	NR	NR	NR
	SS	Pass (47.9)	Pass (62.8)	Pass (62.4)	Pass (66.6)	**Fail**	Pass (70.6)	Pass (78.4)	NR	NR	NR	NR
	NR	Pass (38.1)	Pass (42.5)	Pass (36.6)	Pass (37.8)	**Fail**	NR	NR	NR	NR	NR	NR
	SR	**Fail (10.9)**	**Fail (8.4)**	**Fail (12.9)**	Pass (18.7)	**Fail**	NR	NR	NR	NR	NR	NR
	G/E	Pass (25.3)	Pass (27.6)	Pass (25.4)	Pass (32.5)	**Fail**	NR	NR	NR	NR	NR	NR
	C/E	Pass (38.9)	Pass (52.2)	Pass (51.6)	Pass (62.9)	**Fail**	NR	NR	NR	NR	NR	NR
	A/E	Pass (35.2)	Pass (44.3)	Pass (48.9)	Pass (48.8)	**Fail**	NR	NR	NR	NR	NR	NR
Brady B-423 Thermal Transfer Printable Glossy White Polyester Label Stock	AL1a	Pass (33.1)	Pass (36.5)	Pass (30.0)	Pass (42.2)	**Fail**	Pass (40.2)	Pass (51.4)	Pass (39.6)	Pass (42.6)	Pass (47.1)	Pass (53.8)
	AL2	Pass (74.2)	Pass (92.6)	Pass (89.1)	Pass (91.3)	**Fail**	Pass (92.4)	Pass (92.6)	NR	NR	NR	NR
	SS	Pass (63.7)	Pass (77.3)	Pass (85.5)	Pass (63.7)	**Fail**	Pass (93.5)	Pass (93.1)	NR	NR	NR	NR
	NR	**Fail (1.4)**	Pass (21.1)	Pass (24.4)	Pass (22.6)	**Fail**	NR	NR	NR	NR	NR	NR
	SR	Pass (18.2)	Pass (18.0)	Pass (19.2)	Pass (19.6)	**Fail**	NR	NR	NR	NR	NR	NR
	G/E	Pass (23.8)	Pass (40.7)	Pass (44.6)	Pass (49.2)	**Fail**	NR	NR	NR	NR	NR	NR
	C/E	Pass (43.0)	Pass (68.8)	Pass (64.8)	Pass (79.0)	**Fail**	NR	NR	NR	NR	NR	NR
	A/E	Pass (42.9)	Pass (42.4)	Pass (45.3)	Pass (47.8)	**Fail**	NR	NR	NR	NR	NR	NR
Brady B-437 Thermal Transfer Printable Label Stock	AL1a	Pass (45.0)	Pass (46.8)	Pass (52.2)	Pass (50.8)	**Fail**	Pass (56.0)	Pass (51.6)	Pass (55.9)	Pass (70.8)	Pass (73.1)	Pass (62.4)
	AL2	Pass (63.8)	Pass (97.3)	Pass (83.4)	Pass (102.5)	**Fail**	Pass (97.5)	Pass (97.2)	NR	NR	NR	NR
	SS	Pass (60.8)	Pass (72.8)	Pass (72.2)	Pass (75.0)	**Fail**	Pass (91.6)	Pass (101.2)	NR	NR	NR	NR
	NR	Pass (41.1)	Pass (31.2)	Pass (36.4)	Pass (37.1)	**Fail**	NR	NR	NR	NR	NR	NR
	SR	Pass (17.1)	Pass (25.6)	Pass (22.3)	**Fail (14.2)**	**Fail**	NR	NR	NR	NR	NR	NR
	G/E	Pass (27.3)	Pass (40.3)	Pass (31.7)	Pass (32.7)	**Fail**	NR	NR	NR	NR	NR	NR
	C/E	Pass (51.2)	Pass (75.4)	Pass (74.2)	Pass (81.7)	**Fail**	NR	NR	NR	NR	NR	NR
	A/E	Pass (43.9)	Pass (60.4)	Pass (54.2)	Pass (63.6)	**Fail**	NR	NR	NR	NR	NR	NR
Brady B-652 Printable High Temperature Label Stock	AL1a	Pass (41.6)	Pass (53.3)	Pass (40.0)	Pass (51.5)	Pass (64.6)	Pass (50.8)	Pass (60.2)	Pass (48.6)	Pass (73.0)	Pass (62.6)	Pass (64.9)
	AL2	Pass (69.2)	Pass (93.2)	Pass (87.5)	Pass (118.3)	Pass (109.2)	Pass (107.6)	Pass (113.2)	NR	NR	NR	NR
	SS	Pass (69.6)	Pass (75.8)	Pass (81.7)	Pass (82.1)	Pass (101.6)	Pass (107.4)	Pass (123.2)	NR	NR	NR	NR
	NR	**Fail (9.9)**	**Fail (11.6)**	**Fail (13.6)**	**Fail (14.3)**	**Fail (12.5)**	NR	NR	NR	NR	NR	NR
	SR	**Fail (4.5)**	**Fail (4.3)**	**Fail (9.8)**	**Fail (8.4)**	**Fail (6.2)**	NR	NR	NR	NR	NR	NR
	G/E	**Fail (14.4)**	Pass (37.5)	Pass (42.6)	Pass (30.6)	Pass (48.6)	NR	NR	NR	NR	NR	NR
	C/E	Pass (38.4)	Pass (87.4)	Pass (86.8)	Pass (97.6)	Pass (73.0)	NR	NR	NR	NR	NR	NR
	A/E	Pass (39.4)	Pass (51.4)	Pass (47.4)	Pass (59.4)	Pass (37.6)	NR	NR	NR	NR	NR	NR

(Table 81 continued on next page)

Table 81. Extended Results for Blank Labels (continued)

Alternative	Substrate	Screening	Common Tests									
		3.3.1 Adhesion	3.3.2 Chemical Resistance				3.3.6 Salt Spray Resistance		3.3.7 Temp. Exposure			3.3.8 UV Light/ Condensation
			Isopropanol	Deionized water	Engine oil (21SAE20W)	Flux/solder-terpene	48-hour	168-hour	-48°C	118°C	Thermal Shock	
Brady B-747 Lasertab Markers	AL1a	Pass (39.2)	Pass (52.4)	Pass (57.5)	Pass (54.6)	**Fail**	Pass (61.8)	Pass (61.8)	Pass (61.9)	Pass (68.3)	Pass (70.5)	Pass (83.4)
	AL2	Pass (59.6)	Pass (84.6)	Pass (94.2)	Pass (98.1)	**Fail**	Pass (98.2)	Pass (98.1)	NR	NR	NR	NR
	SS	Pass (57.7)	Pass (66.3)	Pass (69.6)	Pass (70.7)	**Fail**	Pass (84.2)	Pass (89.2)	NR	NR	NR	NR
	NR	Pass (22.8)	Pass (34.3)	Pass (33.8)	Pass (45.0)	**Fail**	NR	NR	NR	NR	NR	NR
	SR	**Fail (9.5)**	Pass (18.2)	**Fail (12.1)**	Pass (21.8)	**Fail**	NR	NR	NR	NR	NR	NR
	G/E	Pass (25.7)	Pass (42.2)	Pass (44.0)	Pass (45.9)	**Fail**	NR	NR	NR	NR	NR	NR
	C/E	Pass (48.9)	Pass (70.0)	Pass (70.7)	Pass (73.8)	**Fail**	NR	NR	NR	NR	NR	NR
	A/E	Pass (47.3)	Pass (58.4)	Pass (56.0)	Pass (59.8)	**Fail**	NR	NR	NR	NR	NR	NR
Alternative	**Substrate**	**Screening**	**Common Tests**									
		3.3.1 Adhesion	**3.3.2 Chemical Resistance**				**3.3.6 Salt Spray Resistance**		**3.3.7 Temp. Exposure**			**3.3.8 UV Light/ Condensation**
			Isopropanol	**Deionized water**	**Engine oil (21SAE20W)**	**Flux/solder-terpene**	**48-hour**	**168-hour**	**-48°C**	**118°C**	**Thermal Shock**	
Critchley Clear Polyester (TTP200CL-10)	AL1a	Pass (39.9)	Pass (36.3)	Pass (43.1)	Pass (50.8)	**Fail**	Pass (36.0)	Pass (18.2)	Pass (51.2)	Pass (51.7)	Pass (32.7)	Pass (51.3)
	AL2	Pass (73.3)	Pass (69.3)	Pass (93.5)	Pass (93.9)	**Fail**	Pass (103.4)	Pass (106.8)	NR	NR	NR	NR
	SS	Pass (64.9)	Pass (63.8)	Pass (70.9)	Pass (75.4)	**Fail**	Pass (99.2)	Pass (104.2)	NR	NR	NR	NR
	NR	Pass (19.9)	**Fail (12.2)**	**Fail (13.8)**	Pass (20.0)	**Fail**	NR	NR	NR	NR	NR	NR
	SR	**Fail (3.3)**	**Fail (6.2)**	**Fail (5.8)**	**Fail (10.6)**	**Fail**	NR	NR	NR	NR	NR	NR
	G/E	Pass (19.2)	Pass (27.2)	Pass (26.0)	Pass (25.1)	**Fail**	NR	NR	NR	NR	NR	NR
	C/E	Pass (51.1)	Pass (68.0)	Pass (74.3)	Pass (81.0)	**Fail**	NR	NR	NR	NR	NR	NR
	A/E	Pass (44.9)	Pass (54.2)	Pass (52.1)	Pass (52.2)	**Fail**	NR	NR	NR	NR	NR	NR
Critchley Metallized Thermal Transfer (CR-1-4-MP)	AL1a	Pass (64.0)	Pass (40.4)	Pass (22.9)	Pass (45.3)	**Fail**	Pass (42.1)	Pass (55.9)	Pass (30.8)	Pass (63.6)	Pass (41.3)	Pass (>70*)
	AL2	Pass (82.8)	Pass (87.2)	Pass (87.4)	Pass (85.8)	**Fail**	Pass (88.0)	Pass (83.2)	NR	NR	NR	NR
	SS	Pass (81.5)	Pass (95.3)	Pass (80.0)	Pass (73.8)	**Fail**	Pass (92.1)	Pass (102.3)	NR	NR	NR	NR
	NR	Pass (18.7)	Pass (21.8)	Pass (23.4)	Pass (23.9)	**Fail**	NR	NR	NR	NR	NR	NR
	SR	**Fail (3.5)**	**Fail (8.1)**	**Fail (8.4)**	Pass (17.0)	**Fail**	NR	NR	NR	NR	NR	NR
	G/E	Pass (20.6)	Pass (46.0)	Pass (58.8)	Pass (54.6)	**Fail**	NR	NR	NR	NR	NR	NR
	C/E	Pass (69.5)	Pass (91.8)	Pass (84.4)	Pass (94.8)	**Fail**	NR	NR	NR	NR	NR	NR
	A/E	Pass (62.2)	Pass (71.3)	Pass (67.0)	Pass (68.4)	**Fail**	NR	NR	NR	NR	NR	NR
Critchley White Polyester Film (CR-119-WP2.5)	AL1a	Pass (35.5)	Pass (51.0)	Pass (50.8)	Pass (55.2)	**Fail**	Pass (46.6)	Pass (59.0)	Pass (50.5)	Pass (57.4)	Pass (52.6)	Pass (51.7)
	AL2	Pass (68.9)	Pass (90.1)	Pass (86.6)	Pass (95.4)	**Fail**	Pass (97.1)	Pass (98.1)	NR	NR	NR	NR
	SS	Pass (64.1)	Pass (60.0)	Pass (59.2)	Pass (70.2)	**Fail**	Pass (86.8)	Pass (95.8)	NR	NR	NR	NR
	NR	Pass (22.0)	Pass (21.6)	Pass (17.9)	Pass (22.2)	**Fail**	NR	NR	NR	NR	NR	NR
	SR	**Fail (5.1)**	**Fail (8.6)**	**Fail (15.4)**	**Fail (7.4)**	**Fail**	NR	NR	NR	NR	NR	NR
	G/E	Pass (25.1)	Pass (28.0)	Pass (26.9)	Pass (27.4)	**Fail**	NR	NR	NR	NR	NR	NR
	C/E	Pass (48.4)	Pass (70.6)	Pass (69.6)	Pass (76.4)	**Fail**	NR	NR	NR	NR	NR	NR
	A/E	Pass (43.6)	Pass (51.0)	Pass (49.6)	Pass (50.2)	**Fail**	NR	NR	NR	NR	NR	NR

(Table 81 continued on next page)

Table 81. Extended Results for Blank Labels (continued)

Alternative	Substrate	Screening	Common Tests									
		3.3.1 Adhesion	3.3.2 Chemical Resistance				3.3.6 Salt Spray Resistance		3.3.7 Temp. Exposure			3.3.8 UV Light/ Condensation
			Isopropanol	Deionized water	Engine oil (21SAE20W)	Flux/solder-terpene	48-hour	168-hour	-48°C	118°C	Thermal Shock	
Tyton 822	AL1a	Pass (39.6)	Pass (55.4)	Pass (55.2)	Pass (59.5)	**Fail**	Pass (82.6)	Pass (79.5)	Pass (62.2)	Pass (71.8)	Pass (74.6)	Pass (84.0)
	AL2	Pass (86.7)	Pass (81.8)	Pass (82.2)	Pass (81.3)	**Fail**	Pass (86.5)	Pass (85.8)	NR	NR	NR	NR
	SS	Pass (69.6)	Pass (72.8)	Pass (70.3)	Pass (62.1)	**Fail**	Pass (85.6)	Pass (86.2)	NR	NR	NR	NR
	NR	Pass (35.5)	Pass (25.2)	Pass (25.1)	Pass (26.8)	**Fail**	NR	NR	NR	NR	NR	NR
	SR	**Fail (13.5)**	Pass (17.2)	Pass (17.0)	Pass (33.0)	**Fail**	NR	NR	NR	NR	NR	NR
	G/E	Pass (26.5)	Pass (29.0)	Pass (30.0)	Pass (34.2)	**Fail**	NR	NR	NR	NR	NR	NR
	C/E	Pass (38.5)	Pass (40.8)	Pass (41.6)	Pass (46.8)	**Fail**	NR	NR	NR	NR	NR	NR
	A/E	Pass (33.4)	Pass (35.5)	Pass (34.2)	Pass (35.8)	**Fail**	NR	NR	NR	NR	NR	NR
Tyton 900	AL1a	Pass (55.7)	Pass (63.9)	Pass (72.6)	Pass (63.9)	**Fail**	Pass (73.2)	Pass (73.2)	Pass (70.0)	Pass (100.4)	Pass (96.8)	Pass (>50*)
	AL2	Pass (85.3)	Pass (>85*)	Pass (>85*)	Pass (95.1)	**Fail**	Pass (61.0)	Pass (97.0)	NR	NR	NR	NR
	SS	Pass (68.2)	Pass (70.5)	Pass (76.3)	Pass (71.2)	**Fail**	Pass (79.5)	Pass (63.2)	NR	NR	NR	NR
	NR	Pass (23.3)	Pass (20.0)	Pass (20.8)	Pass (19.6)	**Fail**	NR	NR	NR	NR	NR	NR
	SR	**Fail (13.7)**	**Fail (10.1)**	**Fail (5.2)**	**Fail (8.4)**	**Fail**	NR	NR	NR	NR	NR	NR
	G/E	Pass (29.0)	Pass (52.0)	Pass (61.7)	Pass (61.9)	**Fail**	NR	NR	NR	NR	NR	NR
	C/E	Pass (37.5)	Pass (59.1)	Pass (57.4)	Pass (61.6)	**Fail**	NR	NR	NR	NR	NR	NR
	A/E	Pass (30.2)	Pass (56.1)	Pass (53.1)	Pass (56.8)	**Fail**	NR	NR	NR	NR	NR	NR

Table 82. Extended Results for Blank Labels

Alternative	Substrate	Screening																						
												Extended												
		3.3.1 Adhesion	3.3.1 Adhesion		3.3.2 Chemical Resistance							3.3.3 Corrosivity			3.3.4 DC Elec. Resist.	3.3.5 IR Reflectance (FED-STD-595B)			3.3.7 Temperature Exposure & Thermal Shock					
			MIL-C-46168	MIL-C-53039	Coolanol	PAO	Hydraulic fluid (MIL-H-5606)	Lubricating oil (MIL-L-23699)	Skydrol	JP5 (MIL-T-5624)	DS2	54°C	71°C	118°C		#34094 (Green 383)	(Field Green)	#37030 (Black)	-48°C		118°C		Thermal Shock	
																			MIL-C-46168	MIL-C-53039	MIL-C-46168	MIL-C-53039	MIL-C-46168	MIL-C-53039
Brady B-107	AL1a	Pass (36.9)	NR	NR	Pass (50.8)	Pass (59.9)	Pass (40.2)	Pass (40.3)	Pass (40.9)	Pass (41.0)	Pass (42.8)	Pass (45.9)	Pass (53.4)	Pass (59.0)	NR	NP	NP	NP	NR	NR	NR	NR	NR	NR
Matte White	AL2	Pass (49.3)	NR	NR	Pass (84.9)	Pass (85.3)	Pass (71.4)	Pass (81.7)	Pass (85.8)	Pass (86.7)	Pass (90.8)	Pass (82.3)	Pass (74.4)	Pass (70.0)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Polyester	SS	Pass (47.9)	NR	NR	Pass (64.8)	Pass (67.4)	Pass (64.4)	Pass (66.8)	Pass (66.9)	Pass (63.2)	Pass (69.9)	Pass (81.0)	Pass (95.7)	Pass (51.2)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	NR	Pass (38.1)	NR	NR	Pass (34.6)	Pass (33.6)	Pass (31.8)	Pass (31.8)	Pass (25.0)	Pass (29.8)	Pass (40.0)	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	SR	**Fail (10.9)**	NR	NR	Pass (24.4)	Pass (21.2)	**Fail (4.7)**	**Fail (12.1)**	Pass (18.9)	Pass (18.4)	Pass (20.3)	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	G/E	Pass (25.3)	NR	NR	Pass (40.9)	Pass (37.2)	Pass (37.7)	Pass (30.4)	Pass (34.0)	Pass (37.3)	Pass (41.6)	NR	NR	Pass	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	C/E	Pass (38.9)	NR	NR	Pass (59.8)	Pass (59.4)	Pass (61.9)	Pass (63.0)	Pass (61.7)	Pass (59.7)	Pass (64.8)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	A/E	Pass (35.2)	NR	NR	Pass (47.4)	Pass (45.0)	Pass (49.4)	Pass (50.0)	Pass (46.4)	Pass (44.4)	Pass (56.0)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Other	NR	Fail (12.1)	Pass (31.3)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	Pass (26.3)	Pass (35.1)	Pass (24.5)	Pass (37.4)	Pass (31.7)	Pass (42.0)
Brady B-423	AL1a	Pass (33.1)	NR	NR	Pass (34.2)	Pass (33.6)	Pass (35.6)	Pass (39.2)	Pass (24.3)	Pass (31.0)	Pass (44.8)	Pass (57.6)	Pass (77.4)	Pass (40.5)	NR	NP	NP	NP	NR	NR	NR	NR	NR	NR
Thermal Transfer	AL2	Pass (74.2)	NR	NR	Pass (89.2)	Pass (88.0)	Pass (92.8)	Pass (92.4)	Pass (88.8)	Pass (92.0)	Pass (90.6)	Pass (92.2)	Pass (83.0)	Pass (60.0)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Printable Glossy	SS	Pass (63.7)	NR	NR	Pass (76.4)	Pass (81.2)	Pass (93.3)	Pass (93.2)	Pass (87.6)	Pass (79.6)	Pass (87.6)	Pass (86.9)	Pass (84.2)	Pass (50.2)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
White Polyester	NR	**Fail (1.4)**	NR	NR	Pass (20.0)	Pass (19.7)	**Fail (5.8)**	**Fail (12.0)**	Pass (20.0)	**Fail (9.2)**	**Fail (10.5)**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Label Stock	SR	Pass (18.2)	NR	NR	Pass (19.8)	**Fail (10.7)**	**Fail (13.4)**	**Fail (10.2)**	**Fail (14.2)**	**Fail (9.3)**	**Fail (15.2)**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	G/E	Pass (23.8)	NR	NR	Pass (43.8)	Pass (46.7)	Pass (52.7)	Pass (34.8)	Pass (49.1)	Pass (51.7)	Pass (53.4)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	C/E	Pass (43.0)	NR	NR	Pass (82.4)	Pass (72.1)	Pass (89.2)	Pass (86.2)	Pass (85.0)	Pass (83.0)	Pass (87.4)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	A/E	Pass (42.9)	NR	NR	Pass (47.9)	Pass (47.4)	Pass (46.2)	Pass (46.8)	Pass (44.7)	Pass (46.4)	Pass (51.8)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Other	NR	Pass (22.2)	Pass (24.3)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	Fail (13.2)	Pass (17.2)	Pass (27.7)	Pass (43.6)	Pass (34.4)	Pass (32.6)
Brady B-437	AL1a	Pass (45.0)	NR	NR	Pass (56.4)	Pass (55.8)	Pass (55.8)	Pass (57.0)	Pass (51.6)	Pass (56.6)	Pass (32.9)	Pass (63.8)	Pass (66.9)	Pass (68.0)	NR	NP	NP	NP	NR	NR	NR	NR	NR	NR
Thermal Transfer	AL2	Pass (63.8)	NR	NR	Pass (101.1)	Pass (99.7)	Pass (99.0)	Pass (99.4)	Pass (91.0)	Pass (95.6)	Pass (67.5)	Pass (93.8)	Pass (96.2)	Pass (93.0)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Printable Label	SS	Pass (60.8)	NR	NR	Pass (75.3)	Pass (78.6)	Pass (80.9)	Pass (89.2)	Pass (71.7)	Pass (73.2)	Pass (62.1)	Pass (95.2)	Pass (93.5)	Pass (58.1)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Stock	NR	Pass (41.1)	NR	NR	Pass (32.6)	Pass (34.8)	Pass (25.8)	Pass (36.2)	Pass (25.8)	Pass (32.0)	Pass (61.6)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	SR	Pass (17.1)	NR	NR	Pass (18.4)	**Fail (15.2)**	**Fail (10.6)**	**Fail (12.5)**	**Fail (15.0)**	Pass (19.5)	**Fail (13.0)**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	G/E	Pass (27.3)	NR	NR	Pass (32.1)	Pass (33.2)	Pass (34.7)	Pass (41.2)	Pass (28.4)	Pass (32.0)	Pass (26.8)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	C/E	Pass (51.2)	NR	NR	Pass (80.3)	Pass (79.4)	Pass (85.6)	Pass (88.8)	Pass (94.0)	Pass (90.1)	Pass (54.6)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	A/E	Pass (43.9)	NR	NR	Pass (62.7)	Pass (68.0)	Pass (63.4)	Pass (63.8)	Pass (60.0)	Pass (62.0)	Pass (57.3)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Other	NR	Pass (23.8)	Pass (28.3)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	Pass (21.2)	Pass (28.0)	Pass (42.6)	Pass (28.0)	Pass (31.7)	Pass (48.8)
Brady B-652	AL1a	Pass (41.6)	NR	NR	Pass (54.9)	Pass (55.8)	Pass (49.0)	Pass (54.2)	Pass (46.5)	Pass (53.8)	Pass (47.6)	Pass (85.6)	Pass (101.5)	Pass (82.4)	NR	NP	NP	NP	NR	NR	NR	NR	NR	NR
Printable High	AL2	Pass (69.2)	NR	NR	Pass (120.8)	Pass (102.6)	Pass (90.8)	Pass (87.3)	Pass (95.0)	Pass (90.4)	Pass (90.0)	Pass (133.8)	Pass (138.6)	Pass (110.4)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Temperature	SS	Pass (69.6)	NR	NR	Pass (81.8)	Pass (81.5)	Pass (82.7)	Pass (83.6)	Pass (82.0)	Pass (82.6)	Pass (82.6)	Pass (134.3)	Pass (132.4)	Pass (111.6)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Label Stock	NR	**Fail (9.9)**	NR	NR	**Fail (14.6)**	**Fail (14.6)**	**Fail (11.4)**	**Fail (8.0)**	**Fail (15.6)**	**Fail (12.9)**	**Fail (12.5)**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	SR	**Fail (4.5)**	NR	NR	**Fail (13.8)**	**Fail (6.1)**	**Fail (6.8)**	**Fail (4.4)**	**Fail (3.6)**	**Fail (3.6)**	**Fail (4.5)**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	G/E	**Fail (14.4)**	NR	NR	Pass (37.4)	Pass (44.6)	Pass (39.5)	Pass (30.3)	Pass (40.1)	Pass (44.6)	Pass (38.2)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	C/E	Pass (38.4)	NR	NR	Pass (46.9)	Pass (47.6)	Pass (106.8)	Pass (106.3)	Pass (98.4)	Pass (102.0)	Pass (104.4)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	A/E	Pass (39.4)	NR	NR	Pass (64.8)	Pass (58.6)	Pass (48.4)	Pass (61.6)	Pass (55.0)	Pass (64.6)	Pass (47.6)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Other	NR	Pass (17.8)	Pass (39.1)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	Pass (33.6)	Pass (48.4)	Pass (43.2)	Pass (43.4)	Pass (28.3)	Pass (39.9)

(Table 82 continued on next page)

Table 82. Extended Results for Blank Labels (continued)

Alternative	Substrate	Screening												Extended											
		3.3.1 Adhesion	3.3.1 Adhesion		3.3.2 Chemical Resistance							3.3.3 Corrosivity			3.3.4 DC Elec. Resist.	3.3.5 IR Reflectance	(FED-STD-595B)		3.3.7	Temp. Exposure & Thermal Shock				
			MIL-C-46168	MIL-C-53039	Coolanol	PAO	Hydraulic fluid (MIL-H-5606)	Lubricating oil (MIL-L-23699)	Skydrol	JP5 (MIL-T-5624)	DS2	54°C	71°C	118°C		#34094 (Green 383)	(Field Green)	#37030 (Black)	-48°C		118°C		Thermal Shock	
																			MIL-C-46168	MIL-C-53039	MIL-C-46168	MIL-C-53039	MIL-C-46168	MIL-C-53039
Brady B-747 Lasertab Markers	AL1a	Pass (39.2)	NR	NR	Pass (56.2)	Pass (69.2)	Pass (62.2)	Pass (56.7)	Pass (58.5)	Pass (57.8)	Pass (44.8)	Pass (77.2)	Pass (75.2)	Pass (61.9)	NR	NP	NP	NP	NR	NR	NR	NR	NR	NR
	AL2	Pass (59.6)	NR	NR	Pass (90.4)	Pass (96.2)	Pass (97.9)	Pass (97.7)	Pass (94.1)	Pass (98.7)	Pass (68.7)	Pass (94.4)	Pass (93.5)	Pass (76.2)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	SS	Pass (57.7)	NR	NR	Pass (75.1)	Pass (78.2)	Pass (81.0)	Pass (82.0)	Pass (78.6)	Pass (80.0)	Pass (52.9)	Pass (93.3)	Pass (111.1)	Pass (56.5)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	NR	Pass (22.8)	NR	NR	Pass (33.8)	Pass (39.9)	Pass (33.6)	Pass (39.4)	Pass (35.8)	Pass (37.6)	Pass (59.9)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	SR	**Fail (9.5)**	NR	NR	Pass (20.0)	**Fail (7.9)**	**Fail (11.0)**	Pass (17.8)	Pass (21.0)	Pass (20.8)	**Fail (11.5)**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	G/E	Pass (25.7)	NR	NR	Pass (49.9)	Pass (39.2)	Pass (39.6)	Pass (36.1)	Pass (33.8)	Pass (39.7)	Pass (28.2)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	C/E	Pass (48.9)	NR	NR	Pass (73.7)	Pass (76.2)	Pass (76.7)	Pass (74.2)	Pass (72.3)	Pass (71.4)	Pass (50.7)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	A/E	Pass (47.3)	NR	NR	Pass (70.0)	Pass (54.5)	Pass (55.6)	Pass (66.0)	Pass (55.0)	Pass (57.4)	Pass (55.0)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Other	NR	Pass (20.1)	Pass (35.5)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	Pass (21.9)	Pass (28.4)	Pass (18.2)	Pass (24.5)	Pass (27.4)	Pass (33.6)
Critchley Clear Polyester (TTP200CL-10)	AL1a	Pass (39.9)	NR	NR	Pass (42.0)	Pass (47.5)	Pass (45.4)	Pass (47.3)	Pass (46.2)	Pass (43.2)	Pass (44.3)	Pass (59.6)	Pass (20.1)	Pass (39.5)	NR	**Fail**	**Fail**	Pass	NR	NR	NR	NR	NR	NR
	AL2	Pass (73.3)	NR	NR	Pass (92.6)	Pass (93.4)	Pass (101.5)	Pass (100.4)	Pass (96.7)	Pass (100.3)	Pass (88.6)	Pass (103.0)	Pass (96.8)	Pass (104.8)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	SS	Pass (64.9)	NR	NR	Pass (74.0)	Pass (72.0)	Pass (81.2)	Pass (79.0)	Pass (83.8)	Pass (82.6)	Pass (80.2)	Pass (100.6)	Pass (88.8)	Pass (104.6)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	NR	Pass (19.9)	NR	NR	**Fail (10.4)**	**Fail (12.4)**	**Fail (12.4)**	Pass (16.9)	Pass (22.0)	Pass (21.0)	Fail (11.0)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	SR	**Fail (3.3)**	NR	NR	**Fail (9.4)**	**Fail (3.8)**	**Fail (2.8)**	**Fail (3.2)**	**Fail (13.4)**	**Fail (13.1)**	**Fail (4.6)**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	G/E	Pass (19.2)	NR	NR	Pass (29.2)	Pass (29.1)	Pass (25.2)	Pass (26.2)	Pass (24.4)	Pass (27.0)	Pass (33.2)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	C/E	Pass (51.1)	NR	NR	Pass (83.0)	Pass (84.3)	Pass (94.8)	Pass (91.9)	Pass (83.7)	Pass (88.8)	Pass (84.1)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	A/E	Pass (44.9)	NR	NR	Pass (50.4)	Pass (53.9)	Pass (54.2)	Pass (55.2)	Pass (51.0)	Pass (49.7)	Pass (54.6)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Other	NR	Pass (16.8)	Pass (18.8)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	**Fail (12.5)**	**Fail (14.6)**	Pass (27.7)	Pass (40.1)	**Fail (9.0)**	Pass (22.9)
Critchley Metallized Thermal Transfer (CR-104-MP)	AL1a	Pass (64.0)	NR	NR	Pass (39.6)	Pass (31.4)	Pass (35.0)	Pass (43.2)	Pass (45.4)	Pass (26.3)	Pass (40.8)	Pass (> 60*)	Pass (> 50*)	Pass (> 50*)	NR	NP	NP	NP	NR	NR	NR	NR	NR	NR
	AL2	Pass (82.8)	NR	NR	Pass (87.5)	Pass (87.4)	Pass (90.3)	Pass (88.2)	Pass (87.8)	Pass (89.9)	Pass (92.2)	Pass (> 85*)	Pass (> 75*)	Pass (85.9)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	SS	Pass (81.5)	NR	NR	Pass (82.3)	Pass (97.9)	Pass (95.7)	Pass (95.6)	Pass (91.9)	Pass (97.0)	Pass (94.8)	Pass (> 90*)	Pass (> 70*)	Pass (82.4)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	NR	Pass (18.7)	NR	NR	Pass (24.3)	Pass (27.6)	Pass (22.2)	Pass (24.1)	Pass (20.0)	Pass (25.6)	Pass (25.3)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	SR	**Fail (3.5)**	NR	NR	Pass (24.0)	**Fail (14.2)**	**Fail (9.1)**	**Fail (6.7)**	**Fail (11.8)**	Pass (21.2)	Pass (16.8)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	G/E	Pass (20.6)	NR	NR	Pass (57.0)	Pass (65.0)	Pass (63.8)	Pass (71.9)	Pass (63.2)	Pass (64.6)	Pass (67.6)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	C/E	Pass (69.5)	NR	NR	Pass (101.2)	Pass (103.6)	Pass (106.8)	Pass (103.6)	Pass (107.8)	Pass (105.0)	Pass (109.0)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	A/E	Pass (62.2)	NR	NR	Pass (66.4)	Pass (67.0)	Pass (70.1)	Pass (68.2)	Pass (68.6)	Pass (68.9)	Pass (69.3)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Other	NR	Pass (31.5)	Pass (16.2)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	Pass (25.1)	Pass (19.5)	**Fail (14.5)**	Pass (24.2)	**Fail (12.0)**	Pass (19.2)
Critchley White Polyester Film (CR-119-WP2.5)	AL1a	Pass (35.5)	NR	NR	Pass (28.6)	Pass (29.9)	Pass (37.8)	Pass (37.2)	Pass (54.2)	Pass (37.2)	Pass (35.8)	Pass (56.6)	Pass (61.9)	Pass (49.4)	NR	NP	NP	**Fail**	NR	NR	NR	NR	NR	NR
	AL2	Pass (68.9)	NR	NR	Pass (94.8)	Pass (93.2)	Pass (83.7)	Pass (82.1)	Pass (89.0)	Pass (94.3)	Pass (96.6)	Pass (93.4)	Pass (88.4)	Pass (96.8)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	SS	Pass (64.1)	NR	NR	Pass (72.0)	Pass (71.3)	Pass (76.3)	Pass (77.8)	Pass (72.2)	Pass (79.0)	Pass (80.6)	Pass (92.1)	Pass (72.7)	Pass (90.6)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	NR	Pass (22.0)	NR	NR	Pass (23.3)	Pass (22.6)	Pass (18.4)	Pass (23.4)	Pass (20.6)	Pass (20.3)	Pass (25.9)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	SR	**Fail (5.1)**	NR	NR	Pass (23.4)	**Fail (10.4)**	**Fail (7.6)**	**Fail (7.2)**	Pass (23.7)	**Fail (7.7)**	**Fail (9.2)**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	G/E	Pass (25.1)	NR	NR	Pass (29.8)	Pass (30.9)	Pass (32.0)	Pass (30.7)	Pass (31.7)	Pass (30.8)	Pass (26.6)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	C/E	Pass (48.4)	NR	NR	Pass (83.2)	Pass (82.2)	Pass (91.2)	Pass (90.2)	Pass (91.4)	Pass (92.0)	Pass (91.4)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	A/E	Pass (43.6)	NR	NR	Pass (45.8)	Pass (49.6)	Pass (52.5)	Pass (49.6)	Pass (48.5)	Pass (51.6)	Pass (49.1)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Other	NR	**Fail (11.2)**	**Fail (15.3)**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	**Fail (15.3)**	**Fail (12.9)**	Pass (31.9)	Pass (43.3)	Pass (21.9)	Pass (33.6)

(Table 82 continued on next page)

Table 82. Extended Results for Blank Labels (continued)

Alternative	Substrate	Screening	Extended																					
		3.3.1 Adhesion	3.3.1 Adhesion		3.3.2 Chemical Resistance							3.3.3 Corrosivity			3.3.4 DC Elec. Resist.	3.3.5 IR Reflectance (FED-STD-595B)			3.3.7 Temp. Exposure & Thermal Shock					
			MIL-C-46168	MIL-C-53039	Coolanol	PAO	Hydraulic fluid (MIL-H-5606)	Lubricating oil (MIL-L-23699)	Skydrol	JP5 (MIL-T-5624)	DS2	54°C	71°C	118°C		#34094 (Green 383)	(Field Green)	#37030 (Black)	-48°C		118°C		Thermal Shock	
																			MIL-C-46168	MIL-C-53039	MIL-C-46168	MIL-C-53039	MIL-C-46168	MIL-C-53039
Tyton 822	AL1a	Pass (39.6)	NR	NR	Pass (62.8)	Pass (56.5)	Pass (64.0)	Pass (64.4)	Pass (60.2)	Pass (60.7)	Pass (66.2)	Pass (40.0)	Pass (52.3)	Pass (80.7)	NR	NP	NP	NP	NR	NR	NR	NR	NR	NR
	AL2	Pass (86.7)	NR	NR	Pass (82.1)	Pass (83.2)	Pass (84.2)	Pass (82.8)	Pass (79.0)	Pass (75.2)	Pass (84.2)	Pass (73.3)	Pass (79.6)	Pass (66.3)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	SS	Pass (69.6)	NR	NR	Pass (68.9)	Pass (65.6)	Pass (65.8)	Pass (65.5)	Pass (65.2)	Pass (72.6)	Pass (66.1)	Pass (83.6)	Pass (66.9)	Pass (55.4)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	NR	Pass (35.5)	NR	NR	Pass (27.0)	Pass (27.2)	Pass (26.6)	Pass (30.8)	Pass (25.8)	Pass (28.2)	Pass (27.3)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	SR	**Fail (13.5)**	NR	NR	Pass (19.2)	Pass (20.0)	Pass (24.1)	Pass (17.8)	Pass (17.8)	Pass (23.1)	Pass (21.2)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	G/E	Pass (26.5)	NR	NR	Pass (34.2)	Pass (30.0)	Pass (36.6)	Pass (33.4)	Pass (33.6)	Pass (32.0)	Pass (34.2)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	C/E	Pass (38.5)	NR	NR	Pass (40.2)	Pass (44.8)	Pass (45.6)	Pass (48.2)	Pass (41.2)	Pass (45.6)	Pass (43.0)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	A/E	Pass (33.4)	NR	NR	Pass (35.3)	Pass (42.2)	Pass (43.8)	Pass (39.8)	Pass (40.0)	Pass (37.9)	Pass (38.8)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Other	NR	Pass (26.9)	Pass (21.4)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	Pass (24.7)	Pass (18.3)	Pass (17.6)	**Fail (15.4)**	Pass (51.6)	Pass (61.9)
Tyton 900	AL1a	Pass (55.7)	NR	NR	Pass (69.4)	Pass (65.5)	Pass (71.6)	Pass (70.1)	Pass (56.1)	Pass (72.6)	Pass (71.3)	Pass (77.1)	Pass (> 64*)	Pass (> 64*)	NR	NP	NP	NP	NR	NR	NR	NR	NR	NR
	AL2	Pass (85.3)	NR	NR	Pass (> 95*)	Pass (> 95*)	Pass (> 85*)	Pass (> 90*)	Pass (> 75*)	Pass (> 90*)	Pass (> 90*)	Pass (> 85*)	Pass (> 95*)	Pass (> 95*)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	SS	Pass (68.2)	NR	NR	Pass (71.1)	Pass (71.2)	Pass (72.9)	Pass (82.0)	Pass (63.0)	Pass (> 70*)	Pass (81.0)	Pass (> 90*)	Pass (> 80*)	Pass (82.3*)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	NR	Pass (23.3)	NR	NR	Pass (20.8)	Pass (20.6)	Pass (17.0)	Pass (26.2)	Pass (21.0)	Pass (20.6)	Pass (20.4)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	SR	**Fail (13.7)**	NR	NR	**Fail (11.9)**	**Fail (7.4)**	**Fail (4.2)**	**Fail (5.4)**	**Fail (15.8)**	**Fail (10.0)**	**Fail (8.2)**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	G/E	Pass (29.0)	NR	NR	Pass (46.2)	Pass (41.8)	Pass (59.8)	Pass (53.6)	Pass (39.0)	Pass (67.8)	Pass (69.4)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	C/E	Pass (37.5)	NR	NR	Pass (60.9)	Pass (60.5)	Pass (49.8)	Pass (59.2)	Pass (46.4)	Pass (46.8)	Pass (62.3)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	A/E	Pass (30.2)	NR	NR	Pass (66.9)	Pass (55.8)	Pass (61.0)	Pass (56.6)	Pass (55.0)	Pass (65.4)	Pass (58.6)	NR	NR	NR	Pass	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Other	NR	Pass (21.3)	Pass (32.3)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	Pass (43.0)	Pass (37.9)	Pass (26.6)	Pass (39.7)	Pass (28.7)	Pass (25.2)

Table 83. Extended Results for Printed Labels

Alternative	Substrate	Screening		Common Tests										
		3.2.2 Adhesion	3.2.6 Legibility	3.2.1 Abrasion Resistance	3.2.3 Chemical Resistance				3.2.7 Salt Spray Resistance		3.2.8 Temp. Exposure			3.2.9 UV Light/ Condensation
					Isopropanol	Deionized water	Engine oil (21SAE20W)	Flux/solder-terpene	48-hour	168-hour	-48°C	118°C	Thermal Shock	
Brady B-107 Matte White Polyester	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	Pass	Pass	Pass	Pass	Pass
Brady B-423 Thermal Transfer Printable	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	Pass	Pass	Pass	Pass	Pass
Glossy White Polyester Label Stock														
Brady B-437 Thermal Transfer Printable	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	Pass	Pass	Pass	Pass	Pass
Label Stock														
Brady B-652 Printable High Temperature	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	Pass	Pass	Pass	Pass	Pass
Label Stock - Uncoated														
Brady B-652 Printable High Temperature	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	Pass	Pass	Pass	Pass	Pass
Label Stock - Polyester-coated														
Brady B-652 Printable High Temperature	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Label Stock - Polyurethane-coated														
Brady B-747 Lasertab Markers	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	Pass	Pass	Pass	Pass	Pass
Critchley Clear Polyester (TTP200CL-10)	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	Pass	Pass	Pass	Pass	Pass
Critchley Metallized Thermal Transfer (CR-104-MP)	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	Pass	Pass	Pass	Pass	Pass
Critchley White Polyester Film (CR-119-WP2.5)	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	Pass	Pass	Pass	Pass	Pass
Tyton 822	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	Pass	Pass	Pass	Pass	Pass
Tyton 900	AL1a	Pass	Pass	Pass	**Fail**	Pass	Pass	**Fail**	Pass	Pass	Pass	Pass	Pass	Pass

Alternative	Substrate	Screening											
		3.3.1 Adhesion	3.2.6 Legibility	3.2.3 Chemical Resistance							3.2.5 IR Reflectance	2.2.1 CAR	
				Coolanol	PAO	Hydraulic fluid (MIL-H-5606)	Lubricating oil (MIL-L-23699)	Skydrol	JP5 (MIL-T-5624)	DS2	#37030 (Black)	Agent HD	Agent GD
Brady B-107 Matte White Polyester	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	NR	NR
	SS	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	**Fail**	**Fail**
Brady B-423 Thermal Transfer Printable	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	**Fail**	**Fail**	NR	NR
Glossy White Polyester Label Stock	SS	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NP	NP
Brady B-437 Thermal Transfer Printable	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	NR	NR
Label Stock	SS	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	Pass	Pending
Brady B-652 Printable High Temperature	AL1a	Pass	Pass	Fail	Pass	Pass	Pass	**Fail**	Pass	Pass	Pass	NR	NR
Label Stock - Uncoated	SS	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	**Fail**	**Fail**
Brady B-652 Printable High Temperature	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	NR	NR
Label Stock - Polyester-coated	SS	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	Pass	Pass
Brady B-652 Printable High Temperature	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	NR	NR
Label Stock - Polyurethane-coated	SS	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	**Fail**	**Fail**
Brady B-747 Lasertab Markers	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	Pass	Pass	NR	NR
	SS	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	**Fail**	**Fail**
Critchley Clear Polyester (TTP200CL-10)	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	**Fail**	Pass	NR	NR
	SS	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NP	NP
Critchley Metallized Thermal Transfer	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	**Fail**	**Fail**	NR	NR
(CR-104-MP)	SS	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NP	NP
Critchley White Polyester Film	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	**Fail**	Pass	NR	NR
(CR-119-WP2.5)	SS	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NP	NP
Tyton 822	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	**Fail**	**Fail**	NR	NR
	SS	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NP	NP
Tyton 900	AL1a	Pass	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass	**Fail**	Pass	NR	NR
	SS	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NP	NP

8. REFERENCE DOCUMENTS

The documents listed in Table 84 were referenced in the descriptions of tests defined in this JTR. References used for defining the tests contained in the JTP are included in the JTP.

Table 84. Reference Documents for JTR Test Descriptions

Reference Document	Title	Date	Test	JTR Section
EPA Method 8260B	Volatile Organic Compounds by Gas Chromatography/ Mass Spectrometry (GC/MS), Revision 2	December 1996	GC/MS	2.2.2
SE NR00001	Environmental Testing of Printed Self-Adhesive Vinyl	2 Jun 99	N/A	Appendix E

APPENDIX A

SUPPLEMENTAL INFORMATION CONCERNING ALTERNATIVES TESTED

Additional information for the baseline ink, ultraviolet (UV)-curable inks, waterborne inks, and self-adhesive labels tested is provided in this Appendix. Information is also available in *Potential Alternatives Report, LM-A-1-2, for Alternatives to Solvent-Based Ink Stenciling for Identification Marking*, dated July 19, 1998.

Additional information concerning the **baseline ink** tested is below:

- ACMI #6051 Ink (American Coding and Marking Ink Co.) - ACMI #6051 Ink is a two-part epoxy ink that was developed for silk screen applications. By thinning the ink with ACMI #6051 thinner, the ink viscosity could be reduced to the point that it could be easily stenciled through a brass stencil using an air brush. The manufacturer claims that it provides good adhesion to epoxy, glass, metal, and other non-porous surfaces. The manufacturer also claims that it has excellent resistance to abrasion and flux-removing chemicals. Estimated pot life for the ink is 5 to 6 hours under normal conditions. ACMI #6051 Ink has an estimated shelf life of one year.

  The base and catalyst components for ACMI #6051 Ink are mixed in a 5:1 ratio by volume. The mixture should be allowed to sit for 15 minutes prior to application. It is a room-temperature cure ink that dries to touch in two hours but requires seven days to develop full solvent resistance. ACMI #6051 Ink can also be cured at 121ºC (250ºF), 149ºC (300ºF), or 177ºC (350ºF). The panels that were tested in this project were cured at 121ºC (250ºF) for 30 minutes.

Additional information concerning the **UV-curable inks** tested is below:

- 80 Series UV Curable Ink (Nor-Cote International) - 80 Series UV Curable Ink is a UV-curable ink that was designed for silk screening applications. It is recommended for use on polyethylene, polypropylene, vinyls, styrene, acrylics, polyesters, bookcloths, paper and card stock, and some coated metals. The manufacturer claims that this ink is resistant to most common chemicals and that it has a shelf life of up to two years. The high viscosity of the ink made it impossible to stencil the markings using an airbrush during Phase I screening. The ink was therefore applied using a rubber stamp. During subsequent testing, a special thinner (Nor-Cote 80 thinner), which is based on N-vinyl-2-pyrrolidone, was added to the ink to no more than 10% thinner by weight. The manufacturer indicated that cure rates may increase and surface durability may decrease when the thinner is added.

  80 Series UV Curable Ink is a one-part ink that cures only upon the application of UV light. The manufacturer recommends that the ink be cured immediately after application. It was noted during panel preparation that this ink exhibited very low slump, and the ink markings retained their appearance for the several minutes of time that it took to move the freshly marked panels to the UV curing station. Test panels were cured in a Uvex UV cure conveyor belt furnace at a conveyor belt speed of 6 feet per minute (total cure time approximately 3 minutes). The conveyor belt moves the panels sequentially past two 300-watt UV lamps followed by a 500 watt UV lamp. The manufacturer's data indicate that the ink is fast curing and will cure with one 300-watt UV lamp.

- MSK Series UV Curable Ink (Nor-Cote International) - MSK Series UV Curable Ink is a UV-curable ink that was designed for silk screening applications. It is recommended for use on polycarbonate and many types of polyester and has an estimated shelf life of two years. The manufacturer's data sheet indicates that it exhibits poor weatherability but that it is light fast. The high viscosity of the ink made it impossible to stencil markings using an airbrush during screening. The ink was therefore applied using a rubber stamp. A special thinner (Nor-Cote MSK 070 thinner), which is based on N-vinyl-2-pyrrolidone, is available for thinning the ink for spray application.

  MSK Series UV Curable Ink is a one-part ink that cures only upon the application of UV light. The manufacturer recommends that the ink be cured immediately after application. It was noted during panel preparation that this ink exhibited very low slump, and the ink markings retained their appearance for the several minutes of time that it took to move the freshly marked panels to the UV curing station. Test panels were cured in a Uvex UV cure conveyor belt furnace at a conveyor belt speed of 6 feet per minute (total cure time approximately 3 minutes). The conveyor belt moved the panels sequentially past two 300-watt UV lamps followed by a 500 watt UV lamp. The manufacturer's data indicate that the ink is fast curing and will cure with one 300-watt UV lamp.

- UV3004 (Polychem Corporation) - UV3004 is a single component, UV-curable ink that is designed for use with metals and glass. During Phase I screening, the as-received material was too viscous to be easily spray stenciled. The ink was therefore applied with a rubber stamp. The rubber stamp permitted a much thinner ink film to be applied. However, rapid slump of the applied ink film resulted in the markings rapidly (within 30 seconds) becoming illegible. In addition, any movement of the panels from the horizontal position resulted in the markings becoming illegible. Test panels were placed in the Uvex UV curing station within seconds of ink application in order to maximize legibility. The curing station had a conveyor belt speed of 6 feet per minute (total cure time was approximately 3 minutes). The conveyor belt moved the panels sequentially past two 300-watt UV lamps followed by a 500-watt UV lamp.

Additional information concerning the **waterborne inks** tested is below:

- AERO No. 6565 (Specialty Ink Company, Inc.) - AERO No. 6565 is a quick-drying, one part ink that can be combined with AERO No. 6565 thinner and then very easily applied by spray stenciling. The material dried within 30 seconds of application. Panels were permitted to sit undisturbed at ambient conditions for an additional 48-hour period prior to testing.

- CS7-56 Water Base Ink (Chemsong, Inc.) – CS7-56 can be applied by brushing or spraying. The manufacturer indicated that this ink can be applied on metal or plastic substrates. Technical representatives of Chemsong indicated that the shelf life of this ink is not well defined.

- DPI #311 (Dell Marking Systems, Inc.) - DPI #311 is a water-based permanent marking ink. It was designed for use in spray marking systems, and can be thinned with water if necessary. The manufacturer's literature indicates that it should be allowed to air-dry for five minutes at 25ºC (77ºF). The as-received material was easily sprayed through a brass stencil with an airbrush. Test panels were allowed to sit at ambient conditions for at least 48 hours prior to testing.

- WB 2040M (Polychem Corporation) - WB 2040M is an acrylic-based waterborne ink. The manufacturer's literature indicates that it can be applied by spray, brush, dauber, or stencil and that it provides excellent adhesion to metal, plastic, and glass. The ink was applied by spray stenciling and allowed to sit for 48 hours prior to testing. The ink was dry to the touch in less than 30 minutes. The estimated shelf life of the ink is six months.

- WB82 (Gem Gravure Company, Inc.) - WB82 ink is a single-component water-based polyethylene marking ink. The ink was easily applied by spray stenciling. The ink was cured in accordance manufacturer recommendations (7 days at 50ºC (122ºF)) prior to testing. The ink was dry to the touch very shortly after spraying.

- Willmark #44 (Willard Marking Devices Corporation) - Willmark #44 is a glycol ether-based ink. It was designed for use on circuit boards, electrical components, metal, plastic, glass, polyethylene, and polypropylene and is intended for application with a rubber stamp. During Phase I screening, this ink was applied with a rubber stamp. A thinner, Willmark E, was used during subsequent testing. The manufacturer claims that Willmark #44 is resistant to most common cleaning solvents and that it meets the performance requirements of MIL-I-16557A Type I [*Military Specification, Ink, Marking, Quick-drying (for Non-porous Surfaces)*, dated February 18, 1952; cancelled on December 31, 1962 and superseded by TT-I-558], TT-I-558C [*Federal Specification, Ink, Marking Stencil, Opaque, for Non-porous Surfaces (Metals, Glass, etc.)*, dated April 14, 1967; cancelled on April 20, 1973 and superseded by TT-I-1795], and TT-I-1795 Type I [*Ink, Marking, Stencil, Opaque (Porous and Non-porous Surfaces)*, dated March 17, 1975; cancelled September 20, 1986 and superseded by A-A-208 (*Commercial Item Description, Ink, Marking, Stencil, Opaque (Porous and Non-porous Surfaces)*, dated November 20, 1995; cancelled on August 31, 1999 without a replacement)]. The ink was dry within 30 seconds, but was allowed to sit for at least 48 hours prior to testing.

Information concerning blank and printed **self-adhesive labels** is below. Printed labels were prepared using ribbons or printing inks and printers that were recommended by the individual label manufacturers.

Brady B-107 Matte White Polyester (W.H. Brady Company)

Brady B-107 is a white polyester film that has been formulated for use with selected ink jet printers. It has a maximum service temperature of 149ºC (300ºF) and reportedly has excellent solvent and abrasion resistance. The vendor literature indicates that the label should be used with pigment-based ink rather than dye-based ink (such as that used by Canon and Epson), and that the labels are compatible with Hewlett-Packard DeskJet 600 Series printers. The labels that were tested in this project were prepared on a Hewlett-Packard DeskJet 695C using black ink

(Hewlett-Packard 51629A cartridge). Unlike other labels that were tested in this project, the ink on the B-107 labels easily smeared immediately after printing. The labels were allowed to sit overnight before they were stacked or handled. The label stock that was used was 8.5-inch by 11-inch standard sheets from which individual labels were removed with an X-acto knife.

Brady B-423 Thermal Transfer Printable Glossy White Polyester Label Stock (W.H. Brady Company)

Brady B-423 is a glossy white polyester film with a permanent acrylic pressure sensitive adhesive and a topcoat that has been formulated for thermal transfer printing. It has a maximum service temperature of 120ºC (248ºF). The label material was purchased as a 3-inch wide continuous roll and was printed on a Critchley 170xi thermal transfer printer with a Brady R6004 ribbon (Lot 80805A043305). The labels were then cut out with an X-acto knife.

Brady B-437 (W.H. Brady Company)

Brady B-437 is a polyvinyl fluoride (Tedlar®) film with a thermal transfer printable topcoat and a permanent acrylic pressure sensitive adhesive. The material is flame-retardant and has a maximum recommended service temperature of 135ºC (275ºF). The label material was purchased as a 3-inch wide continuous roll and was printed on a Critchley 170xi thermal transfer printer with a Brady R4304 ribbon (Lot 9285E1). The labels were then cut out with an X-acto knife.

Brady B-652 Printable High Temperature Label Stock (W.H. Brady Company)

Brady B-652 is a laser-printable high temperature amber polyimide label that is intended for use on the underside of printed circuit (PC) boards and surface mount technology (SMT) components. The vendor data indicate that the labels have a maximum service temperature of 177ºC (350ºF). The maximum standard label size that is available from Brady is 3 inches by 0.375 inches. The labels tested in this project were printed on custom-prepared 8.5-inch by 11-inch sheets of film material and were then cut apart with an X-acto knife.

The manufacturer recommends that the Brady B-652 label not be used with most personal laser printers. Their data indicate that best results are obtained with a Hewlett-Packard LaserJet III, LaserJet 4Plus, LaserJet 4L, LaserJet 4P, and LaserJet 5P printers. The labels that were tested were prepared on a Hewlett-Packard LaserJet III printer with a fresh Hewlett-Packard toner cartridge, product 92295A.

Brady B-652 labels were also tested with polyester tape and with polyurethane coatings. The polyester tape that was applied over the labels was Critchley Clear Polyester (described later in this Appendix). The 2-inch-wide tape was applied directly over the 1.75-inch-high label with equal overlap on each side of the underlying label. The polyurethane coating that was used was a Minwax commercial quick-drying formulation that conforms to ASTM D 4236 (*Standard Practice for Labeling Art Materials for Chronic Health Hazards*, approved 1994). The polyurethane was applied by light brushing and was allowed to air-dry for 24 hours prior to testing.

Brady B-747 Lasertab Markers (W.H. Brady Company)

Brady B-747 is a laser-printable polyester material with a pressure-sensitive acrylic adhesive. Standard colors include white and yellow. The material reportedly offers high print resolution, good solvent resistance, smudge resistance, and good temperature resistance [131ºC (267ºF) maximum]. Label stock sized 8.5 inches by 11 inches is a standard Brady stock item and was used to prepare the labels that were tested. This material has the same printer restrictions as Brady B-652. Labels were printed on a Hewlett-Packard LaserJet III printer with a fresh Hewlett-Packard toner cartridge, product 92295A.

Critchley Clear Polyester (TTP200CL-10) (Tyco Electronics; formerly Critchley, Inc.)
Critchley Metallized Thermal Transfer (CR-104-MP) (Tyco Electronics)
Critchley White Polyester Film (CR-119-WP2.5) (Tyco Electronics)

These thermal transfer-printable polyester labels have an acrylic pressure sensitive adhesive. The vendor recommends a service range of –46ºC (–50ºF) to +149ºC (300ºF) and a minimum application temperature of 4ºC (40ºF). The Critchley labels were purchased in a 2-inch wide continuous roll; 3-inch and 4-inch wide rolls are also standard stock items. The labels that were tested were prepared with a Critchley 170xi thermal transfer printer using a Critchley RHD TT BLK ribbon and were cut out using an X-acto knife.

Tyton 822 (Hellerman Tyton)

Tyton 822 is a white polyester thermal transfer label with a permanent pressure sensitive acrylic adhesive. According to the vendor, it has a temperature range of –40ºC (–40ºF) to +149ºC (300ºF) and has an outdoor durability of one year. It is recommended for use on flat or slightly curved surfaces only. Test samples were printed using a Critchley Model 170xi thermal transfer printer. This printer has a 6.6-inch wide print head and a resolution of 300 dots per inch (DPI). A Tyton TT822OUT ribbon (4-inch wide), Lot 189804, was used to print the samples on a custom-prepared roll of 1.75-inch by 4.75-inch blank labels.

Tyton 900 (Hellerman Tyton)

Tyton 900 is a polyimide thermal transfer ribbon with a permanent pressure sensitive acrylic adhesive. It has been formulated for short term, high temperature applications, and has a temperature range of –73ºC (–100ºF) to +260ºC (500ºF). It was designed for labeling the bottom of PC boards prior to the wave solder process. Test samples were prepared on the Critchley 170xi thermal transfer printer using a Tyton TT900OUT ribbon (4 inches wide), Lot 189554. The labels were on a custom-prepared roll of 1.75-inch by 4.75-inch labels.

APPENDIX B

TEST PANEL CLEANLINESS RESULTS

Discussion

During each phase of testing, cleanliness tests were performed on randomly selected panels from each of the substrates tested. Panels had been cleaned in accordance with *Joint Test Protocol, LM-P-1-2, for Validation of Alternatives to Solvent-Based Ink Stenciling for Identification Marking*, dated March 11, 1997, (referred to as JTP) Section 3.0 prior to testing. Cleanliness tests were performed on individual panels using 3 liters of 65% isopropanol as the extraction solution. Resistivity of the isopropanol/water mixture was greater than 20 megohms prior to the start of each test. A uniform sample extraction time of 10 minutes per panel was used to ensure a stable and reproducible resistivity reading on the OmegaMeter. The results of cleanliness testing for each phase of testing are discussed below.

Phase I Screening

The results of cleanliness testing prior to Phase I screening are shown in Table B-1. Note that the backs of panels were cleaned prior to cleanliness testing. AL1e coupons failed the JTP requirement of 1.56 micrograms per square centimeter ($\mu m/cm^2$). This failure is believed to result from the ionic additives in the topcoat.

Initial tests on neoprene rubber (NR) samples that had been scuffed and cleaned with acetone in accordance with the JTP revealed high ionic contamination levels. Additional tests using intense surface sanding followed by acetone cleaning were also unsuccessful and offered no improvement over the JTP-specified cleaning protocol. Cleaning was also unsuccessfully attempted using isopropanol. Test data that are reported in Table B-1 represent panels cleaned with the JTP-specified process.

Phase I Common and Extended Testing

The results of cleanliness testing prior to Phase I common and extended testing are shown in Table B-2. During Phase I common and extended testing, both the NR and AL1a panels failed to meet the JTP cleanliness criterion of a maximum of 1.56 $\mu g/cm^2$ ionic contamination. AL1a panels were tested during Phase I Screening and exhibited fairly high, but acceptable, levels of ionic material. Tests were performed in which the ionic content was measured as a function of time in the ionograph. These tests showed that, even after 20 minutes, ions continued to be released from the panels at a constant rate. The data suggest the possibility of extraction of an ionic component, possibly excess catalyst, by the isopropanol. Therefore, it is suspected that trace levels of ionic additives in the neoprene and the MIL-C-46168 (possibly excess catalyst) are responsible for the slightly high resistivity measurements that were obtained for these two substrates. Subsequent ink and label adhesion results showed no evidence of substrate-induced adhesion failures for samples prepared from these panels.

Phase II Screening

Two AL1a panels were measured for cleanliness prior to Phase II screening. The two AL1a panels that were tested for cleanliness met the JTP requirement, with measured ionic contamination levels of 1.55 and 1.45 $\mu g/cm^2$, respectively. Note that the maximum permissible level is 1.56 $\mu g/cm^2$, and that the AL1a panels have previously demonstrated marginal performance on the cleanliness test.

Phase II Common and Extended Testing

Thirty randomly selected AL1a panels were measured for cleanliness prior to Phase II common and extended testing. The thirty AL1a panels that were tested for cleanliness met the JTP cleanliness requirement, with measured ionic contamination levels of 0.93 to 1.24 $\mu g/cm^2$ and an average contamination level of 1.03 $\mu g/cm^2$. Note that the maximum permissible level is 1.56 $\mu g/cm^2$, and that the AL1a panels have previously demonstrated marginal performance on the cleanliness test. The somewhat marginal performance is not a cause for concern, because the label adhesion to the test panel was not being measured (the printing ink adhesion to the label was being measured).

Table B-1. Phase I Screening: Test Panel Cleanliness Results

Panel Type	Number Tested	Average Resistivity Reading (Megohms)	Equivalent ppm of Sodium Chloride	Contamination ($\mu g/cm^2$)	Pass/ Fail	Comments
AL1a	5	16.1	0.11	1.12	Pass	None
AL1b	5	>20	<0.09	<0.93	Pass	Contamination levels below instrument detection limits
AL1c	5	16.0	0.11	1.18	Pass	None
AL1d	5	14.8	0.12	1.28	Pass	None
AL1e	5	7.2	0.25	2.60	**Fail**	None
AL2	8	18.8	0.10	0.99	Pass	None
SS	8	>20	<0.09	<0.93	Pass	Contamination levels below instrument detection limits
NR	8	4.24	0.41	3.76	**Fail**	None
SR	8	>20	<0.09	<0.93	Pass	Contamination levels below instrument detection limits
G/E	8	>20	<0.09	<0.93	Pass	Contamination levels below instrument detection limits
C/E	8	17.6	0.10	1.06	Pass	None
A/E	8	>20	<0.09	<0.93	Pass	Contamination levels below instrument detection limits

AL1a - MIL-P-23377/MIL-C-46168
AL1b - MIL-P-23377/MIL-C-53039
AL1c - MIL-P-23377/MIL-C-85285
AL1d - MIL-P-85582/MIL-C-85285
AL1e - MIL-P-85582/MIL-C-22750

Table B-2. Phase I Common and Extended Testing: Test Panel Cleanliness Results

Panel Type	Number Tested	Average Resistivity Reading (Megohms)	Equivalent ppm of Sodium Chloride	Contamination ($\mu g/cm^2$)	Pass/ Fail	Comments
AL1a	23	11.0	0.16	1.65	**Fail**	None
AL2	15	>20	<0.09	<0.93	Pass	Contamination levels below instrument detection limits
SS	14	>20	<0.09	<0.93	Pass	Contamination levels below instrument detection limits
NR	9	4.0	0.44	4.54	**Fail**	None
SR	7	17.9	0.10	1.05	Pass	None
G/E	12	>20	<0.09	<0.93	Pass	Contamination levels below instrument detection limits
C/E	10	17.6	0.10	1.06	Pass	None
A/E	10	>20	<0.09	<0.93	Pass	Contamination levels below instrument detection limits

APPENDIX C

ADDITIONAL INFORMATION FOR FLUIDS USED FOR CHEMICAL RESISTANCE TESTS

Table C-1. Additional Information for Fluids Used for Chemical Resistance Tests

Fluid	Additional Information
Isopropanol	Fisher HPLC Grade, Lot 982958
Deionized Water	1 Megohm minimum resistivity
Engine Oil	Quaker State SAE 30
Solder float/terpene	Performed by coating the specimen with Alpha 611 RMA flux, floating the specimen (marking side up) in a 60/40 tin-lead solder bath for 10 seconds, cooling the specimen to room temperature, and immersing the sample in Bioact EC-7M for three minutes.
Coolanol 25R	multiple lots
PAO	Royco 602 (Royal Lubricants), Batch 98-7
MIL-H-5606 Hydraulic Oil	Royco 756 (Royal Lubricants), Batch 99-2
MIL-L-23699 Lubricating Oil	Exxon 2380 Turbo Oil
Skydrol	500 B-4 (Solutia, Inc.)
JP5	(Phillips Chemical Company), 9CPJP501
DS2	Prepared at LM Missiles and Fire Control Company from Fisher diethylene triamine (70%), ethylene glycol monomethyl ether (28%), and sodium hydroxide (2%)

APPENDIX D

INFRARED REFLECTANCE TESTING:

COLOR MATCHING TEST RESULTS:

Discussion

The Infrared (IR) Reflectance testing specified in the Joint Test Protocol for Validation of Alternatives to Solvent-Based Ink Stenciling for Identification Marking, dated March 11, 1997 (Section 3.1.7, Section 3.2.5, and Section 3.3.5) required that the testing performed on three FED-STD-595B (*Colors Used in Government Procurement*, issued December 15, 1989) colors. One color was required for aircraft applications: green (color 34095). Two colors were required for ground support equipment: black (color 37030) and green 383 (Color 34094).

As discussed in the Joint Test Report (JTR), some alternatives were available in FED-STD-595B custom colors, while others had greens and blacks that had not been previously matched to the standard. Therefore, color matching testing was performed for all alternatives that had greens or blacks available for IR testing.

Color matching was performed by measuring the color difference between the FED-STD-595B color chip and the color of the alternative, as applied to the coupon or (in the case of printing inks) label. A brief description of the test procedure is below.

> *Test Description*: Perform this test in accordance with ASTM D 2244 (*Standard Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates*, approved 1964, re-approved 1993). Set the settings on the instrument and calibrate it. Measure the color of the color chip. Measure the color of the alternative at two places (for quality control). The instrument will then do a color comparison to the parameters that have been set (e.g., delta E).

For this testing, the instrument used was a MacBeth Colorchecker 545, which is controlled by the Optiview software. Three illuminant types were measured: D65, CWF, and SPL Hor. D65 is a 7 phosphor daylight fluorescent lamp type with a color temperature of 6,500° Kelvin (K). D65 simulates average north sky daylight and is typically used for European or Pacific Rim color matching with measuring conformance with spectrophotometry. CWF is a U.S. commercial fluorescent lamp type with a color temperature of 4,230°K. CWF represents typical store or office lighting. SPL Hor is Spectralite Horizon simulated light that is used to correlate what people see visually.

Color Matching Testing prior to IR Reflectance Testing

JTP Test (reference)	Alternative	Color Required	Color Measurement (delta E for D65)	Color Measurement (delta E for CWF)	Color Measurement (delta E for SPL HOR)
3.1.7	Nor-Cote 80 Color 34094	34094	6.53	6.25	6.61
	Nor-Cote 80 Color 34095 – Coupon 1	34095	8.94	7.37	7.08
	Nor-Cote 80 Color 34095 – Coupon 2	34095	8.93	7.48	7.23
	Nor-Cote 80 Color 34095 – Coupon 3	34095	8.85	7.35	6.89
	Chemsong CS7-56 Black	37030	6.46	6.40	6.37
	AERO 6565 Black	37030	19.39	19.45	19.42
	Dell #311 Black	37030	14.81	14.90	14.94
	Willmark #44 Black	37030	9.46	9.50	9.49
	Nor-Cote 80 Color 37030	37030	6.81	6.95	6.97
	AERO 6565 Green (*)	34094	26.15	27.03	27.37
		34095	27.55	29.25	29.17
	Dell #311 Green (*)	34094	43.46	32.75	25.61
		34095	41.53	34.41	37.48
	Willmark #44 Green (*)	34094	36.66	33.25	26.83
		34095	29.80	30.08	31.92
	ACMI 6051 (baseline)	37030	16.35	16.34	16.26

Color Matching Testing prior to IR Reflectance Testing (continued)

JTP Test (reference)	Alternative	Color Required	Color Measurement (delta E for D65)	Color Measurement (delta E for CWF)	Color Measurement (delta E for SPL HOR)
3.2.5	Tyton 822 Label Thermal Transfer Ribbon with TT822OUT Ribbon	37030	10.11	9.94	10.05
	Brady XB-437 Label Thermal Transfer Printer R4304 Ribbon	37030	9.26	9.22	9.13
	Brady XB-107 Label HP 695C DeskJet Printer HP 51629A Ink	37030	6.14	6.44	6.86
	Brady B-747 Label HP LaserJet III Printer	37030	2.66	2.60	2.79
	Brady B-652 Label HP LaserJet III Printer Polyurethane-Coated	37030	15.51	15.49	15.31
	Brady B-652 Label HP LaserJet III Printer Uncoated	37030	3.60	3.72	3.74
	Brady B-652 Label HP LaserJetIII Printer Polyester Tape-Coated	37030	10.76	10.78	10.62
	Tyton 900 Label Thermal Transfer Printer TT900OUT Ribbon	37030	8.80	8.82	8.74

Color Matching Testing prior to IR Reflectance Testing

JTP Test (reference)	Alternative	Color Required	Color Measurement (delta E for D65)	Color Measurement (delta E for CWF)	Color Measurement (delta E for SPL HOR)
	Critchley Clear Polyester Label Thermal Transfer Printer RHD TT BLK Ribbon	37030	13.36	12.96	13.37
	Critchley Metallized Polyester Thermal Transfer Printer RHD BLK Ribbon	37030	9.35	9.30	9.22
	Brady B-423 Label Thermal Transfer Printer R6004 Ribbon	37030	18.33	18.48	18.62
	Critchley White Polyester Label Thermal Transfer Printer RHD TT BLK Ribbon	37030	10.98	10.87	10.81
3.3.5	34095 color chip covered with Critchley clear polyester tape	34095	13.45	13.45	12.44
	34094 color chip covered with Critchley clear polyester tape	34094	8.60	8.56	8.28
	37030 color chip covered with Critchley clear polyester tape	37030	12.50	12.49	12.53
	Critchley Clear Polyester on Color 34094	34094	5.58	5.63	5.38
	Critchley Clear Polyester on Color 34095 – Coupon 1	34095	8.78	8.83	7.28

Color Matching Testing prior to IR Reflectance Testing

JTP Test (reference)	Alternative	Color Required	Color Measurement (delta E for D65)	Color Measurement (delta E for CWF)	Color Measurement (delta E for SPL HOR)
	Critchley Clear Polyester on Color 34095 – Coupon 2	34095	8.60	8.47	7.40
	Critchley Clear Polyester on Color 34095 – Coupon 3	34095	7.87	7.77	6.87
	Critchley Clear Polyester on Color 37070	37030	6.21	6.17	6.11
	Critchley TTP400BK-10 Black Polyester	37030	9.28	9.43	9.48
	Critchley TTP 400 GN-10 Green Polyester (*)	34094 or 34095	23.26	24.32	23.77

APPENDIX E

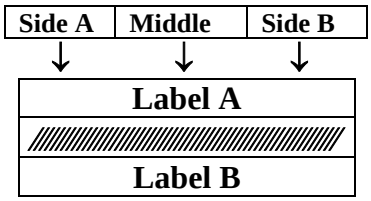
ADHESION RESULTS FOR FUNGAL RESISTANCE TEST:

FUNGAL GROWTH RESULTS FOR FUNGAL RESISTANCE TEST

Adhesion Results for Fungal Resistance Test

Specimen	Label #1 Rating			Label #2 Rating		
	Side A	**Middle**	**Side B**	**Side A**	**Middle**	**Side B**
ACMI #6051 Ink (Control)	5A	5A	5A	5A	5A	5A
80 Series UV Curable Ink	5A	5A	4A	No label	No label	No label
AERO No. 6565 Ink	5A	5A	5A	No label	No label	No label
CS7-56 Water Base Ink	5A	5A	5A	No label	No label	No label
DPI #311 Ink	5A	5A	5A	No label	No label	No label
Willmark #44 Ink	5A	5A	5A	No label	No label	No label
Brady B-107 Label	5A	5A	5A	5A	1A	2A
Brady B-423 Label	5A	5A	5A	5A	5A	5A
Brady B-437 Label	5A	5A	5A	5A	5A	5A
Brady B-652 Uncoated Label	5A	5A	5A	5A	5A	5A
Brady B-652 Coated Label	5A	5A	5A	4A	4A	5A
Brady B-747 Label	5A	5A	5A	5A	5A	5A
Critchley Clear Poly. Label	5A	5A	5A	5A	5A	5A
Critchley Metallized Label	5A	5A	5A	5A	5A	5A
Critchley White Poly. Label	5A	1A	1A	5A	1A	1A
Tyton 822 Label	5A	5A	5A	5A	5A	5A
Tyton 900 Label	1A	2A	5A	5A	1A	1A

5A – No peeling or removal of specimen.
4A – Trace peeling or removal along incisions or at their intersection.
3A – Jagged removal along most of the incisions up to 1/16th (in) (1.6 mm) on either side.
2A – Jagged removal along most of the incisions up to 1/8th (in) (3.2 mm) on either side.
1A – Removal from most of the area of the X under the tape.
0A – Removal beyond the area of the X.



Fungal Growth Results for Fungus Resistance Test

Specimen	Comments	Rating
ACMI #6051 Ink	Moderate growth, no deterioration	3
80 Series UV Curable Ink	No growth	0
AERO No. 6565 Ink	Trace growth, no deterioration	1
CS7-56 Water Base Ink	Slight growth, no deterioration	2
DPI #311 Ink	No growth	0
Willmark #44 Ink	Trace growth, no deterioration	1
Brady B-107 Label	No growth	0
Brady B-423 Label	Slight growth, no deterioration	2
Brady B-437 Label	No growth	0
Brady B-652 Uncoated Label	No growth	0
Brady B-652 Coated Label	Moderate growth, no deterioration	3
Brady B-747 Label	Moderate growth, no deterioration	3
Critchley Clear Poly. Label	Moderate growth, no deterioration	3
Critchley Metallized Label	Slight growth, no deterioration	2
Critchley White Poly. Label	Slight growth, no deterioration	2
Tyton 822 Label	Trace growth, no deterioration	1
Tyton 900 Label	Slight growth, no deterioration	2

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APPENDIX F

PPEP "IMPROVED STENCILING AND MARKING SYSTEM" PROJECT:

TESTING RESULTS OF OTHER SELF-ADHESIVE LABELS

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F.1 INTRODUCTION

While the Joint Group on Pollution Prevention (JG-PP) Low-Volatile Organic Compound (VOC) Identification Marking project was underway, the Navy's Pollution Prevention Equipment Program (PPEP) also had a project that tested alternative identification marking methods. The purpose of the PPEP project was to determine if any of the tested alternatives would be acceptable for use in the shipboard environment. The alternatives tested are listed in Table F-1.

Table F-1. Alternative Labels Tested by PPEP Project

Material Vendor	Color	Thickness[1]	Printer(s)
Roland	White	3 mils	Roland Color CAMMPRO
Avery	White	3 mils	Roland Color CAMMPRO and Gerber Edge Printer
Rexcal	White	3 mils	Roland Color CAMMPRO and Gerber Edge Printer
Scotchcal	White	3 mils	Gerber Edge Printer
Scotchcal	White reflective	7 mils	Gerber Edge Printer

[1] Labels tested were 2 inches by 4 inches.

Testing was performed in accordance with Naval Air Warfare Center Aircraft Division (NAWCAD) Lakehurst Test Directive SE-980001, dated September 1, 1998. In general, the guidelines of the JG-PP *Joint Test Protocol, LM-P-1-2, for Validation of Alternatives to Solvent-Based Ink Stenciling for Identification Marking*, dated March 11, 1997 (referred to as JTP) were followed in the PPEP project. One exception is the acceptance criteria for the label-to-substrate adhesion testing, which was average pull greater than 2 pounds (lb) per linear inch (the JTP requirement is for average pull of at least 16 ounces, or 1 lb, per linear inch). Supplemental testing and variations in testing are described in Section F.2 and Section F.3, respectively.

Labels were applied to mild steel coupons that had been painted on both sides in accordance with standard depot practices for coating support equipment (SE) [i.e., preparation, priming, and topcoating with MIL-C-85285 (*Coating, Polyurethane, High Solids*, dated April 30, 1997), Type II]. Each coupon had six labels applied to each side (six negative, six positive). Testing results are described in Section F.4.

F.2 SUPPLEMENTAL TESTING

A portion of the testing required by the JTP was not performed by the PPEP project, as noted in Section F.4. The following testing was performed in addition to the tests required in the JTP:

- *Chemical resistance testing* – 7-day soak at room temperature in aircraft cleaner, dry cleaning solvent, and JP8.

- *Salt spray corrosion resistance testing* – In addition to measuring the effect of salt spray on the labels as required by the JTP, PPEP also performed an abrasion resistance test after salt spray exposure.

F.3 VARIATIONS IN TESTING

The variations from the JTP that were used during PPEP testing to better meet the PPEP project's goals and objectives are described below:

- *Chemical resistance testing*
  - The JTP requires that specimens be immersed for 3 minutes at 23 ± 1.1°C (73.4 ± 2°F). The PPEP project immersed the specimens in the tested fluids (i.e., isopropyl alcohol, deionized water, aircraft cleaner, dry cleaning solvent, hydraulic oil, lubricating oil, and JP8) for 7 days at room temperature.
  - When testing in accordance with the JTP, labels were wiped with a cloth and tested for adhesion. For PPEP, when peeling/curling of a label occurred, pressure was applied to return it to its original position on the coupon prior to performing the adhesion test.
  - Deionized water – Three AL1 test specimens were tested under PPEP project versus one each of various substrates under JG-PP.
  - Hydraulic fluid – The JTP requires MIL-H-5606 for the hydraulic fluid chemical resistance test. PPEP used MIL-DTL-17111 (*Detail Specification, Fluid, Power Transmission*, dated January 21, 1998) for this test.
  - Isopropyl alcohol – During PPEP test execution, 60 days elapsed between immersion in isopropyl alcohol and the peel test. During this time, the labels became brittle. Under the JG-PP project, label adhesion was tested at least two weeks, but no greater than four weeks, after immersion.
- *Abrasion testing* – For PPEP, gray, pink and white erasers were used to measure abrasion resistance. The JTP only requires testing with one eraser conforming to A-A-132B; for the JG-PP testing, a pink eraser was used.

F.4 PPEP TESTING RESULTS

The results for the alternatives tested are described in this Section. Table F-2 shows the testing summarized in each of the following tables.

Table F-2. Tables with Testing Results

Material Vendor	Printer	Table	
		Blank Label Results	Printed Label Results
Roland (3-mil)	Roland Color CAMMPRO	F-3, F-4	F-5, F-6
Avery (3-mil)	Roland Color CAMMPRO/ Gerber Edge Printer	F-7, F-8	F-9, F-10
Rexcal (3-mil)	Roland Color CAMMPRO/ Gerber Edge Printer	F-11, F-12	F-13, F-14
Scotchcal (3-mil)	Gerber Edge Printer	F-15, F-16	F-17, F-18
Scotchcal (7-mil)	Gerber Edge Printer	F-19, F-20	F-21, F-22

Table F-3. Roland Label with Roland Printer Common Testing Results: Blank Labels (Average Adhesion in Pounds Force per Inch Width)

JTP Section Number and Test Name	Substrate							
	AL1	AL2	SS	NR	SR	G/E	C/E	A/E
Screening								
3.3.1 Adhesion	NP	NP	NP	NP	NP	NP	NP	NP
Common								
3.3.2 Chemical Resistance		NP	NP	NP	NP	NP	NP	NP
Isopropyl alcohol	2.0-2.5 [a]	NP	NP	NP	NP	NP	NP	NP
Deionized water	6.0-8.5	NP	NP	NP	NP	NP	NP	NP
Engine oil 21SAE20W	NP	NP	NP	NP	NP	NP	NP	NP
Terpene-based solvent	NP	NP	NP	NP	NP	NP	NP	NP
3.3.6 Salt Spray Resistance								
48-HOUR TEST	6.0-9.0	NP	NP	NR	NR	NR	NR	NR
168-Hour Test	5.5-8.5	NP	NP	NR	NR	NR	NR	NR
3.3.7 Temperature Exposure and Thermal Shock Resistance								
-48ºC (-55ºF)	4.0-10.5 [b]	NR	NR	NR	NR	NR	NR	NR
54°C (130°F), 30 MINUTES (*)	5.5 [c]	NR	NR	NR	NR	NR	NR	NR
71°C (160°F), 30 MINUTES (*)	7.5-8.0	NR	NR	NR	NR	NR	NR	NR
118ºC (244ºF)	7.5-8.0	NR	NR	NR	NR	NR	NR	NR
THERMAL SHOCK	7.0-9.0 [c]	NR	NR	NR	NR	NR	NR	NR
3.3.8 UV Light/Condensation	NP	NR	NR	NR	NR	NR	NR	NR

[a] All labels tested peeled and the corners rolled from the extended exposure to isopropyl alcohol.
[b] All labels tested experienced material failure (label ripped) instead of lift-off from coupon. The forces to remove all alternatives ranged from 4.0 to 10.5 lb_f.
[c] Negative labels broke.
NP – Not performed.
NR – Not required.
(*) Additional testing; not required by JTP for JG-PP project.

Table F-4. Roland Label with Roland Printer Extended Testing Results: Blank Labels (Average Adhesion in Pounds Force per Inch Width)

JTP Section Number and Test Name	Substrate							
	AL1	AL2	SS	NR	SR	G/E	C/E	A/E
Extended								
3.3.1 Adhesion (Program-specific parts)	NP	NR	NR	NR	NR	NR	NR	NR
3.3.2 Chemical Resistance								
Coolanol	NP	NP	NP	NP	NP	NP	NP	NP
PAO	NP	NP	NP	NP	NP	NP	NP	NP
Hydraulic oil (MIL-STD-17111)	6.5-7.0	NP	NP	NP	NP	NP	NP	NP
Lubricating oil (MIL-L-23699)	6.0-8.5	NP	NP	NP	NP	NP	NP	NP
Skydrol	NP	NP	NP	NP	NP	NP	NP	NP
JP5 (MIL-T-5624)	NP	NP	NP	NP	NP	NP	NP	NP
DS2	NP	NP	NP	NP	NP	NP	NP	NP
Aircraft cleaner (*)	6.0-7.5	NP	NP	NP	NP	NP	NP	NP
Dry cleaning solvent (*)	6.5-7.0	NP	NP	NP	NP	NP	NP	NP
JP8 (*)	2.5-3.0	NP	NP	NP	NP	NP	NP	NP
3.3.3 Corrosivity								
54°C (130ºF)	NP	NP	NP	NR	NR	NR	NR	NR
71°C (160ºF)	NP	NP	NP	NR	NR	NR	NR	NR
118°C (244ºF)	NP	NP	NP	NR	NR	NR	NR	NR
3.3.4 DC Electrical Resistance	NR	NR	NR	NR	NR	NP	NP	NP
3.3.5 IR Reflectance	NP	NP	NP	NP	NP	NP	NP	NP
3.3.7 Temperature Exposure and Thermal Shock Resistance (program-specific parts)	NP	NR	NR	NR	NR	NR	NR	NR

NP – Not performed.
NR – Not required.
(*) Additional testing; not required by JTP for JG-PP project.

Table F-5. Roland Label with Roland Printer Common Testing Results: Printed Labels

JTP Section Number and Test Name	Substrate
	AL1
Screening	
3.2.2 Adhesion	Pass
3.2.6 Legibility	Pass
Common	
3.2.1 Abrasion (Scrub) Resistance	Pass[1]
3.2.3 Chemical Resistance	
Isopropyl alcohol	Pass[2]
DEIONIZED WATER	Pass
Engine oil 21SAE20W	NP
Terpene-based solvent	NP
3.2.7 Salt Spray Resistance	
48-HOUR TEST	Pass[3]
168-Hour Test	Pass[4]
3.2.8 Temperature Exposure and Thermal Shock Resistance	
-48ºC (-55ºF)	Pass[5]
54ºC (130ºF), 30 MINUTES (*)	Pass[5]
71ºC (160ºF), 30 MINUTES (*)	Pass[5]
118ºC (244ºF)	Pass[5]
THERMAL SHOCK	Pass[5]
3.2.9 UV Light/Condensation	NP

[1] Gray eraser removed all printing on negative labels. Pink eraser removed some printing. White eraser showed slight effect.
[2] Medium lift-off of ink on positive labels.
[3] Medium ink removal on negative labels during subsequent abrasion resistance test.
[4] Severe ink removal during subsequent abrasion resistance test.
[5] Only legibility test was used to determine results.
NP – Not performed.
(*) Additional testing; not required by JTP for JG-PP project.

Table F-6. Roland Label with Roland Printer Extended Testing Results: Printed Labels

JTP Section Number and Test Name	Substrate
	AL1
Screening	
3.2.2 Adhesion	Pass
3.2.6 Legibility	Pass
Extended	
3.2.3 Chemical Resistance	
Coolanol	NP
PAO	NP
Hydraulic oil (MIL-STD-17111)	Pass
Lubricating oil (MIL-L-23699)	Pass[1]
Skydrol	NP
JP5 (MIL-T-5624)	NP
DS2	NP
Aircraft cleaner (*)	**Fail[2]**
Dry cleaning solvent (*)	Pass
JP8 (*)	Pass[3]
3.2.4 Fungus Resistance	NP
3.2.5 IR Reflectance	NP

[1] Trace of ink removal at scribe on negative labels.
[2] Ink wiped off when cloth used to dry label.
[3] Slight to heavy ink removal.
NP – Not performed.
(*) Additional testing; not required by JTP for JG-PP project.

Table F-7. Avery Label with Roland/Gerber Printer Common Testing Results: Blank Labels (Average Adhesion in Pounds Force per Inch Width)

JTP Section Number and Test Name	Substrate								
	AL1 - Roland	AL1 - Gerber	AL2	SS	NR	SR	G/E	C/E	A/E
Screening									
3.3.1 Adhesion	NP	NP	NP	NP	NP	NP	NP	NP	NP
Common									
3.3.2 Chemical Resistance			NP	NP	NP	NP	NP	NP	NP
Isopropyl alcohol	2.5-3.5 [a]	3.5-4.0 [a]	NP	NP	NP	NP	NP	NP	NP
Deionized water	5.5-7.0	6.0-7.0	NP	NP	NP	NP	NP	NP	NP
Engine oil 21SAE20W	NP	NP	NP	NP	NP	NP	NP	NP	NP
Terpene-based solvent	NP	NP	NP	NP	NP	NP	NP	NP	NP
3.3.6 Salt Spray Resistance									
48-HOUR TEST	5.0-8.0	5.5-7.5	NP	NP	NR	NR	NR	NR	NR
168-Hour Test	5.0-8.0	5.0-8.0	NP	NP	NR	NR	NR	NR	NR
3.3.7 Temperature Exposure and Thermal Shock Resistance									
-48ºC (-55ºF)	4.0-10.5 [b]	4.0-10.5 [b]	NR	NR	NR	NR	NR	NR	NR
54°C (130°F), 30 MINUTES (*)	6.5	6.5-7.0	NR	NR	NR	NR	NR	NR	NR
71°C (160°F), 30 MINUTES (*)	6.5-7.5 [c]	6.0-7.0	NR	NR	NR	NR	NR	NR	NR
118ºC (244ºF)	6.5-7.0	6.5-7.0	NR	NR	NR	NR	NR	NR	NR
THERMAL SHOCK	3.0-7.5 [c]	3.0 [c]	NR	NR	NR	NR	NR	NR	NR
3.3.8 UV Light/Condensation	NP	NP	NR	NR	NR	NR	NR	NR	NR

[a] All labels tested peeled and the corners rolled from the extended exposure to isopropyl alcohol.
[b] All labels tested experienced material failure (label ripped) instead of lift-off from coupon. The forces to remove all alternatives ranged from 4.0 to 10.5 lb_f.
[c] Negative label ripped.
NP – Not performed.
NR – Not required.
(*) Additional testing; not required by JTP for JG-PP project.

Table F-8. Avery Label with Roland/Gerber Printer Extended Testing Results: Blank Labels (Average Adhesion in Pounds Force per Inch Width)

JTP Section Number and Test Name	Substrate								
	AL1 - Roland	AL1- Gerber	AL2	SS	NR	SR	G/E	C/E	A/E
Extended									
3.3.1 Adhesion (Program-specific parts)	NP	NP	NR	NR	NR	NR	NR	NR	NR
3.3.2 Chemical Resistance									
Coolanol	NP	NP	NP	NP	NP	NP	NP	NP	NP
PAO	NP	NP	NP	NP	NP	NP	NP	NP	NP
Hydraulic oil (MIL-STD-17111)	5.0-6.5	5.5-6.5	NP	NP	NP	NP	NP	NP	NP
Lubricating oil (MIL-L-23699)	5.0-8.0	6.0-8.0	NP	NP	NP	NP	NP	NP	NP
Skydrol	NP	NP	NP	NP	NP	NP	NP	NP	NP
JP5 (MIL-T-5624)	NP	NP	NP	NP	NP	NP	NP	NP	NP
DS2	NP	NP	NP	NP	NP	NP	NP	NP	NP
Aircraft cleaner (*)	6.0-6.5	5.0-7.0	NP	NP	NP	NP	NP	NP	NP
Dry cleaning solvent (*)	5.5-6.0	5.5-6.0	NP	NP	NP	NP	NP	NP	NP
JP8 (*)	2.0-2.5	2.0-2.5	NP	NP	NP	NP	NP	NP	NP
3.3.3 Corrosivity									
54°C (130ºF)	NP	NP	NP	NP	NR	NR	NR	NR	NR
71°C (160ºF)	NP	NP	NP	NP	NR	NR	NR	NR	NR
118°C (244ºF)	NP	NP	NP	NP	NR	NR	NR	NR	NR
3.3.4 DC Electrical Resistance	NR	NR	NR	NR	NR	NR	NP	NP	NP
3.3.5 IR Reflectance	NP	NP	NP	NP	NP	NP	NP	NP	NP
3.3.7 Temperature Exposure and Thermal Shock Resistance (program-specific parts)	NP	NP	NR	NR	NR	NR	NR	NR	NR

NP – Not performed.
NR – Not required.
(*) Additional testing; not required by JTP for JG-PP project.

Table F-9. Avery Label with Roland/Gerber Printer Common Testing Results: Printed Labels

JTP Section Number and Test Name	Substrate	
	AL1 – Roland Printer	AL1 – Gerber Printer
Screening		
3.2.2 Adhesion	Pass	Pass
3.2.6 Legibility	Pass	Pass
Common		
3.2.1 Abrasion (Scrub) Resistance	Pass	Pass
3.2.3 Chemical Resistance		
Isopropyl alcohol	Pass	Pass[1]
Deionized water	Pass	Pass[2]
Engine oil 21SAE20W	NP	NP
Terpene-based solvent	NP	NP
3.2.7 Salt Spray Resistance		
48-HOUR TEST	Pass	Pass
168-Hour Test	Pass[3]	Pass
3.2.8 Temperature Exposure and Thermal Shock Resistance		
-48ºC (-55ºF)	Pass[4]	Pass[4]
54ºC (130ºF), 30 MINUTES (*)	Pass[4]	Pass[4]
71ºC (160ºF), 30 MINUTES (*)	Pass[4]	Pass[4]
118ºC (244ºF)	Pass[4]	Pass[4]
THERMAL SHOCK	Pass[4]	Pass[4]
3.2.9 UV Light/Condensation	NP	NP

[1] Heavy lift-off at scribe to medium lift-off of ink.
[2] Heavy ink removal from negative labels.
[3] Abrasion test completely removed ink.
[4] Only legibility test was used to determine results.
NP – Not performed.
(*) Additional testing; not required by JTP for JG-PP project.

Table F-10. Avery Label with Roland/Gerber Printer Extended Testing Results: Printed Labels

JTP Section Number and Test Name	Substrate	
	AL1 – Roland Printer	**AL1 – Gerber Printer**
Screening		
3.2.2 Adhesion	Pass	Pass
3.2.6 Legibility	Pass	Pass
Extended		
3.2.3 Chemical Resistance		
Coolanol	NP	NP
PAO	NP	NP
Hydraulic oil (MIL-STD-17111)	Pass[1]	Pass[2]
Lubricating oil (MIL-L-23699)	Pass[3]	Pass[2]
Skydrol	NP	NP
JP5 (MIL-T-5624)	NP	NP
DS2	NP	NP
Aircraft cleaner (*)	**Fail**	**Fail[4]**
Dry cleaning solvent (*)	Pass	Pass[2]
JP8 (*)	Pass[5]	Pass[6]
3.2.4 Fungus Resistance	NP	NP
3.2.5 IR Reflectance	NP	NP

[1] Trace of ink removal.
[2] Trace of ink removal at scribe on negative labels.
[3] Trace of ink removal at scribe.
[4] Print smeared on positive labels and lifted off of negative labels.
[5] Slight to heavy ink lift-off.
[6] Medium trace ink removal on negative labels.
NP – Not performed.
(*) Additional testing; not required by JTP for JG-PP project.

Table F-11. Rexcal Label with Roland/Gerber Printer Common Testing Results: Blank Labels (Average Adhesion in Pounds Force per Inch Width)

JTP Section Number and Test Name	Substrate								
	AL1 - Roland	**AL1 - Gerber**	**AL2**	**SS**	**NR**	**SR**	**G/E**	**C/E**	**A/E**
Screening									
3.3.1 Adhesion	NP	NP	NP	NP	NP	NP	NP	NP	NP
Common									
3.3.2 Chemical Resistance			NP	NP	NP	NP	NP	NP	NP
Isopropyl alcohol	3.5-4.0 [a]	**Fail 1.5-3.0** [a,b]	NP	NP	NP	NP	NP	NP	NP
Deionized water	3.0	3.0	NP	NP	NP	NP	NP	NP	NP
Engine oil 21SAE20W	NP	NP	NP	NP	NP	NP	NP	NP	NP
Terpene-based solvent	NP	NP	NP	NP	NP	NP	NP	NP	NP
3.3.6 Salt Spray Resistance									
48-HOUR TEST	3.0-4.5	3.0-4.0	NP	NP	NR	NR	NR	NR	NR
168-Hour Test	3.0-4.5	3.0-4.5	NP	NP	NR	NR	NR	NR	NR
3.3.7 Temperature Exposure and Thermal Shock Resistance									
-48ºC (-55ºF)	4.0-10.5 [c]	4.0-10.5 [c]	NR	NR	NR	NR	NR	NR	NR
54°C (130°F), 30 MINUTES (*)	4.0	4.0	NR	NR	NR	NR	NR	NR	NR
71°C (160°F), 30 MINUTES (*)	4.0	3.5-4.0	NR	NR	NR	NR	NR	NR	NR
118ºC (244ºF)	3.5-4.0	3.5-4.0	NR	NR	NR	NR	NR	NR	NR
THERMAL SHOCK	**Fail 1.0-2.5** [d]	**Fail 1.0**	NR	NR	NR	NR	NR	NR	NR
3.3.8 UV Light/Condensation	NP	NP	NR	NR	NR	NR	NR	NR	NR

[a] All labels tested peeled and the corners rolled from the extended exposure to isopropyl alcohol.
[b] One label failed at 1.5 lb_f.
[c] All labels tested experienced material failure (label ripped) instead of lift-off from coupon. The forces to remove all alternatives ranged from 4.0 to 10.5 lb_f.
[d] Three of the four labels did not meet the criteria of 2 pounds.
NP – Not performed.
NR – Not required.
(*) Additional testing; not required by JTP for JG-PP project.

Table F-12. Rexcal Label with Roland/Gerber Printer Extended Testing Results: Blank Labels (Average Adhesion in Pounds Force per Inch Width)

JTP Section Number and Test Name	Substrate								
	AL1 - Roland	**AL1 - Gerber**	**AL2**	**SS**	**NR**	**SR**	**G/E**	**C/E**	**A/E**
Extended									
3.3.1 Adhesion (Program-specific parts)	NP	NP	NR	NR	NR	NR	NR	NR	NR
3.3.2 Chemical Resistance									
Coolanol	NP	NP	NP	NP	NP	NP	NP	NP	NP
PAO	NP	NP	NP	NP	NP	NP	NP	NP	NP
Hydraulic oil (MIL-STD-17111)	3.0-3.5	3.0-3.5	NP	NP	NP	NP	NP	NP	NP
Lubricating oil (MIL-L-23699)	3.0-4.0	4.0	NP	NP	NP	NP	NP	NP	NP
Skydrol	NP	NP	NP	NP	NP	NP	NP	NP	NP
JP5 (MIL-T-5624)	NP	NP	NP	NP	NP	NP	NP	NP	NP
DS2	NP	NP	NP	NP	NP	NP	NP	NP	NP
Aircraft cleaner (*)	3.0-3.5	3.0	NP	NP	NP	NP	NP	NP	NP
Dry cleaning solvent (*)	3.0-3.5	3.0-3.5	NP	NP	NP	NP	NP	NP	NP
JP8 (*)	**Fail 1.5**	**Fail 1.5**	NP	NP	NP	NP	NP	NP	NP
3.3.3 Corrosivity									
54°C (130ºF)	NP	NP	NP	NP	NR	NR	NR	NR	NR
71°C (160ºF)	NP	NP	NP	NP	NR	NR	NR	NR	NR
118°C (244ºF)	NP	NP	NP	NP	NR	NR	NR	NR	NR
3.3.4 DC Electrical Resistance	NR	NR	NR	NR	NR	NR	NP	NP	NP
3.3.5 IR Reflectance	NP	NP	NP	NP	NP	NP	NP	NP	NP
3.3.7 Temperature Exposure and Thermal Shock Resistance (program-specific parts)	NP	NP	NR	NR	NR	NR	NR	NR	NR

NP – Not performed.
NR – Not required.
(*) Additional testing; not required by JTP for JG-PP project.

Table F-13. Rexcal Label with Roland/Gerber Printer Common Testing Results: Printed Labels

JTP Section Number and Test Name	Substrate	
	AL1 – Roland Printer	AL1 – Gerber Printer
Screening		
3.2.2 Adhesion	Pass[1]	Pass[1]
3.2.6 Legibility	Pass	Pass
Common		
3.2.1 Abrasion (Scrub) Resistance	Pass	Pass
3.2.3 Chemical Resistance		
Isopropyl alcohol	Pass	Pass[2]
Deionized water	Pass[3]	Pass
Engine oil 21SAE20W	NP	NP
Terpene-based solvent	NP	NP
3.2.7 Salt Spray Resistance		
48-HOUR TEST	Pass	Pass
168-Hour Test	Pass[4]	Pass
3.2.8 Temperature Exposure and Thermal Shock Resistance		
-48ºC (-55ºF)	Pass[5]	Pass[5]
54ºC (130ºF), 30 MINUTES (*)	Pass[5]	Pass[5]
71ºC (160ºF), 30 MINUTES (*)	Pass[5]	Pass[5]
118ºC (244ºF)	Pass[5]	Pass[5]
THERMAL SHOCK	Pass[5]	Pass[5]
3.2.9 UV Light/Condensation	NP	NP

[1] Trace of ink removal at scribe on negative labels.
[2] Medium to heavy lift-off at scribe.
[3] Ink lift-off on negative labels.
[4] Severe ink lift-off during subsequent abrasion test.
[5] Only legibility was used to determine results.
NP – Not performed.
(*) Additional testing; not required by JTP for JG-PP project.

Table F-14. Rexcal Label with Roland/Gerber Printer Extended Testing Results: Printed Labels

JTP Section Number and Test Name	Substrate	
	AL1- Roland Printer	**AL1 – Gerber Printer**
Screening		
3.2.2 Adhesion	Pass[1]	Pass[1]
3.2.6 Legibility	Pass	Pass
Extended		
3.2.3 Chemical Resistance		
Coolanol	NP	NP
PAO	NP	NP
Hydraulic oil (MIL-STD-17111)	Pass	Pass[1]
Lubricating oil (MIL-L-23699)	Pass[2]	Pass[1]
Skydrol	NP	NP
JP5 (MIL-T-5624)	NP	NP
DS2	NP	NP
Aircraft cleaner (*)	**Fail**[3]	**Fail**[4]
Dry cleaning solvent (*)	Pass[5]	Pass[2]
JP8 (*)	Pass[6]	Pass[7]
3.2.4 Fungus Resistance	NP	NP
3.2.5 IR Reflectance	NP	NP

[1] Trace of ink removal at scribe on negative labels.
[2] Trace of ink removal at scribe.
[3] Ink wiped off label with dry cloth.
[4] Positive labels smeared with cloth; heavy lift-off with tape.
[5] Trace of ink removal.
[6] Slight to light lift-off.
[7] Trace ink removal on positive labels; medium removal at scribe on negative labels.
NP – Not performed.
(*) Additional testing; not required by JTP for JG-PP project.

Table F-15. 3-mil Scotchal Label with Gerber Printer Common Testing Results: Blank Labels (Average Adhesion in Pounds Force per Inch Width)

JTP Section Number and Test Name	Substrate							
	AL1	AL2	SS	NR	SR	G/E	C/E	A/E
Screening								
3.3.1 Adhesion	NP	NP	NP	NP	NP	NP	NP	NP
Common								
3.3.2 Chemical Resistance		NP	NP	NP	NP	NP	NP	NP
Isopropyl alcohol	2.5-4.0 [a]	NP	NP	NP	NP	NP	NP	NP
Deionized water	5.5-6.0	NP	NP	NP	NP	NP	NP	NP
Engine oil 21SAE20W	NP	NP	NP	NP	NP	NP	NP	NP
Terpene-based solvent	NP	NP	NP	NP	NP	NP	NP	NP
3.3.6 Salt Spray Resistance								
48-HOUR TEST	5.5-7.0	NP	NP	NR	NR	NR	NR	NR
168-Hour Test	7.0	NP	NP	NR	NR	NR	NR	NR
3.3.7 Temperature Exposure and Thermal Shock Resistance								
-48ºC (-55ºF)	4.0-10.5 [b]	NR	NR	NR	NR	NR	NR	NR
54°C (130°F), 30 MINUTES (*)	5.5-6.0	NR	NR	NR	NR	NR	NR	NR
71°C (160°F), 30 MINUTES (*)	6.0 [c]	NR	NR	NR	NR	NR	NR	NR
118ºC (244ºF)	6.0-6.5	NR	NR	NR	NR	NR	NR	NR
THERMAL SHOCK	6.5 [d]	NR	NR	NR	NR	NR	NR	NR
3.3.8 UV Light/Condensation	NP	NR	NR	NR	NR	NR	NR	NR

[a] All labels tested peeled and the corners rolled from the extended exposure to isopropyl alcohol.
[b] All labels tested experienced material failure (label ripped) instead of lift-off from coupon. The forces to remove all alternatives ranged from 4.0 to 10.5 lb_f.
[c] Positive label ripped.
[d] Negative label ripped.
NP – Not performed.
NR – Not required.
(*) Additional testing; not required by JTP for JG-PP project.

Table F-16. 3-mil Scotchal Label with Gerber Printer Extended Testing Results: Blank Labels (Average Adhesion in Pounds Force per Inch Width)

JTP Section Number and Test Name	Substrate							
	AL1	AL2	SS	NR	SR	G/E	C/E	A/E
Extended								
3.3.1 Adhesion (Program-specific parts)	NP	NR	NR	NR	NR	NR	NR	NR
3.3.2 Chemical Resistance								
Coolanol	NP	NP	NP	NP	NP	NP	NP	NP
PAO	NP	NP	NP	NP	NP	NP	NP	NP
Hydraulic oil (MIL-STD-17111)	5.0	NP	NP	NP	NP	NP	NP	NP
Lubricating oil (MIL-L-23699)	5.5-6.5	NP	NP	NP	NP	NP	NP	NP
Skydrol	NP	NP	NP	NP	NP	NP	NP	NP
JP5 (MIL-T-5624)	NP	NP	NP	NP	NP	NP	NP	NP
DS2	NP	NP	NP	NP	NP	NP	NP	NP
Aircraft cleaner (*)	5.0-5.5	NP	NP	NP	NP	NP	NP	NP
Dry cleaning solvent (*)	4.5-5.5	NP	NP	NP	NP	NP	NP	NP
JP8 (*)	2.0	NP	NP	NP	NP	NP	NP	NP
3.3.3 Corrosivity								
54°C (130ºF)	NP	NP	NP	NR	NR	NR	NR	NR
71°C (160ºF)	NP	NP	NP	NR	NR	NR	NR	NR
118°C (244ºF)	NP	NP	NP	NR	NR	NR	NR	NR
3.3.4 DC Electrical Resistance	NR	NR	NR	NR	NR	NP	NP	NP
3.3.5 IR Reflectance	NP	NP	NP	NP	NP	NP	NP	NP
3.3.7 Temperature Exposure and Thermal Shock Resistance (program-specific parts)	NP	NR	NR	NR	NR	NR	NR	NR

NP – Not performed.
NR – Not required.
(*) Additional testing; not required by JTP for JG-PP project.

Table F-17. 3-mil Scotchal Label with Gerber Printer Common Testing Results: Printed Labels

JTP Section Number and Test Name	Substrate
	AL1
Screening	
3.2.2 Adhesion	Pass[1]
3.2.6 Legibility	Pass
Common	
3.2.1 Abrasion (Scrub) Resistance	Pass
3.2.3 Chemical Resistance	
Isopropyl alcohol	Pass[2]
Deionized water	Pass[3]
Engine oil 21SAE20W	NP
Terpene-based solvent	NP
3.2.7 Salt Spray Resistance	
48-HOUR TEST	Pass
168-Hour Test	Pass
3.2.8 Temperature Exposure and Thermal Shock Resistance	
-48ºC (-55ºF)	Pass[4]
54ºC (130ºF), 30 MINUTES (*)	Pass[4]
71ºC (160ºF), 30 MINUTES (*)	Pass[4]
118ºC (244ºF)	Pass[4]
THERMAL SHOCK	Pass[4]
3.2.9 UV Light/Condensation	NP

[1] Trace of ink removal at scribe.
[2] Medium to heavy lift-off at scribe on negative labels.
[3] Heavy lift-off on negative labels.
[4] Only legibility was used to determine results.
NP – Not performed.
(*) Additional testing; not required by JTP for JG-PP project.

Table F-18. 3-mil Scotchal Label with Gerber Printer Extended Testing Results: Printed Labels

JTP Section Number and Test Name	Substrate
	AL1
Screening	
3.2.2 Adhesion	Pass
3.2.6 Legibility	Pass
Extended	
3.2.3 Chemical Resistance	
Coolanol	NP
PAO	NP
Hydraulic oil (MIL-STD-17111)	Pass
Lubricating oil (MIL-L-23699)	Pass[1,2]
Skydrol	NP
JP5 (MIL-T-5624)	NP
DS2	NP
Aircraft cleaner (*)	**Fail[3]**
Dry cleaning solvent (*)	Pass[2]
JP8 (*)	Pass[4]
3.2.4 Fungus Resistance	NP
3.2.5 IR Reflectance	NP

[1] Trace of ink removal at scribe on negative labels.
[2] Trace of ink removal at scribe.
[3] Print smeared on positive labels. Heavy lift-off on negative labels.
[4] Trace of ink removal on positive labels; medium lift-off at scribe on negative labels.
NP – Not performed.
(*) Additional testing; not required by JTP for JG-PP project.

Table F-19. 7-mil Scotchal Label with Gerber Printer Common Testing Results: Blank Labels (Average Adhesion in Pounds Force per Inch Width)

JTP Section Number and Test Name	Substrate							
	AL1	**AL2**	**SS**	**NR**	**SR**	**G/E**	**C/E**	**A/E**
Screening								
3.3.1 Adhesion	> 5.0	NP	NP	NP	NP	NP	NP	NP
Common								
3.3.2 Chemical Resistance		NP	NP	NP	NP	NP	NP	NP
Isopropyl alcohol	**Fail <1.5 - >2.0** [a,b]	NP	NP	NP	NP	NP	NP	NP
Deionized water	5.0-7.0 [c]	NP	NP	NP	NP	NP	NP	NP
Engine oil 21SAE20W	NP	NP	NP	NP	NP	NP	NP	NP
Terpene-based solvent	NP	NP	NP	NP	NP	NP	NP	NP
3.3.6 Salt Spray Resistance								
48-HOUR TEST	8.0-8.5	NP	NP	NR	NR	NR	NR	NR
168-Hour Test	5.0-8.5	NP	NP	NR	NR	NR	NR	NR
3.3.7 Temperature Exposure and Thermal Shock Resistance								
-48ºC (-55ºF)	4.0-10.0 [d]	NR	NR	NR	NR	NR	NR	NR
54°C (130°F), 30 MINUTES (*)	8.0-8.5	NR	NR	NR	NR	NR	NR	NR
71°C (160°F), 30 MINUTES (*)	8.5-9.0	NR	NR	NR	NR	NR	NR	NR
118ºC (244ºF)	11.0	NR	NR	NR	NR	NR	NR	NR
THERMAL SHOCK	3.5-10.0 [e]	NR	NR	NR	NR	NR	NR	NR
3.3.8 UV Light/Condensation	NP	NR	NR	NR	NR	NR	NR	NR

[a] All labels tested peeled and the corners rolled from the extended exposure to isopropyl alcohol.
[b] Positive labels failed at less than 1.5 lb. Two of the three negative labels required forces greater than 2.0 lb.
[c] Positive labels removed at 5 lb; negative labels removed at 6.0-7.0 lb.
[d] All labels tested experienced material failure (label ripped) instead of lift-off from coupon. The forces to remove all alternatives ranged from 4.0 to 10.5 lb_f.
[e] Negative label ripped.
NP – Not performed.
NR – Not required.
(*) Additional testing; not required by JTP for JG-PP project.

Table F-20. 7-mil Scotchal Label with Gerber Printer Extended Testing Results: Blank Labels (Average Adhesion in Pounds Force per Inch Width)

JTP Section Number and Test Name	Substrate							
	AL1	AL2	SS	NR	SR	G/E	C/E	A/E
Extended								
3.3.1 Adhesion (Program-specific parts)	NP	NR	NR	NR	NR	NR	NR	NR
3.3.2 Chemical Resistance								
Coolanol	NP	NP	NP	NP	NP	NP	NP	NP
PAO	NP	NP	NP	NP	NP	NP	NP	NP
Hydraulic oil (MIL-STD-17111)	6.5-7.0	NP	NP	NP	NP	NP	NP	NP
Lubricating oil (MIL-L-23699)	7.5-8.0	NP	NP	NP	NP	NP	NP	NP
Skydrol	NP	NP	NP	NP	NP	NP	NP	NP
JP5 (MIL-T-5624)	NP	NP	NP	NP	NP	NP	NP	NP
DS2	NP	NP	NP	NP	NP	NP	NP	NP
Aircraft cleaner (*)	7.0-8.0	NP	NP	NP	NP	NP	NP	NP
Dry cleaning solvent (*)	6.5-7.0	NP	NP	NP	NP	NP	NP	NP
JP8 (*)	3.0-3.5	NP	NP	NP	NP	NP	NP	NP
3.3.3 Corrosivity								
54°C (130ºF)	NP	NP	NP	NR	NR	NR	NR	NR
71°C (160ºF)	NP	NP	NP	NR	NR	NR	NR	NR
118°C (244ºF)	NP	NP	NP	NR	NR	NR	NR	NR
3.3.4 DC Electrical Resistance	NR	NR	NR	NR	NR	NP	NP	NP
3.3.5 IR Reflectance	NP	NP	NP	NP	NP	NP	NP	NP
3.3.7 Temperature Exposure and Thermal Shock Resistance (program-specific parts)	NP	NR	NR	NR	NR	NR	NR	NR

NP – Not performed.
NR – Not required.
(*) Additional testing; not required by JTP for JG-PP project.

Table F-21. 7-mil Scotchal Label with Gerber Printer Common Testing Results: Printed Labels

JTP Section Number and Test Name	Substrate
	AL1
Screening	
3.2.2 Adhesion	Pass[1]
3.2.6 Legibility	Pass
Common	
3.2.1 Abrasion (Scrub) Resistance	Pass[2]
3.2.3 Chemical Resistance	
Isopropyl alcohol	NP
DEIONIZED WATER	NP
Engine oil 21SAE20W	NP
Terpene-based solvent	NP
3.2.7 Salt Spray Resistance	
48-HOUR TEST	Pass
168-Hour Test	Pass
3.2.8 Temperature Exposure and Thermal Shock Resistance	
-48ºC (-55ºF)	Pass[3]
54ºC (130ºF), 30 MINUTES (*)	Pass[3]
71ºC (160ºF), 30 MINUTES (*)	Pass[3]
118ºC (244ºF)	Pass[3]
THERMAL SHOCK	Pass[3]
3.2.9 UV Light/Condensation	NP

[1] No trace to trace of ink removal at scribe.
[2] On positive label rubbing was evident, but print was legible. A slight effect was observed on the negative labels.
[3] Only legibility was used to determine results.
NP – Not performed.
(*) Additional testing; not required by JTP for JG-PP project.

Table F-22. 7-mil Scotchal Label with Gerber Printer Extended Testing Results: Printed Labels

JTP Section Number and Test Name	Substrate
	AL1
Screening	
3.2.2 Adhesion	Pass[1]
3.2.6 Legibility	Pass
Extended	
3.2.3 Chemical Resistance	
Coolanol	NP
PAO	NP
Hydraulic oil (MIL-STD-17111)	Pass[1]
Lubricating oil (MIL-L-23699)	Pass[1]
Skydrol	NP
JP5 (MIL-T-5624)	NP
DS2	NP
Aircraft cleaner (*)	Pass[2]
Dry cleaning solvent (*)	Pass
JP8 (*)	Pass
3.2.4 Fungus Resistance	NP
3.2.5 IR Reflectance	NP

[1] No trace to trace of ink removal at scribe.
[2] Trace ink removal at scribe.
NP – Not performed.
(*) Additional testing; not required by JTP for JG-PP project.

F.5 SUMMARY OF PPEP RESULTS

A summary of the results of testing each alternative is below:

- *3-mil Roland* - This label had a stronger adhesive than the others tested under this PPEP project. Forces of 5.5 to 9.0 pounds of force were required to remove the labels from most of the coupons. The adhesive was somewhat susceptible to JP8 and isopropyl alcohol; these labels required only 2.0 to 3.0 pounds of force to remove them from the coupon during adhesion tests. These values are within the failure criteria for the test but these two chemicals notably affected the adhesive.
- *3-mil Avery* - This label had a strong adhesive, with forces of 5.0 to 8.0 pounds of force required to remove the labels from most of the coupons during adhesion tests. The adhesive is somewhat susceptible to JP8, isopropyl alcohol, and thermal shock; most of these labels required only 2.0 to 4.0 pounds of force to remove them from the coupon. These values are within the failure criteria for the test. The chemicals affected the adhesive, while the strength of the label material was affected by the thermal shock. The label became brittle and broke at 3.0 pounds.
- *3-mil Rexcal* - The Rexcal vinyl labels had the lowest adhesive values. The measured values to remove the vinyl from the coupons ranged from 1.0 to 4.5 pounds. All four labels exposed to JP8 failed below 1.5 pounds, three of the four labels exposed to thermal shock failed at 1.0 pound, and one of the labels exposed to isopropyl alcohol failed at 1.5 pounds.
- *3-mil Scotchcal* - This label passed adhesion tests, with forces of 4.5 to 7.0 pounds of force required to remove the labels from most of the coupons. The adhesive is somewhat susceptible to JP8 and isopropyl alcohol; these labels required only 2.0 to 4.0 pounds of force to remove them from the coupon. These values are within the failure criteria for the test but these two chemicals notably affected the adhesive.
- *7-mil Scotchcal* - This label had a strong adhesive, with forces of 5.0 to 10.0 pounds of force required to remove the labels from most of the coupons during adhesion tests. The adhesive is susceptible to JP8, isopropyl alcohol, and thermal exposure; these labels required only 1.5 to 3.5 pounds of force to remove them from the coupon. Four of the six labels exposed to the isopropyl alcohol had values below the acceptance criteria. The adhesion of the labels exposed to JP8 ranged on forces from 3.0 to 3.5 pounds. Two labels exposed to thermal shock required only 3.5 and 4.0 pounds, three labels required 5.0 pounds, and the remaining ten labels required forces between 9.0 and 10.0 pounds.

In general, the 3-mil vinyl labels tested by the PPEP project were similar in performance. The 7-mil vinyl label provided better adhesion and ink retention than the 3-mil labels. The adhesives did vary; the Rexcal labels required lower forces consistently than the other labels. All adhesives were susceptible to exposure to isopropyl alcohol, causing many labels to curl up and fall off of the coupons.

During the PPEP project, it was determined that the Gerber printer provided better ink retention than the Roland printer. The ink was susceptible to the aircraft cleaner, which caused Gerber-printed 3-mil labels to smear when wiped with a dry cloth, while Roland-printed labels' ink was removed when wiped with a dry cloth. JP8 had a limited effect on the ink retention.