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Survey of the United States Treaties and Agreements Involving the Peaceful Uses of Nuclear Energy, A

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NOTES

A Survey of the United States Treaties and Agreements Involving the Peaceful Uses of Nuclear Energy

INTRODUCTION

THAT AN ENERGY crisis stands on the horizon of every nation's future is becoming increasingly apparent. The population of the world is swelling.[1] Living standards are rising, especially in the developing states,[2] resulting in increased *per capita* energy consumption.[3] Each nation must supply energy to a population which is both expanding its numbers and increasing its individual requirements. Energy needs, therefore, are simultaneously widening and deepening.

The most rapid energy growth over the past several years has occurred in the use of electricity.[4] World electricity consumption is expected to increase to nearly seven times its 1970 level by the year 2000.[5] Most of this electric power will be generated by the use of either fossil fuels or nuclear fisssion.[6] Other methods of producing power are of course possible, such as solar, hydroelectric, tidal and geothermal energy, windmills, and direct energy conversion (*e.g.*, magnetohydrodynamics), but energy planners worldwide show very little inclination to use these methods to any substantial degree in the near future. Drawbacks such as high cost, inconvenient production sites, and the embryonic stages of some of the technologies make the methods uneconomic or impractical by present standards.

Fossil fuel is the predominant source of electric power today, but supplies are decreasing. For example, conservative estimates predict

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[1] By the year 2000, world population will be at least 30% larger than it was in 1972, numbering more than 4.7 billion people. T. FREJKA, THE FUTURE OF POPULATION GROWTH 55 (1973).

[2] R. ASHER, DEVELOPMENT ASSISTANCE IN THE SEVENTIES 81-82 (1970).

[3] There is a positive correlation between a nation's gross national product and its *per capita* energy consumption. Thus economic progress is closely associated with increased individual energy use. INTERNATIONAL ATOMIC ENERGY AGENCY, NUCLEAR POWER AND THE ENVIRONMENT 1 (1973).

[4] *Id.* at 1, 3.

[5] The world electricity consumption was 4,900 x 10^9 kWh(e) in 1970. It is expected to soar to 3,360 x 10^{10} kWh(e) in 2000. *Id.* at 3.

[6] *Id.* at 2.

that the world's coal reserves will be exhausted by the year 2400. Oil resources are expected to be exhausted by 2025.[7] Thus, as the need for electric power is soaring, fossil fuel supplies are dwindling, creating an ever increasing gap which must be filled by another energy source. As mentioned above, several energy alternatives are possible, but only one alternative is being seriously considered by national energy planners worldwide; nuclear energy.[8]

The United States is a major world producer of nuclear energy technology. In early 1972 the United States' nuclear power capacity accounted for nearly half of the total world capacity.[9] Canada, South Africa and the United States have the largest known deposits of uranium, the resource material used to make most nuclear fuel, accounting for about eighty percent of the proved reserves of uranium outside the Communist nations.[10] Only the five states possessing nuclear weapons (nuclear-weapon states)—China, France, the Soviet Union, the United Kingdom, and the United States—have the capability to convert uranium into nuclear fuel on a large scale.[11] Almost all nuclear power reactors built and planned in the United States and the Soviet Union will use nuclear fuel made from uranium. In the rest of the world, probably eighty percent of the total nuclear fuel used will be made from uranium.[12]

By 1972, at least thirty-four nations were constructing or at least planning to build nuclear power stations.[13] This number jumped to forty-one by 1976, and is expected to continue increasing.[14] Although several types of nuclear reactors have been designed to convert nuclear fission energy into electricity, the United States produces only one type, the light-water reactor, on a large scale. The light-water reactor has been widely adopted worldwide.[15] Obviously, the United States will

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[7] *Id.* at 3.

[8] Nuclear fission is being enthusiastically promoted as a major energy source for the future by energy planners worldwide. Smyth, *The Need for International Safeguards*, in INTERNATIONAL SAFEGUARDS AND NUCLEAR INDUSTRY 3,4 (M. Willrich ed. 1973).

[9] *Id.* at 61.

[10] Willrich, *Worldwide Nuclear Industry*, in INTERNATIONAL SAFEGUARDS AND NUCLEAR INDUSTY 45, 62 (M. Willrich ed. 1973).

[11] *Id.* at 63.

[12] *Id.* at 62.

[13] Smyth, *supra* note 8, at 61.

[14] Bauser, *United States Nuclear Export Policy: Developing the Peaceful Atom as a Commodity in International Trade*, 18 HARV. INT'L L.J. 227, 229, 237 (1977).

[15] *Id.* at 229.

continue to be one of the major suppliers for increasing nuclear energy requirements.[16]

The Energy Research and Development Administration has, in fact, projected that United States nuclear power export revenues will range from three to four billion dollars in 1985, increasing to eight to ten billion per year by 2000.[17] Such exports are authorized by various provisions of the Atomic Energy Act of 1954.[18] In general, the Act authorizes government-controlled commercial development of nuclear power, both domestic and foreign, and allows international cooperation in the peaceful uses of nuclear energy.

On first glance it appears that nuclear technology will offer an efficient and profitable supply of electric power in the future, but closer inspection reveals that nuclear power does not provide a simple answer to the world's energy problems. The technology involves, generally, three basic risks: (1) possible diversion of nuclear energy materials to weapons manufacture, (2) economic pressures stemming from the de-

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[16] However, due to some technology lag and to recent policy changes, the United States share of the nuclear energy market may not be so large in the future as was predicted even a year ago. This development is discussed further in notes 19 and 22, *infra*.

[17] I U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION, FINAL ENVIRONMENTAL STATEMENT ON U.S. NUCLEAR POWER EXPORT ACTIVITIES 3-91 (ERDA-1542, 1976). For the reasons mentioned in note 16 *supra*, these estimates are probably now too high. With that *caveat* in mind, however, one can view them as a general estimate.

[18] 42 U.S.C. §§ 2011-2296 (1976). Under § 123 of the Act, 42 U.S.C. § 2153 (1976), the Nuclear Regulatory Commission (NRC) may license the export of special nuclear materials (*e.g.*, enriched uranium) and production and utilization facilities (*e.g.*, enrichment facilities and light-water reactors) only under the auspices of an agreement for cooperation between the United States and the country to receive the materials, equipment or facilities. (These agreements for cooperation will be examined further on in this note.) The President's approval and authorization of such an agreement is always required. Depending upon the extent of cooperation intended, the agreement must also lie before various Congressional committees for 30 days or before the Congress for 60 days while Congress is in session before becoming effective. Agreements requiring the 60 day waiting period may be rendered ineffective during that time by a concurrent Congressional resolution. 42 U.S.C. § 2153(c)-(d) (1976). For a discussion of the effects and possible abuses of such a law providing for automatic Congressional approval after a certain period of inaction see Notes, *U.S. Military Exports and the Armed Export Control Act of 1976: The F-16 Sale to Iran*, 9 CASE W. RES. J. INT'L L. 407, 413-21(1977). For a more thorough discussion of the provisions of the Atomic Energy Act relating to foreign exports see Bauser, *supra* note 14, at 230-33.

mand for nuclear materials, equipment and technology, and (3) environmental risks, primarily from possible radiation leaks from the reactors and from materials being transported or stored.

If the United States possessed a worldwide monopoly or near monopoly of nuclear trade, then this nation could control these risks by controlling the industry. However, such a situation does not exist today. While it is true that the United States is and will continue to be a major supplier of nuclear energy, its share of the world market is nevertheless decreasing.[19] This is due to three factors: (1) other countries have increased their nuclear energy exporting capabilities, thus making the market more competitive than before,[20] (2) the United States' three enrichment plants (which perform the most complex step in converting uranium into fuel) are presently operating at capacity, thereby precluding future increases in fuel production and exportation unless present enrichment capabilities are significantly expanded,[21] and (3) the Carter administration, in an effort to deter the development of nuclear weapons in foreign countries, has deferred indefinitely the exportation of reprocessing and enrichment facilities and the commercial use of breeder reactors,[22] which many countries are interested in acquiring.[23]

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[19] The United States controlled almost 80% of the reactor export market from 1956 to 1973. During 1974 and 1975, however, the United States only exported 13 out of 24 reactors exported worldwide, thus dropping to slightly over 50% of the market. Bauser, *supra* note 14, at 238.

[20] *Id.* at 238-39.

[21] *Id.* at 239. Such expansion is planned in the near future under the Carter administration's nuclear energy policy. *See President Carter Announces Decisions on Nuclear Power Policy,* 76 DEP'T STATE BULL. 429, 430 (1977).

[22] Reprocessing and enrichment plants and breeder reactors involve the greatest danger of nuclear materials diversions to weapons manufacture. This will be further discussed in the next section of this note. President Carter outlined current United States policy regarding nuclear energy exports in a statement issued April 7, 1977, *President Carter Announces Decisions on Nuclear Power Policy, supra* note 21, at 429. In that statement the President announced a decision to cut off funding and "[f]ederal encouragement" for the reprocessing plant being built at Barnwell, South Carolina. *Id.* He also promised a continued embargo on the export of uranium enrichment technology, *id.* at 430, and deferral of the commercial use of breeder reactors. *Id.* at 429. The President stressed that other policy decisions were designed to counter the negative effects of these decisions on the United States market share. These include a significant increase in production capacity for enriched uranium, and proposed legislation to permit the United States to guarantee delivery of nuclear fuel to other countries under supply contracts. *Id.* at 430.

[23] Nye, *Planning A Safeguardable Nuclear Future,* 77 DEP'T STATE BULL. 183, 188 (1977).

The nuclear energy market, then, is highly competitive and is supplied by many nations. Joseph Nye, Jr., Deputy to the Under Secretary for Security Assistance, Science, and Technology has stated that "it's too late for any one nation to dictate, but it's not too late to cooperate."[24] United States control over the international nuclear energy situation, therefore, depends upon United States cooperation with other nations. Such cooperation is best exemplified by the United States treaties and agreements which are now in effect. This note will examine those treaties and agreements under which the United States is cooperating with other nations to control the peaceful use of nuclear energy.

I. NUCLEAR ENERGY TECHNOLOGY

Before examining the United States treaties and agreements which involve nuclear energy, it will be helpful to first study the nuclear fuel cycle itself. The range of potential problems associated with nuclear energy and their possible solutions will also be discussed. Against this technical and practical backdrop, the treaties and agreements can be meaningfully scrutinized to determine how far they extend over the range of problems which plague nuclear energy use and how well they confront those problems.

A. The Nuclear Fuel Cycle

Uranium ore is mined, milled, enriched, and then made into fuel. The fuel is irradiated in a reactor and the resulting atomic fissions release heat which is converted into electricity. Used fuel (spent fuel) is then either stored or reprocessed. If it is reprocessed, usable materials are separated out and recycled, and the rest of the used fuel (wastes) are stored. This, in simplified form, is the nuclear fuel cycle.

The light-water reactor (LWR) usually uses fuel derived from the element uranium.[25] Natural uranium occurs in a number of different isotopes.[26] The most abundant isotope is uranium-238,[27] which alone is not useful for nuclear energy purposes. Another isotope, uranium-235,

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[24] *Nuclear Power Without Nuclear Proliferation,* 77 DEP'T STATE BULL. 666, 671 (1977).

[25] United States reactors presently use only uranium fuel. Nye, *supra* note 23, at 185.

[26] When an element occurs in isotopes, this means that there are two or more types of atoms of that element. All these atoms have the same number of protons in the nucleus and the same electron configuration, and therefore display basically the

is needed to produce a fission chain reaction in a reactor. Uranium-235 constitutes less that one percent of natural uranium.[28] Consequently, after natural uranium is mined, some of the uranium-238 isotope must be removed to increase the proportion of the fissionable uranium-235. This process of removing some of the uranium-238 isotope is called enrichment. LWRs require uranium enriched to at least three percent uranium-235.[29] Uranium enrichment is the most complex and costly step in the nuclear fuel cycle.[30]

The enrichment process produces uranium oxide powder. This powder is taken to a fuel fabrication plant, where it is pressed into pellets and loaded into thin-walled metal tubing.[31] The resulting fuel elements are transported to a nuclear power plant where they are loaded into the reactor core.

There are two kinds of LWR; the pressurized water reactor (PWR) and the boiling water reactor (BWR). In both types of LWR, the uranium fuel is bombarded with slow neutrons which cause uranium-235 atoms to fission. A nuclear fission releases energy in the form of heat, and also causes two or three neutrons from the split atom's nucleus to break away. The emitted neutrons may be absorbed by other uranium-235 atoms, causing them to fission and creating a sustained nuclear chain reaction.[32] The chain reaction generates a tremendous amount of heat which ultimately, through one type of thermal/kinetic energy conversion or another, creates steam. As in conventional fossil fuel plants, the steam drives large turbines that generate electricity. At the same time that this chain reaction is taking place, some of the emitted neutrons are absorbed in atoms of uranium-238, forming plutonium.[33]

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same chemical properties. But the number of neutrons in the nuclei differ. The different isotopes may have different nuclear properties, as is the case with the uranium isotopes. M. WILLRICH & T. TAYLOR, NUCLEAR THEFT: RISKS AND SAFEGUARDS 11 n.6 (1974).

[27] Natural uranium is 99.3% uranium-238. Willrich, *supra* note 10, at 47.

[28] Only 0.7% of natural uranium is uranium-235. *Id.* at 48.

[29] Nye, *supra* note 23, at 185.

[30] Willrich, *supra* note 10, at 50. For a detailed description of the process of enrichment, see *id.* at 50-52.

[31] *Id.* at 53.

[32] *Id.* at 47.

[33] When an atom of uranium-238 captures a neutron released in the fission process, uranium-239 is formed. This radioactively decays, with a half-life of twenty minutes, to neptunium-239. This atom subsequently decays, with a half-life of about two days, to form plutonium-239. This isotope of plutonium has a half-life of 24,000

The high-temperature, gas-cooled reactor (HTGR) is also in use or under consideration for future use in some countries. This reactor uses highly enriched uranium, *i.e.*, uranium in which the proportion of uranium-235 exceeds ninety percent, together with thorium for fuel. The uranium undergoes a chain reaction as in the LWR while thorium atoms capture some neutrons and are converted to uranium-233.[34]

The fast breeder reactor is under intensive development in at least five other countries.[35] This reactor uses either highly enriched uranium, or plutonium, which is also fissionable, or both as the fuel core. The core is surrounded by a layer of uranium-238 which is converted during reactor operation into plutonium.[36] The end result is that electric power and new fissionable material, plutonium, are generated simultaneously.[37] This reactor type is especially appealing to countries lacking uranium resources or enrichment facilities.

After nuclear fuel is spent, it is removed from the reactor and either stored or chemically reprocessed. At this point it is extremely radioactive.[38] If the fuel is reprocessed, uranium and plutonium are separated out for reuse and the remaining highly radioactive wastes are concentrated and stored.[39]

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years. A half-life is the average time required for half of a given quantity of an isotope to decay and form some other isotope. M. WILLRICH & T. TAYLOR, *supra* note 26, at 12. The time required for all of a given material to decay is *not* equal to twice its half-life, it should be noted. For example, the time required for all of a given amount of plutonium-239 to decay is 250,000 years.

When the irradiated, or spent fuel is removed from the reactor, it typically contains about one atom of plutonium for every four uranium-235 atoms that were fissioned. In an LWR plant which uses slightly enriched uranium (uranium with less than 10% uranium-235) and which steadily produces 1,000 megawatts of electrical power, this translates to about 250 kilograms of plutonium produced per year, of which 200 to 225 kilograms are plutonium-239. The other 25 to 50 kilograms are mostly plutonium 240. *Id.* at 32. Natural uranium reactors would produce twice this amount of plutonium. Willrich, *supra* note 10, at 54.

[34] Willrich, *supra* note 10, at 49.

[35] Nye, *supra* note 23.

[36] This conversion takes place by the process described in note 33, *supra.*

[37] Although it appears in this cursory examination that LWRs and fast breeder reactors produce the same results, the fast breeder reactors actually yield much greater amounts of fissionable materials, due to technical differences not developed here, than do LWRs. The yield from a fast breeder reactor, in fact, can exceed the amount consumed. Willrich, *supra* note 10, at 49.

[38] Willrich, *supra* note 10, at 53.

[39] *See* Appendix A for a flowchart of the nuclear fuel cycle.

B. *Potential Problems Involved With Nuclear Energy*

The nuclear energy problem most often discussed by politicians and diplomats today is the possible diversion of nuclear energy materials to weapons manufacture.[40] Plutonium produced in LWRs and fast breeder reactors, and uranium-233 produced in HTGRs, once isolated by reprocessing, can be used to make a fission bomb.[41] Plutonium, which can be used as fuel in LWRs or fast breeder reactors, and highly enriched uranium, used as fuel in fast breeder reactors and HTGRs, also can be used for fission bombs.[42] Enrichment facilities can be used to produce uranium enriched to more than ten percent uranium-235, the minimum enrichment required for bomb material.[43]

An explosion from a nuclear bomb not only would produce damage with a blast wave and heat, but also would release potentially lethal penetrating radiation (prompt radiation) and radioactive materials that could settle over a large area and cause further irradiation.[44] Plutonium also can be used in a simple dispersal device to make a lethal radiation weapon, as can the highly radioactive fission waste products produced in all reactors.[45] Any government having enrichment or reprocessing facilities or using plutonium or highly enriched uranium for nuclear fuel would have access to these dangerous

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[40] *See generally* the 1977 volumes of the DEP'T STATE BULL., in which the majority of press releases and discussions concerning nuclear energy problems center around possible diversion of materials to weapons manufacture.

[41] M. WILLRICH & T. TAYLOR, *supra* note 26, at 15, 19.

[42] *Id.* at 18-19. It only takes about a dozen pounds of plutonium to make a bomb with destructive capabilities similar to the one dropped on Nagasaki at the end of World War II. Nye, *supra* note 23, at 186.

[43] M. WILLRICH & T. TAYLOR, *supra* note 26, at 16.

[44] *Id.* at 22.

[45] Radioactive substances emit either alpha or beta particles or gamma rays when they decay. These emissions are highly toxic because they damage somatic and reproductive cells, causing cancer and other diseases and genetic defects. NUCLEAR POWER AND THE ENVIRONMENT, *supra* note 3, at 10. Plutonium emits alpha particles which have very little penetrating power, so exposure to the skin is not very harmful. But once plutonium is suspended in the air in very small particles, it is one of the most toxic substances known. A few thousandths of a gram of such particles (about the size of a pinhead), if inhaled, can cause death from fibrosis of the lungs within a few weeks. Fission products emit highly penetrating gamma rays and therefore are extremely hazardous if dispersed, whether inhaled or not. A dispersal device would likely be made from plutonium since plutonium is much safer to handle as long as it is not inhaled or allowed to come into contact with broken skin. *Id.* at 13, 24-27.

materials. Terrorist groups, too, could steal the materials to make the bombs or dispersal devices described above.[46]

The second major problem associated with nuclear energy is the result of the technology's status as an important commodity in international trade. The competitive atmosphere of the nuclear energy market has exerted economic pressures upon the development and use of nuclear technology.[47] Nations which have source material or nuclear technology capabilities are competing vigorously for shares of the export market.[48] Consequently, these countries must participate skillfully in the economic juggling act of supply and demand. Each nation's market survival depends upon world demand for the materials and equipment which the nation can produce. And each nation's supply capabilities must be maintained and constantly improved.

These economic problems, it should be noted, are closely interwoven with the weapons-potential problems previously discussed. The increasing worldwide dependence upon nuclear energy has created an intensely competitive market, in which every sort of nuclear material, facility and equipment is in demand. Materials and facilities of weapons-producing capability can only be kept out of use if attractive alternatives are efficiently and relatively inexpensively supplied.

The third problem associated with nuclear energy is the danger of environmental harm. A major hazard of nuclear energy use is the danger of radiation contamination. Several stages of the nuclear fuel cycle involve radioactive material. A typical large reactor, for example, may contain about one and one-half tons of irradiated material in the reactor core after several months of plant operation.[49] About one-fifth of this is gaseous or volatile.[50] The reactor core is surrounded by a cooling system which draws off the heat created by the chain fission reaction. If this cooling system were to fail, the chain reaction would continue producing heat, and ultimately the fuel rods and the material surrounding the fuel would melt (core meltdown), exposing the radioactive fuel material. A core meltdown potentially could release this material into the surrounding environment.

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[46] For a fuller discussion of the risks of nuclear materials theft, see M. WILLRICH & T. TAYLOR, *supra* note 26, at 107-21.

[47] Bauser, *supra* note 14, at 229-30, 237-41.

[48] *Id.*

[49] UNION OF CONCERNED SCIENTISTS, THE RISKS OF NUCLEAR POWER REACTORS 1 (R. Hubbard & G. Minor eds. 1977).

[50] *Id.*

Spent fuel is highly radioactive and very dangerous to handle without heavy shielding. When it is removed from the reactor core (unloaded), it is stored for several months in a concrete-lined water pool next to the reactor while some of the radioactive material decays to safe isotopes. An accidental break in the lining of the pool would allow radioactive emissions from this stored fuel to reach the surrounding environment.

After the initial storage at the plant site, spent fuel must be transported to a reprocessing plant or storage facility. The material is put into thick-walled containers and transported by truck or train. A simple negligent accident such as a collision or jackknife, especially if an explosion resulted, could cause the containers to spill and break, releasing material which would irradiate heavily travelled and possibly heavily populated areas.

At the reprocessing plant the fuel again is stored in a concrete-lined water pool for about five months to allow further radioactive decay of some of the material. Then the fuel is either transported as is to a permanent storage site or is separated into uranium, plutonium, and fission reaction wastes. Separated uranium is fairly safe to handle. It contains a very low percentage of uranium-235 and can be re-enriched and used as fuel. Separated plutonium is in solution and is initially fairly safe to handle. It can be used as fuel without enrichment.[51] If it is to be stored after separation, however, it must be surrounded by concrete shielding to keep the level of penetrating radioactivity from exceeding safe standards for long-term exposure.[52] The remaining reaction wastes are highly radioactive and very dangerous to handle, and must therefore be heavily shielded to prevent radiation of the surrounding environment until they are no longer toxic, *i.e.*, radioactive. If spent fuel is not reprocessed, the original mixture of uranium, plutonium and waste materials is stored until the radioactivity decreases to safe levels.

The only known "method" of radioactivity detoxification is the passage of time, *i.e.*, waiting for the material to decay to non-radioactive isotopes.[53] This one known "method" is no method of

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[51] At this point plutonium also can be diverted to weapons manufacture. The plutonium can be precipitated out of the solution in a few relatively easy steps and then used in a fission bomb or dispersal device.

[52] Plutonium radioisotopes gradually build up, which emit the highly penetrating gamma rays mentioned in note 45, *supra*.

[53] Note, *The National Environmental Policy Act of 1969 and Nuclear Power Plant Licensing: Judicial Modification of Agency Rulemaking—Natural Resources*

detoxification at all. Further, the reaction waste products, if stored alone after reprocessing require 600 to 1000 years to decay to safe isotopes. If spent fuel is not reprocessed, the mixture of uranium, plutonium, and wastes must be stored until the longest-lasting material has decayed to safe isotopes. Plutonium takes the most time to decay, requiring at least 250,000 years to become safe.

Since no detoxification method exists, radioactive waste materials simply increase year by year as reactors continue to operate. It is estimated that the United States will need at least 500,000 cubic feet of storage space for fuel disposal by 2010.[54] This amount of disposed fuel would fill more than a mile-long stretch of sixty-foot boxcars. When one considers that this material must not only be contained but must be heavily shielded with materials whose endurance has been tested for only a few hundred years, one can only conclude that the danger of leakage and environmental harm is immense. Moreover, even if the container materials might last for the requisite 250,000 years, natural hazards may cause them to break and release their contents. For example, geologists predict that there will be another ice age in about 90,000 years, with glaciers moving over the northern half of the globe.[55] The glaciers would of course gouge the land and cause movements of land masses. Containers of radioactive material stored in caves, salt beds and other natural land formations, if not extracted and moved to new locations, would almost certainly be broken open.

Nuclear energy, then, involves the danger of radioactive contamination during several steps of the nuclear fuel cycle. And when the cycle is completed, a highly toxic end product remains which must be isolated for such a long time that no government can effectively plan for its safe storage during the time that the material remains lethal.[56]

Defense Council, Inc. v. Nuclear Regulatory Commission, 26 DEPAUL L. REV. 666, 666 n.5 (1977).

[54] *Id.* at 667 n.7. Even this alarming estimate may be too low, since the Carter administration has very recently decided to indefinitely defer the reprocessing and recycling of plutonium within the United States so that it will be unavailable in isolated form. *President Carter Announces Decisions on Nuclear Power Policy, supra* note 22, at 429. All of the spent fuel from United States power plants, rather than just the waste material alone must now be stored, increasing the previously estimated storage space requirements.

[55] Calder, *Head South With all Deliberate Speed: Ice May Return in a Few Thousand Years*, SMITHSONIAN, Jan. 1978, at 32, 37, 40.

[56] All of these environmental risks were studied by the NRC and evaluated in U.S. NUCLEAR REGULATORY COMMISSION, REACTOR SAFETY STUDY (NUREG-75/014,

C. *Possible Solutions To The Problems*

What are the possible solutions to these various problems of nuclear energy use?

The problem of the possible use of nuclear technology for weapons manufacture can be approached in several ways. Countries using nuclear energy could submit to a central system of control, using only the materials and facilities allowed them by a central administrative body. If the central body performed enrichment, reprocessing and storage activities, dangerous materials and facilities would be removed from any single country's internal control and possible misuse. Terrorists too would have fewer opportunities to sabotage facilities or steal materials.

Another possible solution would be to have the central body function as a monitor, inspecting nation-owned facilities and materials to detect diversion of weapons-usable materials, reporting such diversion to other concerned nations. Or nations could perform monitoring functions among themselves. Countries could also exchange promises not to divert nuclear energy materials or facilities to weapons manufacture, or they could agree to make nuclear weapons capabilities available to all nations, creating a heavily armed system of military counterbalances. Nations could also enter into agreements to employ

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1975) [hereinafter cited as RSS]. The RSS concluded that the probability of these risks was so low as to be negligible. However, an independent group of scientists, engineers, and mathematicians subsequently performed an analytical study of the RSS and the 50,000 pages of internal working papers which preceded the RSS. The results of this study have been published in a 210-page book. THE RISKS OF NUCLEAR POWER REACTORS, *supra* note 49. This study revealed that several serious errors had been committed in the NRC's study. For example, the probability methods used by the NRC were inappropriate for predicting the absolute probability of an event. Statistical theory was misapplied, leading to systematic underestimates of the probabilities that *were* computed. Much of the equipment reliability data necessary to such computations is presently unavailable, incomplete or uncertain, which seriously detracts from the significance of the probabilities computed. *Id.* at 132-33. The RSS also purposely avoided certain safety issues because the officials involved feared that "the facts may not support our pre-determined conclusions" and because it was "not known in advance" that the results would "engender confidence" in the reliability of reactor safety systems. *Id.* at 6. Internal papers further revealed that the basic purpose of the RSS was to produce a report that would have "significant benefit for the nuclear industry." *Id.* The RSS was internally reviewed before its release. One of the reviewers called the accident probability findings "gibberish," and another reviewer said that some of the estimates were "suspiciously low." *Id.*

protection systems in their nuclear energy facilities to prevent terrorist attacks and thefts.

Economic pressures could be eased by agreements to deemphasize competition in the nuclear energy market. For example, countries possessing uranium deposits and nuclear technology (supplier nations) could promise to satisfy the nuclear energy needs of recipient nations. Under such a guarantee program, nations lacking natural uranium deposits would not feel compelled to acquire nuclear power plants that yield the highest production-consumption fuel ratio (*e.g.*, breeder reactors) in order to guarantee their future energy security. Supplier nations also could agree among themselves that it is more important to reduce the spread of nuclear weapons capabilities than it is to increase sales. Under such an agreement, enrichment and reprocessing plants and certain reactor types such as the HTGR and fast breeder reactor could be removed from the market by all suppliers, completely eliminating the competitive influence of materials and facilities of weapons-producing capabilities. Nations also could agree to vigorously develop other energy technologies (*e.g.*, solar, geothermal, and hydroelectric power) and to actively promote those technologies on the energy market as attractive alternatives to nuclear energy.

The environmental problems posed by nuclear energy offer the smallest hope of adequate solution. Nations cannot make agreements among themselves that nuclear energy materials will not be toxic or take hundreds of thousands of years to decay. Nations cannot make agreements to detoxify wastes according to a certain procedure, since detoxification is impossible. The only effective solution to the environmental danger problem is worldwide abandonment of the nuclear industry itself, and substitution of other safer technologies. The abandonment of nuclear technology is an unlikely prospect, however. The best that states can do if nuclear energy is to be used is to agree to actively develop safety systems and to submit to safety regulations based upon those systems. They of course also can agree to practice energy conservation to slow the production of radioactive waste materials, although such action is not really a solution to the problem since it acts merely to postpone, not eliminate the inevitable buildup of toxic wastes.[57]

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[57] Liability agreements have not been mentioned here because they do not provide solutions in the sense used in this note. Aside from having some possible deterrent effects, the payment of money to an injured party after the fact of injury does not act as a solution to the problems leading to the injury.

II. United States Treaties And Agreements Relating To Nuclear Energy

As discussed earlier, the most effective way in which the United States can control the international use of nuclear energy is to enter into treaties and agreements with other countries and with international bodies. Bo Johnson, Associate Professor of International Law at the University of Stockholm, states that treaties and agreements are "of the utmost importance to the shaping of international norms. They give evidence of the opinion and expectation of states as to what *should* be the law [and] may become part of the corpus of general international law, thus becoming binding also on states *not* parties to a specific treaty."[58] Another author in the field of international agreements has stated:

> The role of treaties and, in fact, of international agreements as a whole in international relations is constantly on the increase. Both sovereign states and international organizations have found it necessary to make constant resort to the conclusion of treaties and other forms of international agreements as a means of developing peaceful co-operation among themselves.[59]

The United States international treaties and agreements relating to peaceful uses of nuclear energy can be divided into two basic groups: safeguards agreements,[60] and research and technical information exchange agreements.[61] Representative treaties and agreements from each of these groups will be examined to determine: (1) the purposes of the agreements, (2) how those purposes are effected by specific provisions, and (3) the ways in which the agreements are to be enforced.

A. *Safeguards Agreements*

Treaties and agreements concerning safeguards developed in three stages. The United States originally supplied nuclear technology to

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[58] B. Johnson, International Environmental Law 20 (1976).

[59] Osakwe, *The Concept and Forms of Treaties Concluded by International Organizations*, in Agreements of International Organizations 165, 165 (K. Zemanek ed. 1971).

[60] The term "safeguards" when used in the context of nuclear energy agreements means a system of accountings and inspections under which the diversion of nuclear materials can be detected.

[61] Treaties banning nuclear weapons tests and prohibiting the emplacement of nuclear weapons on the ocean floor are not included in this survey. Their purpose is the same as that of the safeguards agreements; to prevent the spread of nuclear weapons. But they are not concerned with the peaceful use of nuclear energy.

recipient countries under the auspices of bilateral agreements for cooperation concerning civilian (*i.e.*, peaceful) uses of atomic energy. Later, many of these agreements were supplemented by trilateral agreements between the United States, the recipient countries and the International Atomic Energy Agency (IAEA) for the application of IAEA safeguards to the cooperation agreements. Finally, the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) was signed by more than 100 nations, including the United States. Several of the trilateral agreements mentioned above were subsequently suspended and replaced by trilateral agreements for the application of safeguards pursuant to the NPT.[62]

1. Agreements For Cooperation

The Agreement for Cooperation Concerning Civil Uses of Atomic Energy (Cooperation Agreement), signed with Colombia on April 9, 1962,[63] is representative of the United States agreements for cooperation. The purposes of the Cooperation Agreement are to assist Colombia's research and development of peaceful uses of nuclear energy including civilian nuclear power and medical therapy, and to safeguard the supplied materials and technology against diversion to military purposes.[64] The Cooperation Agreement is grounded upon the premise

[62] For a well-written and detailed treatment of the historical developments leading up to the international safeguards agreements see Bechhoefer, *Historical Evolution of International Safeguards*, in INTERNATIONAL SAFEGUARDS AND NUCLEAR INDUSTRY 21 (M. Willrich ed. 1973). A simpler summary is offered in Nye, *supra* note 23, at 184-85, 188-89.

[63] Agreement for Cooperation Concerning Civil Uses of Atomic Energy, Apr. 9, 1962, United States-Colombia, 14 U.S.T. 388, T.I.A.S. No. 5330; Amendment to Agreement for Cooperation Concerning Civil Uses of Atomic Energy, Feb. 24, 1967, United States-Colombia, 21 U.S.T. 1998, T.I.A.S. No. 6943; Agreement Continuing the Agreement for Cooperation Concerning the Civil Uses of Atomic Energy, Mar. 28, 1977, United States-Colombia, T.I.A.S. No. 8555.

[64] Agreement for Cooperation Concerning Civil Uses of Atomic Energy, *supra* note 63, preamble. The purpose of the Cooperation Agreement has been deduced here and in each subsequent agreement analysis by examining the statements made in the preamble and elsewhere in the agreement following words and phrases such as "whereas," "with the objective of," "considering," and "affirming the principle that." This interpretive method is based upon the principles employed by the International Court of Justice in interpreting treaties. The pertinent principles are that words should be given their natural and ordinary meaning, consideration should be given to their position within the treaty, and analysis should always be conducted within the context of the treaty as an integrated whole. LORD MCNAIR, THE LAW OF TREATIES 364 n.1, 366-84, 393 (1961).

that the peaceful use of nuclear energy "holds great promise for all mankind."[65]

Detailed provisions set forth the manner in which these purposes are to be given effect. Under Article III of the Cooperation Agreement, the two governments are to exchange information on reactors, nuclear materials use, and health and safety problems related to the foregoing.

Paragraph A of Article IV allows the sale or lease of enriched uranium to Colombia. Paragraph B of Article IV limits the quantity of United States uranium which may be held by Colombia. The maximum quantity allowed is the amount necessary for the full loading of each reactor project fueled by the uranium, plus the amount necessary to permit the continuous operation of such reactors or reactor experiments while replaced fuel is radioactively cooling, or in transit, or being reprocessed. Reprocessing of any such material may be performed only in United States facilities, or elsewhere under terms and conditions acceptable to the United States, according to Paragraph D of Article IV. Paragraph F of that article allows Colombia to transfer special nuclear material[66] produced in United States-supplied fuel to a third government only if the United States approves the transfer.

Article VII allows for the performance of the foregoing activities, subject to the same limitations, by authorized persons[67] under the jurisdiction of either government.

The two governments "emphasize their common interest in assuring that any material, equipment, or device made available to . . . Colombia pursuant to this Agreement shall be used solely for civil purposes" in Article VIII, Paragraph A. The United States is given the following rights under Paragraph B of Article VIII: (1) the right to review the design of reactors, equipment and devices either provided by the United States or using materials provided by the United States to assure that their design and operation is for non-military purposes, (2) the right to require records and reports accounting for materials supplied by the United States, or used in or produced by equipment and

[65] Agreement for Cooperation Concerning Civil Uses of Atomic Energy, *supra* note 63, preamble.

[66] "Special nuclear material" is defined in Article I paragraph (j) of the Amendment to Agreement for Cooperation Concerning Civil Uses of Atomic Energy, *supra* note 63, as plutonium or enriched uranium.

[67] A "person" is defined in Article I paragraph (f) of the Amendment to Agreement for Cooperation Concerning Civil Uses of Atomic Energy, *supra* note 63, as an individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, government agency, or government corporation.

materials provided by the United States, (3) the right to require the storage, in facilities designated by the United States, of special nuclear materials (listed in (2) above) which are not otherwise used pursuant to other articles of the Cooperation Agreement, (4) the right to inspect the materials and facilities described in this Article, and (5) the right to consult with Colombia on the matter of health and safety.

Colombia guarantees that no material, equipment or device transferred pursuant to the Cooperation Agreement will be used "for atomic weapons or for research on or development of atomic weapons or for any other military purposes" in Article IX.

One article of the Cooperation Agreement specifically provides for its enforcement by sanctions against its violation. Article VIII, Paragraph B gives the United States the right to suspend or terminate the Cooperation Agreement and require the return of any materials, equipment and devices described in the Cooperation Agreement in the event of noncompliance with the provisions of Article VIII or the guarantees set forth in Article IX. In the event of a dispute over whether the provisions have been violated, or the refusal of Colombia to return the materials and equipment after an admitted violation, either party has the right to bring suit before the International Court of Justice (ICJ), as do all disputing states which are parties to the ICJ Statute.[68] Performance of the Cooperation Agreement is "subject to an over-riding obligation of mutual good faith," as are all treaties, according to general principles of international law.[69]

The agreements for cooperation, in general, further the basic premise that peaceful nuclear energy use should be promoted. Concern over the possible employment of nuclear technology for military purposes is secondary to this promotion. Concern over environmental risks is extremely slight, evidenced only by promises to exchange information and consult on the subject. The inspection, reporting, and reprocessing provisions of the agreements give the United States some control over that portion of the nuclear industry which the United States supplies. These cooperation agreements, it should be noted, require no promises and give the United States no control over the use of

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[68] Statute of the International Court of Justice, June 26, 1945, Art. 35, 59 Stat. 1055, T.S. No. 993.

[69] LORD MCNAIR, *supra* note 64, at 465. "Treaties must be applied and interpreted against the background of the general principles of international law." *Id.* at 466. (Agreements, protocols, arrangements, conventions, etc. are all included in Lord McNair's use of the word "treaty." *Id.* at 22-24.)

nuclear technology which might be supplied by other countries. Sanctions set forth in the cooperation agreements relate only to the military use of nuclear technology, and not to violations of safety standards.

In the final analysis, cooperation agreements are business contracts under which the United States sells a commodity—nuclear technology—to another country, and supervises the use of the commodity to insure that it will not be diverted for military purposes.

2. Safeguards Agreements With The IAEA.

The IAEA was established in October 1957[70] by a treaty signed eventually by 109 countries including the United States. This treaty is called the Statute of the IAEA (Statute).[71]

The purpose of the Statute is to establish an international body that will "seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world."[72] In addition the IAEA is supposed to "ensure, so far as it is able, that assistance provided by it or at its request or under its supervision or control is not used in such a way as to further any military purpose."[73]

Article III, Paragraph A of the Statute authorizes various IAEA functions designed to achieve the Statute's purposes. These functions include: (1) encouraging and assisting the research and development of peaceful uses of nuclear energy, (2) fostering the exchange of informtion, and the exchange and training of scientists in the field of peaceful nuclear energy uses, (3) providing for materials, services, equipment and facilities to meet the needs of the peaceful uses of atomic energy, including the production of electric power, and (4) applying safeguards and/or standards of safety to bilateral or multilateral arrangements or to a state's internal activities in the field of atomic energy, at the request of the parties involved. Under Article IX of the Statute, members may make nuclear materials available to the IAEA, and on request of the IAEA shall deliver such materials to another member or group. The IAEA is to allocate these materials so as to secure the greatest possible benefit in all areas of the world, especially

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[70] Bechhoefer, *supra* note 62, at 32.

[71] Statute of the International Atomic Energy Agency, *opened for signature* Oct. 26, 1956, 8 U.S.T. 1093, T.I.A.S. No. 3873, 276 U.N.T.S. 3; Amendment to the Statute of the International Atomic Energy Agency, *approved* Oct. 4, 1961, 14 U.S.T. 135, T.I.A.S. No. 5284; Amendment to the Statute of the International Atomic Energy Agency, *approved* Sept. 28, 1970, 24 U.S.T. 1637, T.I.A.S. No. 7668.

[72] Statute of the International Atomic Energy Agency, *supra* note 71, Art. II.

[73] *Id.*

in the underdeveloped areas, according to Article III, Paragraph B.

The first three functions listed above are internal IAEA activities and therefore would not be "enforced" against a state. The fourth function can be enforced only against a state which has voluntarily submitted, in a separate agreement, to the application of IAEA safeguards or safety standards. Thus, the Statute of the IAEA sets up a framework for the enforcement of uniform safeguards and safety standards by an international body. That framework is not legally binding on any state without a separate safeguards agreement. Under Article XVII any dispute concerning the interpretation or application of the Statute not settled by negotiation shall be referred to the ICJ.

The IAEA Statute evidences worldwide consensus that the peaceful use of nuclear energy should be promoted. As in the Cooperation Agreement discussed above, concern with the possible military use of nuclear technology is secondary to this promotion. The environmental problems associated with nuclear energy are also of secondary concern, although they are given more recognition than in the Cooperation Agreement, since equal arrangements are made by the Statute for applying either safeguards or safety standards to nuclear energy uses.

The Cooperation Agreement with Colombia, discussed above, was one of several agreements for cooperation later supplemented by trilateral safeguards agreements with the IAEA.[74]

The purpose of the United States—Colombia—IAEA Safeguards Agreement (Safeguards Agreement) is to substitute the IAEA's safeguards system for the monitoring functions formerly performed by the United States under Article VIII, Paragraph B of the Cooperation Agreement.[75]

Colombia promises in § 2 of the Safeguards Agreement that the materials, equipment and facilities discussed above in the Cooperation Agreement will not be used in such a way as to further any military purpose. Under § 9(a), a list of these materials, equipment and

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[74] Agreement for the Application of Safeguards, Dec. 9, 1970, United States-Columbia-IAEA, 21 U.S.T. 2677, T.I.A.S. No. 7010; Protocol for the Application of Safeguards to the Cooperation Agreement, Mar. 28, 1977, United States-Columbia-IAEA, T.I.A.S. No. 8556. Twenty such trilateral agreements have been signed with the United States to date.

[75] Agreement for the Application of Safeguards, *supra* note 74, preamble, §§ 4, 6. The IAEA's safeguards system is very similar to that examined in the Cooperation Agreement. The IAEA safeguards system is set forth in IAEA Document GC (IX)/294, *reprinted in* 4 INT'L LEGAL MATERIALS 512 (1965); and IAEA Document GC(X)/INF/86, *reprinted in* 5 INT'L LEGAL MATERIALS 987 (1966).

facilities is to be prepared by both governments and submitted jointly to the IAEA as the "Inventory for Colombia." The IAEA agrees in § 4 to apply its safeguards system to the Inventory for Colombia. Under § 6, the United States monitoring functions under Article VIII of the previous Cooperation Agreement are suspended. Colombia and the United States agree in § 9(b) to notify the IAEA of any transfer to Colombia under the Cooperation Agreement and any transfer to the United States of any special fissionable material[76] listed in the Inventory for Colombia. The IAEA is to send copies of the Inventory to both governments, pursuant to § 10, at least every twelve months. Section 11 sets forth specific details and time limits to be followed in notifying the IAEA under § 9 of transfers of Inventory items. The governments agree in § 15 to notify the IAEA of any transfer of Inventory items to a recipient country not under the jurisdiction of either state. Such a transfer is allowed only if arrangements have been made for IAEA safeguards after the transfer or if the items will be subject to similar safeguards which the IAEA finds acceptable. Under § 25, IAEA inspectors are granted such privileges and immunities as are necessary for the exercise of their functions.

Enforcement provisions are contained in §§ 23 and 29. Under § 23, if the IAEA determines any non-compliance with the Safeguards Agreement, it shall "call upon the government to remedy such non-compliance forthwith" and shall promptly notify the other government and make any other reports that it deems appropriate.[77] If the offending government fails to take fully corrective action within a reasonable time, the IAEA is relieved of its safeguards functions and may direct curtailment or suspension of any assistance being provided by the other party to the agreement or by the IAEA and may call for the return of materials and equipment made available to the offending state. The IAEA may also deny to the noncomplying state the privileges and rights of membership in the IAEA. If any dispute arising out of the interpretation or application of the Safeguards Agreement is not settled

[76] "Special fissionable material" is defined in Article XX of the Statute of the International Atomic Energy Agency, *supra* note 71, as plutonium-239, uranium-233, uranium enriched in the isotopes 235 or 233, or any material containing any of the foregoing.

[77] Probably the IAEA would report the noncompliance to all IAEA members and to the Security Council and General Assembly of the United Nations, as provided for in Article XII, Paragraph C of the Statute of the International Atomic Energy Agency, *supra* note 71.

by negotiation or by any other agreed upon method, then § 29 provides that either government may request that the dispute be submitted to an arbitral tribunal. That section provides that the decisions of the tribunal "shall be binding on all Parties."

The safeguards agreements with the IAEA strengthen the ability of the United States to guard against the non-peaceful use of United States-supplied nuclear technology. This added strength is due to three factors: (1) The agreements for applying safeguards are more detailed than those contained in the cooperation agreements, and stand as separate documents from the agreements to supply nuclear technology to other nations. This arrangement removes the subject of safeguards from its previously subordinate position in the agreements for cooperation, and emphasizes its importance as the sole subject of separate binding agreements. (2) The administration of the safeguards system by a third party, the IAEA, injects neutrality into the investigative and decision-making process of monitoring nuclear energy use. This adds credibility to any findings or accusations made by the IAEA and may in turn foster quick compliance with IAEA demands to rectify violations of the agreements. (3) In the event of a dispute, either government may request that an arbitral tribunal decide the outcome. Since arbitration is almost always quicker and more efficient than are hearings before the ICJ,[78] gaps in the operation of the safeguards agreements in the event of disputes will be shorter than under the cooperation agreements. Further, the decision of an arbitral tribunal is more likely to be accepted by the parties to the dispute than would a decision of the ICJ, since the disputing parties choose the arbitrators at the time of the dispute.[79] The bench of the ICJ, of course, cannot be chosen by the disputing parties.

It should be noted that no trilateral agreements have been entered into with the IAEA for the application of safety standards to the nuclear technology exported by the United States.

The trilateral agreements with the IAEA, then, contribute nothing to the solution of the environmental problems associated with nuclear energy use. The agreements add some strength to United States control over the possible non-peaceful use of United States-supplied technology. These agreements suffer from one major flaw: entrance in-

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[78] Eubanks, *International Arbitration in the Political Sphere*, 26 ARB. J. 129, 129 (1971).

[79] Agreement for the Application of Safeguards, *supra* note 74, § 29.

to the agreements is voluntary. The United States cannot compel any country already involved in a cooperation agreement to submit to the more effective IAEA safeguards system.

3. Safeguards Agreements Pursuant To The NPT

The NPT has been signed by 102 nations to date.[80] Its purposes are twofold: to prevent the wider dissemination of nuclear weapons by facilitating the application of IAEA safeguards to peaceful nuclear activities, and to make the benefits of peaceful applications of nuclear technology available to all NPT signatory states.

The preamble to the NPT and Article VI declare the parties' intention to cease the nuclear arms race and begin nuclear disarmament as soon as possible. Each nuclear-weapon state agrees in Article I not to assist, encourage, or induce any non-nuclear-weapon state to manufacture nuclear weapons. Under Article II each non-nuclear-weapon state agrees not to receive nuclear weapons or control over nuclear weapons, directly or indirectly, and agrees not to manufacture nuclear weapons or to seek or receive assistance in such manufacture. Each non-nuclear-weapon state agrees under Article III to submit all of its nuclear energy activities to IAEA safeguards, by concluding safeguards agreements with the IAEA. No nuclear technology will be transferred to the states which are parties to the NPT except under IAEA safeguards.

Under Article IV, all parties agree to participate in the fullest possible exchange of peaceful nuclear energy technology. Parties with nuclear capabilities also agree to cooperate in contributing to the development of peaceful nuclear energy use, especially in the territories of non-nuclear-weapon states, with due consideration for the needs of the developing areas of the world.

Enforcement provisions are not specifically mentioned in the NPT. Article X provides that each party has the right to withdraw from the treaty if it decides that "extraordinary events . . . have jeopardized the supreme interests of its country." Notice of withdrawal, including a statement of the extraordinary events, must be given three months in advance of the withdrawal. "Extraordinary events" are not defined in the NPT.

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[80] Treaty on the Non-Proliferation of Nuclear Weapons, *opened for signature* July 1, 1968, 21 U.S.T. 483, T.I.A.S. No. 6839, 729 U.N.T.S. 161 [hereinafter cited as NPT].

Ten trilateral agreements have been entered into between the United States, non-nuclear-weapon states and the IAEA pursuant to the NPT. They do not differ significantly from the trilateral agreements with the IAEA discussed above, and will not be further examined here.[81]

The United States has also entered into a bilateral agreement with the IAEA for the application of safeguards to domestic civilian activities pursuant to the NPT.[82] Such a treaty is allowed by Article III, Paragraph A.5 of the IAEA Statute.[83] The United States entered into this bilateral agreement "for the purpose of encouraging widespread adherence to the Treaty [NPT] by demonstrating to non-nuclear-weapon States that they would not be placed at a commercial disadvantage by reason of the application of the safeguards pursuant to the Treaty [NPT]."[84]

Provisions of this bilateral agreement resemble those in the safeguards agreements with the IAEA, discussed above, except that facilities associated with activities "with direct national security significance to the United States" are excluded from safeguard applications.[85] This seems self-defeating; obviously the excluded facilities are excluded precisely *because* they are engaged in nuclear weapons manufacture or other military activities. However, by entering into this agreement, the United States subjects its commercial facilities to the same accounting and reporting requirements and inspection obligations to which non-nuclear-weapon states are subject under the NPT. As noted above, this eliminates any economic disadvantage that might otherwise befall a non-nuclear-weapon state because of adherence to the NPT. The bilateral agreement safeguards provisions do at any rate provide some supervision over United States use of nuclear energy. Specifically, the United States cannot divert nuclear power plant materials to augment present weapons capabilities without the IAEA discovering the diversion.

Enforcement provisions under Articles 18 and 21 of the bilateral

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[81] *See, e.g.*, the Protocol for Application of Safeguards Pursuant to the Non-Proliferation Treaty, Apr. 14, 1975, United States-Sweden-IAEA, 26 U.S.T. 478, T.I.A.S. No. 8049.

[82] *News in Brief*, 18 INT'L ATOM. ENERGY AGENCY BULL. 74, 76 (1976). For the text of the agreement, *see* Draft Agreement for the Application of Safeguards in the United States, 16 INT'L LEGAL MATERIALS 22 (1977).

[83] Statute of the International Atomic Energy Agency, *supra* note 71.

[84] Draft Agreement for the Application of Safeguards in the United States, *supra* note 82, at 25. (Preamble.)

[85] *Id.* at 26. (Art. 1.)

agreement are the same as those set forth in §§ 23 and 29 of the Safeguards Agreement with the IAEA discussed previously.

The NPT represents a major step forward in controlling the problem of the possible diversion of nuclear technology to military uses. Control of this diversion problem is the main purpose of the treaty. Concern over development and supply of nuclear technology has become secondary. Non-nuclear weapon states which sign the NPT are thereafter *obligated* to submit to IAEA safeguards. And the non-nuclear-weapon states are induced to sign the NPT by the promises that nuclear-weapon states will begin nuclear disarmament and supplier states will undertake to provide signatory states with their nuclear energy needs. In other words, the NPT presents to the non-nuclear-weapon states an offer of nuclear energy security in exchange for some loss of military security. This offer has proved sufficiently attractive to draw more than 100 signers, many more than had voluntarily signed the IAEA safeguards agreements, discussed above, with the United States. The most progressive element of the NPT is the provision under which the non-nuclear-weapon states agree to submit all of their nuclear energy activities to IAEA safeguards, regardless of the origins of the materials and facilities. Such an agreement allows for complete supervision of the nuclear energy industry among those nations which have signed the NPT, except in the five nations already possessing nuclear weapons. The NPT also represents the first agreement in the area of peaceful nuclear energy use in which nuclear-weapon-states agree to reduce their nuclear weapon holdings in order to prevent the diversion of nuclear technology to military purposes in other states.

B. *Research And Technical Information Exchange Agreements*

The numerous agreements concerning research and technical information exchanges are fairly simple. An example is the Agreement on Reactor Safety Experiments (Safety Agreement), signed by eight nations including the United States in 1975.[86] According to Article II of the Safety Agreement, its purpose is to establish a cooperative project using a reactor for safety experiments concerning containment response. Information is to be exchanged in reports under Article VIII. Provisions relating to the right to withdraw, and arrangements for termination in Articles XI and XII deal only with financial matters, presupposing the right to voluntarily withdraw. Article XV provides that disputes which are not settled through consultation shall be

[86] Agreement on Atomic Energy Reactor Safety Experiments, *opened for signature* Jan. 24, 1975, T.I.A.S. No. 8479.

submitted to a Swedish court or, if a party so requests, to arbitration.

It should be mentioned here that agreements of the type discussed in this section are regarded as international business transactions[87] and therefore fall under the United Nations Convention on the Recognition and Enforcement of Foreign Arbitral Awards (New York Convention).[88] One authority on the subject states:

> The [New York C]onvention has introduced in every member country fairly reliable guarantees for judicial recognition of the agreements . . . to arbitrate abroad, and for enforcement of foreign awards, at least when made in another member country. The [New York C]onvention has been already adhered to by more than forty nations. . . .[89]

The New York Convention provides in Article I that signatory states will recognize and enforce, under the rules of procedure in their respective jurisdictions, foreign arbitral awards. Article III states that each signatory state "shall recognize arbitral awards as binding and enforce them. . . ."

Most of the technical exchange agreements state that their underlying purpose is to improve and ensure the safety of reactors or nuclear energy technology on an international basis[90] and provide for the exchange of letters, reports and other documents, visits and exchanges of scientists, and collaboration in the development of certain programs.[91] However, none of these agreements contain provisions requir-

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[87] "[A]greements on research, designing, building and assembly, technical assistance . . . and so forth, are regarded as foreign trade transactions." Bratus, *Arbitration and International Economic Cooperation Towards Industrial, Scientific, and Technical Development*, 27 ARB. J. 230, 231 (1972). *See also* Lebedev, *Developing Effective International Commercial Arbitration*, 30 ARB. J. 59, 60 (1975).

[88] Convention on the Recognition and Enforcement of Foreign Arbitral Awards, *done* June 10, 1958, 330 U.N.T.S. 3 [hereinafter cited as New York Convention]. Several of the 45 signatory states made declarations and reservations when signing the New York Convention, most of them limiting its effect to commercial arbitration awards, or to awards made in the territory of states parties to the New York Convention. These are *reprinted in* UNITED NATIONS, UNITED NATIONS MULTILATERAL TREATIES 523 (1977). The United States Arbitration Act was amended in 1970 to provide for the enforceability of foreign arbitration awards in the United States. 9 U.S.C. §§ 201-08 (1970).

[89] Lebedev, *supra* note 87, at 62.

[90] *See, e.g.*, the Preamble of the Agreement on the Power Burst Facility Research Program, Feb. 25-Mar. 3, 1977, United States-Austria, T.I.A.S. No. 8685.

[91] *See, e.g.*, Article 4, paragraphs (a)-(d) of the Arrangement for Technical Information Exchange in Regulatory Matters, May 18-May 30, 1974, United States-Japan, T.I.A.S. No. 8341.

ing the application of safety standards to the nuclear industry based upon the findings of the research. Moreover, almost all of the arrangements provide for voluntary termination on thirty days' to six months' notice.[92] This means that if any sort of dispute arises, a state may simply give notice and withdraw after the predesignated time period elapses. Other states in that event have no power to force a state to adhere to the agreement beyond the notice period.

The research and information exchange agreements create little more than slightly binding business arrangements for collaboration on research projects. Since the agreements do not contain provisions for the application of safety standards to the nuclear industry, and since parties can voluntarily withdraw from them, the agreements can exert little force upon the solution of any of the problems with nuclear energy.

The United States is a party to an international agreement which falls into neither of the above two groups but which has some bearing on the peaceful uses of nuclear energy. This is the U.N. adoption (by resolutions) of the Declaration of The United Nations Conference on the Human Environment (Declaration).[93] In Resolution 3003, the U.N. states that one main purpose of the Conference was to increase the awareness among governments and public opinion of the importance and urgency of the problems of the environment.[94]

Resolution 2994 states that the international community has a responsibility to take action to preserve and enhance the environment, and draws the member governments' attention to the Declaration and to the recommendations for action at the national level which were made by the Conference.[95] Resolution 2995 says that in the exploration, exploitation and development of their natural resources, states must not produce significant harmful effects in zones situated outside their national jurisdictions.[96]

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[92] *See, e.g.*, Article II, paragraph (h) of the Arrangement for Cooperation in Regulatory and Safety Matters, Mar. 18, 1976, United States-Korea, T.I.A.S. No. 8283.

[93] The Declaration of the United Nations Conference on the Human Environment was adopted unanimously by the U.N. Conference in Stockholm in June, 1972. B. JOHNSON, *supra* note 58, at 21. The 27th Session of the U.N. General Assembly endorsed the declaration in resolutions 2994-3004. 26 Y.B. U.N. 323 (1972).

[94] 26 Y.B. U.N. 323, 337 (1972).

[95] *Id.* at 330.

[96] *Id.*

None of these resolutions specifically mention nuclear energy, but each applies to the environmental dangers of the nuclear industry. For instance, Resolution 2994 calling for action to preserve the environment calls forth the responsibility of states to safely transport and store nuclear wastes in adequately shielded containers to reduce the risk of radioactive contamination of the environment. And Resolution 2995, providing that states must not produce harmful effects outside their territories in the exploitation of their natural resources bears on the responsibility of neighboring states to safely operate their respective nuclear power plants to avoid core meltdowns or other plant accidents that might release radioactivity across their borders.

These Resolutions are not backed by sanctions, but they do carry weight by virtue of the fact that "[a] solemn declaration has a special significance from the legal point of view. The Declaration on the Human Environment will hopefully [*sic*] influence the actions of states and the working out of treaty law."[97]

Even if the Resolutions cause a significant change in international environmental policies, however, they promise to have little impact upon international solutions of the environmental problems associated with nuclear energy. As just discussed, the Resolutions do apply to the environmental dangers of nuclear energy use. But the dearth of provisions in nuclear energy agreements relating to environmental hazards and safety standards indicates that this aspect of nuclear energy use is being ignored on the international level. If nations enter into agreements to protect the environment pursuant to the Resolutions, such agreements unfortunately will probably not confront the environmental hazards associated with nuclear energy use.[98]

III. CONCLUSIONS AND SUGGESTIONS

In dealing with the problem of possible diversion of nuclear energy materials to weapons manufacture, the United States has chosen to try to prevent the spread of nuclear weapons rather than to encourage the

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[97] B. JOHNSON, *supra* note 58, at 22. One such agreement made by the United States since the passage of the Resolutions is the Agreement for Cooperation in Environmental Affairs, May 9, 1974, United States-Federal Republic of Germany, 26 U.S.T. 840, T.I.A.S. No. 8069.

[98] The Agreement for Cooperation in Environmental Affairs, *supra* note 97, for example, does not mention nuclear energy nor the environmental problems associated with it.

expansion of a system of nuclear weapon counterbalances. To further this goal, the United States has entered into a multi-layered series of safeguards agreements to prevent the diversion of peaceful nuclear energy materials to weapons manufacture. Today the solution to the problem of diversion relies most heavily upon the NPT.[99]

The method chosen to prevent weapons proliferation rests, in the end, upon the simple promises exchanged by the parties to the NPT; promises that those who have nuclear weapons will begin to dispose of them, and that those who do not have nuclear weapons will not obtain them through any means whatsoever. On the faith of these promises, the parties to the NPT cooperate in developing and expanding the peaceful uses of nuclear energy. The NPT provides a sufficiently attractive balance of benefits both to nuclear-weapon and non-nuclear-weapon states to have attracted over 100 signatories. If the rest of the nations of the world can be induced to sign the NPT, and if the IAEA safeguards system operates efficiently and thoroughly, and if nuclear-weapon-states do indeed begin to disarm, the NPT will prove an effective international solution to the problem of government diversion of nuclear materials for military purposes.

It must be stressed that nuclear materials can be used for weapons manufacture by terrorists as well as by governments, and this problem has been completely ignored in international nuclear energy agreements. It is incomprehensible that agreements have not been made requiring protection of nuclear facilities and materials against terrorist attack and theft. Such a dangerous problem is far too serious to ignore. Agreements to implement protection systems against terrorism should be implemented immediately.[100]

The economic pressures exerted upon the nuclear energy industry have been partially relieved by the NPT. The NPT's guarantee of an adequate nuclear energy supply to recipient nations will probably serve to reduce their demands for facilities and materials capable of diversion to military use. This in turn will decrease the pressure on supplier nations to produce these facilities and materials for sale on the world market.

The United States also has acted unilaterally to reduce economic pressures on the nuclear industry, with the intent on influencing other

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[99] Nye, *supra* note 23, at 184.

[100] It is highly unlikely that any country would refuse to sign and implement such an agreement. A nuclear weapon in the hands of a terrorist group or other nongovernmental group would threaten the security of all nations.

states' actions by setting an example.[101] Several of these unilateral actions show an intent to deemphasize the competitive aspects of nuclear energy use whenever competitive behavior might undermine nonproliferation goals. The decisions to embargo the exportation of enrichment and reprocessing facilities and to defer the commercial use of breeder reactors in the face of market demands for these facilities are evidence of such an intent.[102] Voluntary submission to a bilateral safeguards agreement with the IAEA is further evidence. An international nuclear fuel cycle evaluation conference was recently sponsored by the United States in the hope that fuel cycles not involving weapons-usable material would be developed and promoted by representatives of governments participating in the world nuclear energy market.[103] President Carter advocates the establishment of an international nuclear fuel bank to provide for any country's peaceful nuclear energy needs so that recipient nations will not feel compelled to obtain facilities such as enrichment plants and fast breeder reactors to provide for their energy security.[104] The President would also like to guarantee fuel supplies and provide for storage of spent fuel under contracts with recipient nations.[105] These unilateral actions have had a significant effect on international nuclear energy policies. Joseph Nye, Jr. stated:

> [W]e continue to embargo the export of sensitive facilities and technologies, particularly enrichment and reprocessing, so as to delay the spread of weapons-usable material and the facilities that produce them. The new aspect here is that we have encouraged other supplier nations to exercise similar restraint. We have achieved considerable agreement among the 15 supplier countries that have met periodically in London since 1975. Less than two weeks ago the West German

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[101] In his message to the Congress on April 27, 1977, President Carter said, "The domestic nuclear policies which I have already put forward will place our nation in a leadership position, setting a positive example for other nuclear suppliers as well as demonstrating the strength of our concern here at home. . . ." *Nuclear Nonproliferation Policy Act of 1977 Transmitted to the Congress*, 76 DEP'T STATE BULL. 477, 477 (1977).

[102] *President Carter Announces Decisions on Nuclear Power Policy*, *supra* note 22, at 432.

[103] *Id.* at 430; *Organizing Conference of the International Nuclear Fuel Cycle Evaluation Meets in Washington*, 77 DEP'T STATE BULL. 659 (1977).

[104] *President Carter Announces Decisions on Nuclear Power Policy*, *supra* note 22, at 432.

[105] *Id.*

> Government announced that it would not export reprocessing technology in the future, thus joining France, the Soviet Union, ourselves, and others in the policy of restraint.[106]

The numerous agreements providing for cooperative research and exchanges of information on nuclear safety technology constitute small steps toward solving the danger of environmental harm presented by the nuclear industry. Considering the gravity of the risks involved, it is clear that such agreements alone do not do enough. The results of the research should be synthesized into safety standards imposed upon the nuclear industry. All research information should be referred to a central body which could organize the information into a system of safety standards designed to minimize the risk of environmental damage during every step of the nuclear fuel cycle. The IAEA is the obvious candidate to perform such a function. This plan is in fact provided for in the Statute of the IAEA.[107] The United States should undertake to promote agreements providing for application of uniform safety standards in cooperation with the IAEA.

An international danger protection and emergency assistance system should also be implemented. Agreements under this system should provide for radiation supervision, timely warnings to neighboring countries in the event of radiation danger, and international emergency assistance after a reactor catastrophe. Such agreements with Canada, Latin America and South America would be especially important to the United States.[108]

It cannot be overemphasized that even if all the protective systems discussed above were implemented, nuclear energy would still pose

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[106] Nye, *supra* note 23.

[107] Statute of the International Atomic Energy Agency, *supra* note 71, Art. III, ¶ A.

[108] Agreements concerning safety standards and warning systems are discussed in the context of general international law in Pelzer, *Legal Problems of International Danger Protection and of International Emergency Assistance in the Event of Radiation Accidents*, in 3 PEACEFUL USES OF ATOMIC ENERGY 451 (1972). In that article the author states:

> Provisions to encourage unification of licensing and supervision laws in the contracting [treaty-making] states would be welcome. When the standards of safety in the contracting states are homogeneous in content, not only will the risks of an accident decrease but assistance teams will then move on familiar ground, so to speak, at foreign installations, so that emergency assistance will be less complicated and, therefore, more effective.

Id. at 463.

enormous insoluble problems. The risks of nuclear energy use are extraordinary given the toxicity of the materials involved, the amounts in which they are produced, and the length of time required for the products to become safe. Nuclear energy is not the best answer, nor even a good answer, to the world's energy needs. The only adequate solution to the environmental problems of nuclear energy is abandonment of the nuclear energy industry. The United States should expend every effort to convince other nations to forsake the use of nuclear power and substitute other energy alternatives. Said President Carter in addressing the Conference of the International Nuclear Fuel Cycle Evaluation: "I have a feeling that the need for atomic power itself for peaceful uses has perhaps been greatly exaggerated and I hope that all the nations represented here and others will assess alternatives to turning to this source of power. . . ."[109]

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[109] *Organizing Conference of the International Nuclear Fuel Cycle Evaluation Meets in Washington, supra* note 103, at 660.

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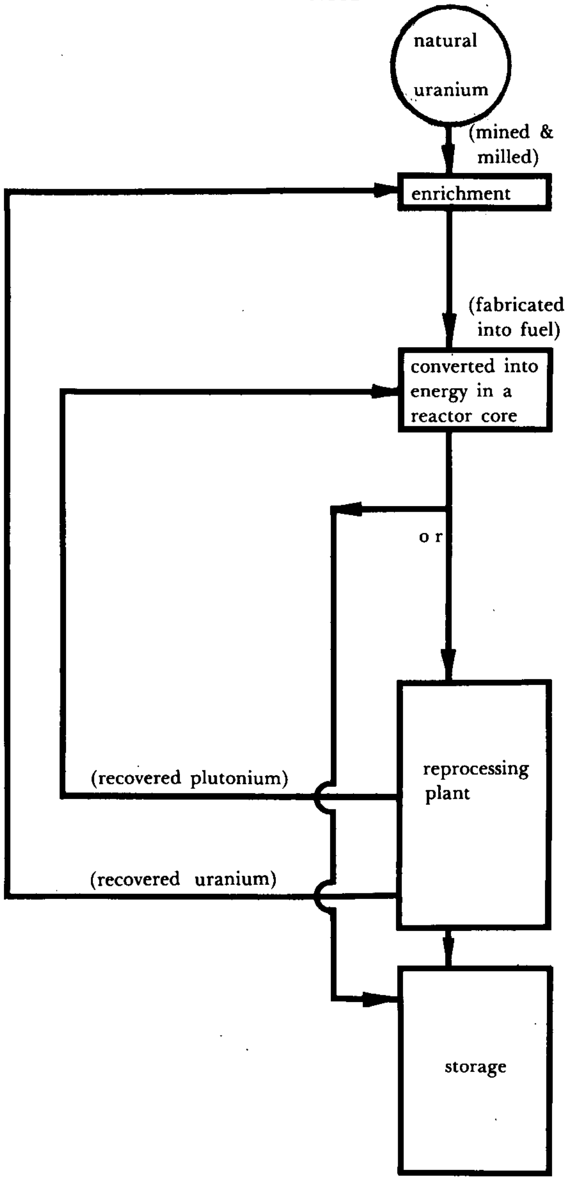
APPENDIX

NUCLEAR FUEL CYCLE



ASSOCIATED DANGERS

(✓ = danger of use for weapons)
(‡ = danger of irradiation)

✓ *could be enriched to more than 10% uranium-235 and used to make explosive weapons*

✓ *if either plutonium or highly enriched uranium is used as fuel, the fuel could be used to make explosive weapons*

‡ *fuel becomes radioactive as it is used, and a core meltdown or other accident could release it into the atmosphere*

‡ *a transportation accident could release highly radioactive spent fuel into the environment*

✓ *separated plutonium could be used to make explosive or dispersal weapons*

✓ *spent fuel or separated wastes could be used to make dispersal weapons*

‡ *highly radioactive spent fuel or separated wastes could accidentally be released into the environment*

‡ ✓ *spent fuel, stored without reprocessing, will remain radioactive for at least 250,000 years, and could be accidentally released into the environment or used to make dispersal weapons*

‡ ✓ *wastes remaining after reprocessing, if stored alone will remain radioactive for 600 to 1000 years, and could be accidentally released into the environment, or used to make dispersal weapons*