NASA

**PREFERRED
RELIABILITY
PRACTICES**

PRE-FLIGHT PROBLEM/FAILURE REPORTING PROCEDURES

PRACTICE:

A formal procedure is followed in the reporting and documentation of problems/failures occurring during test, pre-launch operations, and launch operations for both hardware and software. A separate system, the "Spacecraft Orbital Anomaly Report (SOAR)", is used for the reporting, evaluation and correction of problems occurring on-orbit (see Practice No. PD-ED-1232).

BENEFIT:

This practice significantly enhances the probability of mission success by ensuring that problems/failures occurring during ground test are properly identified, documented, assessed, tracked and corrected in a controlled and approved manner. Another benefit of the PFR procedure is to provide data on problem/failure trends. Trend data may then be analyzed so that errors are not repeated on future hardware and software.

PROGRAMS THAT USE PRACTICE:

All GSFC in-house flight programs must use this failure/reporting procedure in accordance with the GSFC Quality Assurance Requirements defined in Reference 2. Out-of-house contractors may use their system so long as it meets the provisions of the GSFC Quality Assurance Requirements and is approved by GSFC.

CENTER TO CONTACT FOR MORE INFORMATION:

Goddard Space Flight Center (GSFC)

IMPLEMENTATION METHOD:

A formal procedure (Reference 1) establishes the GSFC system for the identification and documentation of Problem/Failure Reports (PFRs), the data collection and monitoring of PFRs, the risk assessment and rating of problems/failures, and the Project and Center management approvals of corrective actions. For hardware, the procedure begins with the first application of power (or first test usage for mechanical items) at the lowest level of assembly of qualification or flight configuration hardware. For software, the procedure begins with the first test use of the software item with a hardware item of the mission system at the component level or higher.

Identification and Documentation of PFRs:

Anyone with knowledge of a problem or failure may initiate a PFR. PFRs are generated for any departure from a design, performance, testing, or handling requirement that affects the function of flight equipment, ground support equipment that interfaces with flight equipment or that could compromise

**GODDARD
SPACE FLIGHT
CENTER**

PROBLEM/FAILURE REPORTING PROCEDURES

mission objectives. All GSFC generated PFRs begin as problem records identified on applicable Certification Logs (Ref. 3), Problem Records (Ref. 4) and work orders. After a PFR occurrence, the Certification Log and Work Order, as applicable, are used to document, define and control any repairs, fixes, or modifications that may be performed on the hardware or software.

PFRs are generated and entered electronically into a PFR database, normally accessible on designated personal computers in hardware assembly and test areas. The PFR database program's on-screen instructions indicate certain required data that is to be provided, and automatically assigns a PFR number for traceability. PFRs can be prepared manually on GSFC PFR Form 4-2 (Figures 1 & 2) when the PFR database is not available or the system is inoperative. The PFR data on this form is entered into the database at the earliest opportunity following the problem/failure, but must be filed within 24 hours.

All PFRs, including both hardcopy and electronic formats, are forwarded to the Project Office for routing to designated personnel. Contractor-generated PFRs are provided to the Project Office in accordance with applicable contract requirements. PFRs generated in-house or at launch sites are provided directly to the Project Flight Assurance Manager (FAM) and the Systems Assurance Manager (SAM) or their designees, as appropriate. The Project FAM/SAM or their designees enter all the hardcopy PFRs that they receive into the GSFC PFR database.

Data Collection and Monitoring of PFRs:

The FAM/SAM provide copies of all PFRs to the members of a Failure Review Board (FRB) that is established and authorized by each project to investigate, analyze, and determine the cause of each problem/failure and the appropriate disposition of each PFR. The FRB consists of the following project personnel as a minimum:

      a.   The project FAM/SAM or designees (serves as chairman)
      b.   The Project Manager or designee
      c.   The cognizant engineer(s) responsible for the failed item(s).

Continuation of operations or immediate initiation of troubleshooting operations after the occurrence of a problem or failure is at the discretion of the cognizant engineer and other members of the FRB as appropriate and is based on the following factors:

      a.   The number and severity of problem/failure occurrences during the operation in question;
      b.   The degree of confidence in ability to quickly diagnose the source or cause of the problem or failure;
      c.   The potential risk to hardware or software posed by continuing the operations after the problem or failure;
      d.   The consequences of terminating an operation in which a failure has occurred (e.g., thermal vacuum testing).

PROBLEM/FAILURE REPORTING PROCEDURES

Risk Assessment and Rating of Problems/Failures:

The residual risk of each PFR must be considered by the FRB before it can be considered for closure. A two-factored risk rating system is used. The first rating factor identifies the impact that the problem/failure would have on the flight hardware and/or software performance capabilities if it occurred during the mission. Redundancy is ignored in establishing this rating. The failure effect ratings are illustrated in Table 1.

Table 1. PFR Failure Effect Ratings

RATING	FAILURE EFFECT
3	Catastrophic or major degradation to mission, system or instrument performance, reliability or safety
2	Moderate or significant degradation to mission, system or instrument performance, reliability or safety, defined as: a) Appreciable change in functional capability b) Appreciable degradation of engineering or science telemetry c) Causing significant operational difficulties or constraints d) Causing reduction in mission lifetime
1	Negligible or no impact on mission, system, or instrument performance, reliability or safety.

The second rating factor identifies the confidence in understanding both the cause(s) of the problem/failure and the effectiveness of the resulting corrective action. The failure corrective action ratings are shown in Table 2.

Table 2. PFR Failure Corrective Action Ratings

RATING	FAILURE CORRECTIVE ACTION
1	The root cause of the problem/failure has been determined with confidence by analysis and/or test. Corrective action has been determined, implemented and verified with certainty. There exists no credible possibility of problem/failure recurrence.
2	The root cause of the problem/failure has not been determined with confidence. However, some corrective action has been determined, implemented and verified with certainty. There exists some possibility that the problem/failure may recur.
3	The root cause is considered to be known and understood with confidence. Corrective action has not been determined, implemented or verified with certainty. There exists some possibility that the problem/failure may recur.
4	The root cause has not been defined with certainty. Corrective action has not been determined, implemented nor verified with certainty. There exists some possibility that the problem/failure may recur.

PROBLEM/FAILURE REPORTING PROCEDURES

Any PFR with a failure effect rating of "2" or "3", coupled with a failure corrective action rating of "3" or "4" is identified as a Red Flag PFR indicating significant residual risk associated with the problem/failure in question. GSFC Project Manager signatures are required on all red flag PFRs. No delegation of signature authority is permitted. All red flag PFRs are highlighted at GSFC Project Flight Assurance Reviews.

Project and Center Management Approval of Corrective Actions:

A PFR is considered for closure when the FRB determines that appropriate and sufficient investigation of the cause of the problem/failure has been completed and that commensurate corrective action has been completed and properly documented. The following signatures are required to formally close a PFR:

a. The Contractor Program/Project Manager and Contractor QC for PFRs initiated by off-site GSFC contractors
b. The GSFC FRB chairman
c. The GSFC Project Manager or his delegated FRB representative. Red Flag PFRs, defined above require the signature of the Project Manager.

TECHNICAL RATIONALE:

This practice ensures that all problem/failure occurrences including minor glitches are fully reported and dealt with as appropriate in a formal procedure with Project and GSFC management oversight and approval.

IMPACT OF NONPRACTICE:

Without this practice with its formal reporting procedures, problems/failures, particularly minor glitches, may be overlooked or not considered serious enough to investigate or report to Project Management. This could result in recurrence of the problem/failure during the mission and result in significant degradation in performance.

RELATED PRACTICES:

1. PD-AP-1304, Problem/Failure Report Independent Review/Approval
2. PD-AP-1305, Risk Rating of Problem/Failure Reports
3. PD-ED-1232, Spacecraft Orbital AnomalyReport (SOAR) System
4. PD-ED-1255, Problem Reporting and Corrective Action System

PROBLEM/FAILURE REPORTING PROCEDURES

REFERENCES:

1. - GSFC Flight Assurance Procedure, No. FAP P-303-849, "Problem/Failure Reporting"
2. - Guidelines for Standard Payload Assurance Requirements (SPAR) for GSFC Orbital Projects
3. - The GSFC Certification Log, FAP P-303-820
4. - Problem Record Items, GSFC, FAP P-303-845
5. - NASA NHB 5300.4 (1A-1) ReliabilityProgram Requirements for Aeronautical and Space Systems Contractors (January 1987)

PROBLEM/FAILURE REPORTING PROCEDURES

PROBLEM/FAILURE REPORT

(1)TEST ELEMENT: **FLT** ☐ HD SW **GRD** ☐ HD SW **TEST** ☐ HD SW	PFR No.				Contractor Report No.			
(2) Project	(3) Spacecraft/Observatory			(4) Operating Time		(5) No. of Cycles		
(6) Sub-System/Instrument	(7) S/W Version	(8) Date & Time of Problem/Failure	Yr	Mo	Day	(9)Date of Report	Yr	Mo	Day

(10) Originator (Last Name, First Name)   Phone (xxx/yyy-yyyy)   Organization (GSFC Code or Company)

(11) Run Test ID

(12) Supporting Information   [ ] Console Printout   [ ] Dump Printout   [ ] Error Codes   [_____] Dump Tape No.   [ ] Criticality   [ ] Other

(13) Problem/Failure Occurred During	[ ] Bench/Unit Test [ ] Qualification Test	[ ] Integration Test [ ] Acceptance Test	[ ] Pre-Launch Operations [ ] Launch Operations	[ ] Other
(14) Environment When Failed	[ ] Acceleration [ ] Shock	[ ] Thermal-Vacuum [ ] Temperature	[ ] Humidity [ ] Vibration	[ ] Ambient [ ] Vibration	[ ] EMI/EMC [ ] Magnetics
(15) Hardware/Integration Level When Failed	[ ] Part [ ] Sub-Assembly	[ ] Assembly [ ] Component	[ ] Spacecraft Sub-system [ ] Instrument/Experiment	[ ] Spacecraft/Observatory
(16) Software/Integration Level When Failed	[ ] OS [ ] User Interface	[ ] Database [ ] Driver	[ ] Communications [ ] Firmware	[ ] Text [ ] Other

NAME	IDENTIFICATION/REVISION NO.	SERIAL NO.	MANUFACTURER	CAGE CODE
(17) Component				
(18) Assembly				
(19) Sub-Assembly				
(20) Part	Manufacturer's Part Number	Date Code		

(21) Description of the Problem/Failure (attach additional sheets if necessary):

(22) Reference:
 Certification Log Book # _____   Page _____   Test Procedure _____   Para _____

(23)   Cause of the Problem/Failure (attach additional sheets if necessary):

(24)   Correction Action Taken (attach additional sheets if necessary):

(25)If Corrective Action is Required on Other Units, List Units by Serial No.

(26) Failure Analysis Performed   Failure Analysis Performed by
[ ] Yes   [ ]No   [ ] N/A   GSFC Code / Contractor _____   Failure Analysis Report Number _____

(27) Action Taken on Failed Unit   [ ] Rework   [ ] Modified   [ ]Discard   [ ] Replace   [ ] None   [ ] PSMB/CCB   [ ] Submit to MRB
      Organization That Performed Rework/Repair _____   MRB No. _____   Date _

(28) Is Retest Required After Corrective Action?
      [ ] Yes   [ ] No   If Yes, State Retest Requirements
                                     Date Completed

(29) Is Unit Suitable for Original Use?
      [ ] Yes   [ ] No   Remarks:

(30) Contractor Program Manager / FRB Approval
Signature _____   Date: _____
OA Signature _____   Date: _____

(31) Safety [ ]	(32) Failure Effect Rating [ ]	(33) Failure Corrective Action Rating [ ]	(34) Red Flag [ ] Yes [ ] No
(35) GSFC Project Manager Approval	Date:	(36) GSFC OFA Approval	Date Closed:

Figure 1. GSFC PFR Form 4-2.

PROBLEM/FAILURE REPORTING PROCEDURES

INSTRUCTION SHEET FOR PROBLEM/FAILURE REPORT

Block (1) Check appropriate block for element being tested.
P/FR #: Leave blank. $# generated by computer when input into system. Contractor Report #: All off site contractor initiators fill in with the contractor unique tracking #.

Block (2) All initiators, use project approved acronym or project name.

Block (3) All initiators, provide the project approved acronym or complete name of the spacecraft or observatory on which problem occurred.

Block (4) Enter the elapsed time to the point where problem occurred to the tenth of hour.

Block (5) If testing in cycles, enter the number of cycles elapsed to the point where the problem/failure occurred.

Block (6) All initiators, enter system or experiment name. Definition: "System" - The next functional subdivision of a spacecraft generally composed of two or more components designed to perform an operation. Example: Electrical Communication system, etc. "Experiment" - The next functional subdivision of a spacecraft, generally a combination of two or more components, including both the sensor and associated electronics designed for acquisition of data for space research.

Block (7) For software testing - enter the configuration nomenclature for the item being tested.

Block (8) Enter date & time of problem/failure. Example - June 8, 1967 at 3 p.m. - Year 67 Month 06 Day 08 Time 1500.

Block (9) Enter date the problem/failure report is originated. Example - June 9, 1967 - Year 67 Month 09 Day 08.

Block (10) Enter the complete: last and first name, telephone number and organization (GSFC Code or Company) of the P/FR initiator.

Block (11) For software enter the ID# of Run Test.

Block (12) For software check the appropriate item, enter the appropriate dump tape number and enter the correct criticality code C U R Critical, Urgent, Routine.

Block (13) Check the appropriate item indicating the type of test being conducted when the problem/failure occurred. If other is checked, describe in Block (21).

Block (14) Check item that defines the actual environment the unit was being subjected to when the problem/failure occurred. Caution for example, do not check vibration if unit failed during a function test prior to the actual application of the vibration environment, check ambient. If the environment in which the unit failed is not listed or the description listed does not give sufficient detail, give this information in Block (21).

Block (15) Check item that defines the hardware level at the time of problem/failure. For example: If a power supply subassembly fails during communications systems test, check spacecraft sub-system.

Block (16) Check item that defines the software level at time of problem/failure. If other is checked, describe in Block (21).

Blocks (17-20) Initiators provide cage code if known of leave blank.

Block (17) Enter component name. Definition: "Component" - The next functional subdivision of a system which is generally a self-contained combination of assemblies performing a function necessary to the systems operations. Example: Power, power supply, transmitter, gyro package, etc. Enter component identification no., serial no., the manufacturer's name, and the manufacturer's cage code.

Block (18) Enter assembly name. Definition: "Assembly" - The next functional subdivision of a component which consists of parts or subassemblies which perform functions necessary to the operation of the component as a whole. Example: Regulator assembly, power amplifier assembly, etc. Enter the assembly identification no., serial no., manufacturer's name, manufacturer's cage code.

Block (19) Enter subassembly name. Definition: "Subassembly" - An assembly within a larger assembly. Example: Wired printed circuit board modules, etc. Enter subassembly identification no., serial no., manufacturer's name, manufacturer's cage code.

Block (20) Enter part name. Definition: "Part" - An element of a component, assembly or subassembly which is not normally subject to further subdivision or disassembly without destruction of designed use. Example: Resistors, transistors, diodes, etc. Enter manufacturer's part number, the manufacturer's name, date code, and manufacturer's cage code.

Block (21) Enter all details of the problem/failure such as inputs, outputs, tolerances, symptoms, abnormal conditions, testing phase, detail of environment and prior environment. Use additional sheets if necessary.

Block (22) Enter reference information.

Block (23) Enter detailed, concise narrative defining the actual direct cause of the problem/failure. Use additional sheets if necessary.

Block (24) Enter detailed, but concise, narrative defining the corrective action taken. The corrective action shall be sufficient to preclude the problem/failure from occurring again. Use additional sheets if necessary.

Block (25) List other units affected by the corrective action. Enter N/A if not applicable.

Block (26) Check appropriate item and fill in requested information if appropriate.

Block (27) Check appropriate item(s) and fill in requested information.

Block (28) Check appropriate item and detail which tests if any need to be re-run. Enter date retest completed if required.

Block (29) Check appropriate item and provide supporting rationale, if any.

Block (30) GSFC hardware/software contractors (program manager/FRB chairman) fill out this block at completion of all actions.

Blocks (31-36) are for GSFC Project Failure Review Board use only. Refer to FAP P-303-849.

Block (31) Check if failure involves a safety related item.

Block (32) Choose appropriate: 1 - None or negligible; 2 - Moderate or significant; 3 - Major or catastrophic.

Block (33) Choose appropriate: 1 - Known cause/certainty in corrective action, no possibility of recurrence; 2 - Unknown cause/certainty in corrective action, no possibility of recurrence; 3 - Known cause/uncertainty in corrective action, some possibility of recurrence; or 4 - Unknown cause/certainty in corrective action, some possibility of recurrence.

Block (34) Check Yes or No, based on conditions of blocks #32, #33. Refer to FAP P-303-849.

Block (35) GSFC project manager approval.

Block (36) GSFC project FAM approval to close.

Figure 2. GSFC PFR Form 4-2 (cont.)