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SECTION 1
INTRODUCTION

1.1 GENERAL

This document describes the procedure for initiation, review and closeout of Problem/Failure Reports (P/FR's).

1.2 SCOPE

This Problem/Failure Reporting and Analysis (P/FRA) procedure covers all Low Cost Silicon Solar Array activities which are:

(1) related to environmental, electrical and mechanical test.

(2) associated with problems/failures experienced in the JPL field test operations.

(3) related to problems/failures experienced by Lewis Research Center, MIT Lincoln Labs, DOD and other Application Centers for applications under their control which are attributable to a solar module.

1.3 REQUIREMENTS

The Low Cost Silicon Solar Array Project requires a comprehensive problem/failure reporting program in which emphasis and control effort shall be placed upon (a) complete coverage of reportable problems/failures, (b) timeliness, completeness and accuracy of reporting, (c) adequacy, completeness and depth of analysis, and (d) the adequacy of corrective actions, and verification that corrective action has been taken.

1.3.1 Reporting Requirements

A P/FR shall be initiated for any observed problem/failure as defined in paragraph 1.3.2 when such problem/failure is the result of test or service during:

(1) JPL environmental or developmental tests.

(2) Application Center test or application.

1.3.2 Reportable Problem/Failures

In general, a P/FR should be initiated for any observed condition which either potentially or actually causes the failure of a module to perform satisfactorily. Such anomalies include but are not limited to:
(1) performance parameter out of specified limits.
(2) delamination of encapsulant.
(3) discoloration of encapsulant/cells.
(4) cracking of cells/encapsulation.
(5) test problem or operator problems (JPL only).
(6) inoperative modules.
(7) electrically degraded modules:
   (a) greater than 5% after any environmental/engineering test.
   (b) in excess of 25% for field or demonstration application.
(8) major structural, mechanical or material problems.
(9) electrical isolation problems between active circuits and mounting structures.
(10) major degradation caused by the environment.
SECTION 2

LSSA P/FRA SYSTEM RESPONSIBILITIES

2.1 OBJECTIVES

The purpose of the problem/failure reporting and analysis system at JPL is to provide a mechanism for reporting anomalies, to focus the talents of qualified specialists in the analysis of observed problems and failures to determine causes and remedies, and to make these findings known to the module manufacturers in order to improve the quality and reliability of their product.

2.2 OPERATIONS AREA

The JPL Operations Area is responsible for assigning and coordinating all PFR verifications and analyses, for overall maintenance of the Project P/FRA system, and for interfaces with Application Centers. The Large Scale Procurement Task is responsible for initiating appropriate corrective action with the manufacturers, with the support of other Operations Area personnel as needed.

Prior to implementation of proposed corrective actions by the manufacturer, the effectiveness, cost and schedule impact must be evaluated by the Large Scale Procurement Manager, with the support of Procurement, Engineering, Operations and Quality Assurance, as required. (See Appendix C, Responsibilities).
SECTION 3
JPL INITIATED P/FR PROCEDURES

3.1 GENERAL

This section of the LSSA P/FR Procedure is applicable to those problems or failures arising from activities directly under the cognizance of JPL personnel and associated with environmental testing, special engineering tests and field testing.

3.2 ORIGINATION - SECTION I OF P/FR FORM

Upon observing a problem or failure, the originator completes Section I of the LSSA P/FR Form. Anyone may originate a P/FR; normally, the originator will be the engineer or inspector with responsibility for the module at the time the problem or failure is detected. After completion of Section I, the originator gives the P/FR to the Module Performance Analyst, who provides copies to the P/FR distribution list within one working day of its origination. The original P/FR will be retained by the Module Performance Analyst until Section II is completed. (See Appendix A, Instruction for Completing Problem/Failure Report Form).

3.3 VERIFICATION AND ANALYSIS - SECTION II OF P/FR FORM

The Module Performance Analyst performs a preliminary failure analysis and enters the results in Section II. If in his judgment further analysis is required, he will send the P/FR and module to the appropriate specialist as noted below, as dictated by the apparent problem.

<table>
<thead>
<tr>
<th>Problem Area</th>
<th>Cognizant Person</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Performance</td>
<td>G. Downing (341)</td>
</tr>
<tr>
<td>Cell and Interconnects</td>
<td>A. Shumka (365)</td>
</tr>
<tr>
<td>Materials and Processes</td>
<td>J. Repar (354)</td>
</tr>
<tr>
<td>Packaging and Cabling</td>
<td>J. Arnett (354)</td>
</tr>
</tbody>
</table>

When doubt as to origin of the problem arises, the module will be submitted to Section 365 for analysis. After a preliminary determination of cause has been made, the P/FR may be reassigned by the Module Performance Analyst, or Section 365 may consult with other specialists for assistance as needed to complete an in-depth analysis. With the concurrence of the Large Scale Procurement Manager, the problem/failure analysis may be supported or performed by the affected module manufacturers. The person who completes the detailed failure analysis will furnish the Module Performance Analyst with a written report. The Module Performance Analyst will complete and sign Section II of
the P/FR and distribute a copy of the completed Section II for information to those on the distribution list. (See Appendix D, Problem/Failure Cause Classification.)

3.4 CORRECTIVE ACTION - SECTION III OF P/FR FORM

After receipt of P/FR and failure analysis from the Module Performance Analyst, the Large Scale Procurement Manager will insure that the module manufacturer understands the contents of the P/FR. If appropriate, he may direct contacts between the manufacturer and the Module Performance Analyst and/or the JPL specialists who participated in the problem/failure analysis. When he is satisfied that appropriate actions have been taken, he or his designated alternate will note these actions in Section III, and he will close out the P/FR with his signature and return the original P/FR to the Module Performance Analyst. It is expected that in many cases no action will be required other than informing the manufacturer of the problem/failure and of the results of the JPL problem/failure analysis.

3.5 P/FR CLOSURE DISTRIBUTION

The Module Performance Analyst will submit to the P/FR Control Center the original P/FR with all sections completed and copies of analyses performed. The P/FR Center will log the P/FR in the P/FR Summary and effect distribution to the LSSA Distribution List. The P/FR Center will issue a monthly Summary Status of all P/FR's in the system and special listing as requested by the Module Performance Analyst.

3.6 P/FR FLOW DIAGRAM

A basic P/FR flow diagram is shown in Figure 3-1.
FUNCTION

PROBLEM OR FAILURE OCCURS

INITIATED BY ANYONE

DISTRIBUTION

LOGS AND FORWARDS ORI-
GINAL (INITIATOR)

MODULE PERFORMANCE
ANALYST DISTRIBUTES
INFO COPIES

CLOSURE RECORDED
COPIES DISTRIBUTED
(PFR CENTER)

PFR SUMMARY
REPORTS DISTRIBUTED
(PFR CENTER)

IMPLEMENTS
(ACTION)

INVESTIGATES, ANALYZES,
RECOMMENDS CORRECTIVE
ACTION (MOD PERF.
ANALYST)

COORDINATE CORRECTIVE
ACTION WITH MANUFACTURER
(LARGE SCALE PROCUREMENT
MANAGER)

SUPPORTS
ACTION

PARTS AND MATERIALS,
FAILURE ANALYSIS LAB,
ENGINEERING, QA

Figure 3-1. P/FR Flow Chart (JPL)
SECTION 4
APPLICATION CENTER P/FR PROCEDURE

4.1 GENERAL

This section of the LSSA P/FR Procedure is applicable to those problems or failures arising from endurance testing, field tests and applications for JPL procured modules supplied to LeRC, MIT/LL, Sandia and DOD.

The intent of this procedure is to provide a common base for reporting problems/failures and to provide a comprehensive and consistent feedback of problems/failures, recommendations and corrective actions to the Project Office, Application Centers and the manufacturers of the modules.

JPL will furnish P/FR forms to all application centers to allow uniform reporting.

JPL will distribute a monthly status summary of all new P/FR's and a complete summary update semianually.

4.2 ORIGINATION - SECTION I AND II OF P/FR FORM

Upon observing a module problem failure, the originator completes Section I of the LSSA P/FR form. After confirming the circumstances of the problem/failure and verifying that the problem/failure was module related and not system induced, the P/FR will be forwarded to JPL. The application center may at its discretion perform nondestructive analysis of the problem/failure and relate the finding in Section II of the P/FR form. Final analysis, including destructive analysis where indicated, will be accomplished at JPL. In those cases where the recall of modules to JPL is needed to complete the analysis, JPL and the Applications Center will mutually determine the quantity of modules and schedule for return based on the needs of the Application Project and the urgency of completing the analysis. (See Appendix A, instruction for completing problem/failure form, and Appendix D, problem/failure cause classification.)

4.3 SUBMITTAL OF P/FR'S TO JPL

After Section I has been completed, a copy of the P/FR will be submitted to JPL within 3 working days of the problem/failure. The original will also be submitted if no analysis is planned. In the event that the Applications Center does verification and analysis, the original and copies of the finding will be forwarded to JPL. Mail to: LSSA Operations Module Control, Bldg. 248, Jet Propulsion Lab, 4800 Oak Grove Drive, Pasadena, CA 91103.
4.4 CLOSEOUT OF APPLICATION CENTER PFR'S

After JPL review of the analysis accomplished and further diagnostics as necessary, closeout will be accomplished by JPL and the manufacturer in the same manner as JPL-initiated P/FR's. Copies of the completed P/FR will be made available to the Application Centers. The P/FR will also be added to the LSSA P/FR Summary.

4.5 P/FR FLOW DIAGRAM

A basic P/FR flow diagram is shown in Figure 4-1.
Figure 4-1. P/FR Flow Diagram
APPENDIX A

INSTRUCTION FOR COMPLETING JPL PROBLEM/FAILURE
REPORT FORM 2505R 7/76 FOR LSSA
Block 1  Name of originator.

Block 2  Insert the location where the P/FR occurred.

Block 3  Insert date of failure. If unknown, insert the date the report is initiated with a prefix "X."

Block 4  Insert inspection report (IR) number.

Block 5  Insert module description comprising the vendor name and block buy; (e.g., Solarex 46 KW).

Block 6  Insert three letter coded vendor designation.

Sensor Tech-  SNT
Spectro Lab-  SQB
Solar Power-  SLP
Solarex-  SLX

Additional vendor codes will be assigned as procurements are placed.

Block 7  Insert true serial number of module as designated by vendor.

Block 8  Describe test activity at time of failure, e.g.: Humidity/heat, temp cycle, field endurance.

Block 9  Describe what was observed and what was expected to be observed. Reference test procedure as applicable. Include comment on actions taken at the time to verify or investigate the problem and any other information the person observing the problem thinks may help resolve it. If module is part of field exposure include date of original installation.

Block 10  Supply an accurate and clear verification of the described problem/failure and supporting analysis. The final verification/analysis of Section II will be supplied by the Module Performance Analyst with the support of an appropriate specialist as needed.

Block 11  Check the proper block describing the cause of the problem/failure.

Block 12  Module performance analysts will sign and date verification and analysis completion.

Block 13  The task manager or designee will complete corrective action taken, fully describing the corrective action. Reference and attach supporting documentation, as required.

Block 14  Check the proper box describing the disposition of the problem module.
Block 15  Signature of person responsible for completing corrective action Section III.

Block 16  Concurrence signature of task managers.
<table>
<thead>
<tr>
<th>I. DESCRIPTION OF PROBLEM/FAILURE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>II. VERIFICATION AND ANALYSIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>cause of problem/failure</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>III. CORRECTIVE ACTION TAKEN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>DISPOSITION</th>
</tr>
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<td></td>
</tr>
</tbody>
</table>

Figure A-1. LSSA Project Problem/Failure Report Form
APPENDIX B
DEFINITIONS
(1) **Failure**: Performance outside the limits of specified requirements. This term includes intermittents or complete cessation of performance from mechanical, electrical or material failure.

(2) **Problem**: Any anomaly or occurrence which may adversely affect module performance. Anomalies not affecting functional performance, such as physical degradation, can be considered as problems where such effects can lead to functional degradation.

(3) **Problem/Failure Analysis**: The study of a specific problem/failure which has occurred to determine the circumstances which caused the problem/failure and to arrive at a course of corrective action which will prevent its recurrence.

(4) **Module**: An assembly of solar cells installed on a substrate which comprise the smallest order of assembly on a panel.

(5) **Panel**: A grouping of solar cell modules into a structural element for use in a test or demonstration application, i.e., part of an array.

(6) **Substrate**: Underlying support structure of a solar cell module.

(7) **Corrective Action**: Recommended or implemented action taken to correct the cause of a problem or failure.

(8) **P/FR**: Problem/Failure Report.

(9) **P/FRA**: Problem/Failure Reporting and Analysis.
APPENDIX C

RESPONSIBILITIES
Large Scale Procurement Task

(a) Interface with manufacturers on P/F interpretation, coordination of failure analysis efforts, and corrective actions.

(b) Review recommendations of failure analysts, determine solutions and implement corrective actions.

Applied Mechanics Division, Technical Support Disciplines

(a) Provide the Module Performance Analyst with nonelectric failure analyses and associated reports.

(b) Participate in P/FR and corrective action related manufacturer briefings, as required.

Electronic Parts Engineering Section

(a) Provide the Module Performance Analyst with electronic failure analyses and associated reports.

Problem/Failure Control Center, Section 153

(a) Provide P/FR administration, control, distribution, and summary reporting.

QA and R Manager

(a) Monitor the P/FR system and coordinate needed modifications.

(b) Provide technical direction to Section 153 activities.

(c) Assist in establishing inspection requirements for the LSSA Project.

(d) Support task managers as required for coordination of corrective actions.

(e) Provide inspection support.

Engineering Manager

(a) Review P/FR's for potential user impact, and recommend module design modifications to task managers.
(b) Provide technical direction for the failure analysis efforts of the technical specialists who report to him.

(c) Establish engineering and design requirements for the LSSA Project.

(7) Operations Manager

(a) Monitor the operation of P/FR system and recommend modifications for improvement.

(b) Provide technical direction for the Module Performance Analyst and Large Scale Procurement Task.

(c) Coordinate JPL problem/failure efforts with those of LeRC, MIT/LL, DOD and Sandia.

(d) Participate in P/FR related manufacturer briefings and negotiations as required.

(8) Module Performance Analyst

(a) Perform preliminary problem/failure analyses, and coordinate failure analysis efforts of technical specialists leading to final conclusions and recommendations.

(b) Interface directly with manufacturers as needed to coordinate joint analyses or clarify JPL results.

(c) Correlate and compile results of P/FR analyses. Reports results in appropriate documentation.

(9) Application Centers: LeRC, MIT/LL, DOD and Sandia

(a) Review field problem/failures to determine whether module failures are module-related or system-related.

(b) Provide P/FR's and other reports relating to application problem/failures for modules.

(c) Maintain and report operating time statistics to the module level.

(d) Coordinate failure analysis efforts with JPL as needed to allow JPL to effect corrective action with the manufacturers.

(e) Return of faulty modules to JPL as required to study problem/failures.
APPENDIX D

PROBLEM/FAILURE CAUSE CLASSIFICATION

D-1
All P/FR's are classified with regard to the cause of the incident to provide a coded correlation of incidents with similar cause factor.

The cause noted shall be the single factor considered to be the cause of the incident; combination of factors, or secondary factors are difficult to notate and track in the cause analysis. Combinations of possible causes are, in reality, an "unknown" and should be rated accordingly.

(1) "Design" Category

Inclusive of all design deficiencies

(a) packaging or mounting

(b) specification

(c) producibility

(d) misapplication of parts or materials

(2) "Workmanship" Category

Damage occurred during fabrication assembly, rework, testing or inspection.

(3) "Piece Part" Problem/Failure Category

Where part or material fault is primary cause of P/F; inclusive of defects originating or believed to have originated prior to fabrication/assembly of the module.

(4) "Manufacturing" Category

Where tooling, tooling design, processes, production drawings, shop planning, or manufacturing paper were deficient or the principal cause.

(5) "Handling" P/F, Damage Category

For incidents during in-transit, handling or storage; not including fabrication, assembly, or rework activities.
(6) "Adjustment" Category

P/F on test interruption caused by test or environmental test equipment.

(7) "Other" Category

Incidents where "cause" cannot be determined as a single or predominant factor, but a combination of factors.