2D BARCODING

U S COAST GUARD

USCG FSCAP DPM Verification Program

MEMORANDUM OF UNDERSTANDING

FOR

COOPERATIVE ACTIVITIES SUPPORTING DIRECT PART MARKING INITIATIVES AS THEY RELATE TO HOMELAND SECURITY

ARTICLE I. AUTHORITY

This Memorandum of Understanding (MOU) is entered into by the United States Coast Guard, Aircraft Repair and Supply Center (hereinafter called Participant) and the National Aeronautics and Space Administration (NASA) Marshall Space Flight Center (MSFC). The legal authority for NASA to enter into this MOU is found in Section 203C of the Space Act of 1958. 42 U.S.C.§ 2473C (as amended).

ARTICLE II. PURPOSE

This Memorandum of Understanding (MOU) is entered into by the National Aeronautics and Space Administration, George C. Marshall Space Flight Center (NASA/MSFC) and the Participant for the purpose of collaborating and supporting the further development (Revision B and later) of NASA Standard 6002 and Handbook 6003 for Direct Part Marking (DPM). DPM is the process by which the identification of a part is applied directly to the surface of the part, eliminating the need for paper label and tag identifiers. The subject standard and handbook contain requirements, methods and instructions regarding the proper application of marks on parts. These requirements, methods and instructions are applicable to both forms of part identification, being human readable characters and machine-readable matrix symbols. In the latter case, a matrix symbol contains encoded data. This MOU formalizes the working relationship between MSFC and the Participant and is intended to facilitate collaborative effort during the review and development of the NASA Standard and Handbook revisions for Direct Part Marking. In particular the Participant will conduct pilot projects on actual United States Coast Guard hardware in conjunction with private industry and government. The Participant will make those test results available to NASA/MSFC for inclusion in revisions to the subject standard and handbook and work with NASA/MSFC to revise the subject documents to reflect the needs of Homeland Security.

ARTICLE III. RATIONALE

It is recognized that MSFC and the Participant have certain common interests with regard to Homeland Security in conducting review and development activities for the NASA Standard and Handbook for Direct Part Marking. **The benefits of DPM include operational cost savings, improved configuration management and greatly reduced data entry error rate**. Since DPM involves methods that have the potential to change the structural properties of critical parts, however, these review and development activities will be conducted with flight safety as the top priority. **This MOU will help ensure that direct part marking requirements and instructions are developed with the cooperation of both the system suppliers and the user community.** It is to the mutual benefit of NASA and the Participant that individual and collective experiences, material test data and other

2D BARCODING

Historical Review

- **In June 1996, Mr. Terry Boyce, Unapproved Parts Investigator for the United States Coast Guard; was asked by Special Agent Harry Schaefer (the National Coordinator for the investigation of unapproved aircraft parts) of the Department of Transportation, Office of the Inspector General; if the Coast Guard would be interested in participating in a pilot program concerning the barcoding of Flight Safety Critical Aircraft Parts (FSCAP).**

2D BARCODING

Historical Review (cont"d)

- **In July 1996, Captain Chris Snyder and Mr. Terry Boyce visited the Boeing North American facility who at that time was holding a demonstration on their project concerning 2D Symbology marking technology. The demonstration included marking different types of metals, plastics, paper, cloth, and even a bird feather. The demonstration consisted of forty (40) different types of marking techniques. At the conclusion of the demonstration Captain Snyder and Mr. Boyce agreed that this was the way of the future and an excellent aid in the current efforts to prevent acquisition of unapproved aircraft parts. Additionally, it would make tracking of FSCAP easier, faster, and more accurate for all maintenance and logistics personnel.**

2D BARCODING

Historical Review (cont"d)

On June 25, 1997, the US Coast Guard signed a contract with Boeing North America to conduct a pilot project for implementing a 2D Symbology based program within the Coast Guard System. This pilot project, "Phase I" included the identification and marking of a total of five hundred (500) AIRCRAFT PARTS with Tamper-resistance labels. It also included the integration of the Coast Guard's "AMMIS" computer software program for logistics with the project's software "Hardbody" system. The pilot program ended in June 1998. The final evaluation of the program was considered a complete success.

2D BARCODING

Historical Review (cont”d)

With the successful completion of Phase I and the realization of all of the positive aspects of 2D Symbology; it was determined that a permanent type of mark would be necessary to ensure that the mark would last the entire life cycle of the part.

2D BARCODING

Historical Review (cont'd)

On March 8th 2000, the US Coast Guard signed a Memorandum Of Understanding (MOU) with NASA and other participants (DOT OIG, FAA, NTSB, US Air Force, US Army, US Navy, DLA and thirteen private companies). The MOU was entered into by NASA / MSFC and all of the participants for the purpose of collaborating and supporting the development of the NASA Standard and Handbook for Direct Part Marking.

2D BARCODING

Historical Review (cont'd)

On July 30th 2002, members of the US Coast Guard ARSC Engineering Staff and the HH60 Production Cell met with the contractor and their sub-contractors to initiate Phase II of this project. Each step of this phase was discussed and agreed to by all members. After the close of the meeting the contractors began their work by photographing and identifying all of the subject parts, establishing the base line database for the project and initiating the study of the make up of each part.

2D BARCODING

Program Benefits

- **The permanent direct marking of the aircraft parts with the 2D Symbology would be a major key in the future of fighting the unapproved / bogus parts problem throughout the aviation community. This system would not only help to prevent the activities of the many unscrupulous vendors in the aviation parts world, but it will be a tremendous asset in the detection, prosecution, and conviction of the individuals who manufacture , repair, overhaul or sell unapproved aircraft parts within the aviation community. In order for us to keep one step ahead of these unsavory individuals, we have to look for ways to prevent bogus and unapproved parts from entering our inventories.**

2D BARCODING

Program Benefits

- **Tamper – resistance; prevents duplication.**
- **Will provide more solid evidence of criminal conduct thus ensuring a better chance of prosecution and conviction.**
- **Automatically capture and update historical data for any given part.**
- **Eliminate human error when capturing part identification.**
- **Has the ability to provide readable markings on very small parts, and internal engine and gearbox parts.**
- **Portable data readers (don't have to remove part from aircraft to review history)**
- **Accumulate part history in a central or national database. The FAA, DOT and the Aircraft Transportation Association (ATA) are addressing this issue.**

2D BARCODING

Additional Benefits Include:

- **Improve inventory / logistics management**
- **Improve ability to trace parts**
- **Improve flight and aviation maintenance**
- **Improve operations efficiency which in turn will reduce overall cost and improve scheduling**

2D BARCODING

Phase II

Phase II included the “permanent direct part marking “ of an additional five hundred (500) aircraft parts. The marking has been done by means of Laser Etching, Laser Bonding, Dot Peen or one of several other types of permanent direct marking methods. The final type of marking will be dictated by the part and whatever best suits its characteristic needs. NASA has agreed to perform all of the pre-marking engineering that is required. This will be accomplished at no cost to the US Coast Guard.

Phase II

PROCEDURES

With Congressional encouragement; the Coast Guard began Phase II. On December 6, 2002; the project consortium gathered at ARSC to begin marking parts for the HH60J type aircraft. Parts were drawn from RFI and Non-RFI stocks to initiate the project.

Phase II

PROCEDURES

The marking portion of the program was successfully completed on May 1, 2003. The team marked 336 parts representing 44 different safety critical parts configurations with 455 Data Matrix symbols. An additional 37 marks were applied to HC130-J tail number 2001 and 5 magneto-optic Read Through Paint markings were applied to 2 HH60-J's; tail numbers 6021 and 6022. The team also marked an additional aircraft frame HU-25 Falcon Jet to obtain high altitude and high speed analysis.

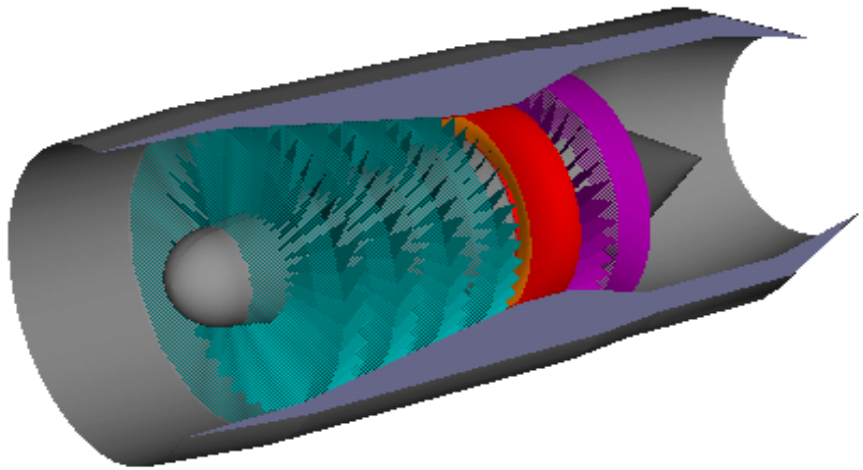
Aircraft Included In Flight Test Program

One or More HH-60 Jayhawk Helicopters

Aircraft selected were based at ARSC and/or Elizabeth City Air Station so that markings can be closely monitored for signs of degradation over time

Types of Parts that were Marked

- Airframe and structural components
- Gear boxes and rotor components
- Internal and external engine components



Phase II

PROCEDURES

On November 17 of 2003 Data Acquisition and interface studies began. The object of this phase is to ensure that the datamatrix software will not only gather the required data, but to also be able to call up the AMMIS and ACMS databases and update the US Coast Guard logistics systems.

Additionally, the applied marks were evaluated to determine how well the marks had survived under actual operating conditions. All marks read at a grade "A" condition which was the same grade as when the mark was originally applied.

MILESTONES

The program has been marked by a number of technical firsts. These included but are not limited to the following:

- **The first use of a fully integrated mobile marking cart in the field**
- **The first use of a hand held laser to mark products in the field**
- **The first use of the laser bonding process to mark FSCAPs.**
- **The first use of color additives in conjuction with deep electro-chemical etch and laser coating removal processes to improve marking contrast.**
- **The first read through paint markings applied to commercial products.**

Marking Processes

Approved marking processes (as-defined by NASA-STD-6002 & MIL-STD-130 - Draft)

- **Decals**
- **Dot Peen**
- **Electro-Chemical Coloring**
- **Micro-Milling**
- **Ink Jet**
- **Laser Coat & Discolor**
- **Laser Coat & Remove Process**
- **Stencil (ink and paint)**
- **Gas Assisted Laser Etch**
- **Deep Dot Peening (>.004-inch deep)**
- **Laser Bonding**
- **Laser Engineered Net Shaping (LENS)**
- **Laser Engraving**
- **Laser Inducted Surface Improvement (LISI)**

New Technology Applications

The Dataline team shall arrange for the demonstration of new AIT technologies.

- **Mobile Marking Carts**
- **Portable Vacuum Arc Vapor Deposition Marker**
- **Read-through-paint (RTP) Readers**
- **Strain Measurement System**

This slide depicts the form that has been developed specifically for this project. Not only does it establish all of the pertinent data for each part; but also shows an actual photo of the part and will also show the location of the datamatrix bar code.

Report Number: USCG FSCAP 032-01

USCG FSCAP DPM DATA SHEET

Part 1: Part Identification

FSC: 1615	NIIN: 012212613	Assy No.: 70103-08103-047	Assy. S/N: 00031
Nomenclature: PRESSURE PLATE ASSY			
Aircraft Type: HH60J		Aircraft Manufacturer: Sikorsky	

Part 2: Part Attributes

Material Family (supplied by USCG): Reactive & Refractory Metals		
Material Type (supplied by USCG): Ti Gr 6AL, 4V		
UNS Number: R56400	Hardness: 331 Brinell, 36R Rockwell	Thickness: ½-inch
Machinability:	Melting Temperature Range: 3000F	
Coatings (supplied by USCG):		
Surface Roughness (ANSI/ASME B46.1): 20	Microfinish Comparator Used: ANSI C-9	
Grey Scale Value: N/A	Color: Blue-Gray – Fed Std 16329	
Geometry: Flat	Available Marking Area: 2-inch x ¾-inch	
Corrosion Protection Method Used (supplied by USCG): None		

Photograph of Part

Photograph of Current Part ID Marking

Part 3: Marking

Current Marking Method(S): Ink marker & vibro-peen with clear coat applied to stripped area

Part 4: Operational Environments (supplied by USCG)

Abrasion:	Chemical Exposure: (Oil, Fuel & Hydraulic Fluid):	UV Exposure:	Salt (Spray, Splash & Emersion): Yes

G:/CiMatrix/Reports/Project Reports/USCG/Part Evaluation Sheet-Report-032

Page two provides for statistical data that will indicate the type of environment that the part resides in. It will also indicate the type of markings to be studied and the subsequent results and environmental effect upon the barcode.

USCG FSCAP EVALUATION RECORD CONTINUED

Part 5: Overhaul Environments (supplied by USCG)

Abrasive Blast:	Shot Peen:	Stripping:	Acid Dip:
Flame Spray:	Heat Treat:	Plating:	Painting:

Part 6: DPM Marking (ARSC):

Proposed DMx Marking Method/Technique (Primary): Strip, Dot Peen, Back fill, and clear coat	
Marking Standard (if no, complete Part 7): NASA-STD-6002 and NASA-HDBK-6003	
Marking Data Sheet Number: Marking Engineer:	Reading Data Sheet Number: Date Marked:

Proposed DMx Marking Method/Technique (Alternate 1): Strip, Micro-mill, Backfill, and clear coat	
Marking Standard (if no, complete Part 7): NASA-STD-6002 and NASA-HDBK-6003	
Marking Data Sheet Number:	Reading Data Sheet Number:
Marking Engineer:	Date Marked:

Proposed DMx Marking Method/Technique (Alternate 2):	
Marking Standard (if no, complete Part 7):	
Marking Data Sheet Number:	Reading Data Sheet Number:
Marking Engineer:	Date Marked:

Part 7: Marking Test Data

Material Testing Agency:

Tests Performed

Test	Date Performed	Report Number	Results
SEM Examination			
Metallurgical Examination			
Salt Fog			
Chemical Resistance			
Sliding Abrasion Impact Abrasion			
High Cycle Fatigue			
Date Test Data Review by Aircraft Mfg.:		Data Approved by:	
Date Test Data Reviewed by USCG:		Data Approved by:	

Part 8: Proposed DPM Process for Manufacturing:

Preferred:
Alternate:

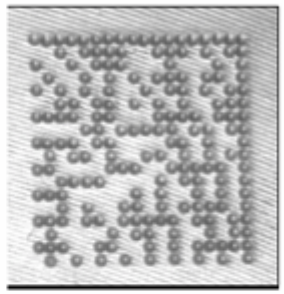
Page three will provide for subsequent photographs actually taken by the bar code reader / scanner. These photographs will provide visual access for the engineers enabling them to study the environmental effects without having to be at the physical location of the part in question and allowing the part to be studied without having to be removed from the aircraft.

Report Number: USCG FSCAP 032-01

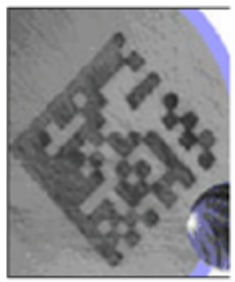
USCG FSCAP EVALUATION RECORD CONTINUED

Part 9: Initial Mark Quality Verification.

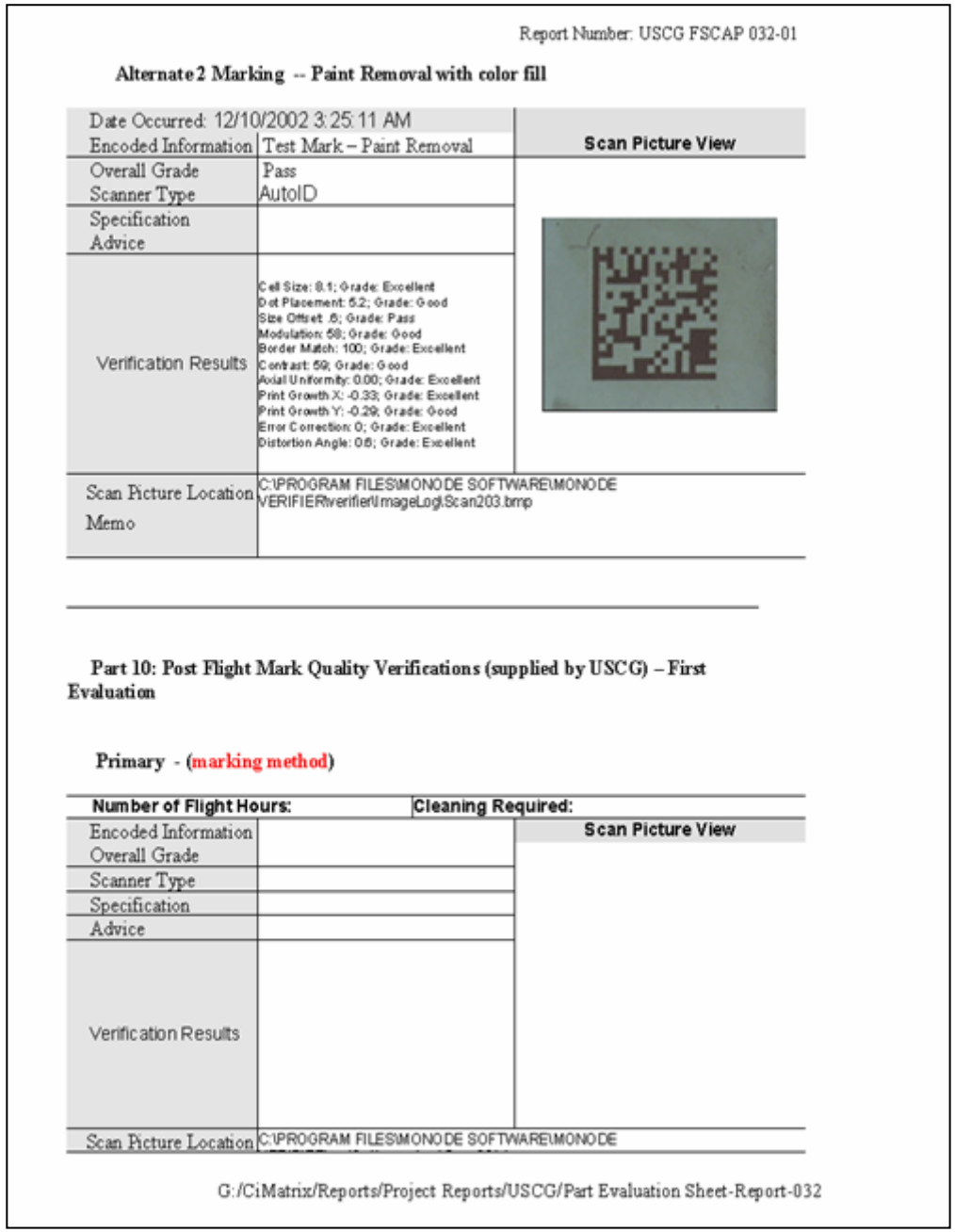
Primary Marking -- Dot Peen

Date Occurred: 12/10/2002 9:35:52 AM		
Encoded Information	Test Mark Dot Peen	**Scan Picture View**
Overall Grade	Pass	
Scanner Type	AutoID	
Specification		
Advice		
Verification Results	Cell Size: 9.1; Grade: Excellent Dot Placement: 5.2; Grade: Good Size Offset: 25.6; Grade: Fail Modulation: 58; Grade: Good Border Match: 100; Grade: Excellent Contrast: 59; Grade: Good Axial Uniformity: 0.00; Grade: Excellent Print Growth X: -0.33; Grade: Excellent Print Growth Y: -0.29; Grade: Good Error Correction: 0; Grade: Excellent Distortion Angle: 0.6; Grade: Excellent	
Scan Picture Location	C:\PROGRAM FILES\MONODE SOFTWARE\MONODE VERIFIER\verifier\ImageLog\Scan201.bmp	
Memo		

Alternate 1 Marking -- Electro Chem-etch

Date Occurred: 12/10/2002 10:39:02 AM		
Encoded Information	Test Mark Chem-etch	**Scan Picture View**
Overall Grade	Pass	
Scanner Type	AutoID	
Specification		
Advice		
Verification Results	Cell Size: 8.7; Grade: Good Dot Placement: 5.0; Grade: Good Size Offset: 24.3; Grade: Goo Modulation: 58; Grade: Good Border Match: 100; Grade: Excellent Contrast: 59; Grade: Good Axial Uniformity: 0.00; Grade: Excellent Print Growth X: -0.30; Grade: Excellent Print Growth Y: -0.19; Grade: Good Error Correction: 0; Grade: Excellent Distortion Angle: 0.6; Grade: Excellent	
Scan Picture Location	C:\PROGRAM FILES\MONODE SOFTWARE\MONODE VERIFIER\verifier\ImageLog\Scan202.bmp	
Memo		

Pages four through seven contain the continuous analytical and statistical data that will be gathered throughout the process of Phase II. This page will also contain exact photographs taken by the reader / scanner to maintain current status of the datamatrix bar code.



Report Number: USCG FSCAP 032-01

Alternate 2 Marking -- Paint Removal with color fill

Date Occurred: 12/10/2002 3:25:11 AM		
Encoded Information	Test Mark – Paint Removal	**Scan Picture View**
Overall Grade	Pass	
Scanner Type	AutoID	
Specification		
Advice		
Verification Results	Cell Size: 0.1; Grade: Excellent Dot Placement: 5.2; Grade: Good Size Offset .6; Grade: Pass Modulation: 58; Grade: Good Border Match: 100; Grade: Excellent Contrast: 59; Grade: Good Axial Uniformity: 0.00; Grade: Excellent Print Growth X: -0.33; Grade: Excellent Print Growth Y: -0.29; Grade: Good Error Correction: 0; Grade: Excellent Distortion Angle: 0.6; Grade: Excellent	
Scan Picture Location	C:\PROGRAM FILES\MONODE SOFTWARE\MONODE VERIFIER\verifier\ImageLog\Scan203.bmp	
Memo		

Part 10: Post Flight Mark Quality Verifications (supplied by USCG) – First Evaluation

Primary - (marking method)

Number of Flight Hours:	**Cleaning Required:**	
Encoded Information		**Scan Picture View**
Overall Grade		
Scanner Type		
Specification		
Advice		
Verification Results		
Scan Picture Location	C:\PROGRAM FILES\MONODE SOFTWARE\MONODE	

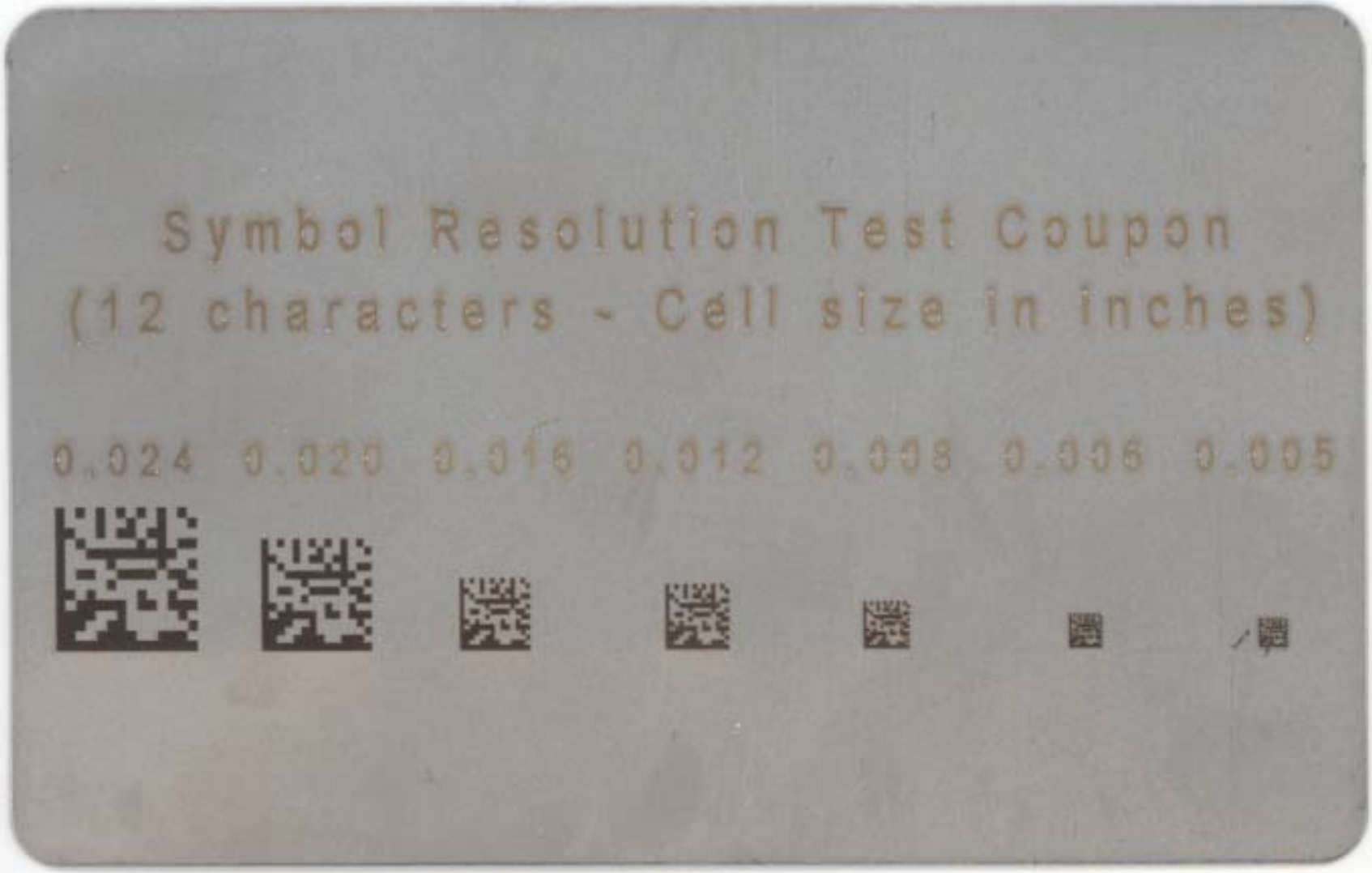
G:/CiMatrix/Reports/Project Reports/USCG/Part Evaluation Sheet-Report-032

Page eight will provide a complete evaluation of the process in reference to all of the environmental effects upon the datamatrix bar code and the type of markings that were applied. Since several types of markings will be used; there will also be a recommendation as to the best types of markings to be used for that particular part and its environment.
All of this information will be included in the final report.

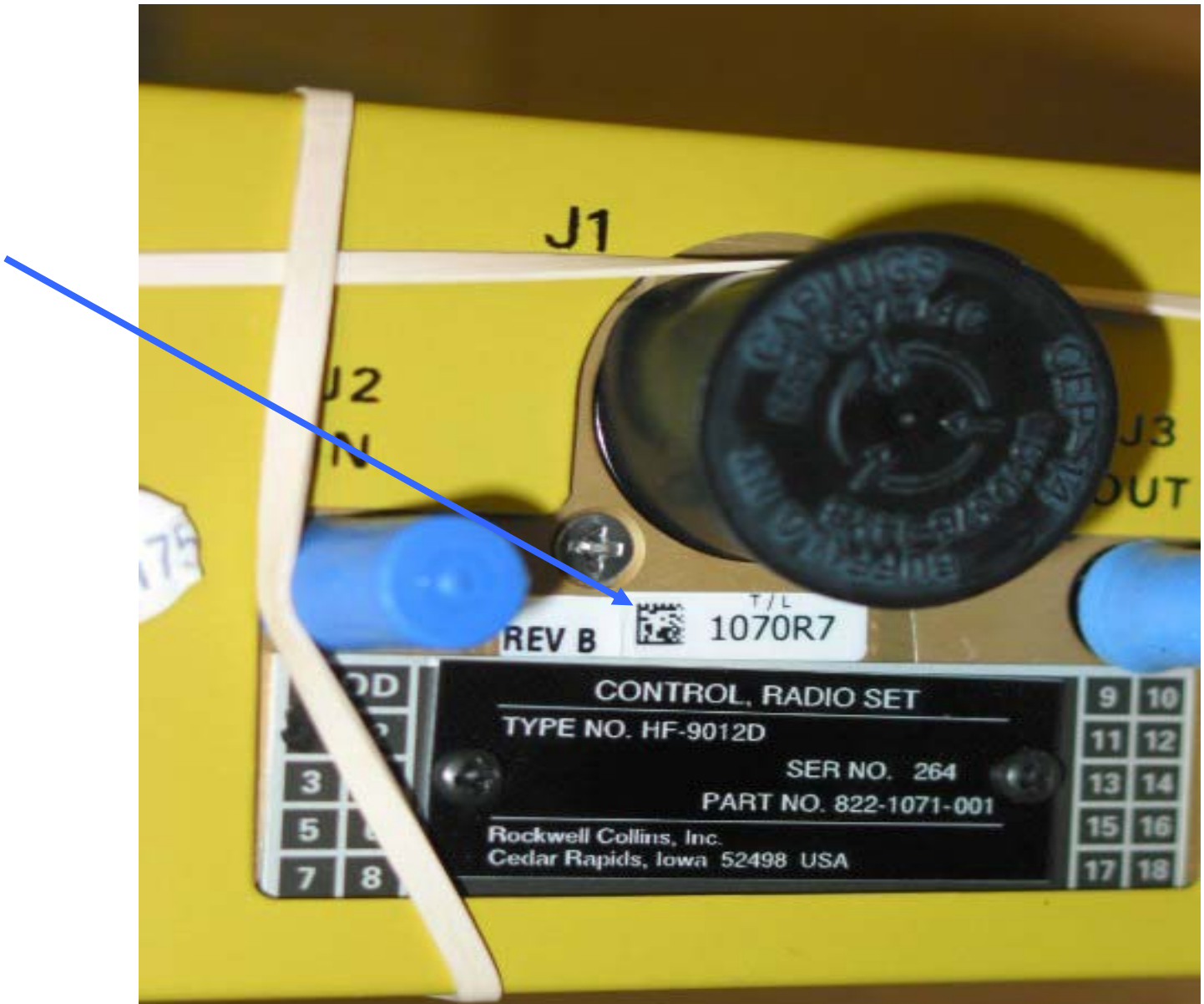
Laser Bonding after 24 hrs in paint stripper.

Laser Bonding that has been dipped, blasted and scraped and still remains readable.

Test Coupon No. 1



Radio Control Set with Datamatrix Label Bar-code recently implemented by Rockwell Collins



CONCLUSION

In conclusion, the US Coast Guard is aggressively pursuing new processes and procedures to help prevent bogus, counterfeit and unapproved parts from entering not only the Coast Guard inventory; but are including all of the aviation industry as well. As we continue our research and development to improve our systems; so will the process of accountability; maintenance and safety.

Contacts

Report suspect unapproved parts to:

Mr. Terry Boyce
Voice Tel: 252-335-6508
Fax: 252-334-5292
Pager: 1-877-713-6950
E-mail: tboyce@arsc.uscg.mil

Mr. Dan Beals
Voice Tel: 252-334-5418
Fax: 252-334-5292
E-mail: dbeals@arsc.uscg.mil