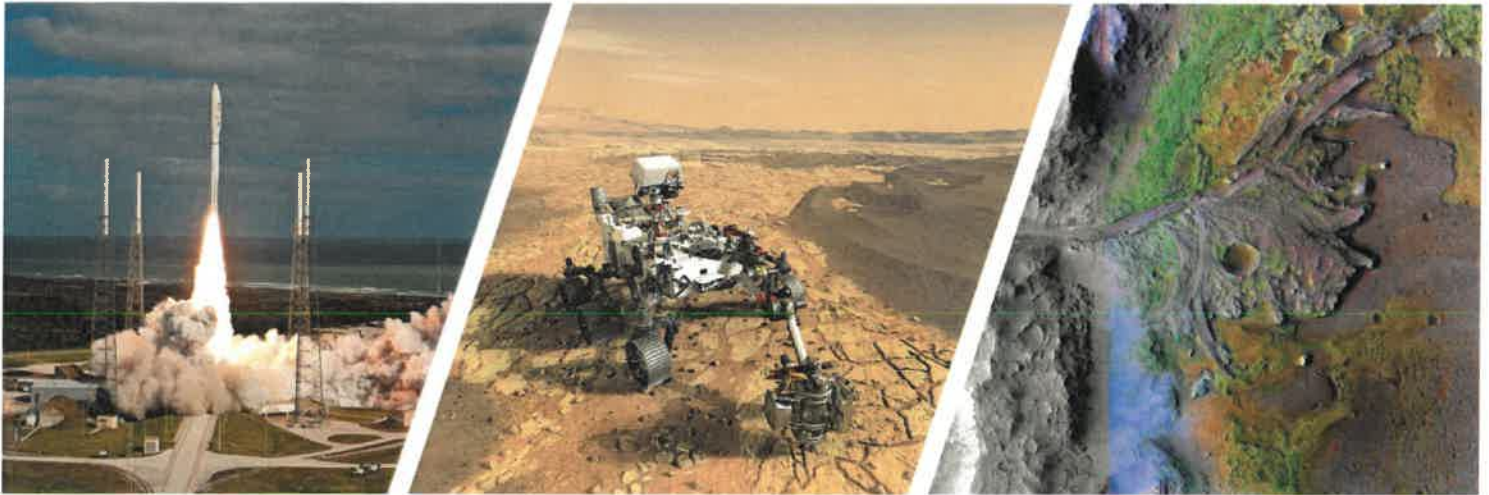


National Aeronautics and Space Administration



**Supplemental Record of Decision
Final Supplemental Environmental Impact Statement
Mars 2020 Mission**

March 2020

Science Mission Directorate
National Aeronautics and Space Administration
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SUPPLEMENTAL RECORD OF DECISION
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MARS 2020 MISSION
SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

A. Background

The National Aeronautics and Space Administration (NASA) in accordance with the National Environmental Policy Act (NEPA) of 1969, as amended, prepared a Supplemental Environmental Impact Statement (SEIS) to assist in the decision-making process for the Mars 2020 mission. The SEIS provides information related to updates to the potential environmental impacts associated with the Mars 2020 mission as outlined in the *Final Environmental Impact Statement for the Mars 2020 Mission* (the “2014 FEIS”) and associated NASA Record of Decision (ROD) issued in January 2015 (the “2015 ROD”). The 2015 ROD identified Alternative 1 [2014 FEIS Section 2.1] as the chosen alternative based on analysis presented in the 2014 FEIS. Alternative 1 involved deployment of a rover using a radioisotope power system—a Multi-Mission Radioisotope Thermoelectric Generator (MMRTG)—to conduct scientific work on the Mars surface. NASA chose Alternative 1 because it would enable the best return of scientific and technical information and make the most effective use of fiscal, human, and material resources.

Since publication of the 2014 FEIS and issuance of the 2015 ROD, NASA and the Department of Energy (DOE) have completed a more detailed risk analysis that incorporates new and updated information, which affected the risk estimate results as compared to what was presented in the 2014 FEIS. This ROD includes a summary of the SEIS, public involvement in the decision-making process, synopses of alternatives considered, a summary of key environmental issues evaluated, statement of the decision made (selection of an alternative), and the basis for the decision.

Purpose and Need for the Mars 2020 Mission and Supplemental EIS

The purpose and need for the Mars 2020 mission is the same as presented in the 2014 FEIS [2014 FEIS Sections 1.2 & 1.3] and 2015 ROD. The environmental analysis presented in the 2014 FEIS was based on the best available information on mission-specific parameters and candidate expendable launch vehicles. The purpose and need for the 2020 Final SEIS is based on the new and updated information associated with postulated launch vehicle accident scenarios. Based on this new information, NASA determined that the purposes of NEPA would be furthered by conducting additional environmental analysis and documentation.

The environmental analysis presented in the 2014 FEIS was based on DOE’s *Nuclear Risk Assessment for the Mars 2020 Mission Environmental Impact Statement* (“the 2014 NRA”). The 2014 NRA was based on mission-specific parameters and expendable launch vehicle (ELV)

estimates that NASA provided to DOE in 2013 and the best available information on how radiological material could be released and transported in an accident.

The potential for launch vehicle-related accidents remains unlikely, and the potential environmental impacts associated with normal launches or launch-related accidents that do not result in release of nuclear materials, as described in the 2014 FEIS, have not changed. The DOE's *Nuclear Risk Assessment 2019 Update for the Mars 2020 Mission Environmental Impact Statement* (the "2019 NRA Update") reflects the new and updated information and presents the risk estimate results as compared to the 2014 NRA used for the 2014 FEIS. The new information that drove the different results includes: a) new knowledge gained about how the MMRTG is affected by accident scenarios; b) updated analytical models and computer simulation input parameters, informed by best available knowledge as well as lessons learned from other missions; and c) updates to account for specific design features of the selected launch vehicle.

B. The Supplemental Environmental Impact Statement

B.1 Introduction

The 2020 Final SEIS identifies substantive changes in the affected environment since the 2014 FEIS, including important regulatory and/or physical changes to resources within the affected environment, and analyzes potential radiological impacts to the affected environment associated with launch vehicle-related accidents based on the updated information presented in the 2019 NRA.

B.2 Alternatives Considered

As documented in the 2015 ROD, NASA made the decision to proceed with Alternative 1, including use of the MMRTG power system on the Mars 2020 rover. Since the 2015 ROD, NASA has actively advanced the mission. Investments have been made that constitute irrevocable commitment of funds, resources, and decisions, including the Mars 2020 rover and payload design, power system fueling, Mars landing site selection, selection of the launch vehicle, and selection of the launch period. Therefore, the 2020 Final SEIS addresses the Proposed Action (which is Alternative 1 as defined in the 2014 FEIS and 2015 ROD) as well as a No Action Alternative as required by NEPA. The Mars 2020 spacecraft under the Proposed Action (Alternative 1) will have one MMRTG that uses plutonium dioxide to provide electrical power so that the rover can operate and conduct science and heat to maintain internal rover temperature. The total plutonium dioxide inventory will be 4.8 kilograms (10.6 pounds), with approximately 59,000 curies at the time of launch. The 2020 Final SEIS does not address Alternatives 2 or 3 as presented in the 2014 FEIS.

B.3 Key Environmental Issues Evaluated

The 2020 Final SEIS addresses the potential environmental impacts associated with the updated mission risk presented in the 2019 NRA Update. Because other mission parameters have not changed since the 2015 ROD and were previously analyzed in the 2014 FEIS (e.g., use of Cape Canaveral Air Force Station (CCAFS) as a launch site), the 2020 Final SEIS does not address

potential impacts associated with normal launch activities or launch vehicle-related accidents that do not result in the release of nuclear material. As a result, the analysis of potential impacts conducted in the 2014 FEIS associated with these retained activities is incorporated by reference throughout the 2020 Final SEIS. The 2020 Final SEIS therefore focuses analysis on potential environmental impacts to the natural and anthropogenic environment from postulated launch vehicle accidents causing a release of radioactive materials.

B.4 Environmental Consequences

B.4.1 Normal Launch

The potential impacts associated with a normal launch would be the same as those described in Sections 2.6.2.1 and 4.1.2 of the 2014 FEIS and Section B.5.1 of the 2015 ROD. Updates to the Proposed Action as described in the 2020 Final SEIS would not result in any new or additional impacts from those identified in the 2014 FEIS or 2015 ROD.

B.4.2 Potential Accidents

The potential non-radiological impacts associated with launch accidents would be the same as those described in Sections 2.6.2.2 and 4.1.3 of the 2014 FEIS and Section B.5.2 of the 2015 ROD. In terms of environmental impacts, should a launch accident occur, potential environmental impacts would be primarily associated with combustion products from released propellants and from falling debris. These impacts were addressed in the 2014 FEIS and were not addressed in detail in the 2020 Final SEIS because they do not substantively differ from the analysis and associated consequences identified in the 2014 FEIS.

The 2019 NRA Update used for the 2020 Final SEIS estimated an overall probability of a launch accident at 1.25 percent, representing a decrease of 1.25 percent probability from 2.50 percent as presented in the 2014 FEIS. The 2019 NRA Update also estimated the probability of a launch accident with a release of plutonium dioxide at 0.10 percent, an increase of 0.06 percent probability from 0.04 as presented in the 2014 FEIS. Although the probability of such accidents occurring is unlikely, it is possible that a launch accident could result in a release of some of the plutonium dioxide from the MMRTG, which could potentially result in consequences to human health and the environment.

Human health consequences are expressed in terms of maximum individual dose, collective dose to the potentially exposed population, and the associated health effects. The maximum individual dose is the maximum dose, typically expressed in units of rem (roentgen equivalent in man), delivered to a single individual assumed to be outside without shelter during the time of radiological exposure for each accident. Collective dose (also called a population dose) is the sum of the radiation dose received by all individuals exposed to radiation from a given release, assuming no mitigations, such as sheltering in place. Health effects represent statistically estimated additional latent cancer fatalities resulting from an exposure to a release of radioactive material calculated over a 50-year period following the exposure and are determined based on Interagency Steering Committee on Radiation Standards (ISCORS) health effects estimators.

The 2014 FEIS reported the very unlikely chance (1 in 11,000) of a launch vehicle accident that would result in a release of plutonium dioxide within the launch area; the 2019 analysis reports a larger unlikely chance (1 in 1,100). The 2014 FEIS reported that an accident in the launch area that releases radioactive material would cause an average maximum dose of radiation equal to about two months of exposure to natural background radiation for a person in the United States. The 2019 NRA Update reports an average maximum dose equal to about eight months of exposure to natural background radiation under the same scenario.

The 2014 FEIS reported that no radiologically related fatalities would be expected as a result of any launch accident. The 2019 NRA Update analysis found that no radiological fatalities are expected to occur at the estimated accident probabilities and maximum individual dose amounts noted above. Some accident scenarios, while very or extremely unlikely (see 2020 Final SEIS Section 3.5.2.2.5, Radiological Consequences), could result in long-term latent cancer fatalities. For example, a full stack intact impact (FSII) accident in Phase 1 (early launch), with a less than 1 in 1 million probability of occurrence, could result in approximately seven latent cancer fatalities (over 50 years), assuming no mitigating measures are taken. For comparison, according to the National Institutes of Health's National Cancer Institute data from 2019, of the population in the nine counties surrounding CCAFS (estimated at 4,633,191 in 2020), about 1 in 5 people (or about 900,000) are estimated to die of cancer from other causes over 50 years.

The 2014 FEIS reported that the average land area that would require further evaluation for potential contamination from a launch vehicle accident resulting in a release affecting U.S. land areas would be between 0.035 square kilometer (km²) (0.014 square mile [mi²]) during Phase 0 (pre-launch) and 7.4 km² (2.9 mi²) from a launch vehicle accident with release in Phase 1 (early launch). This is the land area that would need to be evaluated to determine potential impact levels and the need for detailed characterization for potential cleanup actions. The 2019 NRA Update analysis found that the average land area potentially requiring further evaluation from a launch vehicle accident resulting in a release affecting U.S. land areas would be between 7.4 km² (2.9 mi²) during Phase 0 and 79 km² (31 mi²) from a launch vehicle accident with release in Phase 1 (early launch). A Phase 0 launch vehicle accident resulting in a release is a very unlikely event, and a Phase 1 launch vehicle accident resulting in release is an unlikely event with probabilities of occurrence per launch of less than 1 in 16,000 and 1 in 1,100, respectively.

For the purposes of determining land area that could potentially require investigative or remedial actions in the event of release of radiological material, NASA's contingency response plans will establish specific screening values appropriate for the Mars 2020 launch from CCAFS to ensure the timely identification and implementation of appropriate protective actions.

For the No Action Alternative, no environmental impacts would occur since there would be no launch. The No Action Alternative is discussed in detail in the 2014 FEIS. Implementation of the No Action Alternative would not meet the purpose and need for the Mars 2020 mission because none of the planned science would be achieved.

C. Summary of the Analysis

The analysis in the 2014 FEIS showed that the most likely outcome of the selected alternative is a successful launch of the spacecraft toward Mars; this remains true in the 2020 Final SEIS. If the launch is unsuccessful (about a 1.25 percent probability), the most probable outcome is an accident without a release of radioactive material. In the unlikely event an accident does result in release of radioactive material, the extent of potential area affected and associated consequences have increased since the 2014 FEIS and 2015 ROD, as described in 2020 Final SEIS Section 2.4.3 (Environmental Impacts of Potential Launch Accident with Radiological Release); however, the overall probability of a release of radiological material remains small.

D. Additional Information

D.1 Launch Authorization for Spacecraft Containing Space Nuclear Systems

In addition to the requirements under the National Environmental Policy Act (NEPA) and NASA policy and procedures, there is a separate and distinct Executive Branch interagency process for evaluating the nuclear launch safety of the proposed Mars 2020 mission. The nuclear launch authorization process provides a rigorous, risk-informed safety analysis to ensure that public safety is adequately maintained. The DOE's 2019 NRA Update documents the results and methodology of the safety analysis conducted under this process. The recently published National Security Presidential Memorandum #20 (NSPM-20) on the Launch of Spacecraft Containing Space Nuclear Systems includes safety guidelines focused on the maximum individual dose that are consistent with other regulatory structures employed throughout the U.S. government. The overall results presented in the 2019 NRA Update are within the established NSPM-20 safety guidelines for launch of spacecraft containing nuclear systems.

As noted in the 2015 ROD, an ad hoc Interagency Nuclear Safety Review Panel (INSRP) was chartered to review the Mars 2020 nuclear risk analysis and prepare a Safety Evaluation Report (SER) for the mission. NASA will receive briefings on the results of the analyses presented in the SER prior to a decision on launch authorization in accordance with NSPM-20.

D.2 Comments Received on the Final SEIS

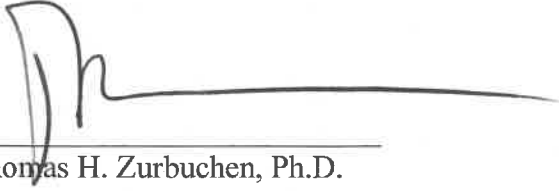
No comments were received since the publication of the Final SEIS.

E. Mitigation

Mitigations are the same as those described in Section F of the 2015 ROD.

Decision

Based upon all the foregoing, it is NASA's decision to continue preparations for and implement Alternative 1 for the Mars 2020 mission as previously selected in the 2015 ROD, and as amended in the 2020 Final SEIS, during July – August 2020 or during the next available opportunity in August – September 2022, and to operate the mission using an MMRTG as the primary power and heat source for the rover.



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Science Mission Directorate

3/5/20

Date