

Acceptance Criteria and Workmanship Standards at Semicon Associates

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This abstract presents a limited review of work accomplished by Semicon Associates in the project area of "Acceptance Criteria" for dispenser cathodes. This work was funded by Department of Defense Title III program office, and managed by the Manufacturing Technology Information Analysis Center operated by IIT Research Institute, for work specified in the Statement of Work entitled "Supply Chain Viability for the U.S. Microwave Tube Industry."

The goal for the project was for Semicon Associates in conjunction with the Title III Vacuum Electron Device working group to jointly agree upon language, photographs and/or illustrations for inclusion in developing the industry standard and to promote consistent interpretation of product quality during and after manufacturing. Additionally, Semicon Associates project called for developing internal acceptance in 14 critical to quality processing steps to provide for consistent internal interpretation, and where possible, provide the instructional means for training and training validation, as well as defining some of the unusual terminology found within the standard. The 14 critical manufacturing operations defined within the project were:

- Surface finish requirement and defect recognition for Tungsten Pellets, Molybdenum Bodies, Potting, Heaters, and Machining;
- Various Braze Joints for cold braze acceptance, % of seal, and visual criteria
- Impregnation for visual appearance, and weight gain;
- Chemical and Mechanical Cleaning,
- Heater Test for repeatability; and
- Final Inspection.

The methodology applied to this project was started with a complete gap analysis on all applicable customer, industry, and Semicon Associates specifications. In those cases where analysis showed, for the most part, across the board agreement within the specification types, those attributes were classified or grouped for "Acceptance Criteria by Product Feature", (i.e. Feature Potting – Cracks, ..., etc). Those requirements which were determined to be more product specific or customer specific were classed as Acceptance Criteria by Product/Part Number." In all cases where minor differences existed between specifications, the more stringent requirement was deemed as taking precedence and Acceptance Criteria was built around that requirement.

This program has resulted in improved training efficiency, documented internal acceptance criteria, an electronic library of photographs detailing defects and methods of recognition, assembly and fabrication methods, and written instructions. All of which has contributed to improved manufacturing efficiency, productivity and significantly reduced the costs associated with scrap and rework. The results of this program have improved Semicon Associates quality system and resulted in several spin-off projects aimed at future process improvement initiatives.

Approved By: _____
Date: _____ Res. A


Feature: Potting Cracks

Acceptance Criteria:


- o Cracks that exceed .003 in width are cause for rejection.
- o No more than four cracks in potting allowed. The acceptable cracks (5 or less) shall:
 - a. Start and end at point on the cathode sleeve that subtend an arc of 135 degrees or greater of the potting circumference.
 - b. Radiate from the heater leg to the wall, and
 - c. Radiate from the center post to the wall for toroidal heaters.

In all cases if the heater element is visible through the crack the part must be rejected.


In all cases where the operator and/or the department supervisor do not feel confident in making a pass or fail decision using this document, contact a Process Engineer for a disposition and explanation.



Pass
Two cracks radiate from heater leg to sleeve. (Semicon internal specification sets minimum separation at 20 degrees)
Condition B



Pass
One crack on potting, subtended arc is greater than 135 degrees.
Condition A



Fail
One crack in potting, subtended arc is less than 135 degrees.
Condition B

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Definition:

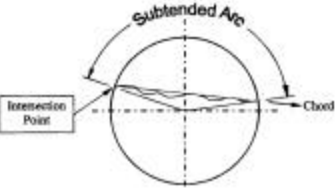
Cracks in Potting - Any separation in the potting that exceed .0005 of width in dimension. Separations in potting that are less than .0005 in width are not defined as cracks, and as such are excluded from consideration when determining fitness for use.

Ocular - An ocular is a graduated eyepiece that can be added to a microscope to measure certain attribute at a fixed magnification. (See your department supervisor for instructions of use.)

"Subtends an arc of 135 degrees or greater": Determining if an arc subtends an angle of 135 degrees or greater is accomplished as follows:

Center the potted surface in the field of view with the angle degree ocular, such that the center point angle degree ocular is at the center of the potting diameter. Rotate the ocular 0 degree line to the intersection point of end of the crack and sleeve wall. To complete the measurement, read the degrees of separation at the opposite crack to sleeve intersection point, if the angle is 135 degrees or greater the part is acceptable.

Finding Subtended Angle: Hypothetically draw a line from one intersection point to the other; this line is geometrically known as a chord. The subtended arc is the generated by angle opposite the chord.

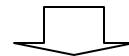


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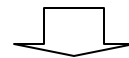
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Realizing that Acceptance Criteria is a defect recognition system which once deployed to the shop floor must meet its clients' needs, Semicon Associates approach to this process was:

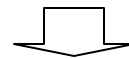
First,
provide the verbatim statement of the feature as described in the specification.



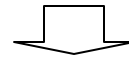
Then breakdown the language within the specification into pictures or illustrations, showing pass/fail or marginal uses representations.



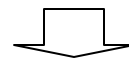
Develop descriptions of each representation that carefully describes the defect in detail and states whether it passes or fails.



Then identify any special handling or lighting conditions that will assist in defect detection.



Then define the terms. Develop definition for terminology contained within the standard to assure compliance and understanding.



And finally, place appropriate controls on the document such as approval, revision, and calibration control.

The author wishes to thank the Title III Cathode Working Group for their contributions to this effort. And I believe, we collectively agree that as additional document such as these are incorporated into a wider industry specification; we as an industry will all benefit.

c SEMICON associates

A Ceradyne Company

Acceptance Criteria and Workmanship Standards

PURPOSE

The project goal for Semicon Associates was to develop clear, concise acceptance criteria and workmanship standards using text, photographs and/or illustrations which promote consistent interpretation of product quality during and after manufacturing.

PROJECT SCOPE

14 Critical Manufacturing Processes were defined within the scope of the project:

- Surface finish requirements and defect recognition for:
 - Tungsten Pellets, Molybdenum Bodies, Potting, Heaters, and Machining
- Braze Joints:
 - Cold Braze Acceptance , % of Seal, and Visual Criteria
- Impregnation: Appearance and Weight Gain
- Chemical and Mechanical Cleaning
- Heater Test
- Final Inspection

Acceptance Criteria as a Communications Model

Semicon Associates recognizes acceptance criteria is a defect recognition system which must meet its clients (internal/external) needs.

Semicon Associates approach:

Breakdown the language within the specification into pictures or illustrations, showing pass/fail or marginal use representations.



Develop descriptions of each representation that carefully describes the defect in detail and states whether it passes or fails.



Identify any special handling or lighting conditions that will assist in defect detection.



Define the terms. Develop definition for terminology contained within the standard to assure compliance and understanding.



Finally, place appropriate controls on the document such as approval, revision, and calibration control.

“Acceptance Criteria and Workmanship Standards at Semicon Associates”

Michael P. Effgen, Special Projects Manager



Acceptable Ceramic to Metal,
Copper Braze Blush
Outside Vacuum Envelope

Feature: Potting Cracks (Verbatim Statement of Standard)

Acceptance Criteria:

- Cracks that exceed .002 in width are cause for rejection
- No more than four cracks in the potting allowed. The acceptable cracks (3 or less) shall:
 - a. Start and end at a point on the cathode sleeve that subtend an arc of 135 degrees or greater of the potting circumference,
 - b. Radiate from the heater leg to the wall, and
 - c. Radiate from the center post to the wall for toroidal heater.

In all cases, if the heater element is visible through a crack, the part must be rejected.

(Breakdown of Language to Pictures or Illustrations)

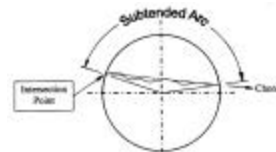
In all cases where the operator and/or the department supervisor do not feel confident in making a pass or fail decision using this document, contact a Process Engineer for a disposition and explanation.



(Defining the Terminology to Enhance Understanding)

“Subtends an arc of 135 degrees or greater”: Determining if an arc subtends an angle of 135 degrees or greater is accomplished as follows:

Center the potted surface in the field of view with the angle degree ocular, such that the center point angle degree ocular is at the center of the potting diameter. Rotate the ocular 0 degree line to the intersection point of end of the crack and sleeve wall. To complete the measurement, read the degrees of separation at the opposite crack to sleeve intersection point, if the angle is 135 degrees or greater the part is acceptable.



Finding Subtended Angle: Hypothetically draw a line from one intersection point to the other; this line is geometrically known as a chord. The subtended arc is generated by angle opposite the chord.

(Special Handling – Defect Detection)

Feature: Cathode - Blisters

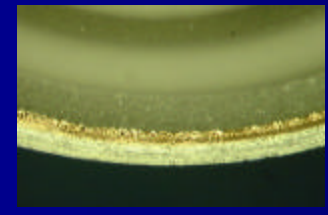
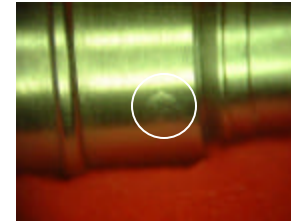
Acceptance Criteria:

No blistering on the cathode surface is acceptable.

Method of Viewing:

This defect is generally best observed by:

Hold the part perpendicular to the microscopes axis of view, then rotating the part about its axis. The defect, as shown in the photograph, becomes apparent as it emerges from the shadows into the light.

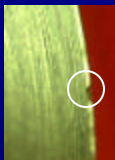
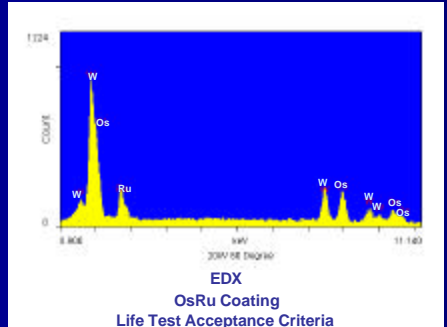


Copper Braze Flow - Ceramic to Metal
Joint at 40X Magnification Acceptable
Inside Vacuum Envelope

Tungsten Pore Structure



- Acceptance Criteria
There shall be a minimum of 30 pores uniformly distributed and visible in a .003” by .005” area.
Photograph at 1000X magnification.



Feature: Cathode Emitter Surface – Chips

Acceptance Criteria:

Chips on the emitting surface or its edge are cause for rejection when visible using 10X microscope.

Acknowledgements

This project was later selected to be included in the project work for "Supply Chain Viability for the U.S. Microwave Power Tube Industry", managed by the DoD Manufacturing Technology Information Analysis Center, IIT Research Institute. Sponsorship for this task is provided by the Defense Production Act, Title III that is executed by the U.S. Air Force, Wright-Patterson Air Force Base

The author also wishes to acknowledge the contributions of the Title III Cathode Working Group: J. Wellington, J. Farrell, M. Wijangco, E. Pekrul, J. Paff, G. Goesser, T.G. Teng, and T. Philippi and her staff at the IIT Research Institute. A special thanks to the employees of Semicon Associates who have contributed countless hours of constructive feedback.