Nuclear Power and the Role of Congress

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NUCLEAR POWER AND THE ROLE OF CONGRESS*

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INTRODUCTION

One of the most critical long-term issues to come before the Nation's legislature will be the inevitable congressional decision on the future of nuclear power in America—a decision that must be made within the next few years and that should be based on considered and informed judgment, rather than response to publicity, pressure or panic. At the moment, there is a growing debate within Congress over the risks and benefits of nuclear power, a debate sustained more by rhetoric and assertion than by reliable, unbiased, valid information and analysis. This article addresses the problem of improving the quality of the ultimate decision, together with a brief discussion of the status of this debate. A proposal is offered that Congress better prepare itself by directing its Office of Science and Technology to make a five-year, comprehensive study of all the industrial activities relating to nuclear power to fully reveal the associated safety and environmental hazards.

In the last three and a half decades, a time barely long enough for an individual to reach middle age, the United States has witnessed the emergence of an Atomic Age that has transformed our international defense and now seems to offer a quick "technological fix" to close the gap between domestic use and supply of fuels and energy.¹ Nuclear proponents anticipate many social, economic and environmental benefits from nuclear power. The President and his administration, the nuclear industry, and many scientists and engineers still expect nuclear power to become a major source of energy for the Nation by the year 2000,² and to offer an ideal source of clean and inexpensive electricity. Nuclear pessimists, while recognizing some benefits, believe that the several drawbacks of nuclear power have been insufficiently considered, and that when they are considered, the risks and dangers so far overbalance benefits as to warrant
shutting down existing nuclear powerplants and barring further use of uranium as a fuel. Thus, in this 36th year of the Atomic Age, many Americans who think about nuclear power are deeply divided over the desirability and safety of nuclear powerplants as an answer to our energy needs.

Nuclear power today, although an economic reality, still contributes less electric power than do the Nation's hydroelectric plants. As of March 31, 1975, some 53 nuclear powerplants, with a combined electrical generating capacity of 36 gigawatts, are licensed to operate; 76 plants representing some 121 gigawatts are in early stages of planning and authorization, for a total of 235 nuclear powerplants, representing a generating capacity of some 234 gigawatts. By comparison, the total electrical generating capacity of the United States in 1973 was some 436 gigawatts.

President Ford in his State of the Union Message announced he would propose measures to energize our nuclear power program and submit legislation to expedite the licensing and rapid selection of sites for nuclear powerplants. His energy plan contemplates that within the next ten years there will be 200 major nuclear powerplants in operation.

I. THE NUCLEAR DEBATE

The election of many new persons to Congress last year has increased the number of Members concerned with the debate over the future of nuclear power. As this debate intensifies, signs can be detected of an unhealthy polarization of attitudes between those who favor nuclear power and those who oppose it. Members of Congress also are confused by the great proliferation of scientific papers and well-reasoned statements pro and con on this issue.

The problem for Congress is the classic one of what to do when equally eminent authorities hold opposing views. The solution must lie in finding new ways for Congress to obtain impartial, informed, competent analyses and assessments that can winnow out the truth from supposition and assertion, and discard the exaggerations of special interests, whether pro or con. The energy and the radiological future of the Nation are issues too important to be decided simply by a heads-or-tails choice between opposing briefs which by their nature emphasize one side and ignore or minimize the other.

It is useful to examine briefly the main issue of the Congressional debate. The underlying concern is the potential risk from commercial nuclear power. Many scientists, engineers, members of the public and even past employees of the former Atomic Energy Commis-
sion have warned of the potential dangers from expanding commercial nuclear power. There are risks which should be carefully scrutinized and debated before permitting nuclear powerplants to proliferate across the American landscape. The most troublesome risks include the possible catastrophic accidental release of radioactive wastes; the reliability of the emergency core cooling system (ECCS), designed to prevent a core melt accident; the possible theft of nuclear materials and sabotage of facilities; the inadequately insulated disposal of highly radioactive powerplant wastes; the long-term effects of routine emission of small amounts of radioactive materials from nuclear facilities; and the possible inferior operating efficiency of nuclear powerplants. These risks have been the focal points for much of the controversy over nuclear power.

A. The probability of a catastrophic release.

A nuclear powerplant contains quantities of radioactive materials which far exceed the amounts that are capable of causing deadly exposures, and also large quantities of plutonium, a material which is toxic and thought by some to be a cancer-producing agent in human beings. The worst conceivable nuclear accident is one that would cause the release of much of these intensely dangerous materials into the environment. Should such a release occur during certain weather conditions, many people would be exposed to injurious or deadly amounts of radiation with large urban or agricultural areas made uninhabitable for a long time.

At issue is the probability of such an accident and the effect of various engineering measures on such a probability. The Congress last year eagerly awaited the arrival of an extensive report by Professor Norman Rasmussen of the Massachusetts Institute of Technology on probabilities of major nuclear accidents. The Rasmussen report was published in draft in August 1974. While the report gave nuclear power a clean bill of health, it has come under heavy fire from those who question both its assumptions and conclusions. In view of the debate over the merits of the Rasmussen report and the fact that it was financed with $3 million from the Atomic Energy Commission (AEC), which had a vested interest in a favorable report, many Members of Congress have had difficulty in accepting its conclusions as disinterested and impartial.

Congress must also consider another recent report on nuclear safety. Published by the American Physical Society and produced by a study group headed by Professor Harold W. Lewis of the University of California, Santa Barbara, the report examined the issue
of safety in the operation of the type of nuclear power reactors most widely used in the United States, the national research and development program for establishing and enhancing safety, and the consequences of nuclear accidents for public health and welfare. Unlike the Rasmussen report, the Lewis report was not funded by the AEC. Rather, the neutral National Science Foundation provided much of the needed support. The Lewis report, while recognizing the excellent safety record of light-water reactors to date, sees the need for a continuing major effort to improve light-water reactor safety as well as to understand and mitigate the consequences of possible accidents.

According to the Lewis report, while a complete quantitative assessment of all the important aspects of reactor safety and behavior under unusual circumstances cannot now be made, a much better quantitative evaluation and consequent improvements of the safety situation can be achieved over the next decade if certain aspects of safety research are substantially improved and the results of that research put to use.

The Lewis report, while not ringing an alarm of immediate danger, makes it clear that the consequences of a major accidental release can be fearsome indeed and that the present technology of nuclear powerplants needs considerable improvement to further reduce the probabilities of such a release. Congress must read these recommendations for additional safety research and analysis as a warning that without this effort, and, even more importantly, without application of the results from additional research and development, the likelihood of major accidents will be unacceptably high if nuclear plants proliferate as now anticipated.

Nuclear industry has maintained thus far a commendable safety record, as noted in both the Rasmussen and Lewis reports. Yet this limited experience and computer or paper and pencil analyses of the remote possibility of nuclear accidents are by no means conclusive. Both the Rasmussen and Lewis reports indicate that the chances of a disastrous nuclear accident occurring, while extremely slight, are not zero. The consequences of such an accident are potentially catastrophic; the stakes of public health and safety become so high that we cannot accept assurances at face value. Both reports clearly indicate that there are gaps in the information needed to estimate valid probabilities for major accidents. These gaps must be filled before a decision is made on the future of nuclear energy. Bland assurances are not a satisfactory basis for legislative action.
B. Design uncertainties: the problem of the ECCS.

One of the most dangerous situations for a nuclear power reactor is the loss of cooling water flow. Without cooling, there is a strong probability that the nuclear core will melt, releasing within the reactor enormous quantities of radioactive fission products. Furthermore, it is conceivable that the extremely hot, molten core could melt its way through the bottom of the reactor, through other protective barriers, and into the earth beneath, whence radioactive gases and other radioactive wastes could escape into the environment. At the insistence of Federal regulatory requirements, the design of nuclear power reactors has emphasized incorporation of emergency core cooling systems (ECCS). In essence, an ECCS is intended to be a nuclear "emergency brake" to cool the reactor if normal cooling is lost, until the radioactivity of the core has diminished enough to make melting unlikely. On its face, the regulatory requirement for emergency core cooling is eminently sensible. But the real safety afforded to the public depends upon whether these systems will work as designed. There has never been a test of an emergency core cooling system in a large operating power reactor under emergency conditions. The AEC, and now the Nuclear Regulatory Commission (NRC), in approving the design of large nuclear powerplants, evaluate their ECCS by relying upon analysis by computer models of what is supposed to happen. A presumably definitive experimental demonstration, the so-called "loss-of-flow-test" (LOFT) initiated years ago by the AEC, after being repeatedly delayed and scaled down in purpose, has yet to start up even though large nuclear powerplants have been licensed for years on the presumption that their emergency cooling systems will indeed perform as designed. In such circumstances, two major categories of questions remain to be answered about this emergency system before Congress can conclude that such systems are adequate to keep the risk of catastrophic core melting within tolerable bounds. The first category involves the problem of devising accurate, complete and comprehensive analytical models for a geometrically complex system that is undergoing transients involving changes of state and rapidly changing pressures and temperatures. The second category is concerned with the response of the parts of the system to the calculated transients. For both categories the dominant issue is the ability of computers to sufficiently simulate an extraordinarily complex physical situation.

As things now stand for the ECCS, some experimental informa-
tion may be available within a year, since the long-delayed LOFT facility is scheduled for completion in fiscal year 1976 and some preliminary non-nuclear experiments are to be performed during this period. Experiments with a live nuclear core to test predictions of core and reactor responses following a loss-of-coolant accident are not scheduled before fiscal year 1977.\textsuperscript{19} Thus, these important issues presently remain open. The doubts concerning the ability of ECCS systems to perform as designed in an emergency are a strong reason to question the wisdom of plans for rapid expansion of nuclear power.\textsuperscript{20}

C. Theft, sabotage and nuclear safeguards.

The possibility of theft of nuclear materials for use by terrorists or other extremist or criminal groups as weapons of terror, and of sabotage of nuclear facilities to release dangerous radioactive materials is a further risk to public health and safety and to national security that must be considered in a decision on the future of nuclear energy.\textsuperscript{21} Until critics of nuclear power recently began to call attention to safeguards and sabotage, these issues received little attention. The development of an effective system to safeguard nuclear materials and facilities, to a greater extent than with other nuclear safeguards, involves social and economic aspects rather than purely technical ones. Increased terrorist activity throughout the world and the measure of terror employed should dispel any assumption that terrorist groups will refrain from using nuclear devices if they can obtain them. Dr. Theodore B. Taylor, a former designer of nuclear weapons and a long-term advocate of stronger safeguards for nuclear materials and facilities, warned Congress in 1974 about two risks associated with nuclear technology: the possibility of theft of nuclear materials that might be used by terrorists for blackmail or other destructive purposes; and the possibility of sabotage at nuclear facilities in ways that might seriously endanger the public.\textsuperscript{22} According to Taylor, nuclear weapons are relatively easy to make, assuming the required nuclear materials and equipment are available. All of the information, non-nuclear materials and equipment required to design and build a variety of types of fission explosives are readily available throughout the world. Under the circumstances conceivable to Dr. Taylor, a few persons, perhaps even one working alone, possessing about 10 kilograms of plutonium or uranium-233 oxide or two dozen kilograms of highly enriched uranium oxide could, within several weeks, safely design and build a crude fission bomb that would be very likely to explode with a
yield equivalent to at least 100 tons of high explosive, and that could be carried in an automobile.\textsuperscript{23}

With this somber assessment in mind, one wonders about the laxity in guarding nuclear materials that was highlighted in a 1973 report of the General Accounting Office (GAO) which declared that protection systems at two nuclear facilities were inadequate.\textsuperscript{24} While the NRC and its predecessor, the AEC, have tightened up regulations for protection of nuclear materials and facilities in private hands, it is by no means reassuring that at the time of the GAO investigation a determined thief could have made off with dangerous amounts of fissionable materials.

The safeguard terrorist problem was brought out in 1974 when Senator Ribicoff obtained and published the Rosenbaum report, an internal report of the AEC that addressed the safeguards issue.\textsuperscript{25} This special Safeguards Study advised the AEC's Director of Licensing that in recent years the factors which make safeguards a real, imminent and vital issue had changed rapidly for the worse:

Terrorist groups have increased their professional skills, intelligence networks, finances, and levels of armaments throughout the world. International terrorist organizations, particularly those of the Arabs, probably have the ability to infiltrate highly trained teams of 10 to 15 men into this country without detection.\textsuperscript{26}

The Rosenbaum report saw two developments which necessitate a new and fundamental look at the problem. First is the widespread and increasing dissemination of precise and accurate instruction on the manufacture of nuclear weapons. As a result, "larger and larger numbers of people with experience in processing special nuclear materials and with varying psychological attitudes are dispersed in the overall industrial community."\textsuperscript{27} Second is the recent upsurge of political kidnappings within the United States. These kidnappings could lead to a rise of urban terrorist groups in the United States likely to have available to them the technical knowledge needed to build a nuclear weapon. The Rosenbaum group concluded that the seriousness of the problem demanded a clear commitment by the AEC to bring the risk to the public from theft down to the level of public risk associated with the operation of nuclear powerplants.\textsuperscript{28}

The need for improved physical protection of nuclear materials and facilities appears again in the draft final declaration of the Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons, which was issued in Geneva on
May 30, 1975. In this document, the participants, including the Soviet Union, expressed their belief that nuclear materials should be effectively protected at all times and urged action for the physical protection of nuclear material in use, storage and transit, with a view to insuring a uniform, minimum level of effective protection for such material.

Such a recommendation gives further reason to fear that nuclear theft is not unthinkable and that grave consequences could result from sabotage or terrorist activities. Unfortunately, nuclear powerplants and associated installations seem to present an ideal target for such activities.29

D. The long-term segregation of nuclear wastes.

The generation of nuclear power inevitably creates intensely radioactive wastes. In principle, these wastes are separated from used nuclear fuels when the latter are processed to recover residual enriched uranium and by-product plutonium. These wastes are so radioactive that they must be kept out of the environment for centuries. Indeed, society may have become party to a "Faustian bargain"30 with nuclear technologists in which it expects to enjoy the benefits of nuclear power in exchange for a commitment to confine these wastes long after the last nuclear powerplant has been decommissioned and forgotten. At the moment there are no commercial arrangements to reprocess nuclear fuel or to store the wastes, nor is there presently a commercially feasible technology to transform them into forms less likely to escape into the environment.31 However, the experience to date with the storage of somewhat similar wastes from the manufacture of plutonium for nuclear weapons gives cause for concern.32

Presently, some 90 million gallons of liquid, intensely radioactive wastes are stored at government-owned sites in about 200 storage tanks. Since the AEC has had the most experience with the handling of these dangerous wastes, it would seem reasonable to expect the AEC's (and now the Energy Research and Development Administration's (ERDA)) management of these wastes to provide an example of thoroughness, reliability and care. Yet over the years several failures have occurred in these storage tanks which have resulted in leaks of highly radioactive liquids into the environment. At Hanford alone, over 423,500 gallons leaked from 16 tanks. The largest single leak occurred in mid-1973, when one tank leaked a total of 115,000 gallons.33 Until an economically and technically feasible way of storing these wastes has been demonstrated, the
nuclear power industry will have no way to dispose of them. This gap in the chain of supporting industrial capabilities for the nuclear industry must give many potential investors in nuclear powerplants cause for concern. And even when such technological measures become available, there will remain the unanswered moral question of the right of this generation to saddle their descendents with the burden of caring for these dangerous wastes. 34

E. Routine low level emissions.

Nuclear powerplants are presently designed to discharge small amounts of radioactive materials into the air and water during routine operations. In principle, these residuals from waste treatment processes are so small that the additional benefit of zero discharge is not worth the additional capital and operating costs of the equipment that would be required to prevent the discharge of a single radioactive atom. 35 While the likely emissions from a single plant are probably genuinely low in level, it may be argued that there has been insufficient attention to the accumulation of these releases as more nuclear powerplants come into operation, particularly in as densely populated an area as New England. While the AEC since 1947 has funded research into biological effects of radiation, even now, some 30 years later, there is only a good understanding of the effects of large exposures, but not of the effects of longterm exposure to very low levels of radioactive materials.

Almost three years ago, the Environmental Protection Agency (EPA) published a major report of the National Academy of Sciences on current scientific knowledge of health risks from ionizing radiation. 36

The Advisory Committee of the National Academy was chaired by Professor Comar of Cornell University. 37 The Comar report was written in anticipation of the widespread increased use of atomic energy and to provide a basis to evaluate radiation protection from small exposures. The report expressed the need for radiation control standards as follows:

... We need standards for the major categories of radiation exposure, based insofar as possible on risk estimates and on cost-benefit analyses which compare the activity involving radiation with the alternative options. Such analyses, crude though they may be at this time, are needed to provide a better public understanding of the issue and a sound basis for better public understanding. 38

These analyses should clarify such matters as: (a) the environmen-
tal and biological risks of given developments, (b) a comparison of these risks with the benefits to be gained, (c) the feasibility and worth of reducing these environmental and biological risks, and (d) the net benefit to society of a given development as compared to the alternative options.

Summing up its anticipations for exposure from nuclear power, the Comar Committee stated its conditional conclusion thusly:

Concern about the nuclear power industry arises because of its potential magnitude and widespread distribution. Based on experience to date and present engineering judgment, the contribution to radiation exposure averaged over the U.S. population from the developing nuclear power industry can remain less than about 1 mrem\(^3\) per year (about 1 percent of natural background) and the exposure of any individual kept to a small fraction of background provided there is: (a) attainment and long-term maintenance of anticipated engineering performance, (b) adequate management of radioactive wastes, (c) control of sabotage and diversion of fissionable material, (d) avoidance of catastrophic accidents.\(^3\)^1

The Committee's analysis led to a statement of nine general principles for radiation protection, some well recognized, some novel. Most of these applied to nuclear power. The two leading principles stated by the Committee were: (1) no exposure to ionizing radiation should be permitted without the expectation of a commensurate benefit; and, (2) the public must be protected from radiation but not to the extent that the degree of protection provided results in the substitution of a worse hazard for the radiation avoided.\(^4\)^0

The cautious approach of the Comar Committee provides additional reason not to blithely assume that routine discharges of presumably small amounts of radioactive wastes to the environment are acceptable for the long term. While one nuclear powerplant may have a minor or negligible effect, several hundred could produce quite a different situation.

Fortunately, both the EPA and the NRC are in the midst of rulemaking actions that should provide more information for the public on routine releases of radioactive wastes. On May 5, 1975, the NRC announced its decision in a longstanding rulemaking proceeding concerned with numerical guides for design objectives and limiting conditions for operations to meet the criterion that emissions be as low as practicable for the type of nuclear powerplants now in general use in the United States.\(^4\) This step should go a long way toward providing the public and public interest groups with specific
yardsticks against which to measure the performance of nuclear powerplants.

More recently the EPA issued proposed standards for environmental radiation protection from nuclear power operations.\textsuperscript{42} In announcing the proposal at a press conference on May 23, 1975, EPA Administrator Russell E. Train estimated the proposed standards would prevent 1,000 cases of cancer or serious genetic damage over the next 25 years. The cost of meeting the standards would be from $2 million to $3 million per plant. He estimated that decreasing radiation emissions over the whole nuclear fuel cycle from uranium ore to disposal of spent materials could cost as much as $100 million, or about $100,000 for each life saved under the new standards.\textsuperscript{43} The proposed standards would be enforced by the NRC which would grant variances if it determined that a temporary and unusual operation condition existed and continued operation was necessary to protect the over-all societal interest for orderly delivery of electrical power, and if the information on the nature and basis of the variance were made public.

The net effect of the standards, according to EPA, is to make the planned releases from the uranium fuel cycle of insignificant consequence to individual members of the public. The standards would apply to planned releases only and would not deal with releases from a major nuclear accident.

Nonetheless, until these proposed EPA standards become final and until the NRC shows that they can be attained in the operations of the nuclear power industry, there is good reason to remain vigilant on the matter of routine releases of radioactive wastes. The short-and long-term consequences of misjudgment to society are simply too great for summary or relaxed regulatory treatment. If there are to be errors, let them be on the side of safety rather than economy.

\textbf{E. The reliability of nuclear power.}

A national commitment to large nuclear powerplants implies that they will be a reliable source of electricity. After all, would we knowingly commit our electrical future to sources that might fail when we need them most? However, if the fears of some observers are correct, this is precisely what lies ahead. Here again is a possible drawback of nuclear power for which inadequate information exists. Both nuclear powerplants and conventional powerplants suffer from troubles that can cause unscheduled outages, and these outages appear to increase in severity with the increasing sizes of power-
Nuclear critic David D. Comey has charged that published AEC data reveal an average capacity of 54 percent for commercial nuclear powerplants, whereas most designs call for 80 percent after a three-to-four-year break-in period. As Comey analyzes nuclear powerplant performance, unless their capacity factor record is dramatically improved, the economic benefits claimed for them by their proponents are not likely to materialize. Indeed, he expects a decrease in plant capacity as nuclear plants get older.

Of course, the proponents of nuclear power do not agree that the situation is as bad as painted by Mr. Comey. For example, the Atomic Industrial Forum (AIF) takes issue with simple, unqualified comparison of coal and nuclear powerplants and the bases for these comparisons. According to the AIF, if the performance of large nuclear powerplants is compared to that of the larger coal plants, the nuclear record is quite good, and the ability of nuclear plants to deliver economic electric power has been a significant factor in the decision of many utilities to choose nuclear power. Also, last December, Congressman Price, chairman of the Joint Committee on Atomic Energy, addressed Congress about a tendency of some reporters to exploit the sensational and to play upon the public's fears concerning reliability. While agreeing that plant performance could be bettered, he expressed his belief that nuclear plants have operated safely and are making substantial contributions to meeting electrical energy needs.

The Federal Energy Administration has entered the fray with a recent report that productivity of large coal-fired and nuclear plants can and should be improved. The major responsibility for achieving this productivity must be with the electric power industry, but the Federal Government must assist. The FEA report concluded that improvements in the productivity of fossil-fired and nuclear powerplants could help reduce U.S. dependence on foreign oil imports, and could also significantly reduce the impact that increasing capital requirements and fuel costs are having on consumer electric bills.

The NRC has received a strong recommendation from one of its staff for direct NRC intervention through licensing and other means of imposing standards aimed at assuring higher reliability of nuclear plants. Ironically, a new factor affecting nuclear reliability is the likelihood that from time to time the NRC may order one or more powerplants to be temporarily or permanently shut down. For example, on January 29, 1975, the NRC directed operators of 23 nuclear powerplants to determine if there were cracks in piping which
is part of the emergency core system. The operators were given 20 days in which to shut down the plants and make the inspections. NRC estimated that each plant would be shut down for about two weeks for the required inspections.\textsuperscript{44} This added factor of nuclear reliability will inevitably weigh heavily in future decisions on nuclear power.

II. LEGISLATIVE MISTAKES, PAST AND PRESENT

Several legislative mistakes have helped bring about the present unhealthy nuclear situation. These include the Atomic Energy Act of 1954,\textsuperscript{55} the Price-Anderson Act,\textsuperscript{56} and funding of ERDA. Congress made a profound mistake in 1954 when it rewrote the Atomic Energy Act of 1946 to promote the civil use of nuclear power.\textsuperscript{57} The legislation had the \textit{de facto}, if unintended, effect of concentrating Federal funds on one energy option, namely nuclear. Neither the executive branch nor the Congress saw fit then or later to increase the funding of the Department of the Interior or the Department of Commerce for the parallel development and demonstration of the renewable energy sources, including solar energy, wind power, ocean heat, and also geothermal energy, energy from urban and rural wastes, and conservation of energy. A contributing factor was a coattail effect in that the AEC's funding for civil nuclear energy, although large in comparison with many Federal programs, was small in comparison to the atomic weapons program and so rode the weapons coattail, receiving less congressional attention during the great expansion of nuclear weaponry of the later 1950's than the level of funding warranted.

Now, well into the 1970's, Congress finds nuclear power possessed with a formidable advantage over other potential new or expanded sources of energy in that the laboratories for nuclear energy have had several decades in which to become well established and to become productive, whereas those for alternatives are in their infancy and cannot promise deliberate, practicable technology for a decade or so.

Another mistake of Congress was the enactment of the Price-Anderson Act in 1957.\textsuperscript{58} In this Act, Congress placed a ceiling for liability by owners of nuclear powerplants for damages, injuries and casualties caused by a major nuclear accident, and also provided a government indemnity of up to $500 million for liabilities exceeding commercially available liability insurance, which was $60 million in 1957. The indemnification was extended in 1966 and is currently due to expire on August 1, 1977.\textsuperscript{59} Legislation to revise this method...
of providing public protection was passed last year but was vetoed by President Ford.

The Price-Anderson Act has enabled the designers, manufacturers and users of nuclear powerplants to rush ahead with new, untried ideas and with an extremely rapid and perhaps unwise increase in size of nuclear plants without the concern of financial liability in the event of mistakes and accidents. Some critics of the nuclear industry would cancel the Price-Anderson indemnification and impose full, unlimited liability for consequences of an accident upon the owners of nuclear powerplants. There is an appealing logic to this idea, which was recently developed by Friends of the Earth. There are, of course, arguments made for continuation of the Price-Anderson indemnification and from the viewpoint of nuclear industry, they have merit. Although this legislation provided financial protection to the public during the first decades of nuclear power, the limitation removed an important reason for the industry to be conservative and cautious in how it designs, builds and operates nuclear powerplants. The sooner the industry is required to take into account the financial consequences of liability from a major accident, the sooner safety will get a much needed boost in the councils of management.

We are at the outset of a long period of inquiry, both public and congressional, in which the Nation will seek to understand why America in the years since 1954 has expended many billions of dollars on nuclear power while spending hardly anything on non-nuclear sources of energy. The end result of America's misguided energy priorities is that there is now an alarmingly uneven distribution of funds for research, development and demonstration between nuclear and non-nuclear options. This means that non-nuclear alternatives are handicapped in catching up with nuclear power, particularly the alternatives of clean fuels from coal, more efficient conversion processes, and environmental protective technologies—especially for the safe burning of coal. The Ford Foundation's Energy Policy Project in its preliminary report examined Federal funding for some $2.4 billion spent during this time for nuclear power in comparison with $2.7 billion for all other energy options.

One reason for creating the ERDA was to remedy this national preoccupation for Federal funding of research and development of nuclear energy, to the detriment of other alternatives. President Nixon, in proposing this new Federal agency, promised that it would pursue all promising energy technologies. In his Message to Congress on June 29, 1973, he stated: "The new Administration would
be organized to give sufficient new emphasis to fossil fuels and potential new forms of energy while also assuring continued progress in developing nuclear power." [emphasis supplied].

Despite these initial assurances, there are few signs that ERDA is reorienting its funding priorities for energy research and development. Rather, it appears that there has been a continued emphasis on nuclear research and development and a perpetuation of the imbalance which has left us with few new options to increase our energy supplies for the near term. A recent analysis of the budget of the ERDA by Congressman Charles Vanik amply demonstrates the one-sidedness of the Administration's continued preoccupation with nuclear power. Mr. Vanik's study shows that direct research and development for non-nuclear energy alternatives—coal, solar, geothermal—count for a little over one-tenth of the ERDA's total budget. On the other hand, excluding administrative costs, over 78 percent of the budget is related directly to research and development of various applications of nuclear energy, with less than one percent for conservation of energy and barely 5 percent for nuclear safety.

The Congress, however, has moved substantially to authorize and fund more research and development for energy. Legislation passed by the 93d Congress that emphasized energy research and development included the Solar Energy Research, Development and Demonstration Act, the Geothermal Energy Research, Development and Demonstration Act of 1974, the Solar Heating and Cooling Demonstration Act of 1973, and the Non-Nuclear Energy Research and Development Act. In addition, Section 305 of the Housing and Community Development Act of 1974 requires the Secretary of Housing and Urban Development to promote, to the maximum extent feasible, use of energy saving techniques through minimum property standards for newly constructed residential housing financed by mortgages insured under the Act. This legislation underscores the bright hopes of the Congress to expand promising and needed alternative energy sources. Unfortunately, a look at the ERDA budget for fiscal year 1976 indicates that the Administration does not share this hope and has not responded to the opportunities intended by Congress. One analysis submitted shows that for solar energy, ERDA proposes to spend only a little over 1 percent of its funds for this alternative, renewable energy source. We cannot expect dramatic breakthroughs in these alternative sources for energy if we continue to orient our money so heavily towards nuclear energy.
With the benefit of hindsight, it is evident that a major mistake was made in concentrating upon the development of nuclear power without the parallel and equally intensive development of other alternatives. It is now time to put the available Federal funds where they can be used to best advantage for the further development and demonstration of energy sources alternative to nuclear power. If this means cutting back on nuclear power to free funds for alternatives, so be it. The step must be taken. On the other hand, nuclear research and development should not be reduced without at least a corresponding increase in funding for alternatives. It is bad enough to be almost wholly dependent now on nuclear power for a new energy source in the short term. It would be still worse to cut back that option with no alternative to take its place.

III. A PROPOSED SOLUTION

As one listens to the evolving debate on nuclear power, it is plain that if a major release of radioactive materials were to occur because of an accident at a nuclear powerplant, there could be widespread death, injury and property damage. The growing shortages of domestic oil and gas supplies, however, are increasing the pressure upon government and utilities to build and use nuclear powerplants, especially if we expect electricity to become a dominant energy form in the future. Opponents warn of grave dangers. Proponents concede that nuclear power can never be zero risk but claim that the probability of a catastrophic accident is so vanishingly small as to justify society incurring the risk. Debate is full of statements of opinion, judgments, biases, all too often supported by limited or incomplete information.

Some Members of Congress would resolve the dilemma by declaring a temporary moratorium on further use of nuclear power until all questions can be answered. Others would impose a permanent moratorium now, based upon their analyses of likely risks. In 1974 Congressman Waldie introduced a proposed Nuclear Energy Reappraisal Act to terminate the granting of construction permits for nuclear powerplants and to require a five-year study of the nuclear fuel cycle before issuance of construction permits could be resumed. Congressman Fish introduced a similar bill in this Congress.

There can be little question that many Members of Congress would be a good deal more receptive to a nuclear moratorium if the present energy crisis did not exist. In the Nation as a whole, nuclear energy supplies seven percent of the generating capacity, while New England already is 22 percent dependent upon nuclear energy and
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its utilities have been advised to move more towards nuclear power.\(^7\)

It is quite probable that a licensing moratorium would compel the government and nuclear industry to develop and present the American public with the real facts underlying nuclear power. Such moratorium pressure to finish such a study would be great, and as a result, answers would be forthcoming. However, for Congress to adopt a nuclear moratorium, there would have to be evidence which is generally supported throughout the scientific and technological communities. Although there is a serious division among some scientists and in the general populace concerning the wisdom of a further national commitment to nuclear power, the evidence is not conclusive. Without consensus, a moratorium on nuclear development should not be imposed.

Nonetheless, there is plainly good cause for concern about the long-term future of nuclear power. Without an independent evaluation of these concerns by a genuinely impartial, unbiased body of scientists and engineers and members of the public, there is no way for Congress to make an informed judgment on fission-based energy. The introduction of a Nuclear Energy Study Act of 1975,\(^9\) is an expression of the belief that it is now incumbent on Congress to order such a study. The bill would require the Office of Technology Assessment (OTA) to conduct a study of the entire nuclear fuel cycle.\(^8\) The OTA would be authorized to contract with individuals or organizations for the purpose of conducting the study, upon the condition that the contractors have no interest in the further expansion of the nuclear industry.

The comprehensive study by the OTA would include a review of many important areas. These topics would pertain to the safety and environmental hazards associated with existing nuclear fission powerplants, the effects of routine emissions, the environmental and safety aspects of perpetual storage of high level radioactive wastes, the feasibility of denaturing these wastes,\(^8\) the transportation of nuclear and radioactive materials, the risks associated with theft of nuclear materials and sabotage of nuclear facilities, and the economic effect of decisions to proceed with nuclear power or to stop use of nuclear power.

In addition, the bill would require the OTA to report annually to the Congress and the public on the progress of the study. Through these reports the Congress will insure that the study is being properly conducted and that governmental agencies are giving their full cooperation to the OTA. As for the level of effort, because of the
critical nature of the decision to be made based upon the report, authorization is proposed of $2 million a year, or a total of $10 million for the study.

In summation, before we proceed much further in a "Faustian bargain" with nuclear energy, Congress should have at hand information and analysis specially compiled for it to help decide just how far the Nation should go. It is not enough simply to read reports of parties with special interests for and against nuclear energy, and to listen to their briefs and arguments in hearings. These proceedings often take on the quality of those arguments long ago as to how many angels could dance upon the head of a pin—too much supposition and too little substance. The Congress needs a major study and analysis performed by an agency identified with the legislature, and not by Federal agencies that would promote or regulate nuclear power, or by the industrial concerns that would sell and use nuclear powerplants, or by opponents who now have acquired a vested interest in their opposition. 82

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FOOTNOTES

* Expanded from a presentation given at the Nuclear Energy Symposium, sponsored by the Center for Law and Health Sciences and the Environmental Law Society of Boston University on February 22, 1975. The author is indebted to the Environmental Policy Division of the Congressional Research Service for extensive assistance in the preparation of this article.

** United States Congressman from Massachusetts.

1 The term "technological fix" is associated with Dr. Alvin Weinberg, a leading nuclear scientist and former director of the Oak Ridge National Laboratory.

2 Representatives of the Energy Research and Development Administration (ERDA) in their appearance before the Joint Committee on Atomic Energy on June 10, 1975, forecast that by the end of the century electric energy inputs to our society will account for half of the total energy input and that nuclear energy will increase from 4 percent of total electric generating capacity in 1973 to between 40 and 57 percent by the year 2000, with nuclear generating capacity increasing from 18.4 gigawatts to between 625 and 1250 gigawatts by the year 2000.

3 The start of the nuclear age is dated in January 1939, when nuclear fission was discovered by the German chemists L. Meitner
A gigawatt is one million kilowatts. Modern large electric powerplants range in electrical capacity from 0.8 gigawatts to 1.5 gigawatts and there are discussions of establishing power parks at which many powerplants would be located together, with total generating capacities of 10 gigawatts or more.

Statement of Roger W. R. LeGassie before the Ad Hoc Subcommittee to review the National Breeder Reactor Program, June 10, 1975.

The President's expectation would be filled with nuclear powerplants now being built or planned. The ERDA representatives cautioned the Joint Committee that determining the nuclear portion of future U.S. electric generating capacity is particularly difficult. The recent financial problems of utilities have had evident effects on the capital intensive nuclear plants. While low nuclear fuel costs may strongly favor the construction of nuclear plants, the long leadtime for their licensing and construction and their high initial cost, together with public acceptance problems, tend to offset some of this incentive to the utilities to choose nuclear power. Supra note 5, at 877-79.

As an example of views questioning a nuclear future, in April 1975 Senator Gravel testified at hearings on nuclear power by the House Committee on Interior and Insular Affairs and analyzed the growing antinuclear sentiment in the United States. 121 Cong. Rec. 7877-79 (daily ed. May 5, 1975) (remarks of Senator Gravel).


As an example of scientific views favoring nuclear power, on March 11, 1975, Congressman Moorhead placed in the Congressional Record the text of a statement of 32 leading scientists, headed by Dr. Hans Bethe, explaining why they saw no alternative to nuclear power. 121 Cong. Rec. 1015 (daily ed. March 11, 1975).

Fortunately, Congress has created a new analytical arm, the Office of Technology Assessment (OTA), which can provide the
analysis and assessment needed. OTA was established in the legislative branch by the Technology Assessment Act of 1972 (86 Stat. 797). The basic function of the OTA is to provide assessments for congressional committees of the beneficial and adverse impacts of technologies, together with analyses of alternatives.

On August 4, 1972, the Atomic Energy Commission (AEC) had specified that a principal objective of the Reactor Safety Study was to "...try to reach some meaningful conclusions about the risks of nuclear accidents using current technology." When the present state of knowledge would not permit a complete analysis of low-probability accidents in nuclear plants with desired precision, the study was to consider the uncertainty and the consequent range in predictions, as well as to delineate outstanding problems. Subsequently, the study group expanded its charter to include the following specific objectives: (1) a quantitative assessment of the risk to the public from reactor accidents, (2) a more realistic assessment than that of the approach of the licensing process, (3) development of methods to perform the assessment and to understand their limitations, and (4) identification of areas for future safety research.

The Reactor Safety Study reported indications that nuclear powerplants have achieved a relatively low level of risk compared to many other activities in which our society engages (Id. at 223). As for quantitative results, the report commented on reactor risks as follows:

Reactor risks are presented to be smaller than many other man-made and natural risks to which we are exposed as a society and as individuals. These other risks include those due to fires, explosions, dam failures, air travel, toxic chemicals, tornadoes, hurricanes and earthquakes. (Id.).

The report predicted that the operation of 100 power reactors would not contribute measurably to the overall risks due to acute fatalities and property damage from either man-made or natural causes (Id. at 226). Concerning large consequence accidents, the report stated:

Potential core melt accidents, occurring under typical or average values of radioactive release, weather, and exposed population, would have modest consequences. The reason that probabilities are much smaller for large consequence events is that all the factors affecting consequences must be at or near their worst condition. Thus, they require a core melt accident coupled with unfavorable weather conditions and a very high population density exposed to the released radioactivity.
Since the accident, the population, and the weather are generally independent, large consequence events are quite unlikely. (Id.)

13 The Union of Concerned Scientists, which opposes nuclear power, on Nov. 14, 1974, reported its review of the Rasmussen report by a committee of scientists and engineers from the Sierra Club and the UCS. This joint review found the Rasmussen report to have serious limitations and defects and said it “cannot be used to sweep away the doubts about reactor safety.” Dr. Henry W. Kendall of Massachusetts Institute of Technology, spokesman for the review group, said that the only technical basis for the AEC’s nuclear safety claims was a “speculative and unverified computer prediction that relies on a wide range of poorly founded and inconsistent assumptions.” H. W. KENDALL & S. MOGLEWER, JOINT REVIEW COMMITTEE OF THE SIERRA CLUB, UNION OF CONCERNED SCIENTISTS: PRELIMINARY REVIEW OF AEC REACTOR SAFETY (1974). See also, Union of Concerned Scientists, news release, Cambridge, Massachusetts (Nov. 24, 1974). Senator Gravel placed materials critical of the Rasmussen report in 120 CONGo REC. 5012-24 (daily ed. July 25, 1974) and 120 CONG. REC. 20757-60 (daily ed. Dec. 9, 1974).

In December, 1974, the Environmental Protection Agency damned the report with faint praise. EPA wrote to the AEC about its preliminary review of the report and said it was imperative the report receive a thorough critical review by the general technical community and public. EPA called for significant expansion of the description of certain critical portions of the overall calculations to permit a “clear understanding of the relationships between the radioactive material release, its dispersion, population distribution, and the resulting health effects.” EPA also noted that although the report indicated no absolute judgment on nuclear power acceptability was intended, the comparative risk analysis highlighted in the summary might well imply an acceptability judgment to the average reader. EPA suggested the AEC indicate that judgments on risk acceptability are extremely complex, with comparative risk evaluations representing only one of numerous inputs which must be considered. Letter from W. D. Rowe, EPA, to S. Levine, AEC, Nov. 24, 1974. The EPA response was also discussed in R. Gillette, EPA CITES ERRORS IN AEC’S REACTOR RISK STUDY, 186 SCIENCE 1008 (1974).

An editorial in 30 THE BULLETIN OF THE ATOMIC SCIENTISTS, No. 8, Oct., 1974, while noting several benefits of the report, was critical of it on six counts which it summarized as follows: The question of risks involved in operation of commercial nuclear powerplants is
of sufficient importance to require an assessment of unimpeachable thoroughness and impartiality. The Rasmussen report, for all the merits it may have, does not meet that requirement.


15 Most of the nuclear power reactors in the United States are varieties of the so-called light-water reactor in which water is used as the coolant and moderator of the nuclear core.

16 The Study Group made eight major recommendations in the Lewis report which called for: (1) human engineering of reactor controls; (2) measures to quantify the effectiveness of quality assurance in construction of nuclear reactors; (3) additional calculations in the final version of the Rasmussen report; (4) revision of the Rasmussen report analysis of accident consequences; (5) study of the problem of sabotage and its effect on increasing the risk of radioactivity release; (6) quantification of the safety margin for the design of emergency core cooling systems with increased emphasis on realistic calculations and experiments; (7) more emphasis on certain safety research including an assessment of benefits and costs of alternative siting policies such as remote, underground, and nuclear-park siting; (8) more effort to resolve major uncertainties in estimating consequences of accidents and to mitigate their consequences; and (9) further improvements in safety research to assure that results of both experimental and computer analyses are openly published. Lewis Report, supra note 14.

17 According to the Lewis report, the last line of defense in preventing or mitigating the release of radioactivity from a nuclear power reactor is a further set of engineered safety features designed as a backstop in case of significant failure of the reactor's safety features. The greater part of this last safety umbrella is the containment and building which encloses the entire reactor and those parts that contain radioactive materials. These containments have worked well in controlling routine and minor emissions, but have not yet been subjected to test by a large-scale controlled or accidental release. More research is needed, according to the report, toward increasing the effectiveness of containment devices, along with more vigorous pursuit of the possibilities for major improvements in containment design.

The Lewis report estimated substantially larger long-term consequences of a major release than did the Rasmussen report, particu-
larly concerning damage to or denial of use of land and possible latent cancers from exposure to individuals who live in areas which are contaminated below the evacuation thresholds of the Rasmussen report. The Lewis report noted that these uncertainties in estimates of consequences need to be resolved because they have important implications in reactor design, siting policy and protection against potential sabotage. "In analyzing the societal risk-benefit balance of commercial nuclear reactors, one must be able to estimate with reasonable confidence both the probability and consequences of system failure; research must continue on both." LEWIS REPORT, supra note 14.

18 These two categories of questions are defined by a leading safety expert of the Oak Ridge National Laboratory, W. B. Cottrell, in his article The ECCS Rulemaking Hearings, 15 NUCLEAR SAFETY 30-56 (Jan.-Feb. 1974) (hereinafter cited as Cottrell).

19 According to the NRC, the experimental program for LOFT, for which $14.3 million was requested for Fiscal Year 1976, is directed toward testing predictions of core and reactor response following a loss-of-coolant accident. The need for such information has been emphasized by regulatory groups. The program objectives are to evaluate the adequacy of analytical techniques for assessing performance of engineered safety systems, evaluate the performance and safety margin of engineered safety systems, and identify unanticipated behavior not presently accounted for in evaluating the performance of engineered safety systems. Hearings on Authorizing Legislation, Fiscal Year 1976, Before the Joint Comm. on Atomic Energy, Nuclear Regulatory Commission, 94th Cong., 1st Sess. 84 (1975).

20 The adequacy of ECCS systems has become and remains a focal point of contention between proponents and opponents of nuclear power. The controversy has raged for several years and presents an extraordinary picture of charge and counter-charge, of suspicions that the AEC had muzzled some of its own staff and the employees of its contractors who have had questions about the system, and of intervenors prying out these unfavorable views from AEC documents. One major battlefield for this controversy was the ECCS Rulemaking Hearing conducted by the AEC from January 27, 1972 to July 25, 1973. For two accounts of these hearings from different viewpoints, see Cottrell, supra note 18, and D. F. Ford and H. W. Kendall, An Assessment of the Emergency Core Cooling Systems Rulemaking Hearings, Union of Concerned Scientists (1974) (hereinafter cited as FORD & KENDALL). Cottrell gives a rea-
sonably impartial account of the hearings, while Ford and Kendall recount in detail the issues raised by the Union of Concerned Scientists during the ECCS hearings. The hearings also are analyzed from the viewpoint of public participation by S. Ebbin and R. Kasper in *Citizens Groups and the Nuclear Power Controversy* (1974).

During the hearings, questioning brought out that in December, 1971, the director of nuclear safety for the Oak Ridge National Laboratory had written to the AEC’s Director of Regulation, noting that since the hearings on the ECCS had been announced by the AEC, it was appropriate for his group to advise the AEC of their views. Director Cottrell summed up the thrust of his letter by writing: “To summarize what follows herein, we are not certain that the interim criteria for the ECCS adopted by the AEC will . . . , ‘provide reasonable assurance that such systems will be effective in the unlikely event of a loss-of-coolant accident.’” (Ford & Kendall, 4.21). The 6-page letter sent by Cottrell was accompanied by a 30-page attachment detailing several serious criticisms of the AEC’s interim policy statement on the ECCS. Cottrell emphasized the inadequacy of the state of knowledge on loss-of-coolant accidents and emergency core cooling systems, saying: “At the present time we would not presume to offer ‘realistic’ criteria because of wide gaps in our knowledge. However, we would welcome the opportunity to work with others in developing interim criteria. Final criteria cannot be developed until more experimental evidence becomes available. . . .” Id. at 4.22.

Although the AEC had published a notice of the ECCS Rulemaking Hearing, and Cottrell’s letter had referenced this notice, the AEC did not put his letter in the docket for the hearings. Instead, it was reportedly withdrawn on the grounds that it was a draft and did not represent the views of the safety group at Oak Ridge. During cross-examination of Cottrell by UCS at the rulemaking hearings, Cottrell said that the letter in his judgment was in its final form when sent to the AEC, that it did not represent a draft, and that it did represent the views of the ECCS researchers at Oak Ridge. Id. at 4.22.

This situation gives reason to wonder how the AEC balanced its dual responsibilities for fostering nuclear power and regulating it in the interests of public health and safety—a conflict of interest that was only partially resolved by the creation of the independent Nuclear Regulatory Commission by the Energy Reorganization Act of 1974, P.L. 94-438, 88 Stat. 1233, approved October 11, 1974.

One must also be discouraged by the state of the nuclear art when genuinely knowledgeable persons can have doubts of the kind exhib-
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21 The two most likely illicit uses of stolen materials would be to make crude nuclear explosive devices or, in the case of plutonium, to make a terror device to disperse this dangerous material in a populated place. For a detailed, recent treatment of the likelihood of these risks and the possibility that terrorists indeed could succeed in making such devices, see, M. Willrich & T. B. Taylor, Nuclear Theft: Risks and Safeguards (1974).

22 This warning was delivered to the Senate Committee on Governmental Operations on March 12, 1974. Hearings to Establish a Development Administration, and a Nuclear Safety and Licensing Commission Before the Subcomm. on Reorganization of Research and International Organization of the Senate Comm. on Governmental Operations, 93rd Cong., 2nd Sess. 107 (1974).

23 Id.


26 Id. at 6623.

27 Id.

28 Id.

29 As an illustration of a recent move by the Congress to inform itself on nuclear safeguards, the Senate Committee on Government Operations published a landmark compendium on this subject. Senate Comm. on Government Operations, Peaceful Nuclear Exports and Weapons Proliferation: A Compendium, 94th Cong., 1st Sess. (1975).

30 The notion of a “Faustian bargain” was developed by the noted nuclear scientist Alvin Weinberg, formerly director of the Oak Ridge National Laboratory. Writing in Science in 1972, Dr. Weinberg said: “We nuclear people have made a Faustian bargain with society. On the one hand, we offer—in the catalytic nuclear burner—an inexhaustible source of energy. Even in the short range, when we use ordinary reactors, we offer energy that is cheaper than energy from fossil fuel. Moreover, this source of energy, when properly handled, is almost nonpolluting. . .

But the price that we demand of society for this magical energy source is both a vigilance and a longevity of our social institutions that we are quite unaccustomed to. In a way, all of this was antici-
pated during the old debates over nuclear weapons. . .

It seems to me . . . that peaceful nuclear energy probably will make demands of the same sort on our society, and possibly of even longer duration. To be sure, we shall steadily improve the technology of nuclear energy; but short of developing a truly successful thermonuclear reactor, we shall never be totally free of concern over reactor safety, transport of radioactive materials and waste disposal. . . .” Weinberg, Social Institutions and Nuclear Energy, 177 SCIENCE 27-34 (1972).

31 The conventional ideas are to solidify these wastes, to combine them into glass or asphalt or some other inert form, and then either to store these solid wastes in a permanent mausoleum, or to put them in holes in salt mines. A complicating factor is that these wastes are so radioactive they become and remain quite hot, so that there may be heat disposal problems at the place of storage.

32 ERDA has large nuclear reactors which produce plutonium for weapons. These are located near Richland, Washington, and Savannah River, Georgia. The fission product wastes from these reactors are stored in liquid form in large storage tanks at these two locations. Recently the AEC, and now ERDA, have begun to solidify some of these wastes for long-term storage.

33 The story of these leaks was analyzed by Gillette in Radiation Spill at Hanford: The Anatomy of An Accident, 181 SCIENCE 728-30 (1973). More recently, Senator Cannon placed in the Congressional Record statements for and against the AEC proposal to develop the storage of radioactive wastes at the AEC’s Nevada test site. 121 CONG. REC. 1919-22 (daily ed. Feb. 17, 1975).

The potential dangers that such wastes might escape from their confinement and contaminate land or water was one factor underlying strong criticisms in Congress of AEC plans to install a permanent nuclear waste dump in a central Kansas salt mine. Indeed, Representative Skubitz of Kansas during 1971 and 1972 successfully challenged the AEC. He testified against the proposal before the Joint Committee on Atomic Energy, kept the issue alive in the Congressional Record, and helped to publicize information about the faults and errors of the plan that led the AEC to abandon this project. Illustrations of the pressure upon the AEC can be found in 117 CONG. REC. 4338, 7294, 14947, 19165, 26222, 26522, 27316, 31636, 32724 (1971); 118 CONG. REC. 39, 512, 4128, 4864 (1972).

34 There may be a risk for opponents of nuclear power in raising issues of morality, for the others can inquire into the morality of this generation of human beings consuming most of the known reserves
of oil and gas and so depriving all future generations of their use for energy or for chemical feed materials. Which then is the more immoral act: to bequeath fission products to posterity and save some oil and gas for them, or to use up remaining oil and gas faster than ever by not using nuclear power?

35 The Atomic Energy Commission in its final environmental statement for the proposed Pilgrim Nuclear Power Station Unit 2 near the town of Plymouth, Massachusetts, provided information on the typical regulatory approach and kinds of wastes likely to be routinely discharged. In discussing radwaste systems, the September 1974 AEC report stated:

During the operation of Pilgrim Station, radioactive materials will be produced by fission and neutron activation of corrosion products in the primary coolant. From the radioactive material produced, small amounts of gaseous and liquid radioactive wastes will enter the waste streams. These streams will be processed and monitored for radioactivity within the station to reduce (but not eliminate) the quantities of radionuclides ultimately released to the atmosphere and to Cape Cod Bay...

The AEC's impact statement estimated that releases of radioactive materials in liquid wastes would be approximately 3.5 curies per year, excluding tritium and dissolved gases. For gaseous waste, the principal source would be gases stripped from the primary coolant, with additional sources from the main condenser air ejector off-gases, ventilation exhausts, and gases collected in the reactor containment building. The AEC calculated that the plant's gaseous waste management system would release about 1200 curies per year of noble gases and negligible amounts of radioactive iodine. In addition, some 350 curies of tritium would be released to the water. In discussing the environmental impact of these releases, the AEC reported no detectable radiological impact would be expected in the aquatic biota or terrestrial mammals as a result of the releases into Cape Cod Bay and into the air at the station. As for the impact upon persons living within 50 miles of the station, the AEC estimated that maximum individual exposures from liquid and gaseous releases would be only a few percent of the natural background exposure of 0.1 mrem per year, would be below the normal variation in background dose, and would represent no measurable radiological impact. REPORT, UNITED STATES ATOMIC ENERGY COMMISSION (Directorate of Licensing: Final Environmental Statement related to the proposed Pilgrim Nuclear Power Unit 2. Boston Edison Company), Sept., 1974 (various pagings).

37 Professor Comar was then Chairman of the Department of Physical Biology, New York State Veterinary College, Cornell University.

38 Comar Report, supra note 36, at 7.

39 The term "mrem" means a milli-rem, which is a small unit of radiation exposure.

40 Additionally, there should not be attempted the reduction of small risks even further at the cost of large sums of money that spent otherwise would clearly produce greater benefit.

Other principles included:

—There should be an upper limit on man-made non-medical exposure for individuals in the general population such that the risk of serious injury from somatic effects in such individuals is very small relative to risks that are normally accepted.

—There should be an upper limit on man-made non-medical exposure for the general population. Average exposure permitted for the population should be considerably lower than the upper limit permitted to individuals.

—Guidance for the nuclear power industry should be established on the basis of cost-benefit analysis, particularly taking into account the total biological and environmental risks of the various options available and the cost-effectiveness of reducing these risks.

—In addition to normal operating conditions in the nuclear industry, careful consideration should be given to the probabilities and estimated effects of uncontrolled releases. It has been estimated that a catastrophic accident leading to melting of the core of a large nuclear reactor could result in mortality comparable to that of a severe natural disaster. Hence extraordinary efforts to minimize this risk are clearly called for. Comar Report, supra note 36.


In announcing its decision on numerical guidelines, the NRC said it fully subscribes to the general principle that, within established radiation protection guides, radiation exposures to the public should be kept as low as practicable, taking into account the state of technology and the economics of improvements in relation to the benefits to the public health and safety and the use of atomic energy in the public interest. In addition, the NRC announced it was directing its staff to prepare and issue for public comment a proposed rule to substitute the currently accepted phrasing “as low as is reasonably achievable” for the older, less precise terminology.

43 ENERGY USERS REPORT, at A.13 (1975).
44 Conventional and nuclear powerplants are now being ordered in sizes of 1000 megawatts and up. By way of comparison, the total generating capacity of the Boston Edison Company in 1973 was 2,658 megawatts which supplied some 469,000 residential customers, 61,971 commercial, 826 industrial and 192 other for a total of 531,989 customers. ELECTRICAL WORLD DIRECTORY OF ELECTRIC UTILITIES 339 (82d ed. 1973).
45 Director of Environmental Research for Business and Professional People for the Public Interest, Chicago, Ill.
47 In a subsequent paper, Comey asked whether nuclear plants could sustain a 20 percent increase in their average capacity factor, and then answered in the negative, stating:

One factor, at least, suggests not. Because of the radioactivity of the reactor and primary coolant systems in light-water reactors, repairs on these systems take more time and more workers than similar repairs on coal-fired plants. In order to avoid exceeding each worker’s maximum permissible radiation exposure, a large number of men must work sequentially within a confined space to make repairs on nuclear reactor systems. For example, at Commonwealth Edison’s Dresden Nuclear Power Station, a recent prolonged outage took 350 to make repairs that 12 men could have done quickly on a fossil-fired plant.

D. COMEY, NUCLEAR POWER PLANT RELIABILITY: THE 1973-1974 RE-
CORD 6, BUSINESS AND PROFESSIONAL PEOPLE FOR THE PUBLIC INTEREST, PUB. NO. BPI-7507 (1975). Comey generalized that since the radioactivity of these plant systems increases with plant age, repairs are likely to become even more time consuming as the plant gets older, leading to longer outages and decreased capacity factors.

48 Reliability of Nuclear Power Plants, AIF BACKGROUND INFORMATION, Issue No. 82, at 3 (1974).

49 According to the AIF, Commonwealth Edison in Chicago, which owns 22 percent of the Nation’s nuclear capacity, found that during the 12 months ending March 31, 1974, its four large nuclear units averaged 80.2 percent availability, compared to 68.8 percent for their five large coal-fired plants. Id. at 2.

50 120 CONG. REC. 11793 (daily ed., Dec. 12, 1974).


52 NUCLEAR INDUSTRY 32-33 (March 1975). The recommendation was made by Edwin G. Triner, NRC director of program analysis. He outlined five steps by NRC to improve reliability of operation, including: (1) expanded collection and analysis of failure data by the utilities; (2) working with State public utility commissions to educate them on the relationship between design investment and operating and maintenance costs; (3) modification of NRC license applications to require utilities to explicitly identify plans for assuring high reliability; (4) using NASA's experience with systems reliability; and (5) selective interaction by NRC with officials of public utilities and architect-engineers to express its interests in improved system reliability and to solicit their ideas.

53 The industry apparently has shown little interest in regulatory effects by NRC to improve reliability. ENERGY USERS REPORT, at A-13 (April 1975). However, in April 1975, the chairman of the Edison Electric Institute, Robert F. Gilkeson, said at the American Power Conference that significant improvement of plant availability must be a major goal. ELECTRICAL WEEK, at 6 (April 1975), Gilkeson was critical of custom designing rather than standard design of large powerplants and called for a slowdown in plant size escalation and application of quality assurance and quality control as ways to improve powerplant availability.

54 NRC Press Release No. 8, 75-13 (Jan. 29, 1975). On February 5, 1975, Chairman Anders of the NRC was called before the Joint Committee on Atomic Energy to explain this action. His remarks give an insight into the still-forming philosophy of this new commis-
sion which was created by Congress to eliminate the old conflict of interest within the AEC between its functions of fostering and regulating nuclear power. Mr. Anders stated:

We do not view our task as an easy one. We and our staff know that it is the nature of regulation to be faced with many difficult and complex decisions where often the deciding factor boils down to judgment. When an issue is not clear, our approach will be one of prudence. . . . In keeping with this approach, the Commission's judgment to issue the inspection directive last week was based on careful consideration of the NRC staff's recommendation and their evaluation of the facts available, and on the Commission's intent to be prudent in dealing with matters which could potentially affect public health and safety.

As for the action itself, Mr. Anders explained:

Gentlemen, there are those who may feel that the action taken by the Commission was too severe. There may be others who seek to use this action to suggest that nuclear power is inherently unsafe. The Commission believes strongly that neither is a proper conclusion.

57 42 U.S.C. § 2011 et seq. (1954). In this revision, Congress declared that the development, use, and control of atomic energy shall be directed so as to make the maximum contribution to the general welfare, and also provided for several programs, including those for conducting, assisting, and fostering research and development in order to encourage maximum scientific and industrial progress; and to encourage widespread participation in the development and utilization of atomic energy for peaceful purposes to the maximum extent consistent with the common defense and security, and with the health and safety of the public.


62 In the June 1975 issue of Not Man Apart, Friends of the Earth devoted a full page to questions and answers about nuclear insurance which it opened with the question: "If nuclear powerplants are as safe as industry claims, then why aren't they fully insured?" It then went on to estimate that a major nuclear accident could cause casualties of up to 45,000 people with 100,000 more injured and property damage of more than $17 billion.

On June 4, 1974, Senator Gravel wrote to all Members of Congress
opposing extension of the Price-Anderson Act and proposed instead a bill to make nuclear utilities take financial responsibility for what they do, like other businesses. "Only if nuclear power is safe enough for utility stockholders can the American people believe it is safe enough for themselves."

63 The interested reader will find a detailed presentation of arguments for extension of the Price-Anderson Act in Hearings on the Possible Modification or Extension of the Price-Anderson Insurance and Indemnity Act Before the Joint Committee on Atomic Energy, 93d Cong., 2d Sess., pts. 1 & 2 (1974).

64 A report of the Congressional Research Service estimated that Federal expenditures relating to nuclear power for fiscal years 1948 through 1974 totaled some $13.6 billion. This consisted of $4.5 billion for military and space applications, $3.7 billion for civil power, $3.9 billion in related physical research and about $1.5 billion for related biological, medical and environmental research. W. H. Donnelly, Congressional Research Service, Federal Expenditures Relating to Civil Nuclear Power, Fiscal Years 1948-1974 (1973).

65 Exploring Energy Choices: A Preliminary Report of the Ford Foundation's Energy Policy Project 75 (1974). The other energy technologies included in the analysis were coal resource development, petroleum and natural gas, nuclear fusion, energy conversion, general energy research and development, conservation including transportation, solar energy and geothermal energy.


69 Id. at 521. The Vanik analysis shows the principal non-nuclear subjects for energy research during fiscal year 1976 as: coal at $279 million, representing 6.5 percent of the ERDA budget; petroleum and natural gas at $23 million, representing 0.6 percent; oil shale at $8 million, representing 0.2 percent; and solar energy at $57 million, representing 1.5 percent. In comparison, he estimated nuclear energy development at $563 million, representing 15 percent.


75 Supra note 68, at 521.
78 In 1973 the management-consulting firm, Arthur D. Little (ADL), delivered a report to the Board of Trustees of Northeast Utilities on base-load alternatives for the northeast utilities system. In that report ADL, after considering all alternatives for the region, concluded that nuclear power is the appropriate choice for the base-load additions contemplated by the utilities for start of service in the period 1981-1984 and so recommended.
80 The term “nuclear fuel cycle” refers to the chain of industrial operations necessary for nuclear power. The cycle starts with the mining of uranium and proceeds through milling, chemical processing, enriching, fuel fabrication, fuel use, fuel reprocessing, waste disposal, and, of course, the transportation of nuclear materials and wastes between these various operations.
81 Some scientists are now looking into the ideas of separating out the most bothersome radioactive species from the nuclear wastes and either storing these separately, which would reduce the storage problem, or using the energy emitted from them for industrial, medical and other purposes. As for the heavy metal components of the wastes, the so-called transuranic elements, some scientists would transmute these into short-lived isotopes by exposure to neutrons. While these ideas are in their preliminary stage, they illustrate some of the innovation in thought that can be expected as solutions are sought to problems of nuclear power. However, we must be sure that the solutions do not in turn generate new and worse problems. For example, if radioactive strontium and cesium were to be removed from nuclear wastes and widely used in industry, would the risk of occupational and public exposure from this solution exceed the risks of exposure from burial of the wastes in salt mines?
82 H. R. 5406, 94th Cong., 1st Sess. (1975) is intended to accomplish this result. The author welcomes this opportunity to invite comment and support from the readers of Environmental Affairs.