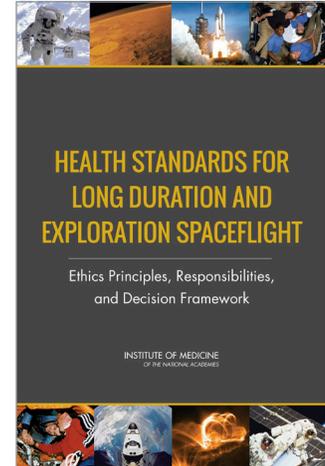


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Health Standards for Long Duration and Exploration Spaceflight

Ethics Principles, Responsibilities, and Decision Framework



Since its inception, the U.S. human spaceflight program has grown from launching a single man into orbit to an ongoing space presence involving numerous crewmembers. As the U.S. space program evolves, propelled in part by increasing international and commercial collaborations, long duration or exploration spaceflights—such as extended stays on the International Space Station or missions to Mars—become more realistic. These types of missions will likely expose crews to levels of known risk that are beyond those allowed by current health standards, as well as to a range of risks that are poorly characterized, uncertain, and perhaps unforeseeable. As the National Aeronautics and Space Administration (NASA) and Congress discuss the next generation of NASA’s missions and the U.S. role in international space efforts, it is important to understand the ethical factors that drive decision making about health standards and mission design for NASA activities.

NASA asked the Institute of Medicine (IOM) to outline the ethics principles and practices that should guide the agency’s decision making for future long duration or exploration missions that fail to meet existing health standards. The IOM committee’s report, *Health Standards for Long Duration and Exploration Spaceflight: Ethics Principles, Responsibilities, and Decision Framework*, identifies an ethics framework, which builds on the work of NASA and others, and presents a set of recommendations for ethically assessing and responding to the challenges associated with health standards for long duration and exploration spaceflight.

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Health Risks and Standards for Astronauts

From terrestrial training and vehicle testing through launch, mission, and return, astronauts may face short- and long-term health consequences. NASA's Human Research Program has identified more than 30 space-related health risks for astronauts, including vision impairment, behavioral health and performance effects, bone demineralization, muscle loss, and radiation exposure.

As part of its effort to prevent or mitigate clinical and behavioral health risks related to spaceflight, NASA has established health standards for astronauts with the goals of maintaining a safe and healthy environment for the crew and providing needed health and medical programs throughout all phases of the mission. NASA's ability to participate in specific missions is dictated, in part, by these health standards. Long duration and exploration spaceflights—because they could involve longer times in space, greater distances from Earth, and exposure to uncertain environments—are unlikely to meet the existing health standards.

When considering such missions, the IOM committee recommends that NASA employ a rigorous ethics-based decision framework based on commonly accepted ethics principles, which include broad responsibilities stemming from those principles.

Ethics Principles

NASA has responsibilities to manage health risks effectively and to serve society by advancing knowledge and managing public expenditures wisely. To fulfill these duties, the IOM committee recommends that NASA adopt the following ethics principles:

- **Avoid harm.** NASA should exhaust all feasible means to minimize risk to astronauts.

- **Beneficence.** NASA should weigh a mission's potential benefits, including scientific and technical importance, as well as benefits to current and future astronauts and the public.
- **Favorable balance of risk and benefits.** NASA should systematically assess risks and benefits and ensure that the benefits sufficiently outweigh the risks.
- **Respect for autonomy.** Astronauts' participation should be voluntary. NASA should keep astronauts informed of a mission's risks and benefits before, during, and after the mission.
- **Fairness.** NASA should ensure fairness in its selection of astronauts and crews, distribution of the risks and benefits, and postflight support of astronauts.
- **Fidelity.** NASA should acknowledge its obligation to astronauts, who serve at great personal risk, by providing health care and other protections not only during but also after the mission.

Ethics Responsibilities

Acting on ethics principles dictates specific responsibilities that NASA should pursue in its multifaceted roles as employer, federal agency responsible for innovation and exploration, research sponsor, and international partner. These responsibilities include fully informing astronauts about the risks of long duration and exploration spaceflights, adhering to a continuous learning approach to ensure that health standards evolve and improve over time, and soliciting independent advice to inform its decisions. NASA should communicate with all relevant stakeholders (including astronauts and the public) about the rationale for, and possible impacts of, its decisions about health standards for long duration and exploration spaceflights and provide equality of opportunity, to the fullest extent possible, for astronauts to participate in those spaceflights. The agency should also provide preventive long-term health screening and surveillance and lifetime health care to protect astronaut health, support ongoing

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evaluation of health standards, improve mission safety, and reduce risks for current and future astronauts. Policy development and application should appropriately and sufficiently protect the privacy and confidentiality of astronauts' health data.

Decision Framework

In assessments of long duration and exploration missions that are unlikely to meet current health standards, the IOM committee recommends that NASA employ a three-step decision framework (see box). In the first and broadest level of decision making, NASA must determine whether, and under what conditions, missions that are unlikely to meet current health standards are ethically acceptable. If so, NASA should develop a process and criteria for granting exceptions to existing health standards. The committee emphasizes that

exceptions should only be granted in rare circumstances and that exceptions increase the ethical responsibilities for NASA and society. The second decision level involves mission-specific decision making, in which the agency must evaluate whether a particular mission is ethically acceptable. The third level of decision making is focused on selecting the crew for the mission and an individual astronaut's informed decision to participate.

NASA has processes for reviewing and revising existing health standards or adopting new health standards. Although NASA updates its health standards every 5 years or whenever new data become available, many of the health effects of long duration and exploration missions remain highly uncertain or unknown. The IOM committee determines that relaxing (or liberalizing) current health standards, outside of established processes, merely to permit long duration or exploration missions would be arbitrary and,

Decision Framework

Level 1: As a general rule, should NASA conduct space missions that will (a) fail to meet health standards, (b) involve significant risks where there are no applicable standards, and/or (c) involve such great uncertainty that NASA cannot exclude the possibility of a or b? If so, what criteria should be used to determine whether exceptions for specific missions should be allowed?

Level 2: Given authorization for missions that will likely fail to meet existing health standards, is a specific long duration and/or exploration mission ethically acceptable?

Level 3: What factors should be considered as NASA and individual astronauts make informed decisions about crew selection and individual astronaut participation for a given mission?



Committee on Ethics Principles and Guidelines for Health Standards for Long-Duration and Exploration Spaceflights

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therefore, ethically unacceptable. Likewise, the committee concludes that there is insufficient justification for developing a separate set of health standards that set a more permissive ceiling on allowable risk for long duration and exploration spaceflight.

Conclusion

As technologies improve and longer and more distant spaceflight becomes feasible, NASA and its international and commercial partners will continue to face complex decisions about risk acceptability. The IOM committee's report provides a roadmap for ethically assessing and responding to the challenges associated with NASA's health standards for long duration and exploration missions. Establishing and maintaining a firmly grounded ethics framework for this inherently risky activity is essential to guide NASA's decisions today and to create a strong foundation for decisions about future challenges and opportunities. 🌀

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