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Radiation from Nuclear Power Plants: The Need for Congressional Directives

Michael Baram
Boston Univeristy School of Law

RADIATION FROM NUCLEAR POWER PLANTS: THE NEED FOR CONGRESSIONAL DIRECTIVES

MICHAEL S. BARAM*

Noisy protests against the construction and operation of nuclear power plants in the United States have convinced some government officials that the future of nuclear energy may depend more on public perceptions of danger than on capital costs, capacity factors, and safe nuclear waste disposal. The assumption of some plant operators and regulatory agencies that low-level additions to the radiological burdens of life on earth from nuclear facilities will cause "acceptable" increases in death and genetic mutation certainly does not raise public confidence. Nuclear power advocates should be as interested as environmentalists in keeping emissions to an absolute minimum. Yet, as Mr. Baram argues in this Article, the present structure of radiation control fails to achieve its goal. He suggests that the absence of an unquestioned position for the Environmental Protection Agency and the states allows the Nuclear Regulatory Commission to narrow its consideration of radiation exposure to the power plant effluent alone and loosen standards where it deems appropriate. Moreover, the Commission's pre-regulatory cost-benefit balancing test biases its regulations against safety. He concludes that Congress must permit other agencies to participate in the regulatory process and must decide for itself what health risks to present and future generations can be tolerated.

Introduction

Congress often responds to a complex problem by empowering an independent regulatory agency to enforce its legislative will. Acknowledging its own lack of knowledge and time, Congress gives the agency a measure of freedom to modify the legal requirements to fit a variety of circumstances that the legisla-

* B.S., Tufts University, 1957; LL.B., Columbia University, 1960; Former Professor of Civil Engineering, Massachusetts Institute of Technology; Member of the staff of the Franklin Pierce Law Center, Concord, New Hampshire. Member of the firm of Bracken Selig & Baram, Boston, Massachusetts; Member of the Committee on the Biological Effects of Ionizing Radiation, National Academy of Sciences. This article is adapted from "Legal and Ethical Aspects of Using Cost-Benefit Analysis," a chapter of the 1977 Report of the Committee to the Environmental Protection Agency.

ture could not foresee. Ordinarily Congress restrains this autonomy by prescribing general criteria that the agency must consider and objectives that must be met.[1] These provisions enable Congress to measure the agency's progress and make necessary changes in the law. In addition, competition from other bureaus forces the agency to act vigorously or face a loss of prestige.

But Congress did not follow its normal practice in enacting the provisions governing radioactive emissions from nuclear power plants. Instead, it permitted the Atomic Energy Commission (AEC) to add protective conditions to power plant licenses whenever the agency felt that they would be appropriate.[2] Criteria and goals for public exposure to power plant radiation were left to the agency's planners. Moreover, Congress granted other agencies authority that logically extends to radioactive discharges, but neither explicitly sanctioned competitive efforts nor provided for interagency cooperation with the AEC. Congress may have been reluctant to clarify its desires while the federal government continued to promote nuclear power in an effort to recoup some of its capital investment in atomic weapons research and gaseous diffusion plants. Yet the end of official optimism implicit in the division of the AEC into research and regulatory branches[3] has not eliminated the uncertainty.

This article explores the consequences of uncontrolled congressional delegation of authority to the AEC's successor, the Nuclear Regulatory Commission (NRC), and recommends ways of curbing agency discretion that could better guard the public health from the risks imposed by ionizing radiation. Section I discusses the potential role of the Environmental Protection Agency and state agencies in the regulation of radioactive discharges. It criticizes the congressional indecision that led to the restrictive judicial doctrines of federal and administrative preemption, but suggests that the EPA and the states still retain

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1 The Federal Water Pollution Control Act Amendments of 1972, 33 U.S.C. §§ 1251-1376 (Supp. V 1975), and the National Environmental Policy Act, 42 U.S.C. §§ 4321-4335 (1970), are examples of recent congressional enactments calling for agency consideration of multiple and diverse factors in the regulatory process.

2 *See* note 18 *infra* and accompanying text.

3 *See* note 14 *infra* and accompanying text.

sufficient authority to adopt standards that complement the NRC's requirements. Section II questions the usefulness of the NRC's cost-benefit balancing test that must justify emission standards before they are imposed. It shows the practical failings of such analyses and advises Congress to reclaim its power to set standards according to a representative assessment of acceptable risk. Once Congress makes these social choices, the NRC can apply cost-effectiveness to select the best method of meeting the congressional standards.

I. Choosing Regulators for Power Plant Radiation

Operators of nuclear power plants routinely release significant quantities of ionizing radiation into the environment.[4] Ionizing radiation is similar to other forms of pollution in the risk it imposes on human health and environmental quality.[5] But it differs from other pollutants in its low susceptibility to chemical change and purification by the environment itself. Although radioactive isotopes vary in their rates of decay, their half-lives are often long and cannot be reduced by natural reactions.[6] Moreover, isotopes may tend to cumulate in animals and humans through the food chain, and cumulative exposure to radiation can produce greater injury.[7] Thus long-lived sources of radiation could continue to cause somatic damage to individuals long after their initial appearance in the air or water. Finally, the potential for long-term genetic damage precludes a safe or "threshold" level of exposure.[8] Control of

4 One estimate suggests that the 100 nuclear reactors projected for operation by 1985 will add 0.5 millirem per year to the average radiation dose of the entire United States population. *See* E. Hall, Radiation and Life 192 (1976).

5 For a detailed discussion of the known health and environmental effects of radiation, *see* M. Eisenbud, Environmental Radioactivity 1-204 (2d ed. 1973); Principles of Radiation Protection 266-496 (K. Morgan & J. Turner, eds. 1967). *See also* W. Patterson, Nuclear Power 280-85 (1976).

6 *See* M. Eisenbud, *supra* note 5, at 10-11, 58.

7 *Id.* at 118-36. Some isotopes, such as iodine-131, may also concentrate in certain organs of the human body, where their ordinary chemical constituents are metabolized and do disproportionate damage. W. Patterson, *supra* note 5, at 142.

8 W. Patterson, *supra* note 5, at 281. *See* A. Tamplin & J. Gofman, 'Population Control' Through Nuclear Pollution 2-27 (1970). The Environmental Protection Agency and the Atomic Energy Commission have adopted this position for regulatory purposes. *See* U.S. Envt'l Protection Agency, Policy Statement: Relationship Between Radiation Dose and Effect (March 3, 1975); U.S. Atom. Energy Commission, Concluding Statement of Position of Regulatory Staff: Public Rulemaking Hearing on Numeri-

radioactive emissions at the power plant site would appear to be necessary to minimize human exposure to radiation.

At the same time, however, some consideration must be given to ambient levels of ionizing radiation in the environment to distribute the primary health risks of radiation among all members of society. Natural sources expose individuals to low levels of radiation that vary according to geographical location and population density.[9] Moreover, scientists have some ability to predict dispersion patterns for radioactive isotopes released into the atmosphere or watercourses.[10] Man-made sources of radiation might therefore be distributed to equalize human exposure to ionizing radiation. Monitoring of ambient levels of certain isotopes could assist in maintaining radioactivity at average natural background rates.[11]

The diverse health effects and unusual environmental flow patterns of radiation complicate its measurement and control. But these complexities should not be allowed to mask the fundamental duality of regulations applied to radioactive releases from nuclear power plants. On the one hand, emission standards can be set to minimize radiation discharges within the limits of technology or some rule of reasonable expense. These standards may or may not produce ambient concentrations of isotopes that take advantage of natural and artificial variations. On the other hand, ambient radiation standards can be translated into specific siting and construction criteria for nuclear power plants. These standards should but might not minimize random emissions. Therefore, while each approach can generate a set of guidelines for control of nuclear power plant

cal Guidelines for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low As Practicable" for Radioactive Materials in Light-Water-Cooled Nuclear Power Reactors 36-37 (Docket No. RM-50-2) (Feb. 20, 1974) [hereinafter cited as Concluding Statement].

9 M. EISENBUD, *supra* note 5, at 458. Exposure to other artificial sources of radiation such as medical x-rays and industrial processes can vary widely between urban and rural areas. *See* E. HALL, *supra* note 4, at 154, 179.

10 *Id.* at 87-158.

11 *Id.* at 432-56. Radiologists often presume that background radiation is biologically harmless because natural radiation is inescapable and ill-effects are not experimentally discernible. The serious danger of genetic injury, however, suggests that such a presumption only reflects the inadequacies of our biological knowledge. *See* W. PATTERSON, *supra* note 5, at 282. High levels of background radiation do not justify additional burdens, although equalization of unavoidable burdens may mitigate the effects of the compromise.

radiation, working from opposite directions, a combination of both methods should best regulate its hazards. Administrators of radiation controls who have separate jurisdiction over ambient and emission standards should act independently in their initial drafting of regulations, but should cooperate in the promulgation of final standards.

Regulation of radioactive discharges from nuclear power plants was initially within the exclusive province of a single agency. From 1954 to 1970, authority to control both on-site and off-site aspects of nuclear power was vested in the AEC. The statutory grant was broad, giving the agency power to impose such conditions on licensees as it determined to be in the public interest.[12] Through its control of the design, construction, and maintenance of nuclear power plants, the AEC could control the level of radiation both at the plant site and in the environment.

Pursuant to its authority, the AEC set outer limits on permissible radiation in the environment. In 1970, Congress transferred this authority to set "generally applicable environmental standards for the protection of the general environment from radioactive material" to the newly-created Environmental Protection Agency (EPA).[13] Congress thereby modified the AEC's

12 "Each license shall be in such form and contain such terms and conditions as the Commission may, by rule or regulation, prescribe to effectuate the provisions of this chapter." Atomic Energy Act, 42 U.S.C. § 2233 (1970).

13 Reorganization Plan No. 3 of 1970, 3 C.F.R. 1072 (1966-70 comp.), *reprinted in* 5 U.S.C. app. at 609 *and in* 84 Stat. 2086 (1970). "There are hereby transferred to the Administrator (of the EPA): —

> (6) The functions of the Atomic Energy Commission under the Atomic Energy Act of 1954, as amended, administered through its Division of Radiation Protection Standards, to the extent that such functions of the Commission consist of establishing generally applicable environmental standards for the protection of the general environment from radioactive material. As used herein, standards mean limits on radiation exposures or levels, or concentrations or quantities of radioactive material, in the general environment outside the boundaries of locations under the control of persons possessing or using radioactive material.
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> (7) All functions of the Federal Radiation Council (42 U.S.C. 2021(h)).

5 U.S.C. app., § 2(a)(6)-(7). The Federal Radiation Council was established in 1959 by executive order and by an amendment to the Atomic Energy Act of 1954, 42 U.S.C. § 2021(h) (1970). Its function was to advise the President on radiation matters and to give "guidance" to other federal agencies. The FRC generally followed the recommendations of the International Commission on Radiological Protection (ICRP) and the National Council on Radiation Protection (NCRP). These two bodies are private, quasi-official organizations that depend upon volunteer efforts by distinguished scientists. *See* W. PATTERSON, *supra* note 5, at 281.

power to impose conditions on its licensees in that conditions affecting off-site radiation levels and exposure henceforth would have to be consistent with EPA regulations and guidelines. Thus the EPA assumed responsibility for protection of the public from radiation while the AEC retained authority to regulate radiation emission levels at the power plant site. In 1974, Congress split the old AEC into the Nuclear Regulatory Commission (NRC) and the Energy Research and Development Agency (ERDA). The NRC was given almost all of the AEC's remaining regulatory authority and ERDA was given responsibility for the development of nuclear energy.[14]

The action of Congress in dividing jurisdiction over on-site and off-site radiation between the NRC and the EPA[15] may reflect a belief that the agencies should share responsibility for making nuclear reactors as safe as possible. Congress' failure to prohibit states from using their land use powers to govern power plants also implies a role for state planning boards. This section will demonstrate, however, that the EPA and the states have not performed to their potential in protecting the public health and welfare against ionizing radiation. Misunderstandings about judicial doctrines of preemption have weakened enthusiasm for action and have established the NRC as the only credible restraint upon radiation emissions.

A. *The Role of the EPA*

The transfer of authority over ambient off-site radiation levels from the AEC to the EPA was part of a general plan to consolidate environmental control programs of the federal government, to establish the EPA as the overall coordinator of pollution control efforts, and to put ". . . into one agency a variety of research, monitoring, standard-setting, and enforcement activities scattered throughout several departments and agencies."[16] Since the EPA inherited its basic authority

14 Energy Reorganization Act of 1974, Pub. L. No. 93-438, 88 Stat. 1243 (1974).

15 *See* note 13 *supra* and accompanying text.

16 Reorganization Plan No. 3 of 1970, 5 U.S.C. app. at 609.

> Our national government today is not structured to make a coordinated attack on the pollutants which debase the air we breathe, the water we drink, and the land that grows our food. Indeed the present governmental structure for dealing with environmental pollution often defies effective and concerted action. . . .

from the Federal Radiation Council and the AEC,[17] the agency, as a matter of course, inherited the discretion and duties that accompany that authority. The Atomic Energy Act of 1954 required the AEC to set and implement standards for the siting, design, and operation of nuclear power plants as required by the public interest.[18] Such a grant of authority indicates that the EPA, as heir to its duty, should now be playing an important part in carrying out these regulatory tasks.

The EPA also possesses authority under the Clean Air Act,[19] the Federal Water Pollution Control Act (FWPCA),[20] and the Safe Drinking Water Act (SDWA)[21] that should involve it further in the control of both radiation emissions and ambient off-site levels of radiation. The SDWA required the EPA to issue regulations for "contaminants," which have been defined to include radiological materials.[22] The Clean Air Act requires the EPA to regulate pollutants that are determined by the Administrator to be hazardous to public health.[23] Finally, the FWPCA requires that the EPA regulate the discharge of water pollutants from point sources, including the discharge of radioactive materials,[24] establish effluent (emission) standards for toxic pollutants,[25] and approve appropriate water quality (ambient) standards to be established by the states.[26] These statutes

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> Despite its complexity, for pollution control purposes the environment must be presented as a single, interrelated system. Present assignments of departmental responsibilities do not reflect this interrelatedness. . . .
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> In organizational terms, this requires pulling together into one agency a variety of research, monitoring, standard-setting and enforcement activities now scattered through several departments and agencies.
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> As no disjointed array of separate programs can, the EPA would be able — in concert with the States — to set and enforce standards for air and water quality and for individual pollutants. This consolidation of pollution control authorities would help assure that we do not create new environmental problems in the process of controlling existing ones. Industries seeking to minimize the adverse impact of their activities on the environment would be assured of consistent standards covering the full range of waste disposal problems.

Id. at 612.

17 *Id.*

18 42 U.S.C. § 2012(e) (1970).

19 42 U.S.C. § 1857c-7 (Supp. V 1975).

20 33 U.S.C. § 1362 (Supp. V 1975).

21 42 U.S.C. § 300f(6) (Supp. V 1975).

22 42 U.S.C. § 300f-j (Supp. V 1975).

23 42 U.S.C. § 1857c-7 (Supp. V 1975).

24 33 U.S.C. § 1362 (Supp. V 1975).

25 33 U.S.C. § 1317 (Supp. V 1975).

26 33 U.S.C. § 1342 (Supp. V 1975).

impose specific duties on the EPA in that they require it to take positive action on certain pollutants, provide explicit criteria for agency use in regulation, impose time limits for compliance, and provide for citizen suits and judicial review of agency actions. As a result, the laws limit the EPA's discretion even more closely than does the transferred responsibility from the AEC.

Finally, the EPA possesses special statutory authority to review the proposals of nuclear power plant construction and operating license applicants. The National Environmental Policy Act (NEPA)[27] and the Guidelines of the U.S. Council on Environmental Quality[28] provide that the EPA and other agencies with jurisdiction or special expertise review environmental impact statements (EIS), including those prepared by the NRC at the construction and operating permit stages of power plant approval. Also Section 309 of the Clean Air Act requires the EPA to review the actions of other federal agencies, as embodied in their EIS's, from the perspectives of public health and environmental quality and to report any problems to the Council on Environmental Quality.[29] These laws provide adequate authority for EPA review and comment on the siting, design, and future operations of a nuclear power facility.

Thus a number of statutes appear to direct the EPA to develop strict standards for ambient radiation levels in the environment and to review nuclear power plant siting, construction, and operation. But the record of past EPA actions indicates that it has yet to pursue its legislative mandate vigorously. First, the EPA has abdicated its responsibility for strict protective ambient radiation standards to the NRC. The NRC has taken the lead in formulating emission control requirements for nuclear power plant licensees according to its ALARA cost-benefit test.[30] These requirements have seldom been applied to siting review and may result in an ambient

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27 42 U.S.C. §§ 4321-4335 (1970). Section 4322(2)(C) requires that the agency preparing an Environmental Impact Statement (EIS) "shall consult with and obtain the comments of any Federal Agency which has jurisdiction by law or special expertise with respect to any environmental impact involved."

28 38 Fed. Reg. 20,550 (1973) (Guidelines on Environmental Impact Statements from the U.S. Council on Environmental Quality).

29 42 U.S.C. § 1857h-7 (1970).

30 *See* notes 86-92 *infra* and accompanying text.

concentration of radioactive isotopes that poses serious genetic and ecological risks.[31] Yet the response of the EPA has not challenged the NRC in any significant way.[32] The EPA has introduced a "dose commitment" concept[33] and has issued general guidelines for the regulation of the uranium fuel cycle,[34]

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31 *See* text accompanying notes 56-57 *infra.*

32 Responsibility for this misallocation of regulatory functions rests, to some extent, with the Office of Management and Budget and with President Nixon. A memorandum from OMB Director Roy L. Ash to the EPA Administrator, Russell Train, of December 7, 1973, contains a preemptory directive that the EPA accepted:

> [T]his memorandum is to advise you that the decision is that AEC should proceed with its plans for issuing uranium fuel cycle standards, taking into account the comments received from all sources, including EPA; that EPA should discontinue its preparations for issuing, now or in the future, any standards for types of facilities; and that EPA should continue, under its current authority, to have responsibility for setting standards for the total amount of radiation in the general environment from all facilities combined in the uranium fuel cycle, i.e. an ambient standard which would have to reflect AEC's findings as to the practicability of emission controls. . . .

EPA was thereby ordered to limit its activities to the setting of general environmental standards and to set such standards in conformance with AEC decisions about the economic and technical feasibility of available source control measures.

33 The "radiation dose commitment" concept

> . . . is the sum of all doses to individuals over the entire time period the (radioactive) material persists in the environment in a state available for interaction with humans. The unit of measure for this total population dose is the person-rems delivered in each of the years following release to the environment until the material has been reduced to innocuous levels by either radioactive decay or removal from the biosphere by other means.

The concept is an important one, but it has yet to be accepted or even publicly acknowledged by source control authorities. As the EPA has noted:

> Since control must be instituted long before the impacts associated with these releases occur, projection of anticipated potential health effects which could result from the release of these radio-nuclides constitutes a necessary basis for decisions concerning the need for institution of control over their release. Future decisions ought to consider these dose commitments with respect to both the types of development that should occur and the choice of controls that should be imposed.

U.S. OFFICE OF RADIATION PROGRAMS, ENVT'L PROTECTION AGENCY, ENVIRONMENTAL RADIATION DOSE COMMITMENT: AN APPLICATION TO THE NUCLEAR POWER INDUSTRY 3, 5 (Feb. 1974).

34 Radiation Protection for Nuclear Power Operations, 42 Fed. Reg. 2,858 (1977) (to be codified in 40 C.F.R. § 190). Public response has varied on the proposed standards. *See, e.g.,* Statement of Roger Mattson, Director of the Division of Siting, Health, and Safeguards Standards, U.S. Nuclear Regulatory Commission (March 8, 1976); Comments of the Natural Resources Defense Council (Sept. 15, 1975).

This sluggish regulatory posture is a sharp contrast to the EPA's regulation of other toxic and hazardous pollutants under the Clear Air Act, 42 U.S.C. § 1857 (1970), and the Federal Water Pollution Control Act Amendments of 1972, 33 U.S.C. § 1251-1376 (Supp. V 1975), which provide explicit pollution control objectives, means for achieving those objectives, and enforcement responsibilities. These laws also provide the criteria to be used in EPA decisions on permissible discharge levels of air and water pollutants. Most significantly, limitations on the level of pollutants are required to be established

but its actual ambient outer boundary limits are far in excess of radiation levels associated with presently-operating nuclear facilities.[35] Thus the EPA has granted the NRC almost complete discretion to adjust emission controls and ambient levels of radiation within the range of probable somatic and genetic harms from low-level radiation.[36]

Second, the EPA has evaded its responsibilities for nuclear power plant siting review. Its regulations state that "sound siting practices will continue to be promoted as in the past and that facility planners will utilize remote sites with low population densities to the maximum extent feasible."[37] But reliance on past practice seems unjustified. Local zoning and planning authorities still have primary siting power in most states, and their consideration of exposure and ambient off-site radiation levels has been noticeably deficient.[38] Furthermore, although the NRC siting guidelines do translate emergency dose limits into site criteria, they have not prevented power plant siting in areas of high population density.[39] This problem has been magnified, moreover, by the NRC's failure to observe its own siting guidelines.[40]

At present, the public can rely only on the courts to ensure that the siting of nuclear facilities is appropriately conducted in the public interest. However, this path through the courts is fraught with difficulties. Litigation in this area is costly and technically complex,[41] and a variety of procedural restrictions militate against extensive judicial review of agency decisions.[42]

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with maximum prevention of environmental and health effects rather than with a balancing of harm against economic cost and technical feasibility. 33 U.S.C. § 1317 (1970); 42 U.S.C. § 1857c-7 (1970).

35 *See* 42 Fed. Reg. 2858 (Jan. 13, 1977).

36 *See* note 8 *supra* and accompanying text.

37 40 Fed. Reg. 23,420 (1975) (proposed regulations).

38 *See* state enabling acts for New York, Maine, and Massachusetts *cited in* Baram, *State Energy Legislation and the Siting of Facilities,* in THE NORTHEASTERN STATES CONFRONT THE ENERGY CRISIS, CONFERENCE PROCEEDINGS (1975).

39 10 C.F.R. § 100 (1976).

40 *See* Porter County Chapter of the Isaac Walton League of America v. AEC, 515 F.2d 513 (7th Cir.), *rev'd,* 423 U.S. 12 (1975). However, NRC siting criteria have forced applicants to abandon several proposed sites.

41 The Supreme Court has ruled that attorney's fees ordinarily cannot be recovered by a prevailing party (e.g., a public interest group) from a losing party (e.g., a federal or state agency involved in siting decisions). Alyeska Pipeline Service Co. v. Wilderness Society, 421 U.S. 240 (1975). This ruling makes such public interest initiatives more difficult to mount.

42 It has been held, for example, that those groups who refrain from participation

The retreat of the EPA from a role in facility-specific regulation to the promulgation of general guidelines once again has weakened the protection of the public health and the environment.

Finally, the EPA has failed to impose any controls upon certain long-lived radioactive materials such as krypton-85 and tritium. The EPA has previously acknowledged that:

> no methods are available to effectively remove such materials from the environment once they have been released, and once released thus imply irreversible commitments for exposure of future generations, except for natural occlusion in environmental sinks . . . it (is) especially important to consider the consequences of irreversible commitment of these discharges to the environment before they have occurred . . . Since control must be instituted long before the impacts associated with these releases occur, projection of anticipated health effects which could result from a release of these radionuclides constitutes a necessary basis for decisions concerning the need for institution of control over their release. Future decisions ought to consider these dose commitments with respect to both the types of development that should occur and the choice of controls that should be imposed . . .[43]

Yet, despite this dire language and the exhortations for action "now" in its earlier assessment, the EPA neglected to impose controls on such releases in its proposed standards. For example, controls on krypton-85 and iodine-129 have been deferred to January 1, 1983, when successful demonstration of control technology may be accomplished; controls on the release of tritium and carbon-14 have been deferred even more vaguely to some future time when knowledge of control measures and their cost have increased.[44] In this way, the EPA is exercising its broad discretionary authority to subordinate its responsibility

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in rulemaking proceedings may not obtain direct judicial review of the regulations promulgated. Gage v. AEC, 479 F.2d 1214 (D.C. Cir. 1973). Such a ruling precludes many public interest groups from making court challenges to siting decisions, since such groups generally mobilize *after* a particular site has been chosen and evaluated.

43 U.S. OFFICE OF RADIATION PROGRAMS, ENVT'L PROTECTION AGENCY, ENVIRONMENTAL RADIATION DOSE COMMITMENT: AN APPLICATION TO THE NUCLEAR POWER INDUSTRY 1-3 (Feb. 1974).

44 "Tritium levels . . . are not expected to become significant until the late 1980's, and development programs are in existence for control. . . . The Agency believes that the development and installation of control . . . are important objectives, and will carefully follow the development of new knowledge concerning the impact and controllability of these radionucleides." 40 Fed. Reg. 23,422-23 (1975).

for protection of human health and the environment to the unrestrained development of nuclear power.

The EPA's reluctance to fulfill its obligations under the Reorganization Plan, NEPA, FWPCA, SWDA, and the Clean Air Act may reflect an overly liberal interpretation of administrative preemption doctrine. In *Train v. Colorado Public Interest Research Group,*[45] the Supreme Court held that the FWPCA's legislative history reflects a congressional intent not to alter the NRC's exclusive authority to control emissions of source, by-product, and special nuclear materials into the nation's waters.[46] The decision limited the application of industrial permits under FWPCA to the release of minor radioactive materials not covered by the Atomic Energy Act, such as radium and particle accelerator wastes.[47]

The *Colorado PIRG* decision does preempt one particular regulatory route that would have overlapped the NRC's powers. But the EPA should not be allowed to shirk other statutory responsibilities through unwarranted extension of the scope of the decision. Restrictions on the authority of the EPA to promulgate effluent standards and issue discharge permits do not affect its power to develop and implement ambient water quality standards for radioactive isotopes in the nation's waters.[48]

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45 426 U.S. 1 (1976). This was a citizen's suit brought to force the EPA Administrator to perform a "non-discretionary" duty to control radioactive effluents from nuclear power plants. Both plaintiff and defendant agreed that the sole issue was a question of law about the meaning of the Federal Water Pollution Control Act, as amended, 33 U.S.C. §§ 1251-1376 (Supp. V 1975).

The statute lists "radioactive materials" among the pollutants to be regulated by the Administrator without qualifying or restricting their scope. 33 U.S.C. § 1362(6). The EPA's position, as exemplified in its regulation (40 C.F.R. § 125(x) (1976)), was that the legislative history of the FWPCA indicated that Congress intended to exempt radioactive materials that were subject to regulation under the Atomic Energy Act of 1954 from the permit program of the FWPCA. The plaintiff's position, with which the Tenth Circuit Court agreed, was that the FWPCA meant what it said. If Congress had intended to make an exemption for radioactivity, it would have done so explicitly. Colorado Public Interest Research Group v. Train, 507 F.2d 743 (10th Cir. 1974), *rev'd,* 426 U.S. 1 (1976).

46 426 U.S. at 24.

47 426 U.S. at 8, 23.

48 *See* 33 U.S.C. §§ 1252(a)-(c), 1313 (Supp. V 1975). The *Colorado PIRG* analysis of the legislative history of the 1972 Amendment sought to test the applicability of the FWPCA's permit program (with effluent standards) to AEC-regulated nuclear power plants. 426 U.S. 1, 10-11. Moreover, the decision created a major exception to the otherwise all-inclusive scheme for water pollution control in the FWPCA. The scheme requires the EPA to regulate electric generating facilities as point sources, 33 U.S.C. §

Furthermore, the Safe Drinking Water Act of 1974 provides independent authority for EPA control over radioactive isotopes in drinking water.[49] Third, the Court's reliance on the specific legislative history of the FWPCA in *Colorado PIRG* would limit any application of its analysis to the EPA's obligations under NEPA and the Clean Air Act. If such extensions could be made, moreover, they would not affect the EPA's power to set ambient standards for radiation exposure.[50] Finally, the Reorganization Plan gave the EPA powers to set and enforce ambient standards that once belonged to the AEC.[51] Therefore EPA ambient radiation standards would not diminish the NRC's authority under the Atomic Energy Act.[52]

The EPA's power to set ambient radiation standards and review environmental decisions could be used to fill a critical void in the present unclear regulatory process. First, EPA ambient standards could provide a countervailing influence on NRC discretion in the formulation of effluent standards for individual power plants. The EPA could set a strict floor for public protection under which the NRC could not go with its ALARA requirements.[53] In pursuing this strategy, the EPA may have to test its authority to enforce ambient standards against the NRC in the federal courts.[54] Second, EPA development of ambient standards could increase the effectiveness of

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1316 (Supp. V 1975), "radioactive material" effluents, § 1362, other wastewater discharges of a polluting nature (such as hot water or anti-corrosion chemicals) from a nuclear power plant, § 1362(6), and toxic materials, § 1317. The EPA should be permitted to retain control over ambient radiation water quality standards to maintain the integrity of the FWPCA.

49 42 U.S.C. §§ 300f(6), 300g-1, 300g-2, 300g-3 (Supp. V 1975). "Section 1401 defines 'contaminant' to mean 'any physical, chemical, biological, or radiological substance or matter in water.' This, of course, would include any radioactive materials whether or not they originated from any source under the jurisdiction of the AEC." H.R. REP. No. 93-1185, 93d Cong., 2d Sess. 16 (1974), *reprinted in* [1974] U.S. CODE CONG. & AD. NEWS 6454, 6469.

50 *See* note 48 *supra.*

51 *See* note 13 *supra.*

52 The Court in *Colorado PIRG* appeared to be concerned that the EPA not be permitted to duplicate a specific area of AEC authority and thus produce ". . . a significant alteration in the pervasive regulatory scheme embodied in the AEA." 426 U.S. at 24.

53 *See* OFFICE OF GENERAL COUNSEL, U.S. ENVT'L PROTECTION AGENCY, A COLLECTION OF LEGAL OPINIONS 581 (1975).

54 But the explicit grant of authority to the EPA under the Reorganization Plan No. 3 of 1970 for the development of ambient standards should provide strong support for this claim. *See* note 13 *supra.*

NRC discharge regulations. Present NRC requirements do not consider adequately the impact of external factors on off-site radiation levels.[55] The EPA and the NRC could pool their knowledge and form interagency panels to translate discharge limits into ambient exposure and to investigate the emission requirements necessary to attain national health goals. Such cooperation would promote more thorough understanding of environmental capacity to absorb low-level radiation without ecological disruption. Third, the EPA could use its siting review power to add radiation emission criteria to siting decisions. Neither the EPA nor the states have translated radiation standards into enforceable siting regulations for nuclear power facilities. The NRC also excludes discharges from its siting analysis.[56] But the considerable variation in background radioactivity and dispersion patterns for discharges among potential sites merit special attention in siting. The legislative mandate of NEPA should compel the EPA to undertake radiation surveys and evaluations in site review for greater protection of health and the environment.[57]

In spite of some restrictions from administrative preemption, the EPA has the power to improve control of radioactive emissions by investigating and setting standards for radiation between discharge and human exposure. Its analyses could assist in the preparation of more sophisticated effluent standards and siting criteria. But the hesitance of the agency to perform these tasks must be overcome. Federal legislation requiring the EPA to carry out its functions within a specified time period may be necessary to prod the agency into action.[58]

B. *The Role of the States*

State and local regulatory bodies have two major sources of authority that could be exercised to enhance public protection

55 Variations in background radiation can arise from natural conditions, such as geography, and artificial circumstances, such as degree of exposure to medical x-rays and population density. *See* note 9 *supra*.

56 *See* text accompanying notes 109-115 *supra*.

57 *See* text accompanying notes 27-29 *supra*.

58 Legislation of this type has been enacted under the general provisions of the air and water pollution control acts for other types of pollution. *See, e.g.*, the time limits for EPA issuance of water quality criteria in the FWPCA, 33 U.S.C. § 1314 (Supp. V 1975).

from the hazards of ionizing radiation. The first form of regulatory power derives from the requirements of federal legislation. The states act concurrently with the EPA in carrying out the requirements of the Clean Air Act, the FWPCA, and the Safe Drinking Water Act. Each of these laws requires EPA approval of state implementation plans, review of subsequent state performance, and EPA action upon state default.[59] The provisions of these laws establish the responsibility of the states for monitoring and regulating ambient concentrations of radioactive isotopes in the environment.

The general police power of the states provides the other basis for state determination of acceptable ambient levels of radiation in the off-site environment. Its traditional concern for the protection of public health, safety, and welfare supports extensive supervision of industrial activities.[60] In addition, police power confers jurisdiction over land use.[61] As a result, state and local governments have primary responsibility for power plant siting. Because siting influences radiation concentrations,[62] states could use site review to govern nuclear power plant discharges indirectly.

At least two obstacles have discouraged the states from par-

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59 42 U.S.C. § 1857c-5 (1970); 33 U.S.C. §§ 1311-1345 (Supp. V 1975); 42 U.S.C. § 300g-2 (Supp. V 1975). Under the Clean Air Act, the states were to adopt plans to enforce the EPA's national primary and secondary air standards, subject to the Administrator's approval. The EPA has had to take over enforcement of several state plans that were inadequate. Under the FWPCA, the states are to set water quality standards and implement them, subject of the Administrator's approval. The relationship between the state and the EPA is complex here. The states may set stringent standards and thereby impose a greater burden upon individual polluters than the EPA national effluent limitations would require. The deadline for achievement of the EPA standards is 1977. The SDWA provides that the states are to have primary enforcement responsibility under the Act. The states must adopt regulations at least as stringent as the EPA's national primary and secondary water quality standards, and must also provide for enforcement that meets with the Administrator's approval. *See* Interim Primary Drinking Water Regulations: Notice of Proposed Maximum Contaminant Levels for Radioactivity, 40 C.F.R. § 141 (1976).

60 U.S. Const. amend. X. The expansive view of the police power was articulated by Justice Douglas in Berman v. Parker, 348 U.S. 26 (1954): "Public safety, public health, morality, peace and quiet, law and order . . . merely illustrate the scope of the power and do not delimit it." 348 U.S. at 32. *See generally* E. FREUND, THE POLICE POWER, PUBLIC POLICY, AND CONSTITUTIONAL RIGHTS (1904).

61 *See* Baram, *Environmental Law and Construction Project Management,* 6 PUB. CONT. L. J. 210 (1974). *See generally* M. BARAM, ENVIRONMENTAL LAW AND THE SITING OF FACILITIES: ISSUES IN LAND USE AND COASTAL ZONE MANAGEMENT (1976).

62 *See* text accompanying notes 9-11 *supra.*

ticipating actively in the control of radionuclides. First, federal preemption doctrine may inhibit state regulatory activity. Ruling on the specific issue of radioactive wastewater effluent standards under FWPCA, the Supreme Court in *Northern States Power Co. v. Minnesota*[63] denied the states an independent role that would interfere with the AEC's power to set emission standards. The Court stated that the regulation of such discharges is a federal responsibility as a result of federal preemption established by the Atomic Energy Act of 1954 and the subsequent scheme of federal legislation and regulation.[64] But the Court's reasoning should not stop states from setting ambient standards for radiation. This action would not duplicate the NRC's authority to promulgate effluent limits.[65] Furthermore, it would be consistent with the requirements of other federal laws and the traditional state powers.[66] The *Northern States* decision should also have no effect upon nuclear power plant site review. The Atomic Energy Act does not permit the NRC to override local zoning and other site restrictions. The agency can do no more than disapprove sites proposed by an applicant.[67]

The second impediment to additional state control is the crudeness of state research. State agencies often lack money and personnel to investigate possible sites and carry out techni-

63 405 U.S. 1035 (1972), *aff'g* 447 F.2d 1143 (8th Cir. 1971).

64 *Id.* at 1154.

65 In the *Northern States* case, the State of Minnesota attempted to regulate the discharge of radioactive effluents from a power plant, using standards that were considerably more stringent than those of the AEC. The Eighth Circuit held that preemption of such regulation was implicit in the Atomic Energy Act of 1954, and the Supreme Court approved the holding without comment. 447 F.2d 1143 (8th Cir. 1971), *aff'd,* 405 U.S. 1035 (1972).

Minnesota attempted to regulate discharges at the source, not radiation levels in the ambient environment. The Eighth Circuit's reasoning dealt with the congressional intent to preempt AEC control over nuclear power plant effluents. The Atomic Energy Act itself forbade such an action on the part of a state agency. 42 U.S.C. § 2021(c)(1); 447 F.2d at 1149 n.6. This decision and a broad reading of Section 274 of the Atomic Energy Act of 1954 have led some industry commentators to sweeping conclusions about the scope of federal preemption. *See, e.g.,* A. MURPHY & B. LAPIERRE, NUCLEAR MORATORIUM LEGISLATION IN THE STATES AND THE SUPREMACY CLAUSE: A CASE OF EXPRESS PREEMPTION (Atomic Industrial Forum, 1975). However, these judgments deny the historic persistence of the state police power in its modern forms (e.g., shellfish regulation, zoning law) that can be used to control various aspects of nuclear power generation. Control over ambient levels of radiation would appear to remain with the states. *See* note 45 *supra.*

66 *See* text accompanying notes 59-62 *supra.*

67 42 U.S.C. §§ 2131-2133 (1970).

cal studies for standards. They become dependent on federal agencies, especially the NRC, for information and prepackaged regulations.[68] This problem should ease as more states recognize the need for stronger regulation. State legislatures could appropriate revenue sharing funds for this purpose.[69]

In spite of these barriers, state agencies have become more involved in the regulation of radioactive emissions. State and local authorities have established various criteria and standards for off-site exposure to radiation.[70] And several states have also developed radiation standards for ambient water quality as part of their effort to achieve water quality objectives of the FWPCA.[71] Finally, many states supplement zoning and subdivision controls with special boards and procedures to govern the siting of power plants and transmission lines.[72]

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68 On the issue of state resources, a World Health Organization survey noted:

> While 47 . . . states have adopted legislation . . . control . . . ionizing radiations, there are major divergences in the implementing regulations . . . . Only 50 percent have adopted most of the provisions of the model regulations (suggested by the Council of State Governments, and drawn up with the collaboration of the AEC and the PHS. . . . eleven states have no regulations for the control of radioactive materials not subject to the Atomic Energy Act of 1954 . . . The following are reported to be major inadequacies . . . (1) lack of regulations or failure to update regulations . . . (2) insufficient funds and personnel . . . (4) lack of uniformity in the control of health hazards from the use of radium and accelerator-produced radionuclides including safety standards, inspection requirements, regulations and enforcement.

See U.N. WORLD HEALTH ORGANIZATION, PROTECTION AGAINST IONIZING RADIATION: A SURVEY OF CURRENT WORLD LEGISLATION 277-83 (1972) [hereinafter cited as SURVEY OF CURRENT WORLD LEGISLATION]. As for state dependence on the NRC, "Suggested Regulations for Control of Radiation" (SSRCR) have been promulgated and updated periodically following an original initiative by the Council of State Governments, the AEC, the U.S. Public Health Service and other federal agencies. The lead role has been played by the AEC because the SSRCR deals with power plant radiation, and the latest SSRCR, published in 1974, also involved inputs from the Food and Drug Administration and the Conference of Radiation Control Program Directors representing state agencies. Health, Education and Welfare: Suggested State Regulations for Control of Radiation, 40 Fed. Reg. 29,749 (1975). EPA was notably absent from this most recent SSRCR effort, further indicating EPA reluctance to assume important responsibilities for the control of radiation.

69 Environmental protection currently makes up about six to ten percent of shared-revenue allocations among the states. R. NATHAN & C. ADAMS, REVENUE SHARING: THE SECOND ROUND 68 (1977).

70 *See* SURVEY OF CURRENT WORLD LEGISLATION, *supra* note 70, at 277-83.

71 *See* U.S. ENVT'L PROTECTION AGENCY, WATER QUALITY STANDARDS CRITERIA DIGEST: A COMPILATION OF FEDERAL/STATE CRITERIA ON RADIATION (1972).

72 The NRC has no express authority to acquire power plant sites for utilities, nor does it have authority to change or override state and local laws governing land use; the NRC is limited to considering the suitability of those plant sites proposed by applicants for plant construction licenses. Applicants must therefore acquire title or lease to sites,

Future initiatives may be even more extensive. As more states adopt coherent land use and coastal zone management programs and empower sophisticated state or regional siting boards, they will have the opportunity to restrict or confine new sources of radiation hazards before power plant construction begins.[73] Whatever the EPA or the NRC may decide to do, this growing state involvement will have a substantial impact upon the regulation of ionizing radiation.

The federal government should encourage active state participation in the protection of the public from the hazards of radiation. One step in this direction would be a more accommodating preemption doctrine. The federal courts may be tempted to apply more severe restrictions on state activity as national energy policy matures.[74] Congress should remove this economic and political question from the purview of the courts by explicitly consenting to certain types of state regulation.[75] The congressional Office of Technology Assessment (OTA), a disinterested and capable body, could provide advice.[76] If Congress refuses to assume a more sympathetic attitude toward state regulation, it may do more than simply increase the risk to public health from radiation. The future of nuclear power itself

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and conform to use restrictions under prevailing state and local laws, in addition to securing NRC approval under NRC regulations and guidelines which have been promulgated to insure public safety.

73 *See* Baram, *supra* note 38.

74 The history of state regulation of airport noise may be a helpful analogue to the potential development of state regulation of onsite and offsite radiation. Under their police powers, a variety of states and municipalities have sought to control aircraft noise by enacting local laws to regulate flight paths, schedules, and off-site noise levels. Federal court decisions, in the absence of congressional resolution of the preemption problem, have consistently extended the scope of federal preemption for regulation of civilian aircraft activities at the expense of state and local authority. *See, e.g.*, City of Burbank v. Lockheed Air Terminal, 411 U.S. 624 (1973). If a similar trend develops for nuclear power, efforts by the states to control radiation, either through site review or regulation of ambient off-site radiation levels, would be invalid whenever such control obstructs or interferes with NRC regulation of its licensees.

75 *See* H.R. 441, 94th Cong., 1st Sess. (1975), a bill introduced by Congressman Hamilton Fish (R.-N.Y.) that would allow the states to regulate the emission of radioactive effluents concurrently with the NRC. Section 3 of the Act provided that

> ... it is the intent of this Act to establish the concurrent authority of the several States to regulate such radioactive emissions, including the authority to enforce standards for such radioactive emissions, which permit lesser quantities of such emissions from such facilities than do the standards established by the Commission.

76 2 U.S.C. § 475 (1970).

depends on state acceptance, local values, and the availability of plant sites.[77]

II. Choosing a Decision Rule for Power Plant Radiation

Judicial review of administrative agency actions often involves examination of the procedure the agency follows to make its decisions.[78] If the procedure seems irrational or ignores some elements of a problem that Congress wanted the agency to consider, the court may overrule the agency and force it to reevaluate its conclusions through a better procedure.[79] Sometimes an agency that possesses substantial discretion can avoid exacting judicial scrutiny by instituting a decision rule that appears to incorporate agency expertise and scientific detachment.[80] Thus the AEC, whose instructions from Congress on safety were vague, adopted a pre-regulatory cost-benefit balancing test to choose radiation emission standards that were "as low as reasonably achievable" (ALARA).[81]

Cost-benefit analysis is a technique widely used by administrators in the public and private sectors for choosing among alternative actions.[82] It involves a comparison of the sum of the expected gains or benefits to be derived from a proposed project or action with the sum of the expected losses or costs which should accrue from the project or action. Usually the only benefits or costs that can be included in this form of analysis are those that can be quantified and expressed in monetary

77 For judicial recognition of the role that local values and laws should play in federal agency decisions under NEPA, *see* Maryland-National Capitol Park and Planning Commission v. U.S. Postal Service, 487 F.2d 1029, 1036-37 (D.C. Cir. 1973).

78 *See* Stewart, *The Reformulation of American Administrative Law,* 88 Harv. L. Rev. 1667, 1674-75 (1975).

79 *Id.* at 1673-74.

80 Such a test appears to promote well-reasoned administrative action and judges are likely to accept it if only because they do not feel competent to review its results. *See* K. Davis, Administrative Law of the Seventies 666-68 (1976). *But see* Ethyl Corp. v. EPA, 541 F.2d 1, 66-68 (D.C. Cir.), *cert. denied,* 426 U.S. 941 (1976); Environmental Defense Fund v. Tennessee Valley Authority, 371 F. Supp. 1004, 1014 (E.D. Wis.) *aff'd,* 492 F.2d 466 (6th Cir. 1974); International Harvester Co. v. Ruckelshaus, 417 F.2d 615, 648 (D.C. Cir. 1973). *See also* Stewart, *supra* note 78, at 1702-11.

81 *See* definition of ALARA in text accompanying note 92 *infra.*

82 *See generally* R. Musgrave & P. Musgrave, Public Finance in Theory & Practice 134-84 (1973). It is important to note that even where there is only one proposal under consideration, there are two alternative actions: to undertake the project or to do nothing. This yes-no character of pure cost-benefit analysis creates difficulties when a number of alternatives are available.

terms.[83] If the resulting sum of the benefits equals or exceeds the sum of the costs, the project or action is "justified" and can be undertaken. In choosing among alternatives, the analyst prefers the project or action with the largest benefit-to-cost ratio.[84]

A cost-benefit calculation requires a series of analytical steps. Each expected cost and benefit must be identified and its magnitude determined. A monetary value must then be assigned to each cost and benefit. These values can only be expected values because they reflect a range of possible magnitudes reduced by the individual probabilities of their occurrence. Each expected value must then be discounted to reflect its present value.[85] Finally, all costs and benefits must be summed; the ratio of these sums is the benefit-to-cost ratio.

Cost-benefit analysis can be a useful tool for raising the quality of administrative decisions. It can force government officials to review all of the possible consequences of proposed actions and to make some estimates, however rough, of their size and probability. It provides a means for holding bureaucrats accountable for their actions.

But allowing cost-benefit analysis to determine how strictly risks from nuclear power plant operation will be managed is a dangerous and unwarranted extension of its proper role. Cost-benefit analysts of optional projects can be reasonably certain about capturing the full costs and benefits, even if the appropriate valuation of these costs and benefits may be arbitrary.[86] As this section will demonstrate, however, uncertainty

83 *See* L. MEREWITZ & S. SOSNICK, THE BUDGET'S NEW CLOTHES 269-70 (1971).

84 Elementary economic theory teaches that at the point where total benefits will most exceed total costs, the marginal benefits and marginal costs are equal. This can be called a "balance point."

85 The concept of present value is based on the fact that the value of a dollar to be received or paid out in the future is less than the value of a dollar to be received or paid out at present. Since the benefits and costs from a project accrue over time, their values must be reduced ("discounted") to reflect the present value. A cost or benefit is then determined by multiplying the expected value of the benefit or cost by a discount rate which reflects a time rate of preference for money and the time at which the cost or benefit is expected to accrue.

86 Some of the reasons for the relative ease of cost-benefit analysis in development projects are the more certain policy costs when enforcement of a law is not central to the government action, the greater likelihood that a project will be contained within a single assessable region, and the more tangible benefits of a project. For a discussion of the special problems of cost-benefit analysis in pollution control, *see* Peskin & Seskin, *Introduction and Overview*, in COST-BENEFIT ANALYSIS & WATER POLLUTION POLICY 1-33 (H. Peskin & E. Seskin eds. 1976).

about costs, benefits, and the validity of the analyses themselves render present NRC judgments about acceptable levels of radiation unsound. Replacement of variable cost-beneficial guidelines with strict emission standards implemented through cost-effective techniques could better protect the interest of all affected groups.

A. *The ALARA Concept — Administrative Shortcomings*

The Nuclear Regulatory Commission inherited a cost-benefit test for power plant radiation embodied in the general principle that radiation exposure should be kept "as low as is reasonably achievable." In 1970 the AEC ruled that "radiation exposures and releases of radioactive materials [be set] . . . as far below the limits specified . . . as practicable."[87] This statement is the conceptual source for significant features of subsequent AEC regulation of its licensees, particularly the AEC's *Appendix I*.[88] *Appendix I* provides "numerical guides for design objectives and limiting conditions for operation to meet the criterion 'as low as is reasonably achievable' for radioactive material in light-water-cooled nuclear power reactor effluents."[89] *Appendix I* does not provide mandatory numerical standards or criteria, but merely serves to give license applicants "qualitative guidance" as to one acceptable method of establishing compliance with the "as low as is reasonably achievable" requirement. An applicant is free to persuade the NRC that some alternative method provides for a level of radiation exposure and release of radioactive materials "as low as is reasonably achievable."[90] As a practical matter, the high cost of such per-

87 35 Fed. Reg. 18,587-88 (1970). The term "as low as practicable" was replaced by "as low as is reasonably achievable" on July 2, 1975. 40 Fed. Reg. 33,029 (1975). The NRC stated that this was not a substantive change, but was only intended to clarify the purposes of the dose limitation.

88 36 Fed. Reg. 11,113 (1971) (Proposed Appendix I). Public hearing commenced January 20, 1972. The Nuclear Regulatory Commission issued its opinion and final version of the regulations on April 30, 1975. 40 Fed. Reg. 33,029 (1975).

89 U.S. Nuclear Regulatory Comm'n, Rulemaking Hearings on Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low as Practicable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents, Docket No. RM-50-2 (April 30, 1975) [hereinafter referred to as NRC Opinion]. The Concluding Statement of Position of the Regulatory Staff from these rulemaking hearings is reprinted in 10 C.F.R. § 50, app. I, at 312.

90 It should be emphasized that the Appendix I guides as here adopted by the Commission are not radiation protection standards. The numerical guides of

suasion and the low probability of success make it an unrealistic option for most applicants.[91]

The NRC's cost-benefit criteria contemplate wide-ranging and recurring tests for suitable regulation of power plant design and operation. Initially, the formal definition of the ALARA concept states a number of factors that must be considered in the cost-benefit analysis:

> as low as is reasonably achievable taking into account the state of technology, and the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to the utilization of atomic energy in the public interest.[92]

The ALARA principle also appears to require that the NRC's tests should be employed to decrease allowable discharges as it becomes economically feasible to do so. Finally, the lower levels of discharge must be "reasonably achievable" or "practicable."

The ALARA concept and its cost-benefit analysis would seem to offer an attractive form of regulation because it considers the potential consequences of an action before adopting it. By employing a "rational" method of evaluation, the agency can exercise the discretion of a legislature in choosing whether to impose a design or operation requirement that produces a certain level of radiation discharge. Moreover, each incremental reduction in emissions requires its own cost-benefit analysis, so that a process of iteration can reach an optimal level of

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> Appendix I which we announce today are a quantitative expression of the meaning of the requirement that radioactive material in effluents released to unrestricted areas from light-water-cooled nuclear power reactors be kept "as low as practicable."

NRC Opinion, *supra* note 88, at 2.

91 Various Regulatory Guides based on *Appendix I* are now being issued to govern power plant siting, design, and performance, making the mandatory effect of *Appendix I* an even stronger force. *See, e.g.*, U.S. Nuclear Regulatory Comm'n, Regulatory Guides 1.109, 1.110 & 1.111 (March 1976).

Since *Appendix I* was adopted by the NRC only as "qualitative guidance" to license applicants, the question of agency accountability under it immediately arises. Judicial reviews of such a "quasi-rule" may not be rigorous, particularly where the guidance expressly allows alternative standards to be presented by applicants. The NRC thus may be less accountable in its rulemaking under *Appendix I* than in the promulgation of more conventional rules and standards. The agency has thereby reserved itself substantial discretion of numerical limitations for implementing ALARA and remains bound only to the 500 millirem total individual exposure limit the AEC adopted in 1960.

92 10 C.F.R. § 50.34a (1976).

emissions. We might hope that Congress would act the same way if it had the time and expertise to make such detailed determinations.

Unfortunately, the cost-benefit approach of ALARA cannot be adapted well to the ordinary operations of an administrative agency. In a number of ways, the NRC and its predecessor AEC have vitiated the strength of the ALARA principle by faulty analysis and insufficient modification of enforcement efforts to fit the conclusions of cost-benefit studies. These deficiencies have consistently weakened the protection of the public from radioactive power plant emissions. The endemic character of these failings will suggest that pre-regulatory cost-benefit analysis is not a useful substitute for legislative judgments on acceptable radiation standards.

One continuing problem has been the adverse effect of inadequate information on the quality of the cost-benefit calculation. In the period before the adoption of the ALARA concept, the AEC licensing process suffered from a lack of sufficient information about the long-term health effects of ionizing radiation. Consequently, the AEC had no "rational" (cost-benefit) basis for radiation exposure limits. It made what it thought to be conservative assumptions. Disputes between the AEC staff and a utility over the degree of radiation control to be imposed were resolved through negotiation. Negotiation resulted in the imposition of arbitrary numerical values.

Court challenges to AEC standard-setting under the previous arbitrary system[93] led to the adoption of the ALARA concept in 1970.[94] The proposed *Appendix I* was designed to impose cost-beneficial interim conditions on nuclear power plant licensees.[95] Yet the AEC's "Staff System" test lacked a primary element of cost-benefit analysis in that it had no dollar values for health damage from exposure of the total population to radiation.[96] From 1970 to 1974, the AEC set discharge limits for maximum individual exposure and varied them on a case-by-

93 *See, e.g.*, Crowther v. Seaborg, 312 F. Supp. 1205 (D. Colo. 1970) (challenging 10 C.F.R. § 20); Calvert Cliffs Coordinating Committee v. AEC, 449 F.2d 1109 (D.C. Cir. 1971) (challenging AEC noncompliance with NEPA requirements).

94 35 Fed. Reg. 18,385 (1970).

95 NRC Opinion, *supra* note 88, at 2-4.

96 *See* Concluding Statement, *supra* note 8, at 41-43.

case basis for individual plants.[97] This procedure ignored the cost of genetic damage from increases in low-level radiation above long-term background rates.[98] Control measures that could have benefitted the populace as a whole but not the most exposed individual were not implemented.

As part of its formal approval of the *Appendix I* procedure,[99] the NRC modified the "Staff System" in an attempt to cure its defects. It adopted an interim dollar value of $1,000 per man-rem[100] of societal exposure for use in cost-benefit analyses.[101] In addition, the NRC retained limits on individual exposure, but added a requirement of further control measures if they were justified by the benefits from reducing total population exposure.[102] Although these changes avoid some of the consequences of past deficiencies in information, other problems remain. First, the dollar values chosen for societal exposure to radiation are themselves arbitrary and conservative. The NRC has proposed rule-making hearings to set a final value, but has not yet held them.[103] Second, ALARA cost-benefit analysis and resulting regulations remain very dependent upon the state of scientific knowledge about radiation. The gaps in current understanding include empirical evidence on the relationship between plant operation and emission levels as well as evidence on health effects. To ensure that ALARA and other conditions are met, the NRC requires licensees to monitor their operations and send the results to the agency. Licensees collect data on actual emissions, off-site levels, and land use patterns in the vicinity of the plant, ensuring, at least in theory, that application of ALARA-based regulations will be responsive to changes

97 *See* W. PATTERSON, *supra* note 5, at 284.

98 *See* ADVISORY COMM. ON THE BIOLOGICAL EFFECTS OF IONIZING RADIATION, REPORT TO THE NATIONAL ACADEMY OF SCIENCES-NATIONAL RESEARCH COUNCIL, THE EFFECTS ON POPULATIONS OF EXPOSURE TO LOW LEVELS OF IONIZING RADIATION 1-2 (1972). [hereinafter cited as BEIR REPORT].

99 NRC Opinion, *supra* note 88.

100 A "rem" is the basic unit of radiation measurement. A millirem is one-thousandth of a rem. A "man-rem" is the product of exposure multiplied by population. Thus 1,000 individuals exposed to twenty millirems of radiation would equal 20,000 man-millirems, or twenty man-rems. Doses to the most exposed individual are expressed in millirems. The exposure of a large population is expressed in man-rems. *See* BEIR REPORT, *supra* note 98, at 10.

101 NRC Opinion, *supra* note 88, at 11.

102 *Id.* at 11.

103 *Id.* at 90.

or unexpected conditions.[104] But the path from operational data to design calculation to regulatory modifications has been blocked by conceptual difficulties. The NRC, the EPA, and the energy industry all agree that present calculational models overestimate radiation exposure.[105]

Although this uncertainty would appear to err on the side of caution, the administrative practice of the NRC often eliminates the cushion. On the assumption that the calculated levels are unnecessarily low, the NRC allows certain facilities to release larger quantities of radioactive materials on a case-by-case basis.[106] This discretionary action is unjustified because the data mentioned above demonstrate that operators can control emissions more strictly without financial hardship. The spirit of the ALARA cost-benefit analysis and the absence of a threshold for health harms[107] demand that lower emission levels be required wherever economically feasible. The actual implementation of ALARA cost-benefit analysis places excessive emphasis upon knowledge of radiation effects and insufficient emphasis upon the economics of emission control.

Even if the NRC had adequate data available for ALARA balancing tests, the agency's limited application of their results would continue to discount their merits. In at least four ways, the NRC had undercut the possible virtues of pre-regulatory cost-benefit analysis. First, the agency has not consistently applied the standards to all nuclear power plants. Although the ALARA guideline is one of the most important of numerous design factors built into NRC regulations for licensing new facilities, it should also have implications for "backfitting" existing plants as well. "Backfitting" involves the addition of cost-beneficial radiation control to existing plants. The process is generally more expensive than installation of similar controls at the time of construction. Yet if a rigorously-applied cost-benefit

104 *See also* Monitoring Radioactivity Releases, General Design Criterion No. 64, 10 C.F.R. § 50, app. A (1976); U.S. Atomic Energy Comm'n, Regulatory Guide 4.1 (1974).

105 NRC Opinion, *supra* note 88, at 33, 126-30.

106 *Appendix I* criteria are mere guidelines for agency action. *See* 10 C.F.R. § 50, app. I, at 309. The only mandatory limit that the agency must observe is the 170 millirem per year increment to background levels as maximum individual exposure that was promulgated by the AEC. *See* note 91 *supra;* note 132 *infra;* BEIR REPORT, *supra* note 98, at 2.

107 *See* note 8 *supra.*

analysis indicates that a particular facility should be backfitted, the ALARA guideline should compel the utility to take such action. Nevertheless, the NRC has left the matter of backfitting existing reactors for future consideration on a case-by-case basis, avoiding any generic approach to the problem.[108]

Second, the NRC has not applied ALARA cost-benefit analysis to its review of nuclear power plant site selection. The National Environmental Policy Act (NEPA) requires the agency to review alternative sites available to a construction license applicant.[109] But the NRC has continued to play a negative role of specifying geological, population, and other constraints upon siting.[110] Moreover, the NEPA requirement does not compel the use of ALARA cost-benefit analysis; the site need only be the alternative that best meets NRC's traditional criteria.[111] Thus the primary siting role has fallen to the utility, the cognizant state energy boards,[112] and local authorities through their zoning and land use powers. Many considerations, including political, cultural, environmental, and economic factors, are involved in the process of site selection, and it is appropriate that the basic authority over sites rests with the state and local governments.[113] Yet the importance of siting for radiation control[114] makes the translation of ALARA results into siting criteria for supplementing state concerns essential.[115] The NRC's failure to employ ALARA for this purpose decreases the qual-

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108 NRC Opinion, *supra* note 88, at 11. Backfitting also becomes a possibility for the current generation of reactors to be licensed under *Appendix I*, for example, where actual growth of the receptor population is markedly different from the expected population growth used in design calculations at the time of the original licensing. Under such conditions, the NRC has the option of either "backfitting" the plant in question or restricting its operation. *Id.*

Neither the NRC nor the states have confronted this issue of receptor population growth and its implications for plant operation. It is, admittedly, a politically tough question involving social planning and land use restrictions for the environs of plant sites.

109 42 U.S.C. §§ 4321-4335 (1970).

110 10 C.F.R. § 100 (1976).

111 The *Calvert Cliffs* decision calls for AEC use of the full environmental impact statement in facility decisions, and for such decisions to be founded on a "finely-tuned, balanced analysis." 449 F.2d 1109, 1130 (D.C. Cir. 1971). This clearly does not require selection of the optimal site on the basis of ALARA criteria and conditions.

112 *See* Baram, *supra* note 38.

113 *See* note 77 *supra* and accompanying text.

114 *See* notes 9-12 *supra* and accompanying text.

115 *See* notes 38-42 *supra* and accompanying text.

ity of regulation and the value of pre-regulatory cost-benefit analysis.

Third, the NRC has attempted to circumvent ALARA to achieve standardization of reactor design. In order to achieve cost reductions, quality control, and enhanced safety, the NRC has adopted the goal of replacing the traditional practice of the custom design of reactors with the standardization of design.[116] The standardization review process would "test" possible reactor designs in different hypothetical sites, such as kale, river, and offshore, with certain assumed population distributions. For a specific facility, site review ideally would be reduced to whether the actual site characteristics are no worse than the hypothetical.

ALARA can conflict with some aspects of standardization, since it calls for site-specific balancing of several factors to determine design limitations and standardization provides for a generic approach to design limitations for plants that fall within certain site and population categories. *Appendix I* could integrate ALARA with standardization with some amount of compromise. The individual dose limits are already standardized because they are derived from calculations involving hypothetical standard reactors and standard sites.[117] Case-by-case pressure on the population dose is provided by the requirement that all controls justified on a cost-benefit basis be added. If an actual site is worse than the standard site in some respects, radiation control measures must be added until the total population dose is brought within the cost-benefit value.[118] Some percentage of these cases will not require the additional treatment.

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116 *See* Atomic Energy Act, 42 U.S.C. §§ 2039, 2232b. *See also* U.S. Atomic Energy Comm'n, Policy Statement on Standardization of Nuclear Power Plants (April 28, 1972); U.S. Atomic Energy Comm'n, Statement on Methods for Achieving Standardization of Nuclear Power Plants (March 5, 1973).

117 Concluding Statement, *supra* note 8, at 85.

118 Since the NRC is not affirmatively involved in siting, there is still the possibility that an inferior site (from an radiation safety point of view) will be selected because of local or state land use decisions and utility acquisitions. However, the population would still be protected from radiation by the cost-benefit provisions, and the only undesirable effect would be an increase in the cost of electricity produced by the plant as compared with the electricity produced at some other site. Furthermore, the state arena is probably a preferable location for these tradeoffs to be made between dollars and land use objectives.

But the NRC has attempted to standardize reactor design by cutting back on the number of radiation criteria that must be met. In *York Committee for a Safe Environment v. NRC*,[119] the D.C. Circuit Court of Appeals ruled that the NRC cannot consider the satisfaction of a single numerical guideline, the radioiodine-thyroid dose limit of 15 millirem per year, to be the equivalent of meeting its ALARA requirements because

> [T]he Commission definition [of ALARA] requires consideration of health and safety effects, costs, the state of technology, and utilization of atomic energy in the public interest. While the last two factors may be constant for any reactor built or operating during a particular time period, the first two will presumably vary depending on the circumstances of each reactor. Since two of the four factors which determine whether radioactive emissions are "as low as practicable" are not constants, the Commission is precluded from determining that any particular positive level of emissions satisfies its requirement in all cases.[120]

Since *Appendix I* itself specifies that, in addition to satisfying the numerical guides,

> the applicant shall include in the radwaste system all items of reasonably demonstrated technology that when added to the system sequentially and in order of diminishing cost-benefit ratio effect reductions in dose to the population reasonably expected to be within 50 miles of the reactor . . . ,[121]

the court concluded that the ". . . 'as low as practicable' standard requires individual consideration of the costs and benefits of reducing radiation emissions from any particular reactor below the numerical guidelines."[122]

The decision in *York Committee* does put the NRC on notice that it will be held accountable for the application of ALARA and cost-benefit analysis to individual nuclear power plant licensees. However, the number of criteria involved in the test and the complexities of their interaction[123] may make court

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119 527 F.2d 812 (D.C. Cir. 1975).
120 *Id.* at 814-15.
121 10 C.F.R. § 50, app. I, at 310.
122 527 F.2d at 814-15.
123 The ALARA test requires consideration of the state of technology, the cost of technology, public health benefits, social conditions, the effect of controls on employment, and the value of promoting atomic energy. *See* text accompanying note 92 *supra*.

evaluation of the NRC's performance under ALARA difficult. Recent Carter Administration pressure for standardization[124] may be difficult for the agency to resist. If pre-regulatory tests are desirable, they will suffer at the hands of the NRC.

Fourth, the NRC permits licensees to delay compliance with ALARA guidelines. These opportunities grew out of an agency compromise on occasional excessive discharges of ionizing radiation by some nuclear power plants. The nuclear industry argued that temporary violations of performance standards must be tolerated because complex systems always vary in performance, insufficient evidence exists to prove that public health is endangered by routine emissions, and continuous supplies of electric power should be maintained.[125] In opposition, some participants in the *Appendix I* hearings advocated that limitations established under *Appendix I* for specific plants be treated as absolutes.[126] The NRC chose enforcement flexibility in requiring that

> [I]f the quantity of radioactive material actually released in effluents — during any calendar quarter is such that the resulting radiation exposure, calculated on the same basis as the respective design objective exposure, would exceed one-half the design objective annual exposure — the licensee shall:
> 1. Make an investigation to identify the causes for such release rates;
> 2. Define and initiate a program of corrective action; and
> 3. Report these actions to the Commission within 30 days from the end of the quarter during which the release occurred.[127]

Two features of this regulation reveal the potential for delay. First, the licensee may exceed the emission standards indefinitely by simply failing to report to the NRC. The NRC does not monitor effluents in a systematic fashion.[128] Second,

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It seems unlikely that these variables would be independent of one another. The value of promoting atomic energy, for example, may be closely related to economic conditions and public attitudes about nuclear power vis-à-vis other energy alternatives.

124 *See Carter's Frustrations on Nuclear Policy,* BUS. WEEK, Sept. 26, 1977, at 62.

125 NRC Opinion, *supra* note 88, at 17-19.

126 *Id.* at 105.

127 *Id.*

128 *See* note 104 *supra* and accompanying text.

the compliance actions need not be completed within the reporting period.

Of course, the utility's ability to ignore the guidelines is not absolute. The NRC may "require the licensee to take such action as the Commission deems appropriate."[129] The Commission has broad discretionary authority, for example, to take action against a licensee who persists in operating in violation of the regulations without corrective action. However, past experience indicates that the NRC has not acted quickly to ensure enforcement of this regulation.[130]

Enforcement delays endanger ALARA cost-benefit analysis because they disrupt the iterative process of tighter standards. Cost-benefit tests made during a particular period are tied to the control costs and economic conditions of that period. If licensees can delay implementation of design and operational guidelines, they can avoid more stringent emission control until costly backfitting would be necessary to comply with updated standards. Alternatively, the licensee could wait until economic conditions worsened and plea hardship to receive looser guidelines. As a result, ALARA guidelines could fall far behind the strongest feasible protection of public health. The preregulatory cost-benefit test will always be susceptible to delays. A certain amount of delay is built into the regulatory process because the NRC must calculate the actual spread of radioactivity through the environment for enforcement purposes.[131] If ALARA is to have any effect, the NRC must promulgate additional regulations setting forth criteria for a program of cor-

129 10 C.F.R. § 50.36(a)(2) (1976).

130 Difficulties in the operation of Vermont Yankee and other facilities, resulting in release above prescribed levels, have aroused public interest groups and state and local health authorities, particularly in light of the failure of the NRC to respond with timely enforcement.

The Commission therefore faces a dilemma. Its administrators must balance the known costs of reducing the operating level or of closing a power plant against the risks caused by indeterminate exposure of the public to new levels of radioactive emissions. Given that the initial design calculations are believed to be highly conservative, a NRC official may decide to allow the situation to continue for some months. But he is unable to present a rational defense of this action because of the broader goal of minimizing emissions to protect the public health. Nevertheless, the courts have been sympathetic to delay when "further study" is undertaken by the NRC. *See* Nader v. NRC, 513 F.2d 1045 (D.C. Cir. 1975), for an example of judicial tolerance of NRC delay on the problems of emergency core cooling systems.

131 NRC Opinion, *supra* note 88, at 33-34.

rective action with specific time periods for its implementation.[132]

Experience with AEC and NRC actions under ALARA has indicated that pre-regulatory cost-benefit tests for radiation emission controls fail to constrain the discretion of agencies to ignore their own stated goals of increasing protection of the public. Inadequacies of information for cost-benefit analyses can be turned arbitrarily against stricter regulation. Furthermore, the agency can choose not to apply the test and its outcome to activities that fall outside the narrow licensing procedure. Finally, licensees can disrupt the progress of ALARA by delaying compliance with ALARA guidelines. The federal courts may be able to provide some check on agency discretion by scrutinizing agency actions under NEPA.[133] But the com-

132 *See* Criteria for Determining Enforcement Action and Categories of Non-Compliance and other portions of 10 C.F.R. § 2 (1976), for specifications on enforcement issued by the NRC to date. *See also* U.S. NUCLEAR REGULATORY COMMISSION, REPORT TO THE CONGRESS ON ABNORMAL OCCURRENCES: JAN-JUNE 1975 (1975), which provides interim criteria for determination of abnormal occurrences in nuclear power plants. Of particular interest in this report is the rule that off-site receptor exposure does not qualify as abnormal unless it is in excess of 500 millirems, far in excess of limitations now imposed under ALARA. This rule provides further evidence that, despite a decade of technological advances, 500 millirems is still the only enforceable emissions limit of the NRC.

133 NRC decisions must comply with the National Environmental Policy Act (NEPA), 42 U.S.C. §§ 4321-4335 (1970), enacted by Congress in 1969 and made applicable to federal administrative agencies in 1970. NEPA requires federal agencies to assess the effects on environmental quality of proposed "major" actions. 42 U.S.C. § 4331(c). Such major actions include the issuance of construction and operating permits for nuclear power plants, Licensing and Regulatory Policy and Procedure for Environmental Protection, 10 C.F.R. § 51 (1976), and the promulgation of agency rules governing the performance of facilities and activities using radioactive materials, *see, e.g.*, 39 Fed. Reg. 5,356 (1974). The courts have also interpreted the development of the fast breeder reactor as a major action. *See* Scientist's Institute for Public Information v. AEC, 481 F.2d 1079 (D.C. Cir. 1973). Under the Act, each federal agency is required to issue environmental impact statements discussing the range of anticipated environmental effects of the project and alternatives to the proposed action. 42 U.S.C. § 4432 (1970).

With the enactment of NEPA, it now seems that there are three balancing processes potentially applicable in the NRC process of approving an application by a utility for a license to operate a nuclear power facility. The first is the use of cost-benefit analysis by the NRC in promulgating agency standards and other rules of *general* applicability to power plant performance. The second use of cost-benefit analysis by the NRC is in the agency's promulgating limitations for a *specific* power plant. Finally, the NRC must use a balancing analysis under NEPA to determine whether or not the separate construction or operating licenses should be issued for a specific plant.

The first two applications of cost-benefit analysis are required by *Appendix I* and other NRC regulations. For the dual licensing procedures of the third step, the NEPA mandate for "balancing analyses" is equally clear. The relationship of all of these

plexity of the cost-benefit analysis may strain judicial expertise[134] and require a legislative solution.

B. *The ALARA Concept — Implementation Problems*

Accurate accounting for both costs and benefits is essential when the imposition of regulation depends upon the outcome of a cost-benefit balancing test. Each level of ALARA analysis defines a public safety objective that is either accepted or rejected after the test is completed. If imputed values of costs or benefits are incorrect, stricter feasible radiation emission control might not be required and unnecessary injury may be inflicted.

Scholarly examination and limited applications of the cost-benefit concept have shown that it is an imprecise tool for making initial decisions about regulation. Cost-benefit analysis has been a worthy addition to the evaluation of public development projects, where opportunity costs can be linked to market rates of interest and benefits are positive and predicta-

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applications to each other is still undeveloped, although a federal court has recently cautioned that the NEPA requirement applicable to the issuance of an operating license may not be short-circuited by automatic qualification of a plant that has passed the first two tests. Citizens for Safe Power v. NRC, 524 F.2d 1291 (D.C. Cir. 1975). But for the specific case before it, the court concluded:

> Apart from the requirements of NEPA or similar ones already implicit under AEA (Atomic Energy Act), it would be pointless, and a waste of agency resources, to require the AEC to reapply efforts that have already gone into its basic health and safety regulations in individual licensing proceedings, in the absence of some evidence that a particular facility presents risks outside the parameters of the original rule making. And in evaluating the sufficiency of agency determinations in particular cases it would be stultifying formalism to disregard the whole record and test AEC compliance by only the evidence received at so-called "health and safety" hearings; or NEPA compliance only on the basis of so-called "environmental" hearings.

524 F.2d at 1300. This judicial decision promotes administrative efficiency by eschewing duplication of balancing analyses, and seems to make good sense. But it is clear that such efficiency is justified only when the risks and benefits appropriate for the facility-licensing balancing task under NEPA have been adequately considered in the prior balancing undertaken by the agency under it own regulations (e.g. *Appendix I*). Determination of these justifying circumstances is a complex task which now rests ultimately with the courts. The extent to which the courts can handle this difficult task responsibly will therefore depend on judicial willingness to examine the substantive features of agency decision processes, and the development of judicial expertise in analyzing the application of cost-benefit analysis.

134 For an analysis of judicial review in this area and its limitations, *see* Leventhal, *Environmental Decision-Making and the Role of the Courts,* 122 U. PA. L. REV. 509 (1975).

ble.[135] This section will show, however, that the use of cost-benefit analysis for risk management will reduce public protection from the danger of ionizing radiation without commensurate social gains.

Because information is a scarce resource that can be costly to obtain,[136] the choice of regulatory framework will affect the outcome of the cost-benefit test.[137] The ALARA test contemplates that the NRC will exert equal efforts to amass information on costs and benefits and will weight all of the elements equally.[138] But several difficulties involved in determining benefits may tip the balance in favor of well-specified control costs and against stricter restraints on radioactive discharges. First, the limits of present scientific knowledge about the effects of radiation on human health hinder identification of future benefits. New research in this field has always persuaded government officials to lower allowable emissions.[139] Future reductions may be too late to prevent damage from present levels of discharge. Second, regulators may not properly value benefits to future generations from radiation control. Present interests may be overvalued because they can reap the benefits of cheaper electrical energy without absorbing the genetic costs.[140] Social discount rates are chosen arbitrarily and can be applied more confidently to positive future benefits than to the avoidance of future costs.[141] Third, the assumption that present social values will remain immutable over the forecasted period leads to conservative estimates of future benefits. "Fragile" intangibles such as aesthetics and ecological health are excluded from the analysis.[142] These considerations may grow in impor-

135 *See* Luft, *Benefit-Cost Analysis and Public Policy Implementation: From Normative to Positive Analysis,* 24 PUB. POL'Y 437, 437-38 (1976).

136 *See* Stigler, *Imperfections in the Capital Markets,* 75 J. POL. ECON. 291 (1967).

137 *See* Crocker, *Cost-Benefit Analyses of Cost-Benefit Analysis,* in COST-BENEFIT ANALYSIS & WATER POLLUTION POLICY, *supra* note 86, at 342-43.

138 *See* text accompanying note 92 *supra.*

139 *See* BEIR REPORT, *supra* note 98, at 1-2; W. PATTERSON, *supra* note 5, at 284-85.

140 The BEIR Report's discussion of cost-benefit analysis, "Needs of the Times," emphasizes direct comparison of nuclear power benefits in units of electricity produced with risks to present citizens. BEIR REPORT, *supra* note 98, at 7-8. *See* Nash, *Future Generations and the Social Rate of Discount,* 5 ENV'T & PLAN. 611 (1973).

141 *See* Fisher & Krutilla, *Valuing Long-Run Ecological Consequences and Irreversibilities,* in COST-BENEFIT ANALYSIS & WATER POLLUTION POLICY, *supra* note 86, at 280-82.

142 *See* note 83 *supra.* Some attempts have been made to quantify these values, but the formulas are still conceptually weak. *See* Bishop & Cichetti, *Some Institutional and*

tance as the world becomes more crowded and interdependent.[143] Fourth, the benefits from the avoidance of dynamic externalities cannot be properly assessed. Some cumulative pollutants such as mercury and radioactive isotopes begin to exceed a linear relationship between dose and injury rates when their concentrations in the environment rise above certain levels for extended periods of time.[144] Uncertainty about the threshold for ecological disaster and the magnitude of the resulting damage wrongfully excludes these possibilities from the cost-benefit analysis.[145] In combination, these unknowns increase the relative information costs of assessing benefits and bias ALARA balancing tests in favor of minimal expenditure on emission control devices.

The scope of the cost-benefit analysis also influences the outcome of the balancing test. Although inclusion of cyclical variables may provide a finer resolution of true regulatory costs at a particular date, it produces a test whose results will vary significantly from year to year. The ALARA principle requires consideration of the impact of regulation upon socioeconomic variables.[146] In times that are economically unfavorable, NRC standards for radiation discharge could be loosened, even though the cost of technology remained the same. Whether or not licensees actively manipulate the regulatory process,[147] the continual variation in cost-benefit ratios would fail to ensure any maximum level of radiation in the environment. Thus the incorporation of economic conditions into the ALARA cost-benefit analysis impedes progress toward the goal of greater protection.

The imposition of a broad, even-weighted cost-benefit analysis on the decision to regulate radiation emissions places excessive emphasis upon documentation of specific health effects in future years that can be quantified in dollars as benefits of

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Conceptual Thoughts on the Measurement of Indirect and Intangible Benefits and Costs, in COST-BENEFIT ANALYSIS & WATER POLLUTION POLICY, *supra* note 86, at 105-25, and critical discussion at 125-26.

143 *See generally* D. MEADOWS, ET. AL., THE LIMITS TO GROWTH (1972).

144 *See* Pearce, *Limits of Cost-Benefit Analysis as a Guide to Environmental Policy*, 29 KYKLOS 97, 106 (1976).

145 *Id.* at 110.

146 *See* text accompanying note 92 *supra*.

147 *See* notes 125-132 *supra* and accompanying text.

increased control. The practical limitations of similar computations of benefits in other areas have prompted analysts to criticize the use of cost-benefit tests for preliminary decisions.[148] Such decisions are inherently political, and intensities of preference on the compromise between present benefits and future harms should be registered through a representative political body.[149] Congress should provide guidance to the NRC in selecting an optimal standard of radiation exposure. In turn, agency officials must devote more attention to the cost of complying with congressionally-prescribed standards.

C. *Radiation Standards and Cost-Effectiveness Analysis*

The previous discussion indicated that present techniques for choosing and implementing radiation emission controls fail to protect the public adequately from the dangers of ionizing radiation. To improve the regulatory process, Congress should bring the NRC's procedure in line with the practice of standard-setting for other pollutants.[150] Legislative and administrative standards could ensure that some maximum exposure for both individuals and society as a whole would be maintained. Moreover, if ongoing research indicates that lower guidelines are desirable or that higher emissions would not harm the public, standards could be adjusted over time without extensive reevaluation and consequent delays. Agency personnel could redirect their efforts from the elusive valuation of future benefits to the minimization of control costs for the nuclear power industry.

Administrators would still need a decision rule to choose among the various combinations of design requirements,

148 *See* L. MEREWITZ & S. SOSNICK, *supra* note 83, at 269.

149 Revelation of individual preferences for acceptable risk and desirable social investment in effluent treatment through congressional representatives may produce a better outcome than a well-designed and informed cost-benefit analysis because the preferences reflect distributional effects of a proposal as well as efficiency effects. For a discussion of the political alternative, *see* Portney, *Voting, Cost-Benefit Analysis, and Water Pollution Policy,* in COST-BENEFIT ANALYSIS & WATER POLLUTION POLICY, *supra* note 86, at 293-311.

150 Air and water pollution control laws in the United States require emission standards to be set initially by a congressional committee or an administrative agency. The agency may require polluters to install the best available technology to meet the emission standards. *See* Abel, *Project-by-Project Analysis vs. Comprehensive Planning,* in *id.,* at 333.

operating procedures, and siting criteria that could achieve desired discharge levels for radioactive isotopes. Cost-effectiveness analysis could provide a sophisticated and workable method for ranking these alternatives. This section will discuss some of the advantages of cost-effectiveness analysis and the potential obstacles that should be anticipated.

Cost-effectiveness analysis has long been used by public managers to evaluate and compare alternative means of achieving a set objective.[151]

> Cost-effectiveness analysis compares the cost of alternative means for effectively achieving an *agreed upon goal.* The means may be programs, technologies, devices or combinations of approaches. The goals are often expressed in terms of public policy as laws and standards.[152] (emphasis added).

The application of cost-effectiveness analysis to nuclear power plant regulation would occur after Congress set health boundary conditions for radiation exposure. Congress' stated health objectives would reflect society's valuation of the health of present and future generations. Within this framework, the agency could balance and compare the relative efficiency of various control alternatives for each plant or source of radiation.

Substituting standards and cost-effectiveness analysis for pre-regulatory cost-benefit analysis could improve the quality of radiation risk management in several ways. One advantage would be the elimination of the arbitrary calculation of benefits. The benefits of stricter standards are difficult to quantify, but there is good reason to believe they are understated.[153] Implementation of cost-effectiveness analysis would eliminate the need to assess health benefits from regulation.[154] A representative political decision would determine the desirable level of health protection.[155]

Cost-effectiveness analysis would also guard against piecemeal neutralization of radiation standards through regulatory delay or changes in economic conditions. Regulatory agencies

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151 *See generally* COST-EFFECTIVENESS ANALYSIS (T. Goldman ed. 1967).

152 B. O'NEILL & A. KELLEY, COSTS, BENEFITS, EFFECTIVENESS AND SAFETY: SETTING THE RECORD STRAIGHT 3, 4 (Society of Automotive Engineers Rep. No. 740988, 1974).

153 *See* notes 103-107 *supra* and accompanying text.

154 *See* Luft, *supra* note 135, at 437 n.1.

155 *See* note 149 *supra* and accompanying text.

could devote greater energy to development and enforcement of the most cost-effective methods of meeting congressional health standards. Fixed standards and analysis of control costs would ensure that fragmented cost-benefit decisions for individual plants and the tactics of power plant licensees do not set exposure levels above socially acceptable health risks.[156]

In addition, cost-effectiveness analysis for fixed standards should broaden the regulatory horizons of the NRC. The present emphasis on pre-regulatory cost-benefit analysis excludes elements of regulation not directly related to the balance.[157] Moreover, its complexity encourages agency circumvention of the full requirements.[158] But cost-effectiveness analysis requires consideration of feasible alternatives for attaining emission standards.[159] As a result, the NRC would have to incorporate backfitting of existing plants, siting analysis, and the effects of reactor standardization into its administration of congressional health standards.

Finally, fixed standards and cost-effectiveness analysis could advance the state of the art in control of radioactive power plant discharges. Cost-benefit analysis is ill-designed to force technological development. The test utilizes currently available technology as its basis for control cost estimates. Furthermore, the technical specifications of present equipment are the presumed boundary of industry's ability to purify its radioactive emissions. The pre-regulatory cost-benefit analysis thus provides no inherent incentive for the development of new control techniques. In its subservience to the concern that society neither under- nor over-invest in radiation safety, the ALARA cost-benefit test tends to entrench primitive technology.[160]

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156 *See* notes 106-107, 127-130 *supra* and accompanying text.

157 *See* notes 108-115 *supra* and accompanying text.

158 *See* notes 116-124 *supra* and accompanying text.

159 *See* L. MEREWITZ & S. SOSKIND, *supra* note 83, at 275.

160 The health effects in a traditional cost-benefit analysis can be conveniently selected and valued at levels which will bring about a balance point *always* within the realm of currently feasible control techniques. Those health effects which, if valued, would bring about a new technique-forcing result (i.e., could lead to shutdown of a plant) can be excluded from the analysis on various grounds. For example, the long-term global health effects of iodine, krypton and carbon-14 release if valued (and such a valuation would always be necessarily somewhat arbitrary) would probably force closing of most plants presently in operation until new cost-effective techniques become available to lessen or prohibit their discharge. *See, e.g.*, Petition by New England

By contrast, the implementation of full cost-effectiveness analysis through the imposition of boundary conditions for human health could create objectives, inducements, and direction for further technological innovations in industry and government. The regulation of health hazards in this manner should force advances in radiation control techniques and their timely use on the part of regulated utilities. By setting health objectives and then balancing costs and benefits subject to that constraint, the NRC may set standards that are not presently within the technological capabilities of licensees. Under threat of shutdown, a utility would be disposed to make those investments in research and development necessary to meet the standards.[161]

Although the advantages of cost-effectiveness analysis within fixed health standards are considerable, they can be achieved only if Congress and the NRC understand and properly perform their functions. First, the NRC must promulgate emission standards that meet congressional health objectives. It should avoid the EPA's error of confusing cost-effectiveness analysis of control techniques with cost-benefit analysis of regulatory alternatives.[162] Second, Congress and the agencies should not

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Coalition on Nuclear Pollution for Amendment of S-3 Table of 10 C.F.R. § 50 (Nov. 19 and Dec. 18, 1975) (criticism of the NRC on krypton, tritium and carbon-14 evaluation on file at Franklin Pierce Law Center, Concord, New Hampshire).

161 The effect should be similar to that promoted by strict liability in tort for manufacturers of defective or inherently dangerous products. *See* Katz, *The Function of Tort Liability in Technology Assessment,* 38 U. CIN. L. REV. 587 (1969).

162 In the preamble to *Proposed Standards for Radiation for Nuclear Power Operations,* the EPA described its analytical method as follows:

> In developing the proposed standards, EPA has carefully considered, in addition to potential health effects, the available information on the effectiveness and costs of various means of reducing radioactive effluents, and therefore potential health effects, from fuel cycle operations. This consideration has included the findings of the AEC and the NRC with respect to practicability of effluent controls, as well as EPA's own continuing cognizance of the development, operating experience, and costs of control technology. Such an examination made it possible to propose the standards at levels consistent with the capabilities of control technology and at a cost judged by the Agency to be acceptable to society, as well as reasonable for the risk reduction achieved. Thus the standards generally represent the lowest radiation levels at which the Agency has determined that the costs of control are justified by the reduction in health risks. The Agency has selected the cost-effectiveness approach as that best designed to strike a balance between the need to reduce health risks to the general population and the need for nuclear power. Such a balance is necessary in part because there is no sure way to guarantee absolute protection of public health from the effects of a non-threshold pollutant, such as radiation,

delegate their standard-setting authority to various "expert groups" such as the International Commission on Radiological Protection and the National Council on Radiation Protection.[163] Even though these advisory organizations may possess more information about the health harms of radiation than Congress or the NRC,[164] they are essentially self-governing and unaccountable to society. Vitally important decisions on upper limits of radiation exposure would be insulated from public scrutiny. Furthermore, the standards promulgated by these private agencies are too narrowly focused on average human exposure. They fail to provide guidance on acceptable levels of radiation that could protect the environment and especially susceptible groups such as children, fetuses, and power plant employees.[165] Congress and the NRC must make their own determinations based upon the information they can accumulate and the preferences of their constituents.[166]

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other than by prohibiting outright any emissions. The Agency believes that such a course would not be in the best interests of society.

Proposed Standards for Radiation Protection for Nuclear Power Operations, 40 Fed. Reg. 23,420 (1975). In implementing the cost-effectiveness approach it outlines above, the EPA should have chosen fixed objectives under which alternative control approaches could have been compared. No such fixed objectives or standards have been publicly announced by the EPA, however, and the obvious conclusion is that the EPA's cost-effectiveness approach to setting radiation standards has been conducted to achieve the technical and economic feasibility parameters generated by the NRC.

163 *See* note 13 *supra.*

164 But experts also recognize the crudeness of their own data and estimates. *See* BEIR REPORT, *supra* note 98, at 1.

165 *See* W. PATTERSON, *supra* note 5, at 283-85.

166 Congressional activity in other forms of safety regulation reflects the belief that Americans may desire more safety than an ordinary cost-benefit test would justify:

> If . . . the principal benefits anticipated are the savings in lives and/or reductions in the frequency or severity of injuries which cannot be reasonably quantified in monetary units, serious theoretical and conceptual difficulties arise . . . Virtually all cost-benefit studies involving the loss of life or limb have assigned fixed monetary values . . . typically obtained either by computing the discounted future income of individuals or by computing the discounted differences between future earnings and personal consumption. These concepts and approaches have been criticized on a number of grounds . . .
> . . . National Highway Traffic Safety Administration (NHTSA) has expressed a similar view (a critical view). In its recent notice of proposed rule-making concerning school bus crashworthiness, the agency stated that it "has conducted conventional cost-benefit studies on school bus safety, but the normal valuation techniques evidently do not adequately reflect general public opinion on the importance of protecting children from death or injury. *It is obvious from the voluminous mail and Congressional interest that society places a higher value on the safety of its children than a conventional cost-benefit analysis would indicate*" . . . . because of the major conceptual and methodological difficulties in the valua-

Third, the NRC must assure itself access to reliable technical information for cost-effectiveness analysis. Where control techniques under consideration have already been utilized in other sectors of industry or are otherwise available "off-the-shelf" or from present production, government regulators should have no difficulty obtaining accurate information on performance and costs. Where the control techniques under consideration are untested or in a developmental stage, however, information on reliability and costs is normally unavailable to government regulators unless the regulated industry provides it. An industry seeking to avoid further regulation will not be generous in providing such information. This deficiency has been recognized in the context of regulatory decision concerning automobile safety.[167] The nuclear power industry is the primary source of information on the technical and cost features of proposed radiation control developments. Ongoing agency review of the quality of industrial information and ongoing congressional oversight of the quality of the agency's evaluations and use of such information is necessary to ensure

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tion of life and limb, cost-benefit studies will be appropriate only in the decision-making processes involving standards *not* primarily intended to save lives and reduce injuries — that is . . . standards to reduce property damage. Congress recognized this distinction. Under Title I of the *Motor Vehicle Information and Cost Savings Act* (P.L. 92-513, 1972) — principally intended to reduce property damage losses resulting from low-speed crashes — it included a mandatory requirement for the Department of Transportation (DOT) to consider both the costs and benefits . . . However, in considering the National Traffic and Motor Vehicle Safety Act, (P.L. 89-563, 1966) which empowered DOT to set motor vehicle safety standards aimed at reducing deaths and injuries, Congress rejected draft language requiring such studies for safety standards. (Hearings Before Committee on Interstate and Foreign Commerce, U.S.H.Rep., 89th Congress, 2d Session, on HR 13228, "Part 2, Traffic Safety", p. 1203).

B. O'NEILL & A. KELLEY, *supra* note 152, at 8.

167 The undependability of manufacturer-provided cost figures has been exemplified often [examples cited]. . . . [a] European auto manufacturer told the General Accounting Office (GAO) of its belief that industry-generated cost information is not useful for valid cost-effectiveness measurement. ". . . the auto industry," Volvo told GAO, "has in some instances taken advantage of the lack of methodology and released biased material aimed purely at resisting regulation."

In its report on "benefit-cost analyses" . . . GAO itself was critical . . . [of] methods for collecting usable cost information involving standards, as well as industry's reluctance to furnish such information.

U.S. GEN. ACCT'G OFFICE, COMPTROLLER GEN. REP. NO. B-164497(3), NEED TO IMPROVE BENEFIT-COST ANALYSES IN SETTING MOTOR VEHICLE SAFETY STANDARDS 20-25 (July 22, 1974).

that the results of cost-effectiveness analysis do not frustrate the achievement of radiation exposure standards.

The implementation of cost-effectiveness analysis within the constraints of external standards requires some care on the part of Congress and regulatory agencies to avoid misinterpretation and neglect of their responbilities. But the improved procedure is worth the extra burden. Fixed standards and cost-effectiveness better reflect society's preferences for acceptable risks from radiation exposure.

Conclusion

The concentration of regulatory power over nuclear facilities in the hands of a single agency can explain many of its limitations. Because the EPA and the states have not been encouraged to set strong ambient radiation and siting standards, the NRC's analysis of the environmental effects of effluent standards has been incomplete and its consideration of siting alternatives superficial. Because Congress has not undertaken the responsibility of determining acceptable health risks from radiation exposure, the NRC has been free to employ a balancing test that favors nuclear power development at the expense of public health. To reverse these conditions, Congress must give other bodies, including its own committees, a voice in the siting, design, and operating requirements that nuclear power plant licensees must satisfy.

Redistributing government responsibility for radiological safety would not deprive the NRC or Congress of their share of challenging tasks. The NRC would retain the difficult duty of conducting cost-effectiveness investigations of current and proposed technology to achieve congressional health objectives at the lowest cost to the utilities. Congressional committees will not find the job of articulating health objectives an easy one, but its results could serve as a model to insure that regulation of activities involving harmful externalities is accountable to public support for environmental health. Congress would also be forced to recognize its role as guardian of future generations. The price of inaction on a development project is an opportunity foregone; the price of inaction on nuclear power plant radiation may be death and disfigurement for our descendants.

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