SUBJECT:	MANUFACTURER	PAGE NO.:	NO. OF PAGES:
Insulation Resistance Degradation of "BG" Characteristic Ceramic Chip Capacitors	American Technical Ceramics (ATC)	1	6
	CAGE CODE: 29990	**PARTS ADVISORY** OFFICIAL BUSINESS U.S. GOVERNMENT	
PART NO.: "BG" Characteristic Parts ONLY: MIL-PRF-55681/4 (CDR11-CDR14) MIL-PRF-55681/5 (CDR21-CDR25) ATC100A, ATC100B, ATC P90 Types	**FSC CODE:** 5910		

REFERENCE: GIDEP Problem Advisory VV-P-99-01, GIDEP Alert F3-A-99-01

MESSAGE TO BE TRANSMITTED

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PURPOSE:

Potential problems have been reported with some "BG" characteristic ceramic capacitors made by American Technical Ceramics (ATC) of Huntington Station, NY (CAGE Code: 29990). The following references provide a detailed explanation of the failure mode and suspected mechanism:

- GIDEP Alert F3-A-99-01 dated 10/05/99
- Jet Propulsion Laboratory (JPL) NASA Advisory NA-JPL-007 dated 09/06/99
- GIDEP Problem Advisory VV-P-99-01 dated 08/30/99

The purpose of this NASA Parts Advisory is to provide more current information and guidance to the NASA community regarding this issue including:

- Proper identification of potentially affected products
  (Part number, manufacturing lot number, date code, etc.)
- Application guidance
- Analysis techniques
  (Scanning Electron Microscopy [SEM] backscatter, electrical testing)

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SUBJECT: Insulation Resistance Degradation of "BG" Characteristic Ceramic Chip Capacitors	NA-048	PAGE NO.: 2	NO. OF PAGES: 6
PART NO.: "BG" Characteristic Parts ONLY: MIL-PRF-55681/4 (CDR11-CDR14), MIL-PRF-55681/5 (CDR21-CDR25) ATC100A, ATC100B, ATC P90 Types			**PARTS ADVISORY** OFFICIAL BUSINESS U.S. GOVERNMENT
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MESSAGE TO BE TRANSMITTED

PURPOSE (Continued):

Release of this value-added update to previously published information is made possible by the cooperation of ATC and the user/industry community. This Advisory contains the best information available at this time. Follow-up information will be provided if the situation warrants.

PROBLEM DESCRIPTION:

The referenced GIDEP documents explain that a small percentage of ATC ceramic capacitor products are susceptible to insulation resistance degradation (including the potential for short circuits). ATC attributes this problem to "BG" characteristic dielectric lots that were over-fired using a batch kiln firing process first introduced by ATC in late 1994. The potential for over-firing using this process continued until the middle of 1998 at which time ATC had fully implemented corrective actions to properly control the temperature profile within these kilns.

ATC and industry analysis has found that over-firing of this dielectric type may create strontium titanate (an additive used in this dielectric type) clusters within the ceramic dielectric. These clusters (observable on cross sectioned samples via Scanning Electron Microscopy [SEM] backscatter techniques) may extend completely or partially between opposing electrodes within the capacitor thus leading to decreased insulation resistance or potential short circuits under certain application conditions.

IDENTIFICATION OF POTENTIALLY AFFECTED PRODUCTS:

All of the potentially affected products were processed in batch kilns between late 1994 and mid-1998 and may be identified by any of the following product designations:

- CDR11BG, CDR12BG, CDR13BG, CDR14BG made in accordance with MIL-PRF-55681/4
- CDR21BG, CDR22BG, CDR23BG, CDR24BG, CDR25BG made in accordance with MIL-PRF-55681/5
- ATC100A and ATC100B series
- ATC's "P90" dielectric types (voltage/temp. characteristic of positive 90 ± 20 ppm/°C)
- Customer Source Control Drawing (SCD) based upon any of the above products

NOTE: Parts manufactured with "BP" or "BX" dielectric formulations are not susceptible to the failure mechanism described by this Advisory.

SUBJECT: Insulation Resistance Degradation of "BG" Characteristic Ceramic Chip Capacitors	NA-048	PAGE NO.: 3	NO. OF PAGES: 6
PART NO.: "BG" Characteristic Parts ONLY: MIL-PRF-55681/4 (CDR11-CDR14), MIL-PRF-55681/5 (CDR21-CDR25) ATC100A, ATC100B, ATC P90 Types		**PARTS ADVISORY** OFFICIAL BUSINESS U.S. GOVERNMENT	

REFERENCE: GIDEP Problem Advisory VV-P-99-01, GIDEP Alert F3-A-99-01

MESSAGE TO BE TRANSMITTED

IDENTIFICATION OF POTENTIALLY AFFECTED PRODUCTS (Continued):

The critical steps necessary to identify potentially affected parts are as follows:

1. Capacitors must be from ATC (CAGE Code: 29990)
2. Capacitors must be "BG" characteristic dielectric as noted above
3. Capacitors must have been fired using the "batch" kiln process during the period when it was not consistently controlled (late 1994 to mid 1998).
   a) Providing ATC with the ATC manufacturing lot number is the most effective way to determine when and how the capacitors were fired. The ATC manufacturing lot number is ten characters long of the form:

      B 25 G 471 E S T, where

      B = Product Series
      25 = Week of Fabrication (approximately two weeks prior to firing)
      G = Year of Fabrication
      471 = Capacitance Code
      E = Run
      S = Plant I.D.
      T = Case Size

      Armed with this information, ATC will be able to assist the user in determining if their capacitors were manufactured using the suspect firing process.

   b) **Users should not rely on the "inspection" lot date code (LDC) as a guide to determine the date when the capacitors were fired**. ATC assigns the inspection LDC, which users commonly use for traceability, as the date when Quality Conformance (Group A) testing is performed. However, this date code does not correlate to the firing date because ATC stocks finished capacitors (prior to Group A) for extended periods (at least as long as six years). When filling orders, ATC may select capacitors from stock, perform Group A testing, and then assign the inspection LDC. Therefore, the manufacturing LDC (which is critical to determining when and how the lot was fired) is different from the inspection LDC and can differ by several years. The GIDEP Alert indicates that products with manufacturing LDCs of 9449 through 9822 are at risk. We suggest that users review products with inspection lot date codes in the range of 9440 through 9930 for the following reasons:

SUBJECT: Insulation Resistance Degradation of "BG" Characteristic Ceramic Chip Capacitors	NA-048	PAGE NO.: 4	NO. OF PAGES: 6
PART NO.: "BG" Characteristic Parts ONLY: MIL-PRF-55681/4 (CDR11-CDR14), MIL-PRF-55681/5 (CDR21-CDR25) ATC100A, ATC100B, ATC P90 Types		**PARTS ADVISORY** OFFICIAL BUSINESS U.S. GOVERNMENT	

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MESSAGE TO BE TRANSMITTED

IDENTIFICATION OF POTENTIALLY AFFECTED PRODUCTS (Continued):

1. Lower bound of 9440 is suggested as a guard band because ATC record keeping from that time period is not convincingly clear as to the earliest possible introduction of the batch kiln process.
2. Upper bound of 9930 is suggested as a guard band because we have learned that ATC began to quarantine residual stock of affected products at some time in the middle of 1999. Therefore, it is possible that up until mid-1999 ATC could have pulled over-fired capacitors from stock, Group A tested them and marked them with a mid-1999 inspection lot date code.

Not all lots within this date code range are over-fired, but users should take appropriate measures to identify and classify potentially affected products.

CLASSIFICATION OF SUSPECT PRODUCTS:

Users who determine that they have capacitor lots that are potentially over-fired will need to classify these lots in terms of their risk of failure. It is currently accepted that lots, which have been over-fired, may develop strontium titanate clusters that are capable of reducing the insulation resistance and/or shorting the capacitor. Parts must be evaluated on a lot by lot basis in order to determine proper actions to be taken. At present, three basic approaches or a combination thereof are being employed by ATC and the industry to identify lots that have been over-fired. These approaches are:

- Scanning Electron Microscopy (SEM) using a backscatter technique
- Accelerated electrical testing (high temperature with DC bias)
  It has been found that tests using DC with superimposed AC are not necessary to stimulate degradation.
- Review of application stresses

SEM Backscatter Technique

The SEM backscatter technique and classification system established by ATC and the industry are well defined in the GIDEP Alert and will not be redefined here. We suggest that capacitor lots classified as SEM category 1 or 2 are acceptable for use in NASA programs "as-is". Products that fit the category 3 and 4 designations are not suggested for use; however, projects must assess each application on a case-by-case basis in accordance with the project's mission requirements and objectives. Further evaluation either in the form of accelerated electrical testing or review of application condition stresses may be warranted.

SUBJECT: Insulation Resistance Degradation of "BG" Characteristic Ceramic Chip Capacitors	NA-048	PAGE NO.: 5	NO. OF PAGES: 6
PART NO.: "BG" Characteristic Parts ONLY: MIL-PRF-55681/4 (CDR11-CDR14), MIL-PRF-55681/5 (CDR21-CDR25) ATC100A, ATC100B, ATC P90 Types		**PARTS ADVISORY** OFFICIAL BUSINESS U.S. GOVERNMENT	

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MESSAGE TO BE TRANSMITTED

Accelerated Electrical Testing

Many in the industry have performed extensive research developing electrical tests that can reliably and quickly identify high-risk lots. Numerous test conditions have been experimented with including pure DC, pure AC and DC with AC superimposed. The industry is now tending to use DC only with these two test condition options:

Test Condition Option 1	Test Condition Option 2
Temperature = 140°C	Temperature = 140°C
Vtest = 40 Vdc	Vtest = 80 Vdc
Duration = 100 hours	**Duration = 20 hours
Pass/Fail Criteria = Comparison of Pre and Post Test Insulation Resistance	

Note: these test conditions are considered to be destructive
*****We recommend 30 hours to provide sufficient acceleration to simulate long term missions [15+ years]***

When performed on sample capacitors from each suspect lot, these tests have been effective at finding substandard lots. Typical sample size is 20 pieces per lot.

Parts that exhibit the subject failure mechanism seem to develop "semiconductor-like" behavior with a forward conducting voltage threshold on the order of 2.5 to 3 Volts independent of dielectric thickness. Because of this polarity sensitive behavior, it is VERY IMPORTANT that the polarity of the test and measurement voltage be the same. Also, based on this semiconductor-like behavior, applications at 2.5 Volts and below (possibly 3 Volts and below) are believed to be low risk. However, more data needs to be analyzed to verify this behavior and to confirm the observed voltage threshold.

Review of Application Stresses

The cooperative industry and ATC working group that has been formed to investigate this problem has been effective at defining risks that are application specific. It is generally accepted that:

- Pure AC applications are not susceptible to the failure mechanism described herein.
- DC applications with an AC signal superimposed where at least 50% polarity reversal occurs are low risk.
- Pure DC applications are at risk
- DC applications with an AC signal superimposed where no polarity reversal occurs are at high risk.

SUBJECT: Insulation Resistance Degradation of "BG" Characteristic Ceramic Chip Capacitors	NA-048	PAGE NO.: 6	NO. OF PAGES: 6
PART NO.: "BG" Characteristic Parts ONLY: MIL-PRF-55681/4 (CDR11-CDR14), MIL-PRF-55681/5 (CDR21-CDR25) ATC100A, ATC100B, ATC P90 Types		**PARTS ADVISORY** OFFICIAL BUSINESS U.S. GOVERNMENT	

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MESSAGE TO BE TRANSMITTED

Review of Application Stresses (Continued)

- For some capacitance ranges and styles, ATC designs each capacitor with an internal series connection of capacitors. Parts using this design construction are at reduced risk since the voltage across the entire capacitor is divided amongst the internal capacitors. This voltage division reduces the stress on the dielectric that would otherwise be present on a capacitor using a single internal capacitor design. ATC uses this construction on CDR14BG capacitors less than or equal to 51 pF.
- At this time parts operating with a peak stress of 2 volts or less are considered acceptable risk, regardless of SEM category.

A large database is being compiled by ATC, Government Agencies and Customers that contains data on SEM backscatter and electrical testing results related to the lot firing date. It may be possible to determine if parts on hand are considered acceptable by comparing them to this database. Parts can be compared to this data by supplying ATC with the ten character ATC manufacturing lot number. If the manufacturing lot number is not available, ATC may be able to identify the lot using the customer or military part number, inspection lot date code, purchase order number, etc.

FOR ADDITIONAL INFORMATION:

Follow up information will be provided if the situation warrants. For questions or comments, please do not hesitate to contact:

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