NASA Electronic Parts and Packaging (NEPP) Program
2019 Electronics Technology Workshop

NEPP Program Task 19-294
Government Working Group Update

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AGENDA

I. Acronyms

II. Purpose, Objective, & Scope

III. Accomplishments

IV. Current Topics

Acronyms

AFC	Army Futures Command
3D-CT	Three Dimensional Computed Tomography
80Au-20Sn	80% Gold 20% Tin
AvMC	Aviation and Missile Center
CE-11	SAE Component Parts Committee
CE-12	SAE Solid State Devices Committee
CCDC	Combat Capabilities Development Command
DLA	Defense Logistics Agency
EP	Engineering Practice
GSFC	Goddard Space Flight Center
GWG	Government Working Group
JEDEC	Joint Electronics Device Council
JSEG	Jacobs Space Exploration Group
MDA	Missile Defense Agency
MIL-PRF	Military Performance Specification
MIL-STD	Military Standard
MSFC	Marshall Space Flight Center
NEPAG	NASA Electronic Parts Assurance Group
NEPP	NASA Electronics Parts and Packaging
NRO	National Reconnaissance Office
NSWC	Naval Surface Warfare Center
R&R	Read & Record
QA	Qualifying Activity
QCI	Quality Conformance Inspection
QML	Qualified Manufacturers Listing
SAE	Society of Automotive Engineers
SMC	Space and Missile Center
SMD	Surface Mounted Device or Standard Microcircuit Drawing
SSTC	Solid State Technical Committee
TM	Test Method

Purpose, Objective, Scope, Meetings

GWG was established in January 2017

- **Purpose:** To discuss in detail government topics from NEPAG which require additional in-depth technical solutions
- **Objective:** To establish a one-government stance applicable to both terrestrial and space programs
- **Scope:** Attendees represent 7 government agencies and DLA
  - Air Force – SMC/The Aerospace Corporation
  - Air Force – Wright-Patterson
  - Army – AFC CCDC AvMC
  - MDA
  - NASA Centers
  - Navy – NSWC Crane Division
  - NRO/The Aerospace Corporation
- **Meetings:** Held 64 meetings to date

1. Radiography Inspection Criteria

- **In the 2017/2018 timeframe, GWG developed a unified stance disapproving two JEDEC Task Group 15-02 X-Ray Seal Voids proposals to change MIL-STD-883 TM2012 lid seal void requirements.**
  - **Initial Proposal: Increase voiding criteria from 75% to 95%**
    - A GWG consensus objection letter signed by NASA, US Air Force (SMC/AFMC), Navy, and Army representatives was sent to DLA
  - **Second Proposal: Inclusion of fillet in the intended seal width**
    - Two GWG opposition presentations were given by Kathy Laird/NASA-JSEG and Matt Dorcon/NSWC Crane at the JEDEC JC13 Task Group 15-02 X-Ray Seal Voids Meeting in January 2018.

Accomplishments

- **MIL-STD-883K Change 2 TM2012.10 Lid Seal Voids Requirements**
  - From paragraph 3.10.2.2 Unacceptable construction:
    - Any device wherein the integral lid seal is not continuous or is reduced from its designed sealing width by more than 75 percent.
    - Width reduction to less than 75% may be the result of either a single void or a combination of voids in the same width area (see figure 2012-7).
  - Fillets are not included in the designed (intended) sealing width.

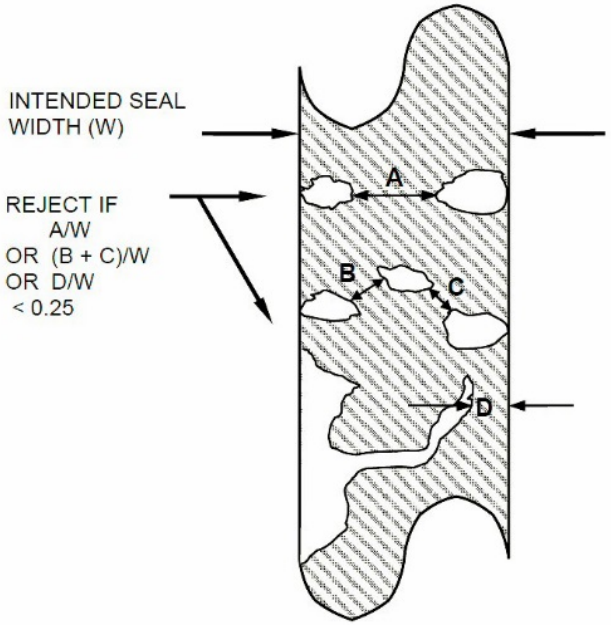


FIGURE 2012-7. Lid seal voids and rejection criterion.

Accomplishments

- **MIL-STD-750 TM2076 Lid Seal Voids Requirements – Includes Fillet**
  - 1.1.1 Designed sealing width. The metalized area where the package lid overlaps the package base (see figure 2076–7).
  - 1.1.2 Seal fillet. Exuded seal material, usually concave in shape, which extends from the edge of the package lid to the point of tangency of the package base (see figure 2076–7).
  - 3.8.2.3.2 Defective seal (see figure 2076–2). Any device wherein the lid seal (including the seal fillet when present) is not continuous or is reduced from its designed sealing width by more than 75 percent. The designed sealing width may be reduced by multiple voids (not to include pin hole voids).

    NOTE: Expulsion resulting from the final sealing operation is not considered extraneous material as long as it can be established that it is continuous, uniform, and attached to the parent material and does not exhibit a ball, splash, or tear-drop configuration.

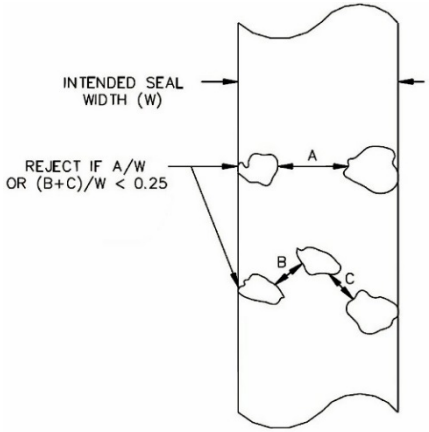


FIGURE 2076–2. Lid seal voids and rejection criterion (drawing).

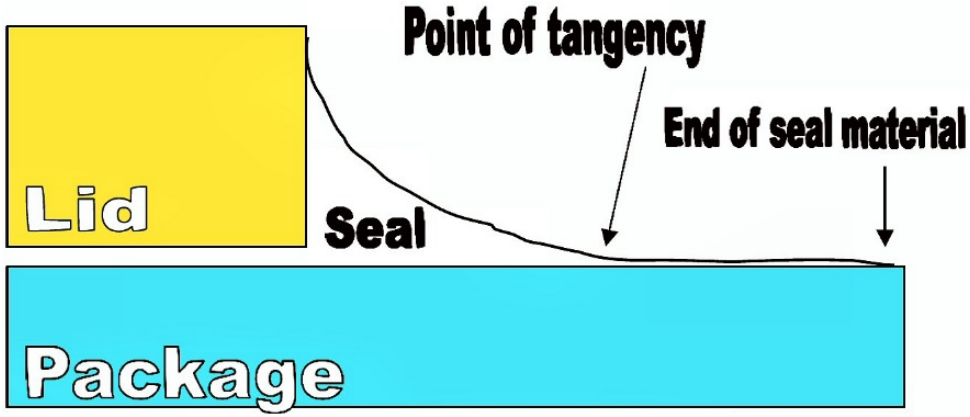


FIGURE 2076–7. Design sealing width and seal fillet graphic.

Accomplishments

- **Justification Not to Allow Inclusion of Fillet in Intended Lid Seal Width**
  - DLA Land and Maritime has no history of why fillet was included in the seal width for MIL-STD-750 product (requirement inserted in TM2076 in 1/3/2012)
    - M750 has significantly tighter leak rates than M883 and some believe the fillet inclusion was a compromise since tighter leak rates and this change were made in the same timeframe.
  - The fillet is not a design feature of the seal process.
    - Fillet width is not a controlled process.
      - Fillet forms when solder flows out from under the lid during the sealing process, and tapering of the fillet results in a non-uniform seal width (see figures on Slide 8).
      - Solder pullback severity can negate the seal effectiveness of the fillet.
      - Microcrack(s) not distinguished in x-rays may compromise seal integrity as they can propagate to a void area when part is placed on board or during box level and system level testing.

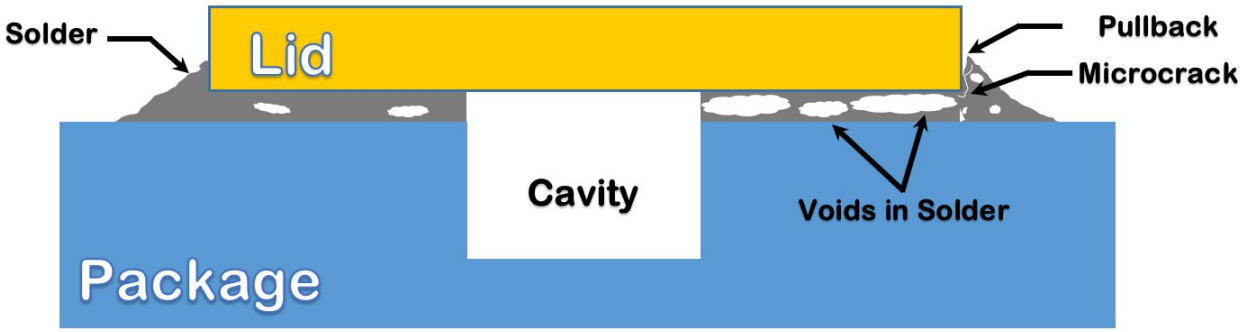
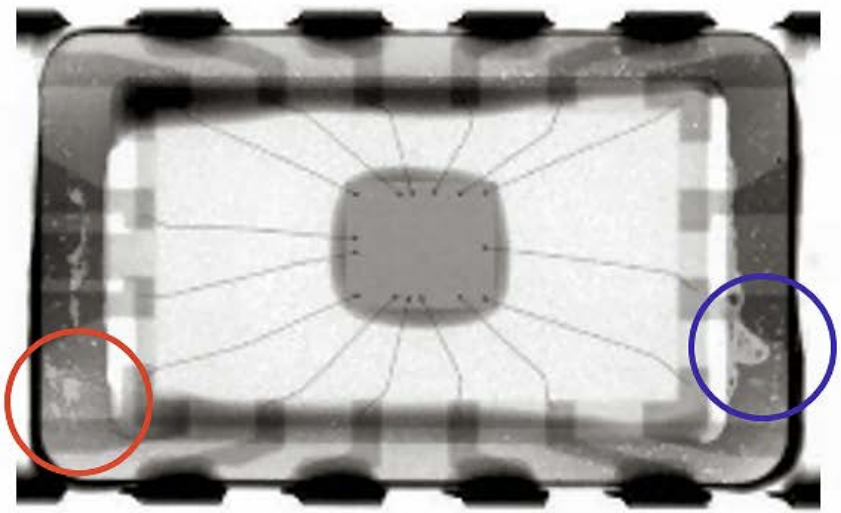


Figure illustrating voids, solder pullback, and microcrack in lid seal

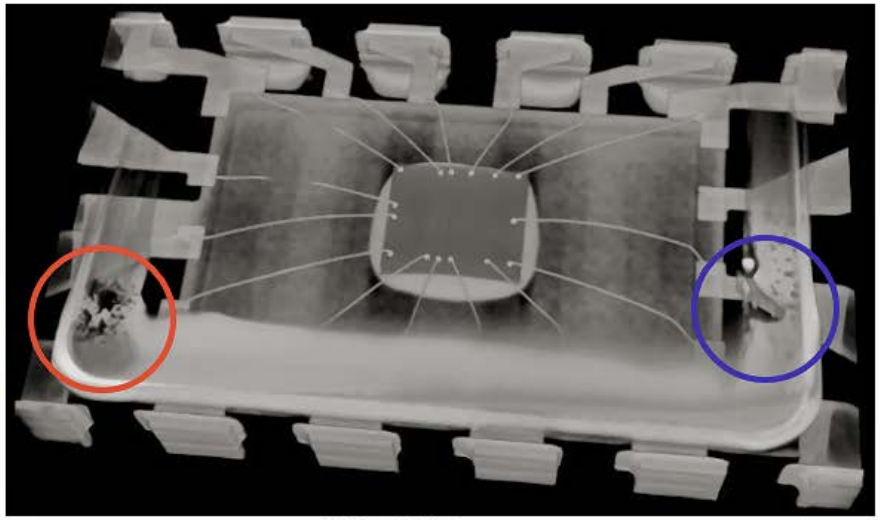
Accomplishments

- **Example 1: Excessive Voiding Underneath Lid**
  - Voids may reduce sealing width underneath the lid by more than 75% and also contact the fillet.
    - Microcrack(s), not distinguished in x-ray, may compromise seal integrity as they can propagate to a void area.
  - The current lid seal requirements would fail this device, yet pass if the fillet is included in the intended seal width.

Source: NASA MSFC Part and Images



2D Image



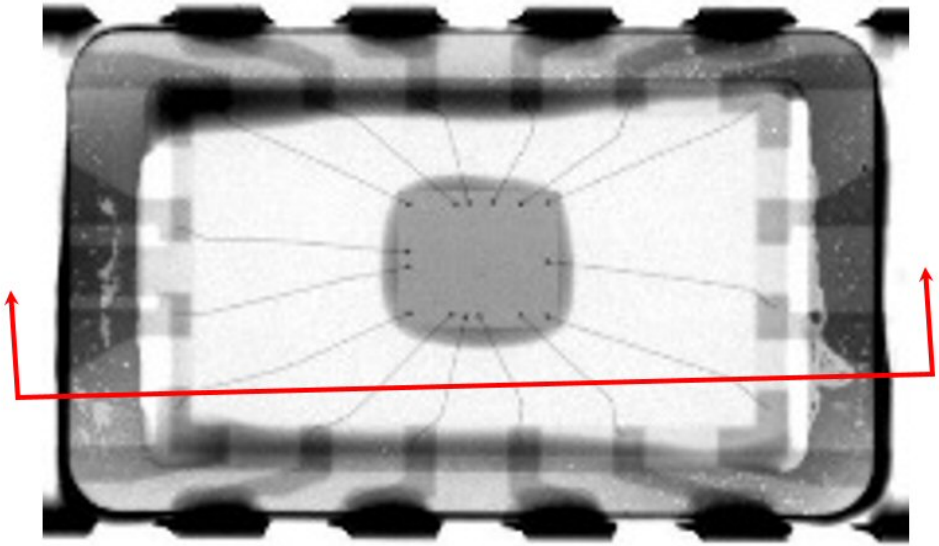
3D-CT Image

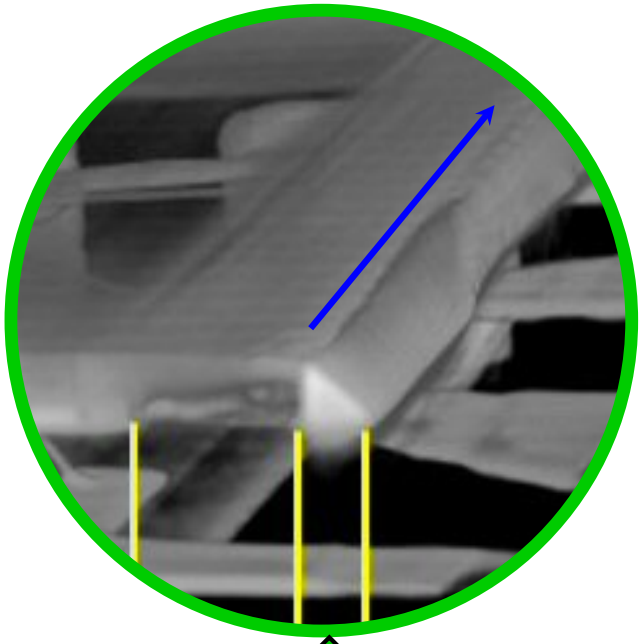
This part was a randomly selected sample and had this void issue. Because this part was randomly selected, it is highly probable that there are other parts with similar issues.

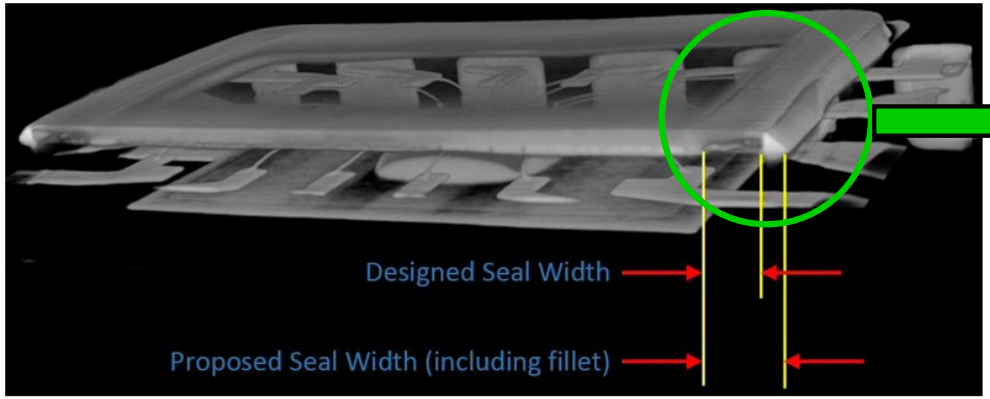
Accomplishments

- **Example 1: Excessive Voiding Underneath Lid (continued)**
  - The current lid seal requirements would fail this device, yet it would pass if the fillet is included in the intended seal width.

Source: NASA MSFC Part and Images





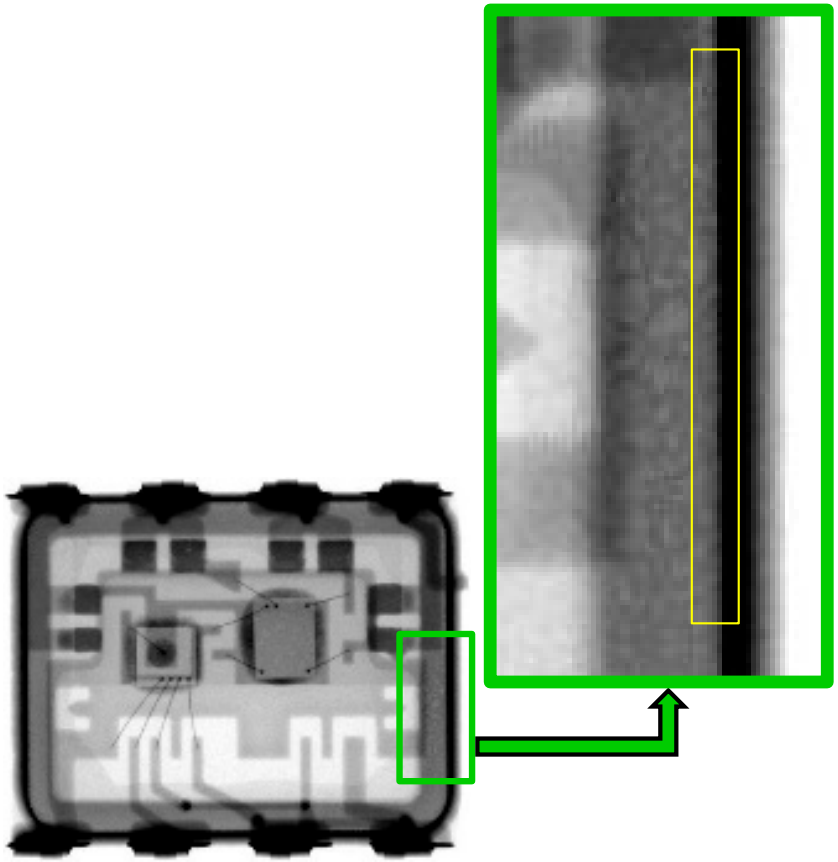


Darkened areas in the designed seal width are voids and the fillet width tapers (blue arrow).

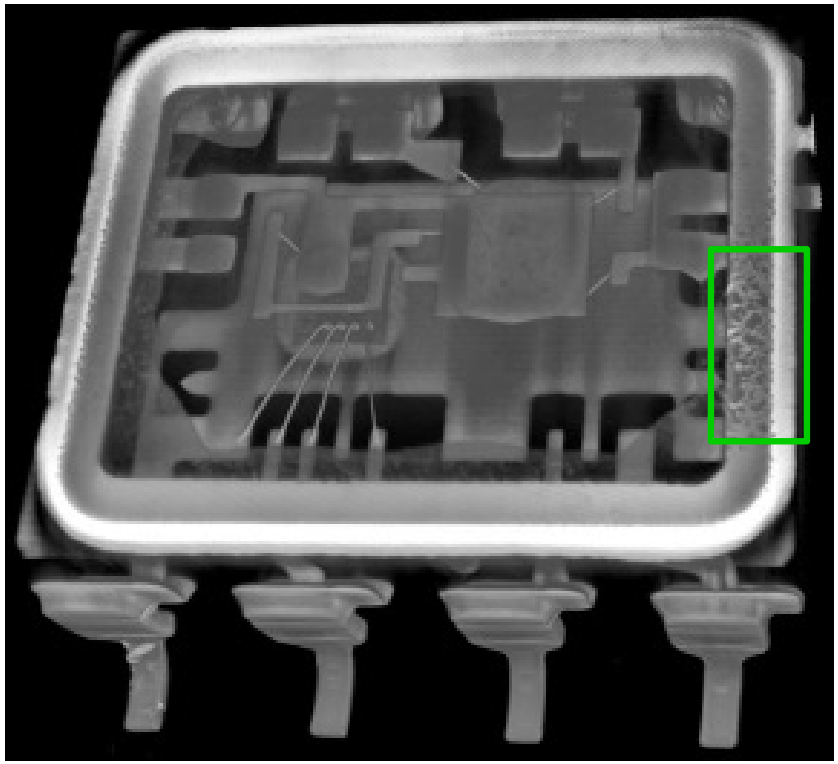
Accomplishments

- **Example 2: Excessive Voiding Underneath Lid**
  - Voids reduce sealing width underneath the lid by more than 75% and pinholes exist in fillet area next to the lid. Note that the pinholes are not clearly detected in the 2D x-ray image (yellow box) due to the thick, x-ray dense solder of the fillet.

Source: NASA GSFC Part and MSFC Images



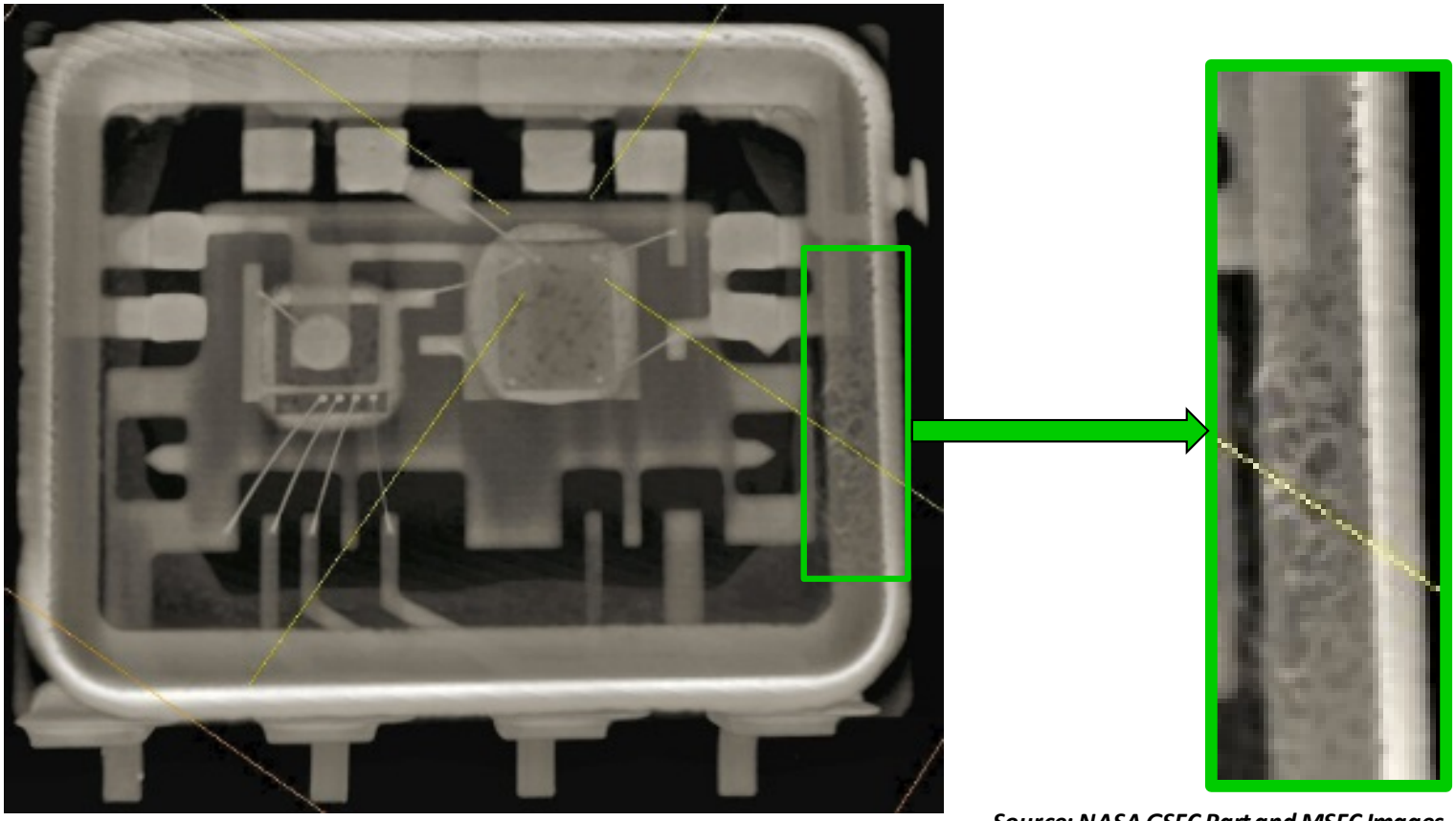
2D Image



3D-CT Image

Accomplishments

- **Example 2: Excessive Voiding Underneath Lid (continued)**
  - Another 3D-CT image of the device shown on Slide 9. This part would fail the current criteria, but would pass if the fillet was included in the design width. Note the pinholes in the fillet next to the edge of the lid, which provides a potential leak path.



Source: NASA GSFC Part and MSFC Images

Accomplishments

- After the GWG presentations, it was agreed by the JEDEC task group in January 2018 that the inclusion of the fillet as part of the intended seal width would not be added to MIL-STD-883 TM2012 due to the fact that:
  - The formation of the fillet is not a design feature of the seal process. Fillets form when solder flows out from under the lid during the seal process.
  - In most if not all cases, the fillet width by itself would meet the 25% required seal width.
- The GWG also recommended the fillet allowance stated in MIL-STD-750 TM2076 be removed. This allowance will be removed in the next draft.
  - Even though TM1071 leak rate limits are tighter than those given in MIL-STD-883 TM1014 (with the exception of space level hybrid microcircuits), these tests are performed on pristine product, which does not take into consideration mechanical shock/vibration/thermal stress induced during handling, installation, board/box/system level testing, and end use.
  - GWG asked DLA and JEDEC for technical justification of why the fillet was added in the 1/2012 release. They could not find any technical justification.

Accomplishments

- **In the 2018/2019 timeframe, a manufacturer requested DLA optimization of TM2012 for their 80Au-20Sn seam sealed packages. The proposal was to include the fillet as part of the intended seal width. This proposal was withdrawn by the mfg.**
  - GWG demonstrated that this optimization would allow instances of 100% voiding in the seal width area due to the solder fillet meeting the 25% requirement.
    - *GWG presented the consensus objection letter signed by NASA, US Air Force (SMC/AFMC), Navy, and Army representatives that was sent to DLA for review which opposed 95% voiding.*
  - GWG contacted a SME at Sandia National Laboratories who has several studies regarding AU/SN solder seal wetting issues. He advised not to relax the specification. His basis was it is not part of the seal frame joint and it is not load bearing due to the fact it is not wetted to the lid. Additionally, the AWS only recognizes the wetted bond area and has tighter criteria, 70%.

2. Military Document Draft Reviews

- **GWG supported the technical review of 6 draft documents and representatives compiled comments. Comments are submitted to DLA or SAE for consideration in the next revision or release.**
  - MIL-PRF-123 Rev E 2nd Draft "Capacitors, Fixed, Ceramic Dielectric, (Temperature Stable and General Purpose), High Reliability (Space)"
  - MIL-PRF-28750 Rev K Draft "Relays, Solid State, General Specification for"
  - MIL-PRF-38534 Rev L Draft "Hybrid Microcircuits, General Specification for"
  - MIL-STD-1580 Rev C Draft Compilation of Comments "Destructive Physical Analysis for Electronic, Electromagnetic and Electromechanical Parts"
  - Members attended Coordination Meeting to adjudicate 218 comments
  - SAE AS6294/3 and /4 Requirements for Plastic Encapsulated Microcircuits Discrete Semiconductors in Space and Military/Avionics Applications

Work in Progress

- **JEDEC Task Group proposal to change MIL-STD-883 TM2012 X-ray lid seal failure criterion.**
  - Would remove "B + C" requirement and replace with seal length calculation along perpendicular line drawn from edge of package to cavity
  - Would allow fillets to be part of intended seal width
  - GWG does not support this change

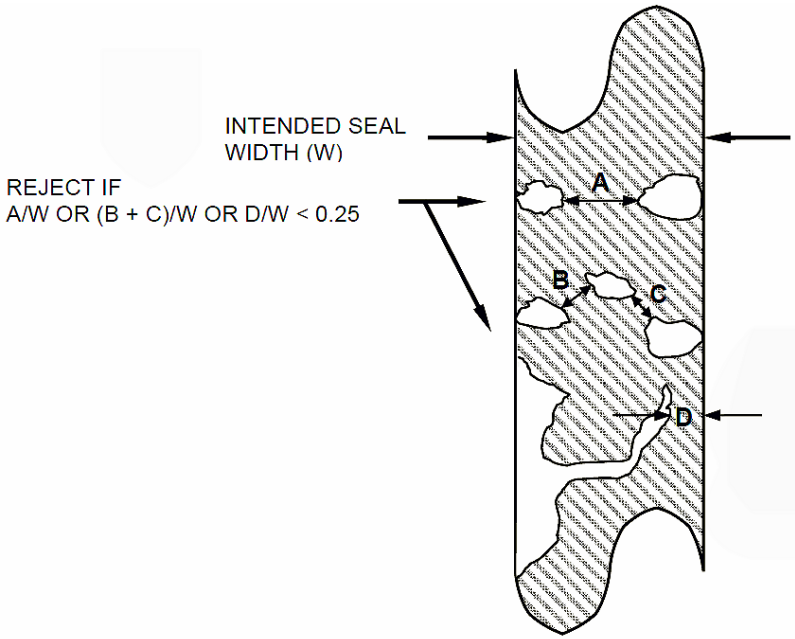


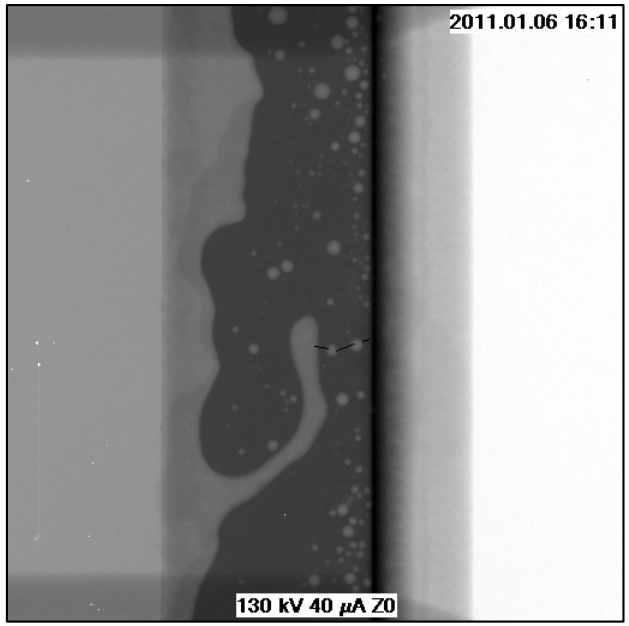
FIGURE 2012-5. Lid seal voids and rejection criterion.

From MIL-STD-883K w/Change 1 TM2012.9

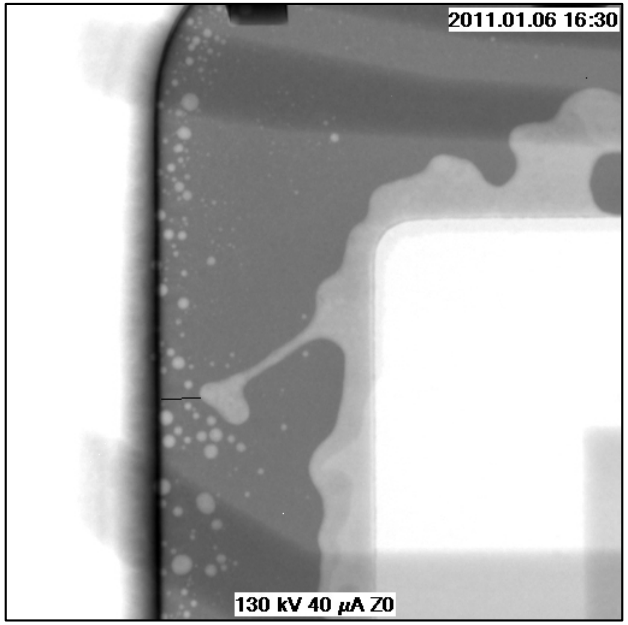
(continued on next page)

Work in Progress (cont.)

- **JEDEC Task Group proposal to change MIL-STD-883 TM2012 X-ray lid seal failure criterion (cont.)**
  - These microcircuits would pass the proposed criteria



A



B

X-ray Image of Voids

Source: A. NASA MSFC JN11-009 SN0079, B. NASA MSFC JN11-009 SN0167

Work in Progress (cont.)

- **Polymer Tantalum Capacitor MIL-Spec Development Working Group Activity Discussions**

Working Group Focus:

1. Develop MIL spec for polymer tantalum capacitors for a diverse range of applications (e.g., terrestrial airborne space, etc.). Two product levels shall be developed:
   - ❑ M Level for standard product
   - ❑ T Level for hi-rel (e.g., space)
2. Develop a series of slash sheets to cover specific product families/constructions Possibilities include:
   - ❑ Standard single anode
   - ❑ Multi anode
   - ❑ Molded case vs. conformal coat

❖ *Hermetic leaded and hermetic surface mount capacitors most likely will not be included with this working group effort*

Work in Progress (cont.)

- **Data Retention Requirements**
  - **Current data retention requirements are not the same for all commodities:**

MIL-PRF-38534:	3 years all Classes except Class K; Class K: 7 years
MIL-PRF-38535:	5 years (records pertaining to screening and quality conformance)
MIL-PRF-19500:	10 years
MIL-STD-790:	The records pertaining to production processes, incoming, and in-process inspections should be retained for a minimum of 3 years (7 years for space level) and those pertaining to performance verification retained for a minimum of 5 years (7 years for space level) after performance of the inspections. Records pertaining to alternate methods (with qualifying activity approval), conformance testing shall be retained for 5 years (7 years for space level) after the process or materials affected have been removed from the qualified flow.

- **GWG requested DLA to perform an EP Study. We provided proposed wording and survey questions for manufacturers input.**

Work in Progress (cont.)

- **Data Retention Requirements (cont.)**
  - ***The proposed requirement wording consisted of the following:***

Record retention. The manufacturer of QML devices (all class levels) shall retain all design, manufacturing, testing and quality records for each lot for a period of 15 years after delivery of product. The records shall include as a minimum:

a. Design
b. Manufacturing
c. Travelers
d. Inspection
e. Test results
f. Screening results
g. Qualification plans and results
h. Quality conformance test results
i. Rework
j. Failure analysis and corrective actions
k. TRB decisions
l. Training
m. Customer returns

The records shall be retained in the form in which they were originally defined but electronic media is preferred and a copy shall be provided to the qualifying and/or procuring activity as requested.

Work in Progress (cont.)

- **Data Retention Requirements (cont.)**
  - ***The EP Study survey questions posed were as follows:***

1. What is the standard amount of time manufacturers retain data for military products? For commercial products?
2. Is a proposed 15 year retention time acceptable?
3. What concerns do manufacturers have with retaining records electronically?
4. Can all lot data be retained, including travelers, incoming inspection, R&R, screening, QCI, etc. If the answer is no, what data can be retained?
5. What financial hardship, if any, would this endeavor impose?
6. For users of military devices, are there any additional types of data that you would like to see retained?

Work in Progress (cont.)

- **Data Retention Requirements (cont.)**
  - **DLA conducted 2 EP Studies to ensure adequate distribution to all technologies. Regarding the survey question as to whether a 15 yr. retention time was acceptable:**
    - 1st Study (MIL-PRF-19500,-38534,-38535): 14 responses
      - ✓ *5 Yes, 5 No, 3 agreeable to 10 yrs., 1 concerned with cost*
    - 2nd Study (MIL-STD-790): 12 responses
      - ✓ *7 Yes, 5 No (feedback indicated current retention times varied from 5 -25 yrs. for military product and 0 -10 yrs. for commercial product)*
  - **DLA decided against an all encompassing specification change**
  - **GWG decided to pursue a compromised 10 yr. retention time in the next revisions of MIL-PRF-38534, -38535 and MIL-STD-790**

Work in Progress (cont.)

- **MIL-STD-750 & -883 TM1018 Internal Gas Analysis**
  - **Concerns:**
    - IGA/RGA has been at the center of controversy in regards to correlation between test labs and "RGA Roulette"
    - GWG technically discussed a problem advisory where two associated test labs performed small volume testing without DLA lab suitability
  - **Response:**
    - GWG is collaborating with a third party to develop a verification process to confirm test equipment capability

Work in Progress (cont.)

- Miscellaneous
  - **Additional Topics Addressed in Meetings:**
    - EP Studies
    - RHA qualification concerns in specification documents
    - Data sensitive issues:
      - Manufacturers concerns and process improvements
      - Findings from audits/pre-cap inspections
  - **Future Topics:**
    - Review test methods of MIL-STD-202
    - Standardization of connector specifications
    - Glass transition temperature (Tg) concerns for plastics

Questions?

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