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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

GEORGE C. MARSHALL SPACE FLIGHT CENTER

SATURN V PROGRAM DIRECTIVE

NUMBER: 26

SUBJECT: Saturn V Single Failure Points (SFP) Control

ORIGINAL ISSUE DATE: April 26, 1966 REVISION NUMBER: _____

DATE OF REVISION: _____ PREPARED BY: Saturn V Reliability and Quality Office, I-V-Q, Phone 876-1632

I. PURPOSE

This Program Directive

A. Establishes policy (Page 2, Para. IV)

B. Establishes definitions (Page 2, Para. V)

C. Prescribes procedures (Page 4, Para. VI)

D. Establishes controls (Page 5, Para. VI.B)

E. Assigns actions (Page 6, Para. VI.C)

F. Assigns Responsibilities (Page 7, Para. VII)

for the establishment and maintenance of:

SATURN V

SINGLE FAILURE POINTS (SFP) CONTROL

II. REFERENCES

A. M-D MA 1400 - Apollo Test Requirements

B. NHB 5300.1 - Apollo Reliability and Quality Assurance Program Plan

C. NPC 500-1 - Apollo Configuration Management Manual

I-V-FORM NO. 53B HARTLEIN JAN. 3, 1966 (OT)

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III. SCOPE

This directive is applicable to all organizations in the Saturn V Program that are responsible for the design and development of Saturn V Stages, Instrument Unit, and Launch Vehicle Ground Support Equipment (LVGSE).

IV. POLICY

The Saturn V Program policy is to identify, evaluate, control and minimize the effects of Single Failure Points in accordance with the provisions of this directive.

V. DEFINITIONS

A. Single Failure Point/Criticality Category

A Single Failure Point is defined as a single item of hardware whose failure in any given mode under specified environmental conditions results in:

- Crew loss due to a single failure of Flight Hardware or Launch Vehicle Ground Support Equipment
- Mission loss due to a single failure of Flight Hardware or Launch Vehicle Ground Support Equipment
- Neither crew or mission loss due to a single failure of Flight Hardware or Launch Vehicle Ground Support Equipment

Assigned Criticality Categories	
Flight Hardware	Launch Vehicle Ground Support Equipment
I	A
II	B
III	C

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1. Criticality Category I - Flight Hardware

   Hardware failure which results in loss of any crew member.

   This category shall include:

   - All Single Failure Points whose effects are not monitored by the Emergency Detection System (EDS).
   - All Single Failure Points whose effects are monitored by the Emergency Detection System but for which, after failure, there is not sufficient reaction time for crew survival.
   - All ordnance components such as Safe and Arming Device, and EBW Firing Unit.
   - All Emergency Detection System components.

2. Criticality Category II - Flight Hardware

   Hardware failure which results in loss of mission but would not cause loss of life.

   This category shall include:

   - All Single Failure Points whose effects are monitored by the Emergency Detection System and which, after failure, allow sufficient reaction time for crew survival.

3. Criticality Category III - Flight Hardware

   Hardware failure which will not result in abort of mission nor cause loss of life.

4. Criticality Category A - Ground Support Equipment

   Hardware failure which results in loss of life of any crew member.

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5. Criticality Category B - Ground Support Equipment

Hardware failure which results in loss of mission but would not cause loss of life.

6. Criticality Category C - Ground Support Equipment

Hardware failure which will not result in loss of mission nor loss of life.

B. Component

A component is defined as an article which is normally a combination of parts, sub-assemblies, or assemblies and is a self-contained element within a complete operating system.

C. Failure

The inability of a component to perform its' designed function or functions within specified limits.

D. Failure Mode Effect and Criticality Analysis

Failure Mode Effect and Criticality Analyses are performed in accordance with MSFC Drawing 10M30111A.

VI. PROCEDURE

A. Identification

1. Single Failure Points will be identified at the component level.

2. Identification of Single Failure Points will be based on Failure Mode Effect and Criticality Analyses performed as defined in MSFC Drawing 10M30111A.

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3. The "Engineering Critical Components List" (see Saturn V Program Directive Number 15, subject: "Saturn V Specification Program") must be identical to the Category I, II, A and B Single Failure Points components list.

B. Controls

1. Interfaces for establishing and maintaining the Single Failure Points components list for Categories I, II, A and B shall be as described in Appendix I.

2. Interfaces for reporting status of Single Failure Points components in Categories I, II, A and B shall be as described in Appendix II.

3. Saturn V Program activities governing Single Failure Points components in Categories I, II, A and B shall include the following:

- In Configuration Management (I-V-P)
  - "Engineering Critical Components List" in the Contract End Item Specification, Part I. (See Saturn V Program Directive Number 15, subject: "Saturn V Specification Program").
  - First Article Configuration Inspections (FACI)
  - Preliminary Design Reviews (PDR).
  - Critical Design Reviews (CDR).
- In System Engineering (I-V-E)
  - Design Certification Review (DCR)
  - Logistics
- In Test Engineering (I-V-T)
  - Pre-delivery Acceptance Review

- Certificate of Flight Worthiness (COFW)
- Program Manager's Pre-flight Review (PMPFR)
- Program Director's Flight Readiness Review (PDFRR)

- In Quality Assurance (I-V-Q)
  - Quality Tests and Inspections
  - Traceability
  - Failure Analysis and Corrective Actions
  - Unsatisfactory Condition Reports (UCR)
  - Quality Surveys
- In Reliability Assurance (I-V-Q)
  - Reliability Statements
- In Qualification and Reliability Testing (I-V-Q)

C. Actions (Responsibilities - see page 7, paragraph VII)

1. Each Saturn V Stage, Instrument Unit, and Launch Vehicle Ground Support Equipment contractor shall prepare and submit Failure Mode Effect and Criticality Analyses to the Saturn V Project (Stage) offices at MSFC. These analyses shall be revised as design and mission requirements change.

2. The Failure Mode Effect and Criticality Analyses shall be utilized for identifying Single Failure Points. Each identifiable Category I, II, A or B Single Failure Point shall be evaluated for potential elimination.

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3. The Single Failure Points components shall be listed in descending order of criticality and categorized.

4. The Single Failure Points components list shall be coordinated, established and revised as required.

VII. RESPONSIBILITIES

A. Saturn V Reliability and Quality Office (I-V-Q):

1. Responsible to the Saturn V Program Manager for the implementation of this directive.

2. Submit quarterly reports on Single Failure Points status to the Saturn V Program Manager and the Director, Apollo Program Control (MA).

B. Saturn V Project (Stage) Offices (S-IC, S-II, S-IVB, Instrument Unit, and Launch Vehicle Ground Support Equipment):

1. Assure contractual coverage for the Failure Mode Effect and Criticality Analyses.

2. Assure contractual coverage to implement the following Saturn V activities:

- Configuration Management
  - Contract End Item Specifications (CEI)
  - Preliminary Design Reviews (PDR)
  - Critical Design Reviews (CDR)
  - First Article Configuration Inspections (FACI)
- Design Certification Reviews (DCR)

- Pre-delivery Acceptance Reviews
- Certificate of Flight Worthiness (COFW)
- Program Manager's Pre-Flight Review (PMPFR)
- Program Director's Flight Readiness Review (PDFRR)
- Quality Assurance disciplines
- Reliability Assurance disciplines
- Qualification and Reliability Testing
- Logistics

for all Category I, II, A and B Single Failure Points components.

3. Concur in the Single Failure Points list as prepared by R-P&VE.

4. Submit monthly status to the Saturn V Reliability and Quality Office (I-V-Q) per requirement in Appendix III.

C. Saturn V System Engineering Office (I-V-E):

1. Establish - in coordination with I-V-P and R&DO - the Single Failure Points procedural requirements for Program Design Reviews and Inspections (see Saturn V Program Directive Number 8, subject: "Saturn V Design Reviews and Inspections").

2. Approve the operating profiles of active Single Failure Points components during prelaunch and launch.

3. Assure performance of system engineering studies to minimize the effects of Single Failure Points.

4. Report status of engineering actions undertaken to minimize the effects of Single Failure Points to the Saturn V Reliability and Quality Office (I-V-Q).

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5. Determine logistics requirements with consideration given to the Single Failure Points components list and the number of failed items experienced.

D. Saturn V Configuration Management Branch (I-V-P):

1. Establish configuration management policy and procedure for Single Failure Points components.

2. Establish the Single Failure Points components list to be identical with the Contract End Item (CEI) "Engineering Critical Components List."

3. Establish the Contract End Item (CEI) "Logistics Critical Components List" with consideration given to the Single Failure Points components list.

4. Maintain and distribute the Saturn V Specification Index.

5. Establish - in coordination with I-V-E and R&DO - procedural requirements for Saturn V Design Reviews and Inspections on Single Failure Points components (see Saturn V Program Directive Number 8, subject: "Saturn V Design Reviews and Inspections").

E. Saturn V Test Office (I-V-T):

Assure that the Procedure for Certification of Flight Worthiness (COFW) and the Procedures for Pre-Flight and Flight Readiness Reviews include provisions for reviewing status and history of Category I, II, A and B Single Failure Points components.

F. Propulsion and Vehicle Engineering Laboratory (R-P&VE):

1. Review Saturn V contractor's Failure Mode Effect and Criticality Analyses and establish the Single Failure Points components list.

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2. Publish and transmit the Single Failure Points components list to the Saturn V Reliability and Quality Office (I-V-Q). (Per Appendix IV.)

3. Update list monthly, if required.

4. Recommend design and mission changes to minimize the effects of Single Failure Points during particular mission phases to Saturn V Systems Engineering Office (I-V-E).

G. Astrionics Laboratory (R-ASTR):

1. Support the Propulsion and Vehicle Engineering Laboratory (R-P&VE) in establishing and updating the Astrionics portion of the Single Failure Points components list.

2. Recommend design and mission changes to minimize the effects of Single Failure Points during particular mission phases to Saturn V Systems Engineering Office (I-V-E).

H. Quality and Reliability Laboratory (R-QUAL):

1. Compile and evaluate test and failure history in support of the Single Failure Points program.

2. Maintain technical cognizance of Single Failure Points components and assure quality production hardware.

3. Support the failure analysis and corrective action review program.

4. Provide monthly assessment reports to Saturn V Reliability and Quality Office (I-V-Q) on Single Failure Points.

Arthur Rudolph
Manager, Saturn V Program

List of Appendices and Distribution:
(See page 11)

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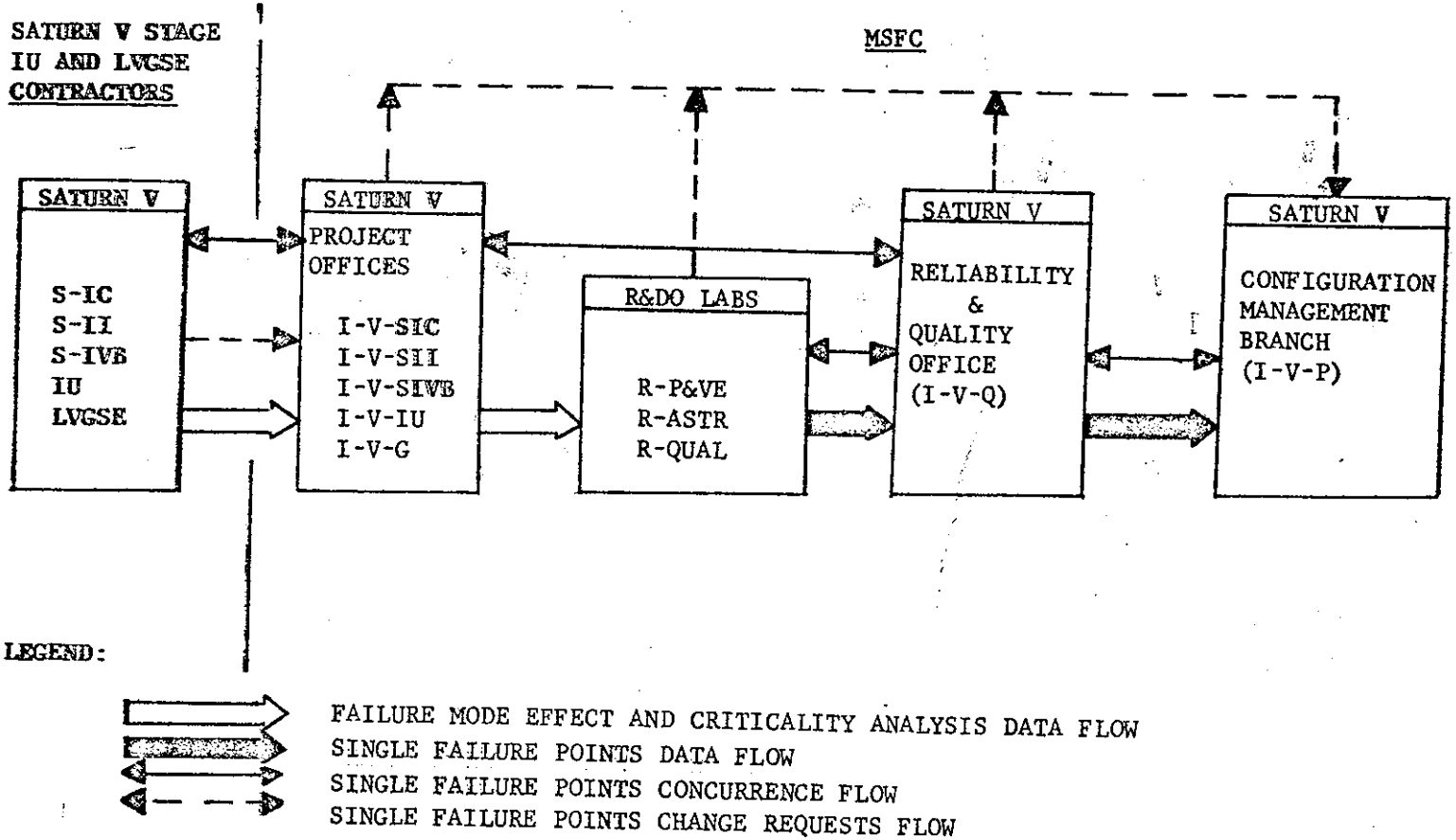
Appendix I, Single Failure Points List Control
Appendix II, Single Failure Points Status Reporting
Appendix III, Single Failure Points Component Test Failure Report
Appendix IV, Single Failure Points Summary List

Distribution:
R-DIR, Mr. Weidner
R-QUAL-DIR, Mr. Grau
R-ASTR-DIR, Dr. Haeussermann (4)
R-P&VE-DIR, Dr. Lucas (3)
R-OM, Mr. Fellows (3)
I-V-MGR, Dr. Rudolph
I-V-P, Mr. Sneed
I-V-T, Mr. Burns (3)
I-V-Q, Mr. Moody
I-V-F, Mr. Rowan
I-V-E, Mr. Bell (3)
I-V-SIC, Mr. Urlaub (3)
I-V-SII, Colonel Yarchin (3)
I-V-SIVB, Mr. Godfrey (3)
I-V-IU, Mr. Duerr (3)
I-V-G, Mr. Smith (3)
R-QUAL-R, Mr. Chandler (2)
R-QUAL-Q, Mr. Brien (3)
R-QUAL-J, Mr. Klauss
R-P&VE-VOA, Mr. Pizarro (3)
R-P&VE-XR, Mr. Burrows
R-ASTR-EA, Mr. Meeks
R-S, Mr. Richards

I-V-FORM NO. 54B HARTLEIN JAN. 3, 1966 (OT)

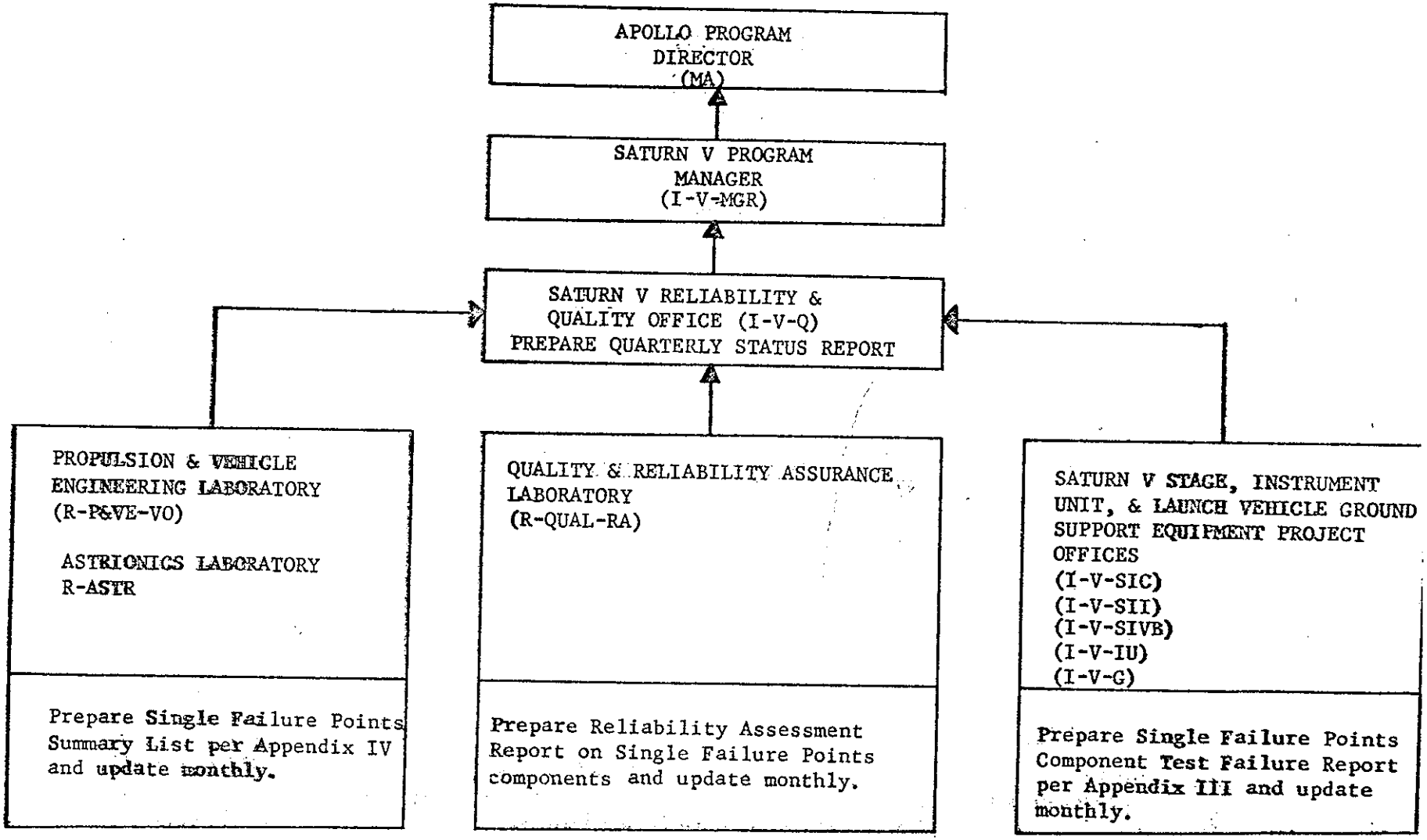
SINGLE FAILURE POINTS LIST CONTROL



LEGEND:

FAILURE MODE EFFECT AND CRITICALITY ANALYSIS DATA FLOW
SINGLE FAILURE POINTS DATA FLOW
SINGLE FAILURE POINTS CONCURRENCE FLOW
SINGLE FAILURE POINTS CHANGE REQUESTS FLOW

SINGLE FAILURE POINTS STATUS REPORTING



APPENDIX III TO SATURN V PROGRAM DIRECTIVE NUMBER 26
SUBJECT: SINGLE FAILURE POINTS CONTROL

SATURN V
SINGLE FAILURE POINTS COMPONENT TEST FAILURE REPORT
Submit to: Reliability and Quality Office (I-V-Q)

STAGE, INSTRUMENT UNIT, or LVGSE

DATE: _____ (MONTH) _____ (YEAR)

1. PART NUMBER:

2. SYSTEM:

3. NOMENCLATURE:

4. SERIAL NUMBER:

5. VEHICLE EFFECTIVITY:

6. QUALIFICATION STATUS:

7. FUNCTIONAL DESCRIPTION:

8. TEST PHASE IN WHICH FAILURE OCCURRED: (Qualification, Reliability, Acceptance, Captive Firing, Flight)

9. FAILURE REPORT NUMBER:

10. DESCRIPTION OF FAILURE:

11. FAILURE TEST CONDITIONS: (Environmental):

12. EFFECT OF FAILURE:

13. CAUSE OF FAILURE:

14. CORRECTIVE ACTION TAKEN (Include date):

15. DESIGN REVIEW HISTORY:

NOTE: The above data is required for each Single Failure Point Component. (Format may be established by originator)

APPENDIX IV TO SATURN V PROGRAM DIRECTIVE NUMBER 26
SUBJECT: SINGLE FAILURE POINTS CONTROL

SATURN V
SINGLE FAILURE POINTS SUMMARY LIST
Submit to: Reliability and Quality Office (I-V-Q)

STAGE, INSTRUMENT UNIT, or LVGSE

DATE: MONTH YEAR

1. PART NUMBER:

2. SYSTEM:

3. NOMENCLATURE:

4. VEHICLE EFFECTIVITY:

5. FUNCTIONAL DESCRIPTION:

6. CRITICALITY NUMBER:

7. CATEGORY: (I, II, A, or B)

8. DESCRIPTION OF POTENTIAL FAILURE MODES:

9. FAILURE INDICATIONS:

10. STATUS OF CORRECTIVE ACTIVITY:

NOTE: The above data is required for each Single Failure Point Component. (Format to be established by R-P&VE-VQ)