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Statement of Brice Smith on *Insurmountable Risks: The Dangers of Using Nuclear Power to Combat Global Climate Change*

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Climate change is by far the most serious vulnerability associated with the world's current energy system. Compared to fossil fuels, nuclear power emits far lower levels of greenhouse gases even when mining, enrichment, and fuel fabrication are taken into consideration. As a result, some have come to believe that nuclear power should play a role in reducing greenhouse gas emissions. To examine the implications of such strategies, we have considered in detail two representative scenarios for the future expansion of nuclear power in the new work Insurmountable Risks.

The first scenario was taken from a 2003 study from the Massachusetts Institute of Technology. Their "global growth scenario" envisions 1,000 gigawatts (GW) of nuclear capacity installed around the world by 2050. Despite this increase in nuclear power, however, the projected demand for electricity would grow rapidly enough that the emissions of carbon dioxide from the electricity sector would continue to increase. In order to consider a more serious effort to limit carbon emissions through the use of nuclear power, we developed the "steady-state growth scenario." Considering a range of assumptions, we found that between 1,900 and 3,300 GW of nuclear capacity would be required just to hold emissions constant at their year 2000 levels. For simplicity we considered 2,500 GW as our alternative case study.

The first thing to note is that nuclear power is an expensive source of electricity, with projected costs for electricity from new reactors in the range of six to seven cents per kWh. Given that both time and resources are limited, a choice must be made as to which sources of electricity should be pursued aggressively and which should not. In making this choice, the following should serve to help guide the selection: (1) the options must be capable of making a significant contribution to a reduction in greenhouse gas emissions; (2) the options should be economically competitive to facilitate their rapid entry into the market; and, (3) the options should minimize other environmental and security impacts and should be compatible with a longer term vision for creating an equitable and sustainable global energy system. It is within this context that the future of nuclear power must be judged.

Our analysis has found that nuclear power plants are a uniquely dangerous source of electricity that will create serious risks, particularly if deployed on a large scale. The largest vulnerability associated with such an expansion of nuclear power is likely to be its potential connection to the proliferation of nuclear weapons. In order to fuel the global or steady-state growth scenarios, the world's uranium enrichment capacity would have to increase by approximately two and half to six times. Just one percent of the enrichment capacity required by the global growth scenario would be enough to supply the highly-enriched uranium for nearly 210 nuclear weapons every year. Reprocessing the spent fuel would add significantly to these security risks.

The potential for a catastrophic reactor accident or well coordinated terrorist attack to release a large amount of radiation is another unique danger of nuclear power. Such a release could have extremely severe consequences for human health and the environment. Even if a reactor's secondary containment was not breached, a serious accident would still be costly. As summarized by Peter Bradford, a former commissioner of the U.S. Nuclear Regulatory Commission,

> The abiding lesson that Three Mile Island taught Wall Street was that a group of N.R.C.-licensed reactor operators, as good as any others, could turn a $2 billion asset into a $1 billion cleanup job in about 90 minutes.

Despite the importance of reactor safety, the risk assessments used to estimate the likelihood of accidents have numerous methodological weaknesses that limit their usefulness. In light of the uncertainties inherent in such risk assessments, William Ruckelshaus, the head of the EPA under both Presidents Nixon and Reagan cautioned that,

> We should remember that risk assessment data can be like the captured spy: if you torture it long enough, it will tell you anything you want to know.

Finally, there is the difficulty of managing radioactive waste. The existence of weapons-usable plutonium in the waste complicates the problem. Building 1,000 reactors by 2050 would lead to nearly a doubling of the average rate at which spent fuel is generated, with proportionally larger increases under the steady-state growth scenario. Assuming a constant rate of growth, a repository with the capacity of Yucca Mountain (70,000 metric tons) would have to come online somewhere in the world every five and a half years in order to handle the waste that would be generated. For 2500 reactors online by 2050, a new repository would be needed every three years on average.

The characterization and siting of repositories rapidly enough to handle this waste would be a very serious challenge. Yucca Mountain has been studied for more than two decades, and it has been the sole focus of the U.S. Department of Energy since 1987. Despite this effort, and nearly $9 billion in expenditures, to date no license application has yet been filed. In fact, in February 2006, Secretary of Energy Samuel Bodman admitted that the DOE can no longer make a firm estimate for when Yucca Mountain might open or what it might cost due to ongoing difficulties faced by the project.

Alternatives to repository disposal are unlikely to overcome these problems. Proposals to reprocess the spent fuel would not only not solve the waste problem, but would greatly increase the dangers. Reprocessing schemes are expensive and create a number of serious environmental risks while still generating large volumes of waste destined for repository disposal. In addition, reprocessing results in the separation of weapons-usable plutonium, adding significantly to the risks of proliferation. While future reprocessing technologies like UREX+ or pyroprocessing could have some nonproliferation benefits, they would still pose a significant risk.

In summary, we have found that nuclear power is a very risky and unsustainable option for reducing greenhouse gas emissions. Trading one potentially catastrophic health, environmental, and security threat for another is not a sensible energy policy. Luckily there are alternatives available. Of the available options for reducing greenhouse gas emissions, the two most promising ones over the next five to fifteen years are increasing efficiency and expanding the use of renewable resources. At approximately four to six cents per kWh, wind power at favorable sites in the United States is already competitive with natural gas or new nuclear power. Without any major changes to the existing grid, wind power could already expand to 15 to 20 percent of U.S. electricity supply without negatively impacting grid stability or reliability.

Energy efficiency and renewable energy programs have few negative environmental or security impacts and should thus be pursued to the maximum extent possible. However, in order to stabilize the climate, it appears likely that some energy sources with more significant impacts will be needed as transition technologies. The two most important transition options are an increased reliance on the use of liquefied natural gas and the development of integrated coal gasification plants with sequestration of the carbon dioxide emissions in geologic formations.

If efficiency improvements and an expanded liquidification and regasification infrastructure can stabilize the long-term price of natural gas at the cost of imported LNG, then the use of natural gas plants is likely to remain an economically viable choice for replacing highly inefficient coal fired plants. In addition, the use of coal gasification technologies would greatly reduce the emissions of mercury, particulates, and sulfur and nitrogen oxides from the burning of coal. However, for coal gasification to be considered as a potentially viable transition technology, it must be accompanied by carbon sequestration, the injection and storage of $CO2$ into geologic formations. The cost of sequestration is more uncertain, but it is likely to be economically competitive with new nuclear power within the next fifteen to twenty years.

In conclusion, we note that just as the claim that nuclear power would one day be "too cheap to meter" was known to be a myth well before ground was broken on the first civilian reactor in the U.S., and just as the link between the nuclear fuel cycle and the potential to manufacture nuclear weapons was widely acknowledged before President Eisenhower first voiced his vision for the

"Atoms-for-Peace" program, a careful examination today reveals that the expense and vulnerabilities associated with nuclear power make it a risky option for reducing greenhouse gas emissions. We have found that it is very unlikely that the dangers associated with nuclear power could be successfully overcome given the large number of reactors required. It has been more than 25 years since the last reactor order was placed in the United States and ten years since the last new reactor began operating in the U.S. It is time to move on from efforts to revive the nuclear option and to begin focusing on developing more rapid, robust and sustainable options for addressing the most pressing environmental concern of our day. The alternatives are available if the public and their decision makers have the will to make them a reality.