



Preparing for a Remote-Site NPR 7120.5D Life-Cycle Review

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2010 IEEE Aerospace Conference

March 6–13, 2010

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The GRAIL Mission

- The Gravity Recovery And Interior Laboratory (GRAIL) mission was selected by NASA as a Discovery Program project
- GRAIL is PI-led (Dr. Maria T. Zuber, MIT) and JPL-managed
- Key development dates:
 - Jan. 2008: Start of Phase B
 - Apr. 2008: Project Mission System Review (PMSR)
 - Nov. 2008: Project PDR
 - Jan. 2009: Confirmation Review/Key Decision Point (KDP)-C
 - Mar. 2009: Start of Phase C
 - Nov. 2009: Project CDR
 - Jan. 2010: Mission Directorate PMC



The GRAIL Mission (cont.)

- Science objectives:
 - Determine structure and interior of the Moon, from crust to core
 - Understand thermal evolution of the Moon
 - Extend knowledge to other terrestrial planets
- Mission outline:
 - Twin spacecraft launched on a Delta 7920H-10
 - 9-month mission; launch in Sept 2011
 - Low altitude, 50-km polar orbit
 - 82-day primary mapping mission
 - Spacecraft operates at ~200 km separation
 - Extensive science data analysis
 - E/PO MoonKAM cameras engage public
 - Heritage: GRACE-like mission concept
 - Heritage: Spacecraft from LM: XSS-11 and MRO
- Science measurements and payload:
 - Ka-band ranging system (with GRACE heritage) measures relative velocity of CM of two spacecraft
 - DSN used for absolute position determination
- Mission management:
 - MIT: PI, SRS contract for E/PO
 - GSFC: Gravity science modeling and data analysis
 - JPL: PM, SE, MA, MO and GDS, payload, LM spacecraft system contract, data processing



CDR Preparation: Organization

- The project established a review preparation team with key roles:
 - Review Captain
 - Team leader
 - Lead for gate products and presentation materials instructions, guidelines, interpretations, content review
 - Supported by project schedule analyst
 - Documentation Lead
 - Lead for gate products and presentation materials formatting, editing, production
 - Supported by other technical writers and reproduction contractor
 - Information Systems Lead
 - Lead for file formats, data repositories, access privileges, and for IT requirements at the remote site
 - Supported by project librarian and CM engineer
 - Logistics Lead
 - Lead for logistics actions and for logistics requirements at the remote site
 - Site Coordinator
 - Lead for hotel negotiations/contract and on-site support staff
- The team employed a detailed preparation schedule to make sure all actions were identified, assigned, and completed on time



CDR Preparation: Organization

ID	Task Name	Start	Finish	July		August				September				October				November				
				7/12	7/19	7/26	8/2	8/9	8/16	8/23	8/30	9/6	9/13	9/20	9/27	10/4	10/11	10/18	10/25	11/1	11/8	11/15
45	CDR Outline Review	9/18/09	9/18/09																			
46	CDR Outline Review	9/21/09	9/21/09																			
47	CDR Outline Review	10/8/09	10/8/09																			
48	Slides drafting instructions/templates	9/10/09	9/10/09																			
49	Supplement Slides drafting instructions/templates	9/29/09	10/15/09																			
50	Draft slides submitted	10/30/09	10/30/09																			
51	Dry Run	10/26/09	10/30/09																			
52	Dry Run Do-Over	10/30/09	10/30/09																			
53	Final slides submission instructions	10/28/09	10/28/09																			
54	Final slides submitted	11/1/09	11/1/09																			
55	QA check with Documentation & Export Compliance	11/1/09	11/1/09																			
56	Advance slides to SRB (in PBMA)	11/2/09	11/2/09																			
57	Final slides to SRB (in PBMA)	11/4/09	11/4/09																			
58	SUPPORTING MATERIALS ACTIVITIES	8/3/09	11/2/09																			
59	Logo selected	9/16/09	9/16/09																			
60	Posters identified	10/14/09	10/14/09																			
61	New/modified posters commissioned	10/14/09	10/14/09																			
62	Posters completed	11/2/09	11/2/09																			
63	Visualization commissioned	8/3/09	8/3/09																			
64	Visualization completed - deferred to after CDR	8/11/09	8/11/09																			
65	Movie updated	9/28/09	9/28/09																			
66	PI voice-over completed - deferred to after CDR	8/11/09	8/11/09																			
67	Movie completed	8/11/09	8/11/09																			
68	Models identified	9/30/09	9/30/09																			
69	Shipping arrangements determined	10/8/09	10/8/09																			
70	OTHER DOCUMENTATION	8/3/09	11/2/09																			
71	CSR book	8/3/09	8/3/09																			
72	Inheritance Reviews book	8/3/09	8/3/09																			
73	PDR Gate Products book	8/3/09	8/3/09																			
74	Project PDR book	8/3/09	8/3/09																			
75	Pre-CDR Reviews book	9/18/09	11/2/09																			
76	Project CDR handouts -- TBS	8/11/09	8/11/09																			
77	Project CDR CDs -- TBS	8/11/09	8/11/09																			
78	SITE LOGISTICS ACTIVITIES	8/3/09	11/8/09																			
79	Attendance policy	8/4/09	8/4/09																			
80	Book hotel	8/3/09	8/3/09																			
81	Book equipment	8/18/09	8/18/09																			
82	Hotel walk-through	8/18/09	8/18/09																			
83	MIT GRAIL research area walk-through	8/18/09	8/18/09																			
84	Research area/campus tour plan	8/18/09	9/22/09																			
85	Materials shipped to Boston	11/4/09	11/4/09																			
86	Materials received at hotel	11/6/09	11/6/09																			
87	On-site preparations	11/6/09	11/6/09																			
88	Hotel staging & set up	11/8/09	11/8/09																			



Pre-CDR Reviews

- As proposed, GRAIL conducted a battery of pre-CDR reviews (throughout 2009)
 - 28 element CDRs/Technical Interchange Meetings (TIMs) covered all spacecraft subsystems and all instrument assemblies; also covered requirements, V&V, and mission design and navigation
 - Top-level assessment of the instrument at Payload CDR (July 2009)
 - MOS CDR scheduled for after Project CDR (May 2010)
 - Delta-CDR required for the Spacecraft Avionics (Dec 2009)
- All reviews had board reports, Recommendations For Action (RFAs), and project responses



GRAIL 2009 Reviews

Name	Start Date	Location	Status
USO EDR (Engineering Design Review)	03/03/09	APL	Done
Ka-Band Antenna CDR	03/06/09	JPL	Done
Risk Management Peer Review	04/03/09	JPL	Done
GPA CDR	05/15/09	JPL	Done
Ka-Band Antenna MRR	05/18/09	JPL	Done
MWA CDR (MRR is on 05/28/09)	05/27/09	SS/Loral	Done
MOS Peer Review (2 days)			
MOS Pre-PDR Requirements Review/Ops Design Peer Review	05/27/09	JPL	Done
RSBA CDR	06/18/09	JPL	Done
KBR Mechanical CDR	07/15/09	JPL	Done
Payload CDR	07/30/09	JPL	Done
Pre-CDR V&V Review	09/15/09	JPL	Done
Science Modeling Peer Review	09/15/09	JPL	Done
Mission Design / Navigation Peer Review	09/21/09	JPL	Done
MOS PDR (3 days)	09/22/09	JPL	Done
STL Baseline TIM	09/28/09	LM	Done
ATLO TIM	09/29/09	LM	Done
Harness CDR	09/30/09	LM	Done
Fault Protection CDR (1.5 days)	10/01/09	LM	Done
Structures & Mechanisms CDR (1.5 days)	10/05/09	LM	Done
Thermal CDR	10/07/09	LM	Done
Propulsion CDR	10/08/09	LM	Done
Avionics CDR (1.5 days)	10/12/09	LM	Done
Electrical Power CDR	10/14/09	LM	Done
Telecom CDR	10/15/09	LM	Done
Attitude Control Subsystem CDR (1.5 days)	10/19/09	LM	Done
Flight Software CDR (2 days)	10/21/09	LM	Done
EPO Peer Review	10/21/09	San Diego	Done
RSBA MRR	10/30/09	JPL	Done
Project CDR (5 days)	11/09/09	MIT	Done
Avionics Delta CDR	12/15/09	LM	Open
Post - CDR CMC	12/17/09	JPL	Open
Post - CDR Briefing to DPO and NASA PSD	01/07/10	NASA HQ	Open
Post - CDR MD-PMC	01/14/10	NASA HQ	Open



Gate Products

- NPR 7120.5D does not specify any gate products for Project CDR. NPR 7123.1 does specify (explicit or implied) gate products as entrance criteria for the review
- JPL Flight Project Practices does require extensive gate products at CDR
 - Fewer in number than for PDR – and many were updates of PDR deliverables
- Gate product content and format are not always clear
 - GRAIL Review Captain and JPL Project Support Office provided instructions and made interpretations, as required
 - In many cases NASA or JPL templates exist (e.g., NASA 7120.5D template for Project Plan, JPL template for Project Acquisition Plan)
 - In other cases NASA or JPL instructions exist (e.g., NASA Safety Standard instructions for orbital debris assessment)
 - Also available were examples from other projects (e.g., Juno project's Science Data Management Plan)
- Product generation instructions were issued
- GRAIL developed a detailed tracking matrix to ensure all gate products were identified, assigned, reviewed, and signed in a timely manner
- Review Captain determined methods for project internal review
- Documentation Lead provided GRAIL-formatted document shells, and her team provided custom graphics, technical editing, etc., as requested by the authors
- Logistics Lead coordinated signatures, both on-site and remotely from a nationally distributed team
- Project Librarian uploaded signed documents to the SRB's repository (PBMA)



Presentation Materials

- GRAIL took a thoughtful approach to defining the CDR agenda
 - Tell the GRAIL story—each day of the review had a theme:
 - Day 1: What is GRAIL?
 - Day 2 & 3: What will fly?
 - Day 4 (half day): How will we operate and support it?
 - Day 4 (remainder): SRB deliberations; outbrief to project team
 - Day 5: SRB deliberations
- The project employed a multi-day Outline Review well in advance
 - To make decisions early—no text slides allowed!
 - Presenters brought in stub slides (title, key points, identification of photos/tables/graphics/video clips/etc.)
 - Results: moved material between presentations or to backup (or primary); revised flow of presentations (delta agenda); adjusted time allocations; identified slide types for standardization
- Issued slide generation instructions (including template slides)
- Followed by a multi-day Dry Run (including a “do-over day”)
 - Export compliance check performed in real time (by trained project personnel)
- Issued finalization and submission instructions
- Final slides given QA check/correction by Review Captain, Documentation Lead



IT and Logistics

- IT needs to be designed-in from the beginning
 - Engineering environment for project work (e.g., project library, Product Data Management System, electronic conferencing, etc.)
 - Access controls (including participation of foreign persons)
- For the CDR, identify the equipment (with backups) and the operators
 - Cover project needs, SRB needs, and attendee needs
- Logistics must start early
 - Key decision: Review on-base or off? (Book early)
 - Arrange facility, equipment, technical support, administrative support
 - Key decision: Who should and should not attend?
 - Include precautions for Foreign Persons
- There are a large number of “little things” that all must be done or the problems won’t be little: Have a checklist
- Special considerations for remote-site reviews in upcoming slide



SRB Coordination

- The NPR 7120.5B SRB process is in some regards still a work in progress
 - 7120.5D provides the concept and the deliverables
- The SRB Handbook provides some how-to's
 - The Decision Authorities and the SRB Chairperson and Review Manager (RM) have significant leeway regarding “how” and “when”
- Absolutely critical: Start the board-establishment process six months in advance of the first life-cycle review (GRAIL did not and was significantly impacted)
- Almost as critical: start the draft Terms of Reference (ToR) while the nominations are being processed
 - Key elements to negotiate: Scope of review (any special assessments), pre-review documentation deliveries (including schedule), participation of SRB members in project-internal reviews – we did all these & still held the review without a signed ToR
- Establish regular communication with the SRB Chairperson and RM
 - Set up the repository for project deliveries to the SRB
 - How you deal with the SRB before the review makes your first impression
- Having SRB members participate in the pre-CDR reviews was very helpful
 - Pre-educates the board; provides insight into careabouts and concerns



Remote-site Considerations

- Holding a life-cycle review at a remote site requires additional actions
 - All of the infrastructure you have at home base must be obtained or accessed
- Establish a local Site Coordinator (SC) to lead the on-site activities
- Provide the SC with your requirements (meeting room, equipment, support services, support staff)
- Make an early reconnaissance trip to meet with the local principals
 - To make sure requirements are understood and priced
 - To identify overlooked requirements and action items
- Employ regular tag up telecons and frequent e-mails to keep everything visible and timely
- Identify the local norms and accommodate to the extent possible
 - Educate the SC and team on project and government contracting constraints
- Make the on-site staff full members of the team and be sure to acknowledge their contributions at the review



Summary

- “Haste makes waste”: Beginning late on preparations for a life-cycle review is asking for trouble
- Although the SRB process is evolving, the essentials of preparing for a life-cycle review are clear
 - Establish a review organization with clear roles and responsibilities
 - Identify all required activities and have a detailed schedule
 - Determine how to handle pre-CDR reviews, gate products, presentation materials, IT, and logistics
 - Establish the SRB, and your relationship with it, early and clearly
- Leverage institutional resources and learn from other projects
- More information is available in the IEEE paper “Reducing NPR 7120.5D to Practice: Preparing for a Remote Site Life-Cycle Review”
- You may request a copy from the author: Randall.L.Taylor@jpl.nasa.gov



Backup Slides

- GRAIL CDR Gate Products (extract)



JPL Gate Products

This version of the Life-Cycle Gate Products List is compatible with 7120.5D and FPP, Rev 7 (JPL Rules! DocID 58032)

March 18, 2009

Seq Number	PRODUCTS		KEY LIFE-CYCLE MILESTONES			D- Number	Status	Comments
			MDR/PMSR	PDR	Proj/Sys CDR			
NASA/Program								
(NASA/Program Products Requiring Timely Inputs from Projects)								
N	1	Project Formulation Authorization Document or equivalent				NA -- NASA document	<completed at PDR or earlier>	
N	2	Project Level 1 Requirements (Program Plan Appendix 3)	Final (Under configuration control)	Update (if required)			SIGNED	This is Rev. A (post Confirmation Review)
N	3	NASA NEPA Compliance Documentation (including EIS if required)		Environmental Assessment.		NA -- NASA document	SIGNED	Title is Memorandum for the Record as a NASA Routine Payload within EA and FONSI
				Environmental Impact Statement (If required).		NA	NA	EIS not required, only EIS
N	4	Interagency and International Agreements (Note 6)		Final		NA	NA	No NASA international agreement required for Dr. Wiecezorek per SMD direction
N	5	Software Independent Verification & Validation Plan (if IV&V is required)	Preliminary	Final			SIGNED	Title is IV&V Project Execution Plan.
N	6	Launch System ICD (Note 7)		Preliminary	Final	NA	Draft only, per Note 7-- submitted	Per Note 7, due date to LV provider (ULA) is May 2011 (initial Dec. 2009) -- ULA to provide. Draft is complete with comments due 10/18 to be consolidated & sent to KSC. Title is Delta II GRAIL ICD: Mission Requirements and Vehicle Description



JPL Gate Products (cont.)

This version of the Life-Cycle Gate Products List is compatible with 7120.5D and FPP, Rev 7 (JPL Rules! DocID 58032)

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Seq Number	PRODUCTS		KEY LIFE-CYCLE MILESTONES			D- Number	Status	Comments
			MDR/PMSR	PDR	Proj/Sys CDR			
N	7	Acquisition Strategy Meeting (ASM) minutes (If Applicable)	Final (Note 27)			NA	NA	Not required per Note 27
N	8	Planetary Protection Certification	Final			38943	<completed at PDR or earlier>	
N	9	Range Safety Risk Management Plan		Preliminary		NA	NA	NASA Range Safety has determined not applicable to GRAIL (not a vehicle project)
Project Management								
PM	1	Task Plan	Phase B (Note 2)	Phases C/D			Signed	Post-confirmation review submittal due to 60-day extension of Phase B
PM	2	Project Plan	Preliminary ready to sign	Final		D-43381	Signed	MDAA signature not requiree (delegated to Program Office)
PM	3	PIP 1.0 - Project Implementation Plan (The overall PIP is the responsibility of the Project Office. It consists of a series of documents, structured by WBS, that are prepared by the organizations responsible for the WBS elements.)	Preliminary - sections listed below (Note 3)	Final		D-44351	NA	This is just a heading for the PIP items that follow
PM	3a	PIP 1.1 - Introduction		Final			<completed at PDR or earlier>	
PM	3b	PIP 1.2 - Project Manager's Decisions, Guidance and Policies Technical, Schedule, & Cost Control Plan	Final			D-44309	<completed at PDR or earlier>	
						D-43382	<completed at PDR or earlier>	
PM	3c	PIP 1.3 - Business Plan	Preliminary	Final		D-38930	<completed at PDR or earlier>	
PM	3d	PIP 1.4 - Launch Approval Engineering Plan	Final			D-44326	<completed at PDR or earlier>	Also serves as the Environmental Management Plan