

## ENGINEERING PRACTICE STUDY

TITLE: RADIOGRAPHIC INSPECTION CRITERIA FOR LEADED  
CERAMIC CAPACITORS IN [MIL-PRF-39014](#)

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## FINAL REPORT

Study Conducted by DLA Land and Maritime

Project Number: 5910-2025-007

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**I. OBJECTIVE:** An engineering practices study has been conducted to solicit feedback from leaded ceramic capacitor manufacturers and users regarding the radiographic inspection criteria in [MIL-PRF-39014](#) (Capacitor, Fixed, Ceramic Dielectric (General Purpose) Established Reliability and Nonestablished Reliability, General Specification for). This study was initiated in response to CE11 (Component Parts Committee) task 24-101.

**II. BACKGROUND:** A radiographic inspection is required on 100 percent of the failure rate level (FRL) "S" capacitors produced in accordance with [MIL-PRF-39014](#) (specification sheets /1, /2, /5, and /23). The radiographic images are used to ensure proper lead attachment as specified in paragraph 4.7.21e(1):

*(1) There shall be a minimum of 80 percent solder fillet between capacitor element and each lead.*

This lead attachment requirement was added to [MIL-PRF-39014](#) over 50 years ago when wet film radiographic techniques were employed to perform this inspection. Wet film can be used to detect the presence of solder between the capacitor element and the leads but little more. Today, radiographic equipment is much more sophisticated and can detect solder voids and bubbles within the solder fillet. These anomalies present as shade variations in the radiographic images.

DLA Land and Maritime believes that the purpose of 4.7.21e(1) is simply to ensure proper lead attachment by confirming the presence of solder between the capacitor element and each lead for at least 80 percent of the interface dimension. Not to detect voids or bubbles internal to the solder fillet. Therefore, we are proposing that the following (or similar) wording be added to 4.7.21e(1) for clarification:

*Voids or bubbles, as indicated by shade variations in the radiographic image, that reduce the thickness of the solder fillet between the capacitor element and the leads shall not be considered a lack of solder attachment.*

**NOTE:** DLA Land and Maritime considers the destructive physical analysis requirements of [EIA-469](#) (Standard Test Method for Destructive Physical Analysis (DPA) of Ceramic Monolithic Capacitors) to be a separate issue and not relevant to this study.

**III. RESULTS:** Recipients of this were asked to provide concurrence, objection, or comments regarding the proposal to add the clarification [above](#) to [MIL-PRF-39014](#). Two qualified manufacturers responded in agreement with the study. In addition, the following comments were received:

1. Missile Defense Agency (MDA):

Recommend updating the acceptance criteria in [MIL-PRF-39014](#). Section §4.7.21e(1) states "There shall be a minimum of 80 percent solder fillet between capacitor element and each lead." I believe the intent of the inspection is "solder fill" not "solder fillet" at the interface of the capacitor element and the lead. Recommending "The interface between each lead and capacitor element shall have solder for at least 80 percent of the interface dimension (see figure 6)". Is DLA proposing to add the same verbiage: "Voids or bubbles, as indicated by shade variations in the radiographic image, that reduce the thickness of the solder fillet between the capacitor element and the leads shall not be considered a lack of solder attachment." to similar standards such as [MIL-PRF-123](#)? This has the same Radiographic Inspection requirements for capacitors of very similar construction.

2. Air Force:

Air Force concurs with the proposed changes. Air Force also concurs with MDA's comment; fill would be a better term vs. fillet in [MIL-PRF-39014](#) section §4.7.21e(1).

3. NASA:

My problem is in the note. [EIA-469](#) addresses voids in the solder and requires that the voids ARE to be counted as part of the 80% fill and voiding that causes this to be exceeded are rejectable. The DLA change does contradict the requirements in [EIA-469](#) where the 80% fill allows for some voiding but not so much that the solder joint is weakened. If DLA goes forward with their change indicating that all voids should be omitted, it would contradict [EIA-469](#) in my opinion. Therefore my suggestion is to incorporate the wording in EIA-469E so that both requirements are in agreement.

**IV. CONCLUSIONS:** Respondents to this study are generally in agreement with the [proposal](#) presented herein. Suggestions were made to update the current radiographic inspection requirement in [MIL-PRF-39014](#), and concerns were raised that the [proposed wording](#) contradicts the DPA requirements in [EIA-469](#) regarding voids. DLA Land and Maritime does not disagree about the contradiction; however, [MIL-PRF-39014](#) does not reference [EIA-469](#) and makes no mention of voids.

**V. RECOMMENDATIONS:** Based on the feedback received as a result of this study, DLA Land and Maritime will revise [MIL-PRF-39014](#) to update the acceptance criteria as suggested and add the [clarification](#) proposed above to paragraph 4.7.21e(1). Similar wording will also be considered for [MIL-PRF-20](#) and [MIL-PRF-123](#).