



Mission Operations Assurance - A Lesson Learned - Update

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Mission Assurance During Mars Climate Orbiter Operations (1999)



Event Description



- Although a Mission Assurance Manager (MAM) was assigned to Mars Climate Orbiter (MCO) during project development, there was no independent mission assurance function established for the work performed at JPL following launch.
- Discrepancies between the delta-Vs expected by the Navigation Team and those produced by the Angular Momentum Desaturation (AMD) file from the Spacecraft Team were observed during mission operations.
 - No Incident/Surprise/Anomaly (ISA) or Problem/Failure Report (P/FR) was written on this issue.



1. Recommendation: Revise JPL mission assurance policies and procedures to require an independent Mission Assurance representative during the operational phase of every flight project. This individual should become familiar with and be integrated into the project during the latter phases of development, and possess independent responsibility to verify compliance with design and operational requirements.

Implementation: FPP 7.7.1 “A mission operations assurance manager (MOAM) is assigned to each JPL-managed project or flight instrument prior to the start of operational readiness testing and continues through the end of mission, including extended missions.”

2. Recommendation: Require all flight projects to report and track post-launch anomalies on ISAs. Project management should rigidly enforce this requirement and maintain a disciplined disposition, tracking, and resolution process.

Implementation: FPP 7.6.1 “Problem reporting at JPL is implemented using the Problem/Failure Reporting (PFR), Incident Surprise Anomaly (ISA), and other systems as appropriate. Contractors use equivalent systems as negotiated in the contract.



Mission Operations Assurance Vision



Integrate the mission operations assurance function into the flight team providing:

- value added support in identifying, mitigating, and communicating the project's risks and,
- being an essential member of the team during the test activities, training exercises and critical flight operations.



Mission Operations Assurance Requirements



- Independently assess project risks throughout mission operations.
- Independently assess the project's operational readiness to support nominal and contingency mission scenarios.
- Implement the project's problem/failure reporting system to comply with JPL's Anomaly Resolution Standard.
- Provide training on problem reporting for the flight team.



Mission Operations Assurance Implementation



- Risk assessment
 - Captures the residual mission risks as the project transfers from the development to the operational phase of the mission.
 - Assesses residual risks throughout the post-launch risk review process and integrates them into an overall risk assessment.
 - Provides an independent risk assessment of the Project's risk posture in preparation for critical events.
- Operational Readiness
 - Participates in Operational Readiness Tests (ORTs) to assess if the test objectives were met; and that residual risks are identified, tracked, and resolved.
- Problem Reporting
 - Manages the problem failure reporting system for flight operations including the system setup; as well as the initiation, processing and closeout of Incidents, Surprises, Anomalies (ISAs).
- Operations Training
 - Oversees/conducts the problem/failure reporting function training to the flight team.
 - Assesses the adequacy of the flight team operations position training and overall system level flight team training program.



Mission Operations Assurance Implementation



- Operational Requirements
 - Works with the Mission Assurance Manager (MAM), Project Systems Engineer (PSE), and Mission Operations System (MOS) engineer to assure operational requirements are implemented into the flight hardware, software, and operations design.
 - Participates in operations peer reviews and the Operational Readiness Review (ORR) to assess resolution of integration issues between development and operations.
- Project Planning
 - Assesses Mission Change Requests (MCRs) to ensure appropriate review has been completed, and provides independent risk assessments, as appropriate.
- Flight Rules
 - Reviews waivers to flight rules and makes recommendations to the project.
- Reporting
 - Briefs independent risk assessments at Mission Management Reviews (MMRs), Project Status Reviews (PSRs), Quarterly Reviews, Office of Safety and Mission Success (OSMS) monthly reviews, and Critical Events Readiness Reviews (CERR).
- Interfacing with other Quality/Operations Assurance Function
 - Coordinates Software Quality Assurance support for in-flight software development, flight software modifications, and the resolution of flight software anomalies.
 - Coordinates with industry partners to assure an integrated mission operations assurance program is in place.



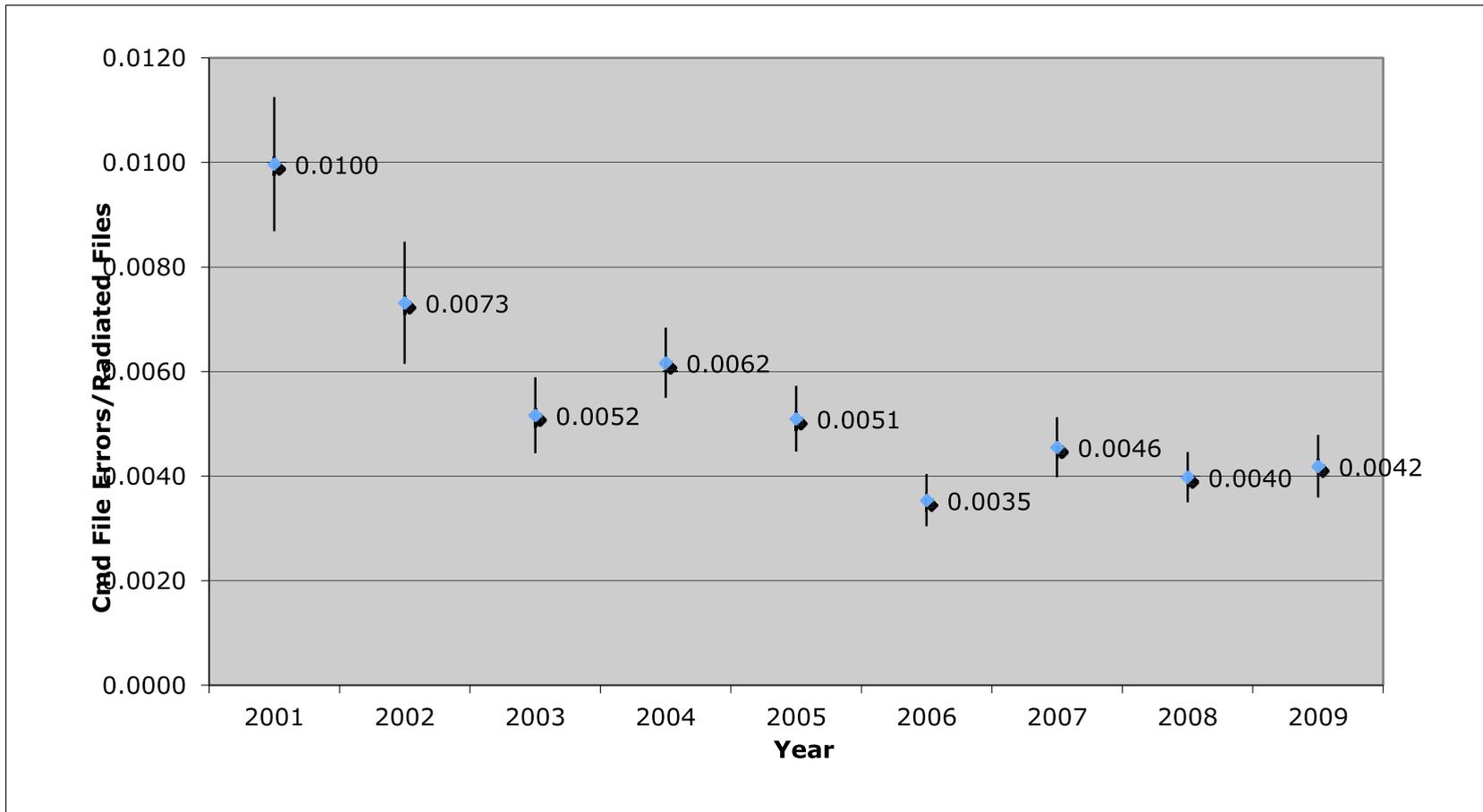
Command File Error Metrics Initiative



- A command file error is:
 - an error in a command file that was sent to the spacecraft;
 - an error in the approval, processing, or uplinking of a command file that was sent to the spacecraft;
 - the omission of a needed command file that was not uplinked to the spacecraft.



Aggregate Command File Error Rate



Although the command file error rate has declined over the years, there still exists a risk of committing a catastrophic command file error.

Projects included are MGS, Stardust, Mars Odyssey, Genesis, Spitzer, Mars Reconnaissance Orbiter, Phoenix, Galex, Dawn, MER A, MER B, Cassini.



Aggregate Command File Errors by Category **JPL**

	2001	2002	2003	2004	2005	2006	2007	2008	2009
CAT 1 (R/T Error)	14	6	10	9	17	10	14	6	8
CAT 2 (Process Error)	21	19	23	39	22	8	24	31	26
CAT 3 (Unexpected Result)	13	10	13	32	17	18	22	13	9
CAT 4 (Non-Interactive CMD File)	12	4	4	4	10	14	3	19	6
Total Cmd File Errors	60	39	50	84	66	50	63	69	49
Total Cmd Files Transmitted	6019	5331	9682	13618	12944	14131	13834	17339	11700
# Projects included	5	5	7	9	9	9	10	10	9
Aggregate Cmd File Error Rate	1.00%	0.73%	0.52%	0.62%	0.51%	0.35%	0.46%	0.40%	0.42%
Cmd File Errors/# of projects	12.0	7.8	7.1	9.3	7.3	5.6	6.3	6.9	5.4

Projects included are MGS, Stardust, Mars Odyssey, Genesis, Spitzer, Mars Reconnaissance Orbiter, Phoenix, Gale, Dawn, MER A, MER B, Cassini.



Aggregate Command File Errors by Criticality **JPL**

	2001	2002	2003	2004	2005	2006	2007	2008	2009
CRIT 1	11	0	7	11	7	3	5	2	3
CRIT 2	26	16	12	23	19	3	14	13	16
CRIT 3	22	21	26	46	38	43	43	54	30
CRIT 4	1	2	5	4	2	1	1	0	0
Total Cmd File Errors	60	39	50	84	66	50	63	69	49
Total Cmd Files Transmitted	6019	5331	9682	13618	12944	14131	13834	17339	11700
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Institutional Operations Working Group Initiative



- To provide a forum for the identification, discussion of solutions, and implementation of corrective action over a broad range of operational issues across JPL institutional boundaries.
 - Review command file and operational errors and draw lessons learned to be incorporated back into the projects and institution.
 - Develop recommendations for process improvements.
 - Communicate findings across all missions and implementing organizations.
 - Track the status of corrective actions approved for implementation.



Implementation



- Initial meeting held on 18 November 2010 with follow-up meetings on approximately two week intervals.
- Focused on the higher criticality 2009 command file errors (crit. 1&2). Continue to review 2009/2010 command file errors along with new ones in 2011.
- look for ways to gain approval and implement corrective action as a result of the effort.



Improvement Areas



- Test-bed/Simulation/Modeling Recommendations
- Spacecraft State/Parameter Tracking Tool
- Operations Development/Sustainability/Training
- Human Factors
- Expert Systems



Infusion Paths – Where do we take them?



- Infusion
 - JPL Rules
 - Line/Peer Reviews
 - Mission Gate Reviews
 - Regular training/Re-certification/Procedural Updates
 - Process Modeling
 - Software Enhancements
- Communications
 - Across Line organizations
 - Across Missions