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MSFC TECHNICAL STANDARD

MSFC COUNTERFEIT ELECTRICAL, ELECTRONIC, AND ELECTROMECHANICAL PARTS AVOIDANCE, DETECTION, MITIGATION, AND DISPOSITION REQUIREMENTS FOR SPACE FLIGHT AND CRITICAL GROUND SUPPORT HARDWARE

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DOCUMENT HISTORY LOG

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FOREWORD

This counterfeit parts control standard establishes requirements, guidelines and practices to mitigate the risk of receiving and installing counterfeit electrical, electronic, and electromechanical (EEE) parts into Marshall Space Flight Center (MSFC) space flight or ground support hardware. This standard may be used to meet Requirement 59029 of NPD 8730.2, NASA Parts Policy.

This document also standardizes requirements related to parts and supplier management, EEE parts selection, specification, procurement, inspection, test and evaluation, and procedures to follow if suspect counterfeit EEE parts are identified. The requirements of this document will be flowed down to the MSFC suppliers of military, military off-the-shelf (MOTS) and commercial off-the-shelf (COTS) EEE piece parts.

Questions concerning the application of this requirements document can be forwarded to the Office of Primary Responsibility, the MSFC EEE Parts Engineering Organization.

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1.0 SCOPE

The scope is to establish a counterfeit parts control document for use by MSFC programs and projects as a method of meeting Requirement 59092 of NPD 8730.2. This document applies to flight hardware, critical ground support equipment (GSE), and critical ground test systems used in Category 1 and Category 2 projects as defined by NPR 7120.5D, NASA Space Flight Program and Project Management Requirements, and/or Class A, B, or C payloads as defined in Appendix A of NPR 8705.4, Risk Classification for NASA Payloads. This document outlines procedures to be employed for risk assessment actions to mitigate the entry of counterfeit EEE parts into the MSFC supply chain.

This document implements the requirements of MSFC-STD-3012 for suspect counterfeit parts based on the guidelines of SAE AS5553.

The document standardizes practices to:

a. Develop risk assessment plans for suspect or counterfeit EEE parts

b. Verify parts authenticity

c. Ensure adequate inspection and testing is performed based on total risk score assessment

d. Control parts identified as suspect counterfeit

e. Report suspect counterfeit findings to Government investigative authorities and potential users

2.0 APPLICABLE DOCUMENTS

The following documents and publications form a part of this counterfeit EEE parts avoidance, detection, mitigation and disposition requirements document to the extent specified herein. The applicable issue shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and the references cited herein, the text of this document shall take precedence.

2.1 SAE Publications

AS5553	Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition
AS9003	Inspection and Test Quality System
AS9100	Quality Management Systems – Requirements for Aviation, Space and Defense Organizations
AS9120	Quality Management Systems – Requirements for Aviation, Space and Defense Distributors

2.2 U.S. Government Publications

MIL-STD-202	Test Method for Electronic and Electrical Component Parts
MIL-STD-750	Test Methods for Semiconductor Devices
MIL-STD-883	Test Method Standard Microcircuits
MIL-STD-1580	Destructive Physical Analysis for Electronic, Electromagnetic, and Electromechanical Parts
MSFC-STD-3012	Electrical, Electronic, and Electromechanical (EEE) Parts Management and Control Requirements for MSFC Space Flight Hardware
NPD 8730.2	NASA Parts Policy
NPR 7120.5	NASA Space Flight Program and Project Management Requirements
NPR 8705.4	Risk Classification for NASA Payloads

2.3 Commercial Publications

IDEA-STD-1010	Acceptability of Electronic Components Distributed in the Open Market
GEIA-GEB1	Diminishing Manufacturing Sources and Material Shortages (DMSMS) Management Practices
JEDEC-JESD31	General Requirements for Distributors of Commercial and Military Semiconductor Devices

2.4 ISO Publications

ISO 9000	Quality Management Systems – Fundamentals and Vocabulary
ISO 9001	Quality Management Systems – Requirements

3.0 ACRONYMS AND DEFINITIONS

3.1 Acronyms

The acronyms used in this standard are defined as follows:

ACORD	Association for Cooperative Operations Research and Development
AS	Aerospace Standard
ASSIST	Articulation System Stimulating Interinstitutional Student Transfer

BGA	Ball Grid Array
C	Celsius
CGA	Column Grid Array
CM	Contract Manufacturer
CMOS	Complementary Metal Oxide Semiconductor
CoC	Certificate of Conformance
CoCT	Certificate of Conformance and Traceability
COTS	Commercial Off-the-Shelf
DMSMS	Diminishing Manufacturing Sources and Material Shortages
DPA	Destructive Physical Analysis
EDS	Energy Dispersive Spectroscopy
EEE	Electrical, Electronic, and Electromechanical
ERAI	Electronic Resellers Association International
ESD	Electrostatic Discharge
EVI	External Visual Inspection
FIB	Focused Ion Beam
FTIR	Fourier Transform Infrared Spectrometry
GEIA	Government Electronics and Information Technology Association
GIDEP	Government Industry Data Exchange Program
ID	Identification
IDEA	Independent Distributors of Electronics Association
IMC	Intermetallic Compound
IP	Intellectual Property
IPR	Intellectual Property Rights
ISO	International Organization for Standardization
JEDEC	Joint Electron Device Engineering Council
JIT	Just in Time

LDC	Lot Date Code
MOTS	Military Off-the-Shelf
OCM	Original Component Manufacturer
OEM	Original Equipment Manufacturers
OIG	Office of Inspector General
OMB	Office of Management and Budget
PIND	Particle Impact Noise Detection
QML	Qualified Manufacturing Line
QPL	Qualified Parts List
PPE	Personal Protective Equipment
RC	Component Risk
RF	Radio Frequency
RP	Product Risk
RS	Supplier Risk
RT	Total Risk
SAE	Society of Automotive Engineers
SEM	Scanning Electron Microscope
STD	Standard
STI	Shallow Trench Isolation
TL	Test Laboratory
XRF	X-ray Fluorescence

3.2 Definitions

Aftermarket Manufacturer

A manufacturer that meets one or more of the following criteria:

a. The manufacturer is authorized by the original component manufacturer (OCM) to produce and sell replacement parts, usually due to an OCM decision to discontinue production of a part. Parts supplied are produced from die that have been transferred from the OCM to the aftermarket manufacturer or produced by the aftermarket manufacturer using OCM tooling and intellectual property (IP).

b. The manufacturer produces parts using semiconductor die or wafers manufactured by and traceable to an OCM that have been properly stored until use and are subsequently assembled, tested, and qualified using processes that meet the OCM technical specifications without violating the OCMs intellectual property rights, patents, or copyrights.

c. The manufacturer produces parts through emulation, reverse-engineering, or redesign that match the OCMs specifications and satisfy customer needs without violating the OCMs intellectual property rights (IPR), patents, or copyrights.

In any case, the aftermarket manufacturer will label or otherwise identify its parts to ensure that the "as shipped" aftermarket manufactured part will not be mistaken for the part made by the OCM.

Broker

A non-franchised distributor. See definitions for "broker distributor" and "non-franchised distributor".

Broker Distributor

A type of non-franchised distributor that works in a "Just in Time" (JIT) environment. Customers contact the broker distributor with requirements identifying the part number, quantity, target price, and date required. The broker distributor searches the industry and locates parts that meet the target price and other customer requirements. A broker distributor is never considered a franchised distributor, regardless of how many franchised product lines it may have.

Buyer

The entity that is directly procuring electronic parts. This may be either. NASA, a NASA contractor, or a NASA subcontractor.

Certificate of Conformance (CoC)	A document provided by a supplier formally declaring that all buyer purchase order requirements have been met. The document may include information such as manufacturer, distributor, quantity, lot batch, lot date code, inspection date, etc., and is signed by a responsible party for the supplier.
Certificate of Conformance and Traceability (CoCT)	A certificate of conformance required by certain military specifications, which requires documented traceability from the Qualified Parts List/Qualified Manufacturing Line (QPL/QML) manufacturer through delivery to the Government if the material is not procured directly from the manufacturer.
Commercial Off-the-Shelf (COTS)	Parts, assembled boards, and assemblies purchased as standard manufactured product with no extra processing except as advertised by the manufacturer.
Counterfeit Part	A part whose material, performance, or characteristics are knowingly misrepresented by a supplier in the supply chain. Examples of counterfeit parts include, but are not limited to the following. a. Parts which do not contain the proper internal construction (die, manufacturer, wire bonding, etc.) consistent with the ordered part. b. Parts that have been used, refurbished, or reclaimed but are represented as new product. c. Parts that have different package style or surface plating/finish than the ordered parts. d. Parts that have not successfully completed the OCM's full production and test flow but are represented as completed product. e. Parts sold as upscreened parts, which have not successfully completed upscreening. f. Parts sold with modified labeling or markings intended to misrepresent the part's form, fit, function, or grade. Parts which have been refinished, upscreened, or uprated and have been identified as such, are not considered counterfeit.
Destructive Physical Analysis (DPA)	A series of inspections and tests performed on samples of a EEE part and resulting in damage to the samples. Usually the DPA is part of a failure analysis or quality conformance inspection.

Disposition	Decisions made by authorized representatives within an organization concerning future treatment of nonconforming material. Examples of dispositions are to scrap, use-as-is (normally accompanied by an approved variance/waiver), retest, rework, repair, or return-to-supplier.
Electrical, Electronic, and Electromechanical (EEE) Parts	EEE parts are designed to perform specific functions, and are not subject to disassembly without destruction or impairment of design use. Examples of electrical parts include resistors, capacitors, inductors, transformers, and connectors. Electronic parts include active devices, such as monolithic microcircuits, hybrid microcircuits, diodes, and transistors. Electromechanical parts are devices that have electrical inputs with mechanical outputs, or mechanical inputs with electrical outputs, or combinations of each. Examples of electromechanical parts are motors, synchros, servos, and some relays.
Electronic Resellers Association International (ERAI)	A privately held global information services organization that monitors, investigates, and reports issues that are affecting the global supply chain of electronics. ERAI is comprised of OCMs, original equipment manufacturers (OEMs), distributors (franchised and non-franchised), contract manufacturers (CMs), government agencies, industry associations. (www.erai.com)
Franchised Distributor	A distributor with which the OCM has a contractual agreement to buy, stock, re-package, sell and distribute its product lines. Franchised distributors normally offer the product for sale with full manufacturer flow-through warranty. Franchising contracts may include clauses that provide for the OCM's marketing and technical support inclusive of, but not limited to, failure analysis and corrective action, exclusivity of inventory, and competitive limiters.
Government-Industry Data Exchange Program (GIDEP)	A cooperative activity between government and industry participants seeking to reduce or eliminate expenditures of resources by sharing technical information essential during research, design, development, production and operational phases of the life cycle of systems, facilities and equipment. (www.gidep.org)
Lot	A group of parts received in a given shipment that are of the same part type and have the same manufacturer, part number, and lot date code.
Lot Date Code (LDC)	A marking, usually inscribed on a EEE part and required by the applicable specification, to identify parts which have been processed as a batch.

Independent Distributor	A type of non-franchised distributor that purchases new parts with the intention to sell and redistribute them back into the market. Purchased parts may be obtained from original equipment manufacturers or contract manufacturers (typically from excess inventories), or from other non-franchised distributors. Resale of the purchased parts, (redistribution) may be to OEMs, contract manufacturers, or other non-franchised distributors. Independent distributors do not have contractual agreements or obligations with OCMs. An independent distributor is never considered a franchised distributor, regardless of how many franchised product lines it may have.
Independent Distributors of Electronics Association (IDEA)	A nonprofit trade association representing franchised distributors that have formally committed to adhere to prescribed quality and ethical standards. The stated purpose of IDEA is to promote the franchised distribution industry through media advocacy; to improve the quality of products and services through a quality certification program, educational seminars and conferences; and to promote the study, development, and implementation of techniques and methods to improve the business of franchised distributors. (www.idofea.org)
Military Off-the-Shelf (MOTS)	An off-the-shelf product that is developed or customized by a commercial vendor to respond to specific military requirements. The source code and design of a military off-the-shelf product may have been changed from a commercially available version to address the military requirements. Because a MOTS product is adapted for a specific purpose, it can be purchased and used immediately. However, since MOTS specifications are controlled by external non-government sources, changes to the product will not be in government's control. For MOTS product that contains software, the source code may not be in the government's control.
Non-Franchised Distributor	A seller of EEE parts or EEE assemblies that may procure from the open market. Brokers or broker distributors, independent distributors, stocking distributors, or suppliers other than the OCM or their franchised distributor are considered non-franchised distributors, regardless of how many franchised product lines they may have.
Open Market	A market in which prices are determined by supply and demand, there are no barriers to entry, and trading is not restricted to a specific area.

Original Component Manufacturer (OCM)	An organization that designs and/or engineers a part and is pursuing or has obtained the intellectual property rights to that part. Notes: a. The part and/or its packaging are typically identified with the OCMs trademark. b. OCMs may contract out manufacturing and/or distribution of their product. c. Different OCMs may supply product for the same application or to a common specification.
Original Equipment Manufacturer (OEM)	A company that manufacturers products it has designed and manufactured (directly or by a third party) from purchased components and sells those products under the company's brand name.
Packaging (Component)	The manner in which EEE parts are prepared for shipment, storage, and use by assemblers. The determination of packaging types is determined by product sensitivities such as moisture, physical (lead pitch, co-planarity), electrostatic discharge (ESD), as well as the method (manually, or by use of automated equipment) to be used to place parts on the printed circuit board. There are four main types of packaging: bulk, trays, tubes, and tape and reel.
Refinished	Using post-manufacture plating methods (such as solder dipping) to alter the plating composition on EEE parts leads.
Refurbished	Parts that have been brightened, polished, or renovated in an effort to restore them to a "like new" condition. For example, refurbished parts may have had their leads realigned and re-tinned.
Seller	An entity that exchanges any type of good or service in return for payment.
Stocking Distributor	A type of non-franchised distributor that stocks large inventories typically purchased from original equipment manufacturers (OEMs) and contract manufacturers. The handling, chain of custody, and environmental conditions for parts procured from stocking distributors are generally better known than for product bought and supplied by broker distributors. A stocking distributor is never considered a franchised distributor.
Supplier	A blanket description of all sources of supply for a part (e.g., OCM, franchised distributor, independent distributor, broker distributor, stocking distributor, aftermarket manufacturer, or Government Supply Depot).

Supply Chain Traceability	Documented evidence of a part's supply chain history. This refers to documentation of all supply chain intermediaries and significant handling transactions, such as from OCM to distributor, or from excess inventory to broker to distributor.
Suspect Counterfeit Part	A part in which there is an indication by inspection, testing, or other information that it may not conform to legal and contractual requirements of the supplier and/or manufacturer.
Uprate	A process used to reduce the risk of using EEE parts outside of the manufacturer's specifications without any design modifications.
Upscreen	Tests performed to remove nonconforming parts, parts with random defects, or parts likely to experience infant mortality, from an otherwise acceptable lot and thus increase confidence in the reliability of the parts selected for use. Examples screening tests are particle impact noise detection (PIND) testing, radiographic inspection, temperature screening, radiation hardness assurance testing, and electrical burn-in.

4.0 GENERAL REQUIREMENTS

The implementation of these requirements will not be interpreted as relieving the supplier/seller from complying with all the contractual/purchase order requirements. In those cases where the additional inspection and test requirements of this document are performed, those activities shall be performed by a test laboratory approved by the relevant NASA MSFC Project Management.

4.1 In Process Investigation

MSFC and its contractors shall have a system in place to address the detection, verification, and control of suspect counterfeit parts. This system will determine whether a failure is attributable to a quality or manufacturing defect or to a suspect counterfeit part.

4.1.1 Risk Assessment and Mitigation Review Team

A Risk Assessment and Mitigation Review Team shall be formed prior to parts procurement. The team shall be composed of personnel with knowledge and background of sufficient experience to understand all the procedures, processes, and controls outlined in this document. As an example, personnel on the team should be from EEE Parts Engineering, Design Engineering, Project Quality, Purchasing, Failure Analysis, and Project Management. The purpose of this team is to develop a procurement risk assessment document based on Appendix A. From this risk assessment document, the team will determine what further action should be taken to make a disposition of the problem and what changes may be required to prevent future occurrences. If a suspect counterfeit part is detected, the Risk Assessment and Mitigation Review Team shall be notified and immediate action taken to identify lot date code, quarantine product, identify shipped field product, initiate investigative action, and observe material control

and reporting procedures. The team will address anomalous findings and technical issues brought up by either the part supplier or test laboratory performing the part authentication procedures. The team will engage other engineering disciplines whenever appropriate, based on the nature of the issue being addressed. The team may require further investigation and additional testing to address the anomalous findings. Anomalous findings identified during part testing should be resolved prior to delivery/acceptance of the parts.

4.2 Procuring parts from OCM and Franchised Distributors and Non Franchised Distributors

4.2.1 OCM and Franchised Distributors

OCMs and their franchised distributors shall be required to provide CoCs and acquisition traceability. Acquisition traceability consists of the name and location of all supply chain intermediaries from the part manufacturer to the direct source of the product. CoCs and acquisition traceability requirements shall be clearly stated in the procurement purchase order. If traceability is unknown or documentation is suspect, appropriate risk mitigation shall be used as described in Appendix A: Risk Assessment and Mitigation Procedure.

4.2.2 Non-Franchised Distributors

Procurement of parts from a non-franchised distributor shall require risk mitigation procedures described in Appendix A.

4.3 Material Control

A system of material control shall be established to control suspect counterfeit parts.

4.3.1 Inventory Control

Data from inventory in stores will be inspected and reviewed to ensure that all material has pedigree with an unbroken chain of custody to the OCM or their franchised distributors prior to use. The data shall include a signed CoC from the OCM or their franchised distributors and test and attributes data identifying the item with the lot date codes. In the absence of this documentation, the material shall be subjected to risk assessment, tests, and inspections identified in Appendix A and Appendix B.

4.3.2 Control of Suspect Counterfeit Parts

If a suspect counterfeit is identified, the following actions shall be taken.

a. Isolate the parts and place them in physical quarantine, pending disposition by appropriate authorities.

b. Determine part authenticity by further inspection and communications with the OCM or supply source.

c. Report suspect counterfeit parts in accordance with the requirements of Section 4.4 herein.

4.4 Reporting

All occurrences of suspect counterfeit parts shall be reported by a Risk Assessment and Mitigation Review Team to Project Management. Project Management or their designated representative shall provide timely notification to GIDEP, ERAI, and the Office of Inspector General (OIG).

4.5 Procurement Requirements

In order to minimize the risk of procuring counterfeit product, the buyer's procurement contract language shall include requirements that will ensure conforming, authentic material is provided. The seller's responsibilities shall be plainly stated and agreed upon, including the following:

a. The seller shall be capable of providing full traceability for the parts being purchased, including names and addresses of prior sources (if any) to the buyer. Both buyer and seller shall maintain records containing date and/or lot codes, and any serialization associated with the purchase order and invoice according to MSFC Requirements.

b. The seller shall be notified by the buyer of all tests and inspections that the seller will be required to perform to assure product authenticity, including development of accept/reject criteria and qualification of test/inspection personnel.

c. The seller shall be required by the buyer to comply with and/or be certified to, an appropriate quality standard (e.g., AS9100, AS9120, ISO 9001, and AS9003).

d. The seller shall be notified by the buyer that the seller may be liable for remedial costs associated with the selling of counterfeit product. Procurement contracts shall state that the buyer is not under obligation to return suspect or confirmed counterfeit product. The buyer may request proof of financial responsibility, such as a product liability/completed operations certificate of insurance (e.g., Association for Cooperative Operations Research and Development (ACORD) Certificate of Liability Insurance) issued from the seller's insurance agent or broker. Limits of at least $1,000,000 per occurrence and $1,000,000 annual aggregate are common. The buyer may also request similar evidence of professional liability and/or product recall insurance with similar limits from the seller.

e. The seller shall be informed by the buyer of the specific time period for which their responsibility applies. Terms and conditions between the buyer and seller shall allow for a reasonable time period for the buyer to detect, quarantine, and confirm counterfeit or substandard product. The buyer should perform a level of inspection or test sufficient to detect gross or common indications of counterfeiting before the time expires.

f. The seller shall be provided with clear and specific instructions concerning deliverable documentation from the buyer. Documentation requirements, including certificates of conformance and test/inspection data, should be included in the contract terms and conditions.

g. The seller shall be notified by the buyer of potential Federal penalties associated with fraud and falsification.

4.6 Obsolescence Management

The obsolescence management plan will be in accordance with the plan outlined in MSFC-STD-3012.

APPENDIX A

Risk Assessment and Mitigation Procedure

Appendix A

Risk Assessment and Mitigation Procedure

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APPENDIX A

Risk Assessment and Mitigation Procedure

A.1.0. PURPOSE

The purpose of this appendix is to establish a suspect counterfeit parts risk assessment and mitigation procedure to prevent counterfeit or suspect counterfeit EEE parts from entering NASA's supply chain. This procedure will address paperwork traceability and establish the appropriate tests that apply to EEE parts. The tests are provided in Appendix B: Part Authentication Procedures.

This Appendix shall apply only when:

a. Parts are purchased from a non-franchised distributor.

b. Parts in inventory are not traceable to an OCM.

c. Parts being procured are not traceable to an OCM.

A.1.1 Procurement Risk Assessment

If parts are purchased from a non-franchised distributor or supplier, or if the parts are available from inventory but traceability or handling is an issue, the procurement risk assessment flow shown in Figure A.1 shall be completed by a Risk Assessment and Mitigation Team. The team will develop a procurement risk assessment document based on the results of the flow. The purpose of this risk assessment document is to ensure that all parties involved in the parts procurement process understand the risks and accepts responsibility for taking the prescribed course of action. This document shall be signed by all team members.

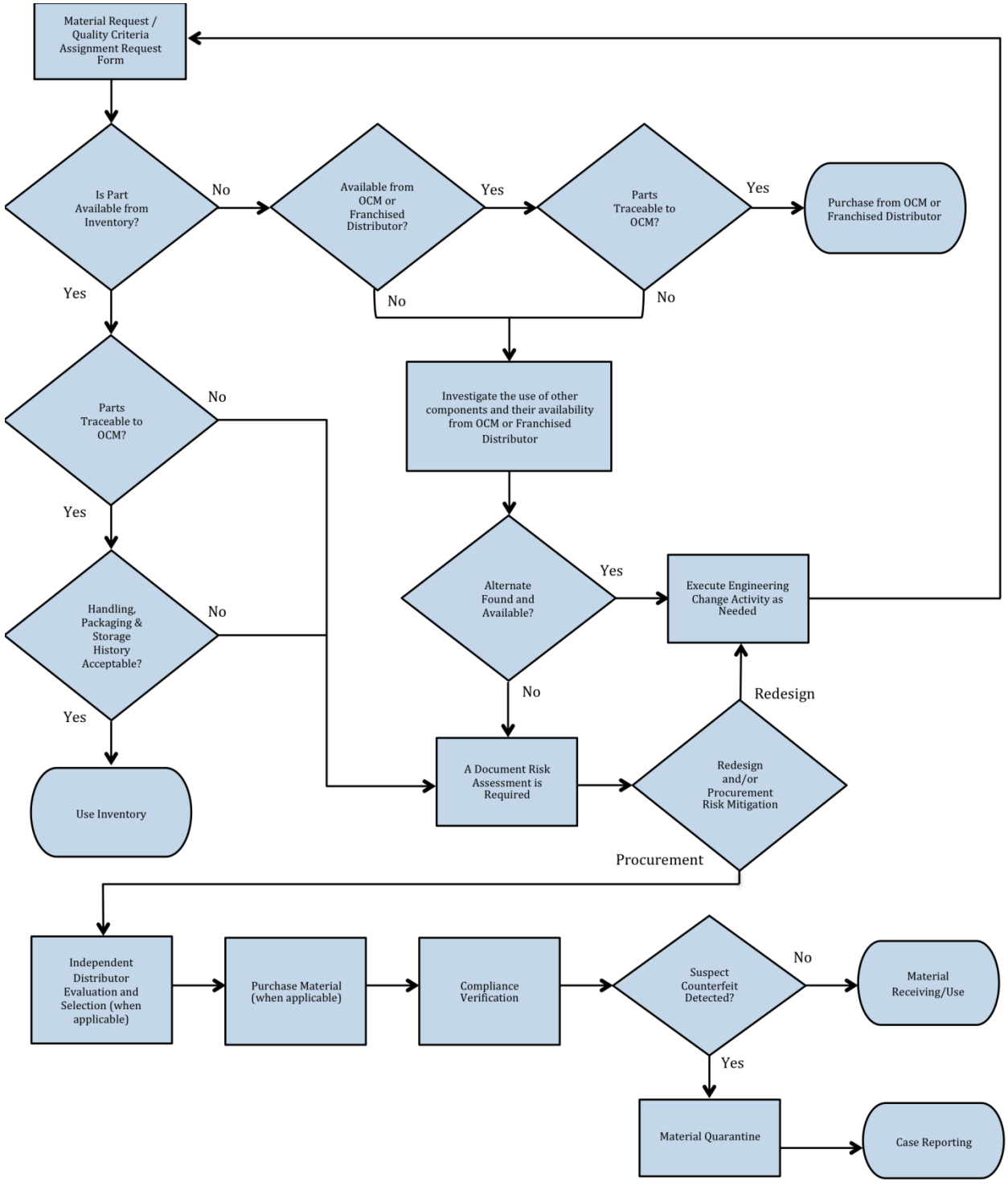

FIGURE A.1 Procurement Risk Assessment Flow

A.1.2 Risk Factors

To determine an appropriate test flow as part of a counterfeit parts risk mitigation strategy, a total risk assessment shall be used. As part of this assessment, a total risk (R_T) score will be calculated using the following parameters: product risk (R_P), component risk (R_C), and supplier risk (R_S). The total risk score is a product of these risk factors and takes the form:

$$\mathbf{R_T = R_P * R_C * R_S}$$

where R_C cannot exceed R_P.

The risk factors are defined in Tables I through III. It shall be the responsibility of the Project appointed Risk Assessment and Mitigation Team to determine the values of R_C, R_P, and R_S. These factors shall be included in the risk assessment document.

Once a total risk score is calculated, a criticality is defined using the following conditions:

CRITICAL	HIGH	MODERATE	LOW
$R_T \geq 200$	$130 \leq R_T < 200$	$75 \leq R_T < 130$	$R_T < 75$

Based upon the criticality level, the appropriate test flow is defined for active devices in Table A.IV and for passive devices in Table A.V.

TABLE A.I. Product (System) Risk – R_P

Product Risk – R_P 1/		
Category	**Definition**	**Score**
Catastrophic	A failure of the product may cause death or a major system loss.	7
Critical	A failure of the product may cause severe injury, major property damage, or major system damage which will result in loss of the product's function.	5
Marginal	A failure of the product may cause minor injury, minor property damage, or minor system damage which will result in delay or loss of availability or degraded operation.	3
Minor	A failure of the product is not serious enough to cause injury, property damage, or system damage, but which will result in unscheduled maintenance or repair.	2

1/ Defines the risk of the product in which the part will be used.

TABLE A.II. Component (Part) Risk – R_C

Component Risk - R_C 1/		
Category	**Definition**	**Score**
Catastrophic	A failure of the component may result in death.	7
Critical	A failure of the component may cause severe injury, major property damage, and/or loss of the product's function.	5
Marginal	A failure of the component may cause minor injury, minor property damage, or minor product damage which will result in delay or loss of availability or degraded operation.	3
Minor	A failure of the component is not serious enough to cause injury, property damage, or system damage but will result in unscheduled maintenance or repair.	2

1/ Defines the risk level of the component's function within the product it is used.

TABLE A.III. Supplier Risk – R_S

Supplier Risk – R_S 1/, 2/		
Category	**Definition**	**Score**
High	No or minimal previous experience using this non-franchised distributor, or the non-franchised distributor has been used by purchasing, or the non-franchised distributor is not AS9120 certified. The following additional criteria will also be met: a. No suspect counterfeit part corrective actions within the last 12 months, or b. No GIDEP or ERAI alerts within the last 24 months, or c. No quality notices related to suspect counterfeit parts (see note). These conditions are independent of whether the non-franchised distributor has been directly audited by NASA.	14
Moderate/High	The non-franchised distributor has been used successfully in the last 24 months by purchasing. The following additional criteria will also be met: a. They are AS9120 certified. b. No counterfeit-part-related corrective actions within the last 24 months. c. No GIDEP/ERAI alerts issued in the last 24 months. d. No quality notices related to suspect counterfeit parts (see note).	10
Moderate/Low	The non-franchised distributor has been used successfully in the last 12 months by purchasing and the non-franchised distributor is AS9120 certified. The following criteria will also be met: a. No part-corrective actions within the last 12 months. b. No GIDEP/ERAI alerts issued in the last 24 months. c. No quality notices related to suspect counterfeit parts (see note).	6
Low	The non-franchised distributor has been used successfully in the last 6 months by purchasing and the non-franchised distributor has been audited by NASA within the last year. The following additional criteria will also be met: a. No part-corrective actions within the last 24 months. b. No GIDEP/ERAI alerts issued in the last 24 months. c. No quality notices related to suspect counterfeit parts (see note).	4

1/ Define the risk level for the supplier based on past experience
2/ This includes no defects in the Procurement Tracking Data System.

TABLE A.IV. Active Devices Risk Mitigation Flow

Steps	Mechanical/Environmental/Electrical Inspections/Tests	Critical Risk	High Risk	Moderate Risk	Low Risk
1	Lot Data Review and Verification	Y	Y	Y	Y
2	External Visual Inspection	Y	Y	Y	Y
3	Remarking test (resistance to solvents)	Y	Y	Y	Y
4	Radiography	Y	Y	Y	Y
5	Lead Finish Evaluation	Y	Y	Y	Y
6	Resurfacing test (acetone, 1-Methyl 2-Pyrrolidinone, Dynasolve 750)	Y	Y	Y	Y
7	Resurfacing (Mechanical tests)	1/	1/	1/	1/
8	Temperature Cycling Seal Test	Y	-	-	-
9	Key Parametric Electrical Tests at 25ºC (read and record)	Y	Y	Y	Y
10	Pre-Electricals at 25ºC (read and record) Burn-In Post-Electricals with Delta Limits	Y	Y	-	-
11	Key Parametric Electrical Tests at Temperature (min and max operating temperature) (read and record)	Y	Y	Y	-
12	Destructive Physical Analysis	Y	Y	Y	-
13	Additional Tests	2/	2/	2/	2/

Key: Y- Yes the test is performed, green means low chance of sample damage, yellow means possible chance of sample damage, red means sample is damaged

1/ This test is only necessary if the chemical test methods failed or if deemed necessary

2/ The Risk Assessment and Mitigation Team will review the need for additional tests based upon risk, samples per lot, and findings from tests listed herein.

TABLE A.V. Passive Devices Risk Mitigation Flow

Steps	Mechanical/Environmental/Electrical Inspections/Tests	Critical Risk	High Risk	Moderate Risk	Low Risk
1	Data Review and Verification	Y	Y	Y	Y
2	External Visual Inspection	Y	Y	Y	Y
3	Remarking test (resistance to solvents)	Y	Y	Y	Y
4	Radiography	Y	Y	Y	Y
5	Lead Finish Evaluation	Y	Y	Y	Y
6	Resurfacing test (acetone, 1-Methyl 2-Pyrrolidinone, Dynasolve 750)	Y	Y	Y	Y
7	Resurfacing (Mechanical tests)	1/	1/	1/	1/
8	Temperature Cycling Seal Test	Y	-	-	-
9	Key Parametric Electrical Tests at 25ºC (read and record)	Y	Y	Y	Y
10	Full Functional over Temp	Y	Y	-	-
11	Pre-Electricals at 25ºC (read and record) Life Test Post-Electricals with Delta Limits	Y	-	-	-
12	Key Parametric Electrical Tests at Temperature (min and max operating temperature) (read and record)	Y	Y	Y	-
13	Destructive Physical Analysis	Y	Y	Y	-
14	Additional Tests	2/	2/	2/	2/

Key: Y- Yes the test is performed, green means low chance of sample damage, yellow means possible chance of sample damage, red means sample is damaged

1/ This test is only necessary if the chemical test methods failed or if deemed necessary

2/ The Risk Assessment and Mitigation Team will review the need for additional tests based upon risk, samples per lot, and findings from tests listed herein.

APPENDIX B

Part Inspection and Testing Requirements

Appendix B

Part Inspection and Testing Requirements

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APPENDIX B

Part Inspection and Testing Requirements

B.1.0 PURPOSE

The purpose of this appendix is to establish inspection and testing requirements to prevent suspect counterfeit EEE parts from entering the MSFC supply chain when procured from a non-franchised distributor. This fulfills the compliance verification block shown in the procurement risk assessment flow of Appendix A, Figure A.1. Inspection and testing procedures are defined for both active and passive EEE parts. Examples of active devices include but are not limited to monolithic microcircuits, hybrid microcircuits, semiconductor devices, solid state relays, and crystal oscillators. Examples of passive devices include but are not limited to capacitors, circuit breakers, crystals, passive filters, fuses, inductors/coils, passive networks, relays, resistors, thermistors, transformers, and connectors.

B.2.0 REQUIREMENTS

B.2.1 Inspection and Testing Procedure

The inspection and testing procedure used on a single lot of EEE parts for making a suspect counterfeit parts determination shall be documented. The level and extent of inspection and testing is governed by the risk score as derived from Appendix A, Section A.1.2. Step-by-step procedures are shown in Appendix A Table A.IV for Active Devices and Table A.V for Passive Devices. A typical flow for a *critical risk* mitigation process is shown in Figure B.1.

The procedure is intended to be flexible. For example, if the x-ray fluorescence (XRF) inspection for lead finish is more favorable to use over the EVI, then the XRF inspection procedure can come first with the EVI as a follow-up procedure. However, the importance of following the flow sequence is due to the increased probability of finding a counterfeit part with the least cost to the program, starting with the EVI where either the part marking has been altered, the leads have been refinished, or poor handling of the parts is detected. In some cases, the Program/Project may require a higher rigor of inspection and testing than is derived from the tables given in Appendix A. In these cases, a Risk Assessment and Mitigation Team shall specify the additional requirements and flow down the requirements to the appropriate Program/Project office.

The Risk Assessment and Mitigation Team shall be notified if any of the tests performed shows anomalies that differ from the population to determine if the sampling size for the methods performed will be increased or additional testing or screening will be required. In the event any anomaly is found that is determined not to be suspect counterfeit, then the Risk Assessment and Mitigation Team will be notified and the Team shall disposition the lot.

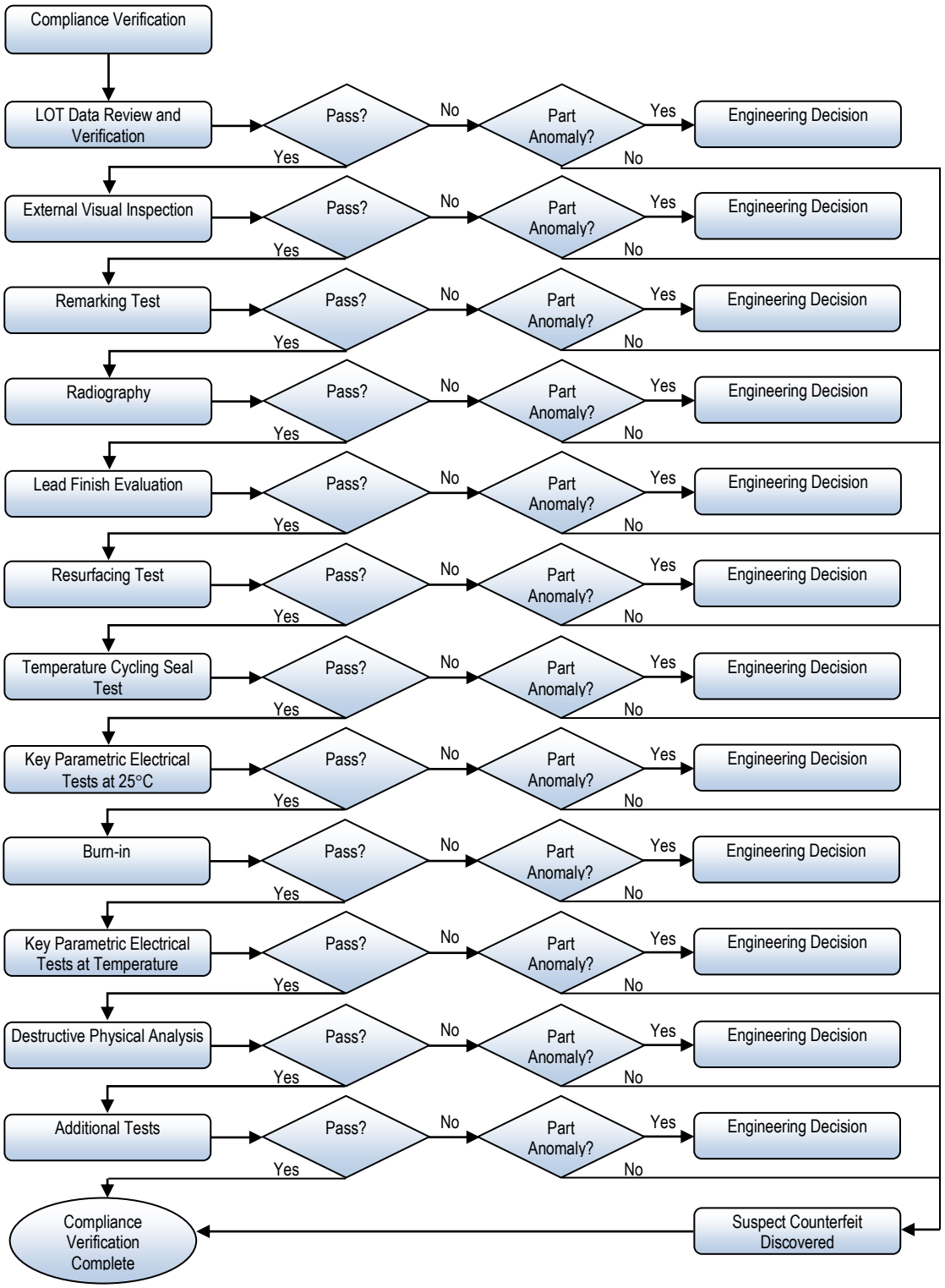

Figure B.1. A typical critical risk mitigation process flow for an active device. This flow will simplify based on the criticality risk factor determined from Appendix A.

B.2.1.1 Personnel Training and Certification

All personnel performing an inspection or test procedure shall be trained in, and familiar with, that part of the operation relevant to their function. Personnel, including incoming inspection and quality control, shall be trained regarding the avoidance and detection of counterfeit parts. For example, Counterfeit Parts Avoidance training is available from The Defense Acquisition University (http://www.dau.mil.), course CLL032 and from JPL. Personnel conducting tests and examinations at the testing facility shall be trained in the use of specialized equipment. Personnel coming in direct contact with ESD sensitive parts shall be trained and certified for handling of ESD sensitive parts.

When the additional inspection and test requirements of this document are performed, those activities shall be performed by a test laboratory approved by the Risk Assessment and Mitigation Review Team.

B.2.2 Lot and Lot Sampling Plan Requirements

B.2.2.1 Lot Requirements

A EEE parts lot is defined as the total number of devices that are received in a given shipment and have the same manufacturer, part number and lot date code (LDC). A future shipment of devices of the same LDC shall be considered a new lot. A lot shall consist of a minimum of 10 and a maximum of 1000 EEE parts. A lot shall contain enough parts to meet the sampling plan described in Section B.2.2.2 below and to provide the project with the proper number of test and flight parts. A lot containing more than 1000 parts shall be divided into sublots having equal number of devices, totaling less than 1000 devices per sublot. Each sublot shall be treated as a unique lot for testing and inspection.

Generally, a procurement lot is a lot consisting of parts having the same LDC; however, for procurement lots with mixed LDCs, the devices shall be separated into separate sublots. The sublots shall meet the lot size requirements stated above.

B.2.2.2 Lot Sampling Plan Requirements

Each lot shall be tested in accordance with the sampling plan given in Table B.I. Samples shall be selected at random from the lot. The same samples can be used for multiple test steps as indicated in the table. For example, the samples used for remarking can be used for destructive physical analysis.

TABLE B.I. Lot Sampling Plan

Inspection or Test	Paragraph	Sample Size 1/	
		10 ≤ Lot ≤ 125	125 < Lot ≤ 1000
Lot Data Review and Verification	B.2.3	Each lot	Each lot
External Visual Inspection	B.2.4	100%	100%
Remarking test	B.2.5	5% or 2 minimum up to 5	2% or 5 minimum up to 20
Radiographic Inspection	B.2.6	100%	100%
XRF/Lead Finish	B.2.7	100% up to 45 maximum	45
Resurfacing test (Chemical or mechanical)	B.2.8	2/	2/
Temperature Cycling Seal Test	B.2.9.1 B.2.9.2	100% up to 45 maximum 3/	45 3/
Key Parametric Electrical Tests at 25ºC with recording	B.2.10	100% 3/, 4/	125 3/, 4/
Pre-Electricals at 25ºC (read and record) Burn-In Post-Electricals at 25ºC (read and record)	B.2.10.1	100% up to 45 maximum 3/, 5/	45 3/, 5/
Key Parametric Electrical Tests at Temperature (min and max operating temperature)	B.2.10	100% up to 45 maximum 3/, 6/	45 3/, 6/
Destructive Physical Analysis	B.2.11	2/	2/
Additional Testing	B.2.12	7/	7/

1/ If the sample size is less than 100% of the lot, samples shall be randomly selected. If the parts are received in tape and reel, select parts randomly throughout the entire tape and reel.
2/ Remarking test samples may be used. Samples used for the remarking test and resurfacing test shall not be used for production hardware.
3/ Samples used for remarking test, resurfacing test, or DPA shall not be used.
4/ Samples that pass Temperature cycling/Seal Test may be used.
5/ Samples that pass Key Electrical Tests at 25ºC may be used. Pre-Electrical Tests do not need to be repeated.
6/ Samples that pass Post-Electrical Testing at 25ºC may be used.
7/ Risk Assessment and Mitigation Team will determine if additional tests are necessary and sample size for each additional test performed.

B.2.3 Data Review and Verification

The data package that arrives with the parts, their associated package types, and shipping containers shall be reviewed and verified prior to conducting tests. This activity must be conducted to catch suspect counterfeit parts before costly testing begins. The following will be verified for part authentication:

a. Parts are received in a single shipment.

b. Parts and shipping materials are marked or otherwise identified with identical lot, batch, run, and identification information (e.g., dates codes, lot codes, and serial numbers). If multiple date codes are observed, follow the criteria defined in Section B.2.2.1 for handling of multiple date codes.

c. Parts and shipping materials appear to have been subjected to the same handling, packaging, and/or storage conditions.

d. Parts have maintained their physical placement relative to each other (i.e., have never been separated based on evidence such as source, packaging, labeling.

B.2.4 External Visual Inspection (EVI)

External visual inspection shall be conducted. Independent Distributors of Electronics Association (IDEA) specification IDEA-STD-1010 can be used as a guideline to understand external visual inspection techniques. Findings from EVI, including photographs of anomalies, shall be reported. When examining electrical connectors, the test lab shall ensure connector pairs are mateable and that the mating and demating forces are within specified limits.

B.2.4.1 Inspection Criteria

All devices in a lot shall undergo the inspection process defined below. Adequate lighting and a typical magnification range of 3X – 100X shall be used to distinguish points of interest. Whenever possible, compare the sample(s) being inspected to a part received from the OCM or OCM approved franchised distributor. When this is not possible, the parts should be compared to others within the lot for evidence of inconsistencies.

1. Part Specifications
   a. Package type
   b. Dimensions
   c. Pin number
   d. Pin 1 position
   e. Device orientation and consistency if tape and reel
2. Part Markings
   a. Visible evidence of previous markings
   b. Marking style consistency (front and back) of sample set having same LDC
   c. Same country of origin designation of sample set having same LDC
3. Package Surface
   a. Significant package variation from part to part having same LDC
   b. Color uniformity throughout sample set having same LDC
   c. Color discrepancies between the top and bottom of same part
   d. Surface Contamination (i.e. glue/adhesives, corrosion, solder, paint)
   e. Visible damage (i.e. cracks, burn marks, tooling marks, unidirectional abrasions)
   f. Uneven package thickness

g. Consistency of dimple pattern depth
h. Corner Radius differences between top and bottom surfaces

4. Leaded Parts
   a. Non-uniform color
   b. Tooling marks
   c. Evidence of straightening or retinning of leads
   d. Exposed copper on lead ends
   e. Bent or non planar leads
   f. Excessive or uneven plating
   g. Gross oxidation, discoloration, dirt, or residue on surface
   h. Scratches or insertion marks on the inside and outside of lead faces
   i. Excessive solder

5. Column Grid Array/Ball Grid Array (CGA/BGA) Parts
   a. Discoloration, dirt, debris, or residue on or between solder spheres/columns
   b. Crushed/flattened solder spheres or misaligned/damaged columns
   c. Non-uniform size and shape of solder spheres or columns
   e. Solder mask damage or scratches in mask underneath solder sphere or column
   f. Excessive Intermetallic Compound (IMC) thickness
   h. Constituents present in the IMC that are not consistent with the plating method used
   i. Solder dross on the solder mask
   j. Evidence of solder mask touchup or repair

B.2.5 Test for Remarking

This first test focuses on the part marking and is a resistance- to- solvents test. To perform this test, mix a solution of three parts mineral spirits with one part ethyl alcohol. Dip a cotton swab into the solution, and wipe the swab across the markings on the part. The markings should not smear or be removed by the solution.

B.2.6 Radiographic Inspection

Radiographic inspection is considered non-destructive if the radiation exposure to the parts does not exceed the manufacturer's specification. Acceptable radiation levels should be validated in the manufacturer's specification prior to performing radiographic inspection. If this data cannot be provided, the test lab shall provide tube voltage, current, and exposure times as part of the test report. Parts that are exposed to radiation levels that do exceed the manufacturer's specification may be used for subsequent destructive tests. Parts should be inspected for homogeneity, consistency, and uniformity. Comparison of die size, general shape, lead frame construction, wire bond gauge, and routing shall be performed. Normally there is some variation across different LDCs, but not in parts with the same LDC. Radiographic film (or real time images) should be inspected using the appropriate military standard requirements: MIL-STD-883 for microcircuits and hybrids, MIL-STD-750 for semiconductors, and MIL-STD-202 for electrical and electronic parts not covered by the previous specifications.

Radiographic films or digital images shall be retained and provided with the lot.

B.2.7 Lead Finish Evaluation

A lead finish evaluation shall be performed using XRF or scanning electron microscopy/energy dispersive spectroscopy (SEM/EDS) to verify that the lead finish/solder ball and column composition matches the device specification or the data sheet. If a pure tin finish is found and called out in the specification, verify the tin thickness and presence of barrier metals using XRF.

B.2.8 Test for Resurfacing

Chemical or mechanical methods shall be used to test for resurfacing. Examples of resurfaced devices are shown in Figures B.2 through B.8.

B.2.8.1 Chemical Method

This test focuses on the parts surfaces and is a sequence of three separate tests: 1) an Acetone Test, 2) a 1-Methyl 2-Pyrrolidinone Test, and 3) a Dynasolve 750 Test. These tests expose plastic part resurfacing attempts. Upon performing each test, examine the texture on the sides at a minimum 30 X magnification and compare it to the top and bottom surfaces. They should be the same. The dimples should also be inspected for surface uniformity (Figure B.2). Typically, dimples are smooth and highly reflective.

When exposing parts to chemicals, the soak times are not fixed. The part should be monitored often during the timed soak. If the coating is reacting quickly, shorten the soak time. Controlling the total exposure time should prevent any issues concerning damage to mold compound on authentic parts. For all of these solvents, make sure proper safety precautions are used including a ventilated fume hood and elimination of any sources of ignition. Also, use the proper personal protective equipment (PPE). Acetone, 1-Methyl 2-Pyrrolidinone, and Dynasolve 750 attack different types of coatings. These three solvents cover a wide range of potential coatings. These tests can also be used on ceramic parts to check for coatings on the part surface. The same samples can be used for all resurfacing tests.

B.2.8.1.1 Acetone Test

To perform this test, dip a cotton swab into Acetone. Wipe the swab across the surface of the part avoiding printed markings. If the surface is coated, a black or grayish substance will show on the cotton swab. If the wiped section exhibits a permanent color change, the part may have been resurfaced, which is indicative of a suspect counterfeit part.

B.2.8.1.2 1-Methyl 2-Pyrrolidinone (1M2P) Test

To perform this test, completely immerse the part in the solution that is preheated to 115 to 120 degrees Celsius. The part should be immersed for two to five minutes maximum (the time and temperature may be adjusted to compensate for the sample). Carefully remove the part from the solution and use a cotton swab to wipe the surface while avoiding printed markings. If the

surface is coated, a black or grayish substance will show on the cotton swab, which is indicative of a suspect counterfeit part.

B.2.8.1.3 DYNASOLVE 750 Test

Using a preheated solution of Dynasolve 750 at 105 degrees Celsius, completely immerse the part in the solution for 45 minutes. Carefully remove the part from the solution and use a cotton swab to wipe the surface while avoiding printed markings. If the surface is coated, a black or grayish substance will show on the cotton swab. If the coating is removed, look for scratch marks on the remaining surface. Either condition is indicative of a suspect counterfeit part.

B.2.8.2 Mechanical Method

Mechanical removal of coatings can be used if coatings are not removed by chemical means and additional resurfacing tests are warranted. This method involves lightly rubbing an X-ACTO blade, in one direction only, over the surface of the part where the blade is maintained perpendicular to the part surface. Using this technique ensures that some of the part surface will be removed. Make a video recording or document part orientation and direction of blade movement to provide confirmation that any anomalies (such as sanding marks) revealed were not caused by the coating removal process.

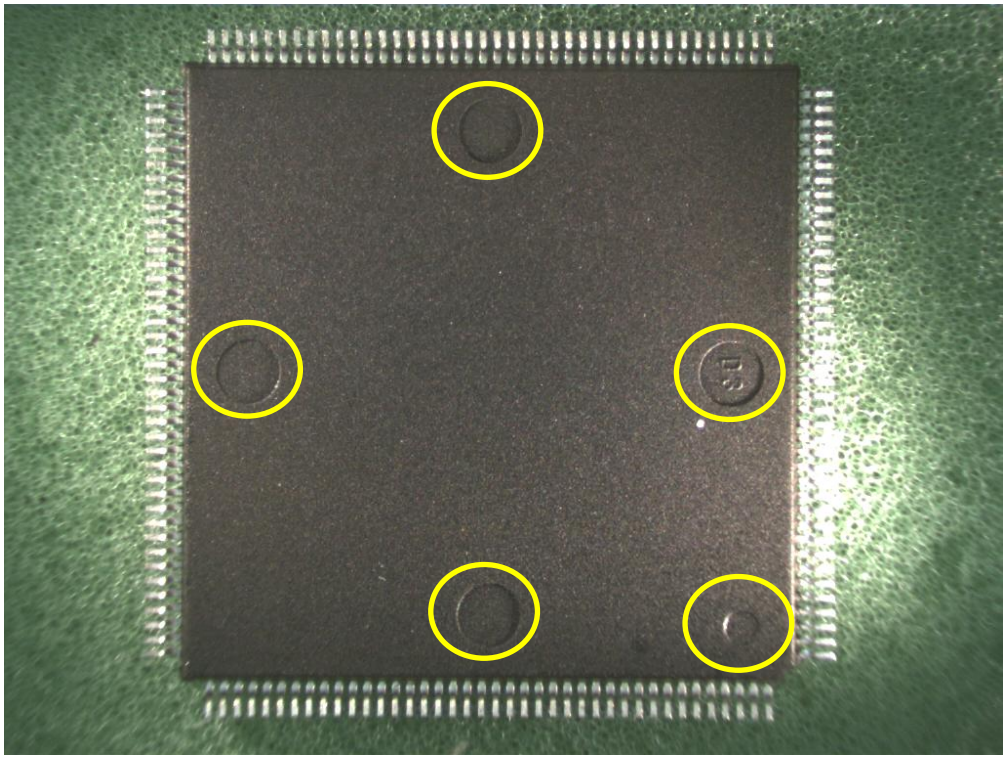

Figure B.2. This image shows the bottom surface of a part where the dimple areas have the same texture as the rest of the surface (yellow circles). This condition is atypical for plastic molded parts.

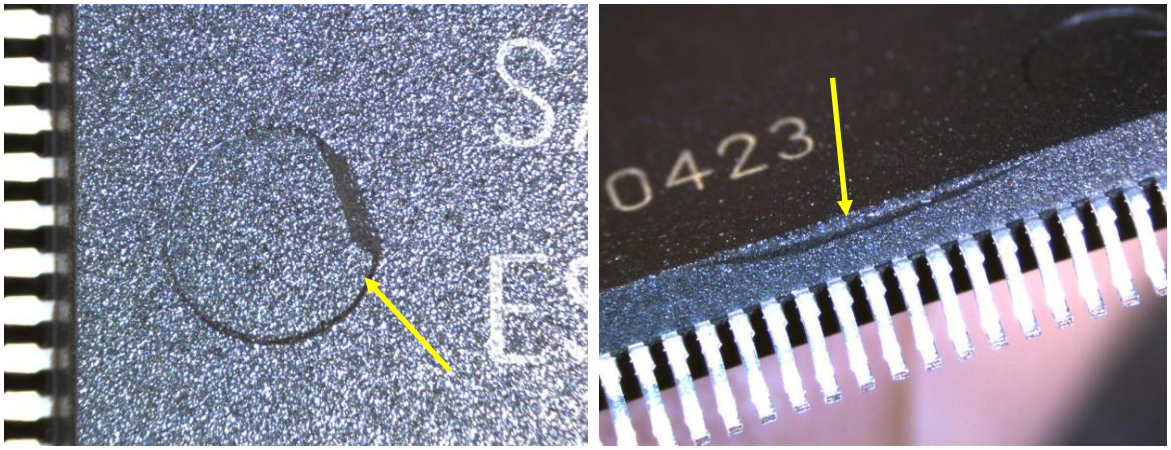

Figure B.3. These images show visual indications of resurfacing (yellow arrows).

Figure B.4. This image shows visible sanding marks (yellow arrow).

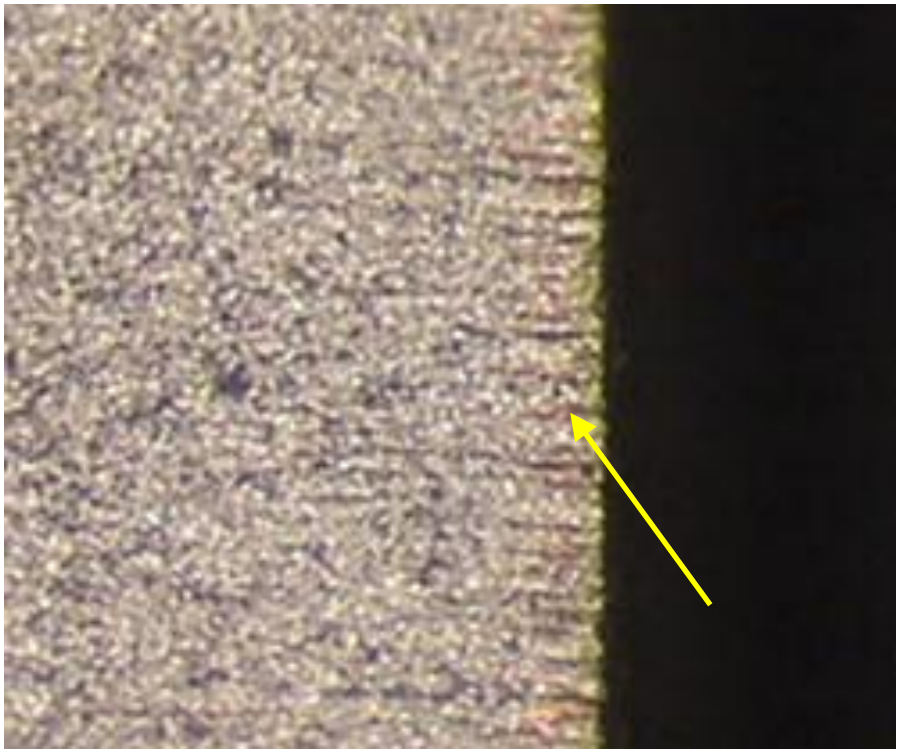

Figure B.5. This image shows visible sanding marks on the edge of a metal lid (yellow arrow).

Figure B.6. This image shows a plastic surface after wiping with an acetone swab. Note the horizontal sanding marks in the plastic (yellow arrow).

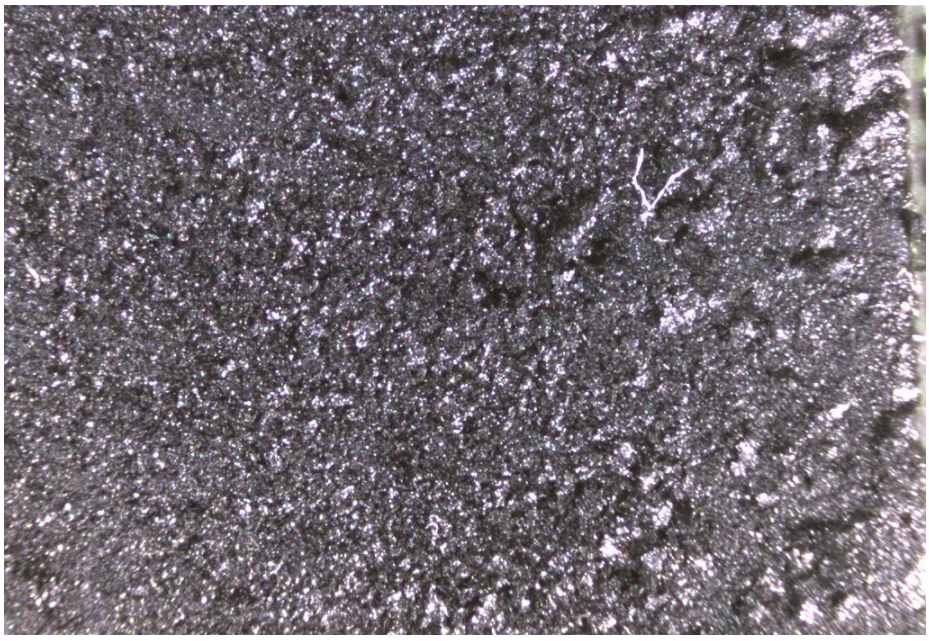

Figure B.7. This image reveals a coating on the surface of a part that has started to bubble after soaking in 1M2P.

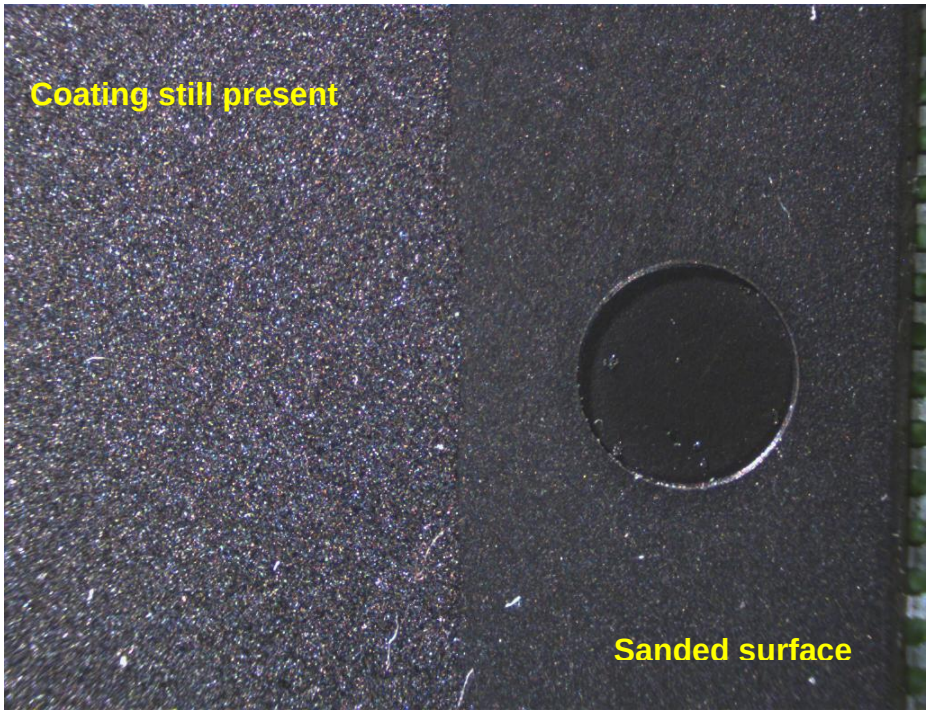

Figure B.8. This image contrasts a surface before and after wiping with a swab.

B.2.9 Temperature Cycling and Seal Test

B.2.9.1 Temperature Cycling

Temperature cycling tests shall be performed a minimum of 10 cycles in accordance with MIL-STD-883 for microcircuits, MIL-STD-750 for semiconductor devices, and MIL-STD-202 for passives. Test conditions will be per the manufacturer's specification. Following completion of testing, parts will be examined for evidence of marking deterioration or other physical damage.

B.2.9.2 Seal (Hermeticity) Test

Hermeticity testing shall be performed on cavity devices. Hermeticity tests will consist of both fine and gross leak tests in accordance with MIL-STD-883for microcircuits, MIL-STD-750 for semiconductor devices, and MIL-STD-202 for other EEE parts as applicable.

B.2.10 Electrical Testing

All electrical tests and test data shall be documented. Appendix A, Tables A.IV and A.V show the required level of electrical testing based on total risk score. The extent of electrical testing will be determined by selecting the pertinent key electrical parameters from the applicable specifications. Commercial off- the- shelf parts will be tested per the manufacturer's datasheet for the key electrical parameters.

B.2.10.1 Pre-Electrical, Burn-In, Post Electrical

Burn-in test conditions and the pre- and post- burn-in electrical parameter limits and delta electrical limits shall be specified. Burn-in shall be a minimum of 80 hours, and the delta electrical limits shall not exceed the percent deviation of the pre-burn-in electrical readings specified in the applicable specification or datasheet.

B.2.11 Destructive Physical Analysis

The DPA technique and process shall be performed per MIL-STD-1580 or equivalent method except internal water vapor, bond strength, and die shear are not necessarily required. A more detailed analysis of the die is necessary. This detailed analysis should include visual inspection, passivation layer analysis, and metallization characteristics analysis. Review and confirm that the die is acceptable by the OCM. If die information is not available from the OCM, compare die between samples selected from the population.

If internal construction anomalies are discovered during radiographic inspection, the samples required for DPA should be selected by utilizing the variant configurations discovered during radiographic screening and should include one sample that represents the majority of the population. In addition, if there are more variations discovered during radiography than required for the DPA sampling plan, the test laboratory shall notify the Risk Assessment and Mitigation Team to determine if a larger sampling size is necessary to identify construction anomalies found during radiographic inspection.

The data collected shall be compared against the expected characteristics for the manufacturer's product. Characteristics should include but not be limited to bond wire location, composition and number of bond wires, die characteristics, lead frame size and shape, double ball bonds (where one ball bond is stacked on another) and internal cavity dimensions (where applicable). Many of these characteristics require a known good part, a database containing information of known good parts to compare against, or it may require support from the OCM.

The analysis may require some of the following analytical techniques and tools:

a. Cross-section analysis

b. Chemical depotting and decapsulation

c. Mechanical disassembly

d. Optical examination and photo-documentation

e. Scanning electron microscope examination

f. Elemental analysis tools such as EDS, Auger, Fourier transform infrared spectrometry (FTIR), XRF, etc

g. Focused ion beam (FIB)

All anomalies shall be documented and the Risk Assessment and Mitigation Team notified. Anomalies between samples within the population shall be recorded and included in a DPA report. The following items should be included in the DPA report:

a. Number of parts inspected

b. All of the information required from previous testing and inspection

c. Key findings

d. Defect characterization

e. Key differences between the parts analyzed and the expected findings

f. A summary statement regarding if any conditions were observed that would indicate that the device was potentially a counterfeit part

g. Photo-documentation as specified in the previously part procedure sections including high magnification photos showing any relevant anomalous conditions

h. A detailed list of the chemicals and techniques used to decapsulated and/or disassemble the part

B.2.11.1 Procedures for Device DPA

B.2.11.1.1 External Optical Examination

Utilize the data obtained from EVI to evaluate any anomalous conditions that may affect the decapsulation process (cracks in the case, uneven surfaces, etc). Photo-document the side of the device through which the die will be exposed.

B.2.11.1.2 Radiographic Inspection

To minimize unnecessary decapsulation damage, obtain x-ray images through the top and sides of the devices. Information of interest includes internal structure, die attach extent and alignment. For plastic encapsulated parts, determine the side of the part that needs to be chemically etched in order to expose the die face. Although the die is not x-ray dense, the die attach provides clues to the area taken up by the die because the die imprint is visible in the die attach. Obtaining a radiographic image that is a 1:1 ratio will help in the location of the die within the case and will also help with the gasket selection when using an automated decapsulator.

B.2.11.1.3 Decapsulation of Plastic Parts and Delidding of Cavity Devices

Decapsulation of plastic parts and delidding of components shall follow MIL-STD-1580 procedures where applicable. Procedures developed by the testing lab that are outside MIL-STD-1580 will be approved by the Risk Assessment and Mitigation Team.

B.2.11.2 Procedure for Inspection of Active Devices

The test lab shall record all decapsulation parameters for each device to determine repeatability or aberrations in the process. The test lab shall photograph the decapsulated devices to document the overall condition of the part after decapsulation. The test lab shall photograph the die at a higher magnification. The die will be examined at a minimum magnification of 500X. This magnification includes the objective lens magnification times the eyepiece magnification. Inspect the die for and photo-document the following information:

a. Manufacturer markings
b. Name
c. Logo
d. Unique image (iconic image used by the die manufacturer such as a flag, a space shuttle, a cartoon man, a tree, etc.)
e. Die part numbers
f. Die mask identification (ID) numbers
g. Year of design
h. Number of metal layers
i. Pin 1 bond pad outline
j. Presence of double ball bond (inspect by tilting the device)
k. Bond wire diameter
l. Bond types
m. Thermal sonic

n. Crescent with or without safety bonds

o. Ultrasonic bonds

p. Compound bonds

q. Any other markings or features that may help in identifying the origins of the die

A more comprehensive analysis may be performed as required by the Risk Assessment and Mitigation team. This may include deprocessing of the die, focused ion beam (FIB) analysis, or a cross-section analysis of the part to determine characteristics of the die and internal part structures. Some types of analysis and part-type characteristics are:

a. Passivation layer type analysis (silicon nitride, oxide types, polyimide, etc.)

b. Metallization characterization

c. Elemental analysis

d. Three or five layers per metal line

e. Etch profile

f. Lead frame characteristics

g. Die attach

h. Lead frame material

i. Die passivation layer thicknesses

j. Passivation types

k. Isolation types (shallow trench isolation (STI), field-ox, deep trench, etc.)

l. Transistor types (complementary metal oxide semiconductor (CMOS), bipolar, radio frequency (RF), etc.)

m. Metallization characteristics

B.2.11.3 Procedure for Inspection of Passive Devices

Passive devices will not have the detail typically found with microcircuits. However, the data collected on characteristics of the internal structures shall be documented in sufficient detail and resolution to enable a comparison against a known good part from the same lot. If a known good part is unavailable, then the original OCM should be asked to provide the data and photos.

The following items will be inspected and documented:

a. Internal dimensions

b. Elemental composition of the part materials

c. Construction and interconnection techniques

e. Overall photos showing the internal structures and alignment

f. Interconnections and interfaces

g. Plating thicknesses and optical characteristics

h. Photomicrographs with calibrated measuring bars for critical dimensional measurements

i. Data and spectra from elemental analysis

j. Internal alignment characteristics

B.2.12 Additional Tests

Additional tests may be used in detecting suspect counterfeit parts when further clarification is necessary. For example, scanning acoustic microscopy may be used to detect original laser-etched part number under a resurface and remarked part. The Risk Assessment and Mitigation Team will work with the test lab to determine if additional tests are necessary.