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Environmental Evaluation and Recommendation for NASA Routine Payload Categorization of the Mars Reconnaissance Orbiter (MRO) Project

The proposed MRO mission has been reviewed in accordance with the Routine Payload criteria established by the *"Final Environmental Assessment of NASA Routine Payloads on Expendable Launch Vehicles from Cape Canaveral Air Force Station Florida and Vandenberg Air Force Base California,"* dated June 2002 and Finding of No Significant Impact (FONSI) dated June 18, 2002. This review shows that the MRO mission meets all of the Routine Payload Criteria and therefore, it is recommended that MRO be designated a NASA Routine Payload. Supporting mission description and Routine Payload Checklist documentation is attached.

James A. Smith
for Mark Phillips 3/17/03
J. M. Phillips, Supervisor Date
Launch Approval and Policy
Planning Group

Concurrence:

3/17/03
R. E. Wilcox, Manager Date
Cross-Program Launch Approval
Engineering

Concurrence:

19 MAR 03
Jim Graf, Manager Date
Mars Reconnaissance Orbiter
Project

Description of Proposed Mission:

The goal of the Mars Reconnaissance Orbiter (MRO) mission is to send a spacecraft into a 255 by 320 kilometers-high (160 by 200 miles) polar orbit around Mars. The spacecraft's instruments would undertake investigations as part of the overall Mars Exploration Program, provide significant improvements in resolution and data volume over previous missions, and would also provide telecommunications and navigation support for future Mars missions. The 2,000-kilogram (4,500 pounds) MRO spacecraft would be launched from Cape Canaveral Air Force Station (CCAFS) on an Atlas III or Atlas V ELV during a launch opportunity extending from August 8 to August 28, 2005.

The orbiter is a new design with an instrument suite which not only recaptures the lost science from the Mars Climate Orbiter (MCO), but extends NASA's objective to "follow the water" with remote sensing. The MRO payload includes the following scientific instruments:

HiRISE, High Resolution Imager
CRISM, Visual and Infrared Imaging Spectrometer
MCS, Mars Climate Sounder
MARCI, Wide Angle Camera
CTX, Context Imager for HiRISE and CRISIM
SHARAD, Subsurface Radar

MARCI and MCS are global mappers. MARCI would conduct low spatial resolution observations of the atmosphere and the surface in six multicolor channels. MCS (previously called PMIRR) profiles the atmosphere through a combination of limb and on-planet sounding with 5 km vertical resolution.

New targeting instruments include HIRISE and CRISM. HiRISE would observe selected areas at resolutions five times better than instruments having flown prior to MRO.

CRISM would enable a search for evidence of prior hot springs, thermal vents, or lakes and ponds. If water were present for an extended time in such regions, it should have left deposits of minerals whose spectral signature can be detected at near-infrared wavelengths.

The Context Imager, would provide panchromatic context imaging for the high-resolution targeted observations by observing simultaneously with HiRISE and CRISM.

SHARAD operates at frequencies near 20 MHz. This radar complements measurements by the radar on Mars Express, which would operate at lower frequencies, and plans to penetrate up to a few kilometers into the ground. The depth of penetration for the MRO radar (< 1 km) would be shallower than that of the Mars Express radar. SHARAD would probe the near-surface structure and composition. In addition, the profiling of the Martian permanent polar caps by the MRO and Mars Express radars would yield new, more definitive observations with regard to subsurface structure and the presence or absence of liquid water near the icy surface. The context imager and the radar are the two regional investigation instruments.

Statement of Purpose and Need:

Scientific advisory committees, including the Committee on Planetary and Lunar Exploration (COMPLEX) of the Space Studies Board of the National Research Council, have established general scientific objectives for the exploration of the Solar System. Specific goals for the exploration of Mars and the methods for achieving them are outlined by COMPLEX and the Mars Exploration Payload Analysis Group. To formulate and focus science requirements, NASA convened a Science Definition Team (SDT) that considered the range of science objectives that would be appropriate for the MRO mission to be launched in the 2005 launch opportunity. These objectives are linked to priorities established in the document, "*Mars Exploration Program: Scientific Goals, Objectives, Investigations, and Priorities,*"

In the 2005 launch opportunity to Mars, NASA plans to launch the MRO 2005 mission having as its specific scientific objectives outlined below:

- researching the processes of present and past climate change on Mars,
- searching the surface and shallow-subsurface for sites that show evidence of water-related activity, investigating the processes that are responsible for the formation of the ubiquitous layers that have been observed on Mars,
- and probing the shallow-subsurface to identify regions where three-dimensional layering could indicate the presence of ice or possibly lenses of liquid water.

This MRO 2005 mission would achieve these objectives through a combination of the reflight of the scientific investigations lost with the failure of the Mars Climate Orbiter (MCO), and by the flight of new types of science investigations.

NASA Routine Payload Checklist (1 of 2)

PROJECT NAME: **Mars Reconnaissance Orbiter (MRO)** DATE OF LAUNCH: August 8-28, 2005

PROJECT CONTACT: Ross Jones PHONE NUMBER: 818-354-7769 MAILSTOP: 301-420

PROJECT START DATE: January 2001 PROJECT LOCATION: JPL

PROJECT DESCRIPTION: The goal of the Mars Reconnaissance Orbiter (MRO) mission is to send a spacecraft into polar orbit around Mars.

A. SAMPLE RETURN:	YES	NO
1. Would the candidate mission return a sample from an extraterrestrial body?		X

B. RADIOACTIVE SOURCES:	YES	NO
1. Would the candidate spacecraft carry radioactive materials?		X
2. If Yes, would the amount of radioactive sources require launch approval at the NASA Associate Administrator level or higher according to NPG 8715.3 (NASA Safety Manual)?		

Provide a copy of the Radioactive Materials Report as per NPG 8715.3 Section 5.8.3.

C. LAUNCH AND LAUNCH VEHICLES:	YES	NO
1. Would the candidate spacecraft be launched using a launch vehicle/launch complex combination other than those indicated in Table 1 below?		X
2. Would the proposed mission cause the annual launch rate for a particular launch vehicle to exceed the launch rate approved or permitted for the affected launch site?		X

Comments:

D. FACILITIES:	YES	NO
1. Would the candidate mission require the construction of any new facilities or substantial modification of existing facilities?		X
2. If Yes, has the facility to be modified been listed as eligible or listed as historically significant?		

Provide a brief description of the construction or modification required:

E. HEALTH AND SAFETY:	YES	NO
1. Would the candidate spacecraft utilize any hazardous propellants, batteries, ordnance, radio frequency transmitter power, or other subsystem components in quantities or levels exceeding the Envelope Payload characteristics (EPCs) in Table 2 below?		X
2. Would the candidate spacecraft utilize any potentially hazardous material as part of a flight system whose type or amount precludes acquisition of the necessary permits prior to its use or is not included within the definition of the Envelope Payload (EP)?		X
3. Would the candidate mission release material other than propulsion system exhaust or inert gases into the Earth's atmosphere or space?		X
4. Would launch of the candidate spacecraft suggest the potential for any substantial impact on public health and safety?		X
5. Would the candidate spacecraft utilize a laser system that does not meet the requirements for safe operation (ANSI Z136.1-2000 and ANSI Z136.6-2000)? For Class III-B and IV laser operations, provide a copy of the hazard evaluation and written safety precautions (NPG 8715.3).		X
6. Would the candidate spacecraft contain pathogenic microorganisms (including bacteria, protozoa, and viruses) which can produce disease or toxins hazardous to human health?		X

Comments:

continued on next page

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F. OTHER ENVIRONMENTAL ISSUES:	YES	NO
1. Would the candidate spacecraft have the potential for substantial effects on the environment outside the United States?		X
2. Would launch and operation of the candidate spacecraft have the potential to create substantial public controversy related to environmental issues?		X
Comments:		

Table 1: Launch Vehicles and Launch Pads

Launch Vehicle	Eastern Range (CCAFS Launch Complexes)	Western Range (VAFB Space Launch Complexes)
Atlas IIA & AS	LC-36	SLC-3
Atlas IIIA & B	LC-36	SLC-3
Atlas V Family	LC-41	SLC-3
Delta II Family	LC-17	SLC-2
Delta III	LC-17	N/A
Delta IV Family	LC-37	SLC-6
Athena I & II	LC-46 or -20	California Spaceport
Taurus	LC-46 0r -20	SLC-576E
Titan II	N/A	SLC-4W
Pegasus XL	CCAFS skidstrip KSC SLF	VAFB airfield

Table 2: Summary of Envelope Spacecraft Subsystems and Envelope Payload Characteristics (EPC)

Structure	**Unlimited:** aluminum, magnesium, carbon resin composites, and titanium **Limited:** beryllium [50 kg (110 lb)]
Propulsion	Mono- and bipropellant fuel; 1000 kg (2200 lb) (hydrazine); 1000 kg (2200 lb)(monomethyhydrazine) Bipropellant oxidizer; 1200 kg (2640 lb) (nitrogen tetroxide) Ion-electric fuel; 500 kg (1100 lb) (Xenon) SRM; 600 kg (1320 lb) (AP)-based solid propellant
Communications	Various 10-100 W (RF) transmitters
Power	Solar cells; 150 A-Hr (Ni-H_2) battery; 300 A-Hr (LiSOC) battery; 150 A-Hr (NiCd) battery
Science instruments	10 kW radar ANSI safe lasers
Other	Class C EEDs for mechanical systems deployment Radioisotopes limited to quantities that are approved for launch by NASA Nuclear Flight Safety Assurance Manager Propulsion system exhaust and inert gas venting