Public Health Considerations of Launching Nuclear Waste to the Sun

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This article addresses the public health aspects of disposing of radioactive nuclear waste by launching it to the sun. The environmental and ecological problems that have occurred since British Petroleum's oil spill in the Gulf of Mexico on 20 April 2010 have prompted discussions about finding alternative energy sources. On 11 May 2010, Senator John Kerry (D-Massachusetts) and Senator Joseph Lieberman (I-Connecticut) introduced legislation (the American Power Act) "to secure the energy future of the United States, to provide incentives for the domestic production of clean energy technology, [and] to achieve meaningful pollution reductions."[1] Nuclear power, one of the many forms of alternative energy, has attracted renewed and increased interest. However, damage to the Fukushima Daiichi nuclear power plant from the 9.0 earthquake and subsequent tsunami in Japan on 15 March 2011 as well as reported problems at several nuclear power plants along the East Coast of the United States during Hurricane Irene have heightened concerns about safety and health regarding the use of nuclear power. Furthermore, when power outages plagued the East Coast after "Superstorm Sandy" struck on 29 October

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2012, the press ran articles about the issue of nuclear power plants endangering the public.

Nuclear waste material, which emits "ionizing radiation," poses a threat to public health, based upon the duration of exposure, distance to the source of radiation, type of radiation (e.g., alpha, beta, gamma, etc.), and the presence and type of any shielding.[2] Sources of radioactive nuclear waste materials include nuclear weapons, nuclear power sources, medical radionuclides used for diagnosis or treatment, radiation-producing machines, radioactive metals, and radioactive isotopes of all elements (usually found in "background radiation" exposures).[3]

The threat of exposure arises primarily from an accident or incident that results in a "spill" of radioactive nuclear material (i.e., a "nuclear spill") normally not encountered by the general (unprotected) population. Collection and containment of radioactive nuclear materials in secure sites—the current method of disposal—require safe transport and placement in specialized, secure installations. These repositories must be located away from populated areas; on installations whose physical security can be assured and where access by intruders—whether deliberate or inadvertent—is extremely unlikely and easy to detect (e.g., the Yucca Mountain Nuclear Waste Repository, which was defunded in 2010); and in places not likely to suffer from geological instabilities such as earthquakes, volcanoes, and so forth.

Another option is the collection and burial of radioactive nuclear waste material in the ocean, particularly in the deep crevices of midoceanic mountain ranges or extremely deep geologic formations such as the Marianas Trench. Clearly, any consideration of deep-sea burial would demand that the area be far removed from the oceanic tectonic plates—locations more subject to volcanoes, earthquakes, or other seismic geological activities. According to Charles Hollister and Steven Nadis, marine scientists feel that such places have not experienced geological activity for more than 50 million years and, therefore, will not likely become active in the future.[4]

Previous proposals for disposing of radioactive nuclear waste by launching it to the sun remove the threats of exposure from leakage of a storage facility or from the diversion of such materials by nuclear terrorists.[5] The underlying principle here is that all matter caught in the sun's gravity will lose its structural integrity due to the stress of gravitational forces and "break up" before reaching the sun. Moreover, high temperatures will incinerate and completely consume all matter prior to its reaching the sun's corona.[6] Specifically, as matter heats up, it expands beyond its structural integrity, and the heat energy encountered causes molecular bonds to break. Even the atomic integrity of elements of atomic number above two (i.e., Helium) does not exist within the sun.[7] Essentially, the intense heat renders such elements into their composite subatomic particles (e.g., electrons, protons, neutrons, etc.).[8] Thus, the radioactive nuclear waste never impacts the sun, having no effect upon its "ecosystem," and therefore cannot "damage" the sun.

Magnitude of the Problem

In terms of the risk to public health, however, one must consider the possibility of a launch accident such as the destruction of a launch vehicle prior to leaving the earth's gravitation or its breakup shortly after launch, scattering radioactive debris. An examination of the US unmanned space program should reveal the likelihood of such an accident. Atlas, Centaur, Delta, Delta II, and Saturn V missions numbered over 1,000. Debris from accidents varied in size from centimeters to several meters in length and width, but none of it was radioactive. During the entire unmanned space program, the probability of an accident involving a space launch vehicle amounted to less than 3 percent.[9] Granted, the probability of such an occurrence is low, but it does exist.

We have long recognized the health risks presented by ionizing radiation. Witness the well-documented short- and long-term health issues associated with the atomic bombs dropped on Hiroshima and Nagasaki, the atmospheric tests of atomic and hydrogen bombs conducted by the United States and Soviet Union from 1946 through 1964, and the incidents involving nuclear power reactors at Three-Mile Island in 1979 and Chernobyl in 1983. Risks associated with a launch vehicle carrying a payload of radioactive waste are analogous to those associated with nuclear fallout patterns observed during the atmospheric nuclear bomb tests until the advent of the Nuclear Test Ban Treaty.

Key Determinants

As mentioned above, the causes of potential public health problems are well known. Specifically, these include the biological effects of a radioactive nuclear waste environment on living organisms. Ionizing radiation can damage the biochemical, molecular, and cellular structures underpinning all life. Human behavior has no direct bearing upon this problem but can have an indirect effect in terms of safety and/or security concerns about the handling or containment of radioactive nuclear waste in the current international geopolitical milieu. That is, we must consider the possibility that such material might fall into the hands of terrorist groups which may use it to build and deploy low-yield "dirty" nuclear weapons (i.e., nuclear terrorism).

Making Policy and Setting Priorities

Again, one may dispose of radioactive nuclear waste material either by (1) sending it into space or by (2) collecting, isolating, and storing it on/under the land or deep within the oceans. Sending waste into space, especially launching it to the sun where it will burn up before reaching the corona, removes this hazard forever. As noted earlier, though, this option incurs the cost of launch vehicle operations and carries with it the risk of a launch accident that could spread radioactive debris unpredictably over a large geographic area. Collecting, isolating, and storing radioactive nuclear waste in or on the earth's land mass would be easy and inexpensive in terms of initial operations and logistics. Doing so, however, requires ongoing monitoring and security measures because terrorist groups could steal this material and put it to nefarious uses. Moreover, containment of the radioactive waste could become compromised by natural causes (e.g., earthquake, volcanoes, etc.), leaking into the water table and contaminating land and/or water resources. Finally, disposal of this material deep in the oceans may prove just as costly as launching it into space. A maritime accident could subject the oceans near populated areas, fishing areas, and so forth, to radioactive contamination. Further, although a deep oceanic site is much more difficult to reach than a land-based containment facility, terrorists could still compromise its security and divert the radioactive material. Again, such a facility would require ongoing monitoring and security.

Regardless, we have the technical and scientific capacity to implement any disposal strategy, including launching payloads into space toward any target.[10] Political and social-behavioral obstacles to implementation arise from the public's perception of the risks associated with the production, use, and by-products of nuclear energy; in actuality, they are not as great as most of the public believes.[11] No published studies demonstrate that the health of workers in the nuclear industry is any worse than that of the general public, assuming observance of the appropriate safeguards. However, a failure to follow safe practices or the occurrence of an accident or incident involving nuclear materials can detrimentally affect the public health, especially in terms of producing cancers.

Regarding economic considerations, launching a payload into space costs about $10,000 per pound.[12] Thus, sending 100 metric tons of radioactive nuclear waste into space would cost $2.2 billion whereas storing it in the Yucca Mountain facility would have cost approximately $200 million per year.[13] Thus in 11 years we could fully amortize the cost of a space launch that carries much more waste than we could store at a single site on the earth's surface.

Space disposal of radioactive nuclear waste benefits individuals, communities, and society in general at the global level since this option removes the possibility of accidents/incidents during storage on the earth or the appropriation of material by terrorists. The attendant risks of space launch, noted earlier, involve incidents that could occur at or shortly after launch—or later but prior to leaving the atmosphere. Clearly, an accident at or shortly after launch would affect neighboring communities downwind of the site (e.g., Melbourne, Florida, near Cape Canaveral and Patrick Air Force Base) where radioactive debris would quickly accumulate and compromise the public's health. According to a press release from Johns Hopkins University,

> Nuclear fallout arising from accident or terrorism contains radioactive iodine that can cause thyroid cancer, especially in babies and children up to 18. Potassium iodine tablets prevent the thyroid from absorbing radioactive iodine, protecting the gland.
>
> "Thyroid cancer historically has been a major public health problem resulting from nuclear incidents including the bombing of Nagasaki, Japan, and the nuclear accident in Chernobyl, Ukraine," says Paul W. Ladeson, M.D., director of endocrinology and metabolism at Johns Hopkins.[14]

Plans call for the distribution of potassium iodine tablets to people living within 20 miles of a nuclear incident.

If an accident occurred in the upper atmosphere, the winds aloft and prevailing jet streams would spread radioactive debris and affect populated areas, the number and location of which depend upon whether the incident took place in the northern or southern hemisphere. Moreover, the debris would disturb maritime life and commerce. Realistically, the impact of such an unlikely accident will be no worse than the results of any atmospheric nuclear bomb test, mentioned earlier, which entailed the detonation of multimegaton nuclear weapons that produced large amounts of radioactive debris in the form of fallout. The amount of nuclear waste material under scrutiny here does not fall into the "megaton" category.

Assessment of Related Risks

Several risk assessments (also known as environmental assessments) have a direct bearing on the collection and transport of nuclear materials, including issues of safety and analyses of the threat posed by potential accidents/incidents and their public health considerations. The National Nuclear Security Administration (NNSA) of the US Department of Energy has performed numerous such assessments. In January 2004, it concluded one that addressed the risks of latent cancer fatalities in the population resulting from the collection and transport of fissionable nuclear material—specifically, the movement by air of highly enriched uranium from Russia to a secure site near Knoxville, Tennessee. The NNSA performed assessments for cases of "no accident/incident," for breakup or destruction of the aircraft in flight, for destruction on the ground (i.e., a "crash landing"), for destruction of ground vehicles transporting the materials (e.g., truck accidents), and for "no action." In all cases and scenarios, the NNSA identified the worst one as a person "maximally exposed" to radioactive material at the site of a traffic accident on the ground, assessing the chance of a latent cancer fatality at "$1.4 X 10^{-10}$, or less than one chance in a billion." For personnel handling the transfer of packages of highly enriched uranium from the aircraft to trucks, the chance was "less than 1 in 140,000."[15] Consequently, the NNSA issued a finding of "no significant impact." Similar risk assessments resulting in the same finding included those of the Chariton Valley Biomass Project, the decontamination and decommissioning of the nuclear reactor facility at the Argonne National Laboratory near Chicago, and the building of a nuclear-reactor fuels-materials facility near Aiken, South Carolina.[16]

Of special significance is the decision to fly the Cassini mission to Saturn in 1997, which has much relevance to the proposed idea. First, the mission involved the launching of a payload destined for other-than-earth orbit. Second, the spacecraft (i.e., the Cassini orbiter) is nuclear powered. Third, its payload, the Huygen probe, contains nuclear components. Risk assessments performed by the Interagency Nuclear Safety Review Panel for the National Aeronautics and Space Administration examined scenarios for launch accidents, accidental reentry into the earth's atmosphere with the breakup and destruction of the space launch vehicle and payload, and accidental reentry due to the earth's gravity during a "swing by" maneuver designed to increase the inertial velocity of the space vehicle during the interplanetary voyage phase. The Final Environmental Impact Statement for the Cassini Mission Report placed the median cancer fatality rate at "1.4×10^{-6}."[17] This varies from "1 in 13 billion" to "1 in 280 billion."[18] These accident/incident scenarios are notable because of their similarity to those that could occur with the proposed idea of launching nuclear waste to the sun.

Conclusion and Recommendation

This article has found that the risks to public health from disposing of radioactive nuclear waste by launching it to the sun are extremely small. Specifically, the median cancer fatality rate of one in 3.8 billion reported by the Cassini panel (based on scenarios comparable to those that might occur during the proposed launch)—and only in the event of an accident involving the space launch vehicle—is significantly less than the cancer fatality rate in the general population (one in 5,000). In light of the extremely minimal risks to public health, as well as the defunding of the previously proposed Yucca Mountain Nuclear Waste Repository, this article recommends that the United States reconsider the economically viable alternative of launching nuclear waste to the sun.

Notes

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