APPENDIX D
RESPONSES TO PUBLIC REVIEW COMMENTS

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RESPONSES TO PUBLIC REVIEW COMMENTS

The U.S. Environmental Protection Agency (EPA) published a Notice of Availability for the Cassini mission Draft Environmental Impact Statement (DEIS) in the Federal Register on October 21, 1994. The public review and comment period closed on December 20, 1994. Timely comments were received from organizations and individuals listed in Table D-1 .

Where no extension of the comment period was requested or otherwise authorized by NASA, untimely comments were considered if received before March 3, 1995 (see Table D-2). As of March 3, 1995, 25 letters were received after the comment period closed, and are included in this Appendix.

This Appendix provides specific responses to the comments received from the individuals and organizations listed in Tables D-1 and D-2. Copies of the comment letters are presented in the following pages. The relevant issues in each comment letter are marked and numbered for identification along with the National Aeronautics and Space Administration's (NASA's) response to each issue. Where changes in the text were appropriate, such changes were noted in the comment response.

The majority of the public comments received raised the following issues on the Environmental Impact Statement (EIS):

- the use of plutonium in space
- the status of solar technology for deep space missions
- the properties of plutonium
- the radiological consequence and risk analyses.

Information on these topics may be obtained in the following sections of the EIS:

The use of plutonium in space -Section 2.2.4 of the EIS describes the plutonium-containing radioisotope thermoelectric generators (RTGs) and radioisotope heater units (RHUs) in detail, including the testing and verification data to ensure containment of the plutonium dioxide fuel under most accident environments. In addition, Section 2.6.3.1 compares the physical properties and the attendant production requirements of alternative radioisotopes to plutonium-238. Section 2.6.3.2 discusses the limitations of the potential alternative conversion technologies to the thermoelectric converter used on the RTGs that would potentially result in the use of less plutonium.

The status of solar technology for deep space mission-Section 2.6.3.4 discusses the level of development of solar technology and the various solar design options that were evaluated for the Cassini mission.

The properties of plutonium-Appendix C of the EIS briefly describes the properties of plutonium-238 and the environmental effects of plutonium dioxide used in the RTGs and RHUs.

The radiological consequences and risk analysis-Section 4.1.5 of the EIS presents: the radiological consequence methodologies, the postulated accident scenarios and the associated probabilities of their occurrence, and the potential source terms. The potential radiological consequences from postulated accidents are described in Sections 4.1.6.2 and 4.2.6 in two ways: the land areas that could be contaminated above the EPA screening level of 7.4×10^3 Bq/m^2 (0.2 $\mu Ci/m^2$), and health effects (excess latent cancer fatalities). The risk analyses for the mission are presented in Sections 4.1.8 and 4.2.8 from three perspectives: contribution by mission phase/scenario to mission risk (expressed as health effects mission risk); average individual risks; and the risk to the maximum exposed individual.

TABLE D-1. LISTING OF COMMENTORS

Commentor Number	Date of Comment	Organization	Individual Presenting Comments
1	11/29/94	Florida Coalition for Peace & Justice	Bruce K. Gagnon
2	12/5/94	Private Citizens	Mr. & Mrs. Puchstein
3	12/9/94	Private Citizen	Horst A. Poehler, Ph.D
4	12/10/94	Private Citizen	Dorothy Scott Smith
5	12/14/94	Private Citizens	Harvey G. and E. Lois Baker
6	12/14/94	Private Citizen	Ronald J. Balogh
7	12/14/94	Private Citizen	Arnie Welber
8	12/15/94	Southern Rainbow Education Project (SREP)	Gwendolyn M. Patton
9	12/15/94	Private Citizen	Anna B. Pilson
10	12/16/94	Florida Coalition for Peace & Justice	Donna Ellis
11	12/16/94	South Dakota Peace and Justice Center	Jeanne Koster
12	12/17/94	Private Citizen	Phil Seligman
13	12/17/94	Private Citizens	Warren and Olive Wilson
14	12/18/94	Private Citizens	Dr. Mary Ann Lawrence

TABLE D-1. LISTING OF COMMENTORS (Continued)

Commentor Number	Date of Comment	Organization	Individual Presenting Comments
15	12/19/94	National Space Society	Glenn Harlan Reynolds
16	12/19/94	Committee to Bridge the Gap	Daniel Hirsch
17	12/19/94	Private Citizen	Beth Raps
18	12/19/94	Women's International league for Peace and Freedom	Jennie Baer
19	12/19/94	Private Citizen	Kathleen Kelly
20	12/20/94	Florida Coalition for Peace & Justice	Sylvia Torgan with 24 additional petitioners
21	12/20/94	Private Citizens	Ruth E. and Jack Snyder
22	12/20/94	Private Citizen	Richard H. Hiers, Ph.D, J.D.

TABLE D-2. LISTING OF COMMENTORS RESPONDING AFTER CLOSE OF THE PUBLIC COMMENT PERIOD

Commentor Number	Date of Comment	Organization	Individual Presenting Comments
23	12/21/94	Private Citizens	Mr. & Mrs. Harry Kernes
24	12/22/94	Private Citizen	Rea D. Ward
25	12/22/94	Private Citizen	Georgia Van Orman
26	12/22/94	Private Citizen	Arthur Draving
27	12/25/94	Private Citizen	John P. Ferrell
28	12/26/94	Private Citizen	Ingeborg F. Roberts
29	12/26/94	Private Citizen	Geraldine Jenara Amato
30	12/28/94	Pikes Peak Justice and Peace Commission	Mary Sprunger-Froese
31	12/28/94	Private Citizen	Harvey Wasserman
32	12/30/94	Private Citizen	Edward Dierauf
33	12/30/94	Private Citizen	Margery D. McIntire
34	12/31/94	Private Citizen	Nancy Strong
35	1/1/95	Private Citizen	Karen McFadyen
36	1/11/95	Private Citizen	Linda Bermann
37	1/2/95	Private Citizen	Merilyn Hiller

TABLE D-2. LISTING OF COMMENTORS RESPONDING AFTER CLOSE OF THE PUBLIC COMMENT PERIOD (Continued)

Commentor Number	Date of Comment	Organization	Individual Presenting Comments
38	1/3/95	Private Citizens	Sidney and Olive Manuel
39	1/3/95	Private Citizen	Ronald P. Reed
40	1/4/95	Private Citizen	V. Lee Fuqua
41	1/8/95	Private Citizen	Robert R. Holt, Ph.D.
42	1/16/95	Private Citizen	Bob Ellenberg
43	1/23/95	Private Citizens	Martina and John Linnehan
44	2/12/95	Private Citizen	Ruth Putz
45	2/19/95	Private Citizens	Carole and Frank Hyneman
46	2/24/95	Private Citizen	Mrs. Fran Collier
47	2/27/95	Religious Education for the Catholic Deaf & Blind	Rev. René Robert

FLORIDA COALITION FOR PEACE & JUSTICE
P.O. Box 90035 • Gainesville, Florida 32607 • (904) 468-3295

November 29, 1994

Dr. Peter B. Ulrich
Solar System Exploration Division
Office of Space Science
NASA HQ
Washington DC 20546

Dear Dr. Ulrich:

This letter is to comment on the Cassini Draft Environmental Impact Statement (DEIS) prepared by NASA. In it I could find no date that comments were due by.

We are glad to see that NASA has incorporated some our our concerns from Galileo and Ulysses into the Cassini DEIS. For example, Table 2-2 acknowledges that there have been accidents in the past. It was my personal experience during the campaigns against Galileo and Ulysses that NASA spokespersons frequently told the media that there had never been any accidents in the past. I have in my files the same table but it lists the inventory of Pu at launch (curies). We'd like to see that make it back into the table in the final EIS.

1-7

You also do much more on alternatives in this DEIS except you still come to the same conclusion that you did in the past. Only now you use alot more mathmatics to come to the conclusion that "the spacecraft requires the use of RTG's to satisfy the mission electrical power needs."
I'm enclosing a European Space Agency (ESA) press release dated April, 1994 that announces that European industry has recently developed high efficiency solar cells and that they won't need RTG's for "future demanding deep-space missions." I ask that the press release be made part of our official comments.

It is clear to us that NASA and DoE much to easily dismiss the use of a solar alternative. The political will is lacking and pressure from the nuclear power industry is a certain factor for the lack of effort. Or instead of saying that the nuclear industry pressures NASA and DoE, maybe we should just say that they have taken over the decision making process.

We still maintain that one of the problems with nuclear power in space is that it is contaiminating people before it ever leaves the earth -- during the fabrication process that happens at Savannah River, Los Alamos, Oak Ridge, Mound Labs and Martin Marietta. You didn't spell

Action Network for Social Justice (Tampa)
Affirmation Lutheran Church (Boca Raton)
Boca Citizens for Social Responsibility
Brevardians for Peace & Justice
Broward Citizens for Peace & Justice
Catholic Diocese of St. Augustine, Office of Peace & Justice (Jacksonville)
Center for Advancement of Human Cooperation (Gainesville)
Deerfield Progressive Forum
Delray Citizens for Social Responsibility
Environmental & Peace Education Center (Ft. Myers)
Florida Southwest Peace Education Coalition (Venice)
Freedom Coalition (Gainesville)
Grace Contino Abrams Peace Education Foundation (Miami)
Grandmothers for Peace (St. Augustine) — 1A
Greens of Alachua County — 1A
Jacksonville Coalition for Peace & Justice — 1A
Metanoia (St. Marys, GA) — 1A
Miami Peace Center — 1A
Orlando Big Mountain Support Group — 1A
Orlando Friends Meeting — 1A
Palm Beach County Committee for Social Responsibility — 1A
Patriots for Peace (Ft. Walton Beach) — 1A
Pax Christi Florida — 1A
Peace & Justice Subcommittee, Presbytery of Tampa Bay — 1A
Peace Coalition (Lake Worth) — 1B
Peace of Highlands County — 1B
Peace Place (Ft. Lauderdale) — 1B
Peacemaking Committee of Central Florida Presbytery — 1B
Peacemaking Group (Naples) — 1B
Physicians for Social Responsibility (South Florida) — 1B
Polk County Citizens for Peace & Justice — 1B
Social Concerns Committee of St. Margaret Mary Catholic Church (Winter Park) — 1B
Southeastern Yearly Meeting — 1B
South Florida Peace Network — 1B
Tallahassee Peace Coalition — 1B
Tallahassee Society of Friends — 1B
Tampa Bay Peace Education Program — 1B
Treasure Coast Citizens for Peace & Justice — 1B
Unitarian Social Action Network (Clearwater) — 1B
Unitarian Social Concerns Committee (Boca Raton) — 1C
Unitarian Social Concerns Committee (Gainesville) — 1C
Unitarian Social Concerns Committee (Jacksonville) — 1C
Unitarian Social Concerns Committee (Melbourne) — 1C
Unitarian Social Concerns Committee (DeLand) — 1C
Unitarian Social Concerns Committee (West Volusia) — 1C
Unitarian Social Responsibility Committee (Vero Beach) — 1C
Unitarian Universalist Church of Sarasota — 1C
Vets for Peace (Gainesville) — 1D
Volusians for a Peaceful World (Daytona Beach) — 1D
Westminster United Presbyterian Church (Lakeland) — 1D
Women's Int'l League for Peace & Freedom (WILPF) (Palm Beach County) — 1D
WILPF (Tallahassee) — 1D
WILPF (Tampa) — 1D
WILPF (Treasure Coast) — 1D
Winter Park Friends Meeting — 1D

RESPONSES TO COMMENTS

Commentor No. 1: Florida Coalition for Peace & Justice
(Bruce K. Gagnon)

Response to Comment 1A:

The Cassini Environmental Impact Statement (EIS) now contains an updated version of the corresponding table from the Ulysses mission Tier 2 EIS (NASA 1990). The plutonium inventories on U.S. spacecraft previously launched have been included in Table 2-2.

Response to Comment 1B:

Solar cells recently developed under laboratory conditions by European Space Agency (ESA) have demonstrated desirable characteristics for missions traveling about two-thirds of the distance to Saturn. For research and development purposes, Deutsche Aerospace and CISE (Milan, Italy) have produced a small quantity of Low-Intensity, Low-Temperature (LILT) silicon solar cells for potential use on space missions such as ESA's Rosetta comet mission. The cells thus far, have tested favorably under simulated environments for use at nearly 6 astronomical units (AUs). (Cassini will need to operate at 9 to 9.3 AU while at Saturn). Calculations suggest that operation at Saturn conditions may subject silicon cells to low temperature freeze out, significantly reducing their performance. However, in view of the margin of error, Jet Propulsion Laboratory (JPL) has assumed that optimum cell performance would be available in all Cassini array studies. The ESA LILT cells are relatively thick compared to other cells evaluated for potential use on the Cassini spacecraft and have low resistance to radiation damage compared to the conventional thin silicon and gallium arsenide space solar cells previously assumed in the array sizing studies. Analysis by JPL spacecraft electrical power systems engineers shows that the improved performance of the LILT cells (25 percent efficiency instead of less than 20 percent achieved by most other cells) would be offset by their increased mass and greater radiation sensitivity (S. Strobel and K. Bogos et al. [in Print] "Si and GaAs Solar Cells for Low Intensity, Low Temperatures Operations," in the Proceedings of 1st World Conference on Photovoltaic Energy, Hawaii, December 5-9, 1994). As with other solar power options studied for the Cassini spacecraft, the extremely large mass of even the lightest solar configuration is beyond the lift capability of the Titan IV (Solid Rocket Motor Upgrade [SRMU]/Centaur launch vehicle. Even if a heavy-lift booster and a suitable upper stage could be made available, the severe field-of-view problems, greatly increased turn times, and greater operational complexity and programmatic risk associated with an all-solar Cassini design makes such a design, from both mission engineering and scientific perspectives, infeasible.

Even if the solar cells discussed in the ESA press release become available for future application in deep space, these ESA solar cells would not necessarily be applicable for all future deep space missions due to the limitations discussed above. Therefore, radioisotope thermoelectric generators (RTGs) are likely to remain the more feasible power source for certain missions.

Response to Comment 1C:

The RTGs that would be onboard the Cassini spacecraft are not a product of or directed by the nuclear power industry. RTGs were developed by the Department of Energy (DOE) in response to the need for a compact, reliable source of small amounts of electrical power for U.S. deep space missions.

Response to Comment 1D:

This EIS addresses the impacts of preparing for and implementing the Cassini mission. The environmental, safety and health impacts associated with RTG and radioisotope heater unit (RHU) manufacturing processes at DOE facilities are the subject of separate National Environmental Policy Act documentation and are not within the scope of this EIS. For more detailed information, see the reference, *Environmental Assessment for Radioisotope Heat Source Fuel Processing and Fabrication* (DOE 1991).

out in the DEIS any of the consequences of this process. Instead you made reference to a 1991 DoE study. It should be printed as part of the EIS. The burden of proof is on NASA. If this isn't a crucial part of the environmental impact study then what in the world is? I enclose an article from the Albuquerque Journal dated 2/26/94 for the record. — 1D

The "Monte Carlo Simulation" computer model that you use to calculate risk assessment and contamination probabilities is totally suspect in our opinion. You put garbage into a computer and you get garbage out. We know that you rig the figures so that everyone can say that the risk is "acceptable". Again, our experience during Galileo and Ulysses showed how the figures changed as often as one changes socks.

For example, the DEIS claims that in an accident after take-off debris would fall on Africa and plutonium might be released on impact resulting in "less than one excess cancer." During the earth swing-by a reentry accident that released plutonium into the atmosphere would be "shared" among 5 billion people causing only 2,300 cancers over 50 years. These numbers are truly pure garbage. We refer you to Dr. John Gofman's study of the 1964 Snap-9A accident and its long term implications on worldwide cancer rates. — 1E

Also unacceptable to us is the language that you use to down-play the health risks of pu-238 and pu-239. You make it sound like a Sunday picnic. Again we urge NASA to look at Dr. John Gofman's work on the subject and include that in the final EIS. — 1F

There is not enough documentation in the DEIS about the consequences of contamination of the land in the event of any accident. If pu-238 and pu-239 was spread over parts of Africa how much land would have to be removed? What would be done with it? The buildings? The plant life, animals, the people? Spell it out. It could happen. — 1G

NASA once again claims that it must rush to meet the October, 1997 launch schedule and that any delay would harm science objectives. It is our contention that a delay is absolutely necessary because proof exists that a solar alternative does exist despite the claims in the DEIS to the contrary. — 1H

The entire Cassini program should go back to square one and a serious solar alternative must be developed.

We can assure NASA that if there is ever an accident with plutonium on a space mission, during any stage, the future of nuclear power missions would be over. But most importantly the agency itself would face total dishonor before the people of the world. — 1I

Response to Comment 1E:

The risk analysis presented in the EIS is deterministic. Monte Carlo simulations, however, were performed in the estimation of the launch phase initiating accident scenario probabilities and the Earth-Gravity-Assist (EGA) inadvertent reentry probabilities. The Monte Carlo technique is appropriate when evaluating functional relationships involving probability distributions. As part of the launch approval process, DOE will be preparing a more in-depth evaluation of the potential environmental consequences as part of the Final Safety Analysis Report (FSAR). Monte Carlo simulations will be applied in the FSAR.

The Systems for Nuclear Auxiliary Power (SNAP)-9A RTG, which used plutonium (Pu-238) fuel in the metallic form, was designed for reentry burnup Following the SNAP-9A reentry burnup, the particles associated with the plutonium (Pu-238) had a measured arithmetic mean particle size of 10μm with a range of 5 to 58μm. Contacts with Dr. Gofman through his organization have failed to yield any indication that he evaluated the SNAP-9A accident.

Response to Comment 1F:

The results of the accident analysis have been factually stated in the EIS in terms of 1) the total probability of release, 2) the radiological consequences of such a release, and 3) the risk. Appendix C discusses the environmental and health risks associated with plutonium (Pu-238) dioxide in greater detail See also Johnston v. U.S., 597 F. Supp. 374, at 409-415 (U.S.D.C., D. Kan., 1984).

Response to Comment 1G:

Tables 4-10 and 4-11 of the EIS present the estimated area of land contamination from potential accidents where plutonium could be release Section 4.1.6.2 deals with the radiological consequences to the land.

A Phase 5 accident occurring during the 8 seconds the instantaneous impact point is over Africa would lead to spacecraft breakup during reentry,
Reentry heating would by design melt the RTG converter housing and release the individual aeroshell modules, which would then reenter separately. General purpose heat source (GPHS) modules are designed to remain intact

under these reentry conditions. Individual reentering GPHS modules impacting rock could lead to fueled clad failures and release of fuel (an average of 5.5×10^{10} Bq [1.5 curies]). No releases would be expected front soil or water impacts. The total probability for such a release is estimated to be around 5.8×10^{-4} for the Proposed Action. Should such a release occur, the maximum individual dose is estimated to be 1.24×10^{-4} Sv (1.24×10^{-2} person-rem) and the collective dose is estimated to be 4.32×10^{-3} Sv (4.32×10^{-1} person-rem), resulting in 1.51×10^{-4} health effects.

A review of Tables 4-10 and 4-11 of the EIS reveals that the estimated area of land contamination based upon a U.S. Environmental Protection Agency screening level of 7.4×10^{3} Bq /m^2 (0.2 µCi/m^2) for a Phase 5 accident would be about 0.02 km^2 (0.008 mi^2) in the expectation source term case, and about 0.1 km^2 (0.04 mi^2) in the maximum source term case (Command Shutdown and Destruct Scenario). It should be noted that these estimates would apply to an accident occurring during the 8-second period of Phase 5 when the GPHS modules could impact the African continent. Even then, the modules would have to impact rock for a release to occur. The amount of land that would have to be remediated, if any, would be determined by an assessment of the impact location. For accidents occurring outside the United States or its territorial jurisdictions, the State Department and diplomatic channels would be employed in accordance with pre-arranged procedures and support elements would be dispatched as appropriate.

Response to Comment 1H:

NASA has followed the technical progress in power source technology worldwide for many years. Indeed, a substantial portion of the work in the area of solar arrays has been funded by NASA. While improvements have been made in solar technology, significant breakthroughs are still required to support a mission like Cassini. Recent international conferences on space power provided no reports of technical breakthroughs that would suggest changing the proposed approach to powering the Cassini spacecraft. The availability of the solar power option was discussed in response to Comment 1B.

Response to Comment 1I:

NASA places the highest priority on assuring the safe use of radioactive materials in space. Thorough and detailed safety analyses are conducted prior to launching NASA spacecraft with RTGS, and many prudent steps are taken to reduce the risks involved in NASA missions using RTGS. In addition to NASA's extensive internal safety requirements and reviews, missions that carry nuclear material also undergo an additional safety review involving detailed verification testing and analyses.

We are presently running an international petition campaign calling for an end to the Cassini mission as long as nuclear power is used on-board.

We urge NASA to rethink its severe opposition to solar in deep space, especially when the Cassini mission partner ESA, now acknowledges that RTG's are not needed for deep space missions.

Our opposition to nuclear power in space will only deepen as NASA explores the use of such power for the moon colony or the Mars exploration mission. As the public learns more about this issue as they have since Galileo they too will begin to pay a closer look at who is running the show down at NASA and DoE when it comes to making these decisions. And we can assure you that people are becoming less intimidated by the so-called science experts as they see technology fail time after time. The taxpayer is footing the bill and is being asked to assume the risk of contamination from missions that do not need to be a threat.

If NASA wants to do pure science they had better start getting out of bed with the nuclear industry that is in it for pure profit. We will continue to shine a light on this unholy alliance.

In peace,

Bruce K. Gagnon
State Coordinator

Response to Comment 1J:

NASA's primary choice of space power for planetary missions has historically been solar. For example, the Mars Observer, Viking Orbiters, Mariners 4, 6, 7 and 9 were solar-powered Mars missions. NASA continues to use solar power for missions when such technology is applicable. Future missions to Mars such as Pathfinder and Mars Global Surveyor will be solar-powered, using the newest high efficiency GaAs/Ge cells. Mars Pathfinder lander and microrover represent the first use of photovoltaics on the Martian surface. However, NASA incorporates RTGs with spacecraft designs when solar power or other power technology is not feasible for the planned mission. The current state of the technology makes solar power infeasible for a mission like Cassini. See also response to Comment 1B.

Response to Comment 1K:

The availability of solar power technology for the Cassini mission has been addressed in response to Comment 1B. The total health effects mission risk to the public (considering all launch phases and the Earth-Gravity-Assist trajectory) for Cassini has been provided in Section 4.1.8 of the EIS, and is estimated to be small (about 1.8×10^3 health effects).

Press Information Note No.07-94

Paris, 29 April 1994

New solar cells with record efficiency

Under contract with ESA, European industry has recently developed high efficiency solar cells for use in future demanding deep-space missions such as the recently approved ROSETTA cometary mission. The new solar cells reach a 25% efficiency under deep space conditions. The efficiency is the ratio between the electrical energy produced by the cell and the incoming solar energy. The higher the efficiency, the "better" the solar cell.

Unlike telecommunications and Earth observation satellites which orbit near the Earth and are normally powered by solar cells arrays, spacecraft operating at very large distance from the Sun (typically deep-space probes) experience a solar intensity which is only about 5% or less of that near the Earth. This was the case for ESA's ULYSSES for instance which, before reaching the Sun's poles had first to travel to Jupiter at 780 million km from the Sun (Jupiter is five times further away from the Sun than we are!). Moreover, the equilibrium temperature of solar arrays at those distances goes down to about -100 °C. Current solar cells used all over the space world are not generally made to operate at these low temperatures and solar intensities. They allow for 10- to 20% efficiencies in near-Earth orbits but show anomalous behaviour at deep space conditions.

For this demanding environment deep-space probes have to use power sources other than solar panels, because their electrical performance degrades too much at these low light intensities and low temperatures. Until now, deep space probes had to use thermonuclear power generators, like the so-called RTGs (Radioisotope Thermoelectric Generators).

As RTG's technology is not available in Europe, ESA therefore attempted to develop a power source based on very high-efficiency solar cells.

Under low-light low-intensity conditions, 25% efficiency has been achieved on 6x4 cm Silicon cells. The 25% mark represents the highest efficiency ever reached worldwide with Silicon cells without special optical concentration devices to increase the amount of sunlight collected to be converted into electricity. Another breakthrough had already been reached by ESA a little over one year ago with solar cells of a different technology, the Gallium Arsenide (GaAs) type, where 23% efficiency was reached on 2x4 cm cells.

This technology milestone in Silicon solar cells was reached by an industrial team led by DASA (Heilbronn, Germany) with CISE (Milano, Italy) as sub-contractor (CISE being also responsible for the development of high efficiency GaAs solar cells).

ESA expects that the new high performance Silicon solar cells could profitably be used in deep space missions for Europe and that this technology could also be of interest for near-Earth orbit space applications as well as for Earth based ones.

ALBUQUERQUE JOURNAL
NEW MEXICO'S LEADING NEWSPAPER

ALBUQUERQUE JOURNAL

Plutonium Lab Safety Questioned

By John Fleck 2/26/94

JOURNAL STAFF WRITER

Federal investigators have raised questions about safety procedures at Los Alamos National Laboratory's plutonium laboratory, where workers soon will begin making key parts for NASA's 1997 Cassini mission to Saturn.

Los Alamos and Department of Energy officials defended the lab's safety, and a NASA official said he doesn't think Cassini will be delayed.

The most serious dispute between investigators and the Department of Energy, which runs Los Alamos, is over whether a backup power generator used to power safety systems should be automatic or manually operated.

The investigation, done during the past year by the Defense Nuclear Facilities Safety Board, didn't find imminent threats to public or worker safety, according to board reports.

The board's staff did, however, find problems in procedures used to ensure safety at Los Alamos' Technical Area 55, the laboratory's main plutonium handling complex.

The board has called a hearing March 7 in Washington, D.C., to look into the problems.

One of those problems, an allegedly inadequate backup power supply, could allow dangerous plutonium to escape the building if there was a plutonium leak inside the building at the same time the power went out, according to a report by board investigators.

DOE officials say they believe a manually operated power generator is sufficient to prevent leaks.

The report also cited a "high frequency" of radiation leaks inside the Los Alamos plutonium complex — 51 during a 19-month period in 1992-93.

In addition, investigators found Los Alamos hasn't done the paperwork to demonstrate it complies with the 51 separate DOE nuclear safety-regulated regulations.

Officials at Los Alamos and the U.S. Department of Energy said Technical Area 55 is safe.

"If we thought that facility was unsafe, we would shut it down," said Jerry Bellows, manager of the department's Los Alamos Area Office.

Bellows acknowledged the problems, but said they involve compliance with bureaucratic regulations, not the actual safety of the plutonium complex.

Bellows attributed the number of reported radiation leaks to heightened safety attention by workers, who now report minor incidents that in the past might not have been mentioned.

Dana Christensen, deputy chief of the Los Alamos division that runs the plutonium complex, pointed out that the laboratory has built plutonium parts for U.S. spacecraft for more than two decades without danger to public or worker health.

The Defense Nuclear Facilities Safety Board is an independent federal agency with the legal authority to investigate safety issues and make recommendations to the U.S. Secretary of Energy, said spokeswoman Carol Morgan.

It doesn't have the authority to shut anything down. Past investigations, however, have led to work delays at other U.S. nuclear facilities.

Plutonium is a radioactive metal made in nuclear reactors and not found in nature.

Dangerous if inhaled, plutonium is only handled in sealed containers with glove-lined portholes allowing workers to work with it remotely.

Los Alamos' Technical Area 55 is the largest functioning plutonium-processing facility in the United States.

NASA uses plutonium to power spacecraft used on deep-space missions. Los Alamos is preparing to begin manufacturing the plutonium parts for NASA's $1.4 billion Cassini spacecraft.

Ron Draper, deputy manager of the Cassini project for NASA, said in a telephone interview that he didn't expect the problems at Los Alamos to cause any delays in Cassini's launch.

DATE: December 5, 1994

TO: Dr. Peter B. Ulrich
Code SLP
NASA Headquarters
Washington, D.C. 20546

FROM: Mr. & Mrs. Paul Puchstein
1733 Athens Court
Lakeland, Florida 33803

SUBJ: Draft Environmental Impact Statement for the Cassini Mission

NASA should choose the "no action" alternative and immediately cease plans to launch the Cassini Mission until the power sources of 32Kg (72 lb) of PU-238 are replaced.

Public confidence in NASA's ability to continue to administer our National aeronautics and space contracts is seriously jeopardized by your morally unconscionable and irresponsible propagation of the production, use and proliferation of non-strategic radioactive material. — 2A

Exploration of the solar system must never unnecessarily risk impacting and contaminating the Earth's environment. — 2B

Sincerely,

Paul Puchstein
Jean Puchstein

Paul and Jean Puchstein
1733 Athens Court
Lakeland, Florida 33803

COPY: Senator John Glenn

D-16

Response to Comment 2A:

Radioisotope thermoelectric generators (RTGS) are the only suitable power technology available for the Cassini mission to Saturn Furthermore, there is no new technology presently available or on the horizon to replace the RTGs for the Cassini mission.

The United States has an outstanding record of safety in using RTGs on 23 missions over the past three decades (See Table 2-2), While RTGs have never caused a spacecraft failure on any of these missions, they have been on board three missions which experienced malfunctions for other reasons. In all cases, the RTGs performed as designed.

More than 30 years have been invested in the engineering, safety analysis and testing of RTGS. Safety features, demonstrated through extensive testing, have been incorporated into the RTG's design. See Section 2.2.4.2 of the Environmental Impact Statement for more detailed information. There is about 32.4 kg (71.4 lb) of plutonium dioxide in the three RTGS. Table 2-3 provides the isotopic composition of the fuel form used for the Cassini mission.

Response to Comment 2B:

NASA places the highest priority on assuring the safe use of radioactive materials in space. Thorough and detailed safety analyses are conducted prior to launching NASA spacecraft with RTGS, and many prudent steps are taken to reduce the risks involved in NASA missions using RTGS. In addition to NASA's extensive internal safety requirements and reviews, missions that carry nuclear material also undergo an additional safety review involving detailed verification testing and analyses.

p 1 of 3

400 4 Ave
Satellite Beach, FL
32937-5202
Dec 9, 1994

Dr. Peter B Ulrich
Chief, Flight Programs Branch
Solar Systems Exploration Division
Office of Space Science
Washington, DC, 20546

Dear Dr. Ulrich:

In accordance with your letter of Oct 14, and your following letter giving the submission date, I am submitting mg comments on the DEIS, as follows:

Economic impact discussions do not consider or discuss the impact losses to the homeowner in cases of a nuclear spill. All homeowner policies are void in case of nuclear contamination, as a result of the Price Anderson Act. The homeowners are left to assume the loss due to NASA's nuclear failure, 3A

The nuclear containment estimates are deficient in overstating the containment of the nuclear spills. The basic containment consists only of a minimum thickness 22 mil cover of iridium (a relatively soft metal) about the thickness of a fingernail. 3B

The DEIS fails to examine the Benefit/risk ration where nuclear spill may place five Florida counties with a population of over 1.5 million and their property values at risk. The expected additional scientific knowledge does not justify the potential risk to the health and property values of the inhabitants that may be exposed. 3C

The DEIS admits that other, safer electrical power supply generators could be developed. The rush to launch with plutonium is not justified. Delay the Cassini launch until safer generators can be developed. 3D

The boundaries of the Cape and KSC launch sites were laid out so that the surrounding civilian population would be free of any toxic releases from launch exercises. The launch of the Cassini missile with 72 pounds of plutonium oxide far exceeds the boundaries that were designed to provide safety to the surrounding population. NASA and the AF have a choice of either buying up the necessary surrounding real estate, or setting up a launch site in the remote Pacific for current and future nuclear launch missions that pose unacceptable dangers to surrounding populations. 3E

Of possible launch sites, French Guiana, Balkanur Russia, and NASA/KSC, only the NASA/AF launch site is surrounded by a large populatiom, (in excess of 1.5 million) within 50 miles. For launch safety, and to live up to NASA's motto "Safety First", it would pay for the United States to pay these foreign countries to launch Cassini and other nuclear-bearing missiles. After all, Cassini is an international undertaking.

Response to Comment 3A:

Homeowners and other property owners would not be left with the financial responsibility for damages resulting from contamination as a result of an accidental release of plutonium associated with the Cassini mission. While it is true that individual homeowner insurance is generally not available for damages resulting from nuclear related activities, Congress has provided a mechanism for financial reimbursement for damages from a nuclear-related incident. The provisions of law that provide for this protection is known as the Price-Anderson Act. This Act is incorporated into the Atomic Energy Act.

The Price-Anderson Act, as amended, (42 U.S.C. Sec. 2210) governs liability and compensation in the event of a nuclear incident arising out of activities of the U.S. Department of Energy (DOE). A "nuclear incident" is defined under the Atomic Energy Act, "as any occurrence, including an extraordinary nuclear occurrence, within the United States causing, within or outside the United States, bodily injury, sickness, disease, or death, or loss of or damage to property, or loss of use of property, arising out of or resulting from the radioactive, toxic, explosive, or other hazardous properties of source, special nuclear or byproduct material..." (42 U.S.C. Sec. 2014(q)]. In the case of the Cassini mission, DOE retains title to the radioactive power systems at all times. The radioisotope thermoelectric generators (RTGS) would, therefore, be subject to the Price-Anderson Act provisions. In the unlikely event that an accident were to occur resulting in release of plutonium, affected homeowners would be eligible for reimbursement for loss of property due to contamination.

Response to Comment 3B:

The fuel containment approach taken in the RTG design is one of Multiple barriers as described in Section 2.2.4.2 of the Environmental Impact Statement (EIS):

"Each general purpose heat source (GPHS) module consists of a graphite aeroshell, two carbon-bonded carbon fiber insulator sleeves, two graphite impact shells (GISs), and four [iridiumencapsulated] fueled clads. The ... aeroshell... serves as the module's primary heat shield to protect the internal components from direct exposure to a reentry's thermal and aerodynamic environment.

> The two GISs contained in the GPHS module provide the primary resistance to impact and mechanical loads. ...The iridium shell protects and immobilizes the fuel. The iridium alloy is compatible ... with the plutonium dioxide fuel material ..., resists oxidation in air, and melts at 2,425°C (4397°F)."

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 GPHS module components limit the release potential for a wide range of accident environments.

A summary of the safety tests conducted to demonstrate the containment of fuel to a high degree of reliability under a range of accident environments is presented in Section 2.2.4.2 of the EIS.

The dimensions of all components of the GPHS-RTG assembly are given in the Reference Design Document, Volume I of the Ulysses Final Safety Analysis Report (FSAR) (U.S. Department of Energy, *Final Safety Analysis Report for the Ulysses Mission, Volume I Reference Design Document* ULS-FSAR-002, March 1990). The iridium clad is 0.56 mm (0.022 in) thick minimum. The plutonium fuel pellet is 27.56 mm (1.085 in) long and 27.53 mm (1.084 in) in diameter. The graphite impact shells have a minimum thickness of 4.24 mm (0.167 in). The graphite aeroshell has a minimum thickness of 4.70 mm (0.185 in).

Response to Comment 3C:

Aside from the multiple benefits being derived during mission planning, the Cassini mission to the Saturnian system would represent a rare opportunity to gain significant insights into major scientific questions about the formation of the solar system and the conditions that led to life on Earth, in addition to a host of questions specific to the Saturn system. See Section 1.4 of the EIS for further details.

Sections 4.1.6 and 4.2.6 of the EIS discuss the estimated consequences and potential impacts of radiological accidents that could occur during the Cassini mission. These sections provide analyses and information on the potential consequences and impacts on the Cape Canaveral Air Station (CCAS) regional area which is defined in Section 3 (Affected Environment) to

include the six-county region surrounding CCAS and Kennedy Space Center (KSC). As discussed in Section 4.1.8 of the EIS, the population which could be affected by a launch accident (near the launch pad) would be the population in the vicinity of CCAS, estimated on the order of 100,000 people.

Response to Comment 3D:

NASA has invested in research and development of solar power technology. Additionally, DOE, the European Space Agency, and other agencies and research centers around the world have been investing in and improving upon solar power technology over the last decade. A number of solar power designs were investigated for the Cassini mission that would utilize unproven yet promising technology (e.g., the Advanced Photovoltaic Solar Array).

NASA studied many different solar, battery, and other power alternatives, including long life fuel cells, available for Cassini and found none that would meet the mission requirements. A Cassini spacecraft equipped with the highest efficiency solar cells available, or fuel cells, or batteries, or combination of these would make the spacecraft too massive for launching to Saturn. Even if a heavy-lift booster were available that could launch the Cassini spacecraft with a massive solar array, such large solar arrays would introduce insurmountable complexity to the mission and would severely jeopardize the chances for mission success. For fuel cells, even assuming the highest currently available energy fuel-per-unit mass and 100 percent efficient conversion (an idealistic assumption since only 60-70 percent is currently feasible), the resulting dry mass (before adding propellants for the spacecraft engines needed for maneuvers in space) would be about 16,000 kg (17.6 tons). It would not be possible to launch Cassini and place it on a trajectory to Saturn if it were that massive, i.e., it would exceed the launch capability of the Titan IV (Solid Rocket Motor Upgrade [SRMU])/Centaur by more than a factor of 2.

Though NASA continues to invest in research and development of solar power technology, the current state of the technology makes solar power infeasible for the Cassini mission to Saturn. See also responses to Comments 1B and 2A.

As discussed in Section 2.2.8 of the EIS, the Range Safety program must ensure that the launch and flight of space vehicles presents no greater risk to the general public than that imposed by the overflight of conventional aircraft. In addition, safety clearance zones and procedures to protect the public on land, on the sea, and in the air are established and controlled for each launch and launch vehicle at the facilities on the Eastern Range (this would include both CCAS and KSC). Safety control zones are established to protect personnel and resources. Consistent with our Nation's policies for outer space missions such as Cassini, a U.S. launch site is used.

Clearly, year after year, as time passes, larger and larger nuclear missiles will attempted to be launched at KSC/AF. In each case the argument will be the same, "The previous nuclear launches succeeded." Sooner or later, a catastrophic nuclear spill will occur. Its time that NASA build a population-safe nuclear launching site in the remote Pacific. — 3E

No place on earth is safe from the reentry of a failed nuclear missile. What if it lands on a population center such as New York, Chicago, Los Angeles, Paris, Rome, London? What will NASA say?. How will they justify their benefit/risk calculation? — 3F

How many TitanIV/Centaur missiles have been flown to date? How many were successful.With this paucity of successful launches how can NASA arrive at a realistic estimate of the launch risk ? — 3G

The present Florida ground level of plutonium contamination is 0.001 microcurie/sq meter. In case of nuclear contamination by the Cassini launch, NASA proposes that a level of plutonium contamination some 200 times higher than the present level is safe, and harmless to health, for which no de-contaminattion is required. NASA leans back on the EPA, for support that this level will do no harm. One should recognize the element of self interest in such a pronouncement. The higher the level, the less money EPA has to spend to clean up the many nationwide sites that have already been contaminated by nuclear bomb tests, nuclear bomb manufacture, and nuclear power plants. — 3H

The health consequences of a plutonium spill are underestimated. In particular the risk to children is not even discussed. Since effects from plutonium contamination may not appear for as long as 20 years. The legacy of NASA's experiment may not appear for decades in the productive life of the children — 3I

No mention, or provision, is made of the distribution of respiratory masks for populations in the near vicinity, or the sheltering of schoolchildren indoors. At the time of the last nuclear launch, Galileo, the local media suggested that children and adults hold handkerchiefs to their faces. What a cruel hoax? NASA said nothing,and did not even provide their workers at KSC with respiratory masks.

NASA mentions, but is not deterred, from its own estimates of the following stated impacts, "Where areas of land cover used by man (e.g. buildings, roads, ornamental vegetation) are contaminated 'mitigation actions could prevent the immediate return of the population to their homes and workplaces. Cleanup actions could last from several days to several months'" High range cost decontamination methods include, "removal and disposal of all vegetation, removal and destruction of topsoil, destruction of citrus and all other perennial growing stocks, banning of future agricultural land use , demolition of some or all structures, land use restrictions, permanent relocation of affected populations". — 3J

Response to Comment 3F:

Neither the Titan IV (SRMU)/Centaur nor the Cassini spacecraft can be considered a missile in the sense of nuclear weapon. If impact and release of fuel were to occur in the U.S., the emergency response plan developed specifically for the Cassini mission would be activated, and the extent of contamination would be assessed and appropriate measures taken. If the impact and release were to occur in a foreign country, the U.S. government would offer its technical expertise, if requested, to assess the level of contamination and the need for further mitigation actions.

As population density increases beyond the expectation values used in the analysis, the radiological consequences would increase accordingly. However, the higher potential consequences would be associated with a lower probability event. Therefore, risk defined as a probability weighted consequence (i.e., total probability times consequence) would be similar to that reported for the expectation case in the EIS. Furthermore, as a result of the launch approval process, DOE will be preparing a more in-depth evaluation of the potential environmental consequences as part of the FSAR. NASA will review the FSAR, when it becomes available, and will evaluate the information presented for differences, if any, concerning estimates of potential consequences.

Response to Comment 3G:

As of March 3, 1995, there had been three Successful Titan IV (SRM)/Centaur flights. The reliability data for the Titan IV/Centaur, expressed as initiating accident probabilities, are discussed in Section 4.1.5.3 of the EIS. The data were developed using peer-reviewed state-of-the-art assessment methodologies developed by a panel of technical experts in the aerospace industry. The methodologies involved the combination of analytical and failure rate predictions with actual flight history using Bayes Theorem. The theorem allows analytical evaluations to be mathematically combined with observed evidence to develop the probability of failure during a single launch.

Response to Comment 3H:

The consequence and risk estimates reported in this EIS do not assume that cleanup of the contaminated lands occurs in the event of an accident with a release of plutonium. The reported doses, based on the expectation case, in

terms of individual doses and doses to the exposed population as a whole, indicate that the estimated radiological dose impacts are small. Mitigation activities described in Section 4.1.9 of the EIS would be employed, where applicable, to reduce radiological impacts even further.

Estimates of land areas potentially contaminated are based on plutonium deposition above a screening level established by the U.S. Environmental Protection Agency of 7.4×10^3 Bq/m^2 (0.2 μCi/m^2), This is a risk-based value at which cleanup actions would be evaluated. It is established independent of prevailing background levels.

Response to Comment 3I:

The radiological consequences of postulated accident source terms in the EIS have been calculated based on internal dose conversion factors presented in International Commission on Radiological Protection (ICRP) Publication 30. As such, these factors apply to adult members of the population. Particle size and age-dependent internal dose conversion factors are treated as part of a model presented in its recently released publications *Human Respiratory Tract Model for Radiological Protection: ICRP Publication 66, 1995*. ICRP-60 recommends a dose commitment period of 50 years for an adult, is in ICRP-30, and 70 years for children. These new internal dosimetry recommendations are being evaluated and will be implemented, as appropriate, in the radiological consequence analysis being performed for the Cassini FSAR.

Response to Comment 3J:

As discussed in Sections 4.1.9 and 4.2.9 of the EIS, a comprehensive radiological contingency plan would be developed, prior to the launch of the Cassini spacecraft, in accordance with the Federal Radiological Emergency Response Plan. Protective action guidelines and post-accident monitoring would be addressed as part of the contingency planning activities. This contingency plan would be developed through the combined efforts of NASA, DOE, EPA, Federal Emergency Management Agency, the State of Florida, and local organizations involved in emergency responses. Portions of the plan would be practiced to assure that the various organizations were prepared to support the launch.

As discussed in Section 4.1.6.3 of the EIS, an accident occurring in the, CCAS regional area could result in up to 1.43 km^2 (0.55 mi^2) of land

contaminated above the screening level of 7.4×10^3 Bq/m^2 (0.2 µCi/ m^2). The appropriate decontamination or mitigation action would be taken upon further evaluation of the accident consequences.

NASA should poll the people in the area affected by the launch to ask them whether they would be willing to risk their health and property for the sake of increased scientific knowledge of the solar system (even if the risk is estimated by NASA to be exceedingly small). After all, ours is a democracy. Tell the public the truth about the possible consequences of a failed nuclear launch. Only then can NASA hold its head high. - 3K - 3L

The fatal flaw in NASA's risk assessment is the failure to allow for human error. The disasters of Chernobyl, Challenger, Bhopal, and Valdez were due to human error. A purely technical risk assessment, such as in the Casini DEIS would have said they could not happen. - 3M

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Horst A Poehler

Horst A. Poehler, Ph D
400 3 Ave , Satellite Beach, FL
32937
Decemberr 9, 1944

RESPONSES TO COMMENTS
Commentor No. 3: Horst A. Poehler, Ph.D.
(Continued)

Response to Comment 3K:

NASA has estimated that the risk to the population near CCAS/KSC would be exceedingly low. The total health effects mission risk to the public (considering all launch phases and the Earth-Gravity-Assist trajectory) for Cassini is provided in Section 4.1.8 of the EIS, and is estimated to be small (about 1.8×10^{3} health effects).

The National Environmental Policy Act process has afforded the population in the area of the launch the opportunity to convey their concerns regarding possible risks to the public and the environment stemming from the proposed Cassini mission. NASA has given serious consideration to all public comments concerning the Cassini draft EIS.

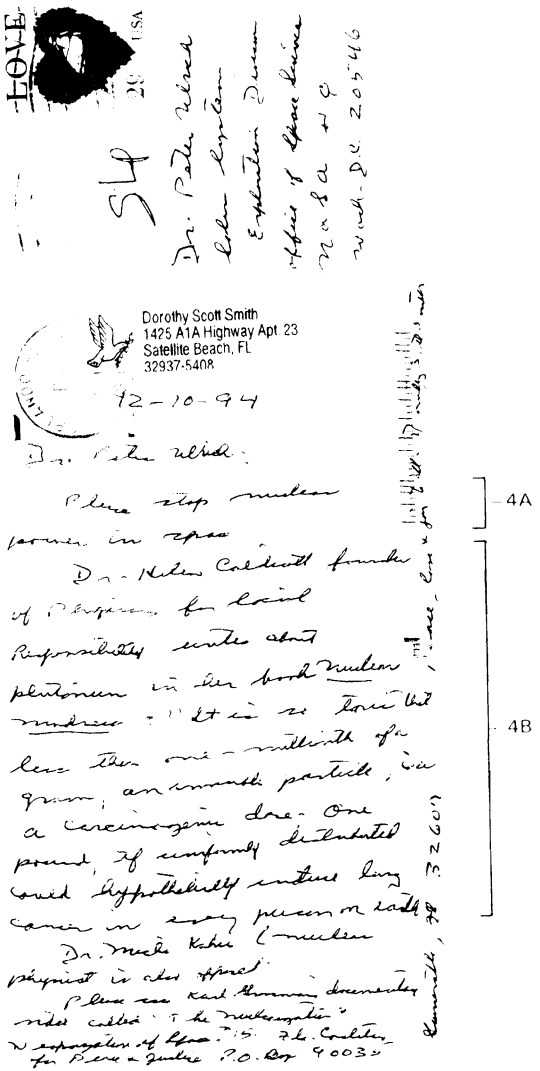
Response to Comment 3L:

Using widely accepted methodologies and best available information, NASA has provided analyses of the consequences associated with a potential launch accident in EIS Sections 4.1.6 and 4.2.6. The analyses indicate that the estimated consequences would be very small.

Response to Comment 3M:

The risk assessment includes the allowance for contributions from human error in several ways. The estimations of the launch failure rates were based in part on historical experience with both the Titan and STS (Shuttle) launch vehicles and in part on estimates of failure sequences that could lead to a severe accident. Human error was an integral consideration in the development of the Titan IV failure probabilities, (i.e. the initiating accident probabilities described in Section 4.1.5.3 of the EIS).

The estimation of the probability of an inadvertent reentry during an Earth swingby also included human error. The estimates are based on historical failure experience with interplanetary spacecraft and their components and on failure sequences that could lead to loss of control of the spacecraft.



Response to Comment 4A:

See response to Comment 2A.

Response to Comment 4B:

The citation on Dr. Helen Caldicott's book, *Nuclear Madness,* reads:

> "...it plutonium is so toxic that less than one-millionth of a gram (an invisible particle) is a carcinogenic dose.
>
> One pound, if uniformly distributed, could hypothetically induce lung cancer in every person on earth," (Caldicott, Helen M., *Nuclear Madness What You Can Do,* W. W. Norton & Company, Inc., New York, 1994).

As used in the Cassini mission, the fuel is a high-fired oxide, a stable and relatively insoluble ceramic material. Plutonium is radiologically toxic if deposited in sensitive tissues, such as the lungs. However, it must first be reduced to particle sizes small enough to deposit in the deep lung region. Typically, deep deposition of particles in the lungs requires particle sizes nominally 3 μm and less, equivalent to the 10 μm respirable particle of unit density used by ICRP (ICRP 1979). Larger inhaled particles are removed in the nasopharyngeal and tracheobronchial regions, and can never reach the lung.

The "invisible particle" of one-millionth gram of plutonium referred to by Dr Caldicott would be, in fact, a single 60 μm diameter plutonium dioxide particle and cannot reach the deep lung region. This " invisible" one millionth gram actually represents a larger number of particles to inhale from the atmosphere if they are to reach the deep lung region. An independent analysis based on the amount of plutonium in human populations around the world resulting from the 6,350 kg (14,000 lb) of plutonium released to the atmosphere from weapons tests, estimated that only about 0.25 g (0.00055 lb) had deposited in the worldwide population (Richmond, Chester R., 1976, "Review of John W. Gofman's Reports on Health Hazards from Inhaled Plutonium," Oak Ridge National Laboratory, ORNL/TM-5257, February 1976). This estimate would be representative of plutonium or plutonium dioxide in a vapor-like state. From these data and a world population of 3 billion at the time, an average uptake factor of 1.3×10^{-17} grams inhaled per gram of plutonium released to the atmosphere

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can be estimated from atmospheric weapons tests. To achieve a uniform distribution of one pound of plutonium in the world population, equivalent to one ten-millionth (1×10^{-7}) not one-millionth (1×10^{-6}**)** gram of plutonium, as stated in Dr. Caldicott's book requires almost 2,000 times the cumulative release of plutonium from all past nuclear weapons tests conducted in the atmosphere. To achieve Dr. Caldicott's one-millionth gram for each person on earth would require about 140,000,000 kg (154,320 tons) of plutonium being released to the atmosphere.

When larger particle sizes are considered, then, in principle, fewer plutonium particles deposited in the deep lung region are required to achieve Dr. Caldicott's one-millionth gram. For example, about 8,400 particles of 3µm diameter must be deposited in the deep lung region to cause a plutonium lung burden of one-millionth gram. Here again, nature conspires against Dr. Caldicott's assertion in two ways; first, radiological toxicity decreases from "hot particle" effects, and second, it is extremely difficult for a person to breathe and deposit one-millionth gram of plutonium in deep lung tissue. As stated by a leading expert in health physics and radiation biology: "There is no scientific evidence to support the allegation that one millionth of a gram of Pu in 'an invisible particle' will cause lung cancer. Theoretically, a single alpha particle could cause a cancer, but because of the random probabilistic nature of the carcinogenic process, the probability is too remote to calculate. Studies on 'hot particles' have shown them to be less carcinogenic than the same amount of radioactivity diffusely distributed in the tissue." (Declaration of Dr. Marvin Goldman, at paras. 6 and 12, October 5, 1989). The second point relates to the lung's physiology, which limits the fraction of inhaled particles that reach and become deposited in deep lung tissue as the size is increased. On the average only about one in twenty-five (0.04) inhaled 3µm particles reach and deposit in deep lung tissue (ICRP 1979).

PDI-1214

December 14, 1994

Dr Peter Ulrich
Solar System Exploration Division
Office of Space Science
NASA Headquarters
Washington, D.C. 20546

Re: SOLAR v. PLUTONIUM

Dear Sir:

Much thanks for our DRAFT Environmental Impact Startement for the Cassini Mission, received 10/18/94, and for the supplemental memo dated 11/29/94 extending comments deadline.

How can you, as a scientist, go forward in the program to send into space 73 pounds of plutonium 238 and 239 when YOU know (and admit) how "horribly" toxic this substance is? We urge you to forego your pet project! — 5A

You infer that it will be quite safe, but just look at the danger if an accident should happen. You surely know a shower of plutionum onto any parts of the Earth would be environmentally devastating (including all peoples' health)! — 5B

You also infer that SOLR WOULD BE MORE SAFE than would plutonium. Consider:

A similar expenditure toward perfecting solar power use for space exploration will offer much more beneficial "fallout" toward widespread solar power use by billions of us on earth — than would "safe cantainers" for plutonium, the most dangerous material known.

If you have children and grand children you should be more concerned with solar benefits toward the good health, schools, education, pure water, air and food for future **tax payers** to **fund** more exploration! — 5C

Please redraft or amend the Draft Statement.

Respectfully,

E. Lois & Harvey G. Baker

Harvey G. and E. Lois Baker
[illegible]38½ Magnolia Avenue
Daytona Beach 32114

Response to Comment 5A:

See response Comment 2A.

Response to Comment 5B:

The radioisotope thermoelectric generators (RTGS) and radioisotope heater units (RHUS) to be used on the Cassini spacecraft have been designed and safety tested to ensure containment of the plutonium (Pu-238) dioxide fuel under most accident environments. The ceramic plutonium (Pu-238) dioxide minimizes the generation of small respirable particles and exhibits a low potential for vaporization in thermal environments in the event some of the fuel is released during an accident. This ceramic fuel form also has a low solubility and is relatively immobile in the environment.

As part of the launch approval process, the Department of Energy (DOE) will be preparing a more in-depth evaluation of the potential radiological consequences as part of the Final Safety Analysis Report (FSAR). NASA will review the FSAR, when it becomes available, and will evaluate the information presented for differences, if any, in the estimation of the potential consequences.

Response to Comment 5C:

NASA is actively studying several future alternate space power sources, including solar cells, and power antennas. NASA has invested substantially in the research and development for such advanced power sources and is continuing to research more efficient technologies. Additionally, the DOE, the European Space Agency, and other agencies and research centers around the world have been investing in and improving upon solar power technology. Historically, NASA's primary choice of power source- for planetary missions has been solar, and it continues to use solar power for missions when such technology is applicable. However, the current state of the technology makes solar power infeasible for a deep space mission such as Cassini. See also response to Comment 1B and 1K.

442 Brightwaters Drive
Cocoa Beach, FL 32931
December 14, 1994

Dr. Peter B. Ulrich
Solar System Exploration Division
Office of Space Science
NASA Headquarters
Washington, DC 20546

Dear Dr. Ulrich:

I am responding to the Draft Environmental Impact Statement for the Cassini Mission. I would like to start by saying that I wrote a letter on the subject of the Cassini mission over three years ago, to Howard Wright Cassini Program Manager, expressing my concerns over the use of plutonium as a fuel source. The letter also requested that NASA search for a solar alternative as a fuel source for Cassini and all other missions that would require plutonium RTGs.

When Galileo was launched NASA argued that the solar option was no option, claiming that the technology did not yet exist for deep space probes. At the time of my letter in April, 1991 I reminded NASA that the next mission requiring a plutonium RTG was not until 1995-96. This time should have been used to develop a solar alternative. The fact is that while NASA has tested the Advanced Photovoltaic Solar Array (APSA), no flight testing has been undertaken or even planned. this does not seem like a serious attempt to remove the risk of plutonium contamination for the people of East Central Florida or of the world as a whole (DEIS) 2-55. 6A

I have spent long hours reading thousands of pages of text over the past several years trying to find the reason for why NASA finds it necessary to put people and the environment under the risk of plutonium contamination. The only reason I have found is a weak one at best. Read from your own Executive Summary/Purpose And Need For The Action (DEIS)V. " With the launch of the Galileo spacecraft in 1989; the program began its transition to exploration-type missions to the outer planets using orbiters and atmospheric probes. The Cassini spacecraft would make remote and close-up measurements of Saturn, its atmosphere, rings, moons, and magnetosphere. This information could also provide significant insights into the creation of the solar system and the conditions that led to life on Earth."

Response to Comment 6A:

NASA has invested in research and development of solar power technology. Additionally, the U.S. Department of Energy, the European Space Agency, and other agencies and research centers around the world have been investing in and improving upon solar power technology over the last decade. A number of solar power designs were investigated for the Cassini mission, including designs that would utilize unproven yet promising technology (e.g., the Advanced Photovoltaic Solar Array).

NASA studied many different solar, battery, and other power alternatives, including long life fuel cells, available for Cassini and found none that would meet the mission requirements. A Cassini spacecraft equipped with the highest efficiency solar cells available, or fuel cells, or batteries, or combination of these would make the spacecraft too massive for launching to Saturn. Even if a heavy-lift booster were available that could launch the Cassini spacecraft with a massive solar array, such large solar arrays would introduce insurmountable complexity to the mission and would severely jeopardize the chances for mission success. For fuel cells, even assuming the highest currently available energy fuel-per-unit mass and 100 percent efficient conversion (an idealistic assumption since only 60-70 percent is currently feasible), the resulting dry mass (before adding propellants for the spacecraft engines needed for maneuvers in space) would be about 16,000 kg (17.6 tons). It would not be possible to launch Cassini and place it on a trajectory to Saturn if it were that massive, i.e., it would exceed the launch capability of the Titan IV (Solid Rocket Motor Upgrade [SRMU])/Centaur by more than a factor of 2.

Though NASA continues to invest in research and development of solar power technology, the current state of the technology makes solar power infeasible for the Cassini mission to Saturn. See response to Comment 1B.

Lets look at the purpose for the mission:

The Goal: Again from Executive Summary/Purpose And Need For The Action (DEIS) V. " The goal of the program is to understand the birth and evolution of the solar system."

Well, I quess that can't wait a few years longer to be discovered. If that information is out there it has been for over four and one half billion years, and will be for another four and one half billion years. There is a chance that NASA may have the time to get serious and develop a solar alternative after all. 6B

I will close by asking two things of you. First that you go with the No-Action alternative on Cassini until an alternate fuel source for this mission is ready; solar or any other non-nuclear. Second, only because I do not believe that you will, I request a hearing on the subject where myself and others can intelligently debate the merits of this mission against the risks. 6C 6D

Very truly yours,

Ronald J. Balogh

Enclosures: Letter to Mr. Wright dated April 12, 1991
Letter of request for comment extension to December 20, 1994

RESPONSES TO COMMENTS
Commentor No. 6: Ronald J. Balogh
(Continued)

Response to Comment 6B:

NASA has followed the technical progress in power source technology worldwide for many years. Indeed, a substantial portion of the work in the research and development of solar arrays has been carried out under NASA funding. Historically, NASA's primary selection of a power source for planetary missions has been solar-based, and NASA has continued to use solar power when feasible. While improvements have been made in solar technology, significant breakthroughs are needed to support a mission such as Cassini. Recent international conferences on space power provided no reports of technical breakthroughs that would suggest changing the proposed approach to powering the Cassini spacecraft. The solar power options for Cassini has been extensively reviewed and rejected for this EIS because no U.S. launch vehicle exists with the required lift capacity to conduct a solar powered mission to Saturn using available solar power technologies.

Response to Comment 6C:

See response to Comment 2A

Response to Comment 6D:

NASA appreciates expression of your views and has considered your comment. If you have any new information or additional pertinent data, which would improve the analysis in the Environmental Impact Statement, please let us know

442 Brightwaters Drive
Cocoa Beach, FL 32931
April 12, 1991

Mr. Howard Wright
CRAP/Cassini Program Manager,
Office of Space Science & Applications
Code SL, NASA
Washington, D.C. 20546

Dear Mr. Wright,

I am writing to you to express my concerns over the upof plutonium as a fuel source for the CRAF/Cassini Mission and any future missions which would use plutonium as a fuel source.

I live in the City of Cocoa Beach, Florida, and have for the past 19 years. I consider the Kennedy Space Center to be my neighbor and as such would prefer a friendly peaceful coexistence with them.

Currently I find this proposition of peaceful coexistence to be impossible because NASA and the Department of Energy choose on their own accord, to subject my family and myself, my community and environment to a calculated risk of plutonium contamination. These same risks were placed on my community and myself during the Galileo and Ulysses Missions. I did not understand then nor do I now, how NASA has the right to put me or anyone else, man, animal, or natural environment under a calculated risk of the effects of PuO_2.

The simple truth to this matter Is that NASA, The Dept. of Energy, or the Federal Government itself does not have this right. This is a great injustice to everyone and everything concerned. I cannot accept this action by NASA. It is arrogance of the highest degree.

The facts to support these calculated risk factors can be found in the Final Environment Impact Statement for the Ulysses Mission (Tier 2), Section 4-33. Section 4-33 (Urban Areas) states and I quote, "If mitigation actions were necessary, temporary relocation of the population from their homes and workplaces my be required." It also states the "Deposition could also have a long-term effect on future investigations at any archaeological site. Archaeological digs, by their very nature, disturb the soil surface with digging and shifting operations, which could expose workers and others to PuO_2." What about our own back yards, does this apply to gardening or planting flowers?

Under Inland Water and Ocean, again Section 4-33, it states "some of the waters surroundrng Merritt Island are considered Outstanding Florida Waters. These waters are designated to

RESPONSES TO COMMENTS
Commentor No. 6: Ronald J. Balogh
(Continued)

receive protection which supercedes any other water classifications and standards, and as such prohibits any activity which reduces water quality parameters below existing ambient water quality conditions. An ascent phase accident leading to a release could deposit sufficient amounts of PuO_2 to result in violation of this protection standard." This is a prime example of NASA's arrogance in its risk assessment. It knew full well that it might violate this protection and launched Ulysses anyway in light of what is in NASA's own Environmental Impact Statement, it should be clear why I feel NASA is no longer a neighbor in good standing. They have violated my trust, they have elevated themselves to playing God with my life and where I live. Subjecting me and others to risks, however small, if actualized would be catastrophic.

NASA has argued that the solar option was no option, that the technology did not yet exist for these Deep Space Probes. While that in itself may be arguable the fact that NASA now has until 1995-96 to develop a solar alternative is not. I implore you to plan solar power as the fuel source for this and all future missions where plutonium RTG's would be used.

Please remember that an individuals rights stop where they infringe on anothers, and this should be true for NASA too.

Sincerely,

Ron Balogh

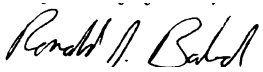
442 Brightwaters Drive
Cocoa Beach FL 32931
December 14, 1994

Dr. Peter B. Ulrich
Solar System Exploration Division
Office of Space Science
NASA Headquarters
Washington, DC 20546

Dear Dr. Ulrich:

I request by way of this letter to extend my comment date to that of December 20, 1994.

Thank You,
Very truly yours,



Ronald J. Balogh

ARNIE WELBER
9710 [illegible]
PLANTATION, FLORIDA 33324 U.S.A.

Dec 14, 94

Dr Peter Ulrich
Solar System Exploration Division
Office of Space Science
NASA HQ
Wash., DC 20546

D-33

Dear Dr Ulrich,

I have a request. Please suspend plans to launch Cassini space probe to Saturn as long as any plutonium is scheduled to be on board.

My request is in accordance with risk of accident is not worth gamble.

Further use of alternative on-board power sources such as solar energy and long-life fuel cells for all future deep space missions

→ over

7A 7B 7C

Response to Comment 7A:

See response to Comment 2A.

Response to Comment 7B:

The total health effects mission risk to the public (considering all launch phases and the Earth-Gravity-Assist trajectory) for Cassini has been provided in Section 4.1.8 of the Environmental Impact Statement (EIS), and is estimated to be small (about 1.8×10^{-3} health effects). See Section 1.4 in the EIS for details on the multiple benefits being derived during mission planning. The Cassini mission to the Saturnian system would represent a rare opportunity to gain significant insights into major scientific questions about the formation of the solar system and the conditions that led to life on Earth, in addition to a host of questions specific to the Saturn system.

Response to Comment 7C:

See response to Comment 6A.

Your cooperation is essential.

Sincerely,

Mr. Arnold J Welbei

SOUTHERN RAINBOW EDUCATION PROJECT(SREP) --- "A FREE-STANDING, MULTI RACIAL, MULTI-ISSUE COALITION DEDICATED TO THE PRINCIPLE THAT GRASS-ROOTS PEOPLE CAN ACT ON THEIR OWN BEHALF AS THEIR OWN ADVOCATES."
COORDINATING COMMITTEE POLICY, 1989

United Church of Christ
COMMISSION FOR RACIAL JUSTICE - SOUTHERN REGIONAL OFFICE

FAX # (205)262-0932(Please Call First) • Correspond To: (205) 288-5754
46 E. Patton Avenue • Montgomery, Alabama 36105

December 15, 1994

Dr. Peter Ulrich
Solar System Exploration Division
Office of Space Science
NASA HQ
Washington, D.C. 20546

Dear Dr. Ulrich:

It is irrational to think that 73 pounds of plutonium 238 and 239 on board a space craft will not be dangerous. To discuss accident "probability" is an admission of its dangers. 8A

We urge you to read Dr. Caldicott's NUCLEAR MADNESS. She states: "It (Cassini--Titan 4 rocket) is so toxic that less than one-millionth of a gram, an invisible particle, is a carcinogenic dose. One pound, if uniformly distributed, could hypothetically induce lung cancer in every person on Earth." 8B

Does science care about human beings and other inhabitants on the earth? We urge you to desist in moving forward with this deadly project. This is not progress; this is destruction. 8C

Sincerely yours,

Gwendolyn M. Patton

Dr. Gwendolyn M. Patton, SREP Program/Field Director

D-35

RESPONSES TO COMMENTS
Commentor No. 8: Southern Rainbow Education Project (SREP)
(Gwendolyn M. Patton)

Response to Comment 8A:

See response to Comment 2A.

Response to Comment 8B:

See response to Comment 4B.

Response to Comment 8C:

NASA and the Department of Energy take very seriously the possibility that an action that they take could potentially result in human fatalities or harm to the environment. Therefore, both agencies have gone to great lengths to reduce the potential for such events, both through design of the radioisotope thermoelectric generators and through design and operation of the spacecraft and its mission. As a result of these designs, the risks of fatalities or harm to the environment from the Proposed Action are considered to be very low. See Sections 4.1.5.2 and 4.2.5.1 of the Environmental Impact Statement for more details on launch phase accident scenarios.

Dec 15, 1994

Dr Peter Ulrich
Solar Systems Exploration Division
Office of Space Science
NASA HQ
Washington DC 20546

Dear Dr Ulrich:

To help make the future safer for this, and future generations, of your family, mine and the rest of ~~innocent~~ members of the human family, as well as yours, STOP the plans of the Cassini plutonium mission. 9A

Even now there has been too much JUNK blasted into our space.

No MORE PLUTonium to be free in the only space shared by all living beings. 9B

I have children and grandchildren, and worry about yours. Don't you?

Sincerly
Anna B. Pilson

ANNA B. PILSON
1479 OLD KINGS RD.
HOLLY HILL, FL 32117-1927

Response to Comment 9A:

We appreciate your concern in taking the time to read and comment on the Draft Environmental Impact Statement (EIS). See response to Comment 2A.

Response to Comment 9B:

NASA and the Department of Energy take very seriously the possibility that an action that they take could potentially result in human fatalities or harm to the environment. Therefore, both agencies have gone to great lengths to reduce the potential for such events, both through design of the radioisotope thermoelectric generators and through design and operation of the spacecraft and its mission. As a result of these designs, the risks of fatalities or harm to the environment from the Proposed Action are considered to be very low. See Sections 4.15.2 and 4 2.5.1 of the EIS for more details on launch phase accident scenarios

CANCEL CASSINI
No Plutonium in Space

We, the undersigned, call upon NASA and our elected officials to suspend plans to launch the Cassini space probe to Saturn as long as any plutonium is scheduled to be on board. Presently, the project calls for 73 pounds of plutonium 238 to generate on-board electricity. The risk of an accident at launch or during its "slingshot fly-by" above the Earth is not worth the gamble. We urge the use of alternative on-board power sources such as solar energy and long-life fuel cells for all future deep space missions.

NAME ADDRESS

1. Donna Jay Ellis/Rt 3-Box 159-2/Spiceland Tx 78669
2.
3. Dear Dr Ulrich —
4. I am a former VISTA VOLUNTEER — US Domestic Peace Corp —
5. I Love my Country, United States of America — The Best
6. Possible Nation To Live, We Enjoy the most freedoms, more civil, human
7. rights than anyone, We are truly a blessed people — But with our
8. rights + priviledges We have obligations as citizens to Voice our
9. opinion to our public officials - for you — + others - to consider our
10. opinions + views as citizens of this country —
11. Mine are —
12. Suspend plans to launch Cassini space probe to Saturn with plutonium aboard
13. Our God - given Earth — people — all creatures — are too precious to
14. all involved — including our God that created it for our use —
15.
16. temporarily - to subject any involved — to such a risk! — Evil!
17.
18. Thank you very much for listening + considering my opinions + views
19. on this — I fulfill my obligation as a responsible citizen here, +
20. respectfully request your comments + decision concerning this
21. situation — I await your response - eagerly —
22. Sincerely
23. Donna Jay Ellis —
24. December 16, 1994
25.

Return to the Florida Coalition for Peace & Justice • P.O. Box 90035 • Gainesville, Fl 32607 • 904/468-3295

10A 10B 10C 10D

D-37

RESPONSES TO COMMENTS
Commentor No. 10: Florida Coalition for Peace & Justice
(Donna Ellis)

Response to Comment 10A:

See response to Comment 2A.

Response to Comment 10B:

See response to Comment 7B.

Response to Comment 10C:

See response to Comment 6A.

Response to Comment 10D:

NASA and the Department of Energy take very seriously the possibility that an action they take could potentially result in human fatalities or harm to the environment. Therefore, both agencies have gone to great lengths to reduce the potential for such events, both through design of the radioisotope thermoelectric generators and through design and operation of the spacecraft and its mission. As a result of these designs, the risks of fatalities or harm to the environment from the Proposed Action are considered to be very low. See Sections 4.1.5.2 and 4.2.5.1 of the Environmental Impact Statement for more details on launch phase accident scenarios.

We appreciate your concern in taking the time to respond to the draft Environmental Impact Statement.

South Dakota Peace and Justice Center

P.O. Box 405
Watertown, SD 57201
(605)882-2822

I want to see
a mighty flood of justice
a torrent of doing good
Amos 5:24

December 16, 1994

Dr. Peter Ulrich
Solar System Exploration Division
Office of Space Science
NASA HQ
Washington, DC 20546

Dear Dr. Ulrich,

In the minds of so many Americans, the cost of space programs is justified chiefly because of the spinoff of technologies that can help our nation and the world realize a better life.

Let us pose the question: which technology development would advance the quality of life—development of plutonium power systems for deep space probes or development of solar-powered systems for deep space probes?

Given that plutonium is fiendishly toxic and carcinogenic and given that solar-powered systems are well within technical reach for space probes and could spin off into sustainable energy technology that the earth is literally dying for want of, the answer to the question is obvious. – 11A

Why no serious commitment to solar power for the 1997 Cassini mission to Saturn? I can assure you that the 700 plus members statewide of the South Dakota Peace & Justice Center will be vigorously lobbying against funding for NASA projects, such as a plutonium-powered Cassini mission, which fly in the face of common sense at the least and may even be said to demonstrate a death wish for our culture and our living world. – 11B

Sincerely,

Joanne Koster

Joanne Koster, staff

copies to Sen. Pressler, Sen. Daschle,
Rep. Tim Johnson, Bruce Gagnon

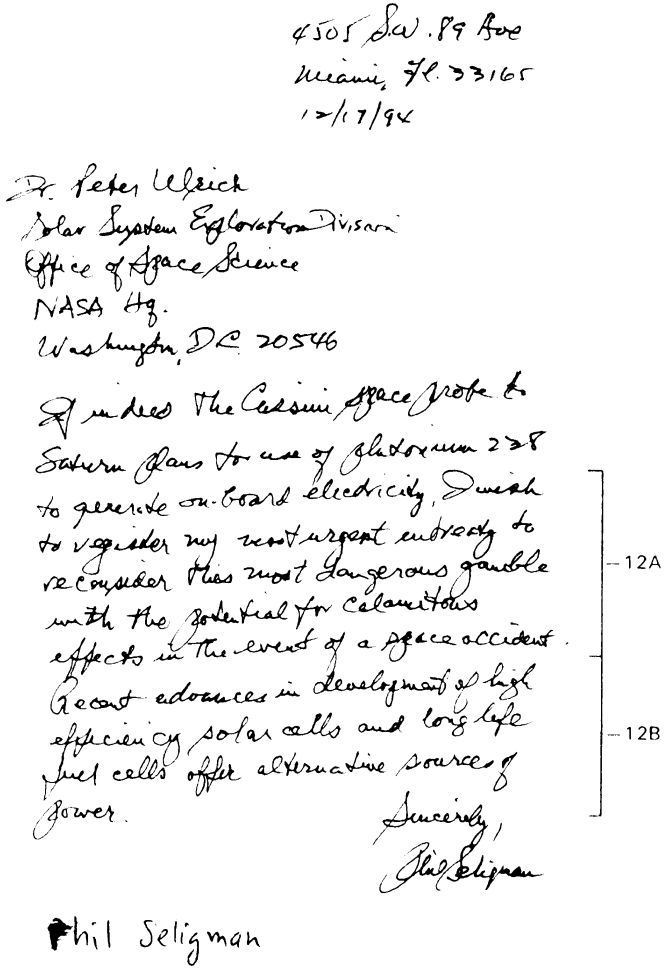
Printed on recycled paper

Response to Comment 11A:

NASA continues to invest in solar and other technologies for space applications. NASA's investment along with that of other Federal research and development programs has yielded advances in solar technologies that are in widespread use today. See also response to Comment 3D.

Response to Comment 11B:

NASA has estimated the risks from plutonium (Pu-238) dioxide onboard the Cassini spacecraft and has found the risks to the world population and our planet to be very low. The risks from the launch of Cassini would be lower than many of the risks that we face in our everyday lives (see Table 4-20 in the Environmental Impact Statement). A wide range of potential accident scenarios was evaluated. See also response to Comment 1K.



4505 SW. 89 Ave
Miami, FL. 33165
12/17/94

Dr. Peter Ulrich
Solar System Exploration Division
Office of Space Science
NASA Hq.
Washington, DC 20546

Indeed the Cassini space probe to Saturn plans to use of plutonium 238 to generate on-board electricity, I wish to urge/ider my most urgent entreaty to reconsider this most dangerous gamble with the potential for catastrophic effects in the event of a space accident. Recent advances in development of high efficiency solar cells and long life fuel cells offer alternative sources of power.

Sincerely,
Phil Seligman

Phil Seligman

12A

12B

Response to Comment 12A:

NASA appreciates expression of your views. Please see response to Comment 7B for more information.

Response to Comment 12B:

See responses to Comments 3D.

5910 440th St
Primghar, Ia
12-17, 1994

Dr Peter Ulrich
Solar System Exploration Div.
Office of Space Science
NASA Headquarters
Washington, D.C. 20546

Dear Peter Ulrich:

You and the Department of Energy have indicated in the Impact Statement for the 1997 Cassini space mission to Saturn that the 73 pounds of plutonium 238 & 239 on board will be of little danger. — 13A

We urge you to restudy and realize the danger that is there.

Dr. Helen Caldicott writes about plutonium in her book Nuclear Madness. "It is so toxic that less than one-millionth of a gram, an invisible particle, is a carcinogenic dose. One pound, if uniformly distributed, could hypothetically induce lung cancer in every person on earth." — 13B

The risk of an accident at launch or during its "slingshot fly-by" above the Earth is not worth the gamble. — 13C

We urge the use of alternative on-board power sources such as solar energy and long-life fuel cells for all future deep space missions. — 13D

Warren & Olive Wilson

Response to Comment 13A:

NASA considers the risk analysis presented in the Environmental Impact Statement (EIS) to be the best estimate based on the available information at the time. As part of the launch approval process, the Department of Energy will be preparing a more in-depth evaluation of the risks as part of the Final Safety Analysis Report (FSAR). NASA will review the FSAR, when it becomes available, and will evaluate the information presented for differences, if any, in the estimates of the potential radiological consequences and risks.

Response to Comment 13B:

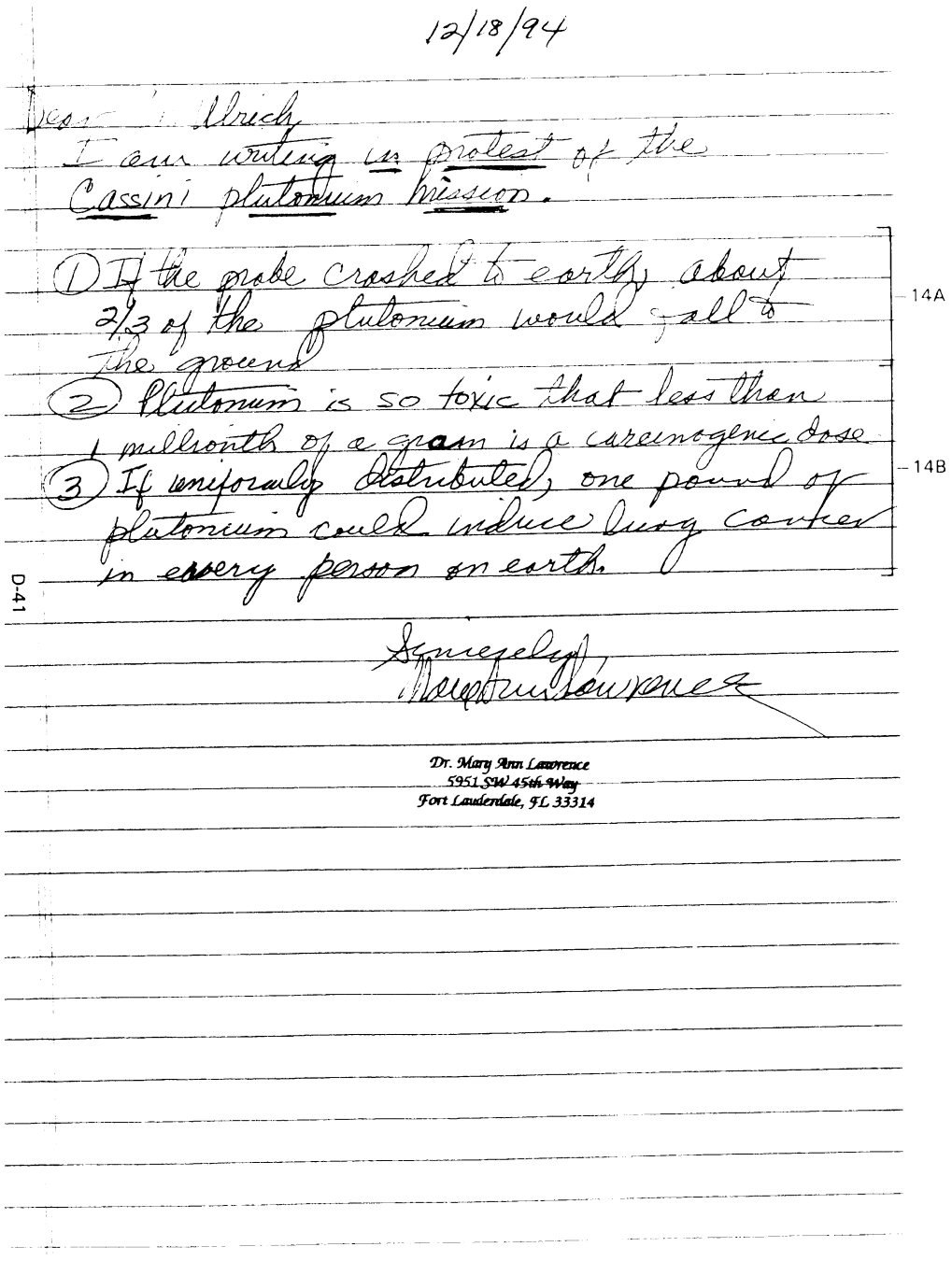
See response to Comment 4B.

Response to Comment 13C:

The total health effects mission risk to the public (considering all launch phases and the Earth-Gravity-Assist trajectory) for Cassini has been provided in Section 4.1.8 of the EIS, and is estimated to be small (about 1.8×10^{3} health effects).

Response to Comment 13D:

See response to Comment 3D.



12/18/94

Dear Mr. Ulrich

I am writing in protest of the Cassini plutonium mission.

(1) If the probe crashed to earth, about 2/3 of the plutonium would fall to the ground. — 14A

(2) Plutonium is so toxic that less than 1 millionth of a gram is a carcinogenic dose. — 14B

(3) If uniformly distributed, one pound of plutonium could induce lung cancer in every person on earth.

D-41

Sincerely,
Mary Ann Lawrence

Dr. Mary Ann Lawrence
5951 SW 45th Way
Fort Lauderdale, FL 33314

RESPONSES TO COMMENTS
Commentor No. 14: Dr. Mary Ann Lawrence

Response to Comment 14A:

The inadvertent reentry accident during an Earth swingby is addressed in Section 4.1.5.4 and Appendix B of the Environmental Impact Statement (EIS). The analyses of this accident show that about one-third of the plutonium dioxide fuel will be released as particles at high altitudes. During the reentry of these particles, about 37 percent will be converted to vapor and small particle sizes, which remain and disperse in the atmosphere gradually reaching the ground over many years. The larger particles will reach the ground much faster under the influence of gravity. The unreleased two-thirds of the fuel is contained in GPHS heat source components that survive the atmospheric reentry. Intact modules will fail and release some fuel if they impact on hard rock and the graphite impact shells will fail and release some fuel if they impact land. Impacts on hard rock are expected to occur only 4 percent of the time and on land masses about 25 percent of the time. All these factors affecting the behavior of the RTGs in the unlikely event of an inadvertent reentry accident are considered in the information contained in the EIS.

Response to Comment 14B:

See response to Comment 4B.

NATIONAL SPACE SOCIETY

December 19, 1994

Dr. Peter B. Ulrich
Solar System Exploration Div
Office of Space Science
NASA Headquarters
Washington, DC 20546

RE: *Cassini Draft Environmental Impact Statement*

Dear Mr. Ulrich:

I am writing in response to the draft environmental impact statement for the *Cassini* mission. Before providing my comments, however, I wish to note that the National Space Society commented on many topics raised by the *Cassini* draft EIS in an earlier proceeding. That was the notice of February 27, 1991, published at 56 Federal Register 8219. The *Cassini* Draft EIS makes no reference to those comments, and does not seem to take them into account. That is frustrating; we are often told that the voices of grassroots space interests should be heard more, only to discover that when we talk, people at NASA aren't always listening. I am attaching a copy of the letter in question for your information. — 15A

Comments on the EIS

Our strongest complaint, echoing the comments that we made almost four years ago, is that the EIS understates the costs of a "no-action" alternative. As has consistently been the problem with NASA Environmental Impact Statements for deep-space missions (see, for example, the *Ulysses* and *Galileo* Statements), the *Cassini* draft EIS fails to recognize the very significant adverse *environmental* effects of a no-action alternative. Instead, the costs of cancelling the mission are characterized strictly in terms of lost scientific opportunities.

Although we agree that there would be substantial costs in terms of lost scientific knowledge, we do not believe that these are the only costs involved. The rather artificial and truncated scope of most Environmental Impact Statements tends to overstate the importance of risks, and understate the importance of benefits, in evaluating whether to proceed. NSS believes that the long-term environmental benefits stemming from a better understanding of our solar system, and the material and energy resources available there, are significant and should be weighed against the short-term environmental risks involved in undertaking the missions. — 15B

922 PENNSYLVANIA AVE., SE
WASHINGTON, DC 20003
202/543-1900
FAX 202/546-4189

D-42

RESPONSES TO COMMENTS
Commentor No. 15: National Space Society
(Glenn Harlan Reynolds)

Response to Comment 15A:

While not directly referencing the comments contained in the National Space Society letter of April 12, 1991, the Environmental Impact Statement (EIS) attempted to be responsive to the three concerns raised-optional power sources. Earth flyby architecture, and the No-Action alternative. Options for onboard power sources for electric power requirements are addressed in Section 2.6.3 of the EIS with supporting documentation prepared by the Jet Propulsion Laboratory (JPL) (see JPL 1994, *Cassini Program Environmental Impact Statement Supporting Study, Volume 2: Alternative Mission and Power Study.* JPL Publication D-11777, Pasadena, CA, July 1994). In addition, NASA's response to Draft EIS Comment 6A provides additional amplification on the issue of optional power sources. The Earth flyby architecture is discussed in detail in Sections 2.2, 2.4 and Appendix B with supporting documentation prepared by JPL (JPL 1993f, *Cassini Environmental Impact Statement Supporting Study, Volume 3: Cassini Earth Swingby Plan.* JPL Publication No. D-10178-3, Pasadena, CA, addendum dated August 1994). See response to Comment 15B for a discussion of the No-Action alternative.

Response to Comment 15B:

See Section 4.4 of the EIS for a discussion of the No-Action alternative. NASA agrees that the potential long-term environmental benefits from understanding the solar system and the material resources there, would be significant. Missions such as Cassini are a significant part of the U.S. space exploration program and afford an opportunity to gather data from both planned and unplanned activities. As with other NASA missions, history suggests that the ultimate value of such deep space exploration may well be in something we cannot envision at the current time-the serendipitous potential that makes exploration so exciting and full of discovery. Solar system exploration improves our understanding of the chemical arid physical conditions needed to foster the development of life. The benefit society reaps from this new understanding is difficult to quantify, but it is notable that the study and understanding of many terrestrial problems (e.g., global climate change) have benefitted from techniques and theories arising from space exploration.

We believe that missions such as Cassini will play a vital role in helping us learn to identify resources that may later be exploited to the benefit of mankind. Over the long term, we believe that the entire solar system is a part of humankind's resource base, and that a key environmental goal is to move polluting industries -- including extractive ones -- off the earth's surface and out of its biosphere. In this way, the long term health of the earth's environment is entirely consistent with -- and in fact assured by -- a vigorous program of space exploration and settlement. (See our position paper, "Outer Space and the Global Environment," a copy of which is attached, for more detail on this topic). — 15B

Such a program of space settlement has already been endorsed by President Clinton during the campaign, (and by his predecessor, President Bush, in his July 20, 1989 speech) and by Congress, in the Space Settlements Act of 1988, Pub. L. 100-685, 102 Stat. 4083 (1988). If we are to continue to lay the groundwork (so to speak) for later human expansion throughout the solar system, missions like Cassini play an essential role --just as early exploration missions, like those of Lewis and Clark or Zebulon Pike, played a vital role in the opening up of the American West for settlement.

Abandoning -- or even substantially delaying -- these missions of exploration would have significant costs in terms of impeding progress toward this important national goal, and a substantial portion of those costs would be environmental in nature. We believe that NASA has the responsibility -- both statutory and moral -- to weigh this cost in the balance in assessing the "no action" alternative. Therefore, we believe that the "no action" alternative should be invoked *only* when the risks of a mission are unacceptable beyond any reasonable doubt. — 15C

For these reasons, we recommend the insertion of the following paragraph at section 4.4, Draft EIS page 4-103:

> A risk of the no-action alternative is that we will fail to develop the understanding of the dynamic processes governing climate and environment on other planets that will permit us to fully understand those processes on our own planet, with the concomitant risk that we may not recognize dangers to the earth's environment stemming from human activities in time to prevent significant environmental harm. A further risk of the no-action alternative is that a failure to lay the groundwork for a spacefaring civilization that makes use of off-earth resources will retard the creation of such a civilization, lengthening the period of time when human activities will impose a strain on the environment and resources of the earth.

An environmental impact statement that fails to recognize these costs of mission cancellation is inadequate.

The Politics of RTGs

Our discussion of the *Cassini* EIS would be incomplete without mentioning that NASA has come under substantial political pressure from antinuclear activists regarding its use of radioisotopic thermoelectric generators in various deep-space probes such as *Cassini*,

In preparing Section 4.4 of the Draft EIS, NASA attempted to confine itself to the more quantifiable impacts of the No-Action alternative. In doing so, NASA tended to be somewhat conservative. NASA therefore has revised the text of Section 4.4 to emphasize the loss of potential benefits and knowledge that would be gained from the Cassini mission, such as our understanding of Earth's processes.

Response to Comment 15C:

Council on Environmental Quality (CEQ) regulations require that NASA evaluate the environmental impacts of the No-Action alternative along with those of the Proposed Action and other reasonable alternatives.

Ulysses, or *Galileo*. In the case of the *Ulysses* mission, NSS participated as a friend-of-the-court in support of the mission, and we will likely do so with regard to *Cassini* if litigation ensues.

The opposition of antinuclear groups to RTG-powered deep space missions has more to do with publicity-seeking and direct-mail fundraising than with any real concerns about the safety of RTGs. In addition, some of these groups fear (against all reason) that such programs are simply stalking-horses for some kinds of massive nuclear-powered antimissile battle stations that they expect the Department of Defense to construct. While NSS neither supports nor opposes military uses of space as such, we consider these fears to be both absurd and irrelevant to the question of whether missions such as *Cassini* are safe. We remain concerned, however, as we were in our 1991 letter, that fear of political opposition from antinuclear groups may cause NASA in the future to adopt mission architectures or strategies that are driven by political, rather than engineering concerns. We stress that any mission design should be based on sound scientific and engineering judgment, not on political concerns. 15D

Conclusion

We consider the *Cassini* draft EIS to be an adequate statement (if occasionally an overstatement) of the risks involved in the mission. Its chief deficiency lies in a failure to address the very real environmental consequences of a no-action alternative. We urge the revision of the *Cassini* draft EIS to reflect this important concern.

Sincerely,

Glenn Harlan Reynolds
Executive Chairman, National Space Society

attachments:
Comments to Howard Wright, 4/12/1991
NSS Environmental Position Paper
NSS Comments, *Ulysses* Draft EIS, 4/6/1990

Response to Comment 15D:

The design of the Cassini mission and the spacecraft will be based on engineering and environmental analyses taking into account scientific benefits, risk assessment and available resources.

Mr. Howard Wright

CRAF/Cassini Program Manager
Office of Space Science and Applications
Code SL
National Aeronautics and Space Admin.
Washington, D.C. 20546

RE: Outer Solar System Exploration Program, 56 FR 8219

Dear Mr. Wright:

In response to your notice of February 27, 1991, published at 56 Federal Register 8219, here are the views of the National Space Society regarding environmental issues associated with new outer solar system exploration programs. The National Space Society is a grassroots public interest organization, with over 120 chapters and over 30,000 members, dedicated to the creation of a spacefaring civilization. That goal underlies the character of our response.

In your notice, you listed three primary issues to be addressed in the CRAF/Cassini Environmental Impact Statement. These issues involve the feasibility and desirability of the following alternatives to the baseline
mission plan: (1) use of alternative (non-nuclear) power sources; (2) use of trajectories involving planets other than earth for fly-by assists (or, in a more accurate formulation, a ban on earth gravity assists); and (3) the "no action" alternative. NSS' views are as follow.

Alternative Power Sources

NSS takes no position on whether alternative power sources are feasible; we consider that to be an engineering question which is far more thoroughly within NASA's competence than within our own. However, we believe that this question should continue to be treated

as an engineering question. Notwithstanding political agitation by various antinuclear groups (whose real agenda seems more related to stopping the Strategic Defense Initiative than to improving civilian space mission planning), NSS believes that NASA should choose power sources based solely on engineering concerns: what configuration best assures that the mission will achieve maximum capability (including reliability) at minimum cost. NSS would strongly oppose the selection of an alternative nonnuclear power source purely for political reasons. We believe that if NASA were to do so, it would be violating its responsibility to taxpayers to produce the best mission at the least cost.

Having said this, we do believe that where solar power is just as suitable on an engineering basis as nuclear power, the safety concerns relating to the use of space nuclear power may appropriately serve as a tie-breaker. Although we consider the risks involved in using nuclear power onboard deep space probes to be minor, they are not zero, and are undoubtedly greater than those associated with the use of solar power.

Ban on Earth Flyby Architectures

NSS' views on the use of earth flyby assists are very similar to those expressed above. We believe that the risks associated with such endeavors are low, and do not believe that mission capabilities should be sacrificed, or missions canceled, solely in order to avoid an earth flyby. Once again, we believe that decisions on whether to use an earth flyby should be made solely on the basis of sound engineering and astrodynamical judgment. Where the use of gravity assists involving planets other than earth is equally effective in terms of mission capabilities, we would favor avoiding an earth flyby, but again we regard the risk involved in such flybys to be so minor as to make it no more than a tie-breaker in deciding between other-wise comparable trajectories.

The "No Action" Alternative

NSS' views are strongest in regard to the question of how the "no action" alternative should be evaluated. The rather artificial and truncated scope of most Environmental Impact Statements tends to overstate the importance of risks, and understate the importance of benefits, in evaluating whether to proceed. NSS believes that the long-term environmental benefits stemming from a better understanding of our solar system, and the material and energy resources available there, are significant and should be weighed against the short-term environmental risks involved in undertaking the missions.

RESPONSES TO COMMENTS
Commentor No. 15: National Space Society
(Glenn Harlan Reynolds)
(Continued)

We believe that missions such as Cassini -- and, much more significantly, CRAF--will play a vital role in helping us learn to identify resources that may later be exploited to the benefit of mankind. Over the long term, we believe that the entire solar system is a part of humankind's resource base, and that a key environmental goal is to move polluting industries -- including extractive ones -- off the earth's surface and out of its biosphere. In this way, the long term health of the earth's environment is entirely consistent with -- and in tact assured by a vigorous program of space exploration and settlement. (See our position paper, "Outer Space and the Global Environment," a copy of which is attached, for more detail on this topic).

Such a program of space settlement has already been endorsed by President Bush - in his speech of July 20, 1989 -- and by Congress, in the Space Settlements Act of 1988, Pub. L. 100-685, 102 Stat. 4083 (1988). If we are to continue to lay the groundwork (so to speak) for later human expansion throughout the solar system, missions like CRAF and Cassini play an essential role --just as early exploration missions, like those of Lewis and Clark or Zebulon Pike, played a vital role in the opening up of the American West for settlement.

Abandoning -- or even substantially delaying -- these missions of exploration would have significant costs in terms of impeding progress toward this important national goal. We believe that NASA has the responsibility --- both statutory and moral -- to weigh this cost in the balance in assessing the "no action" alternative. Therefore, we believe that the "no action" alternative should be invoked only when the risks of a mission are unacceptable beyond any reasonable doubt.

Conclusion

The space mission-planning process seems to have been politicized in the wake of the Ulysses and Galileo launch controversies. NSS believes that this politicization is unfortunate, and that those antinuclear groups who have opposed such launches do not reflect the public interest, and in fact are themselves not particularly interested in the launches and missions in question except as an opportunity to open an additional front in their ongoing campaign against the Strategic Defense Initiative. NSS, as a group favoring the expansion of civilization into outer space, takes no position on the Strategic Defense Initiative. However, we would not wish to see programs that we do support become the victims of "collateral damage" from someone else's war. For this reason, we urge

RESPONSES TO COMMENTS
Commentor No. 15: National Space Society
(Glenn Harlan Reynolds)
(Continued)

again that NASA make its decisions on mission power and architecture solely on the basis of sound engineering judgment, and that it not allow it-self to be swayed by the political campaigns of policy entrepreneurs.

Sincerely,

Glenn Harlan Reynolds
Chair, NSS Legislative Committee
and Member, Board of Directors

Attachment:
NSS Environmental Position Paper

Outer Space and the Global Environment: An NSS Position Paper

I viewed my mother quite differently when I was in the womb than I did after birth. Afterward, I was able to take more responsibility for her.
-- Astronaut Russell Schweickart

Human activity in outer space has already had important ramifications for the Earth. As early as 1949, astronomer Fred Hoyle predicted that "Once a photograph of the Earth, taken from the outside, is available, a new idea as powerful as any in history will be let loose." And so it was, once Apollo astronauts brought back photographs of the Earth from hundreds of thousands of miles away. Among the ideas let loose was the concept of the Earth as a whole, as a system of interrelated parts in which national boundaries were of little importance. Our planet, seen as a small, fragile object amid a sea of blackness and emptiness, became widely known as (significantly enough) "spaceship Earth. It is no coincidence that the first Earth Day took place shortly after these photos became available, and used one of them as its symbol. The consequences of this change in attitudes continue to be played out.

That change would be colossally important even if it were the only impact of the space program on environmental matters. But it is not. On closer examination, it is clear that the creation of a spacefaring civilization and the preservation of Earth's environment are not only complementary, but are in many ways the same. In fact, over the long term, we believe that human expansion

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RESPONSES TO COMMENTS
Commentor No. 15: National Space Society
(Glenn Harlan Reynolds)
(Continued)

into space is not only essential to the preservation of Earth's environment, but in fact will play an important role in promoting the spread of life throughout the solar system and beyond, something that we regard as perhaps humankind's most important role. Following are some examples, in both the near term and the longer term, of how space activity is part of a sound strategy for preserving and restoring environmental quality here on Earth. And following those examples is a larger view of why both environmental preservation and human expansion throughout the solar system are important.

Near Term: Space as a Global Management Tool

Short of killing off the human species altogether, preserving the Earth's environment requires that we understand the impact that our activities have on our planet, and adjust our activities to minimize the harm that we do. This kind of understanding is hard to come by, but many space-related projects play a part.

First, satellite observation of the Earth is vital. It was a NASA satellite, Nimbus 7, that first verified the Antarctic ozone hole - an observation that led to our understanding of how chlorofluorocarbons (CFCs) can lead to the depletion of stratospheric ozone, which in turn led to the beginning of efforts to bring CFC pollution under control.. Similarly, LANDSAT and SPOT photos have dramatized the extent of deforestation in the Amazon, of desertification in Africa and Asia, and of ocean pollution in

many areas. And, aside from spotting crisis situations, satellite imagery plays a vital part in the mundane-but-important process of managing farmland, forests, and public lands generally. The planned Earth observing System, better known as "Mission to Planet Earth," will drastically expand the amount of data available, and, with it, our ability to understand the Earth in order to save it.

Second, the understanding we gain from observing other parts of the solar system also serves to increase our understanding of the Earth. Studies of the Martian climate by the Mariner and Viking probes were instrumental in the development of climatic models that were later used in assessing threats like global warming and nuclear winter. Studies of the solar climate by probes like Ulysses will shed additional light on global warming and ozone depletion, and give us some sense of the extent to which Earthly climate change is driven by solar variation. And studies of other planets in general -- from Venus, with its runaway greenhouse effect, to Mars, with not enough of one -- underscore the fragility of climate, and the preciousness of our Earth. Good planets, as we have learned, are hard to find.

RESPONSES TO COMMENTS
Commentor No. 15: National Space Society
(Glenn Harlan Reynolds)
(Continued)

Longer Term: Space as Safety-Valve

There are many -- perhaps too many -- people on Earth. For several decades, at least, their numbers are likely to expand. This large population puts enormous, and growing, stress on the Earth's biosphere and resource base. Yet, paradoxically, it is not the creation of too much wealth, but the creation of too much poverty, that has produced most of the Earth's environmental problems.

Poverty is bad for the environment. Poor people burn wood for fuel -- leading to deforestation and aggravating the greenhouse effect. Poor people cut down rain forests for farmland, and mediocre farmland at that, with the same results. Poor people have many children, increasing the pressure on resources further, and making it harder to break the cycle of poverty.

But this does not mean that the industrial nations are less to blame. For they, too, are poor, except by comparison with those worse off. They burn oil and coal for fuel, creating acid rain and contributing to global warming. They remove large quantities of resources from the Earth's crust -- so large that the poorer countries could never equal their living standards, even in the absence of other barriers, because there is not enough to go around. And their economies pollute the Earth so much that elevating the poorer nations to their standards of living, if it were possible at all, would be ruinous to the Earth's ecosystem.

In both cases, though, the reason isn't malevolence, or immorality. "Rich" and poor nations alike do the damage that they do largely because they have no other way to live -- because they lark the resources and knowledge needed to do better. Space programs can change that. If we draw on space resources, then we are not limited to the resources, whether of materiel or energy, locked in the Earth's crust, resources that will run out within a few centuries no matter how stringently they are conserved. Within a century, and perhaps much sooner, it will be practical to obtain many minerals from the Moon and asteroids, meaning that destructive and unsightly mining and smelting on Earth will no longer be needed. Energy, too, can come from space: from orbital solar power plants, from similar facilities on the Moon, or even potentially from fusion plants powered by lunar Helium-3, eliminating the use of fossil fuels.

Over the long term (meaning perhaps two human lifetimes), it will be possible to move most polluting industries off the Earth, and into space. And the industries that remain can be made far less polluting through the use of clean, inexpensive energy derived from space. If this is done, Earth can be returned to a

level of environmental health not seen since the industrial revolution began -- and without the need to kill off humanity by the billions, or to condemn poor nations to poverty for eternity.

The Big Picture: Space and the Expansion of Life

> The Earth is the cradle of humanity -- but one cannot remain in the cradle forever.
>
> --Konstantin Tsiolkovsky

For as long as anyone remembers, humans have been wondering about their place in the world. Why are we here? And what makes us different from the rest of life on this planet?

For the past several decades, there has been at least one major difference. We are the only species that has the ability to leave. Space activists have not fully considered the environmental implications of this fact -- but then, neither have environmentalists.

There are two possible ways to view the environmental movement. In its misanthropic form, it may be seen as based on a Romantic hostility to humanity and its works. Space has nothing to offer those who hold this negative view. But in a broader form, the environmental movement can be seen as dedicated to the flourishing of life, both in quantity and diversity, as a primary good. In a more positive formulation, the works of humanity

are good or bad depending on whether they contribute to the flourishing of life, or harm it.

The expansion of humanity into space has a lot to offer those who hold this view. As humanity settles space, it will carry parts of the Earth's biosphere -- plants and animals -- along with it. Perhaps this is humanity's real role. If one believes in the so-called Gaia hypothesis, under which all life on Earth can be viewed in a sense as one meta-organism, perhaps our role is that of meta-gametes, carrying the seeds of life throughout the solar system, and eventually beyond, thus spreading life to places where it could not have evolved on its own, and which it could not have reached in other ways. And even if one does not adhere to the Gaia hypothesis, the spreading of life seems a good thing in itself.

This is a vital role for the space program, but not just for any space program. To support the "greening of the solar system," we must have a robust, vigorous space program that does more than merely send robotic probes to distant planets. We must have a space program capable of fostering a true spacefaring civilization, one in which travel throughout the solar system -- and eventually beyond it -- is routine, and comparatively affordable. That is NSS' goal and it is, we think, one that is profoundly in accord with the true goals of the environmental movement.

NATIONAL SPACE SOCIETY

April 6, 1990

Dr. Dudley G. McConnell
NASA Headquarters
Code EL
Washington, DC 20546
Via Express

RE: NSS Comments on Ulysses Draft EIS

Dear Dr. McConnell:

In response to NASA's request for public comments, 55 Fed. Reg. 6326 (February 22, 1990), the views of the National Space Society (NSS) follow. NSS is a nationwide grassroots organization dedicated to the exploration and development of outer space and to the creation of a spacefaring civilization. Formed by the merger of the National Space Institute and the L5 Society, NSS has tens of thousands of members nationwide, and affiliate organizations throughout the world. Furthermore, NSS' views generally represent those of the substantial majority of all Americans that strongly supports an expansive and ambitious space program.

Scope of Comments

Because NSS believes that NASA has examined the issues in more than adequate scope and detail, and because NASA possesses expertise and experience in dealing with missions of this kind that no private organization can possibly hope to equal, NSS will not engage in a detailed examination of the technical issues addressed in the Environmental Impact Statement, particularly as NSS would have little to add to NASA's already thorough treatment. Instead, NSS will stress items omitted from the EIS, or given inadequate treatment therein, that NSS believes should have an important impact on the decision whether to proceed with the mission. In short, NSS is of the opinion that the EIS takes inadequate cognizance of the importance of the Ulysses mission in terms of the benefits, as well as potential detriments, that the mission will involve for the earth environment.

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The Ulysses Mission and Its Importance

The Ulysses mission is of vital importance for a variety of reasons, some connected with scientific information gathering in the abstract, others connected with more down-to-earth problems. Since Ulysses will gather information regarding previously unobserved solar regions (the poles), it is an essential part of gathering a meaningful understanding of how the Sun, and the solar climate, works. One would not, after all, expect to understand the earth's climate without understanding what goes on at the poles; indeed, most climatological theories today suggest that many important climatic processes take place only at the poles. Similarly, an understanding of what goes on at the Sun's poles is vital to understanding the solar climate, and Ulysses provides an essential first step.

Such understanding has importance from a purely scientific standpoint, of course. Solar scientists have a lot to learn, and the understanding that they achieve will also be of use in understanding other stars as well: the Sun, after all, is the only star we are currently able to observe at close range. In addition, understanding the solar climate will have important ramifications for our understanding of solar-driven events that spread throughout the solar system: the solar wind, various magnetic and plasma effects, solar flares, and so on.

It is worth stressing, however, that abstract scientific benefits are not the only ones likely from Ulysses. There are also many concrete benefits that will come from such knowledge, benefits with considerable down-to-earth importance. These include:

- Better understanding of the earth's climate: Since the Sun is the earth's primary source of heat, variations in solar output can have dramatic impact on the earth's climate. Existing climatological models are unable to take these into account in any significant way, because the mechanisms of solar variation are, to put it mildly, poorly understood. If we are to understand matters such as global warming and other forms of climatic change, we must have more information concerning the solar climate, of the sort that Ulysses can provide.

- Better understanding of the space environment: A

key hazard to manned flight in outer space is excess solar radiation stemming from solar flares. Such flares also pose a hazard to some kinds of spacecraft, and when particularly severe even to earth-based radio communications. A better understanding of the solar climate may lead to an ability to predict solar flares, and to adapt operations to avoid the worst of them. This will be particularly important in the context of space station operations and long-duration manned flights such as the manned Mars mission planned by the President.

· Better understanding of the earth/space interface: The changing solar cycles interact substantially with the earth's magnetic field and with the highest reaches of the upper atmosphere, at an altitude of 100-300 miles, approximately. Expansion of the upper atmosphere during part of the cycle is an important mechanism for removing debris from low-earth orbits. Better understanding of this process will be important in determining ways of addressing the orbital debris problem, which as recent Congressional hearings made clear is of considerable importance already.

Of course, by stressing these concrete benefits NSS does not mean to suggest that abstract scientific knowledge is not important. Such "abstract" knowledge always turns out to have important concrete uses in the end, though often those uses are entirely unforeseeable at the time the knowledge is arrived at.

Adequacy of the Ulysses EIS

In General

Having reviewed the draft Ulysses Environmental Impact Statement, NSS is of the opinion that it is entirely adequate. NASA has reviewed and considered all relevant factors of importance, and in particular has examined the possibility of catastrophic failure resulting in release of radioactive material from the onboard Radiothermal Generators with considerable thoroughness.

Such examinations are of necessity imprecise and subject to dispute; if risks were entirely clear, and all possible modes of failure obvious, we would live in a very different world indeed. And any authoritative

determination is nonetheless open to dispute -- even judicial opinions fail to convince everyone. However, within the limits of the real world, NASA has done a more than adequate job, certainly no one else has the expertise or experience to do better, and the excellent safety record of radiothermal generators in practice suggests that NASA's estimates cannot be too far off base. Some imponderables remain, of course, but that is the nature of risk assessment and it is foolish to pretend otherwise. Given that radiothermal generators are far less risky than nuclear reactors (with which they arc often confused by the public) and given the lack of alternatives, NSS believes that the level of risk is acceptable, and that the EIS identifies and correctly analyzes all significant factors which can be determined in advance.

NSS also agrees that there are no reasonable alternatives to the use of radiothermal generators for the Ulysses mission, As correctly noted in the EIS, available alternative power sources pose unacceptable costs or risks to the mission -- and, in general, simply would not work at the distance from the Sun (that of Jupiter) at which most of the mission's important phases will (and must) take place.

Errors and Inadequacies in the EIS

NSS would, however, like to take issue with NASA's statement (Draft EIS at pp. v, 4-30) that " [t]here are no environmental impacts associated with the no-action alternative." While this statement ray be true from the rather artificial perspective that seems inevitable in the context of an Environmental Impact Statement, it is in fact false. Pursuing a "no-action" alternative -- that is, scrubbing the mission -- would in the real world have negative consequences for the environment that could in fact be quite severe, and that NASA should take into account in determining whether to proceed with the mission.

These consequences would stem from the failure to acquire the information regarding the solar climate, and its interaction with the earth's climate and the earth/space interface, that was described earlier. In the absence of such information, earthbound climatological models will inevitably suffer, understanding of the extent of the (already severe) orbital debris problem will be reduced, and efforts to ameliorate environmental problems on the earth will be

handicapped, perhaps severely. There are no planned missions duplicating (even in part) Ulysses' functions. Given the long lead-times present for Solar System Exploration, this means that a cancellation of Ulysses would result in a major and long-lasting gap in our knowledge of these important topics.

Furthermore, cancellation of Ulysses would result in a squandering of human and intellectual capital, and in very significant demoralization costs among the planetary science community. Leaving aside the specific benefits that Ulysses itself will provide, no one would disagree that space exploration and planetary science have been of enormous benefit to our understanding of the earth environment -- and, in fact, have been an enormous source of consciousness-raising regarding the importance of environmental issues in general. it is no accident that the first Earth Day took place shortly after the first pictures of the earth from the Moon became available (futurist Arthur C. Clarke predicted that such photos would have just such an impact as early as 1959), or that the environmental movement has adopted just those photos as an important symbol. Furthermore, knowledge gained by satellite observations -- both of the earth and of other planets -- has had dramatic impact on our understanding of specific problems such as the Antarctic ozone hole. Senator Albert Gore, Jr. recently discussed this issue, see Gore, Outer Space, the Global Environment, and International Law: Into the Next Century, 57 Tenn. L. Rev. 329 (1990), and a number of environmental commentators have made similar points. See, e.g., Hartmann, Space Exploration and Environmental Issues, 6 Environmental Ethics 227 (1984), and Beyond Spaceship Earth: Environmental Ethics and the Solar System (Sierra Club Press, 1986): G. Reynolds & R. Merges, Outer Space: Problems of Law and Policy 195-98 (1989).

Cancelling the Ulysses mission would have a chilling effect on such enterprises in the future, as scientists would be reluctant to invest years of their time in a mission that might be cancelled at the last moment for environmental reasons. Thus, the losses to the environment from cancelling Ulysses might go far beyond those specific benefits promised by Ulysses itself.

In addition to the loss of these concrete benefits, the abstract knowledge gained from Ulysses would be lost. That is not only a loss to the scientific community, but also a loss of other concrete benefits

(currently unforeseeable but no less important for that) likely to be derived from that knowledge. NSS understands that the nature of EIS drafting, and the assumptions and pressures inherent in the risk assessment process generally tend to lead to a discounting of such unquantifiable benefits (a problem known in the risk-assessment trade as the "dwarfing of soft variables"), but urges that NASA resist these pressures and take account of the substantial potential losses, both immediate and long-term, of adopting a "no action" approach.

For this reason NSS also believes that Section 4.8.2 of the EIS (Draft EIS at P. 4-31) should be revised. That section currently states:

> A potentially large benefit to be gained from successful completion of this project is a better understanding of Earth through exploration and study of the environments of other planets.

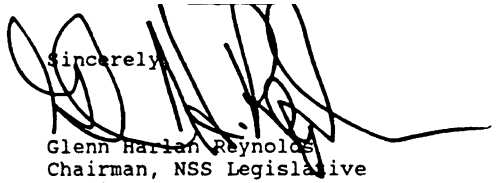
Obviously, NSS does not disagree with this statement. However, NSS believes that the importance of this aspect of the mission is drastically understated in the EIS and should be more fully reflected along the lines set out above.

Conclusion and Recommendations

Environmental Impact Statements, of course, do not make recommendations; their purpose is simply to set out costs and benefits. NSS has already explained why it believes that the Ulysses EIS is adequate in its statement of potential costs and risks, but inadequate in its treatment of the likely benefits of the mission. NSS recommends that the EIS be revised to take these benefits into account.

Regardless of the extent to which such revisions are made, NSS recommends as well that NASA take the benefits noted in these comments into account in making its decision whether to proceed with the Ulysses mission. It is not the function of an Environmental Impact Statement to determine whether a particular project is "too risky." Its function is solely to ensure that the agency to whom decisionmaking authority has been delegated (here NASA and, because radioactive materials are involved, the President) makes an informed decision after considering all relevant factors.

NSS believes that when all relevant factors are considered, the necessary conclusion is that the Ulysses mission is not only justified, but very important -- and that that importance stems not only from scientific factors, but from the very significant positive impact that Ulysses is likely to have on the earth's environment over the long term. For this reason, NSS supports a decision to go ahead with the Ulysses mission.



Sincerely,

Glenn Harlan Reynolds
Chairman, NSS Legislative
Committee, For the
National Space Society

COMMITTEE TO BRIDGE THE GAP
1637 BUTLER AVENUE, SUITE 203
LOS ANGELES, CALIFORNIA 90025
(310) 478-0829

19 December 1994

Dr. Peter B. Ulrich
Chief, Flight Programs Branch
Solar System Exploration Division
Office of Space Science
Code SL
NASA Headquarters
Washington, DC 20546

Re: Cassini Program Draft EIS
by fax

Dear Dr. Ulrich:

These are the comments of the Committee to Bridge the Gap on the Casini DEIS. By letter of 29 November you kindly extended the comment period to 20 December.

Our concerns focus on two primary areas: inadequate assessment of alternatives to the use of plutonium as the power source for the mission and inadequate assessment of potential environmental impacts of accident should plutonium indeed be used. These concerns are summarized below.

D-63

Inadequate Consideration of Alternative Power Sources

The purpose of the National Environmental Policy Act (NEPA) is to require agencies to take (1) a "hard look" at alternatives, and (2) to do so *prior* to making decisions that could significantly affect the human environment. In this case, NASA failed both standards. Its consideration of alternatives was *pro forma*, and its defense of plutonium as the supposed only feasible alternative is that the decision to use plutonium instead of solar as a power source had already been made and it is too late to change plans without delaying the mission. — 16A — 16B

In essence, the Draft EIS indicates alternative, environmentally superior power sources could perform the mission, but because NASA has already started work on acquisition of a plutonium-powered generator and chosen not to develop a solar-energy system, a solar device is assertedly not available and plutonium is supposedly the only alternative available. However, NEPA requires consideration of environmental impacts and alternatives at *the earliest possible time*, before a commitment of resources. Had NASA performed this review earlier, it could have chosen to develop the environmentally superior power source. — 16C

It is somewhat tiresome to see the same excuse raised time after time in NASA EIS's. Beginning with Galileo, then Ulysses, and now Cassini, for years NASA has claimed it must choose to use plutonium because it had failed to develop solar. NEPA is supposed to guide that decision, the decision not guide NEPA.

Inadequate Consideration of Environmental Consequences of Accidents

The DEIS severely underestimates potential risks of an accident involving a plutonium power source. The probability figures and consequence estimates are far below realistic levels. Once again, it appears that the EIS is viewed as a paper hoop to jump through rather than a — 16D

RESPONSES TO COMMENTS
Commentor No. 16: Committee to Bridge the Gap
(Daniel Hirsch)

Response to Comment 16A:

The Cassini Environmental Impact Statement (EIS) examines the range of mission alternatives available for accomplishing the Cassini mission objectives within a reasonable timeframe, as well as the No-Action alternative. A number of optional launch vehicles, mission trajectories to Saturn, and spacecraft power and heating sources were examined in detail.

Response to Comment 16B:

NASA has followed the technical progress in space power research and development worldwide for many years. NASA studied many different solar, battery, and other power alternatives, including long life fuel cells, available for Cassini and found none that would meet the mission requirements. A Cassini spacecraft equipped with the highest efficiency solar cells available, or fuel cells, or batteries, or combination of these would make the spacecraft too massive for launching on the Titan IV (Solid Rocket Motor Upgrade [SRMU])/Centaur to Saturn. Even if a heavy-lift booster were available that could launch the Cassini spacecraft with a massive solar array, such large solar arrays would introduce insurmountable complexity to the mission and would severely jeopardize the chances for mission success. For fuel cells, even assuming the highest currently available energy fuel-per-unit mass and 100 percent efficient conversion (an idealistic assumption since only 60-70 percent is currently feasible), the resulting dry mass (before adding propellants for the spacecraft engines needed for maneuvers in space) would be about 16,000 kg (17.6 tons). It would not be possible to launch Cassini and place it on a trajectory to Saturn if it were that massive, i.e., it would exceed the launch capability of the Titan IV [SRMU]/Centaur by more than a factor of 2.

NASA continues to invest in research and development of solar power technology. Indeed, a significant portion of the work in the area of solar arrays has been carried out under NASA funding. While improvements have been made in solar technology, significant breakthroughs are still required to support a mission such as Cassini (see response to Comment 1B). Recent international conferences on space power provided no reports of technical breakthroughs that would suggest changing the proposed approach to powering Cassini. Within the timeframe of the Proposed Action, no power

source options other than radioisotope thermoelectric generators are capable of meeting mission requirements.

Response to Comment 16c:

As stated previously in response to Comment 16B, NASA continues its research and investment in electric power technology for space missions. Historically, NASA's primary choice of a power source for planetary missions has been solar power and it has continued to be used for missions when such technology is feasible. The solar power option for Cassini has been extensively reviewed and rejected for this EIS because no U.S. launch vehicle exists to conduct a solar powered mission to Saturn using available solar power technology (see response to Comment 1B). To wait for future development of solar power options suitable to meet the mission requirements would indefinitely delay the mission. NASA has proceeded as quickly as possible in providing a high quality and accurate EIS utilizing the best available information.

Response to Comment 16D:

See response to Comment 13A.

serious effort to face comparative risks from alternative decision pathways. The DEIS appears to presume that miniscule quantities of the plutonium source can be released as respirable particles, an assumption that is in error. Furthermore, the use of the *de minimus* assumption is in appropriate. No respectable radiation protection body believes it is appropriate to presume a threshold for radiation injury. — 16E — 16F

We urge NASA to go back and once and for all decide that where there is an environmentally superior alternative, to use it, and to wean itself from its addiction to plutonium power sources.

Sincerely,

Daniel Hirsch
President

RESPONSES TO COMMENTS
Commentor No. 16: Committee to Bridge the Gap
(Daniel Hirsch)
(Continued)

Response to Comment 16E:

The particle size distributions for the accident source terms used in the analysis are based on consideration of the plutonium (Pu-238) dioxide fuel form and its response to accident environments (explosion overpressure, fragment, fire, impact, and reentry) as determined by safety test data and analysis. The small fraction of respirable particles associated with a release particle size distribution reflects the ceramic nature of the fuel and its low potential for vaporization in thermal environments. Impact-related releases are expected to be largely non-respirable particles and chunks.

Response to Comment 16F:

The predicted health effects resulting from postulated accident source terms are presented both with and without the application of a *de minimis* dose. The EIS takes no position relative to the appropriateness of applying a *de minimis* dose in the determination of the radiological consequences.

December 19, 1994

605 K Street, NE
Washington, DC 20002-3529

Dr. Peter Ulrich
Solar System Exploration Division
Office of Space Science
NASA HQ
Washington, DC 20546

Dear Dr. Ulrich:

Please know that I am categorically opposed to development of the Cassini plutonium mission.

Do not let the brevity of this letter dissuade you from thinking that my position is passionately held, and from realizing that I am utterly aghast at the mere notion that NASA could imagine Cassini to be safe. This is sheer nonsense, playing God and potentially lethal to life on this planet. — 17A

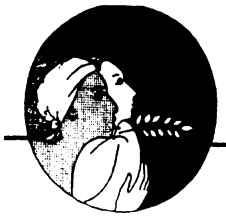
Please stop Cassini now; I am a taxpayer, concerned citizen and mother-to-be, and speak as such.

Beth Raps

Response to Comment 17A:

NASA and the Department of Energy take very seriously the possibility that an action that they take could potentially result in human fatalities or harm to the environment. Therefore, both agencies have gone to great lengths to reduce the potential for such events, both through design of the radioisotope thermoelectric generators and through design and operation of the spacecraft and its mission. As a result of these designs, the risks of fatalities or harm to the environment from the Proposed Action are considered to be very low. See Sections 4.1.5.2 and 4.2.5.1 of the Environmental Impact Statement for more details on launch phase accident scenarios.

NASA appreciates your expressing your views and has considered your comment. Please see response to Comment 2A for further information on the use of plutonium dioxide for the Cassini mission.



Women's International League for Peace and Freedom
Margaret Mead Chapter • Jennie Baer • Islewood A-14 • Deerfield Beach, FL 33442 • (305) 427-9145

Dec. 19, 1994

Dr. PEter Ulrich
Solar SystemExploration Division
Office of Space Science
NASA HQ
Washington, D. C. 20546

Dear Dr. Ulrich:

We are writing to ask you to suspend plans to launch the Cassini space probe to Saturn as long as any plutonium is scheduled to be on board. The risk of an accident at launch or during its "slingshot fly-by" above the Earth is not worth the gamble. 18A 18B

We urge the use of alternative on-board power sources such as solar energy and the long life fuel cells for all future deep space misions. 18C

Sincerely,

MARGARET MEAD CHAPTER-WILPF
Jennie Baer, Secretary

D-67

RESPONSES TO COMMENTS
Commentor No. 18: Women's International League for Peace and Freedom
(Jennie Baer)

NASA appreciates your expression of views. Your comments are similar to those raised by earlier commentors.

Response to Comment 18A:
See response to Comment 2A.

Response to Comment 18B:

See response to Comment 7B.

Response to Comment 18C:

See response to Comment 6A.

Kathleen F. Kelly
1460 West Carmen Avenue
Chicago, IL 60640

Dr. Peter Ulrich
Solar System Exploratin Division
Office of Space Science
NASA HQ
Washington, DC 20546

December 19, 1994

Dear Dr. Ulrich,

I am writing to protest plans to launch the Cassini space probe to Saturn as long as any plutonium is scheduled to be on board. I understand that, presently, the project calls for 73 pounds of plutonium 238 to generate on-board electricity. The risk you are considering gambles with our lives. — 19A, 19B

Please give more consideration to the use of a solar-powered alternative to the Cassini mission. I understand that current plans call for production of the plutonium generator for Cassini at the Savannah River Plant, Los Alamos Labs, Oak Ridge Labs, Mound Labs and Martin Marietta. Please do not seek ways to maintain profits for these labs by developing nuclear power in space. — 19C, 19D

Sincerely,
Kathleen Kelly
Kathleen Kelly

Response to Comment 19A:

See response to Comment 2A.

Response to Comment 19B:

See response to Comment 7B.

Response to Comment 19C:

See response to Comment 6A.

Response to Comment 19D:

The Department of Energy provides radioisotope thermoelectric generators (RTGS) to NASA as an electrical power source for missions to explore the outer solar system. Such interagency cooperation is not for the profit of any laboratory.

CANCEL CASSINI
No Plutonium in Space

We, the undersigned, call upon NASA and our elected officials to suspend plans to launch the Cassini space probe to Saturn as long as any plutonium is scheduled to be on board. Presently, the project calls for 73 pounds of plutonium 238 to generate on-board electricity. — 20A The risk of an accident at launch or during its "slingshot fly-by" above the Earth is not worth the gamble. — 20B We urge the use of alternative on-board power sources such as solar energy and long-life fuel cells for all future deep space missions. — 20C

	NAME	ADDRESS
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5.	Vivienne Williams	4811 SW 133 Ave. Ft Laud, Fl. 33330
6.	Ola M. Iverson	2709 NW 47 Lane Laud. Lakes, FL 33313
7.	Mary Kiner	2926 S. University Dr. #6201 Davie FL 33328
8.	[illegible]	8551 N.W. 48th st. Lauderhill FL 33351
9.	Susan Perry	10410 NW 7 Ct Plantation Fl 33324
10.	Dorothy Morrison	192 S.W. 52 Ave; Plantation 33317
11.	George Voraphe	2995 N. Dixie Hwy. Ft Laud. 33334
12.	Melanie [illegible]	8201 NW 70 St Tamarac Fl 33321
13.	Cynthia Smith	2900 N.W 83 Ter Sun. FL. 33322
14.	Esther Williams	760 E. Melrose Circle Ft. Lauderdale, Fl 33312
15.	Mary Kathleen	101 w 62 St. Hialeah Fla. 33012
16.	[illegible]	8460 NW 28th Pl. Sunrise Fl 33322
17.	Nancy Herman	1216 SW 30 Ave. Ftlauderdale, FL 33312
18.	Belinda White	320 Cambridge Dr. Ft. Lauderdale, Fl 33326
19.	Abdul Salam	2995 N. Dixie Hwy Ftlauderdale 33304
20.	Diane Dice	2320 Cypress Bend Pomp Bch FL 33069
21.	Jacqueline Adams	4261 N.W 24 St Lauderhill Fl. 33313
22.	Sandra Martin	3685 NW 28 CT Laud. Lakes 33311
23.	Rory Sprenger	1415 SW 31 ST Ft Laud. Fl 33315
24.	Sherry Flournoy	3861 NW 6 PL Ft. Laud, 33311
25.	Aida Melendez	6671 Fern St Mrgt 33063

Return to the Florida Coalition for Peace & Justice • P.O. Box 90035 • Gainesville, Fl 32607 • 904/468-3295

D-69

Response to Comment 20A:

See response to Comment 2A.

Response to Comment 20B:

See response to Comment 7B.

Response to Comment 20C:

See response to Comment 6A.

18102 Grove Avenue
Boca Raton, FL 33498-1624
December 20, 1994

Dr.Peter Ulrich
Solar System Exploration Division
Office of Space Science
NASA HQ
Washington, DC 20546

Dear Dr. Ulrich:

We urge you to suspend plans to launch the Cassini space probe to Saturn as long as any plutonium is scheduled to be on board. At present the project calls for 73 pounds of plutonium 238 to generate on-board electricity. The risk of an accident at launch or during its "slingshot fly-by" above the Earth is not worth the gamble. We urge the use of alternative on-board power sources such as solar energy and long-life fuel cells for all future deep space missions. — 21A — 21B — 21C

Sincerely,

Ruth E. Snyder
Jack Snyder

Ruth E. Snyder

Jack Snyder

NASA appreciates expression of your views. Your comments are similar to those raised by earlier commentors.

Response to Comment 21A:

See response to Comment 2A.

Response to Comment 21B:

See response to Comment 7B.

Response to Comment 21C:

See response to Comment 6A

506 sw 40th terrace
Gainesville, FL 32607

December 20, 1994

Dr. Peter Ulrich
Solar System Exploration Division
Office of Space Science
NASA HQ
Washington, DC 20546

I wish to comment on the DEIS for the 1997 Saturn Cassini space mission.

In particular, I am concerned about the utilization of plutonium 238 & 239 as fuels.

Two specific concerns.

(1.) I am not at all convinced that the DEIS correctly estimates the potential risks in the event of possible catastrophe scenarios. As you know well, the carcinogenic risks from **any** exposure to plutonium are very high. Whether in the event of explosion or crash at relatively low altitude levels, or explosion (or leakage) in upper or super atmospheric levels, the risk potential to humans and other terrestial life forms could be much higher than estimated--depending on circumstances. — 22A

(2.) Plutonium use at this point in history is going in the wrong direction. High efficiency solar cells, already developed in some other countries, are clearly the way to go. Not only will such cells cost less in dollar amounts (including externalized costs); they also eliminate the potential risk of plutonium exposure. The more plutonium-powered missions are launched, the greater the likelihood of accident resulting such exposure. We do not want to, nor do we need to go down that path. — 22B — 22C

I urge you to cancel planned use of plutonium in this and all other space missions. — 22D

Thank you for your attention to these concerns.

Sincerely yours,

Richard H. Hiers, Ph.D., J.D.

Response to Comment 22A:

NASA considers the risk analysis presented in the Environmental Impact Statement (EIS) to be the best estimation based on the available information at the time. The results of the accident analysis have been factually stated in the EIS in terms of (1) the total probability of release, (2) the radiological consequences of such a release, and (3) the risk. As part of the launch approval process, the Department of Energy will be preparing a more in-depth evaluation of the risks as part of the Final Safety Analysis Report (FSAR). NASA will review the FSAR, when it becomes available, and will evaluate the information presented for differences, if any, in the estimates of the potential radiological consequences and risks.

Response to Comment 22B:

See response to Comment 1B.

Response to Comment 22C:

Comment noted. Please refer to Sections 4.1.5.3 and 4.2.5.2 in the EIS for a discussion of initiating accident probabilities.

The total health effects mission risk to the public (considering all launch phases and the Earth-Gravity-Assist trajectory) for Cassini have been estimated and are small (about 1.8×10^{-3} health effects). See Section 1.4 in the EIS for details on the multiple benefits already being derived from mission planning. The Cassini mission to the Saturnian system represents a rare opportunity to gain significant insights into major scientific questions about the formation of the solar system and the conditions that led to life on Earth, in addition to a host of questions specific to the Saturn system.

Response to Comment 22D:

See response to Comment 2A.

Harry Kernes
333 W. State St
Trenton, NJ 08618-5722

(RECYCLED) 12/21/94

DEAR DR. ULRICH;

HAVING READ OF THE PROJECT THAT IS TO SEND URANIUM INTO THE HEAVENS I HAVE FELT IT IS A TOTAL WASTE OF OUR RESOURCES AND MONEY. JUST ONE LITTLE MISTAKE CAN CAUSE AN ETERNITY OF PROBLEMS. 23A

I URGE YOU TO CANCEL THE CASSINI-SO-CALLED-SPACE PROBE.

RESPECTFULLY YOUR
HARRY KERNES
Harry Kernes

Response to Comment 23A:

The Cassini mission will use plutonium-238 dioxide in the radioisotope thermoelectric generators to generate onboard electrical power. The mission would commit human, material, economic and other resources (see Section 4.8 of Environmental Impact Statement [EIS]) to provide significant new scientific information to address some fundamental questions about the origins of life and our solar system. Significant technological benefits, as discussed in Section 1.4 of the EIS, have been achieved during the planning of the mission.

22 Dec 94

Dr Peter Ulrich
NASA

Dear Sir

In view of the alternatives available, please reconsider the use of plutonium for the Cassini mission. — 24A

I share the concerns of the Florida Coalition for Peace & Justice which are based upon the possibilities noted in NASA's Draft Environmental Impact Statement. — 24B

Cordially,

Rea D. Ward

Rea D Ward
8440 Truman St
Englewood, FL 34224

D-73

Response to Comment 24A:

NASA has invested in research and development of solar power technology. Additionally, the U.S. Department of Energy, the European Space Agency, and other agencies and research centers around the world have been investing in and improving upon solar power technology over the last decade. A number of solar power designs were investigated for the Cassini mission that would utilize unproven yet promising technology (e.g., the Advanced Photovoltaic Solar Array).

NASA studied many different solar, battery, and other power alternatives, including long life fuel cells, available for Cassini and found none that would meet the mission requirements. A Cassini spacecraft equipped with the highest efficiency solar cells available, or fuel cells, or batteries, or combination of these would make the spacecraft too massive for launching to Saturn. Even if a heavy-lift booster were available that could launch the Cassini spacecraft with a massive solar array, such large solar arrays would introduce insurmountable complexity to the mission and would severely jeopardize the chances for mission success. For fuel cells, even assuming the highest currently available energy fuel-per-unit mass and 100 percent efficient conversion (an idealistic assumption since only 60-70 percent is currently feasible), the resulting dry mass (before adding propellants for the spacecraft engines needed for maneuvers in space) would be about 16,000 kg (17.6 tons). It would not be possible to launch Cassini and place it on a trajectory to Saturn if it were that massive, i.e., it would exceed the launch capability of the Titan IV (Solid Rocket Motor Upgrade [SRMU])/Centaur by more than a factor of 2.

Though NASA continues to invest in research and development of solar power technology, the current state of the technology makes solar power infeasible for the Cassini mission to Saturn. See response to Comment 1B.

Response to Comment 24B:

The concerns of the Florida Coalition for Peace and Justice are addressed in response to Commentor No. 1.

P.O. Box 33074
Indialantic, Florida 32903
December 22, 1994

Dr. Peter Ulrich
Solar System Exploration Division
Office of Space Science
NASA HQ
Washington, DC 20546

Dear Dr. Peter Ulrich:

I am one of America's citizens who wonders about the nescessity of placing 73 pounds of plutonium 238 and 239 on the 1997 Cassini space mission to Saturn.

Dr. Caldicott, founder of Physcians for Social Responsibility writes about plutonium "is so toxic that less than one-millionth of a gram,is a carcinogenic dose. One pound, if uniformly distributed, could hypothetically induce lung cancer in every person on Earth." — 25A

NASA and the Department of Energy do have a cavalier approach that if the rocket explodes there will be just a few "excess cancers." For the poor schnuck (and this could be me) finds him/her self with an "excess cancer" cannot be happy about this casual attitude. — 25B

European industry has recently developed high efficiency solar cells for use in future demanding deep-space missions. For goodness sakes, lets use solar energy! — 25C

As a Floridan who lives in the Space Coast, I have seen several launches that have exploded, I certainly don't want a launch with plutonium on board!!

Yours truly,

Georgia Van Ornam

Georgia Van Ornam

Copy for my own records

Response to Comment 25A:

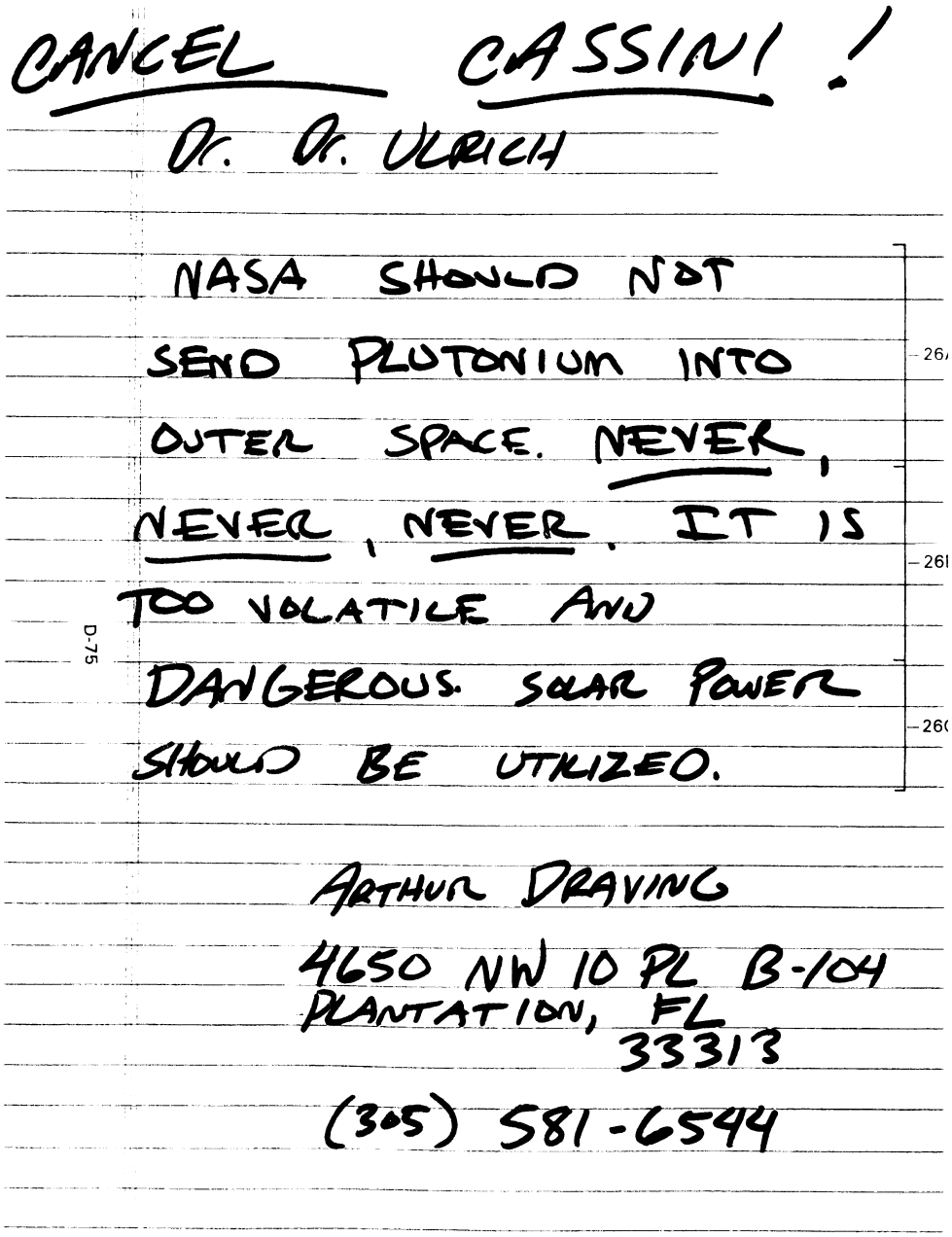
There is about 32.4 kg (71.4 lb) of plutonium dioxide in the three RTGs of which approximately 28 kg (62 lb) are plutonium isotopes. Table 2-3 provides the isotopic composition of the fuel form used for the Cassini mission. See also response to Comment 4B.

Response to Comment 25B:

See response to Comment 2B.

Response to Comment 25C:

See response to Comment 1B.



RESPONSES TO COMMENTS
Commentor No. 26: Arthur Draving

NASA appreciates your comments on the use of plutonium on the Cassini mission to Saturn. Your comments are similar to those raised by earlier commentors.

Response to Comment 26A:

See response to Comment 2A.

Response to Comment 26B:

See response to Comment 5B.

Response to Comment 26C:

See response to Comment 6A.

John P. Ferrell
441 Madeira Avenue
Coral Gables, FL 33134

December 25, 1994

Dr. Peter Ulrich
Solar System Exploration Division
Office of Space Science
NASA HQ
Washington, DC 20546

Dear Dr. Ulrich:

I am writing to express my vehement disapproval of your plan to allow 73 pounds of Plutonium to be launched from Florida. As a resident and voting citizen I urge you not to jeopardize the health of my family's state. — 27A

I hope you make decisions on such delicate matters in the future based on a short and long-term quality of life criteria instead of a short-term cost-benefit analysis. My daughter's quality of life cannot be described by numbers of dollars or "excess cancers." All cancers are excess and should be avoided. — 27B

Thank you for understanding and considering the concerns of your constituents and citizens in making your final decision on our quality of life.

Sincerely,

John P. Ferrell

NASA appreciates Your comments regarding the launch of the Cassini spacecraft to Saturn. Your comments are similar to those raised by earlier commentors.

Response to Comment 27A:

See response to Comment 2A.

Response to Comment 27B:

See responses to Comments 1I and 8C.

December 26, 1994

Dr. Peter Ulrich
Nasa Headquarters
Washington, DC.

Dear Dr. Ulrich:

Planning for nuclear weapons in space, starting with a launch of a rocket carrying 13 pounds of plutonium, is the scariest gamble with the earth's inhabitants. There is no way to control any mishap involving the most toxic material known. Compared to disasters in the past, any failure would be unimaginably worse. — 28A — 28B — 28C

Ethically, nuclear weapons on earth are no longer acceptable. How much less are they defendable in space?

The technology for powering space crafts by solar energy is sufficiently developed to be an alternative for exploration in space. — 28D

Very truly yours
Ingeborg F. Roberts

Response to Comment 28A:

Cassini is a peaceful scientific mission being designed and developed by civilian agencies of the U.S. government and those of Europe. The plutonium fuel form used in the radioisotope thermoelectric generators (RTGS) is not weapons-grade material, and is used to generate electricity for the spacecraft and its scientific instruments.

Response to Comment 28B:

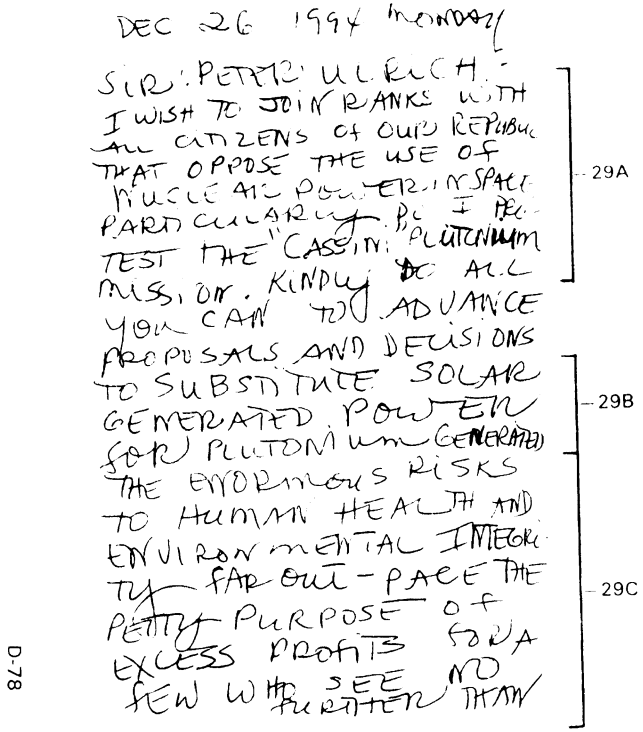
See response to Comment 5B.

Response to Comment 28C:

NASA has estimated the risks from plutonium (Pu-238) dioxide onboard the Cassini spacecraft and has found the risks to the world population and our planet to be very low. The risks from the launch of Cassini would be lower than many of the risks that we face in our everyday lives (see Table 4-20 in the Environmental Impact Statement). A wide range of potential accident scenarios was evaluated.

Response to Comment 28D:

See responses to Comments 3D.



DEC 26 1994 MONDAY

SIR: PETER ULRICH -
I WISH TO JOIN RANKS WITH
ALL CITIZENS OF OUR REPUBLIC
THAT OPPOSE THE USE OF
NUCLEAR POWER IN SPACE
PARTICULARLY BY THE
TEST THE "CASSINI" PLUTONIUM
MISSION. KINDLY DO ALL
YOU CAN TO ADVANCE
PROPOSALS AND DECISIONS
TO SUBSTITUTE SOLAR
GENERATED POWER
FOR PLUTONIUM GENERATED
THE ENORMOUS RISKS
TO HUMAN HEALTH AND
ENVIRONMENTAL INTEGRITY
FAR OUT-PACE THE
PETTY PURPOSE OF
EXCESS PROFITS FOR A
FEW WHO SEE NO
FURTHER THAN

29A

29B

29C

D-78

GERALDINE JENARA AMATO
P.O BOX 951
ALBUQUERQUE, NM 87103-0951
610 MARBLE NE
OR
87102-2433

HAPPY HOLIDAYS

SLP USA 19

DR. PETER ULRICH
SOLAR SYSTEM EXPLORATION
DIVISION
OFFICE OF SPACE SCIENCE
NASA HQ
WASH DC
20546

THE NEXT YEARS
FINANCIAL PROFIT
SHEETS
REFLECT

Response to Comment 29A:

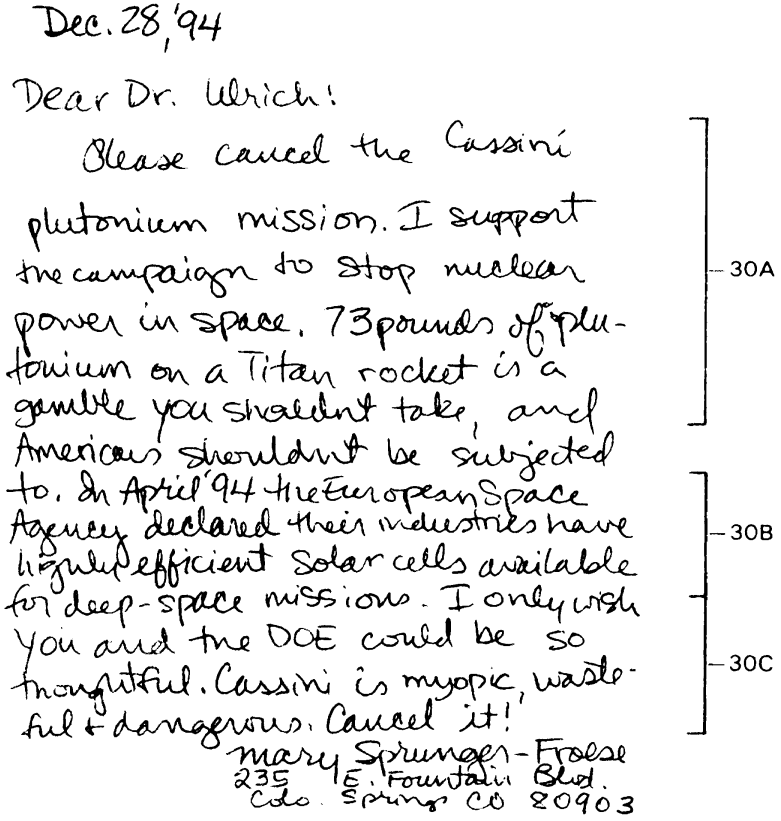
See response to Comment 2A.

Response to Comment 29B:

See response to Comment 6A.

Response to Comment 29C:

The Cassini mission is an international cooperative mission with the European Space Agency and the Italian Space Agency. There is no intent by NASA to generate excess profits for any organization.



Dec. 28, '94

Dear Dr. Ulrich:

Please cancel the Cassini plutonium mission. I support the campaign to stop nuclear power in space. 73 pounds of plutonium on a Titan rocket is a gamble you shouldn't take, and Americans shouldn't be subjected to. In April '94 the European Space Agency declared their industries have highly efficient solar cells available for deep-space missions. I only wish you and the DOE could be so thoughtful. Cassini is myopic, wasteful & dangerous. Cancel it!

Mary Sprunger-Froese
235 E. Fountain Blvd.
Colo. Springs CO 80903

30A

30B

30C

NASA appreciates your comments regarding the Cassini mission to Saturn Your comments are similar to those raised by earlier commentors.

Response to Comment 30A:

See response to Comment 2A.

Response to Comment 30B:

See response to Comment 1B.

Response to Comment 30C:

See response to Comment 7B.

GREENPEACE
1436 U Street NW • Washington DC 20009 • Tel (202) 462-1177
Tlx 89-2359 • Fax (202) 462-4507

Dr Ulrich—

NO Pu in
Space!!

Thanks

—31A

HARVEY WASSERMAN
735 EUCLAIRE AVE
BEXLEY OH 43209

RECYCLED PAPER

Response to Comment 31A:

Please see responses to Comments 2A, 2B, and 8C.

553 15th Avenue
San Francisco CA 94118
December 30, 1994

Dr. Peter Ulrich
Solar System Exploration Division
Office of Space Science
NASA HQ
Washington D.C 20546

Dear Dr. Ulrich;

Please consider solar alternatives for supplying energy to the 1997 Cassini space mission. It is wrong to ~~not~~ embark upon a procedure using radioactive material that can impact upon man's health for thousands of years if something goes wrong in the launch. 32A 32B

Yours very truly
Edward Dierauf

Dierauf

RESPONSES TO COMMENTS
Commentor No. 32: Edward Dierauf

Response to Comment 32A:

See response to Comment 3D.

Response to Comment 32B:

See response to Comment 7B. The dominant isotope of the fuel, 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 (without any mitigation actions) after 100 years would be 45 percent, after 500 years would be 2 percent, after 1,000 years 0.13 percent, and after 5,000 years would be 0.08 percent.

Margery D. McIntire
4600 A1A South, LP 2-1
St. Augustine, FL 32084

December 30, 1994

Dr. Peter Ulrich
Solar System Exploration Division
Office of Space Sciene
NASA HQ
Washingtoin DC 20546

Dear Dr. Ulrich;

It is fitting that I write to you on the last day of the year. I am 84. I may not be alive when the Cassini mission takes place.

According to Dr. Helen Caldicott, plutonium is "so toxic that one-millionth of a gram, an invisible particle, is a carcinogenic dose. One pound, if uniformly distributed, could hypothetically induce lung cancer in every person on Earth." —33A

Okay. One pound of plutonium will not fall. If there should be an explosion, the debris would not be uniformly distributed. But, why chance it? Why use plutonium? Who not try solar-powered alternatives? —33B

I think I know why. You want to keep the nuclear power industry alive and well. —33C

I don't.

Or at least, not in use in space.

Please stop the Cassini launch if it uses nuclear power. —33D
Please give honest estimates of the danger to the planet should even the slightest accident occur. —33E

Use solar-powered cells, or tell me why you won't.

Thanks.

Margery D McIntire

RESPONSES TO COMMENTS
Commentor No. 33: Margery D. McIntire

NASA appreciates your comments on the Cassini mission to Saturn and your concern for the welfare of future generations. Your comments are similar to those raised by earlier commentors.

Response to Comment 33A:

See response to Comment 4B.

Response to Comment 33B:

See response to Comment 6A.

Response to Comment 33C:

See response to Comment 1C.

Response to Comment 33D:

See response to Comment 2A.

Response to Comment 33E:

See response to Comment 13A.

Nancy Strong · 120 S. Chancellor Street · Newtown, PA 18940

31 December 1994

Dr. Peter Ulrich
Solar System Exploration Division
Office of Space Science
NASA HQ
Washington, D.C. 20546

Dear Dr. Ulrich,

I have long had a horror, as many have, over the destructive potential of nuclear power and of my nation's willingness to unleash it not once, but twice. It was not until the early '80s, however, that I became informed about the problem of nuclear waste and decided that we must forego nuclear power and seek alternatives in earnest. I was in correspondence at that time with Prof. Ruston Roy, a chemist at the University of Pennsylvania.

I urge that we NOT GO FORWARD WITH THE 1997 CASSINI SPACE MISSION TO SATURN, USING PLUTONIUM. 34A

If we must pursue space exploration — it grieves me that it is largely military in nature — then solar power must be used. 34B 34C

Sincerely,
Mrs. Nancy Strong

D-83

RESPONSES TO COMMENTS
Commentor No. 34: Nancy Strong

NASA appreciates your comments on the use of radioactive materials on Cassini mission. Your comments are similar to those raised by earlier commentors.

Response to Comment 34A:

See response to Comment 2A.

Response to Comment 34B:

See response to Comment 28A.

Response to Comment 34C:

See response to Comment 6A.

2958 Oakisle Rd. N.
Jacksonville, FL 32257
January 1, 1995

Dear Dr. Ulrich:

I write to protest the Cassini plutonium mission planned for 1997.

I am not convinced that the DEIS recently released has realistic figures that even come close to that of other experts such as Dr. Helen Endicott. 35A

I think that the risks are much greater than NASA and the DOE would have us believe. 35B

I urge you to reconsider this planned launch.

Sincerely yours,

Karen McFadyen

D-84

Response to Comment 35A:

The results of the accident analysis have been factually stated in the EIS in terms of 1) the total probability of release, 2) the radiological consequences of such a release, and 3) the risk. Appendix C discusses the environmental and health risks associated with plutonium
(Pu-238) dioxide in greater detail. See also response to Comment 4B.

Response to Comment 35B:

See response to Comment 13A.

Dr. Peter Ulrich
Solar System Exploration Division
Office of Space Science
NASA HQ.
Washington, D.C. 20546

Jan. 1, 1995

Dear Dr. Ulrich:

I'm writing with deep concern for the safety of the earth and all of us on it.

I'm writing to protest the CASSINI plutonium mission — a most dangerous project — at our expense!

Please don't allow Nuclear Power and weapons in space. We don't need this danger to our lives; the constant tension and worry in addition to our normal daily living. — 36A, 36B

Respectfully,

Linda Bermann

LINDA BERMANN
2550 DANA ST. #7B
BERKELEY, CA 94704-2868

Response to Comment 36A:

Cassini is a peaceful scientific mission being designed and developed by civilian agencies of the U.S. government and those of Europe. The plutonium fuel form used in the radioisotope thermoelectric generators (RTGs) is not weapons-grade material, and is used to generate electricity for the spacecraft and its scientific instruments.

Response to Comment 36B:

NASA has estimated the risks from plutonium (Pu-238) dioxide onboard the Cassini spacecraft. The total health effects mission risk to the public (considering all launch phases and the Earth-Gravity-Assist trajectory) for Cassini is provided in Section 4.1.8 of the Environmental Impact Statement (EIS), and is estimated to be small (about 1.8×10^{-3} health effects).

The risks from the launch of Cassini are lower than many of the risks we face in our everyday lives (see Table 4-20 in the EIS).

46 D Pleasant St.
Provincetown, MA 02657
January 2, 1995

Dr. Peter Ulrich
Solar System Exploration Division
Office of Space Science
NASA HQ
Washington,DC 20546

Dear Dr. Ulrich:

The Cassini plutonium mission is a potentially deadly idea. Why must plutonium (aptly named after Pluto, lord of death) be used as an on-board power source when solar energy could be used instead? —37A

I resent mightily that my taxes are being used for such a misguided and risky plan. Are there not enough cancers growing already in our people that you must dream up still another "risk factor" to be added to an ever-growing list? —37B

Stop this mission, re-think the use of plutonium, consider seriously using instead high efficiency solar cells recently developed in Europe. —37C

Sincerely,

Merilyn Hiller

(Ms.) Merilyn Hiller

cc: Rep. Studds
Sen. Kennedy
Sen. Kerry
Pres. Clinton

D-86

RESPONSES TO COMMENTS
Commentor No. 37: Merilyn Hiller

NASA appreciates your expression of views regarding the Cassini mission Saturn. Your comments are similar to those raised by earlier commentors

Response to Comment 37A:

See response to Comment 3D.

Response to Comment 37B:

See response to Comment 7B.

Response to Comment 37C:

See response to Comment 1B.

January 3, 1994. Gentlemen:
This household thinks putting plutonium into space by powering the Cassini probewith the substance is an act of criminality, and we would ask what gives the right to the Office of Space Science to subject humanity to the dangers inherent in such activity? —38A

Sincerely yours,
Sidney M. Manuel
Olive L. Manuel

Response to Comment 38A:

NASA believes that the Cassini mission to Saturn will be of great benefit to all people. Your comments about the use of plutonium in this mission are addressed in response to Comment 7B.

Ronald P. Reed
112 Behrends Avenue
Juneau, AK 99801-1414
(907) 586-1338

January 3, 1995

Dr. Peter Ulrich
Solar System Exploration Division
Office of Space Science
NASA HQ
Washington DC 20546

Dear Dr. Ulrich:

I am writing to you to express my alarm at the continuing plan to use toxic Plutonium as the power source for the 1997 Cassini Saturn space mission. As a scientist, you are doubtless aware of the dangers inherent in this project. Indeed, only a few years ago the U.S. government was denouncing the Soviet Union for having launched a nuclear-powered satellite which disintegrated in orbit and contaminated northern Canada. — 39A

There is certainly no guarantee that the mission contemplated will not end in disaster; and the past practice of the Department of Energy's Nuclear Regulatory Commission and its predecessor agency of deliberately understating dangers by magnitudes of more than a hundred thousand in order to promote the use of nuclear power inspires little trust in the figures now being bandied about. — 39B

Since the European Space Agency has recently stated that "European industry has recently developed high efficiency solar cells for use in future demanding deep-space missions," there is no excuse for endangering the any of the planet's population by using poison to launch a probe. The fact that you aim the launch in the general direction of Africa rather than New York City or the continental U.S. is a tacit acknowledgment of this danger; are African lives worth so much less than white ones? — 39C — 39D

Given that the launch is still two years away, I should think that you would have ample time to rethink your launch strategy, and retool the probe. — 39E

Sincerely,

Ronald P. Reed

D-88

Response to Comment 39A:

NASA places the highest priority on assuring the safe use of radioactive materials in space. Thorough and detailed safety analyses are conducted prior to launching NASA spacecraft with radioisotope thermoelectric generators (RTGs), and many prudent steps are taken to reduce the risks involved in NASA missions using RTGs. In addition to NASA's extensive internal safety requirements and reviews, missions that carry nuclear material also undergo an additional safety review involving detailed verification testing and analyses.

The Department of Energy has designed the RTGs with a number of safety features. First, the fuel is in the heat-resistant, ceramic form of plutonium dioxide, which reduces its chance of vaporizing in fire or reentry environments. This ceramic-form fuel is also highly insoluble, has a low chemical reactivity, and primarily fractures into large, non-respirable particle and chunks in the unlikely event that the RTGs are in an accident resulting in some released material.

Second, the fuel is divided among 18 small, independent modular units, each with its own heat shield and impact shell. This design reduces the chances of fuel release in an accident because all modules would not be equally impacted in an accident.

Third, multiple layers of protective materials, including iridium capsules and high-strength graphite blocks, are used to protect the fuel and prevent its accidental release. Iridium is a metal that has a very high melting point and is strong, corrosion-resistant and chemically compatible with plutonium dioxide. These characteristics make iridium useful for protecting and containing each fuel pellet. Graphite is used because it is lightweight and highly heat-resistant. See also response to Comment 2A.

Response to Comment 39B:

The U.S. Department of Energy and the U.S. Nuclear Regulatory Commission are two separate governmental agencies that evolved from the Atomic Energy Commission.

NASA considers the risk analysis presented in the Environmental Impact Statement (EIS) to be the best estimation based on the available information at the time. As part of the launch approval process, the Department of

Energy will be preparing a more in-depth evaluation of risks as part of the Final Safety Analysis Report (FSAR). NASA will review the FSAR, when it becomes available, and will evaluate the information presented for differences, if any, in the estimates of the potential consequences and risks.

Response to Comment 39C:

See response to Comment 1B.

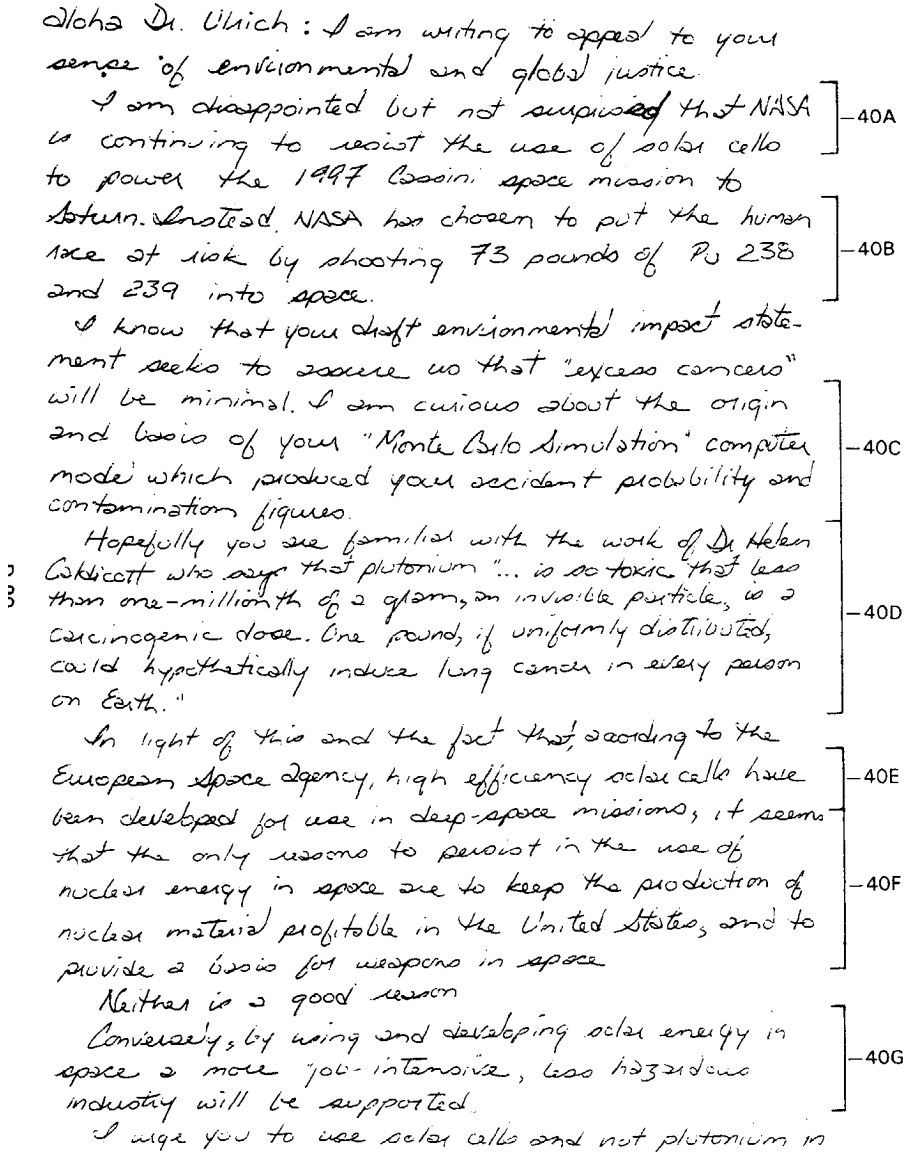
Response to Comment 39D:

While the launch is not aimed at or targeted to Africa, there are several reasons why launch vehicles are generally directed eastward from Cape Canaveral Air Station/Kennedy Space Center. There are no land masses or populations threatened in the event of an early ascent launch accident. An eastward launch from the Cape puts a spacecraft on the proper course to travel toward other solar system bodies within the ecliptic plate, such as Saturn. In addition, from the Cape's location at 28.5 degrees north longitude, launch vehicles receive an extra 1,400-kilometer per hour (900mile per hour) boost due to Earth's rotational velocity. This means less fuel is required for the launch vehicle to reach its destination.

For the Proposed Action, the instantaneous impact point would be over Africa for a brief period of 8 seconds in Phase 5 (see Section 2 2.7). Should an accident occur during this period, NASA has estimated that the total probability of a plutonium release would be very small with statistically indistinguishable health effects (see Section 4.1.8 of the Environmental Impact Statement).

Response to Comment 39E:

See response to Comment 2A.



Aloha Dr. Ulrich: I am writing to appeal to your sense of environmental and global justice.

I am disappointed but not surprised that NASA is continuing to resist the use of solar cells to power the 1997 Cassini space mission to Saturn. Instead NASA has chosen to put the human race at risk by shooting 73 pounds of Pu 238 and 239 into space. — 40A, 40B

I know that your draft environmental impact statement seeks to assure us that "excess cancers" will be minimal. I am curious about the origin and basis of your "Monte Carlo Simulation" computer model which produced your accident probability and contamination figures. — 40C

Hopefully you are familiar with the work of Dr. Helen Caldicott who says that plutonium "... is so toxic that less than one-millionth of a gram, an invisible particle, is a carcinogenic dose. One pound, if uniformly distributed, could hypothetically induce lung cancer in every person on Earth." — 40D

In light of this and the fact that, according to the European Space Agency, high efficiency solar cells have been developed for use in deep-space missions, it seems that the only reasons to persist in the use of nuclear energy in space are to keep the production of nuclear material profitable in the United States, and to provide a basis for weapons in space. — 40E, 40F

Neither is a good reason.

Conversely, by using and developing solar energy in space a more "job-intensive, less hazardous industry will be supported. — 40G

I urge you to use solar cells and not plutonium in

Response to Comment 40A:

Historically, NASA used solar power for missions when such technology was applicable. For example, the Mars Observer, Viking Orbiters, Mariners 4, 6, 7 and 9 were solar-powered Mars missions. Future missions to Mars such as Pathfinder and Mars Global Surveyor will be solar-powered, using the newest high efficiency GaAs/Ge cells. Mars Pathfinder lander and microrover represent the first use of photovoltaics on the Martian surface. However, NASA incorporates radioisotope thermoelectric generators (RTGs) with spacecraft designs when solar power or other power technology is not feasible for the planned mission. The current state of the technology makes solar power infeasible for a mission like Cassini. See also response to Comment 6A.

Response to Comment 40B:

See responses to Comments 2A and 1K.

Response to Comment 40C:

The risk analysis presented in the Environmental Impact Statement is deterministic. Monte Carlo simulations were performed in the estimation of the launch phase initiating accident scenario probabilities and the Earth-Gravity-Assist inadvertent reentry probabilities. The Monte Carlo technique is appropriate when evaluating functional relationships involving probability distributions. As part of the flight approval process, the Department of Energy will be preparing a more in-depth evaluation of the potential environmental consequences as part of the Final Safety Analysis Report (FSAR). Monte Carlo simulations will be applied in the FSAR.

Response to Comment 40D:

See response to Comment 4B.

Response to Comment 40E:

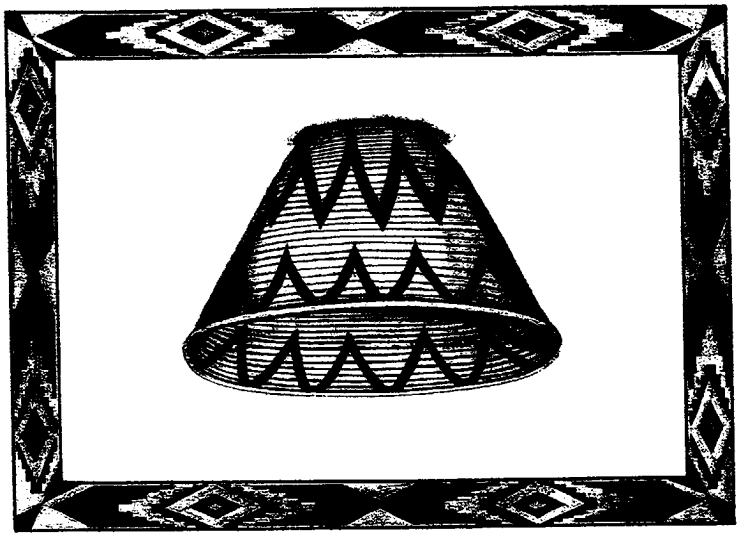
See response to Comment 1B.

Response to Comment 40F:

Cassini is a peaceful scientific mission being designed and developed by civilian agencies of the U.S. government and those of Europe. The plutonium fuel form is not weapons-grade material, and is used to generate electricity for the spacecraft and its scientific instruments.

Response to Comment 40G:

NASA continues to invest in solar and other technologies for space applications. NASA's investment along with that of other Federal research and development programs have yielded advances in solar technologies that are in widespread use today.



The Cassini mission
Thank you for your time

Sincerely,
V Lee Fuqua
V LEE FUQUA
PO Box 1978
WAILUKU, HI
96793

POMA BASKET

Woven in the coil technique, this large conical carrying basket's typical geometric design was either reddish brown or black on a light ground or white on a brown ground.

200*4305
Printed in U.S.A.

January 8, 1995

Dr. Peter Ulrich
Solar System Exploration Division
Office of Space Science
NASA HQ
Washington, DC 20546

Dear Dr. Ulrich,

I am writing to urge you, in the strongest terms, to delay the planned launch of the Cassini space mission to Saturn until its onboard energy system can be made non-nuclear. Doubtless it is easier and cheaper to proceed with the plan to use plutonium in RTG's, but the risks to human life of doing so are simply unacceptable--especially because solar and fuel-cell options are feasible. —41A

As a life member of AAAS and the former director of a research center at NYU, I am a strong advocate of using public funds to advance basic science, and hope that it will not be necessary to cancel the mission altogether, though in these times of new demands for budgetary stringency I would much rather see the required billions used to protect Medicare and Medicaid from threatened cuts. The possible gains to knowledge from Cassini if everything goes well cannot in any way counterbalance the possible consequences of failure: damage to the health of countless thousands of human beings and death to many. —41B

We have been lucky, so far, that there have not been worse disasters from the launching of so many space vehicles carrying radionuclides. It is high time to **stop that risky practice altogether**, surely not to try to launch the largest amount of plutonium ever sent into space. And using the notoriously unreliable Titan IV as the vehicle, to boot! —41C

NASA has the opportunity to get some favorable publicity, for a change, if it is announced that the mission is being delayed because a way has been found to eliminate dangers to human life. Such a delay might also make it possible to redesign it more economically. —41D

Sincerely yours,

Robert R Holt, PhD

Robert R. Holt
Professor of Psychology Emeritus
Box 1087 Truro, MA 02666-1087

D-93

Response to Comment 41A:

See response to Comment 2A.

Response to Comment 41B:

See responses to Comments 1K and 6A.

Response to Comment 41C:

The Titan family of launch vehicles has a flight history which spans more than three decades. They have been used for more than 320 launches including five launches of spacecraft with radioisotope thermoelectric generators and 10 launches carrying astronauts into space. See response Comment 3G. Refer to Section 4.1.5.3 of the Environmental Impact Statement for more details.

Response to Comment 41D:

See response to Comment 1H.

January 16, 1995

Bob Ellenberg
1315 N.E. 9th St.
Gainesville, Fl. 32601
(904) 335-1856

Dr. Peter Ulrich
Solar System Exploration Division
Office of Space Science
NASA HQ
Washington, D.C. 20546

Dr. Ulrich:

It has brought to my attention that as part of the Cassini space mission to Saturn, NASA is planning on sending a Titan 4 rocket from Kennedy Space Center with 73 pounds of plutonium on board as fuel. If one citizens opinion is worth anything, you have mine as totally opposed to fueling this mission with plutonium. Too, too risky, too many lives are potentially in jeopardy if anything should happen to the space ship and it came down anywhere on the planet with the possibility of radiation escaping from its container. Zero is the only acceptable figure for the loss of life, or for more cancers. As a health professional, I know we have enough cancer without creating more. —42A

I have read that the European space industry has been working with high efficiency solar cells that can send space ships into deep space. Let us not continue to depend on such a deadly source of energy as plutonium. —42B —42C

Please pay attention to the will of the people, our monies are paying for the project and we should have input. —42D

Thanks for you time,

Bob Ellenberg

Response to Comment 42A:

See response to Comment 7B.

Response to Comment 42B:

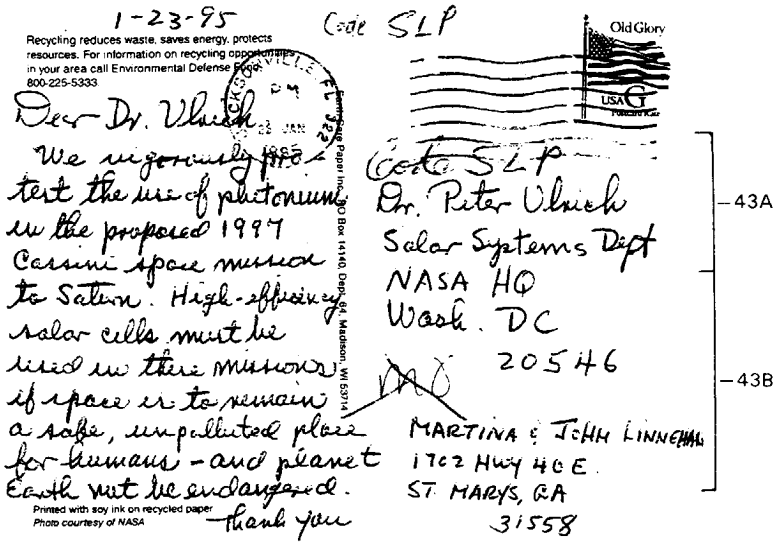
See response to Comment 1B.

Response to Comment 42C:

See response to Comment 5B.

Response to Comment 42D:

NASA appreciates your expression of views.



RESPONSES TO COMMENTS
Commentor No. 43 Martina and John Linnehan

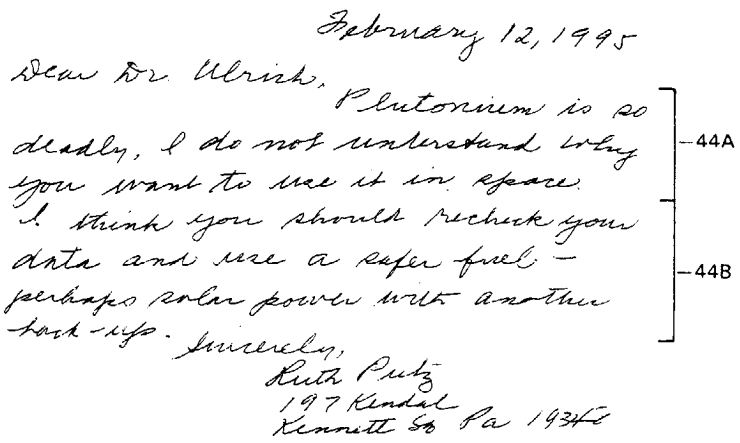
NASA appreciates your comments about the use of plutonium in the Cassini mission to Saturn. Your comments are similar to those raised by earlier commentors.

Response to Comment 43A:

See response to Comment 2A.

Response to Comment 43B:

See response to Comment 1B



February 12, 1995

Dear Dr Ulrich,

Plutonium is so deadly, I do not understand why you want to use it in space. — 44A

I think you should recheck your data and use a safer fuel — perhaps solar power with another back-up. — 44B

Sincerely,
Ruth Putz
197 Kendal
Kennett Sq Pa 19348

RESPONSES TO COMMENTS
Commentor No. 44: Ruth Putz

NASA appreciates expression of your views. Your comments are similar to those expressed by earlier commentors.

Response to Comment 44A:

See response to Comment 2A.

Response to Comment 44B:

See response to Comment 6A.

920 Countryside
Columbus, In. 47201
Feb. 19, 1995

Solar System Exploration Div.
Office of Space Science
NASA HQ
Washington, DC

Dear Dr. Ulrick,

We understand that the 1997 Cassini space mission to Saturn includes plans to use 73 lbs. of plutonium. We are opposed to this because of the terribly toxic nature of plutonium. We urge you to consider using a solar powered alternative. The European Space Agency, in 1994, released a statement saying that "European industry has recently developed high efficiency solar cells for use in future demanding deep-space missions."

Why would the DOE rather use deadly plutonium when there is a safe alternative?

Respectfully yours,
Carole Hyneman
Frank Hyneman

45A

45B

NASA appreciates expression of your views. Your comments are similar to those expressed by earlier commentors.

Response to Comment 45A:

See response to Comment 2A.

Response to Comment 45B:

See response to Comment 1B.

Fran Collier
3187 Windrush Bourne
Sarasota, FL 34235

Dr Peter Ulrich
Solar System Exploration Division
Office of Space Science
NASA HQ
Washington, DC 20546

Dear Sir:

This letter is to urge you to halt the Cassini plutonium mission and stop the use of nuclear power in space. -46A

NASA and DOE give little consideration to the use of a solar-powered alternative on the Cassini mission. However, in April 1994 the European Space Agency released a statement saying that "European industry has recently developed high efficiency solar cells for use in future demanding deep-space missions." -46B

How unfortunate that the nuclear power industry and the DOE continue producing plutonium generation in the Savannah River Plant, Los Alamos Labs, Oak Ridge, Mound Labs and Martin Marietta. These sites were mainstays in producing nuclear weapons. Now nuclear power in space might keep them profitable. -46C

Please use your influence to stop nuclear power in space and to develop solar energy for ALL purposes!

Sincerely,
(Mrs) Fran Collier

NASA appreciates expression of your views. Your comments are similar to those expressed by earlier commentors.

Response to Comment 46A:

See response to Comment 2A.

Response to Comment 46B:

See response to Comment 6A.

Response to Comment 46C:

See response to Comment 19D.

RELIGIOUS EDUCATION
FOR THE
CATHOLIC DEAF & BLIND
207 N. SAN MARCO AVENUE
ST. AUGUSTINE, FLORIDA 32084
(904) 823-4407 VOICE/TDD

February 27, 1995

Dr. Peter Ulrich
Solar System Exploration
Office of Space Science
NASA HQ
Washington, D.C. - 20546

Dear Dr. Ulrich:

Regarding the 1997 Cassini Space launch to Saturn, I greatly protest carrying plutonium on this mission. The possibility of an accident would endanger every living being. —47A —47B

Again, I am against the Cassini plutonium mission.

Thank you.

Very truly yours,

Rev. René Robert

Rev. Rene' Robert

RR/mpf

Supported by the Knights of Columbus, Catholic Daughters and the Diocesan Fund.

Response to Comment 47A:

See response to Comment 2A.

Response to Comment 47B:

NASA has estimated the risks from plutonium (Pu^{238}) dioxide onboard the Cassini spacecraft and has found the risks to the world population and our planet to be very low. The risks from the launch of Cassini would be lower than many of the risks that we face in our everyday lives (see Table 4-20 in the Environmental Impact Statement). A wide range of potential accident scenarios was evaluated.