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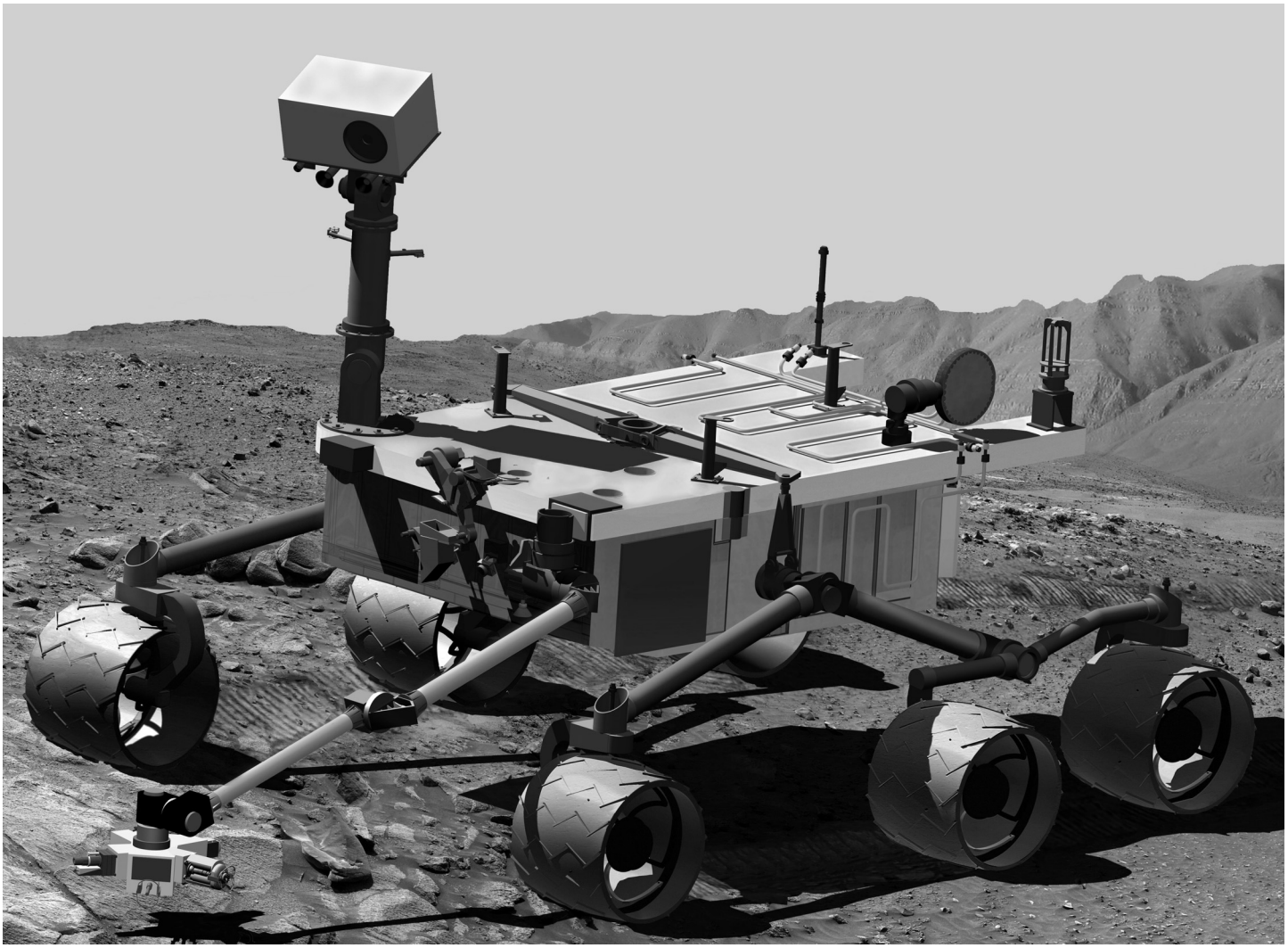
Final Environmental Impact Statement for the Mars Science Laboratory Mission



Cover graphic: artist's concept of the Mars Science Laboratory Rover operating on the surface of Mars. NASA/JPL

FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE MARS SCIENCE LABORATORY MISSION

VOLUME 2
APPENDICES A THROUGH E

Science Mission Directorate
National Aeronautics and Space Administration
Washington, DC 20546

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APPENDIX A
GLOSSARY OF TERMS

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APPENDIX A

GLOSSARY OF TERMS

99-th percentile—An expression of an outcome that would not occur in more than 1 percent of all statistical samples (that is, 1 percent of the outcomes would be greater than the 99-th percentile level); the 99-th percentile is derived from the distribution of outcomes on which the mean value is based.

accident environment—Conditions resulting from an accident, such as blast overpressure, fragments, and fire.

affected environment—A description of the existing environment that could be affected by the Proposed Action or its alternatives.

ambient air—The surrounding atmosphere, usually the outside air, as it exists around people, plants, and structures. (It is not the air in the immediate proximity of an emission source.)

Atlas—A family of launch vehicles manufactured by the Lockheed Martin Space Systems Company.

attainment—An area is designated as being in attainment by the U.S. Environmental Protection Agency if it meets the **National Ambient Air Quality Standards (NAAQS)** for a given **criteria pollutant**. Non-attainment areas are areas in which any one of the NAAQS have been exceeded, maintenance areas are areas previously designated non attainment and subsequently re-designated as attainment, and unclassifiable areas are areas that cannot be classified on the basis of available information as meeting or not meeting the NAAQS for any one criteria pollutant.

background radiation—Ionizing radiation present in the environment from cosmic rays and natural sources in the Earth; background radiation varies considerably with location.

conditional probability—Within the context of this Environmental Impact Statement, the probability that a release of radioactive material could occur given an initiating accident (that is, the accident has occurred).

confidence level—In statistics, the degree of desired trust or assurance in a given result. A confidence level is always associated with some assertion and measures the probability that a given assertion is true.

criteria pollutants—The Clean Air Act requires the U.S. Environmental Protection Agency to set air quality standards for common and widespread pollutants after preparing criteria documents summarizing scientific knowledge on their health effects. Currently, there are standards in effect for six criteria pollutants: sulfur dioxide (SO_2), carbon monoxide (CO), particulate matter equal to or less than 10 microns in diameter (PM_{10}), nitrogen dioxide (NO_2), ozone (O_3), and lead (Pb).

cultural resources—The prehistoric and historic districts, sites, buildings, objects, or any other physical activity considered important to a culture, subculture, or a community for scientific, traditional, religious, or any other reason.

cumulative impact—The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes other such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

curie (Ci)—A measure of the radioactivity level of a substance (that is, the number of unstable nuclei that are undergoing transformation in the process of radioactivity decay); one curie equals the disintegration of 3.7×10^{10} (37 billion) nuclei per second and is equal to the radioactivity of one gram of radium-226.

decibel (dB)—A logarithmic measurement unit that describes a particular sound pressure level compared to a standard reference value. The threshold of human hearing is approximately 0 dB, and the threshold of discomfort or pain is around 120 dB. A-weighted decibels (dBA) refer to measured decibels whose frequencies have been adjusted to correspond to the highest sensitivity of human hearing, which is typically in the frequency range of 1,000 to 4,000 hertz.

Delta—A family of space launch vehicles manufactured by The Boeing Company.

dose—The amount of energy deposited in the body by ionizing radiation per unit body mass.

essential fish habitat—The United States Congress defined essential fish habitat for Federally managed fish species as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity” (16 U.S.C. 1802(10)). The conservation of essential fish habitat is an important component of building and maintaining sustainable fisheries.

exposure to radiation—The incidence of radiation from either external or internal sources on living or inanimate material by accident or intent.

first stage—The launch vehicle stage that provides thrust at lift-off.

full stack intact impact (FSII)—For the purpose of this Environmental Impact Statement, a postulated accident in which the entire launch vehicle (that is, all stages, other vehicle elements, and the payload) impacts the ground in an intact configuration due to a failure at or very shortly after lift-off.

General Conformity Rule—The General Conformity Rule is applicable to non attainment or maintenance areas (see **attainment**) as designated by the U.S. Environmental Protection Agency (EPA), and ensures that Federal actions conform to each State Implementation Plan for air quality. These plans, approved by the EPA, are each State's individual plan to achieve the **NAAQS** as required by the Clean Air Act. The EPA is required to promulgate a Federal

Implementation Plan if a State defaults on its implementation plan. A conformity requirement determination for the action is made from influencing factors, including, but not limited to, non attainment or maintenance status of the area, types of emissions and emission levels resulting from the action, and local impacts on air quality.

General Purpose Heat Source (GPHS)—A passive device that produces heat from the radioactive decay of plutonium (in a ceramic form called plutonium dioxide consisting mostly of plutonium-238, a non-weapons grade isotope). This heat can then be converted into usable electrical power.

geology—The study or science of the Earth (or any solid celestial body), its history, and its life as recorded in the rocks.

health effects—Within the context of this Environmental Impact Statement, health effects are defined as the number of additional **latent cancer fatalities** due to a radioactive release (that is, the number of cancer fatalities resulting from this release that are in excess of those cancer fatalities which the general population would normally experience from other causes).

hydrazine—A toxic, colorless liquid fuel that is hypergolic (able to burn spontaneously on contact) when mixed with an oxidizer such as nitrogen tetroxide (N_2O_4) or placed in contact with a catalyst. Vapors may form explosive mixtures with air.

initiating probability—The probability that an identified accident and associated adverse conditions (accident environments) will occur.

ionosphere—An upper atmospheric region where ionization of atmospheric gases occurs.

isotope—Any of two or more species of atoms of a chemical element with the same atomic number and nearly identical chemical behavior, but with different atomic mass (number of neutrons) or mass number and different physical properties.

latent cancer fatalities—Estimation of latent cancer fatalities assumes that 1) exposures to the radioactive material released to the environment occur over a 50-year period, and 2) the internal **dose** resulting from such exposure are 50-year committed doses, meaning that following inhalation or ingestion of the radioactive material, the resulting internal doses are based on tracking the material in the body for a 50-year period. The time period over which latent cancer fatalities occur is undefined, and could occur well after 50 years following the release.

launch azimuth—The initial angle, measured clockwise from North, which a launch vehicle takes as it begins to ascend.

maximally exposed individual—A hypothetical person that would receive the maximum predicted dose.

mean—The outcome (**source term**, **dose**, **health effects**, or land contamination as used in this Environmental Impact Statement) that would be anticipated if an

accident which released radioactive material were to occur; the mean is a statistical expression of probability-weighted values (source terms or radiological consequences).

Multi-Mission Radioisotope Thermoelectric Generator (MMRTG)—A new generation power source that converts the heat from the radioactive decay of plutonium (in a ceramic form called plutonium dioxide consisting mostly of plutonium-238, a non-weapons grade isotope) into usable electrical energy.

National Ambient Air Quality Standards (NAAQS)— Section 109 of the Clean Air Act requires the U.S. Environmental Protection Agency to set nationwide standards, the NAAQS, for widespread air pollutants. Currently, six pollutants are regulated by primary and secondary NAAQS (see **criteria pollutants**).

oxides of nitrogen (NO_X)—Gases formed primarily by fuel combustion, which contribute to the formation of acid rain. Hydrocarbons and oxides of nitrogen combine in the presence of sunlight to form ozone, a major constituent of smog.

parking orbit—A temporary low-altitude Earth orbit in which a spacecraft with its second or third launch vehicle stage waits until it is in the proper position to continue toward its next or final destination.

payload—The element(s) that a launch vehicle or spacecraft carries over and above what is necessary for the operation of the vehicle. For a launch vehicle, the spacecraft being launched is the payload; for a scientific spacecraft, the suite of science instruments is the payload.

payload fairing (PLF)—The protective shell on a launch vehicle that encapsulates the spacecraft through atmospheric ascent.

radiation—The emitted particles (alpha, beta, neutrons) or photons (X-rays, gamma rays) from the nuclei of unstable (radioactive) atoms as a result of radioactive decay. Some elements are naturally radioactive; others are induced to become radioactive by bombardment in a nuclear reactor or other particle accelerator. The characteristics of naturally occurring radiation are indistinguishable from those of induced radiation.

radiation dose—The amount of energy from ionizing radiation deposited within tissues of the body; it is a time-integrated measure of potential damage to tissues from exposure to radiation and as such is related to health-based consequences.

radioactive half-life—The time required for one half of the atoms in a radioactive isotope to decay.

rem—The unit dose representing the amount of ionizing radiation needed to produce the same biological effects as one roentgen of high-penetration X-rays (about 200,000 electron volts). The biological effects of 1 rem are presumed to be independent of the type of radiation.

risk—Within the context of this Environmental Impact Statement, risk is defined as the expectation of **health effects** in a statistical sense (that is, the product of total

probability times the mean health effects resulting from a release of plutonium dioxide, and then summed over all conditions leading to a release).

second stage—The launch vehicle stage that continues to provide thrust during ascent after the vehicle's first stage has depleted its propellant and been jettisoned.

solar longitude (of Mars)—The apparent longitude of the sun seen on a celestial sphere whose equator is defined by the plane of Mars' orbit about the sun. The transition from Winter to Spring in the Northern hemisphere on Mars defines zero degrees solar longitude.

source term—The quantities of materials released during an accident to air or water pathways and the characteristics of the releases (for example, particle size distribution); used for determining accident consequences.

stratosphere—An upper portion of the atmosphere above the troposphere reaching a maximum height of 50 kilometers (31 miles) above the Earth's surface. The temperature is relatively constant in the lower stratosphere and gradually increases with altitude. The stratosphere is the Earth's main ozone producing region.

take—To pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect (50 CFR 10.12).

tropopause—The boundary between the troposphere and stratosphere, usually characterized by an abrupt change of lapse rate; the change is in the direction of increased atmospheric stability from regions below to regions above the tropopause; its height varies from 15 kilometers (9 miles) in the tropics to about 10 kilometers (6 miles) in polar regions.

troposphere—The portion of the atmosphere next to the Earth's surface in which the temperature rapidly decreases with altitude, clouds form, and convection is active. The troposphere begins at ground level and extends to an altitude of 10 to 12 kilometers (6 to 8 miles) above the Earth's surface.

unavoidable adverse effects—Effects that can not be avoided due to constraints in alternatives. These effects must be disclosed, discussed and mitigated, if practicable.

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APPENDIX B
EFFECTS OF PLUTONIUM ON THE ENVIRONMENT

APPENDIX B

EFFECTS OF PLUTONIUM ON THE ENVIRONMENT

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APPENDIX B

EFFECTS OF PLUTONIUM ON THE ENVIRONMENT

B.1 INTRODUCTION

This appendix addresses the potential impacts from a radioactive source containing plutonium (Pu)-238 released to the environment, which could occur in any of the low-probability accidents described in Chapter 4 of this Final Environmental Impact Statement (FEIS). The health and environmental risks associated with Pu-238 were previously addressed in the National Aeronautics and Space Administration's (NASA) EISs for the Galileo, Ulysses, Cassini, Mars Exploration Rovers, and New Horizons missions (NASA 1989, NASA 1990, NASA 1995, NASA 1997, NASA 2002, and NASA 2005).

The Mars Science Laboratory (MSL) rover carries one Multi-Mission Radioisotope Thermoelectric Generator (MMRTG) containing approximately 4.8 kilograms (10.6 pounds) of plutonium dioxide (PuO_2) (consisting mostly of Pu-238), with a total activity of about 58,700 curies.

The purpose of this appendix is to describe qualitatively the factors that influence the movement of PuO_2 through the environment and into the human body, together with the subsequent health effects, in the event that there is an accidental release of PuO_2 from the spacecraft's MMRTG.

B.2 CHEMICAL AND PHYSICAL PROPERTIES THAT ARE IMPORTANT FOR BEHAVIOR IN THE ENVIRONMENT AND THE HUMAN BODY

In this section, the following important characteristics are discussed:

- Chemical form;
- Particle size distribution;
- Solubility;
- Half life; and
- Decay modes.

B.2.1 Chemical Form

In the MMRTG for the MSL mission, the Pu-238 is present as the dioxide. The predominant risk pathways are those in which this material is released as the result of ground impact and fire. It is therefore assumed that the Pu remains oxidized. This is important because the chemical form influences the solubility, which in turn strongly influences such factors as bioaccumulation and uptake in the human body.

B.2.2 Particle Size Distribution

It is also important to understand the physical form of the material, in particular the particle size distribution, which influences, among other things: whether the material will

fall to the ground in the immediate vicinity of the accident or will be transported over long distances; the initial deposition and subsequent resuspension of particles in both air and water; solubility in water and in biological fluids; and whether or not the material can be inhaled and where it will be deposited and retained within the human respiratory system. Generally speaking, larger particles have less potential for suspension and resuspension; as the particle size decreases, particles are more easily kept in suspension.

The initial particle size distribution is a function of the conditions of the accident. For example, the launch area source terms could initially be in the form of vapor as a result of exposure to fire. The vapors would contain not only the radionuclides but also various structural materials. The radionuclides would tend to condense with and agglomerate with these other materials, which would then predominantly determine the characteristics of the aerosol. The potential for uptake of inhaled particles is critically dependent on the size of the particles (respirable particles are generally considered to be 10 microns or less, although larger sizes can be deposited in the upper respiratory tract).

B.2.3 Solubility

A number of factors affect the solubility of PuO_2 in water. Physical parameters most important to the solubility of PuO_2 are the reactive surface area and oxidation state of plutonium and the water chemistry, including pH, reduction/oxidation potential, and temperature. The mass to surface area ratios of particles affect the reactivity and solubility, with solubility being inversely related to particle size. In general, PuO_2 is insoluble.

Because PuO_2 is so insoluble, movement through the environment depends on physical processes. PuO_2 may be carried into the soil by a number of routes, including the percolation of rainfall and subsequent leaching of particles into the soil, animal burrowing activity, and plowing or other disturbance of the soil by humans. Migration of the PuO_2 into the soil column is of concern, primarily because of the potential for PuO_2 to reach groundwater aquifers used as drinking water supplies. Once deposited on soil, however, PuO_2 appears to be extremely stable. Soil profile studies have shown that generally more than 95 percent of the PuO_2 from nuclear weapons fallout remained in the top 5 centimeters (2 inches) of surface soil (in undisturbed areas) for 10 to 20 years following deposition (DOE 1987).

B.2.4 Half Life

The half-life of Pu-238 is 87.7 years. This half-life is particularly important for chronic exposure pathways (inhalation and ingestion). Over a human lifetime (nominally 70 years), the amount of Pu-238 in the body is reduced by less than a factor of 2 due to radioactive decay.

B.2.5 Decay Modes

Pu-238 is an alpha particle emitter with decay energies of about 5 million electron volts. Its radioactive decay products are also alpha-emitters with about the same decay

energy. These alpha particles are what predominantly determine the effects on the human body. Pu-238 can also undergo extremely unlikely spontaneous fission, but with significantly smaller effects.

B.3 THE TRANSPORT OF PLUTONIUM OXIDES THROUGH THE ENVIRONMENT

Plutonium is one of the most widely studied elements in terms of chemistry and environmental behavior. Although its chemistry and oxidation states are quite diverse, the element's environmental mobility is very limited (INSRP 1989). The pathways and the generalized behavior of plutonium in the environment are described in the literature (*e.g*., Aarkrog 1977, Pinder and Doswell 1985, Pinder *et al*. 1987, Yang and Nelson 1984). The extent and magnitude of potential environmental impacts caused by PuO_2 releases depend on the mobility and availability of PuO_2 and are directly controlled by a number of physical and chemical parameters, including particle size, potential for suspension, deposition and resuspension, solubility, and oxidation state of any dissolved plutonium.

This Section discusses the various ways in which plutonium can be transported through the environment to the point at which it is taken into or irradiates the human body. The modeling for the MSL mission encompasses both short-term (during plume passage) and long-term (chronic exposure) pathways.

B.3.1 During Plume Passage

The predominant pathway during the passage of the airborne plume is inhalation. The important parameters in this calculation are the rate of dilution of the plume as it travels downwind, the deposition mechanisms that deplete the plume and leave radioactive material on the ground, and the rate of inhalation. All of these parameters and mechanisms are independent of the fact that the radionuclide in question is Pu-238. For example, the small particle sizes arising from agglomeration onto aluminum oxide particles (see Section B.1.2) mean that gravitational settling is not important. It is therefore appropriate to use a standard Gaussian model for the atmospheric dispersion. Similarly, the small particle size means that, once it is transported to a human receptor, it is inhaled. Work done for previous EISs shows that inhalation of the particles in the passing plume and of resuspended particles are the two most important contributors to the radiation dose accumulated by human receptors.

The other pathway that is potentially important during plume passage is cloudshine – the irradiation of the human body by neutrons and gamma rays emitted by the passing plume of radioactive material. However, because Pu-238 emits predominantly alpha particles, this irradiation pathway is not important for the MSL Mission.

B.3.2 Chronic Exposure Pathways

This section considers contributions due to resuspension, ingestion of vegetables, external exposure, seafood ingestion, and contamination of drinking water.

B.3.2.1 Resuspension

For launch area accidents, the resuspension model used in the analysis starts with an initial resuspension factor that decreases exponentially to a constant long term resuspension factor (Momeni *et al*. 1979, Strenge and Bander 1981). For materials deposited after traveling more than 100 kilometers (62 miles) from the source of a release, or released high in the atmosphere, the resuspension factor is at all times typically similar to the long term resuspension factor (Bennett 1976, UNSCEAR 1982). The work done in previous EISs shows that resuspension is the most significant of the chronic exposure pathways and is comparable to or larger in its effects on humans than is the direct inhalation pathway.

B.3.2.2 Vegetable Ingestion

Parameters used for estimating the uptake from harvesting and consumption of agricultural products have been measured (Baes *et al*. 1984, Rupp 1980, Yang and Nelson 1984). These and similar agricultural and food consumption parameters and plutonium ingestion parameters (ICRP 1979) are used as the basis for estimating human doses via ingestion. For example, an analysis of Pu-238 contamination of orange trees shows that a total of only 1 percent of the plutonium actually aerially deposited on the plants would be transported on fruit from field to market during the 12 months following harvesting (Pinder *et al*. 1987). Most of this plutonium would adhere to the fruit's peel and would be removed prior to ingestion; uptake to the orange itself would be extremely small or nonexistent.

Four mechanisms of vegetable ingestion were taken into account, as described below.

- *Initial deposition immediately following the accident* – the amount initially deposited per curie released depends on non-PuO_2 specific factors such as particle size distribution and characteristics of the vegetation. The predicted amount of radioactive material ingested by humans then depends on assumptions about physical mechanisms and vegetable distribution, such as: the removal half-life for leaf-deposited material, a leaf interception factor, and a vegetable density. Additionally, harvesting (whether continuous, delayed, or crops are destroyed) and consumption assumptions would affect the predicted amount of radioactive material ingested by humans.

- *Continuous redeposition on the vegetables due to resuspension over the first 50 years following the accident* – the amount ingested by individuals is controlled by the resuspension mechanism (see above), the assumed dry deposition velocity and assumptions about harvesting and distribution.

- *Root uptake* – this mechanism is in principle highly radionuclide and vegetable-specific and depends on such factors as solubility, radionuclide chemistry and vegetable chemistry. In general, PuO_2 is insoluble and is poorly transported in terrestrial environments. Most forms of plutonium, including PuO_2, are removed from biological pathways by processes such as fixation in soil. Only small amounts of material would be concentrated by biological accumulation into grazing animals, and vegetables.

- *Rain splashup* – this mechanism depends in part on the characteristics of the soil and the rainfall.

For Pu-238, radiation doses arising via these pathways are a small fraction of those arising from the inhalation pathways.

B.3.2.3 External Radiation

External radiation from material deposited on the ground and resuspended material is calculated using standard methods for cloudshine and groundshine. Because Pu-238 is predominantly an alpha emitter, this exposure pathway is relatively unimportant.

B.3.2.4 Seafood and Fish Pathway

Radiation doses can result from the bioaccumulation of plutonium deposited on the surfaces of inland waters or oceans. The predicted radiation doses arising from this pathway depend on a number of assumptions and physical and chemical processes, including how the deposited radionuclides are diluted in the water, how the radionuclides are partitioned between water and sediment, and how radionuclides are accumulated in different types of fish, crustaceans and mollusks.

In marine and aquatic systems, larger particles would quickly settle to the bottom sediments; smaller silt-size particles may remain in suspension within the water column for extended periods of time. Smaller particles may not even break the water surface (due to surface tension), forming a thin layer on the water surface that is subsequently transported to the shoreline by wind and wave action. Resuspension of smaller particles from the bottom could occur due to physical disturbance of the sediments by wave action and recreational uses of the water bodies (*e.g.*, swimming, boating, and fishing), as well as by the feeding activity of various marine and aquatic species. Particles of PuO_2, as a component of the bottom sediments, may also be transported toward and along the shoreline by wave action and currents in near-shore environments (NASA 1990).

Studies have indicated that bioaccumulation in marine organisms can vary widely depending on the type and population densities of seafood species impacted (*e.g.*, freshwater fish, saltwater fish, mollusks), the amount and particle size distribution of radioactive material released, and the deposition area.

PuO_2 entering into a water/sediment system would be preferentially taken out of solution and bound in saturated sediments in amounts on the order of 100,000 times greater than the amounts that would remain in the associated water column (NASA 1990).

Clays, organics, and other anionic constituents tend to bind most of the PuO_2 particles in the sediment column. The binding of PuO_2 usually occurs in the first few centimeters of sediment, greatly reducing the concentration of this constituent with depth.

Overall, the seafood pathway is insignificant for PuO_2. This is due to a combination of considerable dilution in the water, overwhelming partition into sediment, and small bioaccumulation factors.

B.3.2.5 Contamination of Drinking Water

It is possible that surface water runoff containing PuO_2 could directly contaminate drinking water supplies that originate from surface water bodies, because this type of contamination is primarily due to suspended PuO_2 particles and not from dissolved PuO_2. Filtering the surface water before chemical treatment would reduce the concentration of total plutonium to very low levels (NASA 1990).

B.4 TRANSPORT AND DEPOSITION OF RADIONUCLIDES IN THE HUMAN BODY

The International Commission on Radiological Protection (ICRP) has developed accepted models for the distribution of inhaled and ingested radionuclides in the body. The ultimate fate of these radionuclides depends on such factors as particle size distribution, solubility, and chemistry. The ICRP models requires knowledge of numerous parameters, most of which are obtained empirically (*e.g.*, there is no theoretical model for determining what fraction of ingested plutonium (say) enters the bloodstream). The required parameters are obtained from animal experiments and, if available, from human studies concerning the effects of nuclear weapons and of nuclear fallout. Of the transuranium elements, plutonium is by far the most widely studied.

PuO_2 that enters the human body by inhalation or ingestion has many possible fates, all of which have been studied in detail (ICRP 1979; ICRP 1986). The inhalation route is found to be approximately 1,000 times as effective as ingestion in transporting plutonium to the blood, due to the short time of residency, the chemical properties of plutonium, and the physiological environment of the gastro-intestinal (GI) tract (ICRP 1979).

Ingested PuO_2 would quickly pass through the digestive system and be excreted with only a small quantity being absorbed via the mucosa into the bloodstream. The fractional absorption of PuO_2 is estimated to average about 1 part in 100,000 ingested (ICRP 1979; ICRP 1986) – that is, in ICRP terminology, the f_1 factor for ingestion is 10^{-5}. The fractional absorption is based on the average individual. Note that PuO_2 in the environment could become more soluble with time due to the use of fertilizers in gardening, chlorination in drinking water, and conversion to soluble forms in seawater. Dietary and physiological factors, such as fasting, dietary calcium deficiency, disease or intake of medications, may also change the fractional absorption (ICRP 1986).

Inhaled PuO_2 would be transported to one or more portions of the respiratory system depending on the particle size. Generally, most particles larger than 5 to 10 microns would be intercepted in the nasopharyngeal region and either expelled or swallowed to pass through the digestive tract; what is not absorbed, would then be excreted. Particles smaller than about 5 microns would be transported to and remain in the trachea, bronchi, or deep lung regions. Particles reaching the deep lung would be cleared from the body much more slowly than those not entering the lung. For example, approximate micrometer-size PuO_2 particles would typically be cleared from the pulmonary area of the lung at the rate of 40 percent in the first day, and the remaining 60 percent cleared in 500 days (ICRP 1979). Particles captured in the mucous lining of the upper respiratory tract would be moved more rapidly to the pharynx, where they would be swallowed. Once swallowed, they would behave as if ingested.

Plutonium dioxide remaining in the lung would continuously irradiate lung tissue, and a small fraction would be transported over time directly to the blood or to lymph nodes and then to the blood. The estimated fraction of plutonium transferred directly from pulmonary lung tissues to the blood would be about 1 percent of the amount retained in the lungs, depending on the size distribution of ultra-fine particles. Smaller particles are likely to form over time from larger particles due to the natural fragmentation processes associated with radioactive decay and may also be transferred to the blood. Over a period of years, approximately 15 percent of the PuO_2 initially deposited in the lungs would be transferred to the lymph nodes. Of that, up to 90 percent would likely be retained in the lymph node with a 1,000 day half-life before being transferred to the blood (ICRP 1986). Overall, the PuO_2 f_1 factor for inhalation is the same as that for ingestion, *i.e.*, 10^{-5}.

Once PuO_2 has entered the blood via ingestion or inhalation, it would circulate and be deposited primarily in the liver and skeletal system. It is currently accepted that plutonium transported by the blood is distributed to the following organs: 45 percent in the liver, 45 percent in the skeletal system, 0.035 percent in the testes, and 0.011 percent in ovaries with a non-measurable amount crossing the placenta and available for uptake by the fetus. The remaining 10 percent of the activity in the blood is excreted through the kidneys and colon or deposited in other tissues (ICRP 1979, ICRP 1986).

The estimated residence times in the liver, skeletal system, and gonads are quite long. Current estimates for 50 percent removal times for plutonium are 20 years for the liver, 50 years for the skeleton, and permanent retention for the gonads.

B.5 CANCER INDUCTION AND GENETIC EFFECTS

The relationship between dose received and the probability of cancer induction is described by the Linear, No-Threshold (LNT) model. For low-level doses such as those predicted for potential accidents involving the MSL mission, the LNT model states that for a collective dose of 10,000 person-rem accumulated by a given population, it is expected that 5 to 6 cancers will develop (EPA 2002). Equivalently, for low levels of radiation dose, the probability of cancer induction in an individual is $5x10^{-4}$/rem to $6x10^{-4}$/rem (where the radiation dose in question is the Effective Dose Equivalent (EDE) to the whole body) no matter how small the dose. LNT is frequently extrapolated to doses as low as one ten thousandth of those for which there is direct evidence of cancer induction by radiation (Cohen 2000). The National Research Council in its report on the Biological Effects of Ionizing Radiation (BEIR) states that the available scientific information is consistent with a linear dose model for low exposure levels and that, in their judgment, it is unlikely that a threshold exists (NRC 2006).

The validity of the LNT model has been questioned by, among others, the Health Physics Society, which has issued a position statement (HPS 2001) that declares “In accordance with current radiation knowledge of health risks, the Health Physics Society recommends against quantitative estimation of health risks below an individual dose of 5 rem in one year or a lifetime dose of 10 rem in addition to background radiation. There is substantial and convincing evidence for health risks at high dose. Below

10 rem (which includes occupational and environmental exposures) risks of health effects are either too small to be observed or non-existent."

In the past decade, there have been numerous studies worldwide on the effects of low dose radiation. One particularly comprehensive program has been initiated by the U.S. Department of Energy, the Low Dose Radiation Research Program (LDRRP), the goal of which is to support research that will help determine health risks from exposures to low levels of radiation. Progress in these areas is documented on the LDRRP web site at http://www.er.doe.gov/production/ober/lowdose.html. The LDRRP began in 1999 and is currently planned to last 10 years.

A nearby cell may be affected in several ways by the ejection of an alpha particle from a decaying Pu-238 nucleus.

- The alpha particle entirely misses the cell and has no damaging effect.
- The alpha particle strikes the cell nucleus and kills it.
- The alpha particle strikes the cell nucleus, damaging the deoxyribonucleic acid (DNA), but the cell survives with one of the following results:
    - The damaged DNA is correctly repaired before cell division with no lasting effects.
    - The damaged DNA is not correctly repaired and the cell lives but does not reproduce and dies at the end of its life cycle (common for highly differentiated cells).
    - The damaged DNA is not correctly repaired and the cell lives to pass on defective genes to future generations of cells (common for undifferentiated stem cells).

In vitro cellular-level irradiation studies have indicated that undifferentiated cells (including human epithelial cells of the type commonly involved in many cancers and leukemias) can survive intact not just single but also multiple alpha particle tracks (Nagasawa and Little 1992, Kadhim *et al*. 1992, Evans 1992, Kadhim *et al*. 1994, Hei *et al*. 1997, Little 1997, Riches *et al*. 1997, Pugliese *et al*. 1997, Miller *et al*. 1999). There is also evidence that low level radiation stimulates biological defense mechanisms. Cohen (2000) reviews the evidence for this, including reference to a report of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR 1994).

Such biological defense mechanisms would tend to support the view that LNT is conservative. However, the latest research as documented on the above-referenced LDRRP web site suggests that it is premature to come to any definitive conclusion. For example, it is now possible to detect "bystander effects" in cells that do not have direct deposition of energy in them. These effects have been detected in model tissue systems by the Gray Laboratory. The past tendency has been to use localized dose to predict effects. However, this may not now be valid since there is a marked response in non-exposed cells and tissues. With bystander effects, especially for alpha particles, the use of dose as a common currency to predict risk may no longer be acceptable.

The biological impact of such observations on radiation risk require a continuing reevaluation.

The use of gene chip technology makes it possible to look more deeply into the mechanisms of action of low dose radiation exposure. The influence of dose, dose rate, tissue type and time on the level of gene expression is creating some very interesting postulates about extrapolation from high doses to low doses. Such data demonstrate that different mechanisms may be involved in radiation-induced changes at high doses as compared to the actions of low doses.

In conclusion, it is premature to consider changes in the cancer induction risk relationships used in this EIS.

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APPENDIX C
ENVIRONMENTAL JUSTICE ANALYSIS

APPENDIX C

ENVIRONMENTAL JUSTICE ANALYSIS

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APPENDIX C

ENVIRONMENTAL JUSTICE ANALYSIS

C.1 INTRODUCTION

Executive Order (EO) 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, directs Federal agencies to identify and address, as appropriate, the disproportionately high and adverse health or environmental effects of their programs, policies, and activities on minority populations and low-income populations.

The Council on Environmental Quality (CEQ) has oversight responsibility for documentation prepared in compliance with the National Environmental Policy Act of 1969, as amended (NEPA) (42 U.S.C. 4321 *et seq.*). In December 1997, the CEQ released its guidance on Environmental Justice (CEQ 1997). The CEQ's guidance was adopted as the basis for the information provided in this Final Environmental Impact Statement (FEIS) for the proposed Mars Science Laboratory (MSL) mission. The launch opportunity for the proposed MSL mission occurs during September - November 2009 and the next opportunity occurs 26 months later.

This appendix provides data necessary to assess the potential for disproportionately high and adverse human health or environmental effects on minority and low-income populations that may be associated with implementation of the MSL mission. The areas examined in this appendix include the land area within 100 kilometers (km) (62 miles (mi)) of Space Launch Complex 41 (SLC-41) located in the southernmost section of Kennedy Space Center, Florida, and the land area within 100 km (62 mi) of Space Launch Complex 37 (SLC-37), located on the northeastern section of Cape Canaveral Air Force Station (CCAFS), Florida. The counties that lie within 100 km (62 mi) of SLC-41 include Brevard, Indian River, Orange, Osceola, Seminole, Volusia, and small portions of Flagler, Lake, and Polk (Figure C-1). The counties that lie within 100 km (62 mi) of SLC-37 include those listed above with the exclusion of Flagler.

C.2 DEFINITIONS AND APPROACH

C.2.1 Minority Populations

During the Census of 2000, the U.S. Bureau of the Census (USBC) collected population data in compliance with guidance adopted by the Office of Management and Budget (OMB) (62 FR 58782). The OMB published its guidelines on aggregation of multiple race data in March 2000 (OMB 2000). Modifications to the definitions of minority individuals in the CEQ's guidance on Environmental Justice (CEQ 1997) were made in this analysis to comply with the OMB's guidelines issued in March 2000. The following definitions of minority individuals and population are used in this analysis of environmental justice:

Minority Individuals: Persons who are members of any of the following population groups: Hispanic or Latino of any race, American Indian or Alaska Native, Asian, Black

or African-American, Native Hawaiian or Other Pacific Islander, or Multiracial (and at least one race which is a minority race under CEQ guidance of 1997).

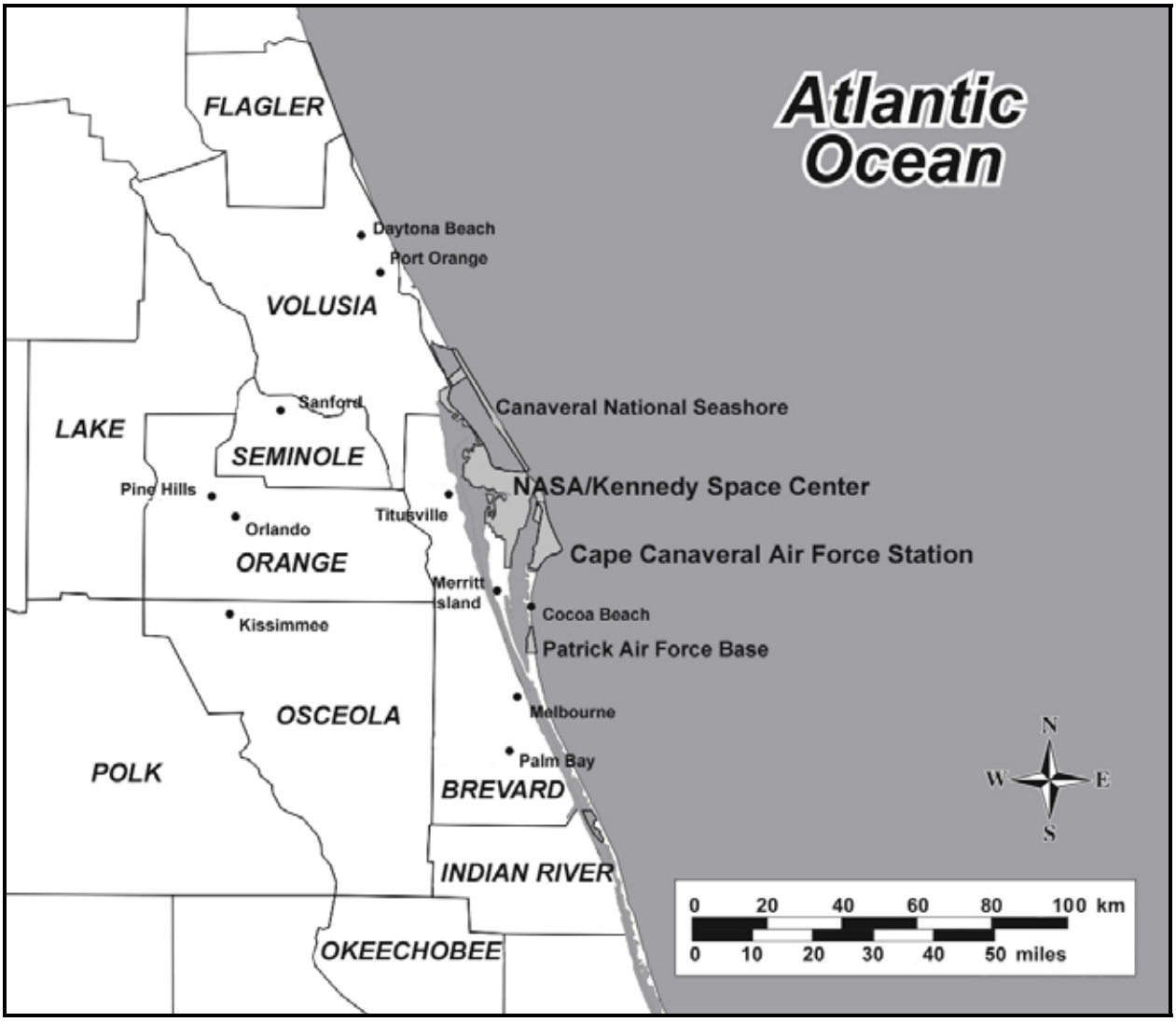

FIGURE C-1. THE AREA WITHIN 100 KM (62 MI) OF SLC-41 AND SLC-37

Minority Population: The total number of minority individuals residing within a potentially affected area.

Persons self-designated as Hispanic or Latino are included in the Hispanic or Latino population regardless of race. For example, Asians self-designated as Hispanic or Latino are included in the Hispanic or Latino population and not included in the Asian Population. Data used to characterize minority populations in the years 1990 and 2000 was extracted from LandView® 4 and 6 database management software containing Census 1990 and 2000 demographic data from the USBC (USBC 1998 and USBC 2003 respectively). Data used for the projection of population groups in Florida for the year 2009 was projected from the USBC's 1990 and 2000 census data for the area surrounding SLC-41 and SLC-37. Data used for the projection of the total resident

minority population in the area surrounding SLC-41 and SLC-37 for the year 2009 was extracted from population studies provided by the Bureau of Economic and Business Research (BEBR 2004) and the Office of Economic and Demographic Research (EDR 2005).

C.2.2 Low-Income Populations

Poverty thresholds are used to identify "low-income" individuals and populations (CEQ 1997). The following definitions of low-income individuals and population are used in this analysis:

Low-Income Individuals: Persons whose self-reported income is less than the poverty threshold for a given year.

Low-Income Population: The total number of low-income individuals residing within a potentially affected area.

Data used to characterize low-income populations in the year 2000 was extracted from LandView® 6 database management software containing Census 2000 demographic data from the USBC (USBC 2003).

C.2.3 Disproportionately High And Adverse Human Health Effects

Disproportionately high and adverse health effects are those that are significant (40 CFR 1508.27) or above generally accepted norms, and for which the risk of adverse impacts to minority populations or low-income populations appreciably exceeds the risk to the general population.

C.2.4 Disproportionately High And Adverse Environmental Effects

Disproportionately high and adverse environmental effects are those that are significant (40 CFR 1508.27), and that would adversely impact minority populations or low-income populations appreciably more than the general population.

C.3 METHODOLOGY

C.3.1 Spatial Resolution

For the purposes of enumeration and analysis, the USBC has defined a variety of aerial units (USBC 2001; USBC 1992). Aerial units of concern in this document include (in order of increasing spatial resolution) states, counties, census tracts, block groups, and blocks. The block is the smallest of these entities and offers the finest spatial resolution. This term refers to a relatively small geographical area bounded on all sides by visible features such as streets and streams or by invisible boundaries such as city limits and property lines. During the 2000 census, the USBC subdivided the United States and its territories into 8,269,131 blocks. For comparison, the 2000 census used 3,232 counties, 66,304 census tracts, and 211,267 block groups.

In the analysis below, a combination of block group and block-level spatial resolution was used in the analysis of minority impacts. Block group-level spatial resolution was used to determine population groups living at a distance of 100 km (62 mi) from SLC-41

and SLC-37. Block-level data was used to determine population groups living at a distance of 20 km (12 mi) and 10 km (6 mi) from SLC-41 and SLC-37. Block group-level spatial resolution was used to determine total resident minority and low-income populations living at a distance of 100 km (62 mi) and 20 km (12 mi) from SLC-41 and SLC-37. Block-level data was used to determine total resident minority populations living at a distance of 10 km (6 mi) from SLC-41 and SLC-37.

C.3.2 Projections of Populations

Projections of population groups living in the area of interest surrounding SLC-41 and SLC-37 for the year 2009 are shown in Table C-1. Population groups living within distances of 100 km (62 mi), 20 km (12 mi), and 10 km (6 mi) of SLC-41 and SLC-37 in 2009 were obtained as linear projections of resident populations for the years 1990 and 2000.

A direct comparison of 1990 Census data and 2000 Census data for minority groups is not possible. During the 2000 Census, the USBC modified its enumerations methodology to include multiracial responses and added a separate racial category, "Native Hawaiian or Other Pacific Islander". As an individual may report more than one race, the aggregate of Population Group may not match the total. For the 1990 Census year, the American Indian includes Eskimo or Aleut groups, the Asian includes Pacific Islander groups, and the Hispanic/Latino includes Hispanics of any race. For the 2000 census year, the Asian includes Native Hawaiian and other Pacific Islander groups and the Hispanic/Latino includes Hispanics of any race.

C.3.3 Environmental Justice Assessment

The purpose of this analysis is to (1) identify minority populations and low-income populations residing that would be potentially affected by implementation of the Proposed Action (Alternative 1) or Alternatives and (2) determine if implementation of the Proposed Action or Alternatives would result in disproportionately high and adverse effects on these populations. In the event that radiological or other human health risks resulting from the implementation of the Proposed Action or Alternatives are found to be significant, then the health risks to minority populations and low-income populations will be evaluated to determine if they are disproportionately high.

C.4 CHARACTERIZATION OF POTENTIALLY AFFECTED POPULATIONS

The land area within 100 km (62 mi) of SCL-41 and SLC-37 includes approximately 1.3 million hectares (3.3 million acres) of central Florida's eastern coast. Approximately 2.4 million persons lived within 100 km (62 mi) of SLC-41 and SLC-37 in the year 2000 (Table C-1). Between 1990 and 2000, the minority population within 100 km (62 mi) of SLC-41 and SLC-37 nearly doubled, and by 2000, minority persons comprised approximately 30 percent of the total population. By the year 2009, the total population is projected to increase to nearly 3 million persons, and minorities are projected to comprise approximately 35 percent of the total population.

In 2000, approximately one-half of the total and minority populations lived in urban areas of Orange, Seminole and Volusia Counties and less than one half percent of the

total minority population lived within 20 km (12 mi) of SLC-41 and SLC-37. No persons lived within 10 km (6 mi) of SLC-41 in 2000. An estimated 56 persons lived within 10 km (6 mi) of SLC-37 in 2000 and approximately 73 persons are projected to live within 10 km (6 mi) of SLC-37 in 2009.

TABLE C-1. COMPOSITION OF THE POPULATION AT VARYING DISTANCES FROM SLC-41 AND SLC-37

Population	Launch Complex	100 km (62 mi)			20 km (12 mi)			10 km (6 mi)		
		1990	2000	2009 [a]	1990	2000	2009 [a]	1990	2000	2009 [a]
White alone	SLC-41	1,592,182	1,860,022	2,139,967	2,191	2,280	2,363	1	0	0
	SLC-37	1,579,770	1,844,060	2,119,724	14,826	19,607	25,205	1	10	13
Black or African American alone	SLC-41	197,608	290,346	410,507	19	67	100	0	0	0
	SLC-37	201,454	294,020	413,081	222	252	283	0	29	33
American Indian and Alaska Native alone	SLC-41	5,496	8,128	11,559	11	17	25	0	0	0
	SLC-37	5,453	8,037	11,400	102	76	83	0	0	0
Asian alone	SLC-41	28,736	54,526	97,003	14	24	39	0	0	0
	SLC-37	28,638	54,394	96,932	205	393	706	0	2	4
Native Hawaiian and Other Pacific Islander alone	SLC-41	No Data	1,620	2,049	No Data	3	3	No Data	0	0
	SLC-37	No Data	1,611	2,038	No Data	13	17	No Data	0	0
Some other race alone	SLC-41	No Data	93,953	118,851	No Data	19	21	No Data	0	0
	SLC-37	No Data	92,987	117,629	No Data	123	161	No Data	11	14
Two or more races	SLC-41	No Data	59,585	75,375	No Data	41	45	No Data	0	0
	SLC-37	No Data	59,399	75,140	No Data	296	388	No Data	4	5
Hispanic or Latino	SLC-41	121,169	308,800	602,031	27	96	187	0	0	0
	SLC-37	120,694	307,084	598,685	463	758	1,478	0	17	33
Total	SLC-41	1,855,532	2,368,180	2,995,747	2,237	2,451	2,661	1	0	0
	SLC-37	1,846,684	2,354,508	2,978,453	15,419	20,760	27,132	1	56	73
Percent Minority	SLC-41	19%	29.4%	34.7%	3.2%	9%	12.4%	No Data	0	0
	SLC-37	19.3%	29.6%	34.9%	6.4%	8.3%	9.5%	No Data	82.1%	82.2%
Percent Low Income	SLC-41	No Data	10.4%	—	No Data	3.9%	—	No Data	0	0
	SLC-37	No Data	10.5%	—	No Data	7%	—	No Data	No Data	—

Sources EDR 2005; BEBR 2004; USBC 2003; and USBC 1998

(a) Projected population values for 2009 do not represent absolute limits to growth; for any group, the future population may be above or below the projected value. — Denotes insufficient data is available to accurately project the estimate.

Note: Because an individual may report more than one race, the aggregate of the population groups may not match the total population.

Hispanic or Latino and Black or African-American populations were the largest minority groups living within 100 km (62 mi) of SLC-41 and SLC-37 in the year 2000. Moving outward from the CCAFS boundary, Blacks or African-Americans are the largest

resident minority group until approximately the outskirts of the City of Orlando. Due to the relatively large concentration of Hispanics or Latinos in the Orlando Metropolitan Area, Hispanics or Latinos comprise the largest group of minority residents in the total area. Hispanic or Latino populations are projected to remain the largest minority group through 2009.

Data from Census 2000 (USBC 2003) shows that 10.4 percent of the population living within 100 km (62 mi) of SLC-41 and 10.5 percent of the population living within 100 km (62 mi) of SLC-37 reported incomes below the poverty threshold; lower percentages than reported by Florida (12.5 percent) and the United States (12.4 percent). During the same period, 3.9 percent of the population living within 20 km (12 mi) of SLC-41 and 7 percent of the population living within 20 km (12 mi) of SLC-37 reported incomes below the poverty threshold.

C.5 IMPACTS ON MINORITY AND LOW-INCOME POPULATIONS

As discussed in Chapter 4 of this FEIS, accidents during launch of the proposed MSL mission could result in human exposure to radioactive and other hazardous materials. Plutonium-238 is the primary radioactive material of concern. Potential radiological releases could affect populations residing both within and beyond 100 km (62 mi) of the launch complex. As shown in Table 4-3 of Chapter 4, if the Proposed Action (Alternative 1) is implemented, and if an accidental release of radioactive material were to occur during any mission phase, on average no latent cancer fatalities would be expected to occur.

Mission risks (consequences that would occur in the event of a radioactive release multiplied by the probability of a release) are also small. As shown in Table 4-2, the likelihood of an accident resulting in a release of radioactive material during the pre-launch and early launch phases combined is 4.5×10^{-3} (approximately 1 in 230). The corresponding risk to the local population (persons residing within 100 km (62 mi) of the launch facilities) of a latent cancer fatality resulting from an accident in pre-launch or early launch is 5.4×10^{-4} (approximately 1 in 1,900) (Table 4-6). The risk to the global population (persons residing more than 100 km (62 mi) from the launch site) of a latent cancer fatality resulting from an accident during the MSL mission is 3.7×10^{-4} (approximately 1 in 2,700).

As discussed in Section 4.1.3, non-radiological accidents also pose no significant risks to the public. Toxic effects that could result from a liquid propellant spill during fueling operations would not extend beyond the immediate vicinity of the launch pad. Members of the public are excluded from the area at risk during fueling operations. A fuel explosion on the launch pad or during the first few seconds of flight could (if the Atlas V is selected) temporarily increase carbon monoxide (CO), hydrochloric acid (HCl), and aluminum oxide (Al_2O_3) levels near the CCAFS boundary. One-hour average concentrations of hazardous emissions from such an explosion are less than the emergency response guidelines recommended by the American Industrial Hygiene Association and the National Research Council for the Department of Defense (USAF 1998).

Thus, implementation of the Proposed Action or the Alternatives would pose no significant radiological or non-radiological risks to the public, including minority and low-income groups within the potentially affected population.

C.6 REFERENCES FOR APPENDIX C

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APPENDIX D
RESPONSES TO PUBLIC REVIEW COMMENTS

APPENDIX D

RESPONSES TO PUBLIC REVIEW COMMENTS

LIST OF TABLES

APPENDIX D

RESPONSES TO PUBLIC REVIEW COMMENTS

NASA published a Notice of Availability (NOA) of the Draft Environmental Impact Statement (DEIS) for the Mars Science Laboratory (MSL) Mission in the *Federal Register* on September 5, 2006 (71 FR 52347). The U.S. Environmental Protection Agency published its NOA for the DEIS in the *Federal Register* on September 8, 2006 (71 FR 53093). The DEIS was mailed by NASA to 59 potentially interested Federal, State and local agencies, organizations and individuals. In addition, the DEIS was publicly available in electronic format on NASA's web site. The public review and comment period closed on October 23, 2006. Ten comment submissions (letters and other written comments) were received from three Federal agencies, one State agency, one private organization, and five individuals. A total of 34 comment submissions were received via electronic mail from 32 individuals.

This appendix provides specific responses to the comment submissions received from the agencies, organizations, and individuals. Table D-1 lists the ten comment submissions received from the Federal and State agencies, the private organization, and the five individuals. Copies of each of these submissions are presented following Table D-1. The relevant comments in each submission are marked and numbered for identification. The comments received included "no comment", requests for clarification of specific sections of text, and objections to the use of nuclear material for space missions. NASA's response to each identified comment is presented in Table D-2, which follows the submissions.

The 34 comments submitted by individuals via e-mail are presented in Table D-3. The relevant comments in each submission are numbered for identification. The comment submissions presented in Table D-3 include general support for the planned MSL mission, and objections to the use of nuclear material for space missions. NASA's response to each relevant comment is included in Table D-3.

In addition to soliciting comments for submittal by letter and e-mail, NASA held three meetings during which the public was invited to provide both oral and written comments on the MSL DEIS. Two meetings were held on September 27, 2006 in Cocoa, Florida, and one meeting was held on October 10, 2006 in Washington, DC. The three written comments submitted to NASA during these meetings are listed in Table D-1. More information on these meetings, including transcripts of the public comments and NASA's responses, can be found in Appendix E.

TABLE D-1. COMMENT SUBMISSIONS FROM AGENCIES, ORGANIZATIONS, AND INDIVIDUALS

Submission Number	Agency, Organization, or Individual
1	State of Florida Department of Environmental Protection
2 [(a)]	Mr. William Young Cocoa, Florida
3 [(a)]	Mr. Andy Pesce Cocoa, Florida
4 [(a)]	Dr. John F. Martin Indialantic, Florida
5	Snake River Alliance
6	Federal Aviation Administration Commercial Space Transportation
7	U.S. Environmental Protection Agency
8	U.S. Department of the Interior
9	Mrs. Leah R. Karpen Asheville, North Carolina
10	Mr. Ralph E. Renno, III Ellicott City, Maryland

a. Written comment submitted during the public comment meetings held on September 27, 2006, in Cocoa, Florida. See Appendix E for further information regarding the public comment meetings.

Department of
Environmental Protection

Jeb Bush
Governor

Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399-3000

Colleen M. Castille
Secretary

September 5, 2006

Mr. Mark R. Dahl, Program Executive
Mars Exploration Program Office
Planetary Science Division
NASA Headquarters
Washington, DC 20546-0001

RE: National Aeronautics and Space Administration – Draft Environmental Impact Statement for the Mars Science Laboratory Mission
Cape Canaveral, Brevard County, Florida.
SAI # FL200609052777C

Dear Mr. Dahl:

Florida State Clearinghouse staff, pursuant to Presidential Executive Order 12372, Gubernatorial Executive Order 95-359, the Coastal Zone Management Act, 16 U.S.C. §§ 1451-1464, as amended, and the National Environmental Policy Act, 42 U.S.C. §§ 4321, 4331-4335, 4341-4347, as amended, has reviewed the referenced Draft Environmental Impact Statement (DEIS).

Based on the information contained in the subject DEIS, the state has determined that the proposed federal action is consistent with the Florida Coastal Management Program. I–1-1

Thank you for the opportunity to review this document. Should you have any questions regarding this letter, please contact Ms. Lauren P. Milligan at (850)[redacted].

Yours sincerely,

Sally B. Mann

Sally B. Mann, Director
Office of Intergovernmental Programs

SBM/lm

Comment Submission #1: State of Florida Department of Environmental Protection

Comment Form

Thank you for participating in the Environmental Impact Statement process. When you have completed writing your comment(s) you may either give this to a NASA representative; or mail to: Mark R. Dahl, Mail Stop 3X63, Planetary Science Division, Science Mission Directorate, NASA Headquarters, 300 E Street NW, Washington, DC 20546-0001; call 202-358-4800; or e-mail to mep.nepa@hq.nasa.gov.

Please provide the following information:

(This information will be used to update NASA's mailing list and to mail future mission related related documents)

~~Mr.~~ Ms. Mr.&Mrs. Dr.

Name: William Young

Title: Engineer

Organization: FSEC

Address: 1679 Clearlake Rd

City: Cocoa State: Fla Zip Code: 32922

Phone: [redacted] E-Mail Address:

Comments:

the rover should be solar powered and not ~~back~~ nuke

But if they make it nuke there should be some solar (PV) to power communications if the nuke fails altogether as back up power

2-1

Please continue on back

Mars Science Laboratory Draft Environmental Impact Statement

Comment Submission #2: Mr. William Young

Comment Form

Thank you for participating in the Environmental Impact Statement process. When you have completed writing your comment(s) you may either give this to a NASA representative; or mail to: Mark R. Dahl, Mail Stop 3X63, Planetary Science Division, Science Mission Directorate, NASA Headquarters, 300 E Street NW, Washington, DC 20546-0001; call 202-358-4800; or e-mail to mep.nepa@hq.nasa.gov.

Please provide the following information:

(This information will be used to update NASA's mailing list and to mail future mission related related documents)

X Mr. ___ Ms. ___ Mr.&Mrs. ___ Dr.

Name: Andy Pesce 9-27-06

Title: Senior Research Engineering Support Specialist

Organization: Florida Solar Energy Center

Address: 1679 Clearlake Road

City: Cocoa State: Florida Zip Code: 32922-5703

Phone: [redacted] E-Mail Address: [redacted]

Comments:

Being a long term employee of the Florida Solar Energy Center, one would naturally support the use of photovoltaic energy generation with respect to the power supply for the Mars Science Laboratory (MSL) mission. However, should the team elect to utilize the alternate power source, it is my suggestion to employ the use of an "escape capsule" to the payload portion of the Atlas rocket.

In the unlikely event of a launch mishap, the escape capsule, similar to the Apollo escape tower, could safely detach the MSL and it's radioactive cargo

3-1

Please continue on back

Comment Submission #3: Mr. Andy Pesce

Comment Form (continued)

~~Cargo~~ away from an explosion and parachute the payload safely to the ocean's surface. 3-1

Once the critical portion of the launch has expired, the rockets of the escape capsule could be fired to assist with the speed of the vehicle to offset the additional weight the escape capsule added to the vehicle.

Thank you for your time and for the opportunity to comment on this exciting mission to Mars. 3-2

Best of Luck to all the members of the MSL team!

Respectfully,

Andy Pesce 9-27-06

Mars Science Laboratory Draft Environmental Impact Statement

Comment Submission #3 (continued): Mr. Andy Pesce

Comment Form

Thank you for participating in the Environmental Impact Statement process. When you have completed writing your comment(s) you may either give this to a NASA representative; or mail to: Mark R. Dahl, Mail Stop 3X63, Planetary Science Division, Science Mission Directorate, NASA Headquarters, 300 E Street NW, Washington, DC 20546-0001; call 202-358-4800; or e-mail to mep.nepa@hq.nasa.gov.

Please provide the following information:

(This information will be used to update NASA's mailing list and to mail future mission related related documents)

____ Mr. ___ Ms. ___ Mr.&Mrs. X Dr.

Name: JOHN F. MARTIN

Title: PRESIDENT / ENGINEER

Organization: COMPASS ENGINEERING CONSULTANT

Address: [redacted]

City: INDIALANTIC State: FL Zip Code: 32903

Phone: 321 [redacted] E-Mail Address: [redacted]

Comments:

Fatigue & Fracture is my specialty. Protection appears to be very good. I had no problem with this launch. 4-1

Please continue on back

Mars Science Laboratory Draft Environmental Impact Statement

Comment Submission #4: Dr. John F. Martin

October 3, 2006

Mark R. Dahl
Mail Suite 3X63
Planetary Science Division
Science Mission Directorate
NASA Headquarters
300 E Street SW
Washington, DC 20546-0001

Re: Comments on the Draft Environmental Impact Statement for the Mars Science Laboratory Mission

Dear Mr. Dahl:

The Snake River Alliance is an Idaho-based grassroots group working through research, education, and community advocacy for peace and justice, the end to nuclear weapons, responsible solutions to nuclear waste and contamination, and sustainable alternatives to nuclear power. I submit these comments on behalf of our dues-paying members and board of directors. **I–5-1**

The Alliance supports using solar energy to power the Mars Science Laboratory Mission. Using solar to power MSLM will provide a unique opportunity to evaluate and enhance existing solar technology in deep space missions. Nuclear power, however, is costly and dangerous. Plutonium-238 operations in support of RTG production at the Los Alamos National Laboratory have resulted in the contamination of many workers over the years, and there are serious questions about the effectiveness of both plutonium containment and monitoring at Los Alamos and other Department of Energy facilities. Plutonium in space launches and missions is also dangerous. The risk of an accident during launch or "slingshot" maneuvers are high and the consequences could be global, long lasting, and incredibly expensive. This is an unnecessary, and quite frankly unacceptable risk, particularly when safer alternative exists. **I–5-2** **I–5-3**

I urge the National Aeronautical Space Administration and the Department of Energy to take this opportunity to move space exploration in a sustainable direction with regard to **I–5-4**

[redacted]
Boise, Idaho 83701
(208) [redacted] voice
(208) [redacted] fax

[redacted]
Ketchum, Idaho 83340
(208) [redacted] voice

[redacted]
Pocatello, Idaho 83204
(208) [redacted] voice

Comment Submission #5: Snake River Alliance

power and energy systems. Using solar rather than nuclear to power the Mars Science Laboratory Mission would keep the US safe, advance energy technologies that are cleaner and more secure, be more fiscally responsible, and set a responsible example to other countries as they make decisions about their energy future. I–5-4

Thank you for your consideration.

Best,

Jeremy M. Maxand
Executive Director

Comment Submission #5 (continued): Snake River Alliance

U.S. Department
of Transportation
**Federal Aviation
Administration**

Commercial Space Transportation
800 Independence Ave., SW.
Washington, DC 20591

OCT - 6 2006

Mr. Mark Dahl
Planetary Science Division
Mail Suite 3X63
NASA Headquarters
Washington, DC 20546-0001

Dear Mr. Dahl:

Thank you for the opportunity to comment on the Draft Environmental Impact Statement (EIS) for the Mars Science Laboratory (MSL) Mission. I am pleased to submit the following comment for your consideration:

General – This document references numerous existing documents. The links to the documents in the references section are helpful. Suggest noting in Executive Summary or Section 1 that website links to referenced material are provided in reference section. **|–6-1**

Section 2.4.2. This section describes the use of 30 Radioisotope Heater Units (RHU) with a solar-powered MSL rover as an alternative considered but not evaluated further. However, the EIS states that if Alternative 2 were selected, NASA may reconsider the use of RHUs to provide additional heat. Suggest removing this scenario from section 2.4 and evaluating the concept as an alternative to the proposed action. **|–6-2**

Section 4.1.2.3. It may be helpful to compare the noise levels to noises that people are exposed to every day to provide a context for the reader. **|–6-3**

Section 4.1.3.2. The Draft EIS states that launches would be postponed if the predicted collective public risk of injury exceeds acceptable limits. It may be helpful to define for the public the acceptable risk limit from launch operations. **|–6-4**

Please feel free to contact Ken Gidlow of my office at (202) [redacted] if you have any questions.

Sincerely,

Patricia G. Smith
Associate Administrator for
Commercial Space Transportation

**Comment Submission #6: Federal Aviation Administration
Commercial Space Transportation**

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OCT 20 2006

OFFICE OF
ENFORCEMENT AND
COMPLIANCE ASSURANCE

Mr. Mark R. Dahl
Planetary Science Division
Science Mission Directorate
National Aeronautics and Space Administration
Washington, DC 20546-0001

Dear Mr. Dahl:

In accordance with National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act, the Environmental Protection Agency (EPA) has reviewed the National Aeronautics and Space Administration's (NASA) draft environmental impact statement (EIS) for the Mars Science Laboratory Mission. This document is a Tier 2 EIS under NASA's Programmatic EIS for the Mars Exploration Program.

The proposed action is to launch a Mars Science Laboratory spacecraft on an expendable launch vehicle during September - November 2009. The spacecraft would then deliver a large, mobile science laboratory (rover) with advance instrumentation to a scientifically interesting location on the surface of Mars in 2010.

EPA believes that this EIS provides an adequate discussion of the potential environmental impacts of this particular Mars mission. Therefore, EPA has no objection to the proposed action discussed in this draft EIS. |–7-1

We appreciate the opportunity to review this draft EIS. The staff contact for this review is Ken Mittelholtz (202-[redacted]).

Sincerely,

Anne Norton Miller
Director
Office of Federal Activities

Comment Submission #7: U.S. Environmental Protection Agency

United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Policy and Compliance
Richard B. Russell Federal Building
75 Spring Street, S.W.
Atlanta, Georgia 30303

TAKE PRIDE IN AMERICA

ER 06/898

October 24, 2006

Mr. Mark R. Dahl
Planetary Science Division
Science Mission Directorate
NASA Headquarters
Washington, DC 20546

RE: Draft Environmental Impact Statement for the Mars Science Laboratory Mission, Brevard County, Florida

Dear Mr. Dahl:

The Department of the Interior has reviewed the referenced DEIS and have no comments to provide for your consideration at this time. |–8-1|

You can reach me at 404-[redacted] if you should have any questions or comments.

Sincerely,

Gregory Hogue
Regional Environmental Officer

cc:
FWS, R4
OEPC-WASO

Comment Submission #8: U.S. Department of the Interior

LEAH R. KARPEN - [redacted] - ASHEVILLE, NC 28801-[redacted]

October 19, 2006

Mr. Mark R. Dahl, Program Executive
Mars Exploration Program Office
Planetary Science Division
Mail Suite 3X63
NASA Headquarters
Washington, DC 20546-0001

Dear Mr. Dahl:

Mars Science Laboratory Mission

I wish to comment on the Draft Environmentral Impact Statement for this mission. |–9-1
My objection is to the use of nuclear batteries to power land rovers which will explore Mars. The plan to esxtablish mining colonies on Mars in future years also sounds out of line with realilty. |

Radioactive spills at production facilities and from space launch explosions with toxic contamination are well-known. Expanding space plutonium power systems will increase chances of accidents and contamination from plutonium. |–9-2

Every expansion of plutonium research, development and transportation of this deadly material increases the risk of nuchear accident or theft. In addition, plutonium production is expensive and diverts resources from the more important social needs of our society today. and in the future. |–9-3

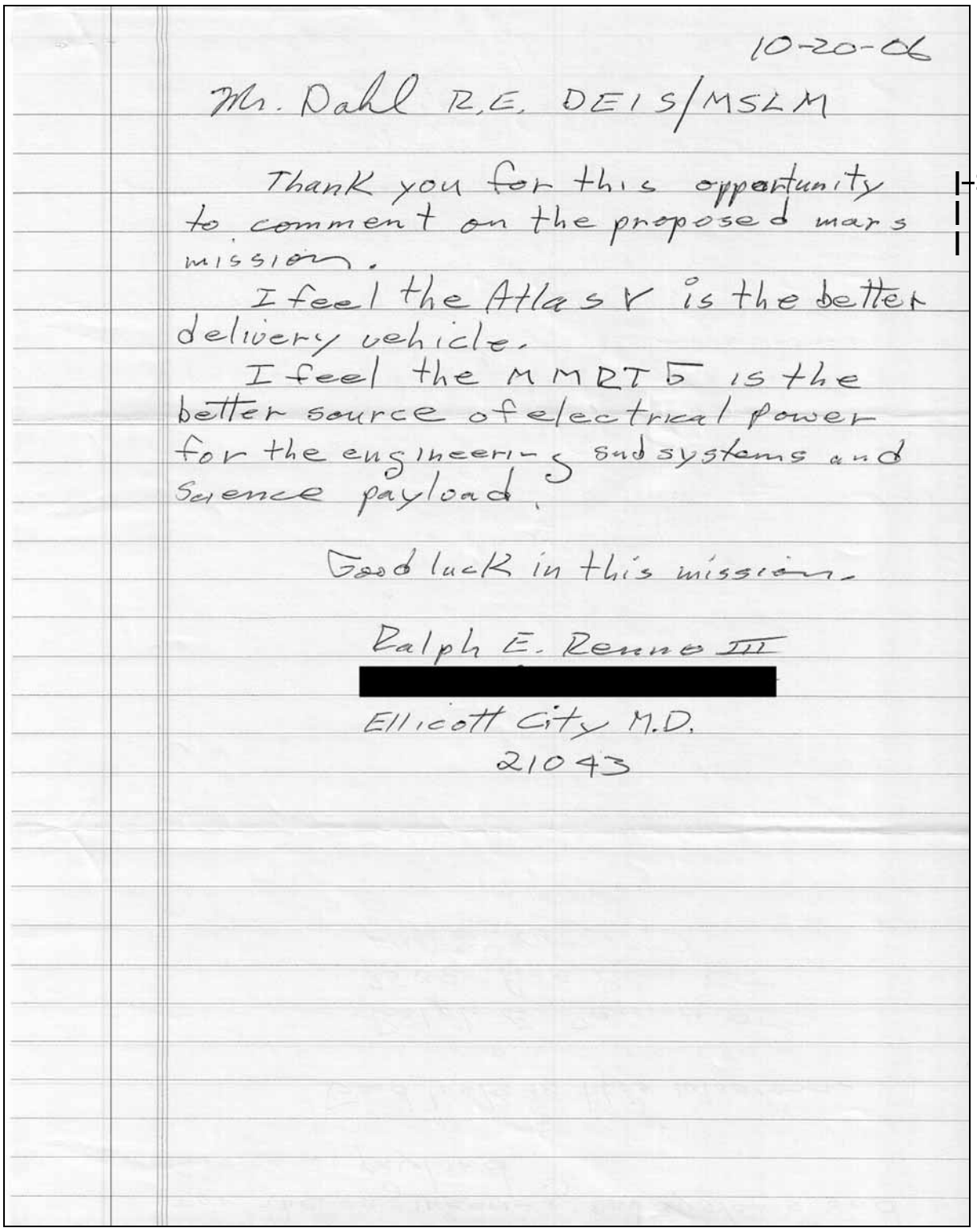
I urge your group to reconsider the use of nuclear batteries and continue to rely on solar, which has been so successful to date. |–9-4

Sincerely yours,

Leah R. Karpen

(Mrs.) Leah R. Karpen
Concerrned Citizen

Comment Submission #9: Mrs. Leah R. Karpen



10-20-06

Mr. Dahl R.E. DEIS/MSLM

Thank you for this opportunity to comment on the proposed mars mission. 10-1

I feel the Atlas V is the better delivery vehicle.

I feel the MMRT 5 is the better source of electrical power for the engineering subsystems and Science payload.

Good luck in this mission.

Ralph E. Renno III

[redacted]

Ellicott City M.D.

21043

Comment Submission #10: Mr. Ralph E. Renno, III

TABLE D-2. RESPONSES TO COMMENT SUBMISSIONS LISTED IN TABLE D-1

Comment Number	Response
1-1	Thank you for your comments.
2-1	Thank you for your comments. Radioisotope power systems used on NASA spacecraft have a record for reliability and longevity unmatched by any other spacecraft power systems. If a backup solar array was considered for the Mars Science Laboratory rover, the solar array would have to be at least the size of the one described in the MSL Solar Alternative (Alternative 2) study to replace the power of a Multi-Mission Radioisotope Thermoelectric Generator. Carrying such an array would preclude the need to carry an MMRTG, and then the mission would be essentially the MSL Alternative 2 described in this EIS. A small array could be postulated to supplement a partially degraded MMRTG – that is, an array that makes up for diminished power from a degraded MMRTG. MMRTGs are designed using internal redundancy so that credible electrical, single-point failures would not generally affect the power output of the device. Hence, a supplemental array for a degraded MMRTG would not be required.
3-1	Presumably, the alternate power source being referred to in this comment is the Radioisotope Power System (RPS) associated with the Proposed Action (Alternative 1). Radioisotope power systems for spacecraft are designed to contain their fuel or limit its dispersal in the event of a launch or reentry accident. As with the RTGs used on previous NASA deep space missions, MMRTG safety features include use of a special type of fuel material, a modular design and construction, and the use of multiple physical barriers. The plutonium dioxide contained in an RTG is a specially formulated, fire resistant ceramic that is manufactured as pellets to reduce the possibility of fuel dispersion in a launch or reentry accident. This ceramic form resists dissolution in water and reacts little with other chemicals. If fractured, the ceramic tends to break into relatively large particles and chunks that pose fewer hazards than small microscopic particles. Multiple layers of protective material including iridium capsules and graphite blocks protect and contain the fuel and reduce the chance of release of the plutonium dioxide. Iridium, a strong, ductile, corrosion-resistant metal with a very high melting temperature encases each fuel pellet. Impact shells made of a lightweight and highly heat-resistant graphite provide additional protection. The suggested “escape capsule” would be impractical to implement for this type of mission.
3-2	Thank you for your comments.
4-1	Thank you for your comments.

Comment Number	Response
5-1	Thank you for your comments.
5-2	Although some external worker contamination did occur at Los Alamos National Laboratory (LANL) during the activities associated with plutonium dioxide (plutonium-238) production and fabrication, most of the contaminations did not result in any measurable dose to the workers, and the workers were not adversely impacted. The Department of Energy has stringent protective measures in place at all its facilities to prevent releases, and detect and minimize any potential exposures. DOE is committed to the continued protection of its workers, the environment, and the public.
5-3	NASA and DOE have estimated that a launch accident leading to release of plutonium dioxide from the proposed MSL mission's MMRTG would be unlikely, but that if such an accident were to occur the potential effects to human health and the environment would be small; see Section 4.1.4 of this EIS for more information. The MSL mission would use a direct trajectory to Mars, and would not include gravity assist, or "slingshot", maneuvers.
5-4	Most NASA missions currently rely primarily on solar energy for electrical power to operate spacecraft, and NASA continues to conduct research and development to further improve solar technology.
6-1	As suggested, footnotes have been added to both the Executive Summary and Chapter 1.
6-2	NASA's rationale for not treating a solar-powered rover that also utilizes radioisotope heater units for additional heat as a distinct alternative to the Proposed Action (Alternative 1) is discussed in Section 2.4.2 of this EIS. Should NASA select Alternative 2, optimization of the solar-powered rover design may indicate a need for additional heat sources, the number of which is currently unknown. As with all missions, NASA continues to monitor the detailed design process for the need for additional environmental documentation.
6-3	As suggested, examples of common noise levels have been added in a new footnote to Section 4.1.2.3.
6-4	The allowable risk limits discussed in Section 4.1.3.2 of this EIS refer only to public risk of acute injury resulting from exposure to toxic gases, blast overpressure, and debris in the event of a launch accident. These risk limits are not applicable for risk of long term health hazards resulting from exposure to accidental release of radioactive material. The allowable per-launch collective public risk limits referenced in this paragraph is 30×10^{-6} with an individual risk of 1×10^{-6} over the varying population densities for exposure to toxic gases, blast overpressure, and debris in the event of a launch accident. These risk limits are further described in the cited reference, USAF 2004 (*Range Safety User*

Comment Number	Response
	Requirements Manual), which is available at http://www.e-publishing.af.mil/.
7-1	Thank you.
8-1	Thank you.
9-1	Thank you for your comments. Your expression of concern regarding mining colonies on Mars, however, is outside the scope of the planned MSL mission described in Chapter 1 of this EIS.
9-2	NASA and the Department of Energy place the highest priority on assuring the safety of their activities and facilities utilizing radioactive materials, including those that would be associated with research and development of advanced radioisotope power systems. Thorough and detailed safety analyses are performed for all DOE facilities used in such R&D efforts. These safety analyses are part of the framework DOE uses to ensure that its facilities are operated in a manner intended to ensure the health and safety of its workers, the public and the environment. NASA and the DOE take very seriously the possibility that an action they take could potentially result in harm to humans or the environment. Therefore, both agencies maintain rigorous precesses to reduce the potential for such events, both through design and operation of spacecraft, power systems, and missions, from launch through completion. Please also see Section 2.1.3 of this EIS for more information on the United States' record of space missions using nuclear power.
9-3	The U.S. Congress and the Administration develop national budget priorities among the various Federal agencies based on many considerations related to national interests and security. The final budget reflects compromises and tradeoffs when all factors and programs are considered from the broadest perspective.
9-4	Most NASA missions currently rely primarily on solar energy for electrical power to operate spacecraft, and NASA continues to conduct research and development to further improve solar technology.
10-1	Thank you for your comments.

TABLE D-3. COMMENTS FROM ORGANIZATIONS AND INDIVIDUALS SUBMITTED VIA E-MAIL

Submission Number	Comment Submission	Responses to Comments
E1	**From:** timyep [mailto:[redacted]] **Sent:** Thursday, September 28, 2006 1:41 PM **To:** mep.nepa@hq.nasa.gov **Subject:** Reuse of nuclear fuel for human exploration I'm sure this was already thought of in the NASA think tank? Consider a contingency to send enough of the nuclear powered rovers to Mars so that when the day human exploration arrives, the power source will be waiting for the team once they arrive. Solar power should still be used as a primary source of energy during the sunlight hours, but at least with nuclear power it can serve as a back-up generator. I would think that the reuse of that energy would aid in the environmental impact. Tim Yep, Concord, CA	Thank you for your comments. Your suggestions, however, are outside the scope of the planned Mars Science Laboratory mission described in this EIS. Please also see reference NASA 2004a, *The Vision for Space Exploration* (available at http://www.nasa.gov/mission_pages/exploration/news/index.html) for more information.
E2	From: Russell 'Ace' Hoffman [mailto:[redacted]] Sent: Friday, September 29, 2006 1:08 PM To: mep.nepa@hq.nasa.gov Subject: NASA's nutty nuclear ambitions continue unabated To: NASA:	
E2-1	Please accept these comments as directed to you and, to summarize (since I know few or even perhaps none of you will ever read them), being decidedly AGAINST your continued murder of children and other living things by your arrogant and unnecessary use of plutonium for power. Sincerely, "Ace" Hoffman Carlsbad, CA	E2-1) Thank you for your comments.

Submission Number	Comment Submission	Responses to Comments
	========== September 29th, 2006 Dear Chris Kridler,	[Note: this portion of Mr. Hoffman's comments is addressed to Chris Kridler, a reporter for *Florida Today* newspaper.]
E2-2	NASA announced that meeting, as far as I know, about two days before it occurred, so no wonder people like me (who lives about 3,000 miles away) didn't happen to be there.	E2-2) Public comment meetings on the MSL Draft EIS, held Sept. 27, 2006 in Cocoa, FL, and Oct. 10, 2006 in Washington, DC, were publicized well in advance of the Florida meetings, beginning with NASA's Notice of Availability published in the *Federal Register* on Sept. 5, 2006. Local newspapers ran both legal notices and display advertisements announcing the meetings at least nine days before the meetings. Please see Appendix E of this Final EIS for specific information on NASA's announcements regarding these public comment meetings.
E2-3 E2-4	NASA's RTG's are incredibly dangerous. They twist their accidents into successes, when in fact, the plutonium they have already released has killed, and continues to kill, human beings throughout the planet.	
E2-5	One estimate I heard is that as many as a million people could be condemned to die, or have died already, from ONE previous NASA Pu failure (Gofman). Another estimate, by a pro-nuker, is that males in the Northern Hemisphere piss out about a million atoms of Pu every day from that one accident. NASA misunderstands totally, the dangers of the radioactive aerosol fumes their accidents create.	
E2-6	And sure, they now have containments for the Pu, they didn't used to. But these containments are paper-thin and not really all that good. There are numerous accident scenarios where they will breach. Furthermore they reduce the efficiency of the devices,	E2-3) The U.S. Department of Energy (DOE) has invested more than 35 years of engineering, analysis and testing in RTGs for space use. The Multi-Mission Radioisotope Thermoelectric Generator is being designed with similar safety features. RTG safety features include use of a special type of fuel material, a modular design and construction and the use of multiple physical barriers. The plutonium dioxide fuel contained in an RTG is a specially formulated, fire resistant ceramic that is manufactured as pellets to reduce the possibility of
E2-7	requiring carrying MORE Pu for the same mission! So an accident with, say, a 10% release of 25 pounds (total) of Pu can be as bad as a full release of a much smaller quantity of Pu, which was delivering the exact same electrical output! (The release amount in the 1964 accident was 2.1 pounds.)	
E2-8	No one at NASA cares to truly understand the dangers of low level radiation, or to accept their (NASA's) true accident rates. Anyone in the organization who does grasp the truth is ostracized and outed as soon as possible. Question the faith that LLR might not even be good for you ("Hormesis," the fallacy that LLR has	

Submission Number	Comment Submission	Responses to Comments
E2-9	beneficial side-effects) and you will never even get in, let alone, advance, in today's nuclear NASA. These people are part of a closed society of dangerous, closed-minded "scientists" who are hoodwinking the American public and who are guilty of premeditated random murder, infanticide, and even genocide. The media has a duty to learn the truth rather than parrot NASA's blanketly-false assertions such as "the risk from the mission would be low". As NASA looks for life on Mars, they don't just "risk" life on Earth. They condemn it, because as surely as day follows night, accidents happen when dangerous activities are repeated ad nauseam. Sincerely, "Ace" Hoffman Carlsbad, CA	fuel dispersion in a launch or reentry accident. This ceramic form resists dissolution in water and reacts little with other chemicals. If fractured, the ceramic tends to break into relatively large particles and chunks that pose fewer hazards than small microscopic particles. E2-4) Safely launching any space mission is of foremost importance, and for nearly four decades NASA has safely launched and used radioactive materials in a variety of scientific instruments and for spacecraft heating or electrical power. Please see Section 2.1.3 of this EIS for information on the United States' record of space missions using nuclear power. Please see Section 3.2.5.2 of this EIS for information about plutonium releases from all sources. E2-5) The results of the accident analysis for the proposed MSL mission have been factually stated in this EIS in terms of the total probability of release, the radiological consequences of such a release, and the risk. Section 4.1.4.4 and Appendix B of this EIS discuss the environmental and health risks associated with plutonium dioxide in greater detail. The risk associated with the Proposed Action (Alternative 1) is low.

Submission Number	Comment Submission	Responses to Comments
		E2-6) The DOE has invested more than 35 years in the engineering and testing of radioisotope power systems. Multiple layers of protective materials, including iridium capsules and high-strength, heat-resistant graphite blocks are used to protect the radioisotope and prevent its release. Graphite is used because it is lightweight and highly heat-resistant. The three key features that make the iridium useful are its high melting temperature, its material compatibility with the plutonium dioxide fuel, and its resistance to oxidation in air. These features, coupled with the reentry heating and impact protection provided by the graphics of the General Purpose Heat Source module components, limit the release potential for a wide range of accident scenarios. E2-7) This comment is incorrect. Smaller, lower-power output radioisotope power systems such as the MMRTG use less fuel than larger devices such as the GPHS RTG. The MMRTG is a modular design, with each generator producing about 100 watts compared to the previous RTG which produced 285 watts. E2-8) Please see response to comment E2-5. E2-9) NASA recognizes the risks inherent in launching any spacecraft, therefore, radioisotope power systems

Submission Number	Comment Submission	Responses to Comments
		are expressly designed and developed to contain their radioisotope fuel over a wide range of launch or reentry accidents.
E3	[Note: the following comment was submitted to the U.S. Department of Energy, NASA's Cooperating Agency in the proposed MSL mission.] From: Dr. Ross McCluney [mailto:[redacted]] Sent: Friday, September 29, 2006 9:53 AM To: [redacted], Alice Subject: FW: NASA ADMITS SOLAR WILL WORK IN DEEP SPACE Dear Alice, It was good to speak with you Wednesday night. I trust that you had a safe return. How come your e-mail address doesn't have "doe.gov" in it? Perhaps you are with a contractor to DOE or something? I wish I had seen Karl Grossman's article below before speaking Wednesday night. I know Karl and have been interviewed by him for one of his TV shows. The report from Aviation Week and Space Technology	Thank you for your comments.
E3-1	indicates that NASA is concerned about the risks of too much use of plutonium in space launches. I'm glad to hear this, but wish you guys could have said something about it last night.	E3-1) There is no such concern expressed by NASA or the author of the referenced *Aviation Week & Space Technology* article. The author discusses a scarcity of plutonium fuel for radioisotope thermoelectric generators that have powered some deep space probes. He writes that planners for NASA's Juno Jupiter mission "opted for solar power as they prepared their mission for NASA's second New Frontiers competition because there wasn't a nuclear power
E3-2	I've been arguing for a long time that solar is just fine, especially for going to Mars, but even beyond. I looked for a paper I wrote on the subject but could not find it. The arguments I heard from NASA people against solar for the Casini indicated problems with stray electromagnetic radiation from large solar arrays and the weakness of the solar radiation at distance from the sun, but feel these can be overcome in flight by solar concentrators. I know that a variety of concentrating	
E3-3	optical systems have been researched and developed for a number	

Submission Number	Comment Submission	Responses to Comments
	of years at NASA/LeRC. Many show good promise. Another suggestion I had was to pipe the concentrated solar radiation onto the PV cells in electrically shielded cages, to keep stray electromagnetic fields from interfering with sensitive electrical circuits. I know this might be less easy for a Mars rover, but the solar option still makes a lot of sense to me. Ross McCluney, Ph.D. [redacted] Cape Canaveral, FL 32920 321-[redacted] [redacted] _____ From: Global Network [mailto:[redacted]] Sent: Thursday, September 14, 2006 8:04 AM To: Global Network Against Weapons Subject: NASA ADMITS SOLAR WILL WORK IN DEEP SPACE NASA ADMITS SOLAR WILL WORK IN DEEP SPACE By Karl Grossman For years NASA insisted it couldn't be done. Beyond the orbit of Mars, NASA said, solar energy could not be used to generate electricity for onboard power on space devices. So the agency used the extremely dangerous nuclear substance, plutonium, as fuel in electric generating systems-and	source available." Source: *Aviation Week & Space Technology, July 17, 2006, page 160, "Improving Solar Cell Efficiency Enables NASA's Solar-powered Jupiter Probe."* E3-2) NASA's Jet Propulsion Laboratory conducted an in-depth analysis of the available electrical power systems, including many different solar, battery, and long life fuel cell power sources and hybrid systems to identify the most appropriate power source for the Cassini mission. A Cassini spacecraft equipped with the highest efficiency solar cells available (including the new high-efficiency cells under development by the European Space Agency) would have made the spacecraft too massive for launching to Saturn. The resulting solar arrays would have been larger than the area of two tennis courts. RTGs were determined to be the only feasible power system for the Cassini mission. E3-3) Existing space based solar concentrator designs are not compatible with the MSL mission and goals. In order for the MSL rover to accomplish its science goals, it must survive rugged driving operations and perform in weather conditions (wind, dust storms, etc.) encountered on the

Submission Number	Comment Submission	Responses to Comments
	people on Earth were put at great risk in the event of an accident. For instance, in 1997 NASA launched its Cassini plutonium-fueled space probe and in 1999 had Cassini hurtle back at Earth in a "slingshot maneuver" to increase its velocity so it could get to Saturn. If there was what NASA called an "inadvertent reentry" of Cassini into the Earth's atmosphere during the "slingshot maneuver" just a few hundred miles up, it would disintegrate and "5 billion of the world population could receive 99 percent or more of the radiation exposure," NASA admitted in its Final Environmental Impact Statement for the Cassini Mission. The death toll from a Cassini accident was put by Dr. Ernest Sternglass, professor emeritus of radiological physics at the University of Pittsburgh School of Medicine, at 20 million to 40 million. And this is not a sky-is-falling story. Of 28 U.S. space missions using plutonium, there have been three accidents, the worst in 1964 in which a plutonium-powered satellite fell back to Earth, breaking up and spreading the toxic radioactive substance widely. That caused NASA to develop solar power for satellites-and today all satellites (and the International Space Station) are energized by solar panels. But, insisted NASA, in deep space sunlight is too weak and solar energy could not work, only plutonium would. Now the leading space industry trade magazine, Aviation Week & Space Technology, reveals that solar energy is to be used by NASA to substitute for nuclear power in deep space. The recent article began: "Budget and technical realities have led NASA to put its once-ambitious space nuclear power plans on a slow track, but development in solar power generation should allow new scientific probes beyond Mars to operate without	Martian surface. Existing space solar concentrators require precise pointing systems to track the sun and have limited rigidity. Incorporating such a power system into a rover mission would be incompatible with the rover's operation.

Submission Number	Comment Submission	Responses to Comments
	nuclear energy. The U.S. space agency is already planning a solar-powered mission to study the atmosphere of Jupiter, and has looked at sending probes as deep into space as Neptune using only the Sun's energy for spacecraft and instrument power. It is all but certain the next U.S. deep-space missions will be solar-powered." The piece went on describe the new giant solar energy systems that will be used to harvest solar energy at record efficiencies vast distances from the Sun. Bruce Gagnon, coordinator of the Global Network Against Weapons & Nuclear Power in Space, comments that "for years NASA said that the Global Network didn't know what we were talking about when it came to solar power working in deep space. Now NASA is planning to do what we've been saying all along they could do. It just goes to show that if you are willing to stay on-top of an issue for a long time that something good can come from your hard work." Jeremy Maxand, executive director of the Snake River Alliance, an Idaho group that's been challenging the use of Idaho National Laboratory to produce plutonium for space power systems, says, "It's good to see plutonium space batteries following in the steps of the now demoted planet Pluto. We've said since day one that plutonium is unnecessary and dangerous, and that we can do the same job a better way, and now we're seeing what that better way is-solar." What's to happen in space is what should also happen on Earth. The Bush administration and nuclear industry are pushing for a "revival" of nuclear power. We don't need to take the enormous risk of building new nuclear plants-or having nuclear poisons over our heads. Safe energy technologies are here. -30-	

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	Karl Grossman, professor of journalism at the State University of New York/College at Old Westbury, is the author of The Wrong Stuff (Common Courage Press) and narrator of the TV documentary Nukes In Space (www.envirovideo.com). --- --- --- Global Network Against Weapons & Nuclear Power in Space [redacted] Brunswick, ME 04011 (207) [redacted] http://www.space4peace.org [redacted] http://space4peace.blogspot.com (our blog)	
E4	From: Bryan Thomas [mailto:[redacted]] Sent: Monday, October 16, 2006 1:54 PM To: mep.nepa@hq.nasa.gov Subject: Mars Science Lab - power source comment Mark R. Dahl Science Mission Directorate, NASA Headquarters Washington, DC 20546 Dear Mr. Dahl,	
E4-1	Do I address comments regarding the choice of power source for the proposed Mars Science Laboratory to you or some other address?	E4-1) Yes, thank you for your comments.
E4-2	I recommend the solar powered choice (Alternative 2). Given the limited area already explored, there would appear to be an adequate percentage of Mars' surface to be explored within the	E4-2) There are sites near the equator that may be good scientific

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E4-3 E4-4 E4-5	specified 15 degree band. The added risk of launching the radioactive material therefore does not appear to be justified. Save those for missions beyond Saturn or for a follow-up mission to Mars, once the equatorial areas have been better explored. If NASA were less conservative about the planned lifetime of the radioactive decay powered rover, and so its planned life was longer than the solar powered version (which seems counterintuitive but was implied by the space.com article), then I might reconsider, but for equal planned lives, there is no reason to loft the radioactive material. It would also be helpful to have future EIS contain the estimated cost differential of the alternatives. Regards, Bryan Thomas [redacted] Pelham, NY 10803	targets for the planned MSL mission. However, in order to understand Mars as a planet and whether it may have ever supported microbial life, scientists need to be able to access the place on the surface that provides the best chance of landing safely and answering these questions. The current spacecraft in orbit around Mars are scouring the planet to find that place, and while this is going on, the MSL mission is being designed with the capability to operate over as much of the planet as is practical (for example, the polar regions are not considered practical for either the MMRTG or solar power alternative). E4-3) NASA and DOE have estimated that a launch accident leading to release of plutonium dioxide from the proposed MSL mission's MMRTG would be unlikely, but that if such an accident were to occur the potential effects to human health and the environment would be small; see Section 4.1.4 of this EIS for more information. E4-4) NASA's technical requirements for the planned MSL mission call for a rover that would operate for one Mars year, equivalent to about two Earth years. If the rover, with either alternative power source, was still operational after its two-year mission was completed, NASA could possibly authorize extended operations for

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		enhanced exploration and science return. Many solar-powered spacecraft have continued to operate long past their originally planned lifetimes. All NASA spacecraft that have used radioisotope power systems continued to operate for years, even decades, after their primary missions were completed. E4-5) NASA's decision-maker, in rendering the Record of Decision, will take into account and weigh a variety of factors, such as ability to meet the purpose and need, technical feasibility and maturity, potential environmental impacts, and the relative financial cost of the reasonable alternatives under consideration.
E5	**From:** claire whitehill [mailto:[redacted]] **Sent:** Thursday, October 19, 2006 1:00 PM **To:** mep.nepa@hq.nasa.gov **Subject:** Mars Exploration Comment Dear NASA, E5-1 This citizen believes that it is a total waste of taxpayer money to go to Mars and that you should be spending that money on finding renewable energies on planet Earth. If you must waste this money, kindly do not do it with nuclear materials which pollute our lives. E5-2 Get a solar power system going, or do something else that is worthwhile. Claire Whitehill, [redacted], Chestertown, Maryland	Thank you for your comments. E5-1) The U.S. Congress and the Administration develop national budget priorities among the various Federal agencies based on many considerations related to national interests and security. The final budget reflects compromises and tradeoffs when all factors and programs are considered from the broadest perspective.

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		E5-2) Most NASA missions currently rely primarily on solar energy for electrical power to operate spacecraft. However, solar power may not be adequate in all cases for future Mars exploration. A range of power sources is considered for any Mars mission, and each power source type is evaluated on how well it enables achieving the science and engineering requirements of the mission.
E6	**From:** Shirley Morrison [mailto:[redacted]] **Sent:** Thursday, October 19, 2006 1:45 PM **To:** mep.nepa@hq.nasa.gov **Subject:** NO toPlutonium Too dangerous, Plutonium accidents would cost so much money and we have SO many other needs and uses for that same money. Forget this exploration now. Peace, Shirley Morrison Shirley Morrison	Thank you for comments; please see responses to comments E2-3, E4-3, and E5-1.
E7 E7-1	**From:** mary jude jun [mailto:[redacted]] **Sent:** Thursday, October 19, 2006 1:54 PM **To:** mep.nepa@hq.nasa.gov **Subject:** I say NO to this experiment planned for Mars -- too expensive and the needs of the poor, uninsured, homeless, unemployed, sick, etc. are far more	Thank you for your comments. E7-1) The U.S. Congress and the Administration develop national budget priorities among the various Federal agencies based on many considerations related to national interests and security. The final

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	important ways to spend $$$	budget reflects compromises and tradeoffs when all factors and programs are considered from the broadest perspective.
E7-2	-- too dangerous for the environment	E7-2) NASA and the Department of Energy take very seriously the possibility that an action they take could potentially result in harm to humans or the environment. Therefore, both agencies maintain rigorous processes to reduce the potential for such events, both through design and operation of spacecraft, power systems, and missions, from launch through completion. Please also see responses to comments E2-9 and E4-3.
E7-3	-- can easily lead to militarization of space	E7-3) NASA's planned Mars Science Laboratory mission is for peaceful scientific purposes.
	Sincerely yours, Sister Mary Jude Jun, OSU (Helen Rose Jun)	
E8	From: premilla dixit [mailto:[redacted]] Sent: Thursday, October 19, 2006 2:14 PM To: mep.nepa@hq.nasa.gov Subject: NO NUCLEAR BATTERIES FOR MARS Dear Friends, We are all human, biological matter, with limited life spans subject to disease and death, with an extraordinarily common human desire for "life, liberty and happiness".	Thank you for your comments.
E8-1	You know as well as anyone that there is NO SFAE USE OF NUCLEAR MATERIALS IN SPACE EXPLORATION. WHY DO IT? Do you have no love of this beautiful earth and our children's children who will inherit all the problems we cause with our unintelligent decisions?	E8-1) Please see response to comment E7-2.

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E8-2	* NASA and the Department of Energy have long records of accidents and toxic contamination, from radioactive spills at production facilities and from space launch explosions. Expanding space plutonium power systems will increase chances of environmental contamination from plutonium. * Page 4-31 of the DEIS identifies Potential Land Decontamination Cost Factors. It examines the cost of decontaminating affected areas, including Mixed-Use Urban areas at $1.5 billion per mile. The ³secondary societal costs² of an accident identified include relocation of residents; destruction or quarantine of agricultural products; land use restrictions; and restriction or bans on commercial fishing.	E8-2) NASA and the Department of Energy place the highest priority on assuring the safety of their activities and facilities utilizing radioactive materials, including those that would be associated with research and development of advanced radioisotope power systems. Please also see Section 2.1.3 of this EIS for more information on the United States' record of space missions using nuclear power.
E8-3	* Every expansion of the plutonium process, including research, development and transportation of this deadly material over thousands of miles, increases the risk of nuclear accidents or theft.	E8-3) The DOE places the highest priority on assuring the safety of their activities and facilities utilizing radioactive materials, including those that would be associated with research and development of advanced radioisotope power systems. Thorough and detailed safety analyses are performed for all DOE facilities used in such R&D efforts. These safety analyses are part of the framework DOE uses to ensure that its facilities are operated in a manner intended to ensure the health and safety of its workers, the public and the environment. DOE radiological materials are rigorously protected against loss, theft and sabotage through physical protection and accounting. The materials are strictly contained to prevent accidental release due to the inherent health and safety risk of the
E8-4	* Every effort made to improve the design of nuclear-powered batteries for use in space furthers the technological infrastructure for the development of nuclear powered space-based weapons.	
E8-5	* Plutonium production is expensive and diverts tax dollars from more important social concerns present in our society today. Please use you position in society responsibly. Do not use nuclear batteries to power land rovers to explore Mars. Hoping public opinion matters. Best, Premilla	

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		material. DOE continually assesses and implements measures to minimize the risk and consequences of radiological sabotage or theft. E8-4) NASA is the nation's civil space agency. NASA space missions and related research programs are conducted for peaceful scientific purposes. Any potential military application of a NASA-developed advancement is purely speculative and would be beyond the scope of activities for which an MMRTG for NASA would be intended. E8-5) The U.S. Congress and the Administration develop national budget priorities among the various Federal agencies based on many considerations related to national interests and security. The final budget reflects compromises and tradeoffs when all factors and programs are considered from the broadest perspective.
E9	**From:** leila ryterski [mailto:[redacted]] **Sent:** Thursday, October 19, 2006 2:20 PM **To:** mep.nepa@hq.nasa.gov **Subject:** Mars exploration Abandon nuclear power. It's dangerous to human (and other) life. Lilly Ryterski	Thank you for your comments. Please see response to comment E7-2.
E10	From: William Sell [mailto:[redacted]] Sent: Thursday, October 19, 2006 3:08 PM To: mep.nepa@hq.nasa.gov Subject: Mars	

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	Please remove all bacteria or any live growth from this and other space missions. Thanks Bill Sell [redacted] Milwaukee, WI 53207	Thank you for your comment. Stringent planetary protection procedures would be applied to the MSL spacecraft prior to launch, and precautions would be taken to ensure that the spacecraft does not contaminate Mars. Please see NASA's planetary protection web site at http://planetaryprotection.nasa.gov for more information.
E11	From: Lois Clark [mailto:[redacted]] Sent: Thursday, October 19, 2006 2:57 PM To: mep.nepa@hq.nasa.gov Subject: For the sake of our children's future, PLEASE do not do ANYTHING during your explorations that would hamper our world's capability to live in peace with one another. "For the good of the order" Shalom/Salaam, Lois Clark	Thank you for your comments. NASA's planned Mars Science Laboratory mission is for peaceful scientific purposes.
E12 E12-1	**From:** Carroll and Edith Webber [mailto:[redacted]] **Sent:** Thursday, October 19, 2006 2:59 PM **To:** mep.nepa@hq.nasa.gov **Subject:** Comment on MSL Mission Mark Dahl, MEP Office, Planetary Science Division, NASA Dear Dr. Dahl, I have one comment on the Mars Science Lab Mission. \ It's my considered opinion that use of plutonium batteries or power systems is a kind of Russian roulette, primarily because of an eventuallaunch accident.	Thank you for your comments. E12-1) Please see response to comment E7-2.

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E12-2	We got away with it in Cassini, we may get away with it a few more times (or not). But eventually, both Florida and Mars will get contaminated. Alternative, especially solar, power is the proper choice, especially to near-Sun objectives like Mars. Sincerely, Carroll Webber	E12-2) Please see response to comment E5-2.
E13	**From:** ALAN JOHNSON [mailto:[redacted]] **Sent:** Thursday, October 19, 2006 4:11 PM **To:** mep.nepa@hq.nasa.gov **Subject:** Mars Science Laboratory Mission Dear Folks, With all the brain power you people have, can't you think of something more beneficial for our planet? Yours, Nancy Goodspeed	Thank you for your comment. NASA space missions and related research programs are conducted for peaceful scientific purposes. NASA-funded research and development historically has generated a wealth of technology innovations that translated into widespread benefits with applications in medicine, communications, information systems, transportation, and numerous other fields.
E14 E14-1	**From:** Mjhfos[redacted] [mailto:[redacted]] **Sent:** Thursday, October 19, 2006 4:42 PM **To:** mep.nepa@hq.nasa.gov **Subject:** Draft Environmental Impact Statement I am writing to comment on the draft environmental impact statement concerning the proposed exploration of Mars. It is alarming to me that scientists would give any consideration to using plutonium for anything and especially for use in space or on other celestial bodies. This is one of the most dangerous substances on earth and the span	Thank you for your comments. E14-1) The ceramic form of plutonium-238 dioxide that is used in radioisotope power systems is

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E14-2	of its lethality too long to even comprehend. Such intentions are beyond any moral justification. Using our natural and fiscal resources for further exploration of Mars at this time in our nation's history is irresponsible. Monies allocated to space exploration should be postponed while human and environmental needs are increasingly unmet. The talents, experience and knowledge being given to space exploration would be better employed in solving many of our earthly problems. Instead, this preparation for mining Mars and getting nuclear weapons in space risks both environmental disaster and an ever-growing list of social and economic failures. I don't hear the public clamoring to use our resources on space exploration and I urge you to resist the temptation to divert them to this purpose. In a democracy, the people's voices should be heard and respected. Please report to me the results of public opinion about this planned endeavor. Thank you, Jane Hanna [redacted] Santa Fe, NM 87508	designed specifically for safety. The plutonum-238 isotope produces heat through natural decay by giving off alpha particles which travel only about three inches in air. Clothing, skin, or even a sheet of paper stops external alpha radiation. This combined with the choice of a ceramic fuel form and the protective features of the radioisotope power system's heat source minimize the potential for dispersal and inhalation, and limits any potential risks to the public. Plutonium-238 has a half-life of 87.75 years. Because of radioactive decay and accounting for all the plutonium isotopes in the original fuel, the amount of plutonium remaining after 100 years would be 45 percent, after 500 years would be 2 percent, and after 1,000 years would be 0.13 percent. Please also see response to comment E5-2. E14-2) The U.S. Congress and the Administration develop national budget priorities among the various Federal agencies based on many considerations related to national interests and security. The final budget reflects compromises and tradeoffs when all factors and programs are considered from the broadest perspective. Your expression of concern regarding mining Mars is outside the scope of

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		the planned Mars Science Laboratory mission described in Chapter 1 of this EIS. NASA's planned MSL mission is for peaceful scientific purposes.
E15	**From:** peter carson [mailto:[redacted]] **Sent:** Thursday, October 19, 2006 9:07 PM **To:** mep.nepa@hq.nasa.gov **Subject:** Space Programs To whom it concerns.	Thank you for your comments.
E15-1	In my opinion, the entire space race must be extinguished immediately. It serves no worthwhile purpose in sustaining life on earth, costs billions of taxpayer dollars, diverts huge sums fo money into the pockets of a few plutocrats and their corporations, while stripping away the funding needed to expand food cultivation and water purification, while contemporaneously developing sustainable, non polluting, eco-friendly, rewable sources of energy to supply domestic and industrial consumer needs, including transportation.	E15-1) The U.S. Congress and the Administration develop national budget priorities among the various Federal agencies based on many considerations related to national interests and security. The final budget reflects compromises and tradeoffs when all factors and programs are considered from the broadest perspective.
E15-2	I do not see any measurable benefit flowing to common persons by expending even one penny to undertake the Mars program, which I personally view as a very thin and transparent veil to market the weaponization of space behind. The only possible use I can imagine for a spacecraft, would be to ship off all the members of the current administration of the United States of Assassination, for a one way ride into the cosmos. However, in consideration of the growing awareness of the falacious activities of this government, the rising tide of people stepping up to stop the mass murder and genocide of literally millions of innocent defenseless civilians all over the third world, as commissioned by the scum of plutocratic puppets, including virtually all members of congress and the senate, I beleive a revolutionary uprising is soon at hand, which will smite these despicable Nazi cowards from all over this planet, and delivering them to their rightful place in Hell, thus precluding the need for a rocket.	E15-2) NASA's planned Mars Science Laboratory mission is for peaceful scientific purposes.

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	yours very truly peter carson Vancouver BC Canada	
E16	**From:** Wilfred Phillips [mailto:[redacted]] **Sent:** Friday, October 20, 2006 5:16 AM **To:** mep.nepa@hq.nasa.gov **Subject:** Mars Landing vechicles Hello, I write to protest against the use of Nuclear powered vechicles on Mars. These vechicles will have a limited life before they break down and lose their usufullness BUT the Plutonium will last for thousands of years and will contaminate the planet.This is morally inexcusable. Please go ahead and explore Mars but do not use Nuclear products. Wilfred Phillips	Thank you for your comments. Radioisotopes have a safe and productive history of use on NASA's Mars missions. Various radioisotopes have been used to supply spacecraft electrical power and heat, and as calibration sources for scientific instruments. These include uses such as radioisotope calibration sources for instruments in the NASA Mariner program of the 1960s and '70s, radioisotope thermoelectric generators for the 1976 Viking Landers, and radioisotope heater units for rovers such as the Mars Pathfinder Sojourner rover and the Spirit and Opportunity Mars Exploration Rovers. Please also see response to comment E14-1.
E17	From: Sarah Lasenby [mailto:[redacted]] Sent: Friday, October 20, 2006 5:52 AM To: mep.nepa@hq.nasa.gov Subject: Re: Nuclear powered landrovers on Mars Dear Sir/Madam I am writing to bring my serious concern about the plan to use	Thank you for your comments.

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	nuclear/radioactive powered vehicles on Mars.	
E17-1	In view of the long record of accidents and space launch explosions this will lead to unacceptable risks being taken on this earth let alone in space - I imagine Mars is as yet virtually uncontaminated ? Any expansion of space plutonium powered systems will increase chances of environmental contamination from plutonium.	E17-1) Please see response to comment E8-2.
E17-2	It is not as if NASA and the Department of Energy does not have a long records of accidents and toxic contamination, from radioactive spills at production facilities and from space launch explosions. By chance alone these are likely to continue and this is not the kind of risk I believe we should be undertaking. The cost of clearing up these accidents and spillages is also very large. Solar powered devices would be much less contaminating.	E17-2) Please see response to comment E7-2.
E17-3	Any expansion of the plutonium process, including research, development and transportation of this deadly material over thousands of miles, increases the risk of nuclear accidents or	E17-3) Please see response to comment E8-3.
E17-4	theft. It is also expensive ! and I believe the US [and Britain] should concern itself with the needs of the increasing number of disadvantaged citizens before contaminating space at enormous expense. Yours faithfully Sarah Lasenby - Oxford England	E17-4) The U.S. Congress and the Administration develop national budget priorities among the various Federal agencies based on many considerations related to national interests and security. The final budget reflects compromises and tradeoffs when all factors and programs are considered from the broadest perspective.
E18	From: J. Schmidt [mailto:[redacted]] Sent: Friday, October 20, 2006 10:24 AM To: mep.nepa@hq.nasa.gov Subject: Mars missions	

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E18-1 E18-2	To who it may concern, It is severely unwise to take nuclear batteries or other items using nuclear items into space, and certainly to take them onto Mars. They are incredibly dangerous, and leave contamination possibly forever. You do not have the right to take such dangerous actions. As a country we need to be a good example to the world, not a BAD one, as we would be in this case. Such bad actions can turn around and harm our country and citizens directly, as well as people in other parts of the world. I urge you not to take such dangerous pollutants into space and to Mars. Sincerely, Judith Schmidt PhD -- Blessings and Balance Dr. Judith Schmidt [redacted] Washington, ME 04574 207 [redacted] 207 [redacted] fax [redacted] http://www.midcoast.com/~jgs/#TOP (Solar site) http://www.spirituality.com	Thank you for your comments. E18-1) Please see responses to comment E7-2 and submission E16. E18-2) NASA's planned Mars Science Laboratory mission is for peaceful scientific purposes.
E19	**From:** Deborah Kreis [mailto:[redacted]] **Sent:** Friday, October 20, 2006 12:11 PM **To:** mep.nepa@hq.nasa.gov **Subject:** Mars	

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	How about we schedule a one-way ticket to all you eco-terrorists that believe all planets are fair to our polluting techniques? All you will see on your screen after take-off, maiden flight is "Return trip cancelled" Love, Mars?Venus Think about it!!!!	Thank you for your comments. NASA's planned Mars Science Laboratory mission is for peaceful scientific purposes.
E20	**From:** natasha [mailto:[redacted]] **Sent:** Friday, October 20, 2006 5:39 PM **To:** mep.nepa@hq.nasa.gov **Subject:** plutonium in space, mars exploration Mark R. Dahl, Program Executive Mars Exploration Program Office NASA I would like to comment on the Mars Exploration Program.	Thank you for your comments.
E20-1	Expanding space plutonium power systems will increase chances of environmental contamination from plutonium.	E20-1) Please see response to comment E7-2.
E20-2	NASA and the Department of Energy have long records of accidents and toxic contamination, from radioactive spills at production facilities and from space launch explosions. Therefore I oppose your project. Natasha Mayers [redacted] Whitefield, Me. 04353	E20-2) Please see responses to comments E8-2 and E8-3.
E21	**From:** rosemary galli [mailto:[redacted]] **Sent:** Saturday, October 21, 2006 12:39 PM **To:** mep.nepa@hq.nasa.gov **Subject:** Mars Exploration: comment!	

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	Importance: High Dear Sir or Madam: I am a US citizen resident in Oxfordshire. It has just come to my attention that there is a program to explore Mars which will utilize nuclear-powered batteries in Land Rovers for the purpose of collecting soil and rock samples. Although in favour of scientific exploration of our solar system in principle, I feel this methodology may have serious and damaging consequences. So I would like to register my dissent based on the following which has been called to my attention: • NASA and the Department of Energy have long records of accidents and toxic contamination, from radioactive spills at production facilities and from space launch explosions. Expanding space plutonium power systems will increase chances of environmental contamination from plutonium. • Page 4-31 of the DEIS identifies Potential Land Decontamination Cost Factors. It examines the cost of decontaminating affected areas, including Mixed-Use Urban areas at **$1.5 billion per mile**. The "secondary societal costs" of an accident identified include relocation of residents; destruction or quarantine of agricultural products; land use restrictions; and restriction or bans on commercial fishing. • Every expansion of the plutonium process, including research, development and transportation of this deadly material over thousands of miles, increases the risk of nuclear accidents or theft. • Every effort made to improve the design of nuclear-powered batteries for use in space furthers the technological infrastructure for the development of nuclear powered space-based weapons. • Plutonium production is expensive and diverts tax dollars from more important social concerns present in our society today. I trust you will add my comment to the others as you have called for a public consultation on the DEIS.	Thank you for your comments. Please see responses to submission E8.

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	Thank you for your consideration of my views. Yours truly, Rosemary Galli [redacted] Charlbury, Oxfordshire, [redacted]. United Kingdom	
E22	**From:** Molly Willcox [mailto:[redacted]] **Sent:** Saturday, October 21, 2006 10:17 PM **To:** mep.nepa@hq.nasa.gov **Subject:** Public comment on DEIS for MSL mission Comments on Draft Environmental Impact Statement (DEIS) for the Mars Science Laboratory (MSL) Mission: **Every expansion of the plutonium process, including research, development and transportation of this deadly material over thousands of miles, increases the risk of nuclear accidents or theft**. NASA and the Department of Energy have long records of accidents and toxic contamination, both from radioactive spills at production facilities and from space launch explosions. **Expanding plutonium power systems into space will exponentially increase the chances of environmental contamination from plutonium**. Page 4-31 of the DEIS identifies **cost factors of potential land decontamination**. The cost of decontaminating affected areas, including Mixed-Use Urban areas, is estimated at **$1.5 billion per mile**. The identified "secondary societal costs" of an accident include relocation of residents; destruction or quarantine of agricultural products; land use restrictions; and restriction or bans on commercial fishing. Plutonium production is expensive and **diverts tax dollars from more important social concerns** that challenge this country. Every effort to improve the design of nuclear-powered batteries for use in space furthers the technological infrastructure for the development of nuclear powered space-based	Thank you for your comments. Please see responses to submission E8.

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	weapons. For all these reasons and more, I am unequivocably opposed to the Mars Science Laboratory mission. Sincerely, Faith M. Willcox	
E23	From: Karl Johanson [mailto:[redacted]] Sent: Saturday, October 21, 2006 11:34 PM To: mep.nepa@hq.nasa.gov Subject: RTG powered space missions. Thank you for running missions to examine other planets. I think the radio-isotope power supplies for the missions are a good idea. Work to maintain good safety standards, for RTGs and other technologies, but the RTGs are worth while. Thank you. Karl Johanson Editor and science writer for Neo-opsis Science Fiction Magazine www.neo-opsis.ca	Thank you for your comments.
E24	**From:** Marghi Dutton [mailto:[redacted]] **Sent:** Sunday, October 22, 2006 2:27 AM **To:** mep.nepa@hq.nasa.gov **Subject:** Plutonium batteries Please, what is the hurry ? There may be unknown safer ways to conduct these amazing little robots in the future. Plutonium is no element to be used in space. What will your grandchildren think of you in years to come. Save space for Peace! Margaret Dutton, age 89 and caring about the future.	Thank you for your comments. Please see response to submission E16. NASA's planned Mars Science Laboratory mission is for peaceful scientific purposes.
E25	**From:** Richard Paczynski [mailto:[redacted]] **Sent:** Sunday, October 22, 2006 3:12 PM	

Submission Number	Comment Submission	Responses to Comments
E25-1	**To:** mep.nepa@hq.nasa.gov **Subject:** Go Rover ! (Perfect Nuclear "Batteries") Dear NASA Administrators -- I wanted to weigh in on the issue of nuclear-fuel batteries for the Mars Rover program. This seems to be a completely sensible approach to the problem of consistent, sustained energy supply for long-term exploration and, possibly, materials exploitation down the road. It is my sincere hope that this effort will not be de-railed by antinuclear hysterics. This is a golden opportunity for the USA to perfect the techniques relevant to the safe containment and transportation of fissile materials. Safety and utility go hand in hand. Let's get on with it **!** Richard Paczynski, M.D., Harrisburg, Pa	Thank you for your comments. E25-1) Department of Energy radiological materials are rigorously protected against loss, theft and sabotage through physical protection and accounting. The materials are strictly contained to prevent accidental release due to the inherent health and safety risk of the material. DOE continually assesses and implements measures to minimize the risk and consequences of radiological sabotage or theft.
E26	**From:** lpeterson [redacted] [mailto:[redacted]] **Sent:** Sunday, October 22, 2006 8:12 PM **To:** mep.nepa@hq.nasa.gov **Subject:** As a citizen of the US and the planet Earth, I am against any more funds being spent on Mars projects, etc. particularly ones	Thank you for your comments. The U.S. Congress and the

Submission Number	Comment Submission	Responses to Comments
	that deal with toxic chemicals such as plutonium. We need to clean up our act here on Earth and take care of business "at home" rather than blow tons of money and increase pollution on some obsessions in space. Thank you, L Peterson	Administration develop national budget priorities among the various Federal agencies based on many considerations related to national interests and security. The final budget reflects compromises and tradeoffs when all factors and programs are considered from the broadest perspective.
E27	**From:** Richard Paczynski [mailto:[redacted]] **Sent:** Sunday, October 22, 2006 3:20 PM **To:** mep.nepa@hq.nasa.gov **Subject:** Go Rover ! **Mark R. Dahl, Program Executive** **Mars Exploration Program Office** **Planetary Science Division** **Mail Suite 3X63** **NASA Headquarters** **Washington, DC 20546-0001** Dear Mr. Dahl -- I wanted to weigh in on the issue of nuclear-fuel batteries for the Mars Rover program. This seems to be a completely sensible approach to the problem of consistent, sustained energy supply for long-term exploration and, possibly, materials exploitation down the road. It is my sincere hope that this effort will not be de-railed by antinuclear hysterics. This is a golden opportunity for the USA to perfect the techniques relevant to the	Thank you for your comments.

Submission Number	Comment Submission	Responses to Comments
E27-1	safe containment and transportation of fissile materials. Safety and utility go hand in hand. Let's get on with it **!** Richard Paczynski, M.D., Harrisburg, PA	E27-1) Please see response to comment E25-1.
E28	**From:** lpeterson [redacted] [mailto:[redacted]] **Sent:** Sunday, October 22, 2006 8:22 PM **To:** mep.nepa@hq.nasa.gov **Subject:** Re Mars and other projects Please halt any projects that use harmfull plutonium or other deadly toxins and that also waste millions of our dollars on Mars and other projects in space that we humans may become obsessed with. As a citizen of the US and planet Earth, and as a parent, I have always been against the amount of money, energy, pollution and time that is used on unnecessary space projects when we have so many messes here on Earth that should logically be dealt with first. It is not responsible or moral to focus on outer space while avoiding our problems at home. Thank you. LP	Thank you for your comments. The U.S. Congress and the Administration develop national budget priorities among the various Federal agencies based on many considerations related to national interests and security. The final budget reflects compromises and tradeoffs when all factors and programs are considered from the broadest perspective.
E29	From: West Family [mailto:[redacted]] Sent: Sunday, October 22, 2006 11:19 PM To: mep.nepa@hq.nasa.gov Subject: DEIS-MSL Re. public comment concerning the draft environmental impact statement on the Mars science lab:	Thank you for your comments.
E29-1	I am against this project because NASA and the Department of Energy already have a history of accidents and toxic contamination. I don't believe the danger of such risks warrants	E29-1) Please see response to comment E8-2.

Submission Number	Comment Submission	Responses to Comments
	the expansion of plutonium power systems. In fact, it stands to reason, that expansion would increase the probability of further accidents.	
E29-2	Secondly, I believe the exorbitant cost of this project , along with the high costs of possible decontamination, not to mention the financial an societal cost to all those affected, is far too great.	E29-2) The U.S. Congress and the Administration develop national budget priorities among the various Federal agencies based on many considerations related to national interests and security. The final budget reflects compromises and tradeoffs when all factors and programs are considered from the broadest perspective.
E29-3	Our government's concern over other countries developing plutonium is warranted. It would also be wise for us to curtail our expansion of this deadly material. Any project which entails the development and transportation of plutonium increases the risk of nuclear accidents. This is too great a risk for American citizens or for the citizens of the world. Thank you for allowing this opportunity for comment. Sincerely, Linda West	E29-3) Please see response to comment E8-3.
E30	From: William Powell [mailto:[redacted]] Sent: Sunday, October 22, 2006 10:40 PM To: mep.nepa@hq.nasa.gov Subject: Mars Exploratio I think it's a stupid idea! Let's concentrate our efforts on distribution of resources equally among people on earth! Mary Anne Powell	Thank you for your comments. The U.S. Congress and the Administration develop national budget priorities among the various Federal agencies based on many considerations related to national interests and security. The final budget reflects compromises and tradeoffs when all factors and programs are considered from the broadest perspective.
E31	**From:** Sebnem Koyunluoglu Aynur [mailto:[redacted]] **Sent:** Monday, October 23, 2006 9:50 AM	

Submission Number	Comment Submission	Responses to Comments
	To: mep.nepa@hq.nasa.gov **Subject:** Comment on MSL I am a graduate student in Environmental Engineering Programme in the George Washington University. Among the environmental impacts of the MLS, I was mostly concerned about the environmental impacts that can be caused by accidents resulting in release of PuO_2 to the environment. I was concerned about the health effects on the population exposed and also the potential impacts of the release on natural vegetation, wetlands, agricultural land, urban areas, inland water, and the ocean. In the DEIS it is said that the prediction of doses to the maximally exposed individual is subject to large variations and uncertainties in the locations of individuals, meteorological conditions, periods of exposure, and dispersion modeling. In the case of after launch scenario, it is said that assuming no mitigation actions, such as sheltering and exclusion of people form the contaminated areas, the radiation dose to the potentially exposed population is predicted to result in less that one additional health effect over the long term. This mean estimate for this scenario is 0.2 health effects. It is also said that in the case of very unlikely launch area accidents, higher mean releases (2% of the MMRTG's inventory) could occur with potentially higher consequences. Again assuming no mitigation actions such as sheltering, mean health effects among the potentially exposed population for these accidents are estimated to range from less than 1 health effect up to 62 health effects among the regional and worldwide populations. But all in all, according to DEIS, when both the unlikely and the very unlikely launch accidents assessed, the maximally exposed member of the exposed population faces a less that 1 in 1 million possibility of incurring a latent cancer due to failure of the MSL mission. In spite of the considerable effects, since the probability of these scenarios to happen are very low, the risks are also considerably low according to the DEIS. In addition the environmental impacts including short—term impact caused by	Thank you for your comments.

Submission Number	Comment Submission	Responses to Comments
	exhaust emission form the launch vehicle and the short-term ozone degradation along the flight path of the of the vehicle would not be long-term or cumulative. Taking into account the scientific benefits of radioisotope-powered rover over solar-powered rover I think the radio-isotope powered one must be used. Regards, Sebnem Aynur	
E32	**From:** chatterjee sandip [mailto:[redacted]] **Sent:** Monday, October 23, 2006 3:05 PM **To:** mep.nepa@hq.nasa.gov **Subject:** Comments regarding Draft EIS briefing on NASA Mars Science Laboratory Mission Mr. Mark R. Dahl Mail Stop 3X63, Planetary Science Division Science Mission Directorate NASA Headquarters 300 E Street NW Washington, DC 20546 - 0001 **Comments regarding Draft Environmental Impact Statement briefing on NASA 'Mars Science Laboratory Mission'**	Thank you for your comments.
E32-1	NASA is presently through the phase of development of a 2009 Mars mission to send a robotic laboratory carrying the most advanced scientific instruments to conduct research and gather information regarding many of Mar's intriguing regions, which were not accessed before. The draft EIS was presented to inform the public regarding the potential environmental impacts due to the mission or due to any accident during the course of the mission.	E32-1) The 2009 Mars Science Laboratory mission is still in its early development phase.
E32-2	The preferred alternative is the use of radioisotope power system (plutonium dioxide) instead of the other alternative to use solar power. The mission was conceived to cover a vast range of latitudes of the Mars and collect many	E32-2) At the time of publication of the Draft EIS for the MSL mission NASA had not declared a preferred

Submission Number	Comment Submission	Responses to Comments
	new information since the MMRTG is not dependant on the solar energy for its source of power. Though during the presentation, the environmental concerns were not discussed in detail, the draft EIS includes all of them in minute details. In case of a successful launch, the EIS confirms regarding environmental impacts related to air quality, noise, water quality, biological resources, release of carbon dioxide etc. Though the EIS stated that the damages will	alternative; NASA's preferred alternative is declared in this Final EIS.
E32-3	not be substantial and short – term, it does not contain any quantification whatsoever of the damages that will occur. If the launch is unsuccessful, they the potential environmental hazards are much more. If the failures are not on-pad or near pad, chances are more that the debris fall in the Atlantic Ocean and may have adverse impact on the marine life. The terrestrial environment will also be affected due to the	E32-3) Potential environmental consequences from a normal launch have been quantified in Sections 4.1.2 and 4.4 of this EIS where feasible. In part, these sections summarize the underlying reference documentation cited in Section 4.1, which contain greater detail.
E32-4	debris falling and leaching of ammonium perchlorate into soil and mixing with ground water. From the draft EIS, it is clear that such effects on the environment cannot be avoided if a launch failure occurs. The prime environmental concern for this mission is in the case of an unsuccessful launch and release of the radiological materials. The chance for such a situation is only 0.4%. But in case the radiological substances are	E32-4) The text in Section 4.1.3.2 concerning possible perchlorate contamination from unburned solid propellant released in the event of a launch accident has been revised. The revision states, in part, that no substantial impacts to water quality and biota would be expected as the solid propellant slowly dissolves.
E32-5	released, it will be an environmental disaster with fatal effects on human beings as well as plants and animals, whoever will be within the affected region. A mission of such stature always has its portion of risk factor associated with it. The actions to reduce the chances and effects of the environmental impacts due to propellant spills, debris due to unsuccessful launch and radiological releases to atmosphere are identified. The planning for the	E32-5) Please see response to comment E2-5.
E32-6	mission includes every possible action to be undertaken to mitigate any chance of environmental disaster. These precautionary measures have to be taken care of during the actual execution of the mission. I would like to	E32-6) For any launch of radioactive materials, a comprehensive set of radiological response plans is developed by NASA prior to launch to

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	take this opportunity to wish the NASA MSL mission a grand success. Sandip Chatterjee Graduate Student (Environmental Engineering) Department of Civil and Environmental Engineering The George Washington University Washington DC	ensure that any launch accident could be met with a well-developed and thoroughly tested response. NASA's plans would be developed in accordance with the *National Response Plan* and applicable state and county emergency plans, in coordination with the Department of Homeland Security, the Federal Emergency Management Agency, the U.S. Air Force, the Department of Energy, the Department of Defense, the Department of State, the U.S. Environmental Protection Agency, the State of Florida, Brevard County and local launch site response organizations.
E33	**From:** earthhelp [redacted] [mailto:[redacted]] **Sent:** Monday, October 23, 2006 5:09 PM **To:** mep.nepa@hq.nasa.gov **Subject:** Mars and other planetary mining	Thank you for your comments.
E33-1	The use of nuclear weapons(rockets) or other nuclear materials in space exploration and development would not help us here on earth.	E33-1) NASA's planned Mars Science Laboratory mission is for peaceful scientific purposes.
E33-2	We need more r and d on climate change and global warming.	E33-2) The U.S. Congress and the Administration develop national budget priorities among the various Federal agencies based on many considerations related to national interests and security. The final budget reflects compromises and tradeoffs when all factors and programs are considered from the broadest perspective.
E33-3	In addtion, releasing radiation into space where it can find its way back into the atmosphere of the earth is extremely hazardous and contraindicated because it can cause cancer and birth defects. Sylvia Zisman [redacted] Long branch,N.J. 07740	

Submission Number	Comment Submission	Responses to Comments
		E33-3) Under normal operating conditions, a radioisotope power system, such as the Multi-Mission Radioisotope Thermoelectric Generator for the proposed MSL mission, does not release radiation that would find its way back into the atmosphere of the earth or pose a health or environmental hazard. Radioisotope power systems for spacecraft are designed to contain their fuel or limit its dispersal in the event of a launch or reentry accident.
E34	**From:** hknox [redacted] [mailto:[redacted]] **Sent:** Monday, October 23, 2006 8:40 PM **To:** mep.nepa@hq.nasa.gov **Subject:** Danger of Plutonium Dear NASA officials: Please find an alternative to plutonium as a power source for space exploration such as the Mars missions planned for the next ten years. The real danger of another accident or launch explosion, however unlikely, is too horrific in its consequences to risk. Sincerely, Helene Knox, Ph.D. (in Who's Who in America)	Thank you for your comments. E34-1) Please see responses to comments E4-4 and E5-2. E34-2) Please see response to comment E4-3.

APPENDIX E
PUBLIC REVIEW AND COMMENT MEETINGS

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APPENDIX E

PUBLIC REVIEW AND COMMENT MEETINGS

NASA published a Notice of Availability (NOA) of the Draft Environmental Impact Statement (DEIS) for the Mars Science Laboratory (MSL) Mission in the *Federal Register* on September 5, 2006 (71 FR 52347). The U.S. Environmental Protection Agency published its NOA for the DEIS in the *Federal Register* on September 8, 2006 (71 FR 53093). The public review and comment period closed on October 23, 2006. During this period NASA held three public comment meetings on September 27 and October 10, 2006. NASA's NOA announced the purpose, dates, times, and locations of the public comment meetings. Two meetings were held at the Florida Solar Energy Center in Cocoa, Florida, beginning at 1 p.m. Eastern time and again at 6 p.m. Eastern time on September 27. The third meeting was held at the Hyatt Regency Hotel in Washington, DC, beginning at 1 p.m. Eastern time on October 10.

For the public meetings in Cocoa, FL, NASA placed paid advertisements announcing the date, times, and purpose of the meetings in the *Daytona Beach News-Journal, Florida Today, Orlando Sentinel* and *Vero Beach Press Journal* on September 18, together with the full text of NASA's NOA in the legal notices section of each newspaper. The advertisements appeared a second time on September 24 in each newspaper. NASA's Kennedy Space Center also issued a news release on September 22 to Florida media announcing the meetings in Cocoa, FL.

For the public meeting in Washington, DC, NASA placed a paid advertisement announcing the date, time, and purpose of the meeting in *The Washington Post* on October 1. The advertisement appeared a second time, together with the full text of NASA's NOA in the legal notices section, on October 2 in that newspaper. NASA Headquarters also issued a news release on October 5 announcing the meeting in Washington, DC.

This appendix provides a summary of the meetings, including an excerpt of the official transcript of the 6 p.m. meeting held on September 27, during which two members of the public presented oral comments. No questions were raised and no oral comments were offered during the 1 p.m. meeting on September 27 and during the October 10 meeting.

Members of the public attending either meeting were asked to register their attendance at the meeting. However, registration was not a requirement for anyone wishing to present either oral or written comments. Eleven members of the public registered for the 1 p.m. meeting and seven registered for the 6 p.m. meeting on September 27. Eleven members of the public registered for the meeting on October 10.

Each meeting began with the opportunity for members of the public to hold informal discussions with representatives from NASA and the U.S. Department of Energy (DOE) in an open house format. These sessions included displays and printed material regarding the planned MSL mission and the process under which NASA is complying with the National Environmental Policy Act (NEPA).

Each open house session was immediately followed by a town hall session, during which NASA representatives gave brief presentations followed by a period during which members of the public were invited to provide oral comments. Written comments submitted to NASA during the meetings, together with NASA's responses, can be found in Appendix D of this EIS.

Each town hall session was moderated by an independent facilitator who made opening remarks summarizing the intent and format of the meeting and then introduced each of the NASA representatives making presentations. All oral presentations and discussions were recorded by a certified court reporter during each town hall session. The NASA representatives and the topics of their presentations were as follows.

Presentation Topic	NASA Representative
Overview of the NEPA Process for the Planned MSL Mission	Mr. Kenneth Kumor, NASA NEPA Coordinator, NASA Headquarters (Cocoa, FL meetings) Ms. Tina Norwood, Environmental Specialist, NASA Headquarters (Washington, DC meeting)
Overview of the Planned MSL Mission	Mr. Mark Dahl, MSL Program Executive, NASA Headquarters
Overview of the Science on the Planned MSL Mission	Dr. Ashwin Vasavada, MSL Deputy Project Scientist, Jet Propulsion Laboratory
Overview of the Planned MSL Mission Design and Spacecraft	Mr. Richard Cook, MSL Project Manager, Jet Propulsion Laboratory (Cocoa, FL meetings) Mr. John Klein, MSL Deputy Project Manager, Jet Propulsion Laboratory (Washington, DC meeting)
Overview of the MSL DEIS	Mr. Mark Dahl, MSL Program Executive, NASA Headquarters

Table E-1 of this appendix presents excerpts of the official transcripts taken by the court reporter during the town hall sessions of the meetings held on September 27, 2006. Page and line numbers embedded in the transcript are shown on the left. These portions of the transcripts include all oral comments offered by members of the public in attendance as well as NASA's responses. In addition to the NASA representatives listed above, the other individuals identified by name in the transcript are Ms. Kristin Bakke, the session moderator, and Dr. John Martin, Dr. Ross McCluney (spelled "McClooney" in the transcript), and Mr. Charles Ryan, members of the audience.

TABLE E-1. ORAL COMMENTS PRESENTED TO NASA ON SEPTEMBER 27, 2006

Comment Number	Transcript Except with Oral Comments	Responses to Comments
O-1	**Excerpt of the 1 p.m. Town Hall Session** MS. BAKKE: That concludes the formal presentations for this meeting. At this time, anyone who may be interested in presenting a comment is most welcome to do so. I don't have anyone that has signed up. So, I wonder if we might open the floor. Are there any particular comments that anyone would like to make, or questions for any of our technical team members? Yes, sir. If you'd kindly go to the mike so that we can hear you, that would be appreciated. AUDIENCE SPEAKER: My name is John Martin. I'm a private consultant. I work mostly for aerospace, not NASA though at all. I'm just curious, how many watts does this little generator put out, the radioisotope? DR. VASAVADA: 120. AUDIENCE SPEAKER: 120. That's what you told me earlier. How does 120 watts power that thing at all? MR. COOK: Basically the rover sleeps part of the time. So, during the day, the rover is essentially awake, operating, doing things. Then at night, it's asleep, and during that time, batteries are used for -- to -- batteries are charged up from the RTG, and then during the day we utilize that stored-up energy to do more than what you normally can do with just 120 watts. AUDIENCE SPEAKER: I'll just make a general comment on environment. I'm all for the launch. And things that fracture, things that break are my specialty. And it just kind of seems, from what I've seen from this demo out there, this thing seems to be super safe as far as releasing any kind of radiation. I don't see any hardy possibility. It would seem, like the paper said, one out of 426, that seems very conservative to me. I'll just leave it go at that. I have never	O-1) Thank you for your comments.

Comment Number	Transcript Except with Oral Comments	Responses to Comments
	seen any of the real details. And so, that's my comment. MS. BAKKE: Thank you. And I believe you will have plenty of opportunity to ask additional questions or have conversations with members of our technical team. Other questions? For the third time, going once, going twice. This truly is a wonderful opportunity, I believe, that NASA provides to the public for you to make your views known. All right. We'll turn it back to the technical team for a moment, and see if there are any final comments that any of you would like to make. MR. KUMOR: I'd just like to say one final thing. After the formal presentations are over, if there are any questions that occur to you, or you just wanted to ask an individual, the members of the team will be around for a while after the formal presentations. MS. BAKKE: All right. If there are no other comments, we will conclude this portion of this public meeting. We do invite you to complete the Public 00042 Meeting Evaluation form that you would have received in your package. They're also available outside the exit door. NASA is interested in continuous improvement, obviously, and wants to continue to improve its communication with the public. You can help us to do so by completing that form. We appreciate your attendance at this meeting, and participating in today's information provided about the Mars Science Laboratory Environmental Impact Statement process. I would like to invite everyone to enjoy -- I know there is some light refreshments -- and another opportunity to interact with the technical team members outside. Thank you very much for your attendance. Thank you, gentlemen.	

Comment Number	Transcript Except with Oral Comments	Responses to Comments
O-2	**Excerpt of the 6 p.m. Town Hall Session** MS. BAKKE: Thank you, gentlemen. That concludes the formal presentations for this meeting. We now invite you to present comments on the MSL mission Draft EIS. I will first call upon the two members who have registered to present comments after which any other member who wishes to speak may do so. If Mr. Ross McClooney is in the audience and could proceed to the center microphone. AUDIENCE SPEAKER: Thank you. Yes, my name is Ross McClooney. I live in Cape Canaveral, which I believe is the closest opportunity to the launch, the most likely launch platform. So, I have a personal concern as well as a larger safety concern. When I was in high school, I remember the launches beautifully very well and the following excitement of the country to try to catch up with the Russians with science and technology. I chose to pursue a path towards science myself and worked for three degrees in physics, the last one at the University of Miami which was my Ph.D. And I was a fan of NASA and space travel the whole time; still am. I think it's exciting. I think every aspect of our missions to space are thrilling. And I guess one of the most exciting things I could envision, when I was pursuing my doctorate, was the possibility of working for NASA. My research project at the end was optical oceanography. I'm an optical physicist. I said how would an optical oceanographer ever work for NASA. But the interesting thing is that was the first job I got after graduation. I worked at NASA's Goddard space flight center for three years, since '73, when I moved down here to Florida, and I have been here ever since. So, I'm a real proponent of NASA in general, and	O-2) Thank you for your comments.

Comment Number	Transcript Except with Oral Comments	Responses to Comments
O-3	unmanned robotic, science missions in particular. I love the Mars missions, I really do. My main concern is both a personal safety issue should an RTG have the worse case accident on launch and somehow result in the pulverization of the plutonium material into the particles that disburse in the atmosphere, which I think is relatively unlikely, but I have that concern.	O-3) Radioisotope power systems for spacecraft are designed to contain their fuel or limit its dispersal in the event of a launch or reentry accident. As with the RTGs used on previous NASA deep space missions, MMRTG safety features include use of a special type of fuel material, a modular design and construction, and the use of multiple physical barriers. The plutonium dioxide fuel contained in an RTG is a specially formulated, fire resistant ceramic that is manufactured as pellets to reduce the possibility of fuel dispersion in a launch or reentry accident. This ceramic form resists dissolution in water and reacts little with other chemicals. If fractured, the ceramic tends to break into relatively large particles and chunks that pose fewer hazards than small microscopic particles.
O-4	My second concern is for my beloved NASA should something like that happen. It's a policy issue. I fear that if NASA gets too far involved 00041 in nuclear programs, especially if it gets involved with the military parts of the nuclear, involves launching much larger quantities of nuclear material and has an accident, even if it's safe, but especially if it causes injury to any human or massive injury to plants or animals, that it would possibly doom the agency. So, I think we have to concern ourselves very carefully about use of RTGs. And I'm excited about this particular mission and the larger size and ability to cover a larger territory and operate for longer times. And I can understand, therefore, the desire for RTGs which are compared to nuclear reactors rather safer in quality of material, and the way it is protected.	O-4) NASA is a civilian agency dedicated to the peaceful exploration of space. NASA places the highest priority on assuring the safe use of radioactive materials in space that have facilitated some of the most exciting voyages and discoveries in the history of science. NASA and the Department of Energy take very seriously the possibility that an action they take could potentially result in harm to humans or the environment. Therefore, both agencies maintain rigorous processes to reduce the potential for such events, both through design and operation of spacecraft, power systems and missions from launch through completion. Thorough and detailed safety analyses are conducted prior to launching NASA spacecraft with radioisotope power systems, and prudent steps are taken to reduce the risks involved in NASA missions using such systems.
O-5	So, I kind of knew a lot of this before coming to this meeting, but after looking at the model in the lobby, I thought there would be a lot more protection around the plutonium core. The iridium seems awfully thin. I know it's strong, and I know there is work that you've done to try to prove that if it is penetrated it would hopefully break into small pieces. But I worry about fiery crashes, and I'm not exactly sure how 00042 that might happen. It would have to be, I believe, at the early launch phase because once it's up pretty high, it would -- well, it might be disbursed more widely and the concentrations back here in Cape Canaveral may not be so great,	

Comment Number	Transcript Except with Oral Comments	Responses to Comments
O-6	especially if it gets to space, we don't have a concern. I just a, really concerned that I didn't see enough of what I would consider enough protecting material, heavy metal surrounding or whatever else is needed around those plutonium cores. And especially am concerned that -- this is related to this mission -- if NASA goes into the nuclear reactors, which I heard they are planning to do, the danger there is much greater. But dealing just with this mission, those are my concerns. MS. BAKKE: Thank you, sir. The second audience member who indicated they have a comment is Mr. Charles Ryan, Jr. AUDIENCE SPEAKER: Yes. My name is Charles Ryan. I'm a north Merritt Island resident. I live two miles from NASA property. I am in favor of the MSL mission. And one thing I've learned is the further I go in school in science and engineering, the more I realize that just how 00043 fantastic some of these things are, and the more I learn the more I forget -- the more I learn the -- the more I realize the less I know, in other words. It's just obvious you can't second guess or armchair quarterback these kind of decisions. It's just not possible. You have to rely on the experts for such things. And I am 100 percent competent in JPL's ability to make good decisions like that. Also, in the world today we have so many negative influences. I mean, you can turn on any network station today and it's just non-stop negativity. And I think certainly as a country, if we have the resources and the will and the imperative to do one positive thing that is peaceful, a peaceful endeavor to give us hope and inspiration to its people and NASA has always done that. And we are certainly behind you where we should have been, not because of the call of NASA but because of lawyers and individuals and a beltway somewhere.	O-5) Multiple layers of protective material including iridium capsules and high-strength graphite blocks protect and contain the fuel and reduce the chance of release of the plutonium dioxide. Iridium, a strong, ductile, corrosion-resistant metal with a very high melting temperature encases each fuel pellet. Impact shells made of lightweight and highly heat-resistant graphite provide additional protection. O-6) Thank you for your comments.

Comment Number	Transcript Except with Oral Comments	Responses to Comments
	But I know also that there have been those who have protested the RTGs in the past. And they are wonderful individuals. They are just 00044 concerned with the safety of mankind, in other words. And I like them. And the only thing I have to say to them is you're fighting the good guys. And NASA is the premiere environmental organization, period, as far as I'm concerned, as far as mission to planet Earth by the very nature of exploring other planets, finding out more about our own and the imperative of protecting ours. And I pled with those people to redirect their passions which I am for to where it would do the most good. And I have US Space Command Colorado Springs Director of Air and Space Operations number here. It's (719)[redacted]. One of the things that's very different between the NASA and the military is the military can protect itself. NASA is part of the executive branch of the federal government and they're kind of forbidden to do such things. So, it's, you know, with so many ICBMs and warheads and bombs and so forth all over the place, there is a lot of work to be done, and that kind of passion is awesome. I think we need those people, but something that's going to be around for five minutes isn't worthy of their time 00045 especially since it's peaceful. Thank you. MS. BAKKE: Thank you. Are there other audience members that wish to make a comment? This is the time for public comment if you wish. Okay. Members of the technical team, any closing? MR. KUMOR: Just one thing, Kristin. Members of the JPL NASA staff will be available after the meeting if you have any further questions you'd like to know about the mission. So, we will be around for a period of time, and certainly if you have the opportunity, avail yourselves of their expertise.	

Comment Number	Transcript Except with Oral Comments	Responses to Comments
	MS. BAKKE: Final opportunity for any public comments. If there are no other comments, this does conclude the public meeting.	

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