Mars Exploration Program Status
Planetary Science Subcommittee of NAC
16 October 2009

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Planetary Science Division, Director
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Mars Exploration Program, Director
• Decision to slip to 2011 Mars launch opportunity (December 2008)
  – Schedule no longer viable for 2009 LRD

• Replanned baseline approved by the DPMC and APMC (June 2009)
  – Approved $32M reserve augmentation (FY10 and FY11) as requested by the Project and Program.

• Submit MSL Cost and Schedule Analysis Report (“Breach Report”) to Congress.
  – Development = $1,631M (68% development overrun); LCC = $2,286M
  – Report states that additional reserves may be needed ($15M to $115M range)

• Conduct a “Readiness to Proceed” Review in November 2009—actuators, avionics, power, etc.
  – Project must stabilize these key technical issues for meaningful CTG estimates
  – Include updated cost estimate and independent cost review

• After “Readiness to Proceed” Review, reassess the need for added funding reserves
  – APMC approval required

• This telecon is to provide to the PSS the results of the SMD internal progress review held on October 1, 2009.
• Major project accomplishments in FY’09

  – System / subsystem design assessment completed, and changes have been incorporated into the technical and implementation baselines.
  
  – Avionics design has been finalized at the board level, but FPGA design has lagged.
    • Completion now scheduled for mid November.
  
  – Actuator schedule has been adversely affected by technical issues
    • Corrective actions are now in hand and being implemented
  
  – SA/SPaH Robot Arm and Drill / CHIMRA Engineering Model testbed deliveries have been completed, and sample chain validation initiated
  
  – Radar has completed corrective actions and tests on key technical problems
    • Radar Subsystem in integration & test for delivery in January 2010
  
  – Descent Stage Propulsion rework 90% complete (accelerated from FY’10).
  
  – All instruments are complete with the exception of the REMS, ChemCam and SAM
  
  – The budget forward will incorporate FY’09 actuals and final institutional rates. Review at the “Readiness to Proceed” Review (with SRB) November 18-19.

• The project is on plan, has schedule reserve, and there are no insurmountable technical obstacles to launch in the 2011 opportunity.
Key technical and management issues that delayed the 2009 launch have been addressed

- System and Subsystem design assessment completed.
- Avionics
  - Hardware rework and deliveries are on schedule to support the system integration schedules.
    - Resolving final open design issues Problem Failure Reports (PFR’s)
    - Major progress in completion of test infrastructure and maturing of FPGA designs.
    - Rover Computer (RCE) #101 PFR diagnosis proceeding, including repeat of environmental testing.
- Actuators
  - Sufficient flight motors have been completed to support the mission.
  - Focusing on:
    - Low-Power High Torque Actuator (LPHTA) Life Test failure at the end of July 2009.
    - Root cause identified: Inadequate retainer ring design and bearing failure. Replace ring.
    - Restart of LPHTA Life Test at the end of October.
    - Flight Actuator assembly, test, and delivery.
    - “Path to flyability”--Analyses and tests that would permit flying existing Aeroflex WSA and LPHTA actuators
    - Alternate suppliers determined to be not feasible within MSL’s schedule.
Project Status - 2

- Flight Software development and V&V implementation.
  - FSW development is on schedule; including personnel assignments and margin, to support the system integration schedule.
  - FSW capabilities are synchronized with ATLO needs,
  - Testbed schedule for V&V is in place and synchronized with FSW deliveries – substantial margin exists.

- All Engineering Model actuators have been delivered.
  - SA/SPaH Robot Arm, Drill, and CHIMRA EM deliveries have been completed.
  - Sample chain validation initiated.

- All Entry, Descent, and Landing hardware has completed qualification, delivery, and is in storage.

- Descent Stage propulsion rework is 90% complete, ahead of schedule. Cruise Stage propulsion rework will be complete in early FY’10

- Implemented larger rover battery to solve surface energy balance issue.
• Sample Analysis at Mars (SAM) Wide-Range Pump (WRP)
  – WRP lifetime concerns raised based on review of bearing design.
  – Go-Forward Review held August 19th
    • Parallel WRP redesign/rebuild path established
      – Procure long-lead parts for replacement WRP
      – Conduct life test of existing WRP (life test stopped at >40% complete – under investigation as of 10/14.)
    • December 1, 2009 decision date for replacement WRP build
    • May 1, 2010 decision date for replacement WRP install

• Industry-wide issue for Western Titanium non-conforming titanium.
  – This effort may take several months to thoroughly determine and document all impacts to MSL.
### Project Status – 4, Payload Status

<table>
<thead>
<tr>
<th>System</th>
<th>FM Deliv. Status</th>
<th>Open Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>APXS</td>
<td>Delivered</td>
<td>Penalty Vib. Pending following Cooler Bumper</td>
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<tr>
<td></td>
<td></td>
<td>Tube heat leak repair</td>
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<tr>
<td>CheMin</td>
<td>re-del ~Oct 15</td>
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<td>ChemCAM</td>
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<tr>
<td>Mast Unit</td>
<td>Storage @LANL</td>
<td>w/ External CCD Cooler modification incorporated</td>
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<td>Body Unit</td>
<td>Mar’10</td>
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<tr>
<td>DAN</td>
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<tr>
<td>Pulse Neutron Generator</td>
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<tr>
<td>Detection Electronics</td>
<td>Delivered</td>
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<tr>
<td>Mastcam</td>
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<tr>
<td>Camera Heads</td>
<td>Nov ’09</td>
<td>Delivered in place; Mastcams in extended Cal</td>
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<tr>
<td>Digital Electronics Ass’y.</td>
<td>Nov ’09</td>
<td>Ready for Delivery; supporting Mastcam Cals</td>
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<td>MAHLI</td>
<td>Delivered</td>
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<tr>
<td>MARDI</td>
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<tr>
<td>RAD</td>
<td>Storage @ SwRI</td>
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<tr>
<td>REMS</td>
<td>Jan ’10</td>
<td>Final I&amp;T prior to PFM Deliv.</td>
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<td></td>
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<td>Spares in test for swap (Improved Performance)</td>
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<tr>
<td>SAM</td>
<td>Apr ’10 or Aug ’10</td>
<td>Baseline Delivery is Apr’10</td>
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<tr>
<td></td>
<td></td>
<td>Deliv w/ WRP Retrofit would be Aug’10</td>
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Status as of 100109
Major Development Work to Go

- Completion of all actuator deliveries to support mechanism build-up and timely delivery into the ATLO flow.
- Completion of the required “path to flyability” analyses and tests for the actuators / mechanisms to assure the flyability of the existing as-built actuators.
- Completion of SAM Wide Range Pump testing leading to a Wide Range Pump decision, completion of the SAM development and delivery of SAM into the ATLO flow.
- Completion of Flight avionics development and delivery.
- Development and completion of the V&V program.
- Completion of the acceptable cost / acceptable risk project implementation plan.
- Complete review of Titanium applications in MSL.
Budget Status and Impacts

- Baseline at APMC in June 2009 committed to $432M, but reserves were acknowledged as low (~18% cost-to-go)

- Several different cost models predict additional resources will be required.

- Final budget approval expected at APMC on January 28, 2010.
Near-Term Events (next 6 months)

- HQ/SMD will continue tracking progress through weekly meetings and metrics (resolution of technical issues, reserve burn rates, PFR closure rates, workforce profile, etc.)

- Conduct a “Readiness to Proceed” Review in November 2009

- PSS meeting, December 3-4, 2009

- Project/SAM review to proceed with full development of a backup Wide-Range Pump (December 2009).


- Project System Integration Review (SIR-III) in April 2010

- Project/SAM decision point to install and test replacement backup WRP in May 2010.

Typical Actuator

- Gearbox
- Output Resolver
- Motor
- Brake
- JPL Cold Encoder