Journal of Legislation

Volume 4 | Issue 1 Article 10

1-1-1977

Nuclear Power: Legal Solutions for Lethal Problems;Note

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NUCLEAR POWER: LEGAL SOLUTIONS FOR LETHAL PROBLEMS

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INTRODUCTION

This essay considers environmental hazards of the nuclear energy electrical generating industry and the legal remedies for those hazards. Primary emphasis is given to federal legislation. Technical and other non-legal remedies lie beyond the scope of the topic. Problems unrelated to reactor generation of electricity and legislation designed to assist industry development rather than solve environmental problems are not discussed. Finally, human safety considerations are touched upon only tangentially in order to lay greater emphasis on the ecological impact of the nuclear industry. The author, of course, recognizes that human safety is a distinctive facet of environmental safety which requires separate treatment at another time.

BACKGROUND

Nuclear energy came into an environmentally unconscious world. When an atomic bomb exploded over Hiroshima, the world was at war. Environmental concerns, if there were any, lay buried and remote in people's minds.

1. The Atomic Energy Act of 1946

Assumption of governmental responsibility for the control of nuclear energy followed quickly on the heels of the war's end. President Truman called for congressional action in 1945; the result is the Atomic Energy Act of 1946 (AEA 1946).[1]

AEA 1946 provides that:

> subject at all times to the paramount objective of assuring the common defense and security, the development and utilization of atomic energy shall, so far as practicable, be directed toward improving the public welfare, increasing the standard of living, strengthening free competition in private enterprise, and promoting world peace. [2]

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1. Atomic Energy Act of 1946, Pub. L. No. 585, Sec. 21, 60 Stat. 755 [hereinafter cited as AEA 1946].
2. AEA 1946, Sec. 1(a).

The 1946 Act is a piece of cautious optimism. Though the law vested government with a monopoly over nuclear materials, it laid the groundwork for the expanded application of the peaceful atom. Rather than assign command of nuclear energy development to military authorities, Congress chose the route of civilian control. [3]

AEA 1946 created a Joint Congressional Committee on Atomic Energy (JCAE) and an independent executive branch agency, the Atomic Energy Commission (AEC). Unique in several respects, the JCAE until recently possessed broad legislative and oversight powers. But the Democratic caucus of the House of Representatives has voted to revoke the bill-writing power of the JCAE. Final action is expected in the next session and the Senate is likely to do the same with respect to itself. The outcome of this upheaval may include stricter congressional oversight of the nuclear industry. However, the JCAE's supervisory mandate under AEA 1946 will probably remain unchanged. [4]

During the Committee's early years, Congress and the American people relied solely on the JCAE to satisfactorily control AEC activities.[5] The Committee has come under increasing fire with the development in recent years of the environmental movement. U.S. Senator Clinton P. Anderson, a committee member, summarized the outlook of critics: the JCAE is considered "rather as a board of guarantors, saying to the Congress and the American people that all is well, even if many transactions are behind closed doors."[6]

The AEC was created to implement research and development, support the exchange of scientific and technical information, and control production, ownership and use of fissionable material. Its powers included the authority to grant licenses and to make regulations in order to fulfill the stated purposes of the law. [7]

2. The Atomic Energy Act of 1954

As potential commercial applications of nuclear energy evolved, pressure grew to relax legal restraints, especially the government monopoly over ownership of nuclear materials. Because foreign governments now also possessed "the secret," the military rationale for government restrictions became ineffective.

The Atomic Energy Act of 1954 (AEA 1954),[8] as amended, constitutes government's response. AEA 1954 restructured the AEC, granted limited private ownership of certain nuclear material, expanded the scope of licensing activities, and gave the Commission rule-making powers. [9]

Three types of nuclear materials are distinguished with reference to three

3. The Vandenburg amendment to the AEA 1946 did establish a Military Liaison Committee to "advise and consult with" the AEC "on all atomic energy matters which the Committees [sic] deems to relate to military applications." *Id.* Sec. 2(a) 4(c). Scientists were reluctant to leave atomic energy in military hands. *Hearings on S. Res. 179 Before the Special Committee on Atomic Energy, Part 1,* 79th Cong., 1st Sess. 103 (1945) (testimony of Dr. Harold Urey).

4. AEA 1946, Sec. 15 (b).

5. H. Green and A. Rosenthal, *Government of the Atom: The Integration of Powers* 6 (1963) [hereinafter cited as Green and Rosenthal].

6. Green and Rosenthal, *supra* note 5, at 29-30.

7. AEA 1946, Secs. 7 (a), 12 (a).

8. Atomic Energy Act of 1954, Sec. 1 et seq., 42 U.S.C. Sec. 2011 et. seq. (1971) [hereinafter cited as AEA 1954].

9. AEA 1954, Secs. 41 (a), 101-10, 161-69, 42 U.S.C. Secs. 2061 (a), 2131-40, 2201-10 (1973).

generalized stages of the fission fuel cycle. Source material, basically uranium ore,[10] is mined and produced into special nuclear material.[11] The latter is any material "capable of releasing substantial quantities of atomic energy."[12] The wastes left from the use of special nuclear material constitute byproduct material.[13]

Despite complaints from industrialists, Congress, in the 1954 act, vested exclusive title to special nuclear material in the United States. The AEC was designated licensing agent for the use of such materials.[14] A 1964 amendment, however, extended the right of ownership to private parties. [15]

With certain limited exceptions, the 1954 act also placed sole ownership of facilities for the production of special nuclear material in governmental hands. Yet the AEA of 1954 did contemplate the prospect of ownership of production facilities by licensees of the Commission.[16] Private ownership of licensed production facilities "is currently a rapidly growing industrial interest."[17] It is also the focal point of recent environmental concerns. This is understandable not only due to the real potential harm of developing technologies, as will be discussed below, but also because of the severely limited production experience of private industry. The AEC endorsed, as early as 1964, a policy to transfer radioisotope production and distribution activities to private industry "as rapidly as possible consistent with the national interest."[18] Yet today private industry has still made no significant inroads into the production market.[19]

Two types of licensees are envisaged by the 1954 AEA: section 103[20] (commercial) and section 104[21] (medical therapy and research and development). Most controversy with respect to environmental problems has focused on commercial licensees under section 103, especially the operators of reactors for the commercial generation of electricity.[22]

Reactors are of several types but they all work in a similar fashion. Heat, the product of nuclear fission, is "released to a turbine generator where the heat energy contained in the steam is converted to electricity."[23] Reactor types differ

10. AEA 1954, Sec. 11 (z), 42 U.S.C. Sec. 2014 (z) (1973). *See* Nuclear Regulatory Commission, 10 C.F.R. Sec. 40.4 (h) (1976).
11. AEA 1954, Sec. 11 (aa), 42 U.S.C. Sec. 2014 (aa) (1973). *See* 10 C.F.R. Sec. 40.4 (i) (1976).
12. AEA 1946 contains the initial formulation of this concept. AEA 1946, Sec. 5 (a).
13. AEA 1954, Sec. 11 (e), 42 U.S.C. Sec. 2014 (e) (1973). *See* 10 C.F.R. Sec. 30.4 (1976).
14. AEA 1954, Sec. 41 (a), 42 U.S.C. Sec. 2061 (a) (1973).
15. Act of August 26, 1964, Pub. L. No. 88-489 Sec. 1 et seq., 78 Stat. 602 (amending 42 U.S.C. Secs. 2011-13, 2072-73, 2075-78, 2133-34, 2153, 2201, 2221, 2233-34 (1965)).
16. AEA 1954, Sec. 41 (a), 42 U.S.C. Sec. 2061 (a) (1973).
17. 30 Fed. Reg. 3247 (1965).
18. 30 Fed. Reg. 3247 (1965).
19. Division of Biomedical and Environmental Research, ERDA, 11 *Balanced Program Plan--Fission* 8 (1976) [hereinafter cited as *Balanced Program Plan*].
20. AEA 1954, Sec. 103, 42 U.S.C. Sec. 2133 (1973).
21. AEA 1954, Sec. 104, 42 U.S.C. Sec. 2134 (1973).
22. *See,* Denver Sun, Oct. 24, 1976, at 3, col. 1, and Stevens Point (Wis.) Daily Journal, Nov. 23, 1974, at 3, col. 1. The first of these articles relates the claims made by nine former Nuclear Regulatory Commission staff members charging the agency with refusing to act upon safety questions which they raised. Denver Sun, *supra.* The second article relates a debate between former AEC Chairman Dixie Lee Ray and Dr. Paul Ehrlich of Stanford University. For a fairly even-handed treatment, *see* Skeptic, August, 1976.
23. "The reactor consists of an active core in which the fission reaction is sustained and in which most of the energy is released as heat. The core contains the fissile fuel material, the moderator which slows down the neutrons released by fission . . . and the coolant which removes the heat produced during fission." Nuclear Fuels Policy Working Group, The Atlantic Council, *Nuclear Fuels Policy* 17 (1976) [hereinafter cited as *Fuels Policy*].

principally with respect to their moderators,[24] coolants,[25] and fuels.[26] A light-water reactor (LWR--either boiling or pressurized) utilizes ordinary ("light") water as both coolant and moderator. Enriched uranium is used as fuel. The boiling water reactor (BWR) allows the coolant to boil, thereby freeing it for direct use within the turbines. In the pressurized water reactor (PWR), on the other hand, the steam used to turn the generators is isolated from the coolant.[27]

Light water reactors comprise most of the current nuclear energy work force. Of the other types, the most significant in terms of the likelihood of its future use is the liquid metal fast breeder reactor (LMFBR). The LMFBR contains no moderator, uses molten sodium as a coolant, and requires a mixed (uranium and plutonium) oxide fuel (MOX) for efficient operation.[28] As will be seen, all of these reactors present real environmental risks.

Under AEA 1954, licensing of section 103 licensees is a two-step process. First, a construction permit must be granted. Following the completion of construction, the applicant must petition for an operating license. No license may be granted which would be "inimical to the common defense and security or the health and safety of the public." Though subsequent developments have somewhat altered the licensing procedure, the basic two-step process persists.[29]

In addition, the 1954 act gives the AEC express rule-making authority in order to establish

> minimum criteria for the issuance of specific or general licenses for the distribution of special nuclear material depending upon the degree of importance to the common defense and security or to the health and safety of the public. [30]

AEC rule-making procedures start with a petition for rule-making. A docket number is assigned and notice of filing is published in the *Federal Register.* If

24. *Fuels Policy, supra* note 23.
25. *Fuels Policy, supra* note 23.
26. *Fuels Policy, supra* note 23.
27. *Fuels Policy, supra* note 23.
28. *Fuels Policy, supra* note 23, at 20-21.
29. "Before the AEC issues either a construction permit or an operating license, it must resolve four principal issues regarding a proposed nuclear plant. These are: health and safety, environmental protection, safeguards, and antitrust. The protection of public health and safety is foremost among these issues. Under the AEC's NEPA [National Environmental Policy Act] procedures, comprehensive evaluations and assessments are made of the full range of environmental effects--both radiological and non-radiological--of each proposed nuclear plant, which are used to arrive at a balancing of benefits against environmental costs in the public interest." U.S. Atomic Energy Commission, *The Nuclear Industry--1973* (Wash. 1174-73), reprinted in *Hearings on Developments in the Energy Industry in General and the Nuclear Power Industry in Particular Pursuant to Section 202 of the Atomic Energy Act of 1954, as Amended, Before the Joint Committee on Atomic Energy,* 93rd Cong., 2d Sess. 271 (1974).

As will be seen below, these agency proceedings do not always live up to the standards formulated in the preceding excerpt.

Also it should be noted that a fair amount of construction is allowed prior to granting a construction permit and that there is a movement afoot within the successor to the AEC, the Nuclear Regulatory Commission, to amalgamate the two steps into a single accelerated process. This will be accomplished through advance site selection, thereby eliminating siting controversies likely to otherwise arise and standardization of facility designs.

Environmentalists claim that the "pre-construction" construction constitutes a significant investment of time and money, thereby making industrialists resistant to abandoning a site if it should later be found unsafe. Also, the environmental groups charge that one cannot simply plug in a pre-selected site with a standard design and necessarily come up with a safe plant. As they see it, the sum is greater than its parts. *See*, for example, *Hearings on Proposed Budget of the Nuclear Regulatory Commission for Fiscal Year 1977 Before the Joint Committee on Atomic Energy,* 94th Cong., 2d Sess. 22, 26-27, 39-40 (1976) [hereinafter cited as *Proposed Budget*].

30. AEA 1954, Sec. 53 (b), 42 U.S.C. Sec. 2073 (b) (1973).

the Commission considers it advisable, a hearing on the petition is scheduled. Interested parties are given an opportunity to comment. An adopted regulation or rule is then published in the *Federal Register.* [31]

3. The Energy Reorganization Act of 1974

The separation of commercial from medical and research licensees in sections 103 and 104, respectively, represents an early realization of distinctive problems. It soon became apparent, however, that the section 103 licensing process was itself caught up in a conflict between interests favoring strict regulation and governmental personnel pushing for faster development of nuclear technology. In answer to criticism, the AEC, in 1961, attempted to separate its promotional and regulatory functions.[32] The Division of Reactor Licensing was created as an independent branch of the Commission. Initial licensing activities were assigned to it. [33]

But this internal realignment did not stop criticism. Consequently, in 1974, Congress passed the Energy Reorganization Act. [34] The AEC was in effect abolished and replaced by two separate organizations: the Energy Research and Development Administration (ERDA)[35] and the Nuclear Regulatory Commission (NRC).[36]

Though ERDA incorporates a portion of the non-regulatory functions traditionally held by the AEC, its legislative mandate reaches beyond nuclear energy. In conjunction with a series of subsequent statutes, the Reorganization Act places upon ERDA responsibility for the promotion of other energy technologies. [37]

The NRC inherited "all the licensing and related regulatory functions of the Atomic Energy Commission."[38] Indeed, the structure of the NRC is strikingly similar to the organizational breakdown of the old AEC. In place of the Division of Reactor Licensing, there is now an Office of Nuclear Reactor Regulation.[39] An Office of Nuclear Material Safety and Safeguards has replaced the old Division of Compliance.[40] Confirmatory research, previously conducted by the Division of Reactor Safety Research, was not transferred to ERDA and is now carried out by the Office of Nuclear Regulatory Research.[41] In addition, the 1974 Act rejuvenates, without altering, the Atomic Safety and Licensing Board

31. Administrative actions are to comply with the Administrative Procedure Act. AEA 1954, Sec. 181, 42 U.S.C. Sec. 2231 (1973). Such actions are of two kinds. Either they are adjudicatory proceedings such as license decision-making or they are generic rule-making. Whether the AEC, and now the Nuclear Regulatory Commission, uses one or the other is a matter left for the Commission to decide. Morningside Renewal Council, Inc. v. U.S. Atomic Energy Commission, 482 F. 2d 234 (2nd Cir. 1973), *cert. denied,* 417 U.S. 951 (1973).

32. Energy Reorganization Act of 1974, Sec. 1 et seq., 5 U.S.C. 5313-16, 42 U.S.C. Secs. 5801, 5811-20, 5841-49, 5871-79, 5891 (Supp. 1976) [hereinafter cited as ERA 1974].

33. Schraff, *The Atomic Energy Commission* (1971).

34. ERA 1974, Sec. 1 et seq., 5 U.S.C. 5316-16, 42 U.S.C. Secs. 5801, 5811-20, 5841-49, 5871-79, 5891 (Supp. 1976).

35. ERA 1974, Sec. 101, 42 U.S.C. Sec. 5811 (Supp. 1976).

36. ERA 1974, Sec. 201, 42 U.S.C. Sec. 5841 (Supp. 1976).

37. ERA 1974, Sec. 103, 42 U.S.C. Sec. 5813 (Supp. 1976).

38. ERA 1974, Sec. 201 (f), 42 U.S.C. Sec. 5841 (f) (Supp. 1976).

39. ERA 1974, Sec. 203 (a), 42 U.S.C. Sec. 5843 (a) (Supp. 1976).

40. ERA 1974, Sec. 204 (a), 42 U.S.C. Sec. 5844 (a) (Supp. 1976).

41. ERA 1974, Sec. 205 (a), 42 U.S.C. Sec. 5845 (a) (Supp. 1976).

Panel (ASLBP),[42] the Atomic Safety and Licensing Appeal Panel (ASLAP),[43] and the Advisory Committee on Reactor Safeguards (ACRS).[44]

Partly due to these structural similarities as well as for other reasons, critics maintain that the NRC is no improvement over its predecessor. The most glaring structural defect is that the old Division of Reactor Licensing, since 1961, stood apart from the AEC as a quasi-independent licensing authority, while the Reorganization Act integrated the Division's replacement into the new parent body.[45] Whatever the real degree of the Division's former independence, there now was none. Partly as a consequence, the NRC instituted its own internal reforms in 1975. The Office of Nuclear Reactor Regulations was reorganized, "establishing a [quasi-independent] division responsible for operating reactor safety."[46] Just how successful this internal devolution will prove remains to be seen.

The AEA 1946 and 1954 expressed concern for public welfare and human safety.[47] But the Energy Reorganization Act is the first piece of nuclear legislation to state a congressional intent "to advance the goals of restoring, protecting, and enhancing environmental quality."[48] The NRC and ERDA are directed to give equal priority to "preservation of material resources [and] reduction of pollutants"[49] as they allow for economic-related factors.

Implementation of such a policy has been antedated and reinforced by the enactment of the National Environmental Policy Act of 1969 (NEPA),[50] the Federal Water Pollution Control Act (FWPCA),[51] and other environmental legislation and orders.

LETHAL PROBLEMS

Before addressing legal remedies for the environmental hazards created by nuclear energy, it would be appropriate to review the nature of these hazards.

A current ERDA publication[52] considers the major environmental issues engendered by the use of LWRs and LMFBRs in terms of a nine step fuel cycle:

42. Under AEA 1954, the AEC was authorized "to establish one or more atomic safety and licensing boards . . . to conduct such hearings as the Commission may direct and make such intermediate or final decisions as the Commission may authorize with respect to the granting, suspending, revoking or amending of any license or authorization. . . ." AEA 1954, Sec. 191, 42 U.S.C. Sec. 2241 (1973). Translated into practice the ASLBP and ASLAP review the sufficiency of the record and the adequacy of the health and safety analysis prepared by the Commission staff to support necessary findings. *See* Union of Concerned Scientists v. Atomic Energy Commission, 499 F. 2d 1069 (D.C. Cir. 1974). The functions of the ASLBP and ASLAP were transferred to the NRC under the Reorganization Act. ERA 1974, Sec. 201 (g), 42 U.S.C. Sec. 5841 (g) (Supp. 1976).

43. ERA 1974, Sec. 203, 42 U.S.C. Sec. 5843 (Supp. 1976).

44. AEA 1954 established the ACRS with a directive to "review safety studies and facility license applications [and to] advise the Commission with regard to the hazards of proposed or existing reactor facilities and the adequacy of proposed reactor safety standards." AEA 1954, Sec. 29, 42 U.S.C. Sec. 2039 (1973). *See* also AEA 1954, Sec. 182 (b), 42 U.S.C. Sec. 2232 (b) (1973). The Reorganization Act makes no mention of the ACRS and thereby leaves it functioning without alteration.

45. ERA 1974, Sec. 205, 42 U.S.C. Sec. 5845 (Supp. 1976).

46. *Proposed Budget, supra* note 29, at 61.

47. AEA 1946, Sec. 1 (a); AEA 1954, Sec. 1, 42 U.S.C. Sec. 2011 (1973).

48. ERA 1974, Sec. 2, 42 U.S.C. Sec. 5801 (Supp. 1976).

49. ERA 1974, Sec. 2, 42 U.S.C. Sec. 5801 (Supp. 1976).

50. National Environmental Policy Act of 1969, Sec. 1 et seq., 42 U.S.C. Sec. 4321 et seq. (1973) [hereinafter cited as NEPA].

51. Federal Water Pollution Control Act, Sec. 1 et seq., 33 U.S.C. Sec. 1251 et seq. (Supp. 1976).

52. *Balanced Program Plan, supra* note 19.

1) mining of uranium ore;
2) milling of the ore to produce purified uranium oxide (U_3O_8);
3) conversion of U_3O_8 to uranium hexafloride (UF_6);
4) isotopic enrichment of U_{235};
5) conversion of the isotopically enriched UF_6 to UO_2, recycling of plutonium, and fabrication of fuel elements;
6) power production;
7) spent fuel reprocessing;
8) waste management;
9) fuel and waste transportion.[53]

1. Mining of Uranium Ore.

There is little question that the mining of uranium ore constitutes an occupational threat to the mine-workers. Actually, the uranium itself is found in such low concentrations – about 4 pounds of U_3O_8 per ton – that the health hazard really lies elsewhere. Uranium becomes radium as it decays "which in turn slowly changes into a radioactive gas called radon which slowly seeps out of the rocks and into the mine atmosphere."[54] Finally, the "gas changes into a series of highly radioactive solid particles called 'radon daughters.' "[55] Radon daughters, when inhaled, are liable to collect on the lung tissue and may produce cancer. No one precisely knows their long-term carcinogenic effects.

ERDA found that dusts containing uranium and radon gas and the daughters are all released to the atmosphere during mining operations. These materials are also found "dissolved and suspended . . . in mine drainage water."[56] The study concluded, however, that such releases do "not cause measureable increases in environmental radioactivity outside the immediate vicinity of the mines."[57]

2. Milling of the Ore

More serious environmental effects are thought to result from the milling process. "[U]ranium is crushed, ground, and then leached with either sulphuric acid or sodium carbonate solution to extract the uranium values."[58] Further processing draws out U_3O_8 in the form of "yellowcake."[59] The waste residue left over, known as tailings, is dangerously radioactive. They are usually deposited in man-made ponds. Most of the water evaporates, but some percolates into the ground carrying radioactivity with it. Tailings have even been used in the foundations of homes and schools. Others have been dumped into the Colorado River and have entered its tributaries:

> "The Federal Water Pollution Control Agency quickly established that the radioactivity downstream from the . . . mill was almost five hundred times normal levels. . . . this radioactivity was eight times more than the maximum amount permitted in drinking water. . . .

53. *Balanced Program Plan, supra* note 19.
54. H. Metzger, *The Atomic Establishment* 118 (1973) [hereinafter cited as Metzger].
55. Metzger, *supra* note 54.
56. *Balanced Program Plan, supra* note 19, at 6-7.
57. *Balanced Program Plan, supra* note 19, at 6-7.
58. *Balanced Program Plan, supra* note 19, at 7.
59. *Balanced Program Plan, supra* note 19, at 8.

> . . . [T]he worry here is that . . . man at the end of the food chain will concentrate the radium into his bones. . . . [60]

Despite all this, the ERDA study found that while "uranium milling activities contribute to the content of radioactivity in the environment, it appears from available measurements that population doses from this source cannot be distinguished from background." [61]

3. Conversion Of U_3O_8 To UF_6.

The potential for environmental damage from the process of converting yellowcake into gaseous UF_6 is significant. There are two plants presently producing UF_6. One "uses a dry process of successive reduction, hydrofluorination . . .and fluorination of the uranium, followed by fractional distillation. The other uses wet chemical solvent extraction followed by calcination to prepare a high-purity uranium feed to the dry process steps."[62]

These complicated techniques release various gases. "Of greatest concern are the fluorides . . . and their potential for accumulation in vegetation." [63] Also, uranium and soluble radionucleides, including radium, are released in water, solid wastes, and sludge. The solid wastes and sludge are disposed of by burial; the water evaporates. The report concludes that these occurrences "are potential impacts that require attention" [64] without elaborating upon their nature.

4. Isotopic Enrichment Of U_{235}

The next step in the fuel cycle is uranium enrichment. Plans are now being made to expand current uranium enrichment facilities in order to meet increased demand. In April, 1976, ERDA issued a final environmental statement assessing the relative costs and benefits of carrying through such a program.

Certain adverse environmental effects from the expansion are unavoidable, according to the ERDA Final Environmental Statement. They include: a) "increased water treatment costs and decreased recreational and aesthetic values," [65] b) "[l]eachate from contaminated burial grounds [which] could adversely affect groundwater quality," [66] c) "[a]ir quality. . .affected slightly due to gaseous and particulate emission," [67] d) "[c]ooling tower operation . . . [that] may increase local fog frequency and noise levels," [68] e) terrestrial effects entailing the possible destruction of "biota on [surrounding] plant acreages," [69] f) "minor local effects [within about 350 feet] on terrestial flora and fauna . . . due to salt and chromate deposition." [70] and g) "the principal adverse effect on acquatic biota: . . . an unknown degree of nutrient-induced eutrophication of local surface water." [71]

60. Metzger, *supra* note 54, at 162-63.
61. *Balanced Program Plan, supra* note 19, at 8-9.
62. *Balanced Program Plan, supra* note 19, at 9.
63. *Balanced Program Plan, supra* note 19, at 9.
64. *Balanced Program Plan, supra* note 19, at 10.
65. ERDA, *Final Environmental Statement--Expansion of U.S. Uranium Enrichment Capacity* 4-2 (1976) [hereinafter cited as Enrichment Capacity].
66. *Enrichment Capacity, supra* note 65.
67. *Enrichment Capacity, supra* note 65.
68. *Enrichment Capacity, supra* note 65, at 4-3.
69. *Enrichment Capacity, supra* note 65, at 4-3.
70. *Enrichment Capacity, supra* note 65, at 4-3.
71. *Enrichment Capacity, supra* note 65, at 4-3.

> By the year 2000, with 11 operating [enrichment] plants and 103 years of plant operation, the total body population dose [of] . . . radiation exposure [would represent] . . . an increase of 0.05% to that received from natural background sources.[72]

Though this change seems negligible, no one can predict with certainty the long term effect of slight but sustained increases of radioactivity.

5. Conversion of UF_6 To UO_2, Recycling of Plutonium, and Fabrication of Fuel Elements

Facilities for the conversion of uranium hexafluoride into mixed oxide fuel are now being planned. This technological development depends upon first recovering plutonium isotopes by reprocessing the spent fuel. Such adaptations must be made if the light water reactor is to become an efficient means of generating power.[73]

The recovery process leaves behind other solid plutonium wastes. Various proposals have been made for the safe storage of these materials. Their radioactivity will remain at highly dangerous levels for thousands of years.[74] Safeguards against theft must also be taken because nuclear weapons utilize plutonium. A great deal of expertise is apparently not requisite to construct such weapons. One must only secure the requisite raw materials.[75]

In addition, production of MOX "releases plutonium, americium, and curium to the biosphere."[76] The ERDA report states that "the radiation doses that may result will be only a small fraction of natural background. Nevertheless, plutonium is very toxic if deposited in the body. . ."[77]

6. Power Production

Environmental effects of the operation of nuclear reactors are the focal point of major controversy. Extensive studies have been conducted to measure the probability of accidental occurrences and their likely effects. In addition, records are maintained of unanticipated events, and these are regularly reported to Congress.[78]

It is worthwhile briefly to examine the environmental implications of normal reactor operations and postulated accidental possibilities.

A 1974 AEC report identifies nine possibly serious environmental problems arising from the normal operation of light water reactors: radiation exposure from effluents; radioactive wastes indirectly released to the environment; non-radioactive air pollutants; possible weather modifications resulting from water vapor and waste heat; depletion of water resources; non-radioactive water

72. *Enrichment Capacity, supra* note 65, at 4-4. It should be noted that these effects are only some of those considered unavoidable. There are many other avoidable effects which can be expected to negatively affect environmental quality. *Enrichment Capacity, supra* note 65, at 3.12.

73. The NRC, in 1975, deferred its decision whether to permit the plutonium recycle "until alternative safeguards systems studies were complete and a safeguards program designed and subjected to public review." Council of Environmental Quality, *The Sixth Annual Report of the Council on Environmental Quality* 129 (1975) [hereinafter cited as *Annual Report*].

74. Skeptic, August, 1976, at 6. *Annual Report, supra*, note 73, at 130.

75. Newsweek, March 10, 1975, at 40.

76. *Balanced Program Plan, supra* note 19, at 12.

77. *Balanced Program Plan, supra* note 19, at 12.

78. See Skeptic, *supra* note 74, at 51. *See* also *Hearings on the Status of Nuclear Reactor Safety Before the Joint Committee on Atomic Energy, Part I,* 93rd Cong., 1st Sess. 128-37 (statement of Dr. N. Rasmussen) (1973) [hereinafter cited as *Reactor Safety*].

contaminants; internal facility operations liable to harm acquatic species; the withdrawal of the construction site from alternative land uses, and deleterious effects on the overall quality of life.[79]

The worst possible accident envisioned with respect to the light water reactor is a loss of coolant accident followed by a melt-down of the reactor core. Ultimately, if there were no injection of new coolant, the entire reactor core would melt through the floor of the chamber. The consequent escape of radioactivity would produce untold damage and destruction to man and the environment. Present safety measures to prevent such an accident, and remedy one that has begun, are the subject of dispute.[80]

There is growing support among industrialists for the development of the liquid metal fast breeder reactor (LMFBR). Its main attraction, in light of the shortage of available uranium, is that it produces more fuel than it consumes.[81]

Predictions indicate that during normal operations, the LMFBR will be environmentally as clean or cleaner than the present generation of light water reactors.[82] The risk of accident, however, is nonetheless substantial.

Sodium, the coolant required by the LMFBR, rapidly oxidizes when exposed to air. When exposed to liquid, however, sodium "burns spontaneously."[83] As a result of the presence of steam generators, and the fact that generator leaks are common, there is a high likelihood of fire.[84]

Further, sodium exposed to liquid not only causes fire, but also releases hydrogen, thereby increasing the reaction energy.[85] Since the LMFBR contains several critical masses,[86] a sudden increase of reaction energy, combined with a fire and a loss of coolant, could set off a chain reaction. In the event of a core melt-down such a chain reaction is assured.[87]

7. Spent Fuel Reprocessing

The reprocessing of spent nuclear fuel "releases virtually all of the noble gasses . . . and tritium, and also small amounts of iodine to the environment. . . . Because of the large inventories of radioactive contaminants . . . the possibility of substantial environmental contamination from reprocessing plants is greater than from power reactors."[88]

79. Directorate of Regulatory Standards, U.S.A.E.C., *Nuclear Power Facility Performance Characteristics for Making Environmental Impact Statements* 3-7, 3-16, 3-31 (1974).

80. *Reactor Safety, supra* note 78. *See* also *Joint Hearing on Nuclear Regulatory Commission Action Requiring Safety Inspections Which Resulted in Shutdown of Certain Nuclear Powerplants Before the Joint Committee on Atomic Energy and the Committee on Government Operations* (1975).

81. *Annual Report, supra* note 73, at 130.

82. T. Cochran, *The Liquid Metal Fast Breeder Reactor* 152 (1974) [hereinafter cited as Cochran].

83. Cochran, *supra* note 85, at 171.

84. Cochran, *supra* note 85, at 172. The risk of a LOCA is also greater in the LMFBR; because sodium "becomes intensely radioactive when exposed to neutrons . . . provisions must be made for refueling the reactor without the benefit of visual observation, thereby increasing the possibility of refueling accidents." Cochran, *supra* note 85, at 172.

85. Cochran, *supra* note 85, at 172.

86. A critical mass is sufficient nuclear material in great enough concentrations to produce an atomic explosion.

87. Cochran, supra note 85, at 172. "It takes only a slight compaction (about 2 per cent volume reduction of a core) to trigger an explosive nuclear runaway." Cochran, *supra* note 85, at 173.

88. *Balanced Program Plan, supra* note 19, at 17.

8. Waste Management

Future reprocessing plants will reduce the release of radioactively high-level liquid and solid wastes. By converting the liquid wastes to solid form, then storing the wastes on-site for five to 10 years and, finally, shipping them for permanent storage at a federal repository, it is believed that environmental releases can be substantially eliminated.[89] There is a great deal of dispute, however, as to the likelihood of leakage and the availability of alternatives; the long-term outcome is uncertain.

9. Fuel and Waste Transportation

Fuel and waste transportation occurs at several steps along the fuel cycle. Shipments are made by both rail and truck,[90] and the reliability of air shipments is currently under study.[91] Two other areas of concern are accidental radiation exposure and, with the increased use of plutonium in LMFBRs, theft. Under normal conditions, however, there is no significant environmental danger from fuel and waste transportation.[92]

LEGAL SOLUTIONS

Governmental responsibility for environmental protection usually takes shape in three types of regulations or laws. The law establishes: (1) a methodology of environmental protection, (2) limitations on the use or emission of specified substances, or (3) means to preserve a single natural resource. A fourth method receiving increased attention is the implementation of financial incentives.

1. Methodological Protection: The NRC and NEPA

NRC actions encompass both the methodological and the specified substances approaches. Methological tools include general design criteria, site criteria, regulatory guides, letters of the ACRS, and decisions by ASLBP, ASLAP, and the Commission itself. In addition, the NRC relies on industry codes and standards whenever feasible.[93]

These methological considerations cannot fully be understood without reference to other influential legislation. The National Environmental Policy Act (NEPA)[94] has had a great impact on the procedures used in the licensing of commercial nuclear reactors. Section 102(2)(c) of this act calls upon all federal government agencies to include a detailed environmental impact statement

89. *Balanced Program Plan, supra* note 19, at 18.
90. *Annual Report, supra* note 73, at 129-30.
91. *Balanced Program Plan, supra* note 19, at 21.
92. The NRC began a rule-making proceeding and undertook to prepare an environmental impact statement regarding the air transportation of radioactive materials in June, 1975. However, Congress responded in August, 1975, with an act to prohibit licensed air transportation of plutonium except for plutonium in a medical device until a safe container is developed. This container must be able to sustain a crash and blast-testing equivalent to a crash and explosion of a high-flying aircraft. *See* 16 Nuclear Law Bulletin 24 (1974).
93. *Balanced Program Plan, supra* note 19, at 21-22 "There is, however, a potential for transportation accidents, followed by exposure of the public to radionucleides released to the environment." *Balanced Program Plan, supra* note 19, at 21-22.
94. P. Morris, Nuclear Power Plant Safety, in *Mechanical Failure: Definition of the Problem* 143, 147-48 (National Bureau of Standards ed. 1976).

"in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment."[95]

NEPA establishes a Council on Environmental Quality (CEQ), designed initially to act as an advisory body.[96] But the President, in 1970, ordered the CEQ to establish guidelines for agency preparation of section 102 statements.[97] These guidelines call for draft statements "prepared and circulated to the Council early enough in the agency review process before an action is taken in order to permit meaningful consideration of the environmental issues involved."[98]

Even though NEPA did not literally empower the Council to issue such guidelines, the AEC was obliged to comply with CEQ directives. Certain other effects of NEPA on AEC (and now NRC) practices have been settled only after lengthy litigation.

Most cases dealing with NEPA, whether or not they concern nuclear energy, can be read in terms of judicial activism vis-a-vis agency procedures or findings of fact. In *Calvert Cliffs Coordinating Committee v. U. S. Atomic Energy Commission,*[99] the U. S. Court of Appeals for the District of Columbia Circuit concluded that "Section 102 of NEPA mandates a particular sort of careful and informed decision-making process and creates judicially enforceable duties."[100] The AEC was ordered fully to comply throughout the agency review process, something it had apparently been reluctant to do.[101]

Two years later, the same court used a "rule of reason" in holding that NEPA required a detailed statement for the proposed LMFBR program.[102] Previously, statements were prepared only for individual actions and facilities.

The "rule of reason" which the court recommends consists of balancing various competing interests[103] and, in effect, constitutes the economist's cost-benefit analysis. Today, cost-benefit analysis is typically employed by the NRC. It is also noteworthy that this decision takes the Circuit Court further than *Calvert Cliffs.* Here the court does not merely enforce NEPA-mandated procedures. It demonstrates a willingness to prescribe substantive formulae which are, in its own view, guides to statutory compliance.

In continuing this activist posture, the U.S. Court of Appeals for the D. C. Circuit recently found that the NRC's rule-making proceedings on the matter of radioactive waste storage failed to address major contentions that were raised.[104] The agency findings were considered the result of "capricious and

95. NEPA, Sec. 102 (2) (c), 42 U.S.C. Sec. 4332 (c) (i) (1973).
96. NEPA, Sec. 202, 42 U.S.C. Sec. 4342 (1973).
97. Exec. Order No. 11,514, 35 Fed. Reg. 4247 (1970). Though these guidelines are advisory only (Hiram Clarke Civil Club, Inc. v. Lynn, 476 F. 2d 421 (5th Cir. 1973)), they are given substantial weight by the courts. *See* Carolina Action v. Simon, 389 F. Supp. 1244 (M.D.N.C. 1975), *aff'd on other grounds,* 522 F. 2d 295 (4th Cir. 1975).
98. 40 C.F.R. Sec. 1500 et seq. (Supp. 1976).
99. 449 F. 2d 1109 (D.C. Cir. 1976).
100. 449 F. 2d 1109, 1115 (D.C. Cir. 1976).
101. 449 F. 2d 1109, 1116-17 (D.C. Cir. 1976).
102. Scientist's Institute for Pub. Info., Inc. v. AEC, 481 F. 2d 1079 (D.C. Cir. 1973).
103. 481 F. 2d 1079, 1092 (1973).
104. NRDC v. NRC, 9 ERC 1149, 1167 (D.C. Cir. 1976). *See* also Aeschliman v. NRC, 9 ERC 1289 (D.C. Cir. 1976) in which the court ruled that an intervenor in an agency proceeding "must only bring 'sufficient attention' to the issue to stimulate the Commission's consideration of it. Thereafter, it is incumbent on the Commission to undertake its own preliminary investigation. . . . " The rule of reason, the court found, required nothing more of the intervenor. 9 ERC 1289, 1293-94.

arbitrary" proceedings and were set aside.

The D. C. Circuit uses the "rule of reason" in reviewing the adequacy of agency proceedings under NEPA. On the other hand, the "capricious and arbitrary" standard is used to review final orders of the NRC under AEA 1954. [105] However, NEPA considerations may also be raised within the context of an action regarding NRC final orders.

NEPA contains no jurisdictional provision. Actions brought under it must endure the lengthy process of district court trials. On the other hand, cases filed under AEA 1954 go directly before the circuit court "in which the petitioner resides or has its principal office, or in the United States Court of Appeals for the District of Columbia Circuit."[106] The activist role of the D. C. Circuit explains why so many cases are brought before it.

Certain tactical considerations are thus involved in deciding whether to bring suit under NEPA or whether to raise NEPA within the context of an AEA-based action. Though the second route accelerates judicial review, it delays the moment at which an action can be filed. At the same time, an AEA-based action widens the opportunity for forum shopping, but may subject the petitioner to a tougher standard of review than an action grounded in NEPA.

Despite the success of environmental groups in the D. C. Circuit, the United States Supreme Court has been less willing to inject its judicial presence into administrative deliberations. In *Public Service Co. v. Porter County Chapter,* [107] the Supreme Court ruled that the Seventh Circuit Court of Appeals "erred in rejecting the Agency's interpretation of its own regulations."[108] As long as the NRC "sensibly" applied its regulations, "the Court of Appeals was 'obligated to regard as controlling (such) a reasonable, consistently applied administrative interpretation.' "[109]

In *Porter County,* the Court found for the industrialists.[110] But if the decision means that unreasonable and inconsistent interpretations are now to be the standard of AEA judicial review, the holding actually liberalizes the "arbitrary and capricious" standard currently used by the D. C. Circuit. Consequently, *Porter County* is probably a pyrrhic victory for the pro-nuclear forces.

Kleppe v. Sierra Club, [111] however, presents the environmental forces with a real defeat. It strikes directly at the rule of reason and judicial activism of the D. C. Circuit.

The Court of Appeals for the D. C. Circuit stated in *Sierra Club v. Morton* [112] that "the courts must reserve the right to analyze federal actions to determine if, in fact, a comprehensive program, however labelled, is under way or proposed."[113] If the analysis turns up such a program, the court's decision in *Scien-*

105. 9 ERC 1149. The capricious and arbitrary standard is contained within the Administrative Procedure Act, 5 U.S.C. Sec. 706 (2) (a) (1967) [hereinafter cited as APA]. A court must set aside agency action which is "arbitrary, capricious, and abuse of discretion, or otherwise not in accordance with law." APA, 5 U.S.C. Sec. 706(2) (a) (1967). The NRC is subject to the APA. AEA 1954, Sec. 189 (b) 42 U.S.C. Sec. 2239 (b) (Supp. 1976).

106. Act of January 1, 1975, Sec. 3, 28 U.S.C. Sec. 2341 (Supp. 1976), Act of September 6, 1966, sec. 4 (e), 28 U.S.C. Sec. 2343 (Supp. 1976).

107. Nothern Ind. Pub. Serv. Co. v. Walton League, 423 U.S. 12 (1975).

108. 423 U.S. 12, 15 (1975).

109. 423 U.S. 12, 15 (1975).

110. 423 U.S. 12, 15 (1975). *See* also Porter Cty. Chapter of Izaak Walton League v. AEC, 503 F. 2d 1011 (7th Cir. 1976).

111. 96 S. Ct. 2718 (1976).

112. 514 F. 2d 856 (D.C. Cir. 1975).

tist's Institute for Pub. Info., Inc. v. AEC[114] mandates the preparation of a section 102 statement. The method of analysis to be used is again the balancing technique of the rule of reason.

In reversing *Sierra Club v. Morton,*[115] the Supreme Court commented that NEPA "clearly states when an impact statement is required, and mentions nothing about a balancing of factors."[116] Justice Lewis F. Powell, Jr., criticized the lower court's decision:

> A court has no authority to depart from the statutory language and, by a balancing of court-devised factors, determine a point during the germination process of a potential proposal at which an impact statement *should be prepared.* Such an assertion of judicial authority would leave the agencies uncertain as to their procedural duties under NEPA, would invite judicial involvement in the day-to-day decisionmaking process of the agencies, and would invite litigation. As the contemplation of a project and the accompanying study thereof do not necessarily result in a proposal for major federal action, it may be assumed that the balancing process devised by the Court of Appeals also would result in the preparation of a good many unnecessary impact statements.[117]

2. Specified Substance Limitations and Natural Resource Preservation: The NRC and the EPA

NRC regulations establish limitations on the use and emission of radioactive materials.[118] The Environmental Protection Agency (EPA), under authority granted by the President, also holds jurisdiction over certain uses of radioactive materials. According to Reorganization Plan No. 3 of 1970, the EPA was assigned the "functions of the Atomic Energy Commission . . . to the extent that such functions . . . consist of establishing generally applicable environmental standards for the protection of the general environment from radioactive material."[119] EPA duties were limited to "the general environment outside the boundaries of locations under the control of persons possessing or using radioactive material."[120]

The Reorganization Plan also transferred other duties to the EPA including enforcement functions under the Federal Water Pollution Control Act (FWPCA).[121] By the terms of this act, the EPA is to assure the preservation of applicable water quality standards in the navigable waters of the United States.[122]

Interagency conflict arose soon afterwards over the meaning of the Reorganization Plan. The AEC claimed, for instance, that "generally applicable environmental radiation standards" authorized the EPA to set "ambient or exposure limits unrelated to class of activity."[123] EPA officials argued that dif-

113. 514 F. 2d 856, 873 (D.C. Cir. 1975).
114. See text corresponding to note, *supra* note 102.
115. 514 F. 2d 856, 874 (D.C. Cir. 1975).
116. 96 S. Ct. 2718, 2728 (1976).
117. 96 S. Ct. 2718, 2729 (1976).
118. 10 C.F.R. Sec. 20.1 et seq. (Supp. 1976).
119. Reorg. Plan No. 3 of 1970, 35 Fed. Reg. 15, 623 (Supp. 1970).
120. Reorg. Plan No. 3 of 1970, 35 Fed. Reg. 15, 623 (Supp. 1970).
121. Reorg. Plan No. 3 of 1970, 35 Fed. Reg. 15, 623 (Supp. 1970).
122. Federal Water Pollution Control Act, Sec. 1 et seq., 33 U.S.C. Sec. 1251 et seq. (Supp. 1976).
123. *See* Office of General Counsel, EPA, *A Collection of Legal Opinions* 275 (1975) [hereinafter cited as *Legal Opinions*].

ferent "generally applicable" standards could be fixed "for different classes of activity."[124] Later, the AEC withdrew from its position. By the time of *Calvert Cliffs* in 1971, the EPA asserted without challenge that "EPA water quality standards. . . establish a minimum below which AEC licensees cannot go."[125] Two AEC-EPA joint memoranda in 1973 formalized the EPA position.[126] Thus, in 1975, the EPA proposed rules for environmental protection from radiation caused by nuclear power operations. The interagency position was further clarified: the EPA guides *are* minimums but primary responsibility for their implementation is vested in the NRC.[127]

Yet a 1976 Supreme Court decision, *Train v. Colorado Pub. Int. Research Group,*[128] redefines the respective roles of the NRC and EPA. The Court, referring to the legislative history of the FWPCA, held that the EPA has no authority to regulate discharge into the nation's waterways of those nuclear materials subject to regulation by the NRC. Source, special nuclear, and byproduct materials are not 'pollutants' within the meaning of the FWPCA. All other radioactive materials, e.g. radium and accelerator-produced isotopes, are covered by the FWPCA.[129] It is too early to predict the effect of this decision. For the present, however, the NRC continues to rely on the EPA in denying or granting approval of nuclear reactor construction permits and operating licenses.

3. Financial Incentives

An alternative method of environmental protection through law is the creation of financial incentives not to pollute. A negative incentive such as the tax on nuclear materials waste storage recently imposed by Kentucky has the effect of discouraging industrial expansion into the reactor field.[130]

The Tax Reform Act of 1976,[131] on the other hand, develops positive financial incentives at the federal level. Qualifying pollution control devices will allow their purchaser an investment credit to the extent of 50% of the property's cost, amortized over a five-year period. The asset must have a useful life of at least five years and "must not lead to a significant increase (more than 5%) in the capacity or useful life of the plant." Nor can the device "significantly alter the production process or reduce operating cost."[132]

CONCLUSION: THE CHALLENGE OF CHANGE

We have looked at different types of environmental protection laws, distinguished on the basis of their functions and contents. Some require a methodology of environmental protection; some aim to preserve specific natural resources, and others attempt to place limits on the use or emission of speci-

124. *Legal Opinions, supra* note 122.
125. *Legal Opinions, supra* note 122, at 581.
126. 38 Fed. Reg. 24,936 (Supp. 1973). 38 Fed. Reg. 32,965 (Supp. 1973).
127. 40 Fed. Reg. 23, 420 (Supp. 1975).
128. 96 S. Ct. 1938 (1976).
129. 96 S. Ct. 1938, 1944 (1976).
130. *Audubon Magazine*, November, 1976, at 131.
131. Pub. L. No. 94-455, Sec. 1 et seq., 90 Stat. 1520 [hereinafter cited as Tax Reform Act] (amending I.R.C. Sec. 3 et seq.).
132. Tax Reform Act, Sec. 2122 (b) (amending I.R.C. Sec. 169 (d)). *See* Arthur Anderson and Co., *Tax Reform Act of 1976--Summary of Changes and Impact on Selected Businesses* 94 (1976).

fied substances.

But if there is to be a fully developed understanding of environmental law, these legal controls must also be delineated in terms of their purposes. Common law is traditionally punitive or remedial. Actions are punished, wrongful conditions are alleviated, only after a judicial determination of the occurence of those conditions. The common law insists on specificity and, chronologically, the punishment or remedy always follows and never precedes the wrong. Deterrence of future wrong-doing is an incidental side-effect of punitive and remedial legal norms. Perhaps setting an example will discourage others from the same sort of behavior. Perhaps not.

Environmental laws, such as those discussed previously, are preventive laws. Their sole purpose is the prevention of unlawful behavior before it occurs. Philosophically, preventative norms are the outgrowth of utilitarianism and, more recently, the sociological school of jurisprudence. Historically, preventive laws are a contemporary phenomenon and a convincing argument can be made that they are the product of runaway technological change, *viz:* the only way to control technology is to slow it down; preventive laws silently express this unarticulated need.

Whatever the persuasiveness of such an argument, the potential risks of uncontrolled nuclear energy development are something not even the staunchest pro-nuclear advocate is ready to live with. Preventative environmental measures are a universally recognized need, but preventive law seriously challenges the integrity of the present legal system. While the judicial process operates somewhat apart from the hustle of other societal spheres, the enforcement of preventive laws means the legal system cannot always wait for wrongdoers to come to it.

Instead, the law must reach out and *prevent* wrongdoing. As shown above, some courts are more willing to get involved than others. There is after all no assurance in the minds of some judges that greater judicial involvement will do any good. But there is good possibility that it will undermine judicial objectivity. . . . The challenge to the legal structure, therefore, is, ironically, also one of change. It is ironic because the courts are being asked to slow technological change by themselves changing.