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NUCLEAR POWER AND NUCLEAR WEAPONS

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It is with no little trepidation that I address the topic of nuclear proliferation. There is no doubt in my mind that proliferation, no matter by what route, is a matter of deep concern to the world's population. Yet, it is my opinion that there is a distinct difference between the concern about (or desire for) the proliferation of nuclear weapons and the desire to use nuclear energy for the production of electricity and other peaceful uses. The two aspects can and must be considered separately.

Nuclear energy is in use in many countries of the world. Nuclear power plants generate about 9 percent of the world's production of electricity, today, and are projected to produce about 18 percent by the year 1990 in some 31 countries. It is the hope of the developed countries that the use of nuclear power will provide the energy needed to maintain their place in the world. I was talking with a Dutch scientist who said the Dutch have mostly gas- and oil-fired generating stations. There are strong political pressures to shut down the two small reactors now in service. It was his opinion that industry and jobs in his

country were suffering from high relative energy costs compared with their neighbors in that part of Europe. While there have been many voices raised against the use of nuclear power in the Netherlands, he felt that eventually the resistance to generating electricity from the atom and from coal would die out, largely due to economic reasons.

It is the hope of the Lesser Developed Countries, at least those that have no other significant sources of energy, that through nuclear power they may break free of the old ways of dependence on foreigners and the sweat of their own brows. A year ago, or so, I read that a regional government in India refused permission for their only power reactor to shut down for routine maintenance because the region was so dependent on its electricity for running irrigation pumps and local industies.

Because nuclear energy has demonstrated it can meet our special needs for electricity, it seems illogical to deny ourselves the benefits of the peaceful atom on the premise that it will lead to nuclear proliferation, while at the same time we gorge ourselves on the fruits of the military atom. For this reason, a Non-proliferation Treaty was put into place in 1970 to allow the use of the atom for generating electricity, for medical purposes, and for other peacefully oriented endeavors and to deny the spread of this technology for building a nuclear arsenal. The Treaty has two main features: Article IV(2), "All of the Parties to the Treaty undertake to facilitate, and have the right to

participate in, the fullest possible exchange of equipment, materials, and scientific and technical information for the peaceful uses of atomic energy"; and Article VI, "Each of the Parties to the Treaty undertakes to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control". The Treaty provides for the inspection of Signatories to determine compliance through the International Atomic Energy Agency.

As of 1982, 97 of the nations of the world have signed the Non-proliferation Treaty, 93 of which have also ratified it. Another 23 have acceded to its principles by declaring their intention to conform to the precepts of the Treaty. While this appears to be overwhelming support for the Treaty, there are a significant few that have neither signed nor acceded to the Treaty, as yet. In a few cases, one may suspect that some of the non-signatory Nation-states do not wish to foreclose any future options, including weapons; however, some may not have signed simply to make a protest against the nuclear weapons powers for not fulfilling the requirements of Article VI.

With this apparently overwhelming support it would seem that we should be well on the way to a careful use of atomic energy for peaceful purposes, throughout the world. In the United States, and some of the other developed countries the use of

nuclear electricity appears to be more controversial today than it was a few years ago. One of the reasons appears to be the concern for proliferation. Over the past six or seven years I have been seeking to understand the anti-nuclear positions of certain groups and to reason with them about the need for energy, even nuclear energy. My experience has been, until recently, that the main efforts of the anti-nuclear groups appeared to be focussed on stopping nuclear power plants as a first step on the way to stopping nuclear weapons. The justification used was that people can think about nuclear power plants, but they appeared to be unable to think about nuclear war (which was blocked because it was too horrible to contemplate). By building on existing fears of nuclear power plants, one would be able to open up the thinking on the real issue. The strategy worked. However, to make a more effective stepping stone, the dangers from nuclear power were overstated. Even today some equate the dangers from nuclear power with the destruction from a nuclear war!

Considering the arguments against nuclear power concerning the potential nuclear power holds for the proliferation of nuclear weapons, there is merit to the concern about having nuclear weapons readily available to all countries. Some 40 countries are engaged in violent conflict or war at this time (1983). The emergency created by battlefield reverses could lead to the small-scale use of nuclear weapons, if they were available. Any such use could lead to a major confrontation between the weapons states, which could escalate to a full scale

nuclear war. Therefore, one should limit the horizontal spread of nuclear weapons. True. However, this sequence is not inevitable; this hypothetical chain of events might be broken at any link, and the final result might be reconciliation, rather than nuclear war. In addition, the hypothetical consequence of nuclear war is not limited to scenarios in which warring countries use nuclear weapons on a small scale, any confrontation could escalate to a major confrontation between the weapons states.

In spite of the multiple paths to nuclear war available today, some anti-nuclear advocates insist that there is an inevitably fatal connection, in their view, between atoms for peace and atoms for war. They seem to believe that by giving up the benefits of nuclear power society will be able to avoid the penalties of nuclear war. This argument has logical as well as technical dimensions. One of the major problems in analyzing this argument is the qualitative nature of the logic. There are no quantitative estimates of likelihoods of events ocurring, nor any comparisons between one scenario and another. Any scenario is acceptable and any unfavorable scenario is fatal.

In brief, the anti-nuclear argument goes something like this: nuclear power plants make plutonium, plutonium is used in bombs, therefore spreading nuclear power plants spreads bombs. Furthermore, reactors are made with nuclear technology, bombs are made with nuclear technology, therefore the spread of reactor technology spreads bomb technology. The syllogisms conclude with:

stopping nuclear power plants will result in stopping the spread of nuclear weapons.

The serious person must admit that there might be one way, or another, to generate weapons by misusing the nuclear power cycle. Using qualitative reasoning, this is apparently all the anti-nuclear advocate needs to hear to confirm her or his worst fears and, in her or his mind, seal the fate of nuclear electricity. Adding some quantitative dimensions, the fact that none of the estimated 50,000 nuclear weapons available to the weapons states was derived from a nuclear fuel cycle should cause some degree of moderation of these fears and some degree of examination of the final premise. After all, many technologies have the potential to be misused, yet they are socially acceptable. Furthermore, the potentially negative effects of not developing nuclear power should also be examined in this calculus of social utility.

Considering the technical particulars, in the first argument (nuclear power reactors make plutonium, plutonium is used to make bombs, therefore spreading reactors spreads bombs), the will of the nation-state to build a nuclear arsenal is not addressed. If the nation-state does not wish to make bombs, it will not do so. This opens up many possibilities for action to reduce the perceived need to have a nuclear arsenal, including strengthening the techniques for arriving at political solutions using advanced conflict resolution techniques and by removing the causes of war.

In addition, one can seek to understand the reasons a nation-state would seek a nuclear arsenal. What are the apparent benefits, what are the apparent penalties? I have heard it asked: "What can a nation do with one or two (or even 15,000) nuclear weapons?" (The situation of sub-national groups or terrorists is beyond the scope of this paper; however, let me state that it appears to me unlikely that they would use power reactors to get weapons.) In the case of India, have India's relationships with its neighbors and the rest of the world been improved by its having exploded an atomic bomb? Have the benefits of having the nuclear capability out-weighed the adverse effects of the sanctions imposed over the past 8 years? I think they have not.

However, if the nation-state does choose to build a nuclear arsenal there are several ways in which it might proceed. One of these ways could include plutonium from power reactors. While it is true that a nation-state needs only one way to produce nuclear weapons, it is my contention that the nuclear power route is technically and economically the least attractive way to an arsenal. By this, I do not mean to imply that one cannot produce a nuclear weapon starting with irradiated power reactor fuel; it can be done, but it requires a much greater financial commitment, a much larger technically trained staff, and a much more sophisticated technology to derive nuclear weapons from the common power reactor fuel. In addition, the detection of diversion is handled much like a bank audit. The fuel exists in fixed fuel elements which can be counted for accountability. The

numbered fuel elements that have been delivered to the reactor must be in the reactor, in the storage pool, or on the shipping invoice (and at the receiving site) or there are questions to be answered.

The ubiquitous light-water-moderated power reactors used to generate electricity produce a plutonium ill-suited to bomb use because it is less pure (ie; the concentration of fissionable plutonium is relatively low) and because it emits excessive radiation, which makes the weapon more detectable, more hazardous to the personnel around it, and which reduces its "shelf-life" and reliability. As support for these statements, you may have noticed the recent brou-ha-ha caused by the announcement that the Department of Energy wanted to use laser enrichment to produce weapons grade plutonium from civilian reactor fuel to meet the needs for increased numbers of nuclear weapons in our arsenal. (Laser enrichment is very high technology, with as-yet undemonstrated technical practicality.)

The above logic leads to the revised syllogism: light water reactors are made with low-enriched uranium and make impure plutonium, bombs are made from highly enriched uranium or pure plutonium, therefore light water power reactors are poor sources of bomb materials.

Historically, the development of nuclear weapons either

preceded the production of electricity from nuclear reactors, or was developed independently. Even in the case of India, the nuclear weapon exploded in 1974 was produced from plutonium from a research reactor, the 40 MW Cirus reactor, not a power reactor. The question to be answered for the case that some nation might choose to go the nuclear power route to nuclear weapons, no matter how difficult or costly, is: Is the chance that even one weapon may be derived from a power reactor somewhere in the world sufficient reason to abandon the nuclear power option and dismantle the nuclear power economy?

As part of the process of answering this question for ourselves we can phrase other questions. Would the abandonning of the nuclear power option stop the proliferation of nuclear weapons? Probably not, although it might be one place to start. For example, most nuclear fission weapons appear to be built from highly enriched uranium because of its relatively low radiotoxicity and ease of fabrication and handling. This material is obtained from specialized enrichment cascades. The main reason that one would want to convert to plutonium-based nuclear weapons appears to result from a desire for smaller sized weapons, a tactically desirable feature. If a nation-state desired plutonium weapons, it would probably follow the historical trend and build production reactors or divert special kinds of research reactors to plutonium production. This would not require the involvement of the nuclear power reactors.

The second syllogism, (reactors use nuclear technology, bombs use nuclear technology, therefore the spread of reactor technology spreads bomb technology) can be addressed in this manner: reactor technology consists of the physics of controlled nuclear reactions in large cores surrounded by coolant. The fuel is fabricated into long rods and must be replaced periodically to maintain reactor criticality. Highly trained operators are needed. Reactors are equipped with extensive redundant safety control features. Heavy construction methods are needed for the thick reactor vessels, the containment structures and the cooling towers. Nuclear power reactors are used most effectively for base-load (constant) generation of electricity.

Bomb technology is different in concept. It consists of the physics of uncontrolled, and unmoderated nuclear reactions. The bomb components must be fabricated to fit together precisely and quickly. Bomb technology utilizes sophisticated high explosive ignition technology to hold the parts together for as many milliseconds as possible. Safety features are used to prevent premature explosion, and to assure ignition when wanted. Highly sophisticated light construction methods are required to make deliverable weapons. Nuclear weapons are built to be accumulated without end, and stored indefinitely. They are not built to be used, except in "emergencies".

The materials and technologies for making light water power reactors and for making nuclear weapons are quite different. The

oft-stated claim that the spread of nuclear power reactors inevitably spreads nuclear weapons is an oversimplification, at best. Does this mean that one need not be concerned, that everything will work out without our paying attention to the nuclear power fuel cycle? No, that is why the Non-proliferation Treaty is needed. It is a valuable signal of the intentions of the nation-states and provides for controls to monitor that a signatory nation-state is following its proclaimed path, that of developing the atom for peaceful uses.

As in the past, it will be necessary to maintain institutional controls to keep the military applications out of the civilian nuclear power programs, even in the United States. All steps in the fuel cycles of the various reactors can be monitored under the Non-proliferation Treaty with special attention to a few key areas, as mentioned in the box, above. Sanctions can be applied where non-conformance is suspected or known. In this way nuclear power can be used for the benefit of all.

INSET BOX

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PROLIFERATION CONTROL POINTS FOR VARIOUS POWER REACTORS

Many kinds of reactors are designed for producing power. The

two most commonly used are light water moderated reactors (LWR). These were described in some detail above. It is sufficient to monitor their operation to ensure that they are not being operated on a non-standard fuel loading and discharge cycle, and that the fuel is accounted for after discharge. Similar controls are needed for the Canadian heavy water moderated reactors (CANDU). These reactors have an added feature that they may be refueled "on-line", that is, without being shut down. This feature opens up the possibility that non-standard fuel loading and discharge cycles could occur almost at any time. The Canadian people (and hence, the Canadian government) are debating the exporting of these reactors. Certainly, the exports will be limited to what appear to be trustworthy nation-states, and sanctions (etc.) will be applied in instances where suspicious activities are detected. India has been under sanctions for eight years.

There are two other contenders: the high temperature gas-cooled (HTGR) and the breeder (LMFBR) reactors. In the case of the HTGR, the control point is the fresh "driver" fuel. Like some research reactors, it contains highly enriched uranium. In principle, the unirradiated fuel could be diverted, purified, and used in weapons. This would not be a simple task since the fuel is encapsulated in small spherical particles imbedded in massive graphite blocks. The fuel that has been irradiated would be too radioactive for stockpile weapons. As mentioned above for light-water reactors, the plutonium recycled to breeders from the

HTGRs and from breeder reactor cores would be a poor material for weapons. Full Safeguards controls should be applied, nonetheless. The sensitive control point for breeders is the plutonium bred in the depleted uranium blanket materials; the plutonium bred in this section is of high purity, and controls would be needed to prevent its use to provide weapons materials both at home and abroad.

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