LSSA PROJECT

REJECTION CRITERIA FOR JPL LSSA MODULES

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REJECTION CRITERIA
FOR JPL LSSA MODULES

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Large Scale Production Task
Low Cost Silicon Solar Array Project

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FOREWORD

This work was performed by the Jet Propulsion Laboratory, California Institute of Technology, under National Aeronautics and Space Administration Contract NAS7-100, for the U.S. Energy Research and Development Administration (ERDA), Division of Solar Energy.

The Low-cost Silicon Solar Array (LSSA) Project is funded by ERDA and forms a part of the ERDA Photovoltaic Conversion Program to initiate a major effort toward the development of low-cost solar arrays.
I. OBJECTIVES - The objective of this document is to define the rejection criteria for silicon solar cell modules procured for the JPL Low-Cost Silicon Solar Array Program.

II. APPLICABLE DOCUMENTS - The latest approved revision shall apply.
- Module Performance Requirements, JPL Document 5101-16
- Contractor Interface Control Drawing
- Contractor Top Assembly Drawing

III. INSPECTION REQUIREMENTS
A. Magnification - Inspection will be performed using a microscope with 10X minimum. Higher magnification will be used for evaluation or clarification only.

IV. REJECTION CRITERIA FOR MODULES
The following defects shall cause for module rejection:
(The figures referred to are presented for illustration and clarification purposes only. Module designs not applicable to this criteria will have rejection criteria on a level comparable to those described herein.

A. Module Identification
   1. Module serial number location other than the position indicated on the manufacturer's drawing.
   2. Required markings or identification which cannot be correctly read or interpreted.
   3. Markings or identification printed with ink which has not cured, or which show signs of readily rubbing off.
4. Missing or additional markings and identification
5. Incorrect markings or identification

B. Module Dimensions
1. Module length, width or depth out of the tolerance specified on the manufacturer's drawing.
2. Module mounting hole size or location out of the tolerance specified on the manufacturer's drawing.

C. Solar Cells
1. Cracked or broken solar cells (Figs. C-1, C-2, C-3, C-4, C-5, C-6, C-7, C-8, C-9).
2. Cells in edge to edge contact (Fig. C-10).

D. Interconnects and Soldering
1. Contact delamination and spalling in excess of 10% of the contact area disturbed (Figs. D-1, D-2, D-3, D-4).
2. Extensive dewetting (50% or less solder coverage) of interconnect to collector contact (Figs. D-5, D-6).
3. Less than 50% solder fillet on interconnect joints (Fig. D-7).
4. Interconnect metal fatigue fractures (Fig. D-8).
5. Damaged interconnects having less than 75% of the current carrying path remaining (Figs. D-9, D-10, D-11).
7. Broken or nicked wire strands at solder joints in excess of the following criteria: (Fig. D-12).
   7-strand wire; 1 strand broken, 2 strands nicked
   9-strand wire; 2 strands broken, 3 strands nicked
8. Broken or fractured solder joints at output terminals (Fig. D-13).
9. Split, burnt, crushed or cut insulation on any of the lead wires.
10. Insulation of wire buried into solder joint (Fig. D-14).

E. Encapsulation
1. Encapsulant, cracking or splitting.
2. Frame seal delamination
3. Holes or air bubbles in the encapsulant which could serve as a direct moisture path from the outside environment to an internal module component (Fig. E-1).
4. Exposed cells or interconnects (Fig. E-2).
5. Uncured or insufficiently cured encapsulant characterized by excessively sticky surfaces, and/or streaks of liquid on the surface of the encapsulant.
6. Cracked glass or other protective coating.
7. Delamination between glass or other protective coating and encapsulant.

F. Foreign Material
1. Any metallic particle (including solder) resting on the cell junction (Fig. F-1).
2. Any metallic particle (including solder) trapped between the interconnect and the cell (Fig. F-1).
CRACK STARTED FROM EDGE CHIP

FIG. C-1.
RIM TO RIM HAIRLINE CRACK
UNDER COLLECTOR

FIG. C-2.
IRREGULAR HAIRLINE CRACK THRU COLLECTOR

FIG. C-3.
TERMINATED CRACK 1/2 OF CELL DIAMETER OR MORE UNDER COLLECTOR

FIG. C-4.
EDGE CRACK TERMINATED
UNDER COLLECTOR SOLDER JOINT

FIG. C-5.
RIM TO RIM CRACK UNDER GRID LINE AND COLLECTOR

FIG. C-6.
BROKEN PORTION OF CELL INTERSECTING COLLECTOR STRIP

FIG. C-7.
BROKEN - TOTAL SEPARATION

FIG. C-8.
FOUR SECTION BREAK - TOTAL SEPARATION

FIG. C-9.
TWO CELLS IN EDGE TO EDGE CONTACT

FIG. C-10
COLLECTOR BROKEN AND DELAMINATED AT CELL SOLDER JOINT

FIG. D-1
ALLIGATED CELL, BROKEN CELL
MATERIAL UNDER COLLECTOR SOLDER JOINT

FIG. D-2
INTERCONNECT

COLLECTOR DELAMINATED FROM SILICON

FIG. D-3
SPALLING IN CELL SURFACE MATERIAL AT COLLECTOR.

FIG. D-4
INTERCONNECT TO COLLECTOR CONTACT DEWETTING

FIG. D-5
INTERCONNECT TO BACKSIDE CONTACT DEWETTING

FIG. D-6
SOLDER FILLETS WHICH EXTEND LESS THAN 50% OF THE DISTANCE AROUND THE AREA INCLUDED IN THE SOLDER JUNCTION ARE NOT ACCEPTABLE.

INSUFFICIENT SOLDER FILLETS

FIG. D-7
IN

IS 

SOLID STRIP INTERCONNECT

METAL FATIGUE FRACTURE

UNACCEPTABLE CONDITION
REJECT

FIG. D-8
SOLID STRIP INTERCONNECT DISCREPANCIES

FIG. D-9

UNACCEPTABLE CONDITION IF THE CROSS-SECTIONAL AREA OF THE STRIP IS REDUCED BY 25% OR MORE.
SOLID STRIP INTERCONNECT DISCREPANCIES

FIG. D-10

UNACCEPTABLE CONDITION IF THE CROSS-SECTIONAL AREA OF THE STRIP IS REDUCED BY 25% OR MORE.
Defects which reduce the cross-sectional area of the web material by 25% or more are grounds for rejection of the unit.

- Over etch
- Metal fatigue fractures
- Crease or tool mark
- Broken web strands

Fig. D-11 Web type interconnect defects
Splayed or Birdcaged Wire Strands at Solder Joint, with Strand Breakage. Usually shows exposed copper in breakage area.

FIG. D-12
CRACKED SOLDER
AT OUTPUT TERMINALS

FIG. D-13
INSULATION BURIED INTO THE SOLDER

FIG. D-14
AIR BUBBLE DISCREPANCIES

FIG. E-1
EXPOSED INTERCONNECT

FIG. E-2
LOOSE METAL FRAGMENT ADHERING TO EDGE OF CELL.

SOLDER TRAPPED UNDER INTERCONNECT STRIP.

POSSIBLE JUNCTION SHORTS

FIG. F-1