NUCLEAR ENERGY IMPACTS ON HEALTH

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Summary

The first section of this article addresses the nature of health risks associated with the production of nuclear energy. While positive impacts are acknowledged, the focus is on the landscape of risks that give rise to detrimental impacts unique to this energy source, since these are a considerable source of controversy. In the second section, the article explores trends and issues that are likely to bring more attention to the issue of nuclear energy impacts on health. These trends include the growing use of nuclear energy in the developing world; the debate over nuclear energy’s potential role in limiting annual greenhouse gas emissions; and a growing body of research on the health effects of low levels of ionizing radiation. In the third section, the stages of the nuclear fuel cycle and the sources of potential impacts at each stage on both worker and public health are examined. The impacts on health of accidents in reactors and other fuel cycle facilities are also explored. The fourth section covers the national and international regimes in place to limit nuclear energy impacts on health, focusing on institutions. The section also includes a discussion of recent debates over the validity of the linear non-threshold dose response model, which holds that health effects, at very low levels of exposure to radiation, are proportional to received dose. Rejection of this model, which has been used by most international and national institutions charged with the development of standards, could have considerable implications for health regulation throughout the fuel cycle. The final section provides the authors’ concluding remarks about priority areas for research.
I. Nuclear Energy and Health: Categories of Risk

An exploration of nuclear energy impacts on health is complicated by several factors. First, scientific understanding of the translation of health risks into effects is not complete. A key example of this problem is the current debate over the validity of the linear non-threshold dose response model, which for years has supported the development of radiation standards established to protect nuclear industry workers and the public. Second, compared to other forms of energy, nuclear energy is surrounded by a highly complex web of political, economic, environmental, safety and other issues. An examination of impacts on health cannot ignore the context formed by, and values linked to, many of the above factors. Third, discussions of health impacts can be quickly polemicized. Epidemiological studies that indicate one result or another may become irrefutable evidence in the minds of advocates on either side of the nuclear energy debate. In this debate, it is difficult not to be reminded of the famous statement “There are lies, damned lies, and statistics.” One epidemiologist recently remarked “What leads two groups of epidemiologists to attach different meanings or give different emphasis to essentially the same data is a puzzle that is likely to remain with us for as long as subjectivity plays a role in epidemiology.”

For these and other reasons, this discussion makes no attempt to quantify nuclear energy impacts on health, nor does it pass judgment on the merits of this energy source. Rather, the article identifies the nature of health hazards, risks and impacts arising from nuclear energy; describes these at each stage in the process of nuclear energy production; sketches the landscape of contemporary issues and concerns, including recent controversies; addresses the regimes in place to guard against detrimental impacts; and makes recommendations for further research. The article concludes with the authors’ thoughts on holistic approaches to consideration of nuclear energy impacts on health.

It should be no surprise that nuclear energy has both positive and negative impacts on health. Broadly speaking, on the positive side, nuclear energy, like other energy sources, provides electricity that permits societies to maintain or develop modern economies that realize positive health benefits, including higher living standards and improved health care access. On the negative side, nuclear energy, like other sources, relies on materials and operations that pose health risks to both industry workers and members of the public who reside within the vicinity of facilities. These risks may manifest themselves in populations as deleterious health effects.

There is little debate over the positive health impacts of nuclear energy or other energy sources for that matter. It is the presence and magnitude of negative health impacts that have been a major battleground in the long-standing war among advocates and opponents of nuclear energy. For the purposes of this discussion, a health “impact” can be considered as the manifestation in populations of health effects arising from risks posed by hazards. Hazards and risks particular to nuclear energy are discussed in Section 3 below. A health impact does not by force arise from the mere presence of a hazard. The magnitude of a hazard and potential exposure pathways from the hazard to humans determine the significance of health risks, and it is in the absence of fully adequate risk mitigating measures, which may not always be available, that health impacts occur.
The operations and materials normally associated with the production of nuclear energy pose numerous health risks, which can be broadly categorized as radiological and non-radiological in nature.

- Radiological health risks arise from the presence at each stage in the nuclear fuel cycle (discussed below) of materials that emit radiation. Of concern are materials that emit gamma rays, alpha particles, beta particles and neutrons. Gamma radiation, alpha particles and beta particles are forms of ionizing radiation energetic enough to break chemical bonds in living cells, which can be very detrimental to human health. Neutrons, while not directly ionizing, are very penetrating and can impart considerable energy to human tissue. When ingested or inhaled, radioactive materials pose particularly significant risks, since they more readily cause tissue and other damage from within the body. Depending on factors such as total dose, dose rate, whole body vs. partial body irradiation, internal vs. external exposure, age at exposure, and the nature of radiation in question, the health effects that may arise from radiation exposure include various forms of radiation sickness, thyroid disease, numerous cancers, long-term health problems, genetic effects that can manifest themselves in future generations, and death.2,3

- Throughout the nuclear fuel cycle, many activities require the use of heavy machinery and equipment, hazardous chemicals, and large, complex facilities. The non-radiological health risks posed by such activities are similar to those one might expect to find associated with any large-scale industrial endeavor. For example, just as any industrial endeavor, fuel cycle activities have given rise to physical injury from faulty machinery, the careless operation of equipment, fires and explosions. Physical injury, illness and cancer are effects that may arise from inadvertent exposure to chemicals and materials used in fuel cycle activities. Uranium-238, for example, which is ubiquitous in the fuel cycle, is toxic and has been shown to impair kidney function in humans when ingested.4

In addition to the risks associated with normal operations, there are also radiological and non-radiological health risks associated with nuclear accidents and with the misuse or unauthorized use of nuclear materials and facilities. As demonstrated in 1986 at Chernobyl, nuclear plant accidents can result in the release and dispersion into the environment of large quantities of radioactive materials hazardous to human health. High levels of radiation exposure to workers and members of the public can ensue, causing acute radiation effects and death. Beyond the health effects arising from radiation exposure, physical injury to workers can result from an accident, and an accident may create panic in populations and lead to physical injuries. Perhaps the greatest possible health impact that could arise from nuclear energy is the clandestine development and use of nuclear weapons by a nation using materials that have been diverted from civilian nuclear energy facilities.

A final set of impacts on health that may arise from nuclear energy is psychological in nature, relating to mental health. For a number of reasons, it has been argued that both normal operations and accidents pose psychological risks to workers and members of the public. Believers in the notion of psychological impacts from nuclear energy argue that psychological risks arise because 1) radiation is invisible, tasteless, odorless and
generally intangible and 2) it is not uncommon for the potential consequences of nuclear energy accidents to be equated with the effects of nuclear weapons.5 According to this perspective, public fear of being unable to detect and avoid radiation and the fear of Hiroshima-like consequences of nuclear industry accidents may lead to feelings of anxiety and dread among members of communities near nuclear installations.

Beyond the psychological risks associated with normal operations, it has been argued that in the event of actual nuclear accidents, psychological impacts can be particularly pronounced. In fact, it is generally accepted that the Chernobyl accident had significant psychological impacts on affected populations, even on those populations with relatively low exposures to radiation. These impacts arose, according to some analysts, because the accident was followed with inadequate or conflicting information and it ultimately disturbed the life patterns of many individuals.6

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Biographical Sketches

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Michael McGovern is a Senior Analyst with Analytical Systems Engineering Corporation (ASEC) and based at the Center for Verification Research in Springfield, Virginia (USA). Mr. McGovern works on nuclear and other arms control issues, with a focus on technologies required for treaty and agreement implementation. Prior to joining ASEC, Mr. McGovern worked at Resources for the Future (RFF), an environmental policy research organization, where he examined and wrote about the environmental cleanup of the U.S. Department of Energy’s nuclear weapons complex. Mr. McGovern’s related experiences include employment at the Twentieth Century Fund, a public policy research organization based in New York, where he worked on environmental issues; employment at the American Embassy in Paris, where he tracked and reported on developments in the French civilian nuclear energy program; and teaching positions at Princeton University and the University of Massachusetts at Amherst, where he taught about nuclear weapons and nuclear energy issues. Mr. McGovern has an MPA, International Affairs, from Princeton University’s Woodrow Wilson School, and an MS, Physics, from the University of Massachusetts at Amherst.

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ENDNOTES

5 World Health Organization, Nuclear Power and Health: The Implications for Health of Nuclear Power Production, WHO Regional Publications, European Series, No. 51, p. 107
6 Ibid