Mars Pathfinder Project

Science and Instrument Requirements

Revision 3
March 15, 1996

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Science and Instrument Requirements

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CHANGE LOG

Revision no.	Description	Date
Revision 0	Initial signature version	August 1, 1994
Revision 1	Incorporates numerous inputs from PSG and other Project personnel. Mission success images changed and defined. Desired capabilities that have been incorporated are no longer listed as desires.	November 10, 1994
Revision 2	Corrections to describe IMP final flight filter selections. Clarify number of APXS samples for rover nominal mission (7 sols) and lander nominal mission (30 sols). Elimination of TBDs. Minor editorial corrections.	Feb. 15, 1996

Revision 3	Corrections to resolution of IMP images. Corrections to APXS/rover images. Corrections to instrument health checks. Revised IMP wind sock and radiometric target observations. Minor editorial corrections.	March 15, 1996

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1.0 Introduction

This document contains the top-level science and instrument requirements for the Mars Pathfinder Mission. Section 2.0 contains the science operational requirements, segregated by scientific discipline. Those requirements that are essential to satisfying one or more of the mission success criteria are so noted. Sections 3.0 to 5.0 contain science requirements imposed on the project by each of the individual investigations. Section 6.0 contains requirements placed on the science instruments to support operational objectives (other than science), for example, imaging in support of rover operations. Section 7.0 establishes the relative priorities for all of the observational requirements, both science and operational. Section 8.0 collects the requested requirements which the Pathfinder Project has not accepted, along with the reasons for their non-acceptance.

Requirements and desires are listed in this document. Desires are capabilities that will considerably enhance the science return from the mission and that are thought to be achievable within the baseline mission capabilities. Desires are clearly identified as such, to distinguish them from requirements.

Observation frequencies assume that the lifetime requirement of 30 days for the lander (including the IMP) is met and that after the nominal 30-day mission periodic measurements will be continued indefinitely at the same frequency. The lifetime requirement for the rover is 7 days.

The instrument characteristics are summarized in the “Mars Pathfinder Science and Instruments” brochure and are defined in the individual instrument Functional Requirements. The implementation of the instruments is described in the Science and Instruments Implementation Plan (PF 100-1.4). Individual instrument characteristics that are relevant to the science and instruments requirements stated in this document are described below.

1.1 Imager for Mars Pathfinder (IMP) Characteristics

The IMP hardware consists of two cameras that are offset by a stereo baseline distance of 15 cm. The cameras are mounted at the top of a deployable mast that, when deployed, elevates the cameras approximately 80 cm above their stowed position. The camera can acquire images over a full range of azimuth and elevation angles in both undeployed and deployed configurations. The obscuration due to lander structure is different for the two elevations.

Each camera (or optical path) contains a filter wheel with 12 positions. The filters in the two sides are not identical except for three positions intended explicitly for stereo use. There are 4 pairs of solar filters, three pairs of stereo filters, 9 individual geologic filters (which, when combined with the three pairs of stereo filters, result in 12 distinct geologic filters) and one diopter or close-up lens, designed to acquire images of magnetic wind-blown dust which adheres to a small magnet located on the IMP tip plate (part of the camera). These numbers total to 24.

The IMP experiment includes a magnetic properties investigation, which includes a set of magnetic targets that are observed by the camera. Two arrays of five magnets of differing strength are positioned at two different locations on the lander structure. An additional magnetic target is mounted on the camera baseplate so that it can be viewed with a diopter (or close-up) lens in the IMP filter wheel. A magnetic target is also included on each rover deployment ramp such that an APXS analysis of a magnetically-segregated sample may be acquired.

A set of three wind socks, mounted on the ASI/MET mast, are provided as part of the IMP experiment. These wind socks may be imaged in stereo to determine the wind speed and direction as a function of height from the surface.

The IMP software provides a variety of ways to reduce the data volume contained in a raw image, including lossless data compression, lossy data compression, pixel averaging (which directly reduces resolution) and segmenting frames into subframes so that only the desired portion of a frame need be transmitted. Images containing the wind sock are an example of a situation in which subframing may be used to advantage. The stated requirements refer to these several methods for reducing data volume; however, the reductions in data volume are not stated quantitatively.

In describing data quality in this document, full resolution implies lossless compression. A full panorama is a set of images from one of the IMP cameras that covers 360 degrees in azimuth and an elevation range that, as a minimum, covers from the edge of the lander to above the local horizon at all azimuths. Note that for some panoramas, it may be necessary to cover more of the lander structure; for example, the rover deployment panorama, in which it is desired to image the rover and both of its egress ramps. This level of detail is more appropriately addressed in the mission scenarios.

1.2 APXS Characteristics

The APXS will address the detailed and complete chemical composition of multiple Martian rocks and soil samples. This information will supplement the partial soil analyses of two sites obtained by the Viking X-ray Fluorescence Experiment. The information obtained by the APXS will help to better understand the history and the evolution of the planet Mars.

The APXS consists of two parts: the sensor head and the main electronics box. The sensor head contains the alpha, proton and x-ray detectors, the Cm-244 radioactive alpha sources, the collimators, source shutter and the preamplifier for the x-ray detector. The main electronics box contains the rest of the analog, digital and microcontroller electronics that handle the signals from the three types of radiation detectors, and stores the data in the form of three independent energy spectra. The chemical composition of the measured samples is obtained by deconvolution of these energy spectra in terms of an elemental library derived during the extensive calibration of the instrument prior to launch.

The APXS Instrument on the Mars Pathfinder Mission is carried aboard the Rover, which enables selection of multiple, interesting samples for analysis. The ability to be positioned at a chosen target location is provided both by the mobility characteristics of the Rover and by the positioning capability of the APXS Deployment Mechanism (ADM). In general, the selection of target locations will be made using images from the IMP (target selection) and from the Rover cameras (fine positioning). When potential target sites are obscured or sufficiently remote from the IMP, target selections may be made using Rover images alone.

It is expected that many rock and soil samples will be analyzed for periods up to 10 hours each during the mission. Because the APXS consumes relatively little energy per analysis, most of the measurements can be done during the Martian night, when there is little other activity aboard the rover. The amount of data transmitted per analysis is sufficiently small that data compression is unnecessary.

1.3 ASI/MET Characteristics

The ASI/MET Investigation addresses the profile of the atmosphere, as sensed during the entry and descent phases; and the local meteorologic conditions at the landing site after landing. During the entry and descent phases measurements are provided by both the ASI/MET Instrument and the Science Accelerometers (contained within the AIM Subsystem). After landing the meteorological measurements are provided by the ASI/MET instrument, which consists of a pressure sensor, a set of thermocouples at varying heights above the surface, and a wind sensor that detects wind direction and speed. During entry, the ASI/MET also supports the engineering function of the Aeroshell Instrumentation Package -- a set of thermocouples mounted in the aeroshell to determine its heating and ablation rates. Requirements in this document specifically address the ASI/MET Investigation (which includes the Science Accelerometers) or the ASI/MET Instrument (which excludes the Science Accelerometers).

The ASI/MET Instrument data-taking sequence start and stop cycles are controlled by the AIMS. There is complete flexibility in the times and durations of observational sequences (limited by power, data storage and telemetry constraints). For the purposes of these requirements two data taking modes are defined -- an observation and a continuous observation -- defined as follows. ASI/MET post-landed observations of temperature, pressure, wind speed and wind direction consist of samples taken 8 times per second for each sensor for a five minute period. Post-landed continuous observations of these sensors consist of samples taken eight times per second for each sensor for a specified duration in excess of five minutes.

2.0 Science Observation Requirements

2.1 Surface Morphology and Geology at the Meter Scale

2.1.1 Pre-deployment Panorama

A full, monoscopic, monochrome panorama shall be acquired prior to deployment of the IMP mast. This panorama shall be returned at full resolution.

2.1.2 Post-deployment Panorama

A full panorama in three colors for one camera and one color for the other (stereo) camera shall be acquired after IMP mast deployment and at high sun elevation angle. This panorama shall be returned at full resolution.

2.1.3 Panoramas for Change Detection

Monoscopic, single color (750 nm) panoramas shall be acquired monthly over the life of the mission, at the same local time of day (either at high sun elevation or in late afternoon), and returned at full resolution. The second panorama shall be scheduled to be acquired and returned before the end of the nominal (30-day) mission.

2.1.4 Photoclinometric Images

Images of eight (8) selected features shall be acquired at four (4) different solar elevation angles to permit topographic analysis by shadow length and photoclinometry.

2.1.5 Use of Rover Images for Surface Morphology and Geology

Images acquired by the rover cameras for operational purposes shall be made available for science data analysis.

2.2 Surface Mineralogy

2.2.1 Multispectral Panorama

A full monoscopic panorama at full resolution in each of the geology spectral filters shall be acquired at high sun elevation angles at least once during the landed mission.

2.2.2 Multispectral Observations of Selected Targets

Multispectral observations in each of the geology filters of at least 6 selected features shall be acquired at low phase angles. (Note: these observations may be combined with those in requirement 2.2.1 to reduce the number of frames acquired).

2.2.3 High Resolution Soil Images

Images shall be acquired at low phase angle in each of the geology filters at three locations closest to the lander to provide the highest resolution IMP images of the local soil. Preferably these images shall be acquired from the undeployed IMP location.

2.2.4 Observations of Magnetic Properties Targets

Subframe images of the two magnetic properties target arrays shall be acquired in as many of the geology filters as possible, at least six times during the mission (more frequently at first, then less frequently; i.e. on sols 1, 2, 4, 8, 16 and 30).

2.2.5 Observations of Near-Field Magnet

A close-up image of the near-field magnetic target shall be acquired in the close-up (diopter) filter position at least six times during the mission at the same times as the magnetic properties target array observations.

2.2.6 Observations of Magnetic Targets Attached to Rover Ramps

The magnetic and the nonmagnetic reference targets attached to the rover ramps shall be imaged in each of the geology filters at least six times during the mission (at the same times as the magnetic properties target array observations). It is highly desirable to acquire the first set of images before the rover is deployed.

2.2.7 Search for Surface Frosts

At least 30 surface images (one complete 360 degree rotation in azimuth) in the blue filter and at high compression shall be acquired within one hour after sunrise to search for evidence of surface frost formation. These images shall be acquired on at least 4 separate sols, equally spaced throughout the nominal landed mission.

2.3 Elemental Composition of Rocks, Soil and Surface Materials

2.3.1 APXS Analysis of Rock

The APXS shall be employed to analyze a rock sample (mission success criterion)

2.3.2 APXS Analysis of Soil

The APXS shall be employed to analyze a soil sample (mission success criterion)

2.3.3 Documentation of APXS Samples (Rover Imager)

The rover shall acquire images of the rock and soil samples at close range in conjunction with performing an APXS measurement. Images of the APXS target location shall be acquired both before and after the APXS ADM deployment to allow confirmation of the actual sensor head location relative to the target surface.

2.3.4 Documentation of APXS Samples (IMP)

The IMP shall acquire multispectral images in each of the geology filters and at a minimum of three different illumination geometries of the area immediately surrounding the APXS sample sites within ±1 sol of the APXS analysis. For APXS sample sites consisting of disturbed soil (desire) or abraded rock (desire) IMP images shall be acquired both before and after the APXS analysis (desire).

2.3.5 Number of APXS Samples

The APXS shall be employed to analyze a minimum of 3 samples (of rocks and of soil) during the nominal (7 sol) rover mission.

If the rover operates a total of 30 sols (nominal lander mission) then a total of 6 rock and 4 soil analyses shall be acquired.

2.3.6 APXS Analysis of Disturbed Soil (Desire)

It is desired that the APXS be employed to analyze the soil in a trench dug by the rover wheels at least twice during the landed mission.

2.3.7 APXS Analysis of Abraded Rock (Desire)

It is desired that the APXS be employed to analyze a rock sample before and after an abrasion attempt using one of the rover wheels. Rover images of the site shall be acquired both before and after the abrasion attempt.

2.3.8 APXS Analysis of Material on Rover Ramp Magnetic Targets (Desire)

It is desired that the APXS be employed to analyze a sample of dust collected on at least one of the magnetic targets attached to the rover ramps. (Note: this sample should be acquired at a time late in the nominal mission when data from the other magnetic targets indicates that a sufficient sample has been acquired). It is desired to image the magnetic targets on the rover ramp within one hour prior to the APXS analysis with both the rover camera and the IMP.

2.3.9 APXS Analysis of Material on Rover Ramp Non-Magnetic Targets (Desire)

(Deleted)

2.3.10 APXS Analysis of Relatively Unoxidized Rock (Desire)

It is desired that the APXS be employed to analyze at least one relatively dust-free and unoxidized (low red:blue reflectance ratio) rock surface, if there is such a rock available and the rover can reach it.

2.4 Atmospheric Science

2.4.1 Measurement of Vehicle Accelerations During Entry

The accelerations of the entry vehicle in three axes shall be obtained as a function of time during the entry phase and transmitted to earth after landing (mission success criterion).

2.4.2 Measurement of Temperature and Pressure During Descent

The free stream temperature and pressure of the atmosphere as a function of time shall be obtained during the descent phase (from parachute deployment until landing) and transmitted to earth after landing (mission success criterion).

2.4.3 Post-landed Temperature Measurements

Temperatures of the ambient atmosphere shall be obtained by observations performed hourly at three heights above the Martian surface after landing. It is desired to obtain these measurements more frequently, at least once every half-hour. Continuous measurements shall be acquired for one hour each day. The particular hour shall be selectable by command.

2.4.4 Post-landed Wind Speed and Direction Measurements

Wind speed and direction observations shall be obtained concurrently with the temperature data using the ASI/MET sensors after landing. Continuous measurements shall be acquired for one hour each day. The particular hour shall be selectable by command.

2.4.5 Post-landed Atmospheric Pressure Measurements

Ambient atmospheric pressure measurements shall be obtained hourly after landing. It is desired to obtain these measurements more frequently, at least once every half-hour. Continuous measurements shall be acquired for one hour each day. The particular hour shall be selectable by command.

2.4.6 Wind Sock Observations

During daylight hours, monoscopic observations (10 frames in each of two positions) of the wind socks shall be acquired hourly by the IMP, concurrent with the ASI/MET observations. These images may be transmitted as subframes of 100 wide x 256 high pixels, compressed 25:1.

2.4.7 Aerosol Opacity Measurements (Sun Images)

Aerosol opacity shall be measured by imaging the sun through two narrow band filters, once every 10 minutes for the first two hours after sunrise and for the last two hours prior to sunset, and hourly in between. Full resolution subframes of the images will be transmitted to minimize the data volume.

2.4.8 Aerosol Opacity Measurements (Phobos and Star Images)

Images of Phobos (when visible) and at least four (4) bright stars shall be acquired in four (4) filter positions, hourly at night. These images shall be transmitted at full resolution as subframes.

2.4.9 Dust Particle Characterization (Sky Images)

Dust particle characterization shall be performed by making IMP observations through 4 spectral filters of the sky at sunrise and sunset at least once every 3 days. Observations shall be made every 10 minutes for the two hours preceding sunrise and for the two hours following sunset. Images of the flat field calibration target shall be acquired at full resolution in conjunction with these observations.

2.4.10 Water Vapor Abundance Measurements

Water vapor abundance shall be measured every three days by making IMP observations of the sun through 4 filters, 12 times a day (sampled nonuniformly in time such that the greatest sampling frequency occurs when the sun is within 15 degrees of the dawn or dusk horizons). Full resolution, 25 x 25 pixel, subframes of the images will be transmitted to minimize the data volume. Images of the flat field calibration target shall be acquired in conjunction with these observations.

2.5 Astronomical Observations

2.5.1 Phobos and Deimos Radiometry

Images of Phobos and Deimos through eight filters shall be acquired at least once during the mission to establish their photometric properties.

2.5.2 Jupiter, Saturn and Earth Radiometry

If these objects are visible from the lander at night, the images of Jupiter, Saturn and the Earth through eight filters shall be acquired at least once during the mission to establish their photometric properties.

2.5.3 Star Images

Images of bright stars shall be acquired through eight spectral filters in conjunction with the Phobos, Deimos, Jupiter, Saturn and Earth images to standardize the radiometric observations.

3.0 Imaging Investigation Requirements

3.1 Mounting

The Flight System shall supply mounting surfaces for the camera assembly, for two radiometric calibration targets, and for two sets of two each magnetic target arrays. Mounting for three wind socks shall be provided by the ASI/MET meteorology boom. Mounting surfaces for two additional magnetic plaques, one each on the two rover deployment ramps shall be provided so that the APXS can analyze a magnetically sorted sample of wind-blown dust.

3.2 Data Storage

The Flight System shall provide long term (30 days minimum after landing) data storage capability for IMP calibration files, image files and data compression parameter files.

3.3 Pointing

3.3.1 Local Target Pointing

The project shall calculate the pointing angles needed to point the camera at features located within the Flight System-referenced coordinate system (calibration targets, lander structure and rover for both undeployed and deployed IMP locations).

3.3.2 Celestial Object Pointing

The project shall calculate the pointing angles needed to point the camera at the sun, earth, Jupiter, Saturn, Phobos, Deimos and selected bright stars.

3.3.3 Field of Regard

It shall be possible to point the IMP such that the field of view covers the range of 360 degrees in azimuth and from -66 to +90 degrees in elevation. Portions of this field of regard will be obscured by spacecraft structure and portions cannot be imaged in stereo because of these obstructions.

3.4 IMP Calibrations

3.4.1 IMP In-flight Health Checks

Two IMP health checks shall be made during the cruise phase of the mission, the first within approximately 30 days following launch, the second within 30 days prior to arrival at Mars. The health check consists of pairs of dark current frames acquired at three different integration times and two different CCD temperatures, totalling 12 frames. These data shall be losslessly compressed and transmitted with accompanying engineering data. At the end of the health check the filter wheel shall be commanded to rotate to its limit switch position.

3.4.2 Dark Current Calibration Images

Dark current calibration images at full resolution are required for each of the stereo optical paths at least three times per day or once per major imaging sequence, whichever is less.

3.4.3 Flat Field Calibration Images (Full Frame)

Images of the flat field calibration target shall be acquired for both of the stereo optical paths in all filter positions. These images shall be acquired on the day of landing and at 5 day intervals thereafter. They shall be returned at full resolution.

3.4.4 Radiometric Calibration Images (Partial Frame)

Images of the radiometric calibration targets shall be acquired in each filter position used that sol at three different solar elevation angles to permit spectral correction of sky brightness. These images shall be returned as full resolution subframes.

3.5 Camera Operations

The IMP shall be operable at any time during the landed mission (day and night)

3.6 Onboard Software to Command the IMP

The Flight System Computer shall contain and execute the software needed to command the camera operations, including heater control, pointing of the camera, stepping of the filter wheel and the execution of data taking sequences.

3.7 Onboard Software for Image Data Processing

The Flight System Computer shall contain and execute the software needed to perform image data compression, data storage, packetization and queuing of the telemetry packets.

4.0 Elementary Composition Investigation Requirements

4.1 Mounting Location

The APXS shall be mounted aboard the rover so that it can be transported to sampling sites within the operating range of the rover

4.2 Deployment Mechanism

4.2.1 Orientation

It shall be possible to orient the APXS sensor head with its axis of symmetry (look angle) at any angle between horizontal (parallel to the ground) and vertical (downward).

4.2.2 Alignment with Rock or Soil Surface (Angular)

It shall be possible to align the APXS sensor head to within 20 degrees of normal to a tangent plane at the intersection of the APXS sensor head axis of symmetry with the sample surface.

4.2.3 Alignment with Rock or Soil Surface (Spatial)

It shall be possible to align the APXS sensor head center line within 5 cm of a preselected target location (using rover images) for horizontal surfaces and for inclined surfaces within the range of motion of the APXS Deployment Mechanism.

4.2.4 Elevation Above Soil Surface

It shall be possible to place the APXS sensor head in contact with soil or rock samples within the range of motion of the APXS Deployment Mechanism.

4.3 APXS Calibration

4.3.1 APXS In-flight Health Checks

Two APXS health checks shall be made during the cruise phase of the mission, the first within approximately 30 days following launch, the second within 30 days prior to arrival at Mars. Each health check shall consist of powering on the APXS instrument, followed by an abbreviated set of commands sent to the APXS from the rover. Telemetry containing the appropriate command acknowledgements from the APXS instrument shall confirm its operational status.

4.3.2 APXS Background Calibration

Prior to the first acquisition of data from soil or rock samples, a calibration data take of three hours duration shall be acquired with the APXS shutter in the closed position, followed by the transmission of a complete APXS spectrum.

4.4 APXS Integration Times

Integration times of up to ten hours duration shall be provided for APXS observations (the integration time need not be continuous). The APXS shall be held in a single, fixed position until data have been acquired.

5.0 Atmospheric Structure and Meteorology Investigation Requirements

5.1 Mounting Locations

5.1.1 Science Accelerometer Mounting

The science x-, y-, and z-axis accelerometers shall be mounted in a plane (the Lander x-y plane) perpendicular to the Lander spin, or z-axis. The z-axis accelerometer shall be positioned on the z-axis. As a goal the plane containing the three accelerometers shall pass through the Lander center of mass. Should this goal not be achievable, then the positions of the effective centers of the x-, y- and z-axis sensors shall be known to an accuracy of 5 mm. (The center of mass is that of the entry vehicle, at entry into the atmosphere).

5.1.2 Pressure Sensor Mounting

The pressure sensor head shall be mounted inside the thermal enclosure. It shall be coupled via tubing to an inlet port location mounted near the opening between two solar panels and the base plate such that it can measure stagnation or total pressure. The response time of the pressure in the pressure sensor to pressure changes in the outside atmosphere shall be less than 0.1 s.

5.1.3 Descent Temperature Sensor Mounting

The descent temperature sensor shall be mounted near the opening between two solar panels and the base plate where the atmospheric flow velocities are high. The intent is to achieve good thermal coupling to the atmosphere and to avoid thermal contamination of the measurements by the Lander thermal boundary layer.

5.1.4 Post-landed Temperature Sensor Mounting

The temperature sensors used for post-landed meteorology shall be mounted so that they sample the ambient temperature at three different heights above the surface and are unperturbed by the thermal influences of the lander for most wind directions. The temperature sensors shall be mounted below the wind sensor to avoid thermal contamination by wind sensor natural convection, and shall be shielded from a direct view of the wind sensor heaters.

The post-landed temperature sensors shall be mounted to the meteorology boom. The three heights are nominally 0.25, 0.5 and 1.0 m above the lander attachment point. The three temperature sensors each consist of a single electrical element containing three thermocouples connected in parallel.

5.1.5 Wind Sensor Mounting

The wind sensor will be mounted on the meteorology boom and will be deployed as high above the surface as possible. It shall be positioned so as to avoid the disturbance in the flow caused by the lander for most wind directions.

5.2 ASI/MET Calibrations

5.2.1 ASI/MET In-flight Health Check

Two ASI/MET health checks shall be made during the cruise phase of the mission, the first within approximately 30 days following launch, the second within 30 days prior to arrival at Mars.

5.2.2 Pre-entry Calibration of the ASI/MET Pressure Sensor

The ASI/MET Instrument shall be turned on prior to entry so that at least fifteen (15) minutes of pressure measurements can be made after the instrument has stabilized and before the sensible atmosphere is reached, so that the zero offset of the pressure sensor can be established.

5.2.3 Pre-entry Calibration of the Science Accelerometers

The Science Accelerometers shall be turned on prior to entry so that at least fifteen (15) minutes of acceleration measurements can be made after the sensors have stabilized and before the sensible atmosphere is reached, so that the zero offset of the accelerometers can be established.

6.0 Operational Requirements on Science Instruments

Requirements listed in this section describe uses of the science instruments and instrument data for non-science operations and for mission planning functions.

6.1 Operational Requirements on IMP

6.1.1 IMP Sun Locating Capability

Under control of the AIMS, the IMP shall execute a search for the sun and return the most probable sun location coordinates in the camera frame of reference to aid in positioning of the high gain antenna. No returned images are required, however diagnostic data generated during the search shall be transferred to the AIMS.

6.1.2 Rover Deployment Images

Prior to deployment of the Rover and the deployment of IMP, a set of stereo images shall be acquired which include the rover, the egress ramps and an azimuthal segment of the Martian surface in the vicinity of the lander. These images shall provide a minimum of 1 cm ground pixel resolution (IFOV).

6.1.3 Pre-deployment Color Mosaic

A 3-color mosaic extending from the lander to the horizon and including the rover (approximately 4 frames in elevation and 5 frames in azimuth for a total of 60 frames) shall be acquired prior to deployment of the IMP mast. This color mosaic shall be compressed only to the extent that its image quality does not fall below that of the Viking Lander color images (mission success criterion).

6.1.4 Rover Operations Support Images

Stereo images of the rover and its surrounding terrain shall be acquired at the end of each sol during which the rover is operated. These images shall provide a minimum of 1 cm ground resolution (IFOV).

6.1.5 Images of the Rover Tracks

The IMP shall acquire full resolution, subframe images of the rover tracks (disturbances of the soil caused by rover movement) in the vicinity of the lander.

6.1.6 Images of the Lander

The IMP shall acquire a panorama of the lander hardware visible within the pointing constraints of the camera to assess the post-landed condition of the lander. These images may be highly compressed.

6.1.7 Images of Impact Sites

Panoramas acquired by the IMP in satisfaction of other requirements listed herein shall be used to search for and characterize the modification of the surface produced by the lander.

6.2 Operational Requirements on APXS

None

6.3 Operational Requirements on ASI/MET

6.3.1 Establishing the Landed Environment

ASI/MET post-landed data shall be used to establish the temperature, pressure and wind conditions of the landing site, to aid in the interpretation of engineering data and in the planning of surface operations.

6.4 Operational Requirements on the Science Accelerometers

6.4.1 Science Accelerometers to provide Back-up to Engineering Accelerometers

Science Accelerometer data acquired during the entry phase shall be available for use by the AIMS as a back-up signal to be used in deploying the parachute.

6.4.2 Lander Orientation with respect to Local Vertical

Following landing, the Science or Engineering Accelerometers shall be reset to the highest on-scale gain state and shall be used to determine the lander angular orientation with respect to local vertical. These measurements shall be repeated at least hourly during the first two sols and daily during the remaining sols to determine the settling characteristics of the lander on the surface.

7.0 Observation Priorities

The majority of the requirements contained in this document address observations to be acquired by Mars Pathfinder. They are divided between science requirements and operational requirements. Clearly, some observations may satisfy both science and observational objectives. Because the total list of required observations may exceed the capabilities of the flight system and MFEX, a set of priorities are given in this section, with the expectation that they will be useful in constructing and evaluating scenarios. At some risk, the priorities given in this document imply a relative priority among the science and operational requirements. While setting such priorities is controversial, it is also necessary in order to provide a basis for the design of scenarios.

The priorities described below are tempered by the expectation that the Flight System performance will be nominal or better. For scenarios addressing partial failure modes, a finer division of priorities may be needed.

As with any priority system some judgment must be exercised to assure that the intent of the observation requirements is met, not simply the letter of the requirement. For example, it may be more desirable to satisfy 75% of a high priority requirement and 25% of a lower priority requirement than to satisfy 100% of the high priority requirement. With these provisos, the priorities are established as described below.

7.1 Definition of Observation Priorities

Priority 1: An observation essential to meeting or verifying a mission success criterion.

Priority 2: A fundamental part of a science investigation or of a major technology or engineering investigation.

Priority 3: A significant part of a science investigation or of a technology or engineering investigation.

Priority 4: An observation of value to a science investigation or to a technology or engineering investigation, the loss of which does not invalidate the investigation.

7.2 Observation Priority Listing

The observation priorities are given in Table 1.

8.0 Requested Requirements Not Accepted

The requirement statements listed below have not been accepted, but are listed here to indicate that they have been considered. The requester for each is identified. The reason for non-acceptance is stated in each case.

8.1 IMP Requirements Not Accepted

8.1.1 IMP EEPROM Storage

In the event that volatile storage (DRAM) are to be powered off to conserve energy, the flight system shall provide EEPROM storage to enable the IMP to execute, process and store (afternoon) imaging sequences acquired after the last preceding downlink and to facilitate (morning) image acquisition and processing prior to the next planned downlink.

Requester: Peter Smith

Reason for Rejection: The Flight System cannot commit to providing more than the currently incorporated 2 Mbytes of EEPROM which is completely consumed with software routines to sustain lander operations.

8.2 APXS Requirements Not Accepted

None

8.3 ASI/MET Requirements Not Accepted

8.3.1 Second Wind Sensor (Desire)

Wind speed and direction at a second elevation shall be obtained concurrently with the temperature data using ASI/MET sensors after landing. The second wind sensor shall be mounted on the meteorology boom just above the middle set of temperature sensors, nominally 0.5 m above the surface.

Requester: Al Seiff

Reason for rejection: ASI/MET electronics channels and board space are fully subscribed, thus additional sensor cannot be accommodated within current instrument constraints.

8.4 Science Accelerometer Requirements Not Accepted

None

Table 1. Priorities of Mars Pathfinder Observational Requirements

Paragraph	Requirement	Priority	Comments
2.1.1	Pre-deployment Panorama	1	
2.1.2	Post-deployment Panorama	2	
2.1.3	Panoramas for Change Detection	2	
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2.1.5	Use of Rover Images for Surface Morphology and Geology	3	
2.2.1	Multispectral Panorama	2	
2.2.2	Multispectral Observations of Selected Targets	2	
2.2.3	High Resolution Soil Images	3	
2.2.4	Observations of Magnetic Properties Targets	3	
2.2.5	Observations of Near-Field Magnet	4	
2.2.6	Observations of Magnetic Targets Attached to Rover Ramps	3	
2.2.7	Search for Surface Frosts	4	
2.3.1	APXS Analysis of Rock	1	
2.3.2	APXS Analysis of Soil	1	
2.3.3	Documentation of APXS Samples (Rover Imager)	3	
2.3.4	Documentation of APXS Samples (IMP)	3	
2.3.5	Number of APXS Samples	2	
2.3.6	APXS Analysis of Disturbed Soil	3	
2.3.7	APXS Analysis of Abraded Rock	3	
2.3.8	APXS Analysis of Material on Rover Ramp Magnetic Targets	3	
2.3.10	APXS Analysis of Relatively Unoxidized Rock	3	
2.4.1	Measurement of Vehicle Accelerations During Entry	1	
2.4.2	Measurement of Temperature and Pressure During Descent	1	

Table 1. Priorities of Mars Pathfinder Observational Requirements - Continued

Paragraph	Requirement	Priority	Comments
2.4.3	Post-landed Temperature and Pressure During Descent	1	
2.4.4	Post-landed Temperature Measurements	2	
2.4.5	Post-landed Atmospheric Pressure Measurements	2	
2.4.6	Wind Sock Observations	3	
2.4.7	Aerosol Opacity Measurements (Sun Images)	3	
2.4.8	Aerosol Opacity Measurements (Phobos and Star Images)	3	
2.4.9	Dust Particle Characterization (Sky Images)	3	
2.4.10	Water Vapor Abundance Measurements	3	
2.5.1	Phobos and Deimos Radiometry	4	
2.5.2	Jupiter, Saturn and Earth Radiometry	4	
2.5.3	Star Images	4	
3.4.1	IMP In-flight Health Checks	1	
3.4.2	Dark Current Calibration Images	2	Generally, but priority 1 in conjunction with priority 1 imaging sequences
3.4.3	Flat Field Calibration Images (Full Frame)	2	Generally, but priority 1 on the day of landing
3.4.4	Radiometric Calibration Images (Partial Frame)	2	
4.3.1	APXS In-flight Health Checks	1	
4.3.2	APXS Background Calibration	1	
5.2.1	ASI/MET In-flight Health Check	1	
5.2.2	Pre-entry Calibration of the ASI/MET Pressure Sensor	1	
5.2.3	Pre-entry Calibration of the Science Accelerometers	1	

Table 1. Priorities of Mars Pathfinder Observational Requirements - Continued

Paragraph	Requirement	Priority	Comments
6.1.1	IMP Sun Locating Capacity	1	
6.1.2	Rover Deployment Images	1	
6.1.3	Pre-Deployment Color Mosaic	1	
6.1.4	Rover Operations Support Images	1	
6.1.5	Images of Rover Tracks	3	
6.1.6	Images of the Lander	2	
6.1.7	Images of Impact Sites	3	
6.4.2	Lander Orientation with respect to Local Vertical	2	