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GODDARD TECHNICAL STANDARD

GSFC-STD-8002

Goddard Space Flight Center
Greenbelt, MD 20771

Approved: 09-03-2015
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STANDARD QUALITY ASSURANCE REQUIREMENTS FOR THE USE OF WATER SOLUBLE FLUX

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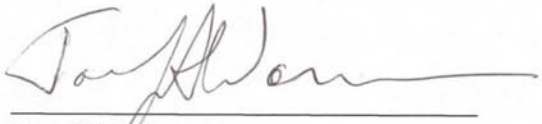
FOREWORD

This standard is published by the Goddard Space Flight Center (GSFC) to provide uniform engineering and technical requirements for processes, procedures, practices, and methods that have been endorsed as standard for NASA programs and projects, including requirements for selection, application, and design criteria of an item.

This standard establishes the requirements to perform the qualification of a manufacturing process for Printed Wiring Assemblies/Printed Circuit Board Assemblies (PWAs/PCBAs) that uses Water Soluble Fluxes (WSFs) for manufacturing mission hardware or Critical Electrical Ground Support Equipment (CEGSE).

Requests for information, corrections, or additions to this standard should be submitted via "Contact Us" on the GSFC Technical Standards website at http://standards.gsfc.nasa.gov.



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1. SCOPE

1.1 Purpose

The purpose of this standard is to establish the requirements applicable to soldering processes for Printed Wiring Assemblies (PWAs) that use Water Soluble Flux (WSF).

1.2 Applicability

This standard is applicable to soldering processes for PWAs intended for use in Goddard Space Flight Center (GSFC) mission hardware for programs and projects governed by NPR 7120.5 and is not applicable to those governed by NPR 7120.8 or for other research and technology projects not otherwise required to follow a project management directive, also known as "Do No Harm" projects.

This standard may be cited in contract, program, and other Agency documents as a technical requirement. Mandatory requirements are indicated by the word "**shall**".

The Quality Engineering Branch is responsible for Workmanship quality policy at GSFC and is the certification body when applicable for processes defined herein.

Tailoring of this standard for application to a specific program or project **shall** be approved in advance by the program or project Chief Safety and Mission Assurance Officer (CSO) and by the Quality Engineering Branch head, who is the TA for the Workmanship discipline at GSFC and owner of this technical standard.

2. APPLICABLE DOCUMENTS

2.1 General

The documents listed in this section contain provisions that constitute requirements of this standard as cited in the text of Section 4. The latest issuances of cited documents **shall** be used unless otherwise approved by the assigned TA. The applicable documents are accessible via the NASA Technical Standards System at http://standards.nasa.gov, directly from the Standards Developing Organizations, or from other document distributors.

2.2 Government Documents

NPR 7120.5	NASA Space Flight Program and Project Management Requirements
NPR 7120.8	NASA Research and Technology Program and Project Management Requirements
NPR 8705.4	Risk Classification for NASA Payloads
GSFC-STD-6001	Ceramic Column Grid Array Design and Manufacturing Rules for Flight Hardware

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2.3 Non-Government Documents

IPC J-STD-001 w/Space Addendum	Requirements for Soldered Electrical and Electronic Assemblies w/Space Addendum
IPC-9202	Material and Process Characterization/Qualification Test Protocol for Assessing Electrochemical Performance
IPC-9203	Users Guide to IPC-9202 and the IPC-B-52 Standard Test Vehicle
IPC-TM-650, Method 2.3.28	Ionic Analysis of Circuit Boards, Ion Chromatography Method

2.4 Order of Precedence

When this standard is applied as a requirement or imposed by contract on a program or project, the technical requirements of this standard take precedence, in the case of conflict, over the technical requirements cited in applicable documents or referenced guidance documents.

3. ACRONYMS AND DEFINITIONS

3.1 Acronyms and Abbreviations

CEGSE	Critical Electrical Ground Support Equipment
CSO	Chief Safety and Mission Assurance Officer
ECM	Electrochemical Migration
GSFC	Goddard Space Flight Center
IC	Ion Chromatography
KPI	Key Process Indicator
PCB	Printed Circuit Board
PCBA	Printed Circuit Board Assembly
PCER	Process Chemicals Entrapment Review
PWA	Printed Wiring Assembly
SIR	Surface Insulation Resistance
SMA	Safety and Mission Assurance
SME	Subject Matter Expert

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TV	Test Vehicle
WSF	Water Soluble Flux

3.2 Definitions

Critical Electrical Ground Support Equipment	Any custom designed and manufactured electrical equipment, assembly or subassembly that directly interfaces with electronic flight hardware.
Electro Chemical Migration	Electrochemical migration is phenomenon in which metal ions migrate through a suitable medium (e.g., flux residues bridging conductors) under the influence of an electrical field. Electrochemical failure mechanisms are comprised of three elements: 1) an ionic residue; 2) an electrical potential or voltage gradient; and 3) moisture or humidity [4].
Flatpack/Flat Package	A rectangular or square package with leads parallel to base plane attached on two opposing sides of the package periphery [2].
Mission Hardware	In-scope Flight Hardware, Engineering Units and everything in between.
Production Run	A group of products manufactured using the same manufacturing processes, procedures and conditions. The quantity of products is typically limited to a manageable number due to restrictions of size and the number or type of processes involved. Depending on the product, the production run may vary from one to several thousand units.
Process Change	When a process is modified intentionally or unintentionally from a given state. Examples of process changes are changes in: • Materials • Method • Manpower • Environment • Equipment
Risk Class	Classification assigned to mission hardware in accordance with NPR 8705.4 that determines the extent to which a variety of quality assurance requirements are applied herein.

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Shadowing	With regard to board cleanliness, the condition in which the proximity of adjacent components or adjacent PWAs (e.g. while being processed in a batch cleaner) prevents the cleaning solution (e.g. water) from reaching and removing residues on the assembly being cleaned or rinsed.
Special Cause	Abnormal, atypical cause of variation in a process.
Surface Finish	The surface finish of a Printed Circuit Board (PCB) is the part of the PCB that protects the copper from oxidation as well as provides a solderable surface for components assembly. Some of the types available are: • HASL • ENIG • ENEPIG • Immersion Tin • Immersion Silver • OSP
Surface Insulation Resistance	The electrical resistance of an insulating material between a pair of contacts, conductors or grounding devices in various combinations, that is determined under specified environmental and electrical conditions [1].
Test Vehicle	A test pattern for determining acceptance/reliability using a test method [1].
Unprocessed Control	A test vehicle that has not been exposed to candidate assembly manufacturing material/processes. These are in the "as-received" condition from the supplier [1].
Water Soluble Flux	An organic chemical soldering flux that is soluble in water [1].

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4. REQUIREMENTS

4.1 General

4.1.1 Assurance Processes

The requirements contained in this standard are tailored to the project risk classification (Class A through D) as defined by NPR 8705.4.

The quality assurance requirements herein ensure that the soldering and cleaning processes applied when using WSF are repeatable and reliable prior to their use for producing GSFC mission hardware. The requirements also provide production lot quality assessment for solder joint voiding. These requirements reinforce and are in addition to all other flux and cleaning Workmanship requirements imposed by J-STD-001 w/Space Addendum.

The Quality Engineering Branch will certify WSF processes of GSFC suppliers, renew certifications or revoke certifications according to the requirements herein. The GSFC Workmanship Program maintains the records and certification status of suppliers using Water Soluble Fluxes to build mission hardware for GSFC projects.

Test data acquired for a prior project may be determined by the GSFC Workmanship Program to be acceptable based on test vehicle compliance with the design and manufacture requirements set forth in this document for the current project (see paragraphs 4.2.3 and 4.2.4) and the current compliance of the supplier with the process certification maintenance requirements (see paragraph 4.4).

Processing of mission hardware using WSF **shall not** commence at suppliers whose processes certification is not current, or whose certification is not applicable to the impending work by complexity or risk class.

Process certification requirements fall into the following groups:

a. **Initial GSFC Process Qualification.** Initial GSFC qualification of the supplier's soldering process is achieved using:

   i. A process documentation review to establish that the process baseline meets the requirements herein and critical parameters are controlled,

   ii. A Process Chemicals Entrapment Review (PCER) to identify features or conditions on the PWAs that can cause entrapment of chemicals or residues.

   iii. Inspection and test of sample production articles ("test vehicles") which demonstrate that the process can achieve acceptance conditions for cleanliness and solder joint voiding density.

b. **GSFC Process Certification.** Upon successful initial process qualification, the Quality Engineering Branch certifies in writing that the supplier's soldering process is compliant with the requirements herein and processing of GSFC mission hardware may commence. The approval is tied to the project requesting the certification, the mission risk class of the project, the supplier manufacturing location, the flux used, the manufacturing processes and the test vehicle used.

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c. **GSFC Process Certification Maintenance.** Certification maintenance requirements are defined to ensure the supplier performs lot-based product quality inspections, keeps the process unchanged, under control, and in compliance with the requirements in this standard.

d. **Process Changes.** Process change requirements are defined for suppliers with certified processes seeking process change approval. Delta qualifications are allowed.

4.1.2 Related Workmanship Requirements

The requirements in this standard supplement those imposed by the following references and do not intend to relieve suppliers of these requirements:

a. GSFC-STD-6001, Paragraph 4.4.7.2 "Radiographic Inspection (X-ray)"

b. J-STD-001 w/Space Addendum,

   i. Paragraph 3.1, "Materials"

   ii. Paragraph 3.3, "Flux"

   iii. Paragraph 4.3, "Solderability"

4.2 Initial GSFC Process Qualification

4.2.1 Process Documentation Review

For all risk classes the supplier **shall** make the documentation described in a. through c. below available for the GSFC Workmanship Program review. These documents will capture the process baseline being certified by GSFC. The Process Documentation Review is a prerequisite for GSFC process certification.

a. **Document List.** The supplier **shall** identify by number and revision the documents that define and control:

   i. Processing of hardware using water soluble flux.

   ii. Customer process change notification.

   iii. Provisions that prevent shadowing as defined in 3.2.

b. **Documentation Contents.** The information to be included in the process documentation **shall** be as a minimum:

   i. All sub-processes defined,

   ii. List of key process indicators (KPIs),

   iii. Process controls employed, and

   iv. Quality records demonstrating that KPIs have been in control for the last six months.

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c. **Flux Manufacturer's Recommendations Compliance Map.** The supplier **shall** provide:

   i. A copy of the WSF specification sheet.

   ii. A list mapping the recommendations contained in the WSF manufacturer's specification sheet to the related process controls in the supplier's soldering and cleaning process documentation, by document and paragraph number.

4.2.2 Process Chemicals Entrapment Review (PCER)

Per 4.2.3, the IPC-B-52 board is used by this standard as the test vehicle to perform the inspection and testing required.

For Class A and B missions, prior to fabricating mission hardware, the supplier **shall** review all PWAs to identify any features or conditions that may entrap residues or processing chemicals (e.g. flux residue, water, alcohol, solder process by-products). Such contaminants can lead to corrosion or Electrochemical Migration (ECM), also known as dendrite growth.

The supplier **shall** report all conditions detected during the PCER that can lead to process chemicals entrapment on the project PWAs that are not already covered by the design of the IPC-B-52 board.

4.2.3 Design of the Test Vehicles

a. The supplier **shall** use the IPC-B-52 design to build the TV.

b. When a supplier plans to manufacture boards with higher levels of physical complexity than the IPC-B-52 board, the TV design **shall** be modified to be representative of the most complex packaging design to be processed.

   Note: The IPC-B-52 contains an open area where a component and SIR pattern can be added to accommodate new PCB designs or new type of component packages. The users guide in IPC-9203 can be used as a reference to design SIR patterns for the open area on the IPC-B-52 TV or for a different test vehicle.

c. **Previously Approved Test Vehicle Designs.** Test vehicle designs used for a prior GSFC process certification may be determined by the GSFC Workmanship Program to be suitable for reuse for a new certification. "Heritage" alone does not guarantee acceptability.

4.2.4 Manufacture of the Test Vehicles

a. **For Mission Risk Class A.** The test vehicles **shall** be representative of the mission hardware to be delivered by complying with i. through ix. below.

   i. **Water-only Cleaning Process.** Water-only cleaning processes are preferred. The use of chemistries other than water (e.g. solvents, saponifiers, detergents, additives, etc.) during the cleaning process **shall** be disclosed.

   ii. **PCB Manufacturer.** The printed circuit boards used to build the test vehicles **shall** be procured from the same manufacturer and manufacturing location as

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applies for the printed circuit boards to be used to manufacture the mission hardware.

iii. **Surface Finish.** If more than one type of surface finish is being used for the mission hardware then one set of test vehicles **shall** be produced and submitted for testing per type of surface finish used.

iv. **Solderability.** The printed circuit boards and the components used **shall** meet the solderability requirements of J-STD-001 paragraph 4.3.

> **Note:** Solder dipping component leads is acceptable for parts that are not manufactured, guaranteed by the component supplier, or otherwise handled to achieve and maintain solderability per J-STD-001. Solder dipping may not be practicable for chip resistors and capacitors, where solder joint voiding tends to be worst case; however it is not prohibited when assembling the test vehicle because the part element quality does not affect the test results.
>
> **Note:** Excessive oxidation of solderable surfaces is associated with failure to meet the required solder joint voiding criteria.

v. **Process-Representative.** The test vehicle **shall** be assembled via soldering in the same order, using the same equipment, flux, solder, solder paste, soldering process parameters, as well as rework and cleaning processes as will be used to build the mission hardware.

> **Note:** This is particularly important when water soluble flux, rosin-based flux, batch cleaning systems and localized cleaning by hand are used during the manufacturing process.

vi. **Conformal Coating. Shall not** be applied to the test vehicles.

vii. **Hand Soldering Rework.** Hand soldering **shall** be performed on areas of the test vehicle objectively representative of the most critical type of rework the supplier is approved to perform on the mission hardware.

viii. **Soldering Processes Identified by Location.** The supplier **shall** record and report the locations where rework, hand soldering, selective soldering or another type of special soldering was performed on each test vehicle board.

ix. **Assembled Patterns.** All through-hole and surface mount land patterns **shall** be populated during the assembly of the test vehicle.

b. **For Mission Risk Class B.** The test vehicles **shall** comply with the requirements of 4.2.4.a (i.e. Class A) with no exceptions.

c. **For Mission Risk Class C.** The test vehicles **shall** comply with the same requirements of Class B with the exception of 4.2.4.c.i and 4.2.4.c.ii below.

i. Paragraph 4.2.4.a.ii, **PCB Manufacturer**, is not applicable.

ii. Paragraph 4.2.4.a.iii, **Surface Finish**, is not applicable

d. **For Mission Risk Class D.** Not applicable. No test vehicle inspection or test is required.

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Table 4-1 – Reviews, Inspection and Test Sample Sizes per Mission Class

Mission Risk Class	Process Documentation Review	Process Chemicals Entrapment Review	Surface Insulation Resistance		Ion Chromatography		X-ray Inspection
			Test Vehicles	Unprocessed Controls	Test Vehicles	Unprocessed Controls	Test Vehicles
A	Yes	Yes	10	1	10	1	3
B	Yes	Yes	10	1	10	1	3
C	Yes	No	1	1	1	1	1
D	Yes	No	N/A	N/A	N/A	N/A	N/A

4.2.5 Surface Insulation Resistance (SIR)

A SIR test **shall** be performed on the SIR coupon of the TV per IPC-9202 with the following provisions:

a. **IPC-9202 Process Qualification.** The "Process Qualification" conditions, requirements and recommendations **shall** be followed.

b. **Sample Size.** The sample size **shall** be per table 4-1.

c. **SIR Testing Parameters.** The SIR testing parameters of IPC-9202, Table 8-1 **shall** be used.

d. **Acceptance Criteria.** Acceptance criteria **shall** be in accordance with IPC-9202, paragraph 9 "Acceptance Criteria". Ionic and non-ionic salt deposits on the surface of the test vehicles are considered test failures.

e. **Reporting.**

   i. The reporting of the results **shall** be in accordance with IPC-9202, paragraph 10.

   ii. Photo documentation and reporting of abnormal conditions (e.g. discoloration, corrosion, oxidation, and partial dendrite growth) **shall** be performed even if they did not cause the tests to fail.

4.2.6 Ion Chromatography (IC)

An IC test (also known as Ionic Analysis Test) **shall** be performed on the IC coupon of the TV per IPC-9202 with the following provisions:

a. **Sample Size.** The sample size **shall** be as per table 4-1.

b. **Test Limits.** No test limits have been established for the IC test. The IC test results are used to establish a baseline for the process that is traceable to successful SIR test results. The laboratory **shall** identify the content of the ions shown in Table 4-2.

c. **Reporting.** Results **shall** be reported in accordance with IPC-9202, paragraph 10.

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d.

Table 4-2 – Ion Contents for a Cleaned Printed Wiring Assembly

Ion Type	Ion
Anions	Nitrite (NO_2^-) Nitrate (NO_3^-) Phosphate (PO_4^{2-}) Sulfate (SO_4^{2-})
	Chloride (Cl^-),
	Bromide (Br^-)
	Total Weak Organic Acids *Including but not limited to:* • *Acetate* • *Adipate* • *Formate* • *Glutamate* • *Malate* • *Methane Sulfonate* • *Succinate* • *Phthalate*
	Fluoride (F^-)
Cations	Lithium (Li) Sodium (Na) Ammonium (NH_4) Potassium (K)
	Magnesium (Mg) Calcium (Ca)

4.2.7 X-ray Inspection for Solder Joint Voiding

A solder joint survey **shall** be accomplished by performing an X-ray inspection per the requirements below:

a. **Sample Size.** The sample size **shall** be as per table 4-1.

b. **Apparatus.** The X-ray process (including equipment, operator and procedure) **shall** be capable of discerning a solder void that is one thousandth of an inch (0.001") in diameter. If the supplier's X-ray capability is not adequate, specimens can be sent to GSFC for X-ray inspection.

c. **Areas to be Inspected and Method of Voiding Percentage Calculation**

i. **Solder Joint Areas of Interest.** For all package styles voiding percent **shall** be determined for the solid, continuous solder joint. Blowholes and features not fully enclosed by solder, such as unenclosed non-wetting, are not considered to be voids. Acceptance criteria are defined for the fillet area of the solder joint for all

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package types and also for the area underneath the solderable area of the end termination for chip packages (See Table 4-3)

ii. **Method of Voiding Percentage Calculation.** Voiding density is expressed as a percentage of the total area of the solder joint viewed in two-dimensions. The plane of view for surface mount parts is parallel with the x-y plane of the printed circuit board. The plane of view for through-hole parts is parallel with the z-axis or may be a tilt off of the x, y, or z axes. The voiding percentage is determined by estimating the area of each visible void, calculating the sum of all the voids and then dividing that by the total area being evaluated (Figure 4-2).

Note: Though this approach to quantifying void density results in rough estimates, care is needed to avoid false positive results by using the two-dimensional area of the solder pad rather than of the area of the solder joint in the denominator of the fraction. Fully-enclosed, non-wetting, and voiding are interchangeable for the purposes of this requirement.

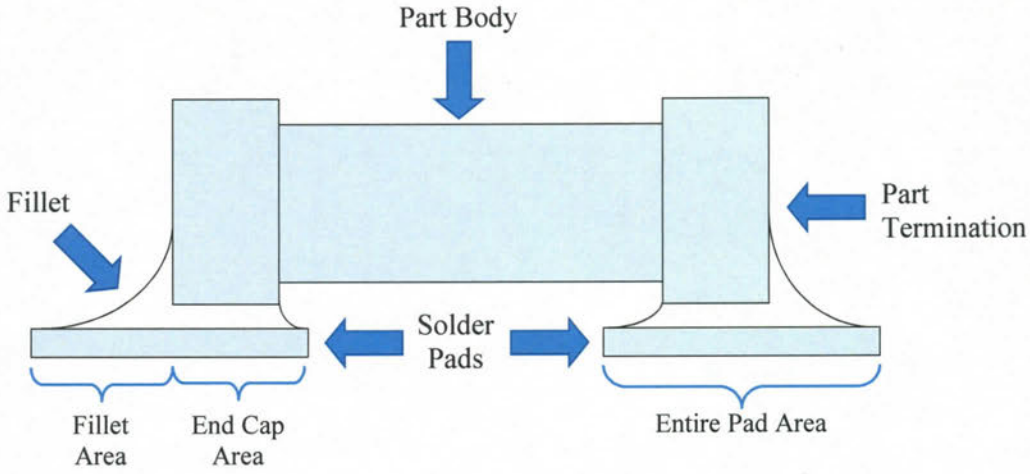

Figure 4-1 – Cross sectional representation of a chip joint – Side View

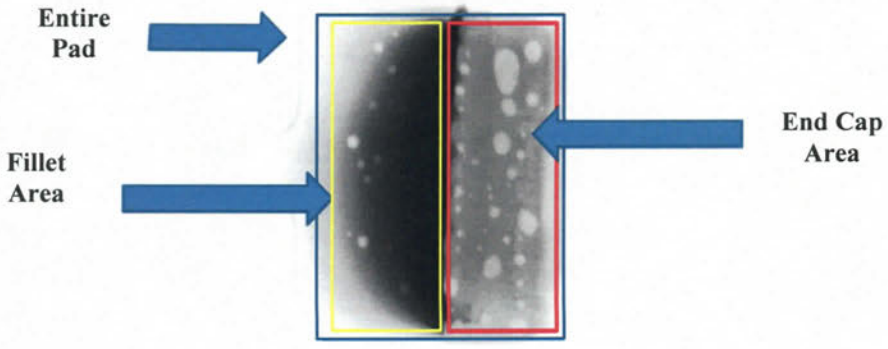

Figure 4-2 – X-ray Sampling Areas for Chip Package – Top View

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d. **Limits.** For each assembly test vehicle or sample examined via X-ray, the five worst case examples on the test vehicle **shall** be selected for measurement to show compliance with the criteria in Table 4-3. See Appendix A for examples and measurements of voiding.

e. **Reporting.** The report **shall** include X-ray images of the five worst case examples and their percentage of voids.

Table 4-3 – Voiding Limits

Component Type	Area	Limits
All	Entire Pad	Void area **shall not** exceed 10% [3]
Chip package styles and flatpacks	End Cap Area	Void area **shall not** exceed 25% [3]
BGA	Solder connections	Void area **shall not** reduce joint thickness by more than 25%
CCGA	Solder connections	Per J-STD-001XS and GSFC-STD-6001

4.2.8 Process Qualification Evaluation

The GSFC Workmanship Program **shall** evaluate the process qualification results based on the following:

a. Compliance with 4.2.1 herein provides evidence that the soldering process can be controlled to the criteria and limits defined in the flux manufacturer's specifications as well as the supplier's procedures. It also provides evidence that the supplier can recognize significant process changes and is compelled by internal policy to notify GSFC of a process change before or while they process GSFC mission hardware. The supplier's soldering and cleaning processes baselines are defined by the process document list which is retained by GSFC for reference.

b. Compliance with 4.2.2 herein provides evidence that the Process Chemicals Entrapment Review was performed as required and that any findings were documented.

c. Compliance with 4.2.3 herein provides evidence that the design of the Test Vehicle is sufficiently similar to the mission hardware with respect to residue entrapment and solder voiding and matches the requirements established for the mission risk class by this document.

d. Compliance with 4.2.4 herein provides evidence that the test vehicles are produced using the relevant materials and processes that will be used to manufacture project mission hardware.

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e. Compliance with 4.2.5 through 4.2.6 herein provides evidence that the supplier's process can produce SIR and IC test results within the limits and acceptance criteria defined therein.

f. Compliance with 4.2.7 herein provides evidence that the supplier's process does not produce voiding in solder joints in excess of the percentages defined therein.

4.3 GSFC Process Certification

Upon successful completion of the reviews, testing and inspection defined in 4.2, the GSFC Workmanship Program will recommend the process for certification. In this case, the Quality Engineering Branch will certify in writing that the supplier's soldering process using WSF was found in compliance with the requirements herein.

Certifications **shall** be tied to the project requesting the certification, the mission risk class of the project, the supplier manufacturing location, the flux used, the manufacturing processes and the Test Vehicle used.

4.4 GSFC Process Certification Maintenance

Certification is sustained when the supplier ensures that all of the conditions of 4.4.1 through 4.4.4 are met and **shall** be automatically voided when the supplier ceases to comply with any of the applicable requirements set in this standard.

4.4.1 Unchanged Process

The supplier **shall** ensure that the process remains unchanged and in compliance with this standard.

See 4.5, Process Changes below for the requirements for qualifying process changes related to the use of water soluble fluxes.

4.4.2 SIR Monitoring

SIR testing **shall** be repeated on the schedule shown in Table 4-4.

Table 4-4 SIR Testing of TVs Required for Sustaining Process Certification

Mission Risk Class	Requirement
A	SIR testing **shall** be performed per 4.2.5 every six (6) months or less without detecting failures
B	
C	Not applicable
D	

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4.4.3 Lot X-ray Inspection Monitoring

X-ray inspection **shall** be repeated on the schedule shown in Table 4-5.

Table 4-5 X-ray Inspection of TVs Required for Sustaining Process Certification

Mission Risk Class	Requirement
A	X-ray Inspection **shall** be performed per 4.2.7 on one test vehicle for each production run of mission hardware processed without detecting failures.
B	
C	
D	Not applicable

4.4.4 Process in Control

The supplier **shall** maintain and provide upon request quality records showing the process KPIs are in control (e.g. Cpk Index, Control Charts) and that any special causes, as defined in 3.2, have been properly addressed and resolved.

4.5 Process Changes

Process changes are not permitted during production of mission hardware without prior approval from GSFC.

The affected projects, the supplier and the GSFC Workmanship Program **shall** develop a process change qualification plan on a case-by-case basis that is in compliance with this document. Changes to the in-scope processes may be cause for a delta qualification or loss of process certification as determined by the GSFC Workmanship Program.

5. GUIDANCE

5.1 Reference Documents

[1] IPC T-50 Terms and Definitions for Interconnecting and Packaging Electronic Circuits

[2] MIL-STD-1835C Department of Defense Interface Standard - Electronic Component Case Outlines

[3] Monte Carlo Simulation of Void Concentrations in Surface Mounted Solder Joints by Jacob C. Burke, John W. Evans and Kamili Jackson

[4] IPC-CH-65B Guidelines for Cleaning of Printed Boards and Assemblies

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5.2 Key Word Listing

None.

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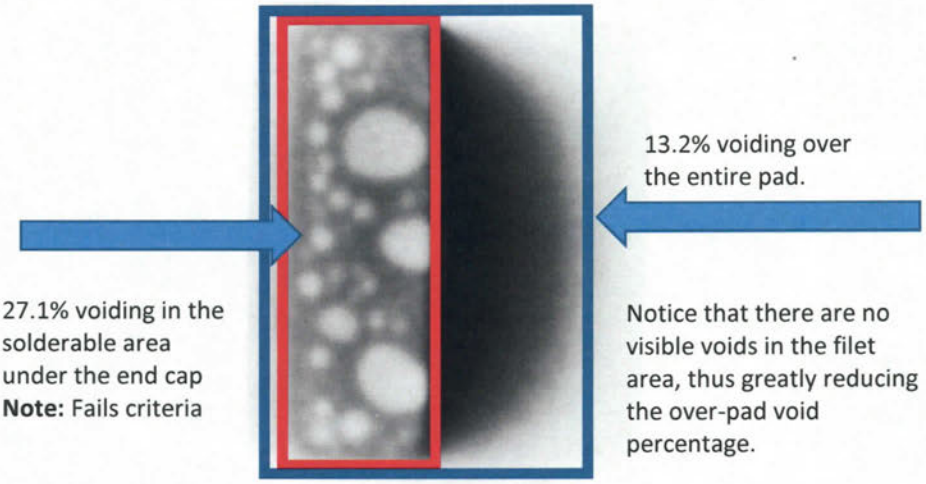
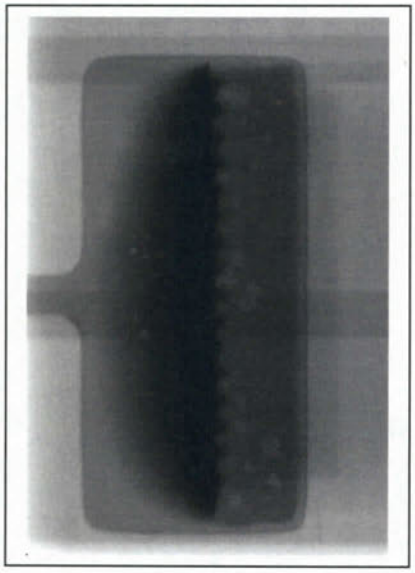
APPENDIX A – Examples of Percent Voiding In Chip Package Solder Joints

Illustration of the Areas

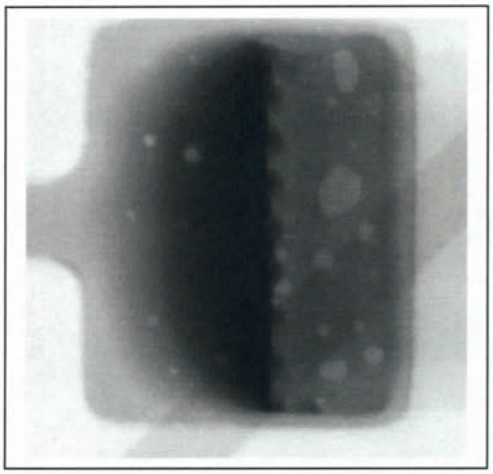


Examples of voiding appearances

- Arranged in ascending order by total pad voiding
- Including separate voiding percent measured in the area under the end cap and the fillet



Void Counting Method	End Cap Area Voiding	Total Pad Voiding
Draw & measure areas by "hand"	7.5%	3.9%
ImageJ Software *	8.6%	4.5%



End Cap Area Voiding	Total Pad Voiding
10.2%	5.1%
Hand drawn & measured	

* ImageJ software is available via free download from the National Institutes of Health website: http://rsbweb.nih.gov/ij/

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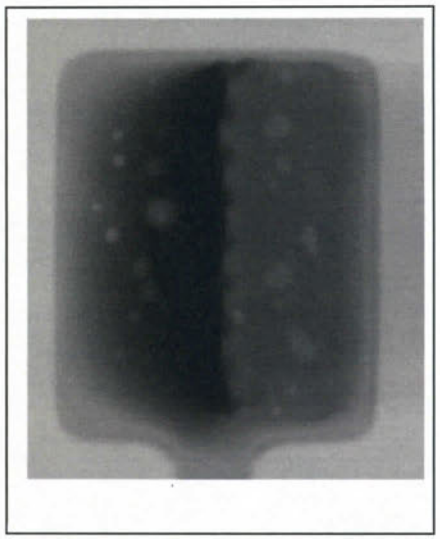
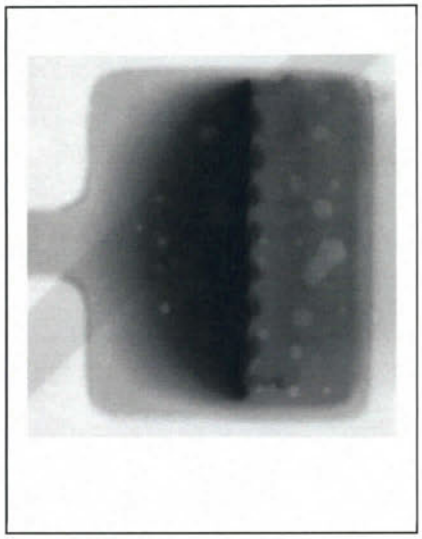
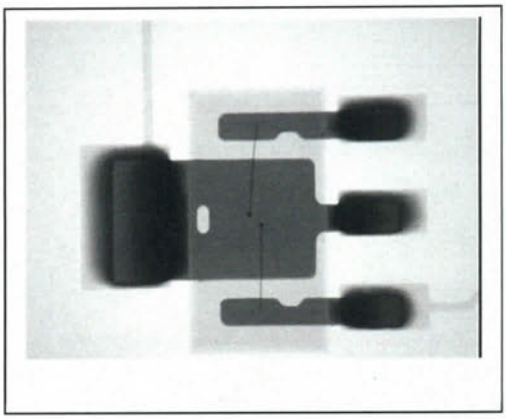


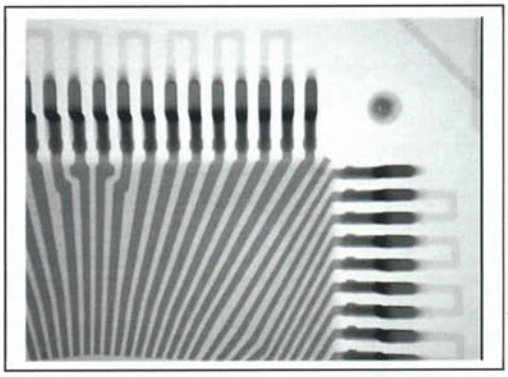
End Cap Area Voiding	Total Pad Voiding
6.7%	5.7%
Hand drawn and measured	



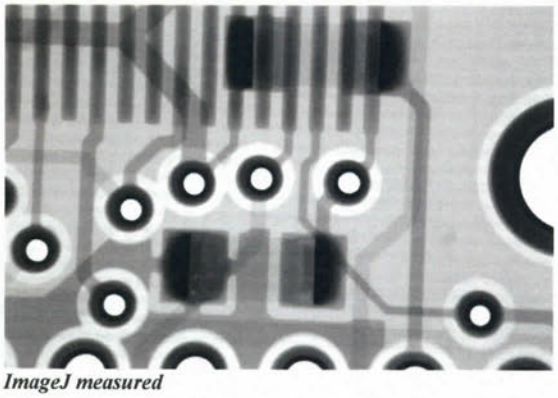
End Cap Area Voiding	Total Pad Voiding
13.1%	6.1%
Hand drawn and measured	



No voiding

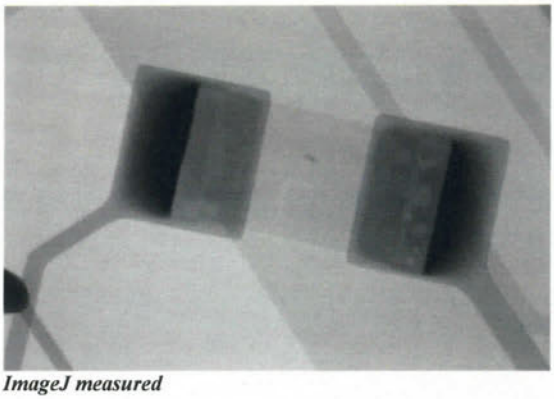


No voiding



ImageJ measured

Left solder joint:	Entire Pad:	45.1%
	End Cap Area:	33.0%
Right solder joint:	Entire Pad:	20.9%
	End Cap Area:	37.2%



ImageJ measured

Left solder joint:	Entire Pad:	1.6%
	End Cap Area:	2.6%
Right solder joint:	Entire Pad:	9.5%
	End Cap Area:	12.6%

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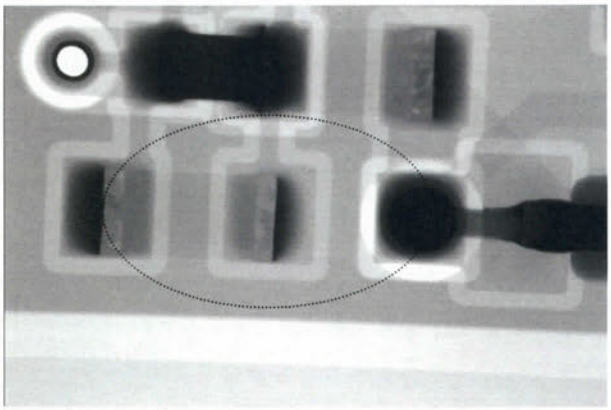
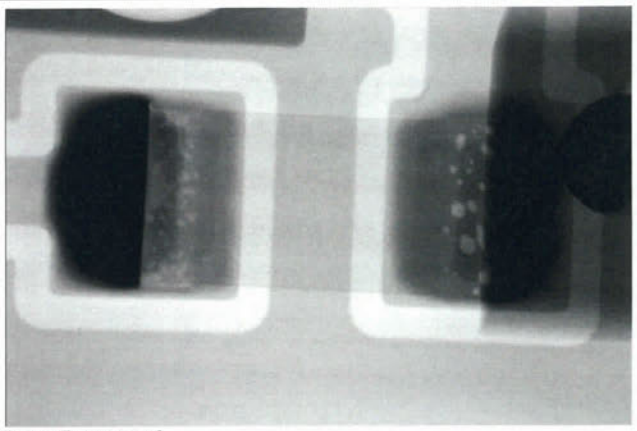


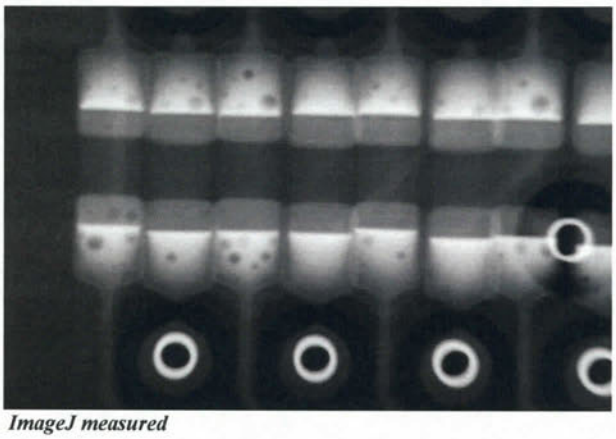
ImageJ measured

Left solder joint:	Entire Pad:	13.3%
	End Cap Area:	22.5%
Right solder joint:	Entire Pad:	19.9%
	End Cap Area:	30.6%



ImageJ measured

Left solder joint:	Entire Pad:	12.2%
	End Cap Area:	2.3%
Right solder joint:	Entire Pad:	5.1%
	End Cap Area:	8.9%



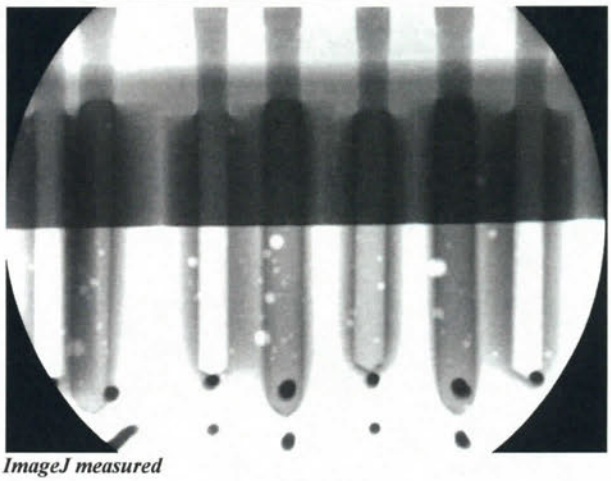
ImageJ measured

Top

% void	1	2	3	4	5	6	7
Entire Pad	2.8	3.8	5.8	0.7	2.6	2.2	8.7
End Cap Area	1.7	0	0	0	0	0	0

Bottom

% void	1	2	3	4	5	6	7
Entire Pad	13.8	3.6	2.6	1.3	0	0	0
End Cap Area	8.2	2.4	9.9	0	1.7	0	5.1



ImageJ measured

% void	1	2		3	4	5	6	7
Entire Pad		3.2			3.4			2.5
End Cap Area		5.5			5.7			1

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APPENDIX B – Water Soluble Flux Initial Qualification Reports Checklist

	Process Qualification	Reference

☐	**Process Documentation Review**
	• Document List
	• Documentation Contents:
	  ○ All sub-processes defined:
	  ▪ Procedures
	  ▪ Work Instructions
	  ○ List of KPIs
	  ○ Process Controls
	  ○ Quality Records
	• Flux Manufacturer's Recommendations Compliance Map
		4.2.1

☐	**Process Chemicals Entrapment Review (PCER) – For Class A and B Missions** • List of any conditions detected and mitigations implemented	4.2.2
☐	**Design of the Test Vehicles** • Test Vehicle used	4.2.3

☐	**Manufacture of the Test Vehicles.** Document the as-built condition:
	• Cleaning Solution
	• PCB Manufacturer
	• Surface Finish
	• Solderability
	• Process Representative
	  ○ Flux
	  ○ Solder
	  ○ Solder Paste
	  ○ PWA Cleaning Method
	  ○ Localized Cleaning Solution
	• Conformal Coating
	• Hand Soldering Rework
	• Soldering Processes Identified by Location
	• Assembled Patterns
		4.2.4

☐	**Surface Insulation Resistance as per IPC-9202 – For Class A, B and C Missions** • Sample Size per Table 4-1 • SIR Testing Parameters per IPC-9202, Table 8-1 • Test Limits and Acceptance Criteria per IPC-9202, paragraph 9	4.2.5
☐	**Ion Chromatography as per IPC-9202 – For Class A, B and C Missions** • Sample Size per Table 4-1 • Ion Contents per Table 4-2	4.2.6
☐	**X-ray Inspection for Solder Joint Voiding – For Class A, B and C Missions** • Sample Size per Table 4-1 • Inspection Limits per Table 4-3	4.2.7