Ames Research Center

Internal Assessment Report

Mars Sample Return Box (MSRB) - ARC Project component of Mars Science Laboratory (MSL) - JPL led Program

Ames Management System / Project & Process Assessment

Mar - April 2008

Lead Auditor/Assessor: Al Cook (Code DJ)

Signature: _____ Date: 5/21/08

Ames Management System Manager: Rick Serrano (Code DJ)

Signature: _____ Date: 5/22/08

MSRB Project Manager: Mina Cappuccio

Signature: Mina Cappuccio Date: 5/21/08

1. Executive Overview

The Ames Research Center's (ARC) Internal Assessment of Center led Projects is a transition from the FY07 Internal Assessment footprint intending to incorporate more process oriented Assessments in conjunction with on-going AMS element driven Ames Management System (AMS) Assessments.

This Internal Assessment was of the ARC Mars Sample Return Box (MSRB) Project component of the Jet Prolusion Laboratory (JPL) led Mars Science Laboratory (MSL) Program.

The MSRB Project is relatively short duration (< 2 years) and moderate budget (< $1.3m) Project tasked with delivering both proto-flight and flight items for ground based MSL rover test bed, and MSL rover space flight package, respectively. The actual duration of the ARC MSRB Project is planned from Q3 FY2007 to Q4 FY08, with delivery of the Project products no later than August 2008. See Enclosure (1) for key Project timeline and milestones.

The ARC Project Team included an experienced Project Manager, Science Lead, Design Engineer, System Engineers, dedicated SS&MA Manager, and in-house Product Development Management and Machinists. As mentioned above, actual product realization/fabrication was done with both ARC in-house and outside sub-contract supplier support. Enclosure (2) is the MSL (at JPL) and MSRB (at ARC) contact list at the time of this report.

The Project deliverable, the MSRB consists of the design, manufacture, test and delivery of a flight item/unit that consists of (3) key components; a cradle that mounts directly to the front of the MSL Rover, a sample basket with an integrated retrieval knob and tabs to hold the basket into the cradle. The entire item/unit has a mass of < 400g. The item/unit's intended purpose is to facilitate the collection and storage of specified sized mars samples (for a total sample size of 66 cc), as delivered by the MSL robotic arm, for a period of 10 or more years, so that another follow-on sample return mission might retrieve the basket at a future date. There were no Customer requirements for software and as of the Revision A of the Customer Agreement, dated 12/11/07, no systems integration requirements. See Enclosure (3) for representative drawings of the MSL and MSRB.

The proto-flight and flight items (multiple items/assemblies meeting the same requirements) are to be delivered to the Customer (JPL) assembled, tested, planetary protection activities completed and sealed for storage and/or use. Per the current Customer Agreement (the Project Plan), all delivered items/units are to be identical and the Customer will determine which to use as the proto-flight, which to use as the flight item, and which will be stored.

At the period of this Internal Assessment, April 2008, the Project had successfully proceeded to the point of product realization (in-house/ARC and vendor/sub-contract supplier fabrication) of the proto-flight and flight item components but had not yet completed acceptance testing, assembly, test, planetary protection, validation, verification or delivery to JPL. Those Project deliverables will be conducted from May through June, or until completion.

It is to be noted that the Project is tasked with final delivery to JPL by August 2008, so any timeline slip at the period of this Assessment was considered to be within the built in Project contingency plan for the final delivery date requirement, and the Project at the time of the Internal Assessment was deemed to be within budget and on schedule for the Customer's required delivery date of August 2008.

2. Assessment Objective and Scope

2.1 Objective - Assess the MSRB Project in meeting customer requirements, meeting Program and Project requirements, and assess the Center's AMS applicable core and supporting processes in support of the MSRB Project, IAW Ames Procedural Requirements (APR) 1280.1 and Center documented requirements

(APRs and APDs) as contained on the Center Directives Management System (CDMS) and local area procedures (e.g. Code QS Division work instructions as found on the Code QS web pages). Particular emphasis was given to Program/Project requirements as found in the APR 7120.5 Program and Project Management for Space Flight and APR 8705.1 System Safety and Mission Assurance. Where the Customer (JPL) requirements/procedures/directives were more stringent than the local/ARC requirements/procedures/directives, the Customer requirements were accepted as taking precedence in interpretation, unless specifically waived or addressed as being relaxed in the Customer Agreement or other CCB controlled Project documentation.

2.2 Scope - The scope of the Assessment included both detailed review (bench audit) of, and sampling of, customer requirements documents, Project documentation, and objective evidence of Project and support process activities. The Project and support process activities included those to date of this report, as well as, where applicable, forward looking evidence for upcoming Project or support process activities (e.g. the authorized Service Requests for the Engineering Evaluation Lab (EEL) in N244 for upcoming testing IAW the Project Verification and Validation Plan).

3) Assessment Team Composition

Al Cook (Contractor – Lockheed Martin Program and Project Support Services/ Code DJ).

4) Assessment Criteria

The Internal Assessment was conducted IAW to NASA Policy Directive (NPD) 1210.2, NASA Surveys, Audits and Reviews Policy and APR 1280.1, Ames Management System. NOTE: Some deviation from APR 8700.3, Internal Assessment of the Ames Management System occurred though the overall specified and implied process requirements were followed.

5) Audit Approach & Communication

The Internal Assessment/audit is meant to be a value added event for the Project and the Center. The specified approach for Internal Assessment activities is to be accomplished as non-obtrusively as possible to the Project and other associated organizations/Codes that provide key support processes to the Project. To minimize the disruption to the Project personnel, extensive Bench Auditing of Project documentation and records was conducted up front, which led to a reduction of the time needed for extensive interview for validation of records or clarification of information for interpretation.

Communication was managed primarily through the Project Manager, and other process owners/SMEs accessed during the Internal Assessment were on an as needed basis. All preliminary observations, findings, and recommendations were discussed with the Project Manager prior to submission of the written report. The written report was submitted to the Center AMS Manager at a separate out brief.

6) Positive Observations & Project Best Practices

- The Project was strongly led by a seasoned Project Manager SMEs in all functional areas assessed.
- The Project approach in both resourcing, cost management and time management was very appropriate for the scope of the deliverable, and enhanced flexibility to deliver considering the design changes mid-project.
- All Project documentation and records assessed were extremely well organized, easily accessible and, in the case of key documentation and records that will form the core of the MSRB Data Package for delivery to the Customer, stored in a controlled NASA MINX folder structure.
- The use of the NASA MINX for document and records retention is a best practice.

7) Repeat Findings

None. Not applicable to the Project and none noted on key Center supporting process areas.

8) Assessment Findings

None.

9) Assessment Observations and/or Recommendations

9.1 Observation 1. Not all Vendors/Suppliers involved in product realization (fabrication) had an associated Code QS form QS.001, Supplier Quality System Assessment or form QS.002, Procurement Quality Requirements record. Nichols Mfg, who manufactured the cradles, did have a record associated with it but it was dated nearly two years earlier. Other Vendors/Suppliers did not, however, this can be interpreted as still meeting the intent of APR 8705.1 System Safety and Mission Assurance, and specifically paragraph 8.6.1.29 concerning criteria for evaluating a vendor/sub-contractor's quality performance, as the APR is written. At a minimum, it was observed that there was not a consistent approach for Vendor/Supplier assessment.

It is recommended that the consideration of the appropriate level or timing of assessing Vendors/Suppliers for quality and performance be specifically addressed as a probable root cause contributor considering specifically NCR # 00313, and possibly also NCR #0312.

9.2 Observation 2. The Center does not have a clear Center-Wide Corrective Action Reporting policy or directive in place that systematically address Corrective Action Systems. Several Center APRs address Corrective Action and CAR submission and routing, yet this activity is largely left open to local area interpretation for implementation. The APR 7100.1, Continuous Improvement Action has been treated as the default highest level AMS document that addresses Corrective Action, yet as it is currently written, the APR 7100.1, Continuous Improvement Action requirements does not address all systems or possible mechanisms that are either components of Corrective Actions or mechanisms (manual or electronic systems) for Corrective Action Reporting process. It was observed that the SS&MA function of the Project did use a local test region of cxPRACA for SS&MA Corrective Action Reporting and activity.

It is recommended that the Center consider publishing a policy directive or appropriate document that will address Center-Wide Corrective Action requirements. It is suggested that one possible example of a short Corrective Action System best practices document to emulate might be Dryden Policy Directive (DPD) 1281 that addresses the berth of normally Corrective Action requirements and mechanisms included in Management Systems and Quality Management Systems.

9.3. Observation 3. NCR 00313 and MRB disposition does not address current possible rework being conducted by the sub-contract fabricator Nichols Mfg. The cradle was returned to the shop on or near the date of the MRB 4/28/08 for evaluation/inspection for formal response and possible rework (if the surface flaw could be removed and tolerances maintained).

It is recommended that the Project Management and SS&MA Manager determine if additional documentation is required via the MRB, if rework is conducted on the specific cradle. Additionally, if the specific cradle is to be reclassified (regrade) to non flight hardware status (as per the plans of the MRB at the time of the Assessment), the Project should request a formal Waiver or equivalent written Customer concession to that fact.

9.4 Observation 4. APR 8700.3, Internal Assessment of the Ames Management System is currently being re-written for a draft submission, thought it has not formally entered the Center Directives Update Process. As

noted by the Auditor in paragraph 4, above, the Auditor did deviate from the specified reporting structure as directed by the AMS Manager.

It is recommended that the Center should hasten the re-publication of an updated APR 8700 to meet the current direction of AMS Internal Assessments management (roles), the change in approach that included Program and process oriented Assessment as well organizational management Assessments.

9.5 Observation 5. The use of the NASA MINX for document and records retention was observed to be a best practice as referenced in paragraph (6) above.

It is recommended that the Center should consider the use of NASA MINX as a requirement for comparable sized initiatives, when the Program/Customer does not specify other electronic document retention systems of comparable security and functionality.

10) Representative List of Objective Evidence for Basis of Assessment:

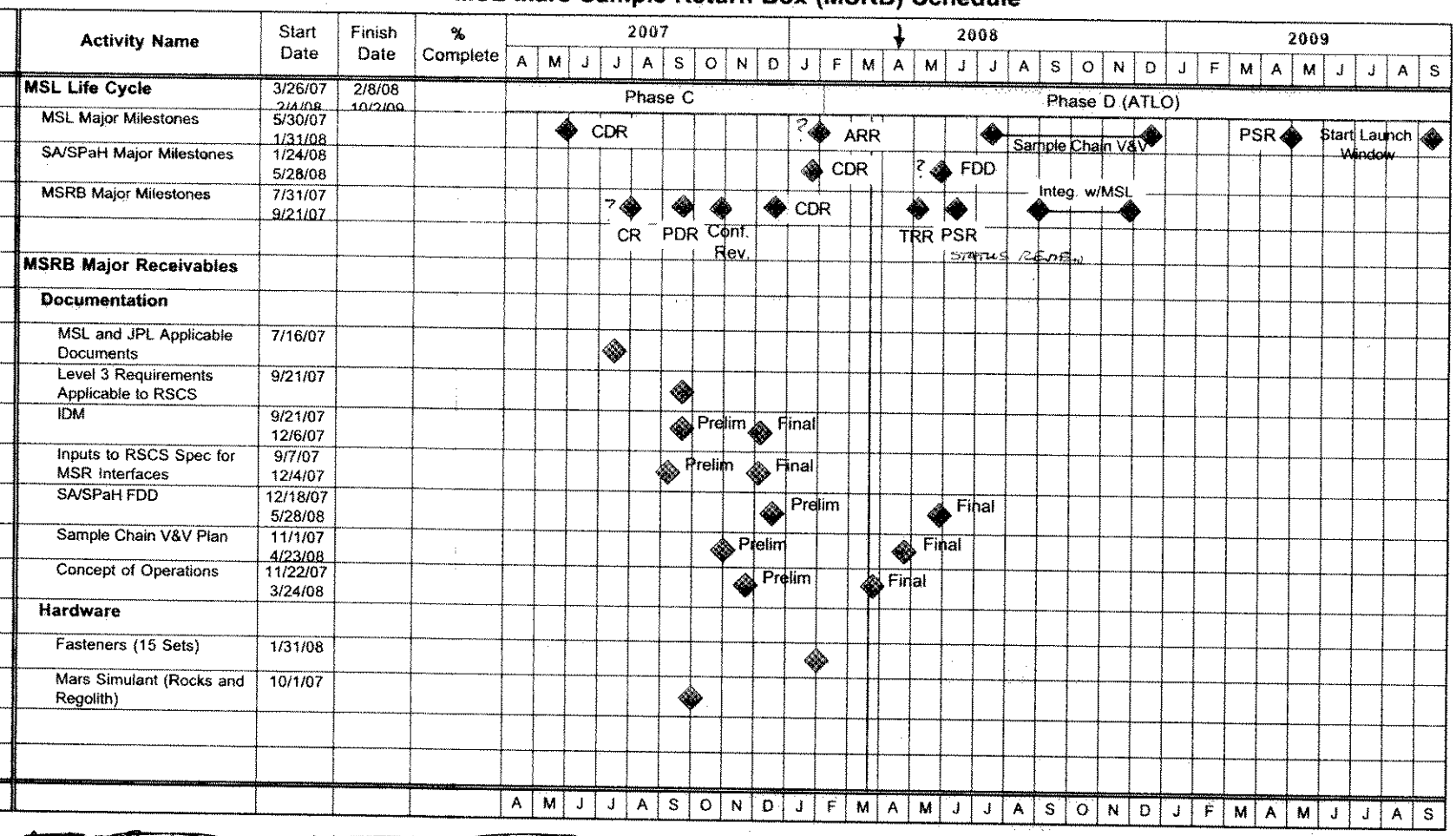
Note: Most Relevant Project Documents and Program/JPL references/requirements are well organized and maintained in the MSRB Project folder on the NASA MINX. Additional records were reviewed as locally maintained by the Project Manager, SS&MA Manager and Code RMX QC. Some documents, maintained at a local level, were planned for and waiting uploaded to the MINX.

Representative List Core Project Documents/Records and other Objective Evidence.

Various JPL Guidance, Rules and Standards.
Concept Review, PDR and CDR and Confirmation Reviews.
Mars Sample Return Box (MSRB) **Customer Agreement**, Revision A, 12/11/07 A9SP-073-XB01 (Project Plan)
Mars Sample Return Box (MSRB) **Specifications,** 9/19/07, A9SP-073-XR01
Mars Sample Return Box (MSRB) **Configuration Management Plan,** 01/08/08, A9SP-073-XS03
Mars Sample Return Box (MSRB) **Material Identification Usage List,** 01/08/08, A9SP-073-XS03
Mars Sample Return Box (MSRB) **System Safety and Mission Assurance Plan,** 11/27/07, A9SP-073-XS01
Mars Sample Return Box (MSRB) **Rover Systems Safety Analysis Report,** 11/27/07, A9SP-073-XS02
Mars Sample Return Box (MSRB) **Verification and Validation Plan,** 11/27/07, A9SP-073-XR05
SS&MA Plans and Records
Change Control Board and Material Review Board records and evidence
Purchasing Records
Service Requests for Fabrication and Engineering Drawings and associated records
Service Requests for Test and Validation
Nonconformity Reporting and associated NCR Database
Corrective Action Reporting – Record but no access to Ames SS&MA PRACA test region
Physical Control of Vendor Supplied as well as fabricated products.
QC Procedures
Shop Routers –as directly associated with materials or components
Representative number of Test Plans (many were still in draft)
Discussions with the Project Manager, Line Managers and SS&MA Manager.

MSL Mars Sample Return Box (MSRB) Schedule

	Activity Name	Start Date	Finish Date	% Complete
1	**MSL Life Cycle**	3/26/07	2/8/08	
2	MSL Major Milestones	5/30/07	1/31/08	
3	SA/SPaH Major Milestones	1/24/08	5/28/08	
4	MSRB Major Milestones	7/31/07	9/21/07	
5				
6	**MSRB Major Receivables**			
7	**Documentation**			
8	MSL and JPL Applicable Documents	7/16/07		
9	Level 3 Requirements Applicable to RSCS	9/21/07		
10	IDM	9/21/07	12/6/07	
11	Inputs to RSCS Spec for MSR Interfaces	9/7/07	12/4/07	
12	SA/SPaH FDD	12/18/07	5/28/08	
13	Sample Chain V&V Plan	11/1/07	4/23/08	
14	Concept of Operations	11/22/07	3/24/08	
15	**Hardware**			
16	Fasteners (15 Sets)	1/31/08		
17	Mars Simulant (Rocks and Regolith)	10/1/07		
18				
19				



ENCLOSURE (1)

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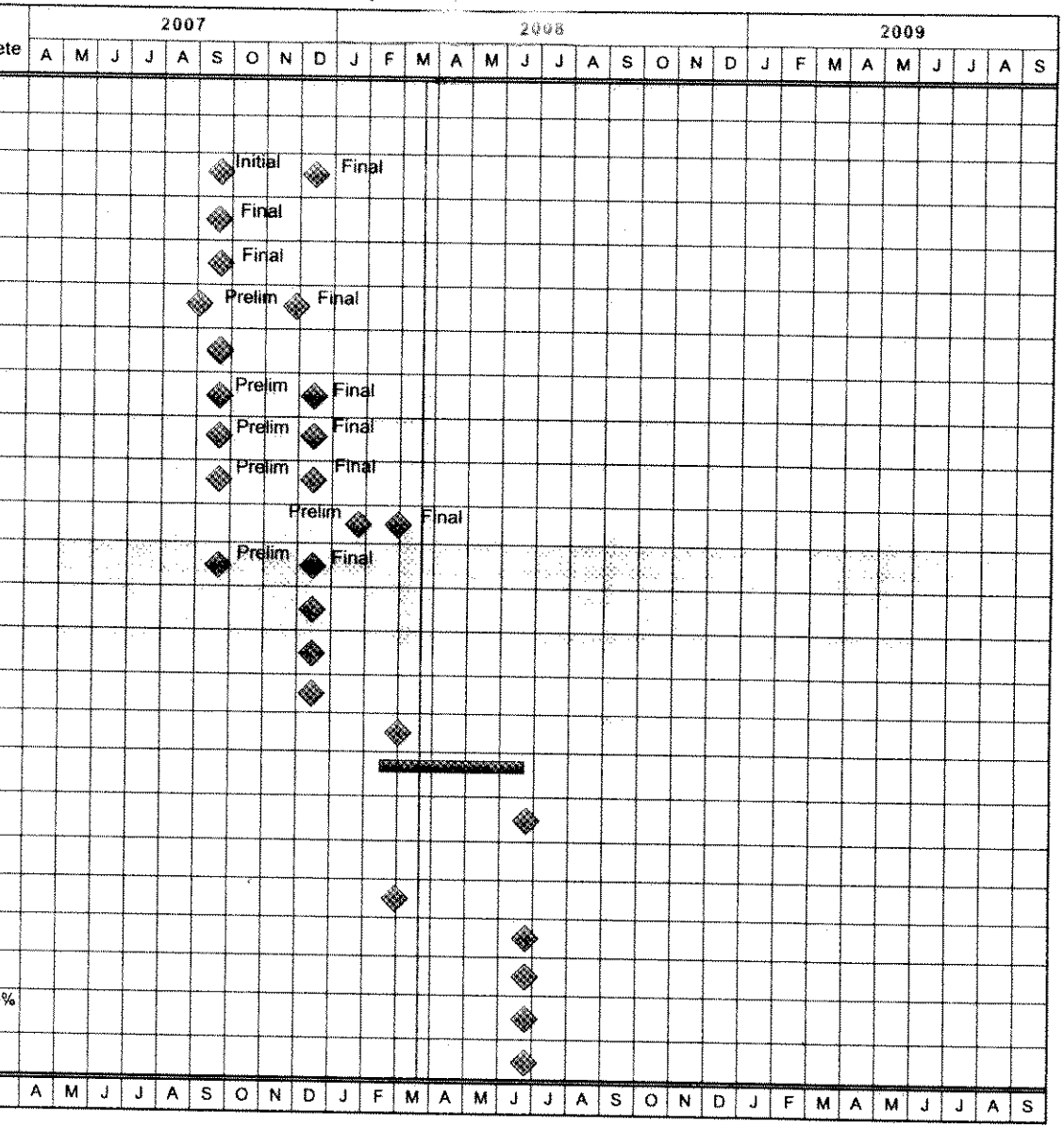
MSL Mars Sample Return Box (MSRB) Schedule

	Activity Name	Start Date	Finish Date	% Complete
20	**MSRB Major Deliverables**			
21	**Documentation**			
22	Specification	9/21/07 12/14/07		
23	Trace Matrix to Level 3 Requirements	9/19/07		
24	System Safety and Mission Assurance Plan	9/21/07		
25	Inputs to MSL IDM	9/3/07 11/27/07		
26	Inputs to Planetary Protection (PP) Plan	9/21/07 9/21/07		
27	Addendum to PP Implementation Plan	9/21/07 12/14/07		
28	Inputs to Concept of Operations	9/21/07 12/14/07		
29	MIULs/MUAs	9/21/07 12/14/07		
30	Inputs to SA/SPaH FDD	1/24/08 2/28/08		
31	V&V Plan	9/21/07 12/14/07		
32	Inputs to Sample Chain V&V Plan	12/14/07		
33	Environmental Analysis Verification	12/14/07		
34	Reliability Data	12/14/07		
35	Test Plan	2/29/08		
36	Problem/Failure Reports, as written	2/13/08	6/20/08	
37	End Item Data Package (EIDP)	6/24/08		
38	**Hardware**			
39	Mass Model (1)	2/28/08		
40	Engineering Unit (1)	6/24/08		
41	Flight Units (2)	6/24/08		
42	Witness Plates with each Flight Unit	6/24/08		0.0%
43	GSE Cache Retrieval Tool	6/24/08		



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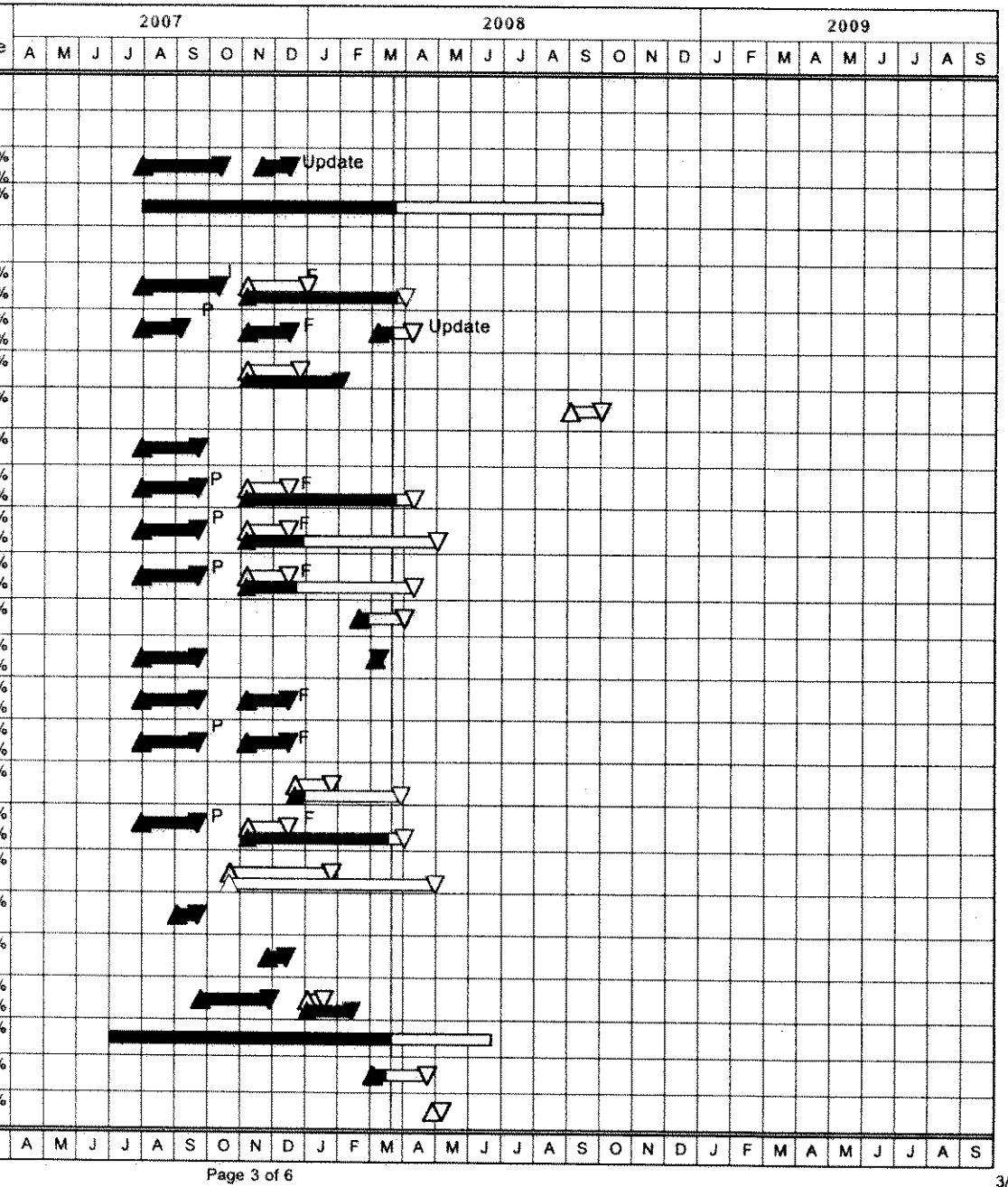
MSL Mars Sample Return Box (MSRB) Schedule

	Activity Name	Start Date	Finish Date	% Complete
44	**MSRB Tasks**			
45	1.0 Project Management			
46	Customer Agreement	7/30/07 11/19/07	10/10/07 12/14/07	100.0% 100.0%
47	Cost/Schedule Management	7/30/07	9/30/08	55.0%
48	2.0 Systems Engineering			
49	Specification	7/30/07 11/5/07	10/9/07 1/1/08	100.0% 95.0%
50	Inputs to MSL IDM	7/30/07 11/5/07	9/3/07 12/14/07	100.0% 100.0%
51	Inputs to MSR IRD	11/5/07	12/24/07	100.0%
52	Update MSR IRD/ICD with max shear/moment loads	9/2/08	9/30/08	0.0%
53	Inputs to PP Plan	7/30/07	9/21/07	100.0%
54	Addendum to PP Implementation Plan	7/30/07 11/5/07	9/21/07 12/14/07	100.0% 90.0%
55	Inputs to Concept of Operations	7/30/07 11/5/07	9/21/07 12/14/07	100.0% 30.0%
56	Trace Matrix to Level 3 Requirements	7/30/07 11/5/07	9/21/07 12/14/07	100.0% 30.0%
57	Update Level 3 Reqs	2/19/08	3/31/08	20.0%
58	Camera Capabilities Testing	7/30/07 3/4/08	9/21/07 3/7/08	100.0% 100.0%
59	TPMs	7/30/07 11/5/07	9/21/07 12/14/07	100.0% 100.0%
60	Document Tree	7/30/07 11/5/07	9/21/07 12/14/07	100.0% 100.0%
61	Inputs to SA/SPaH FDD	12/21/07	1/24/08	10.0%
62	V&V Plan	7/30/07 11/7/07	9/21/07 12/14/07	100.0% 90.0%
63	Inputs to Sample Chain V&V Plan	10/22/07	1/24/08	0.0%
64	Assemble PDR Data Package	9/3/07	9/21/07	100.0%
65	Assemble CDR Data Package	11/25/07	12/13/07	100.0%
66	RFA Closure	9/24/07 1/3/08	11/27/07 1/18/08	100.0% 100.0%
67	Risk Management	7/2/07	6/20/08	74.0%
68	Test Plans/Procedures	3/3/08	4/22/08	25.0%
69	TRR Prep	4/28/08	5/5/08	0.0%



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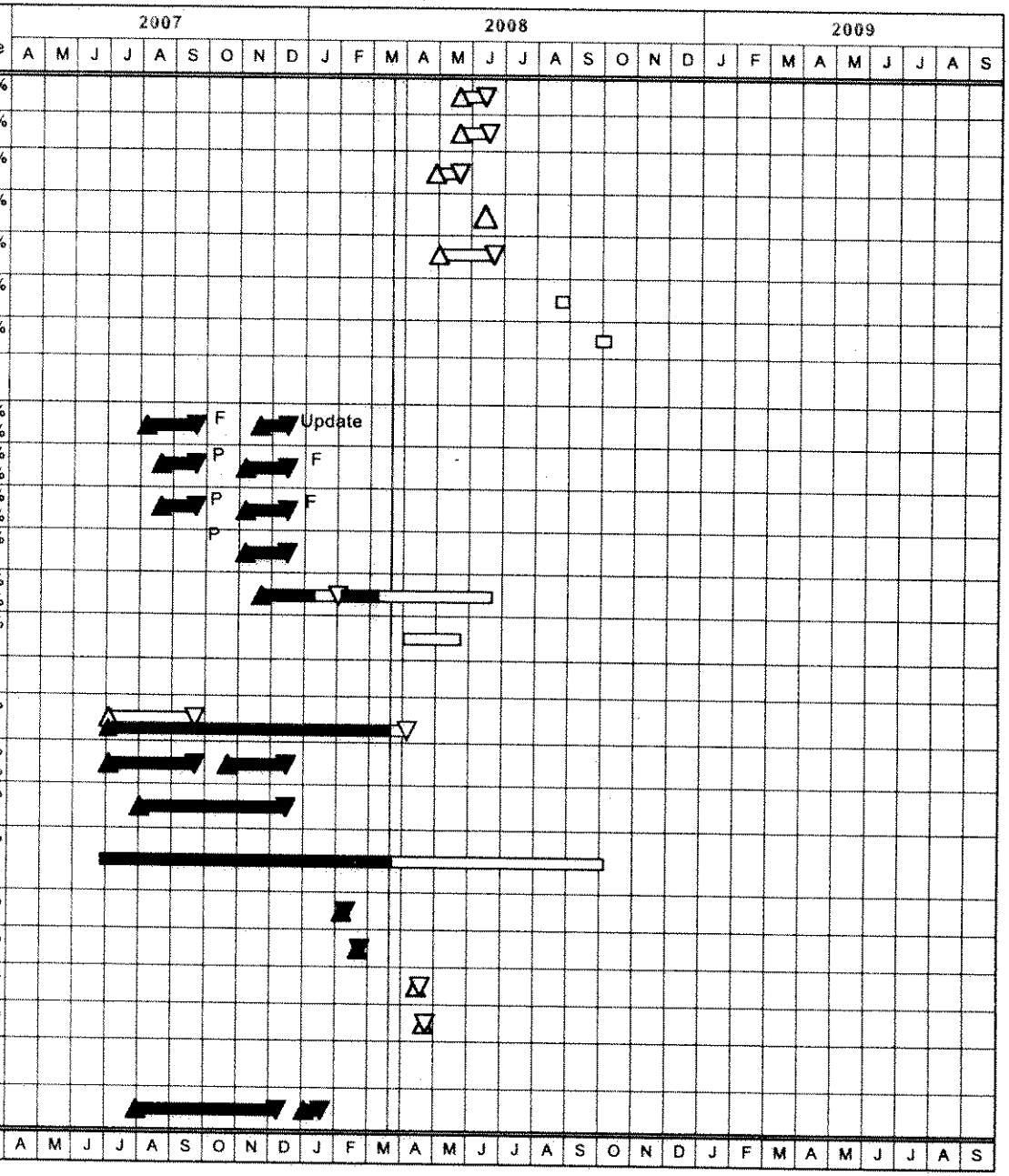
MSL Mars Sample Return Box (MSRB) Schedule

	Activity Name	Start Date	Finish Date	% Complete
70	Test Results/Reports	5/19/08	6/13/08	0.0%
71	V&V Report	5/20/08	6/16/08	0.0%
72	Ground Handling and Integration Plan	4/28/08	5/20/08	0.0%
73	Pre-Ship Review (Flight Units & Witness Plates)	6/12/08		0.0%
74	Assembly of EIDP (Include Ops Constraints)	5/1/08	6/20/08	0.0%
75	Support Sample Chain V&V Test	8/18/08	8/29/08	0.0%
76	Support ATLO at JPL	9/23/08	10/7/08	0.0%
77	3.0 Safety & Mission Assurance			
78	SS&MA Plan	8/6/07 11/19/07	9/21/07 12/14/07	100.0% 100.0%
79	MIULs/MUAs	8/20/07 11/5/07	9/21/07 12/14/07	100.0% 100.0%
80	Hazard Analysis	8/20/07 11/5/07	9/21/07 12/14/07	100.0% 100.0%
81	Manufacturing and Assembly Plan	11/5/07	12/14/07	100.0%
82	Travelers/QA Process	11/21/07 2/4/08	1/31/08 6/20/08	70.0% 25.0%
83	Inputs to MiA Process Map and Matrix	4/1/08	5/23/08	0.0%
84	4.0 Science			
85	Science Definition Document	7/2/07	9/21/07	95.0%
86	Support evaluation of design effort	7/2/07 10/22/07	9/21/07 12/14/07	100.0% 100.0%
87	Cache Impact on Science and Ops Memo from SMD	8/1/07	12/14/07	100.0%
88	Presentations/Discussions to/with Science Community on Cache	6/25/07	10/3/08	58.0%
89	MSR Tech. Workshop	2/6/08	2/8/08	100.0%
90	MEPAG Meeting	2/20/08	2/21/08	100.0%
91	Astrobiology Conference	4/14/08	4/17/08	0.0%
92	Mars Gnd Truth Wrkshp	4/21/08	4/23/08	0.0%
93	5.0 Engineering and Fabrication			
94	Mechanical Design	7/30/07 1/3/08	12/7/07 1/18/08	100.0% 100.0%



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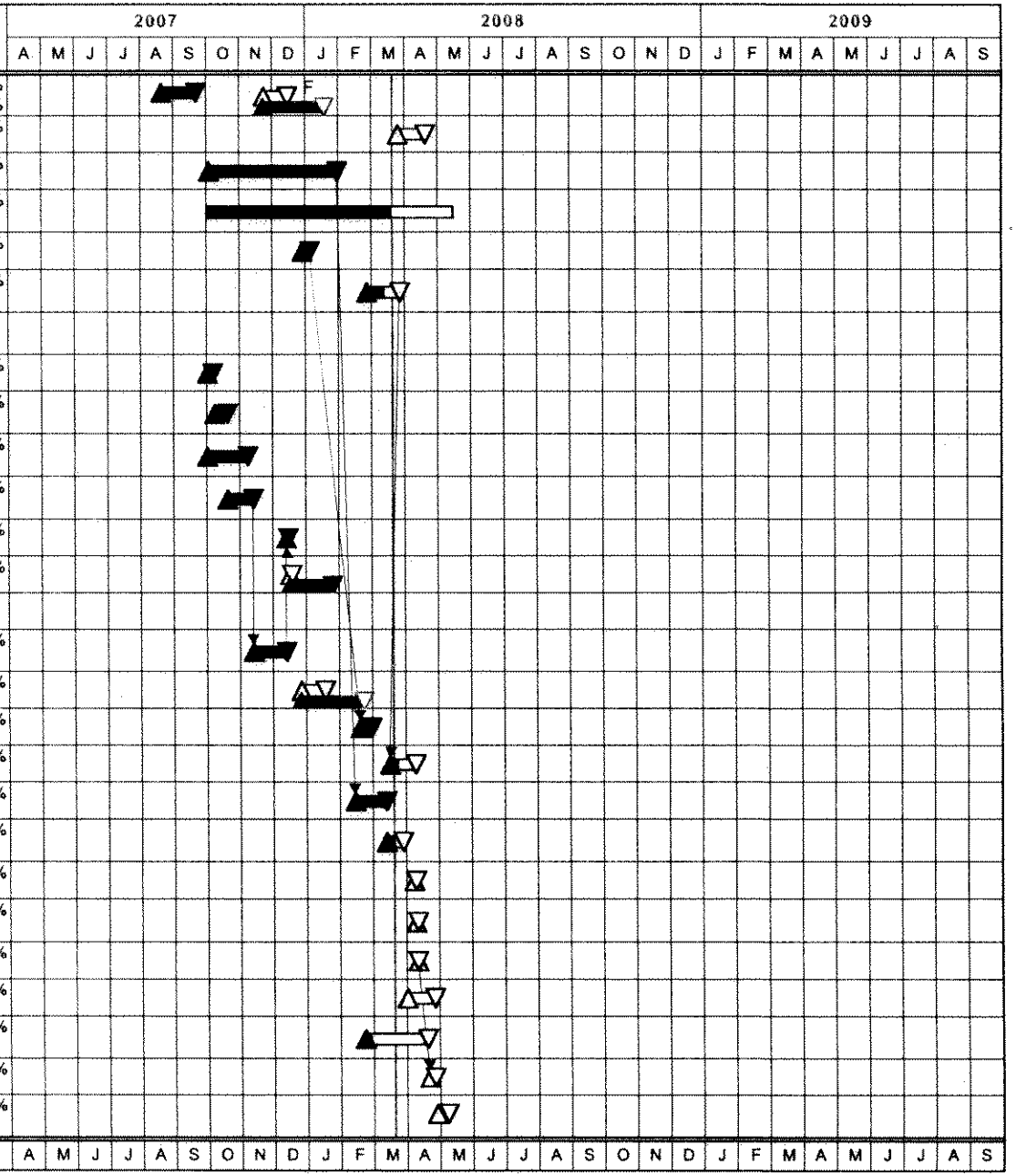
MSL Mars Sample Return Box (MSRB) Schedule

	Activity Name	Start Date	Finish Date	% Complete
95	Stress/Thermal Analysis	8/20/07 11/22/07	9/21/07 12/14/07	100.0% 95.0%
96	Tab Rotation Analysis	3/24/08	4/18/08	0.0%
97	Drawings	10/2/07	1/29/08	100.0%
98	Shop Coordination and Follow-Through	10/1/07	5/14/08	75.0%
99	Mass Model Design	12/28/07	1/4/08	100.0%
100	Flight Unit Test Fixture Design	2/25/08	3/26/08	50.0%
101	Engineering Develop. Tests & Test H/W Development			
102	Funnel Clog Test	10/1/07	10/5/07	100.0%
103	Drop test for Sample Loss	10/8/07	10/19/07	100.0%
104	Secondary Restraint Test (incl design/fab)	10/1/07	11/7/07	100.0%
105	Engineering Test Fixture Design (Brassboard)	10/19/07	11/12/07	100.0%
106	Vibe Test	12/13/07	12/14/07	100.0%
107	Retrieval Concept Tests	12/17/07	12/18/07	100.0%
108	Fabrication/Assembly			
109	Engineering Test Fixture (Brassboard)	11/12/07	12/13/07	100.0%
110	Order Material	12/27/07	1/18/08	95.0%
111	Fab. Mass Model	2/18/08	2/27/08	100.0%
112	Fab. Flight Test Fixtures	3/17/08	4/9/08	30.0%
113	Fabricate Caches (4)	2/13/08	3/12/08	100.0%
114	Engrave/Anodize Cache Parts	3/13/08	3/28/08	50.0%
115	Clean Cache Parts	4/7/08	4/8/08	0.0%
116	Assay Cache Mated Surfaces	4/9/08	4/10/08	0.0%
117	Assemble Caches (4)	4/10/08	4/11/08	0.0%
118	Fabricate Tabs (300)	3/31/08	4/25/08	0.0%
119	Fab. Cradles (4) (Nichols)	2/21/08	4/18/08	10.0%
120	Modify Cradles (ARC)	4/21/08	4/25/08	0.0%
121	Engrave/Anodize Cradles	4/28/08	5/7/08	0.0%



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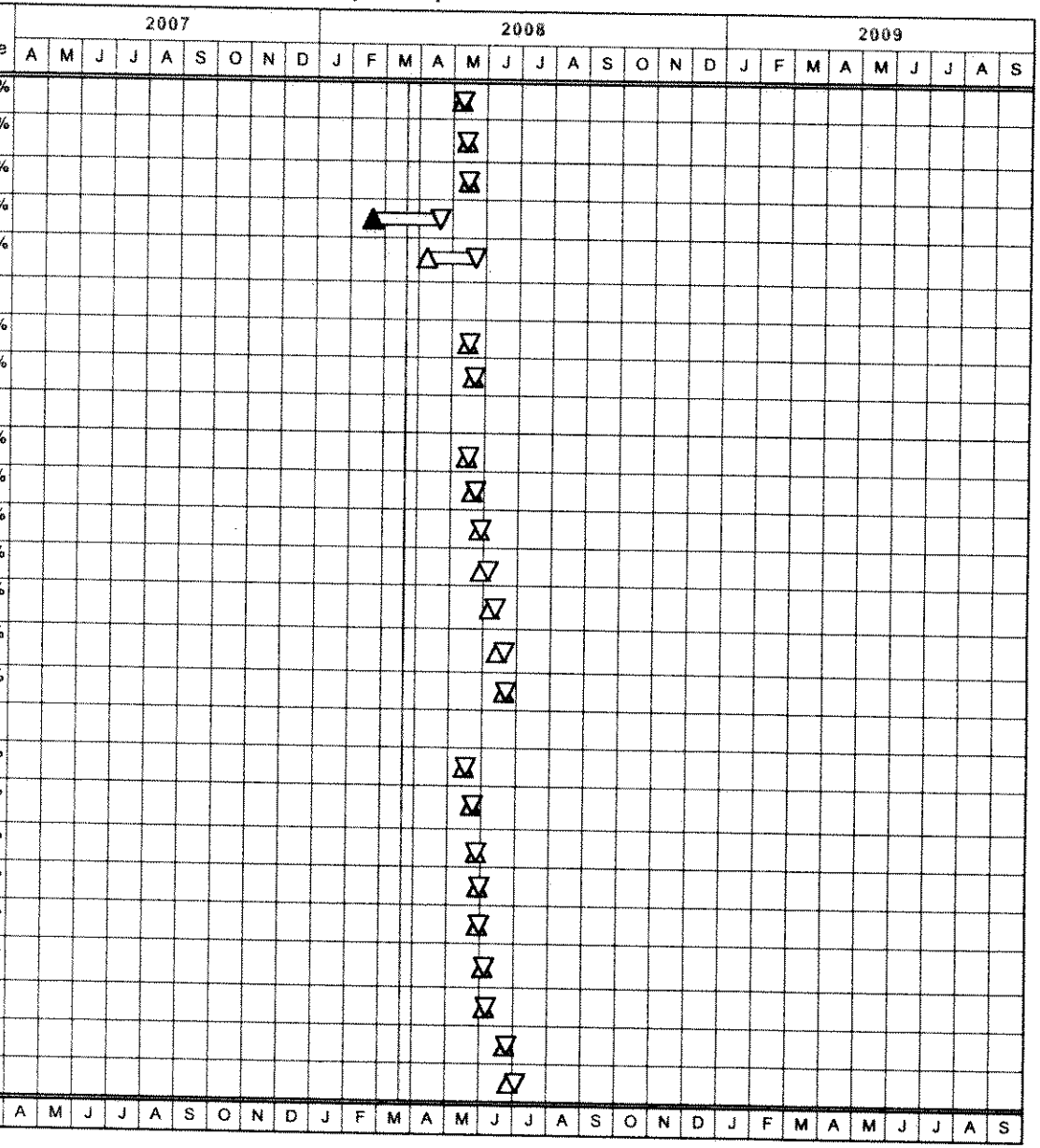
MSL Mars Sample Return Box (MSRB) Schedule

	Activity Name	Start Date	Finish Date	% Complete
122	Clean Cradle Parts	5/8/08	5/9/08	0.0%
123	Assay Cradle Mated Surfaces	5/12/08	5/13/08	0.0%
124	Assemble Cradles (4)	5/14/08	5/14/08	0.0%
125	Fab. Witness Plates	2/18/08	4/18/08	5.0%
126	Engrave/Anodize Witness Plates	4/7/08	5/21/08	0.0%
127	JPL Eng Unit I&T			
128	Integration	5/15/08	5/16/08	0.0%
129	Random Vibe Test	5/19/08	5/21/08	0.0%
130	ARC Eng Unit I&T			
131	Integration	5/15/08	5/16/08	0.0%
132	Bake-out/DHMR @ JPL	5/19/08	5/23/08	0.0%
133	Random Vibe Test	5/26/08	5/28/08	0.0%
134	Sample Caching Tests	5/29/08	6/4/08	0.0%
135	Sample and Cache Retention Tests	6/5/08	6/11/08	0.0%
136	Cache Removal Tests (with full cache)	6/12/08	6/18/08	0.0%
137	Clean and Re-Integrate	6/19/08	6/20/08	0.0%
138	Flight Units (2) I&T			
139	Integration	5/15/08	5/16/08	0.0%
140	Random Vibe Test	5/21/08	5/23/08	0.0%
141	Cache Removal Test	5/26/08	5/27/08	0.0%
142	Bonding Test	5/28/08	5/29/08	0.0%
143	Precision Cleaning	5/29/08	5/30/08	0.0%
144	PP Assay of Exposed Surfaces	6/2/08	6/3/08	0.0%
145	Bag Units	6/4/08	6/5/08	0.0%
146	Ship to JPL	6/23/08	6/24/08	0.0%
147	Bake-out/DHMR @ JPL	6/25/08	7/2/08	0.0%



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MSL Contact List

Name	Discipline	Office Phone	Cell Phone
Anderson, Bob	Mars soil samples	(818)393-1253	
Burke, Kevin	Deputy Sample System Mgr	(818)354-3971	
Buxbaum, Karen	Mars Program PP Lead	(818)393-1135	
Conley, Cassie	NASA PP Officer (HQ)	(202)358-3912	
Cook, Richard	Project Mgr	(818)393-7820	
Crisp, Joy	Deputy Project Scientist	(818)354-9036	
Eisen, Howard	Deputy Flight System Mgr	(818)354-9360	
Feldman, Jason	Cache Accommodation POC	(818)393-2406	(818)653-6409
Forgrave, John	S&MA (ERD)	(818)354-8891	
Jandura, Luoise	SA/SPaH systems eng.	(818)354-0373	
Kingery, Cindi	S&MA Manager	(818)393-4939	
Koukol, Robert	PP Lead	(818)354-8528	
Maki, Justin	Cameras	(818)354-6227	
Mattingly, Richard	MSR Study Lead	(818)354-4605	
Melko, Joe	Sampling System Engineer	(818)354-6031	
Owen Julie	Scheduling	(818)393-7220	
Pounders, Eric	Mars soil samples		(818)825-1649
Serviss, Orin	Cache Acc. POC (back up)	(818)354-1882	(818)653-9597
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220-1

CONTRACT ADMIN

LOGISTICS / AQUISITIONS

ENCLOSURE (2)

ENCLOSURE (3)

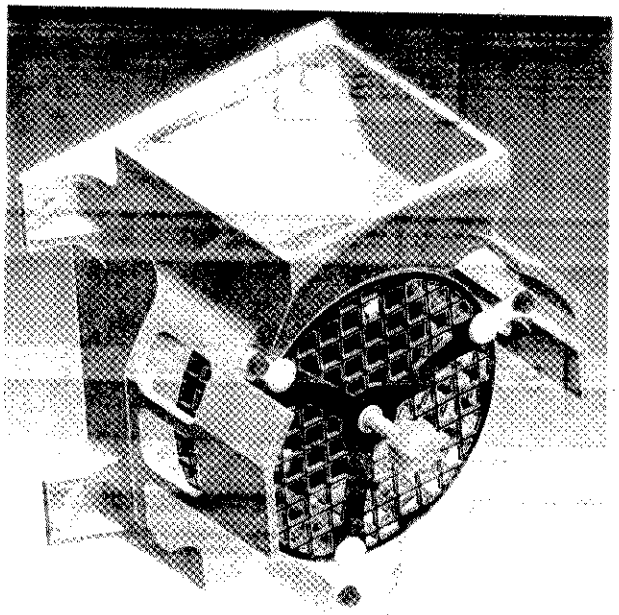
Mars Science Laboratory

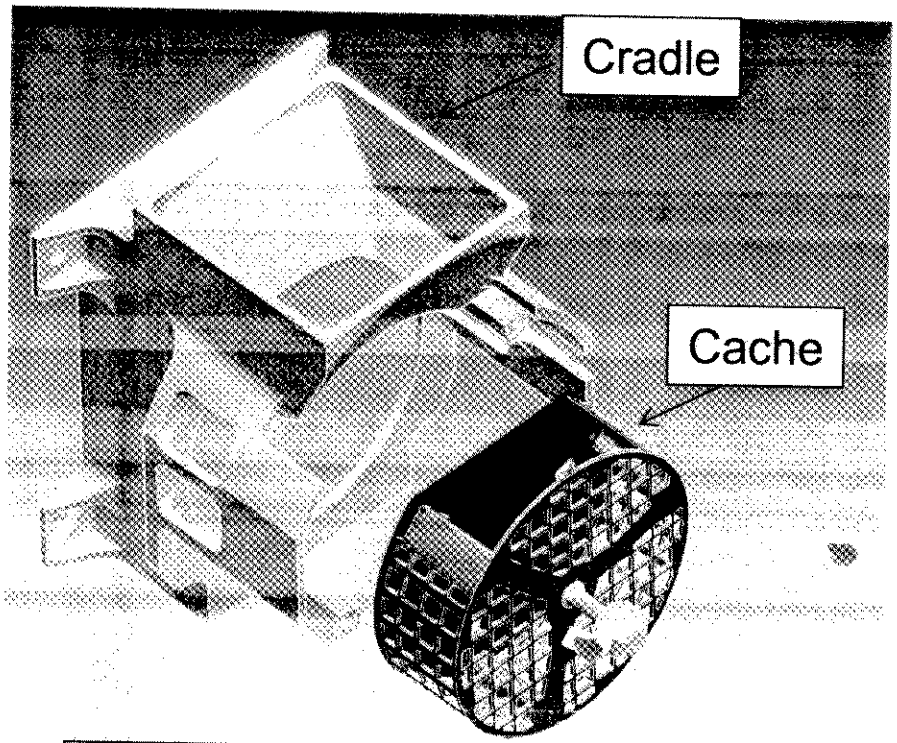
Mars Sample Return Box (MSRB) Project Delta Confirmation Review

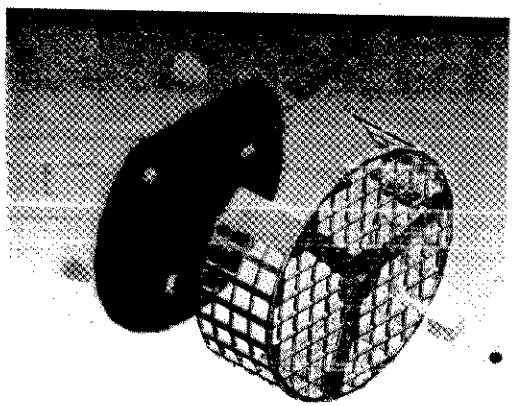
Mina Cappuccio, ARC, MSRB Project Manager
Howard Eisen, JPL, MSL Deputy Flight System Manager

11/29/07

Rover Sample Cache System







- 2 Main Assemblies:
  Cradle and Sample Cache