Record of Decision

National Aeronautics and Space Administration

The Galileo Program

Decision

The Galileo Mission has been redesigned to use the inertial upper stage (IUS) in place of the Shuttle-Centaur upper stage. The redesigned mission has undergone an intensive safety and environmental analysis and promises to open a new era in solar system exploration. It is my decision to select the proposed action to complete preparation and operate the mission, including its launch on the Space Shuttle in October 1989.

Introduction

This environmental impact statement (EIS), Tier 2, was developed to address the completion of development and operation of the Galileo mission, including its launch. Scoping began in September 1988 and continued through October 1988. Two scoping comments were received, both of which dealt with nonradiological matters. The Draft EIS (DEIS) was made available to the public in January 1989. A total of seven (7) timely comment letters were received. These comments dealt with a range of issues including nonradiological impacts and monitoring, contingency planning, and radiological health effect modelling.

Alternatives Considered

The alternatives addressed in the EIS (Tier 2) were:

1. Completion of preparation and operation of the mission, including its launch on the Space Shuttle in October 1989. This would enable the earliest return of valuable scientific information at the lowest cost in scarce human and fiscal resources.

2. Adoption of the no-action alternative, resulting in the termination of further commitment of resources to the mission.

Delay alternatives to launch in 1991 and to consider use of the alternative Titan IV launch vehicle had been addressed in the DEIS, but have been removed from consideration on the following grounds. The United States Air Force (USAF) notified NASA, in November 1988, that the USAF could not provide NASA with a Titan IV launch vehicle for the May 1991 launch opportunity due to high priority USAF requirements. Thereupon, NASA stopped all activity in support of the May 1991 Titan IV launch opportunity. Since a minimum of three years is required to prepare for a Titan IV launch, the Titan IV vehicle is no longer a feasible alternative for the May 1991 launch opportunity. Thus, the only alternatives

now available are Shuttle launches in October 1989 and May 1991. The environmental considerations of Shuttle launches in October 1989 and May 1991 are largely the same. So no new information would be gained from separate treatment of the October 1989 and May 1991 launch dates. Therefore, the delay alternatives have been removed from further consideration.

Safety and Environmental Analyses

In considering the consequences of the alternatives, it was recognized that the only direct or immediate environmental impacts of the Galileo mission were associated with the launch. The environmental consequences of normal Shuttle launches have been addressed in other NEPA documentation [e.g. the Space Shuttle, Kennedy Space Center, and Galileo (Tier 1) EISs], and deemed acceptable.

Consideration of launch accidents was the main task of the Galileo EIS (Tier 2). NASA and the Department of Energy (DoE) completed a detailed safety and environmental analysis of the Galileo mission. DoE, which provides the nuclear power system and nuclear materials to NASA, has prepared and published a Final Safety Analysis Report (FSAR) for the Galileo mission and has been a cooperating agency in the preparation of this EIS. The FSAR was the primary data source for this EIS.

The safety and environmental analyses proceeded as follows:

1. NASA defined the launch vehicle, accident scenarios, accident scenario of probabilities, and the environments (e.g. flames, blast overpressure, high speed fragments, and so forth) to which the nuclear power system might be exposed in the event of an accident.

2. DoE, using the extensive test and analysis data base developed over some three decades and a Monte Carlo simulation* of various accident environments, then estimated the response of the RTG to the environment. That is, would the accident lead to a release of nuclear material--called a "source term."

3. DoE, then estimated the dispersion, deposition, and health and environmental consequences for the cases where a release occurred.

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*The Monte Carlo simulation is a computer technique to sample among the range of possible accident environments for a given accident scenario. In that sense, the Monte Carlo technique provides a reliable way to estimate conditional probabilties of a nuclear release given that an initiating accident has occured.

As the analysis yielded a range of possible results with differing probabilities (i.e., the analysis is a probabilistic risk assessment), the results have been presented in terms of the most probable, the maximum credible and the expectation case for each of the six mission phases.

Mission Phase Nomenclature

Mission Phase 0 - Prelaunch (T-8 hours to T-6 seconds)
Mission Phase 1 - Ascent [up to solid rocket booster (SRB) separation]
Mission Phase 2 - Ascent [SRB separation to Main Engine Cut-Off (MECO)]
Mission Phase 3 - Shuttle orbit insertion
Mission Phase 4 - Inertial Upper Stage Development
Mission Phase 5 - VEEGA Earth Flybys (1 and 2)

One-in-ten million (1E -7) was adopted as the probability threshold below which accidents were judged not credible. The expectation case, a probability weighted mean of all outcomes in a mission phase irrespective of credibility, was used to estimate mission risk.

Rationale for the Decision

Through some three decades of research, development, test, and evaluation, DoE has reduced the safety risks of the RTG space power system to a minimal level. The results of the detailed safety analysis clearly show that the residual risks associated with the launch and operation of the Galileo mission are two to three orders of magnitude less than many of the risks routinely faced and accepted in everyday life. Indeed, there are no direct or immediate adverse health or environmental consequences expected to result from the operation of the Galileo mission. The only adverse impacts occur in the rare event of an accident during launch or reentry during the mission. Even in the rare event of the maximum credible launch area accident, statistical models of health effects would indicate less than one excess cancer fatality. In the unlikely case of an accidental VEEGA reentry, there is a one-in-ten million (1E -7) possibility of 9.4 cancer fatalities worldwide over a 70-year period. This should be compared with some 630 million cancer fatalities which would normally occur over the same period of time. These models, which are the accepted practice, indicate very small risk.

In view of the small risks associated with the mission, the proposed action, alternative one, was the obvious choice based on programmatic grounds as follows:

Alternative one, completion of preparation and operation of the mission, including its launch on the Space Shuttle in October 1989, would enable the earliest return of scientific

information, protect the investment of resources to date, and avoid disruption of the Nation's solar system exploration program.

Environmentally Preferred Alternative

The no-action alternative, while presenting the minimum environmental risk, would, however, abandon a sizeable (over $800M) financial and human investment in the program, and would deprive society of the invaluable scientific knowledge which will result from this mission.

This decision to complete preparations and operate the mission is fully consistent with the mandate of the National Aeronautics and Space Act to contribute materially, among other things, to the expansion of human knowledge of phenomena in space.

Additional Information

In mid-May 1989, NASA received a Safety Evaluation Report (SER) for the Galileo mission prepared by an Interagency Nuclear Safety Review Panel (INSRP) composed of representatives of NASA, DoE, and the Department of Defense (DoD). The SER is considered pre-decisional; consequently, it is not available to the public, and therefore, not referenceable in the EIS. Nevertheless, I have considered the findings of the SER in reaching my decision. In my judgement both the FSAR and the SER indicate small probabilities of an accidental nuclear fuel release, and limited consequences should such an improbable accidental release occur.

The SER presented its findings in terms of launch area and global consequences rather than by mission phase. For launch area accidents, the SER finds greater consequences than those presented in the FSAR. To some extent this reflects both the range of views in the technical community as well as uncertainties in the analyses. For instance, there is a paucity of data on radiological health effects at the very low dose rates encountered here. Still, NASA and DoE's Office of Nuclear Energy have completed a detailed comparison of the FSAR and the SER and have determined that the FSAR presents a realistic estimate of the risks. The SER, in key areas, characterizes itself as a "bounding analysis." There is, finally, substantial reliable data from the safety verification test and analysis program which supports the results of the FSAR. Therefore, I judge the FSAR as the appropriate estimate of the risk on which to base my decision.

Mitigation

The NASA Kennedy Space Center, with expert technical assistance from DoE, the Environmental Protection Agency, and other federal agencies, and in cooperation with state and local authorities is

developing a federal radiological emergency response plan. Key elements of monitoring and data analysis equipment will be predeployed to enable rapid response in the event of a launch contingency. The plan, to be completed shortly and documented elsewhere, will comprehensively address both monitoring and mitigation activities associated with the launch.

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