Docket No. 50-263

JUN 4 1969

PDR

Mrs. Earl R. Alton
4216 40 Avenue South
Minneapolis, Minnesota 55406

Dear Mrs. Alton:

Your letter of April 14, 1969, to the President has been referred to me for reply. I am enclosing several documents that I believe will be of interest to you.

On January 2, 1969, the White House released a report on the environmental and other public interest problems in siting large electric power plants, both nuclear-powered and fossil-fueled. The Atomic Energy Commission was pleased to cooperate with the President's Office of Science and Technology and other Government agencies in the study leading to this report. I am enclosing a reprint of Chapter III, "Nuclear Power Reactor Plant Siting;" the full report, "Considerations Affecting Steam Power Plant Site Selection," may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402, for $1.25.

The waste products of nuclear reactor fuel have been handled safely and stored in such a fashion that they pose no present pollution problem. A detailed discussion of radioactive waste management and research and radioactivity in the environment, is contained in the enclosed copy of AEC testimony presented at 1968 hearings on "Environmental Quality" before the Subcommittee on Science, Research, and Development of the House Committee on Science and Astronautics.

You mention in your letter that "We also know death rates from cancer and leukemia have increased in areas on Columbia River downstream from the reactor by 12.9% in a study by Bailar & Young for Public Health Service." I am not aware of any such statement in a study by Bailar & Young. I am aware, however, of an article published by Public Health Reports in

April 1966 by John C. Bailar III and John L. Young who are with the National Cancer Institute, Public Health Service. I am enclosing a copy of that article, entitled "Oregon Malignancy Pattern and Radioisotope Storage - A Reappraisal," which concludes that "no evidence was found that persons living downstream from the Hanford Preserve or along the Pacific coast of Oregon have had an excess risk of death from cancer in general or from leukemia in particular."

I am also enclosing for your information a staff report on the status of the licensing of the Northern States Power Company's Monticello Nuclear Generating Plant, and our evaluation of radiological effects from its operation. With this report I am enclosing two booklets, "Licensing of Power Reactors" and "Atomic Power Safety."

Sincerely,

(signed) Harold L. Price

Harold L. Price
Director of Regulation

Enclosures:
1. "Nuclear Power Reactor Plant Siting"
2. Statement of Dr. Joseph A. Lieberman
3. "Oregon Malignancy Pattern and Radioisotope Storage - A Reappraisal"
4. Report on Monticello plant
5. "Licensing of Power Reactors"
6. "Atomic Power Safety"

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Statement of Dr. Joseph A. Lieberman, Atomic Energy Commission,
before the
Subcommittee on Science, Research and Development of the House Committee
on Science and Astronautics
February 1, 1968

1967 has been an eventful year in the growth of the nuclear power industry. The rate at which electric utilities have ordered nuclear power units has been remarkable, even to those who are close to the industry. By the end of 1967, approximately 50,000 megawatts of nuclear electric power had been firmly committed, with about 2000 megawatts of plant capacity now in operation. This rate of growth is even more remarkable when one considers that it was only ten years ago (December 1957) that the first commercial plant -- the Shippingport Atomic Power Station operated by the Duquesne Light Co. -- went on the line to supply 60 megawatts of electricity to the city of Pittsburgh.

The most significant aspect of this nuclear power growth is that the safety and reliability of light water reactors have been established and nuclear plants now being planned or under construction are being built on the basis of their economics. While economics have played a major role in this surge of nuclear power, another advantage of nuclear power plants is that there has been a growing awareness of their advantage as clean sources of power which do not contribute to the current burden of air pollution. In fact, some utilities have chosen nuclear power and have indicated that in so doing, they wished to reduce air pollution.

The management of radioactive waste effluents from commercial nuclear power plants continues to be carried out on a highly satisfactory basis; operational records for the past 7-10 years indicate effluent discharges of less than 10 per cent of internationally accepted radiation protection limits. The following material presents summary information as requested on specific aspects of radioactive effluent control.

Future Waste Management Problem

With the recent surge of the nuclear power industry, some people have expressed concern that a serious environmental pollution problem would result from this growth; similarly, others have been concerned that the development of safe and economical nuclear power might be deterred because of the waste disposal problem. In this connection, the management of radioactive wastes resulting from the processing of spent fuel elements from nuclear electric power plants is a major consideration. The highly radioactive waste materials which are separated in this operation must be contained and isolated from man and his environment for literally hundreds of years. Long-term high activity waste management requirements are continually being evaluated, in order to guide the development and planning of the Commission's effluent control R&D program. This potential future problem was discussed at length, during hearings of the Joint Committee on Atomic Energy in 1959 when it was estimated that, using the then current processing technology, the volume of high and intermediate level wastes accumulated by 1980 would reach 36 million gallons.

Since the time of these hearings, extensive improvements in fuels technology and fuel reprocessing methods have markedly reduced the volume of high-activity reprocessing wastes which are generated per unit of nuclear power produced. Also, during this period of nine years, estimates of installed nuclear power in 1980 have risen by a factor of 5-7 -- from 25,000 MW_e in 1959 to the present 120,000-170,000 MW_e forecast. However, the estimated accumulated high-activity waste to be handled by 1980 has dropped by a factor of about 7 -- from 36 million gallons to approximately 5 million gallons. Even with the currently projected nuclear power growth rate, the accumulated waste volumes by the year 2000 are estimated at about 80 million gallons, which is comparable to the high activity waste volumes which have been satisfactorily managed by the Commission in its operations to date.

These estimates are based on an assumption that the wastes would be stored as liquids for long terms in underground tanks. However, with the satisfactory development of processes for conversion of high-level liquid wastes to stable solids (now in the engineering demonstration phase), with subsequent long-term storage or disposal in a dry geologic formation such as salt (now in the field testing stage), technology for an alternative waste management system will become available. With adoption of a conversion-to-solids waste management concept, approximately 1 cubic foot of solid waste would be produced per hundred gallons of high-activity waste (per 10,000 MWd of fuel exposure). Preliminary engineering and economic evaluations indicate a 30-year interim storage of waste solids would be desirable before final disposal; by the year 2000, the rate of production of waste solids for final disposal or long term storage would require about 2.8 acres of salt mine floor space per year. (Additional information on salt disposal is provided under the Section "Long-term Safety of High-Activity Waste Storage".)

During the past year, various task force groups have been involved in an extensive cooperative effort to update the 1962 Report to the President on Civilian Nuclear Power. Included in this effort is a study of nuclear power growth patterns in the U. S. to the year 2020 in order to determine the size and location of fuel reprocessing plants and associated waste management requirements. An up-to-date comprehensive long-range waste management plan is also being developed, taking into account the latest power projections and fuel reprocessing plant size and locations, in order to determine the number and size of permanent high-activity waste storage sites which may be required. It is planned that reports of these studies will become available to industry and the public upon their completion.

In a related question, some concern has been expressed on the decommissioning of power reactors and the associated disposition of the reactor site, if this should be required. Nuclear power plants are currently being built using a design life basis of forty years. If, for some reason, it is decided to retire the plant, procedures for dismantling the plant would be subject to Commission approval and would be required to meet the Commission's standards for protection of the worker and the general public. Decommissioning alternatives, which require evaluation, include varying degrees of "moth-balling" the plant, i.e., decontaminating, dismantling and removing the facility (in whole or in part) and burial in place or at an approved disposal facility. Procedures for these operations must be submitted to the Commission in accord with its regulations, to assure that adequate safety measures will be taken in the course of decommissioning the reactor, and with respect to any sources of radiation that may thereafter remain at the site. Experience is being gained in moth-balling plants, such as the Hallam Nuclear Power Facility in Nebraska and the Carolinas - Virginia Tube Reactor in South Carolina, which indicates that power reactors can be decommissioned safely.

Transportation of Radioactive Materials

The principal hazards which must be guarded against during the transport of radioactive or fissile material are accidental criticality (nuclear chain reaction, and release of radioactive material or radiation because of loss of containment or shielding as a result of impact or exposure to a severe fire. These hazards are avoided by specifying the shipping conditions, carefully controlling the quantity of fissile material which may be shipped in a single container, and by designing and fabricating the shipping containers to withstand a series of hypothetical accident conditions, including severe impact and fire. Each shipment, including container design, must meet the requirements of various regulatory agencies, including the AEC and the Department of Transportation.

The shipping experience of AEC contractors and licensees has been exceptionally good. During the transportation of this material there has been no death or injury due to the radioactive nature of this material.

A continuing research and development program is being supported by the AEC to assure that the engineering technology is adequate to satisfy the needs of the cask designer. A shipping cask design code is presently being developed for the use of the industry at the Oak Ridge National Laboratory (ORNL) in Tennessee. Other research is underway to develop a substitute for lead as the primary shielding material in large shipping casks because of its relatively low melting point. Future R&D is anticipated in the area of fast breeder reactor fuel shipping, as an integral part of the Commission's Fast Breeder Reactor Development program.

Long-Term Safety of High Activity Waste Storage

More than 20 years' experience with the storage of liquid high-activity wastes in specially designed underground tanks has shown it to be a safe practical means of interim handling, but the long-term usefulness of this method may be limited. Assessments have been made which indicate that large releases of radioactivity due to geologic and hydrologic events are only remotely possible in the areas where high-activity wastes are stored. These studies have included an evaluation of the historic record of seismicity and the longer-ranging geologic record, including investigation of geologic structure; physical and hydrologic properties of sediments and rocks; and analysis of terrains in the vicinity of high level waste management operations. Studies of extremely unlikely hydrologic events are being continued in a further effort to specify their probability of occurrence and potential effects on nuclear facilities and associated waste management systems.

Due to the inherent restrictions of tank storage, such as potential leakage and the necessity of liquid waste transfer for periods of hundreds of years, the Commission has supported an extensive research and development program directed at engineering practical systems for conversion of high activity liquid waste to a solid form. Concurrently, extensive studies have been carried out to determine the most suitable geologic formations for the long term storage of highly radioactive waste material. Salt is an advantageous disposal media because of its unique geologic characteristics. Salt formations are dry and impervious to water. They are not associated with usable ground water sources and, therefore, have no connection or contact with the biosphere. Because of its plasticity, fractures in salt seal or close rapidly. Deposits of rock salt underly some 400,000 square miles of the United States and represent some of the few naturally occurring dry environments in the eastern part of the country where the most extensive development of the nuclear industry is taking place. Extensive laboratory investigations at ORNL and field studies in the Carey Salt Mine, Lyons, Kansas, are providing field data and design information required for the engineering design of a long term disposal facility for high activity waste solids.

A field experiment called Project Salt Vault, has been carried out in which Engineering Test Reactor fuel elements of high-radioactivity were used to simulate the thermal and radiation characteristics of full-scale power reactor fuel reprocessing wastes, such as would exist in a pot containing calcined solids. The field demonstration began in November 1965 -- four successful changes of fuel elements were completed in June 1967. The experimental results from Project Salt Vault are now being evaluated and appear most encouraging. The feasibility and safety of handling highly radioactive materials in an underground environment has been demonstrated, and the stability of salt under the effects of heat and radiation has been shown. Engineering reports of this work will be available to industry during this year and the various factors involved in establishing a prototype salt disposal facility for the storage of high activity waste solids is now under study at ORNL. The use of other geologic materials for long term storage, such as crystalline bedrock, thick anhydrite, or limestone beds is also under study.

Waste Management Research

The management of radioactive waste materials in a growing atomic energy industry can be classified under two general categories. These are the treatment and disposal of large volumes of low activity gaseous, liquid, or solid wastes which are evolved during the course of operating reactors and other nuclear facilities; and the treatment and ultimate disposal of much smaller volumes of high activity wastes generated during the reprocessing of irradiated nuclear fuels. Significant progress and accomplishments have been achieved during the past ten years in developing satisfactory waste management systems for both categories of waste. The success, over the years, of the Commission's waste management program is illustrated by the excellent effluent control record which has been achieved by the industry and AEC contractors. AEC production and research facilities and large commercial nuclear power plants limit releases of radioactive materials to the environment to concentrations which are only a small fraction of internationally accepted radiation protection standards. Highlights of the R&D program are briefly summarized --

1. Advanced low-level waste treatment and disposal technology involving the use of evaporation, ion exchange, foam separation, electrodialysis, water recycle, and asphalt solidification has been developed. This technology is now being used in the design of commercial power reactor and fuel reprocessing waste management facilities.
2. The disposal of actual intermediate level waste by hydraulic fracturing of shale has been demonstrated with an engineering-scale pilot plant at ORNL. This technique which was obtained from the petroleum industry, consists of injecting a waste-cement-clay mixture under high pressure through a slotted well casing into an impermeable formation at depths of, in the case of ORNL, 700-1000 feet. A hydrofracturing plant was placed in operation at Oak Ridge during 1966 for the disposal of evaporator slurries; the use of this disposal method at other sites is now under study.
3. The Waste Calcining Facility at the National Reactor Testing Station in Idaho became the world's first plant-scale facility for converting actual high-level radioactive wastes to a safer, solid form in December 1963. This plant has continued to operate satisfactorily over the past four years, during which time about 1.3 million gallons of high-activity aluminum type waste from the reprocessing of test reactor fuel have been solidified with a volume reduction to about 1/10 the original, and then stored in stainless steel bins in underground vaults.

4. The technology for solidification of power reactor fuel reprocessing high-level waste has reached the engineering-scale demonstration phase with a "hot"-pilot plant having been placed in operation at the Commission's Laboratories in Hanford, Washington, in November 1966. Operational data are now being obtained for three waste solidification processes using full-scale high activity waste; results of this program will be available for industrial use during 1969-70.
5. ORNL laboratory and field research involving the storage of high-level waste solids in a salt mine has culminated in a full-scale field test program at the Carey Salt Company Mine in Lyons, Kansas (details provided above). Results of this field study and engineering design information will be available for industrial use by 1969.

In brief, the waste management R&D program has been and is providing the technology to engineer systems for effluent control, as required by an expanding nuclear energy industry, and no "breakthroughs" are required to meet future loads. The nature and quantity of waste effluents from thermal and fast breeder reactors are being evaluated as development proceeds on these future reactor systems.

Waste Reconcentration by Biological Organisms (Ecological Processes)

Certain radionuclides are known to be concentrated by biological processes in organisms. This concentration by biological processes may occur in the food chain leading to man. Four notable examples are the reconcentration of (1) cesium-137 from fallout in Caribou meat which is eaten by Eskimos; (2) phosphorous-32 by fish in the Columbia River from cooling water which passes through the Hanford production reactors and is then discharged to the river; (3) zinc-65 by shellfish, particularly oysters, that live in locations near the mouth of the Columbia River, and (4) iodine-131 in animal and human thyroid glands. The reconcentration of radionuclides in man's food chains must always be considered whenever radionuclides are released to the environment. The Commission takes into account reconcentration aspects in setting release limits to the environment from operating facilities. The U. S. Fish and Wildlife Service is regularly consulted on questions in this area.

In the case of waste released by power reactors and fuel reprocessing plants the radionuclides most likely to be reconcentrated are the iodine-131 released to the atmosphere and zinc-65 released to a water system. Evidence available from the Clinch River Study (a comprehensive stream study carried out during 1960-64 by the AEC, ORNL, USGS, USPHS, TVA, the Tennessee Dept. of Public Health, the Tennessee Stream Pollution Control Board and the Tennessee Game and Fish Commission) indicates that the maximum accumulation of radionuclides entering the Clinch River from Oak Ridge National Laboratory operations which might concentrate in the biomass constitutes only an insignificant part of the radioactivity in the river. Thus the river system can be likened to a pipeline with little retention or concentration of radionuclides in either the bottom sediments or the biota.

If zinc-65 is to be released into or can be transported to a marine environment, special consideration must be given to its reconcentration. Zinc is concentrated by shellfish (1000-10,000 times); as an activation product, zinc-65 is present in the waste discharged by several light water reactor power plants and, where required, special limits can be applied to its release.

The gaseous wastes discharged by nuclear fuel reprocessing plants may contain small amounts (below permissible limits) of tritium, krypton-85 and iodine-131. Only iodine is capable of being concentrated by biological processes; however, the other radionuclides may be cycled by ecological processes. Iodine-131 appears principally in the food chain which leads through milk to man and the procedures for monitoring this food chain are well developed. Environmental monitoring data again indicate radioactivity concentrations well below those of public health significance.

Thermal Effects of Steam Electric Generating Plants

The generation of electrical power produces waste heat which must be discharged to surface water or to the atmosphere via cooling towers. The average thermal efficiencies of different types of steam electric plants vary approximately as follows:

	Net thermal efficiency %
Modern Coal Fueled Plant	38
Modern Light Water Reactor	32
Future Fast Breeder (Calculated)	40

Therefore, at the present time, a nuclear plant of current design discharges more waste heat to surface streams than a conventionally fueled plant of the same size because of a lower thermal efficiency. Of course, about ten per cent of the waste heat from a coal-fired plant is discharged to the atmosphere with the combustion gases, whereas essentially all of the heat discharged by a nuclear plant is through the water cooling system. When fast breeder reactors become operational, this disparity will be reduced.

Generally speaking, the problem of "thermal pollution" is one of degree. An increase in water temperatures can be harmful, or in some cases, beneficial to certain fish and aquatic life. The questions that must be answered are -- what are the effects of small increases of temperature in various situations, and if harmful, how can these effects be avoided? The world's electric power demand will continue to grow at an ever increasing rate. Increasing quantities of waste heat will have to be dissipated, regardless of the proportion of coal-fueled to nuclear-fueled plants that are built. Large quantities of condenser cooling water (several hundred thousands gallons per minute for a 1,000 MW_e plant of either type) will be required. As a result, the availability of adequate condenser cooling water is becoming a major consideration in selecting sites for these plants. Proper site selection requires information on the physical dispersion of heat in the environment and the effects of small temperature increases on the biota.

Research in this area has been underway for some time - for example, the AEC has sponsored research on the physical and biological effects of temperature on Columbia River for more than fifteen years. As a result, mathematical models are now being developed for predicting the increase in temperature of the receiving water from heated effluents which are discharged into rivers, lakes, and tidal systems. The reliability of these models is being determined against known conditions. A model has been used to predict temperatures of the Deerfield River downstream from the Yankee Atomic Reactor, Rowe, Mass., for example, and the predicted temperatures have agreed very closely with temperatures actually measured. This mathematical model development is being followed with an application of the model to the prediction of temperature increases throughout an entire river basin. The upper Mississippi River basin has been selected for the pilot effort.

In brief, the magnitude and severity of thermal effects problems from both nuclear- and fossil-fueled electric power plants depend on local environmental conditions. Proper site selection is becoming more important as the availability of adequate surface water supplies for condenser cooling becomes more critical. However, it should be noted that technology for solving potential thermal pollution problems is available. Auxiliary cooling systems (reservoirs, ponds, or cooling towers) can be a solution, but increased initial plant costs, in the range of 5-10%, may be required over a conventional river water cooling system. However, these costs may be offset by increased flexibility in site selection, which could result in lower costs for fuel, power transmission, and land, plus a lower heat rejection to the river.

Extent of AEC Pollution Research Program

Extensive radioactive waste management and pollution related research and development have been carried out as an integral part of the Atomic Energy Commission's overall R&D program in order to assure an orderly growth and safe development of the nuclear energy industry. Approximately $30 million was spent during FY 1967 and about $31 million is budgeted for FY 1968 in the Commission's biology and medicine, reactor development, weapons, raw materials, production and isotopes development programs for this purpose.

Resources at AEC multiprogram laboratories are also being utilized in a number of pollution and environmental health studies being conducted in direct support of the objectives of other agencies. Now underway are two joint efforts with HEW's National Center for Air Pollution Control. One, conducted at AEC's Brookhaven National Laboratory on Long Island, is examining the economic and technical feasibility of using stable isotopes of sulfur to trace the migration and chemical reactions of oxides of sulfur emitted with stack effluents. The other, is a joint program involving AEC's Argonne National Laboratory near Chicago, with the Department of Air Pollution Control of the city of Chicago and the National Center for Air Pollution Control. The objective of this tripartite effort is to develop an air dispersion model which will aid in the establishment of pollution control measures for the Chicago Metropolitan area.

At Brookhaven National Laboratory a study of the oxidation, by radiation, of iron in acid mine drainage has been conducted in order to assess the potential of this method in relation to other mine drainage treatment methods being developed by the Department of the Interior and the Department of Mines and Mineral Industry of the State of Pennsylvania.

During the past year Commission staff and representatives of the Departments of Commerce, Interior and HEW have discussed how resources available at AEC's multiprogram laboratories might be applied to pressing pollution control and abatement problems. The aforementioned programs and a number of proposed programs now being discussed have, in large part, resulted from this series of interagency meetings. The Commission is continuing its efforts along this line and is hopeful that other areas can be identified in which the experience and facilities available at its multiprogram laboratories can be used to make substantial contributions to solving pollution and environmental health problems.

Very recently, last year, Sec. 33 of the Atomic Energy Act was amended to authorize AEC to assist others on health or safety research and development problems unconnected with AEC's nuclear missions. This added authority will serve to provide AEC with more flexibility in utilizing its laboratories, facilities and talent to help others solve important national problems such as environmental pollution.

Summary and Conclusions

In summary, AEC strongly supports the efforts which are directed toward restoring and/or maintaining the quality of our environment -- a goal which has become an important national objective. The Commission's program of radioactive waste control is consistent with this objective. Independent evaluations of the program that have been made over the years by various technical committees in the National Academy of Sciences, and an advisory group to the President's Federal Council for Science and Technology have shown that radioactive waste management operations are being carried out in a safe and economical manner, without harmful effect on the public and its environment. Also, the Joint Committee on Atomic Energy maintains a continuing review and surveillance over the Commission's waste management program to assure that development of the nuclear energy industry can be carried out with full protection of the public health and safety. Waste processing technology and environmental science have been, and are being developed, which will continue to provide satisfactory pollution control systems for the expanding nuclear power industry. We believe this source of energy will make an increasingly significant contribution to the nation's energy needs and, in so doing, will lead to a major reduction of the country's overall environmental pollution problem.

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frontispiece

This pharmacy of the 1890's is part of the permanent exhibit of medical history which opened this month in the Museum of History and Technology, Smithsonian Institution, Washington, D.C.

—*Smithsonian Institution photograph*

Oregon Malignancy Pattern and Radioisotope Storage

JOHN C. BAILAR III, M.D., and JOHN L. YOUNG, Jr., M.P.H.

AN INCREASED mortality rate for cancer, including leukemia particularly, among Oregon residents near the south bank of the Columbia River or along the Pacific Coast was reported recently by Fadeley (*1*). This would be an important observation if it were confirmed, because there is an increase in the radioactive content of water which flows through or past the Hanford (Washington) Atomic Storage Preserve before it is carried downstream past the areas which Fadeley reported to have high mortality rates. Because of the following features of his report, however, we have re-examined the question.

1. Several inland counties were omitted without explanation in the analysis.

2. Basic data (numbers of deaths) were not reported, and random variations of rates calculated on the small numbers of deaths occurring in single counties were not considered.

3. Al' ·ugh the age and sex structure of the population varies from one county to another, the rates were neither age adjusted nor sex adjusted.

4. The fact ... ou, ·out the United States and in many other countries cancer mortality rates are higher in cities than in rural areas (*2, 3*) was not mentioned. The river and Pacific counties generally are more densely populated than the inland counties, and, on this basis, they might be expected to have higher rates.

5. No study was made of cancer mortality data from earlier y··rs to determine if the reported excess risk was present before the Hanford Atomic Energy Facility started operation.

6. No study was made of cancer mortality rates along the north bank of the Columbia River, which is in the State of Washington.

The authors are with ... *Biometry Branch, National Cancer Institute, Pub* ... *Health Service.*

Method of Analysis

Total cancer mortality rates and leukemia mortality rates for groups of counties in Oregon and Washington from 1934 through 1963 were adjusted by the indirect method (*4–6*) for differences between counties in the age and sex composition of the population (table 1 and fig. 1). The 1950 observed mortality rates for all forms of cancer and for leukemia in the U.S. white population (7) were taken as standard. For the years prior to 1949, the rates include a small adjustment for differences in cause-of-death assignments in the fourth, fifth, and sixth revisions of the International Classification of Diseases (*8, 9*).

Because the 1960 nonwhite populations were rather small in Oregon (2.1 percent) and Washington (3.6 percent), no adjustment was made for race. The numbers of deaths on which the rates in table 1 are based are shown in table 2.

Table 3 lists the counties included in each area, and figure 2 shows the boundaries of the counties and county groups. Counties in the Metropolitan Portland area were considered separately from the other river counties because of the different cancer risk between urban and rural areas in general (*2, 3*).

The age-sex-adjusted mortality rates for all forms of cancer and the numbers of deaths upon which these rates were based for Oregon and Washington are shown by county in tables 4 and 5. We did not include a similar tabulation of leukemia mortality in this report because the numbers of deaths in most counties were quite small.

Results

Several trends are clear from figure 1. First, total cancer mortality rates in Oregon and Washington have been consistently lower than the average rate for the U.S. white population. In contrast, leukemia mortality rates in both States have been above average for as long as data by county are available (1940 in Oregon and 1934 in Washington). Although the rates in both States have increased rapidly in recent years, the increase has been about the same as in the rest of the United States. Interestingly, the excess in leukemia mortality existed before the Hanford Preserve began operation in 1945.

Second, total cancer mortality rates in the Portland region of Oregon have remained essentially unchanged since 1935. Mortality in the river counties has increased up to the State average, but remains substantially below that for the entire United States, and mortality in the ocean counties has actually declined. In Washington total cancer mortality in the river counties has been consistently lower than in other parts of the State. Mortality rates for

Table 1. Mortality rates [1] per 100,000 population for all forms of cancer and for leukemia in the United States, Oregon, and Washington, in various time periods

Area	1934–37	1938–42	1943–47	1948–52	1953–57	1958–63
	All forms of cancer					
Total United States [2]	145.6	140.6	138.2	143.8	144.9	[3] 141.9
Oregon	[4] 128.8	[5] 128.8	128.5	129.9	130.5	132.5
River counties	[4] 111.0	[5] 123.8	112.7	127.3	131.4	133.7
Ocean counties	[4] 133.4	[5] 120.3	113.5	121.5	123.8	121.8
Portland counties	[4] 143.0	[5] 137.8	142.3	140.9	138.1	142.4
Inland counties	[4] 112.7	[5] 121.6	120.3	118.8	122.6	123.8
Washington	144.8	136.7	130.2	135.0	139.3	138.5
River counties	125.6	121.5	106.0	114.4	125.0	128.9
Ocean counties	126.3	126.5	128.7	135.8	127.2	133.7
Portland counties	123.9	139.4	134.1	134.9	128.1	137.5
Inland counties	149.1	138.8	131.9	136.4	142.0	139.7
	Leukemia					
Total United States [2]	3.4	4.2	4.9	6.1	6.8	[3] 7.0
Oregon	([6])	[7] 4.8	5.3	6.2	7.4	7.6
River counties	([6])	[7] 4.8	4.9	5.5	7.3	7.9
Ocean counties	([6])	[7] 5.9	4.2	6.2	8.1	6.2
Portland counties	([6])	[7] 5.6	6.9	7.0	7.5	8.3
Inland counties	([6])	[7] 3.4	3.7	5.3	7.0	7.3
Washington	[8] 3.1	4.1	5.4	6.1	6.9	7.4
River counties	[8] 3.3	2.7	4.6	7.2	6.1	6.1
Ocean counties	[8] 3.1	3.7	4.1	4.9	4.8	7.1
Portland counties	[8] 1.1	3.2	7.4	7.6	6.7	7.4
Inland counties	[8] 3.2	4.3	5.5	6.1	7.2	7.6

[1] Rates adjusted for age and sex by the indirect method, taking U.S. 1950 observed rates for males and females in 10-year age groups as standard.

[2] Rates for white population only.

[3] Rates for 1958–62.

[4] Rates for 1935 only.

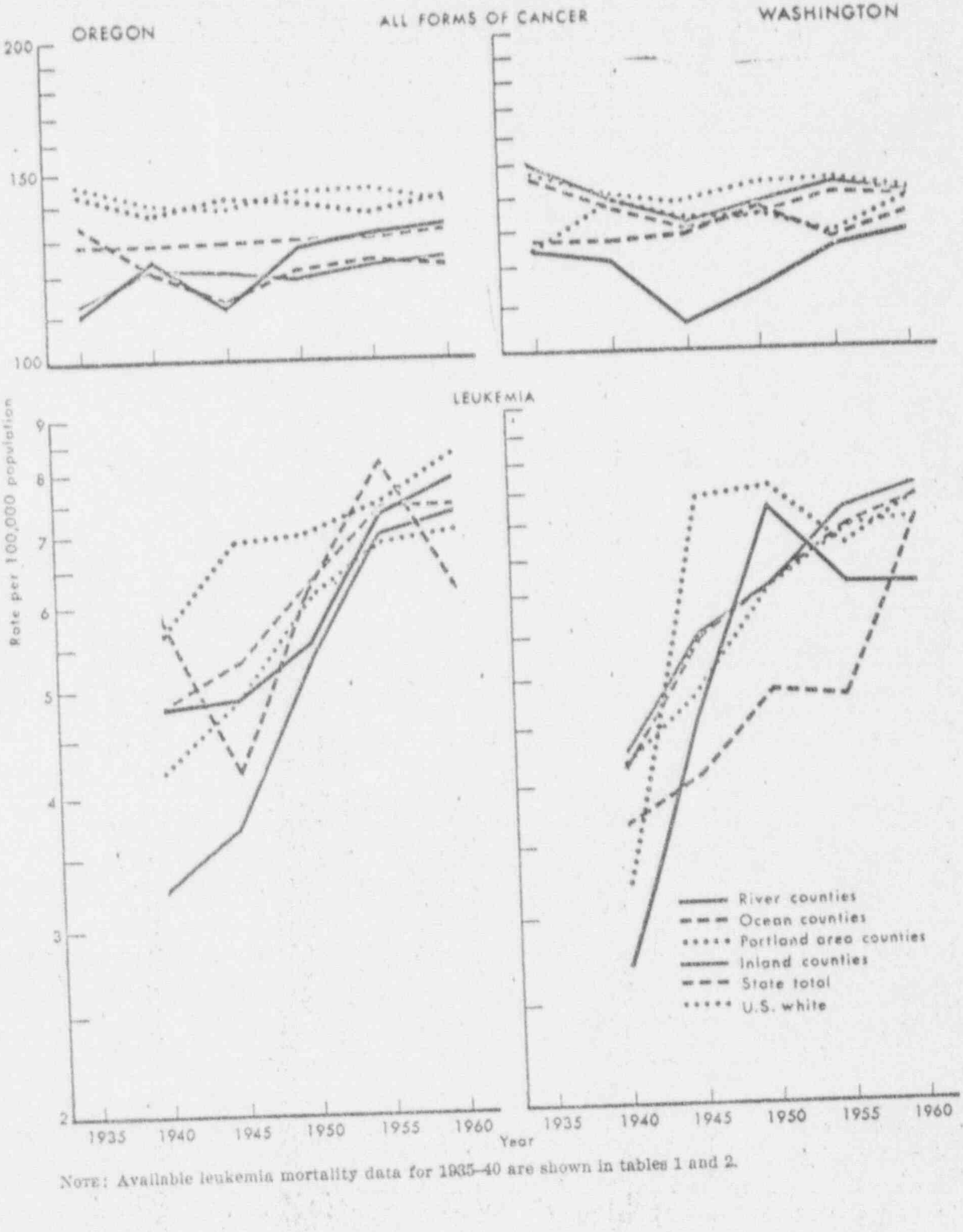
[5] Rates for 1939–42.

[6] Leukemia deaths by county not available for these years.

[7] Rates for 1940–42.

[8] Rates based on leukemia deaths in 1935 and 1937 only. Leukemia deaths not available by county for 1934 and 1936.

Figure 1. Annual mortality rates per 100,000 population for all forms of cancer and for leukemia, United States, Oregon, and Washington, 1935–60



NOTE: Available leukemia mortality data for 1935–40 are shown in tables 1 and 2.

the ocean counties have also been generally low.

Trends in mortality rates for leukemia are somewhat less clear-cut than trends for total cancer because of the small numbers of deaths in some areas. In Oregon leukemia mortality increased at about the national average in the Portland area, slightly faster in river counties, and even faster in the inland counties. Rates for the ocean counties have fluctuated widely, but in the most recent period (1958–63) they were the lowest in the State.

In Washington leukemia mortality rates in the river counties increased rapidly before 1950, but they have actually decreased since that time while rates in other parts of the State and in the total United States were rising. Leukemia mortality rates in the ocean counties also have increased rapidly since 1934, but the increase

Table 2. Numbers [1] of deaths from all forms of cancer and from leukemia in the United States, Oregon, and Washington, in various time periods

Area	1934–37	1938–42	1943–47	1948–52	1953–57	1958–63
	All forms of cancer					
Total United States [2]	527,601	733,045	824,849	969,037	1,102,279	[3] 1,200,361
Oregon	[4] 1,229	[5] 5,845	8,659	10,229	11,641	15,832
River counties	[4] 100	[5] 521	682	878	992	1,314
Ocean counties	[4] 173	[5] 754	1,119	1,456	1,746	2,368
Portland counties	[4] 606	[5] 2,786	4,298	4,994	5,495	7,528
Inland counties	[4] 350	[5] 1,784	2,560	2,901	3,408	4,622
Washington	8,644	12,127	13,690	16,462	19,130	25,352
River counties	415	593	648	843	1,068	1,501
Ocean counties	755	1,080	1,221	1,421	1,448	1,970
Portland counties	204	345	434	541	590	851
Inland counties	7,270	10,109	11,387	13,657	16,024	21,024
	Leukemia					
Total United States [2]	13,796	22,985	30,246	41,476	51,036	[3] 58,260
Oregon	(6)	[7] 170	354	[8] 484	648	873
River counties	(6)	[7] 16	30	38	54	74
Ocean counties	(6)	[7] 30	44	70	121	127
Portland counties	(6)	[7] 84	199	234	280	408
Inland counties	(6)	[7] 40	81	132	193	264
Washington	[9] 98	365	573	745	941	1,342
River counties	[9] 6	14	31	59	56	75
Ocean counties	[9] 10	32	39	50	52	99
Portland counties	[9] 1	8	25	32	31	45
Inland counties	[9] 81	311	478	604	802	1,123

[1] Numbers which were reported. Before the rates were calculated for table 1, comparability ratios were applied to adjust for differences in cause-of-death assignments between the 4th, 5th, and 6th revisions of the International Classification of Diseases.

[2] White population only.

[3] Data for 1958–62.

[4] Data for 1935 only.

[5] Data for 1939–42.

[6] Data not available by county.

[7] Data for 1940–42.

[8] Total includes one with county of residence unknown.

[9] Data for 1935 and 1937 only. Leukemia deaths not available by county for 1934 and 1936.

SOURCES: Oregon leukemia deaths by county for 1940–57 and deaths due to all forms of cancer by county for 1941–44 were obtained from the State Registrar, Oregon State Board of Health, Portland. Washington leukemia deaths by county for 1935 and 1937–57 and deaths due to all forms of cancer for 1934, 1936–38, and 1941–44 were obtained from the State Registrar, Washington State Board of Health, Olympia. The remainder of the data were obtained from annual volumes of Vital Statistics of the United States.

has been no greater than that of the State as a whole.

No significant trends were observed in individual counties in either Washington or Oregon.

Summary

Because of recent concern over possible contamination of the Columbia River by radioactive products from the Hanford (Washington) Atomic Storage Preserve, an independent study was undertaken to determine cancer trends in Washington and Oregon from 1934 to 1963.

For the analysis, the counties within the two States were divided into four categories: river, ocean, Metropolitan Portland, and inland.

Results of the study revealed that in both States mortality rates for all forms of cancer combined have been consistently below the mortality rate for the U.S. white population. Both States have had a consistent excess in leukemia mortality, but the excess was present before the Hanford Preserve began operation. No important mortality trends were observed in individual counties in either State.

No evidence was found that persons living downstream from the Hanford Preserve or along the Pacific coast of Oregon have had an excess risk of death from cancer in general or from leukemia in particular.

Table 3. Counties in Oregon and Washington, by geographic category

Area	Total counties	Area	Total counties
Oregon	36	Washington	39
River	8	*River*	7
Clatsop		Benton	
Columbia		Cowlitz	
Gilliam		Franklin	
Hood River		Klickitat	
Morrow		Skamania	
Sherman		Wahkiakum	
Umatilla		Walla Walla	
Wasco			
Ocean	6	*Ocean*	7
Coos		Clallam	
Curry		Grays Harbor	
Douglas		Island	
Lane		Jefferson	
Lincoln		Pacific	
Tillamook		San Juan	
		Whatcom	
Metropolitan Portland	3	*Metropolitan Portland*	1
Clackamas		Clark	
Multnomah			
Washington			
Inland	19	*Inland*	24
Baker		Adams	
Benton		Asotin	
Crook		Chelan	
Deschutes		Columbia	
Grant		Douglas	
Harney		Ferry	
Jackson		Garfield	
Jefferson		Grant	
Josephine		King	
Klamath		Kitsap	
Lake		Kittitas	
Linn		Lewis	
Malheur		Lincoln	
Marion		Mason	
Polk		Okanogan	
Union		Pend Oreille	
Wallowa		Pierce	
Wheeler		Skagit	
Yamhill		Snohomish	
		Spokane	
		Stevens	
		Thurston	
		Whitman	
		Yakima	

Figure 2. Counties in Oregon and Washington, by geographic category

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Table 4. Mortality rates per 100,000 population and numbers of deaths for all forms of cancer by county, in various time periods, Oregon

County	Rates						Numbers					
	1935	1939–42	1943–47	1948–52	1953–57	1958–63	1935	1939–42	1943–47	1948–52	1953–57	1958–63
River:												
Clatsop	130.5	132.9	116.6	137.8	154.0	141.3	26	125	163	225	269	315
Columbia	119.8	112.3	101.0	129.1	117.5	142.8	20	88	110	156	150	230
Gilliam	80.3	89.1	113.1	118.1	102.1	144.6	2	10	16	17	15	26
Hood River	102.6	112.5	99.8	86.8	129.7	130.2	9	48	58	55	92	131
Morrow	124.3	113.8	133.1	149.0	122.8	119.4	5	20	31	37	32	39
Sherman	85.6	77.9	64.8	125.3	127.8	121.3	2	8	8	15	16	19
Umatilla	100.0	128.1	116.9	127.5	127.6	126.3	24	143	199	258	291	384
Wasco	101.2	143.7	123.6	129.3	126.5	126.7	12	79	97	115	127	170
Ocean:												
Coos	130.8	139.6	119.5	133.8	147.5	121.9	32	162	200	256	325	364
Curry	143.3	81.0	87.2	136.6	92.4	87.1	5	14	24	46	43	62
Douglas	121.8	97.8	110.9	117.8	125.8	119.2	31	117	209	270	334	431
Lane	142.9	122.2	111.6	123.5	120.2	124.4	79	328	485	665	776	1,122
Lincoln	106.7	112.5	112.6	103.7	112.0	121.0	12	66	108	124	155	228
Tillamook	143.0	143.2	129.8	111.0	120.5	131.8	14	67	93	95	113	161
Portland:												
Clackamas	127.4	108.5	121.3	122.4	120.5	131.8	67	274	465	557	642	965
Multnomah	147.1	144.1	149.7	146.2	143.1	147.8	493	2,302	3,549	4,047	4,367	5,906
Washington	128.1	122.3	106.6	121.5	123.4	117.4	46	210	284	390	486	657
Inland:												
Baker	131.3	127.4	128.5	120.6	125.4	107.5	21	94	119	113	126	138
Benton	125.2	121.9	107.6	95.2	104.0	115.6	20	92	118	120	150	225
Crook	115.9	105.6	144.0	88.3	149.1	109.6	4	18	38	28	56	57
Deschutes	108.9	121.0	129.6	117.4	111.8	122.6	13	72	110	113	128	195
Grant	167.5	125.4	91.7	134.2	112.7	125.8	9	30	30	48	43	61
Harney	46.3	73.8	121.6	105.6	124.6	128.1	2	14	31	29	37	49
Jackson	101.8	127.8	120.3	119.8	133.0	120.4	36	211	313	379	501	630
Jefferson	59.1	121.1	44.2	105.3	95.6	115.8	1	9	6	19	21	36
Josephine	156.7	104.5	104.3	127.9	113.4	138.7	25	84	128	187	192	320
Klamath	98.3	118.8	126.3	113.0	116.9	132.4	21	125	185	184	219	336
Lake	46.3	97.1	91.3	112.7	131.1	141.3	2	20	25	33	42	59
Linn	127.1	132.0	117.5	123.4	122.1	119.7	36	173	236	296	330	431
Malheur	94.4	85.6	103.7	115.7	124.2	131.8	10	47	84	109	132	187
Marion	113.8	131.5	122.4	116.6	119.3	126.9	79	432	593	656	780	1,131
Polk	101.6	122.1	122.0	111.8	110.8	113.3	17	95	134	138	152	205
Union	112.6	114.5	127.9	135.5	136.6	115.6	17	78	120	140	148	157
Wallowa	97.3	132.2	104.3	118.7	115.2	135.1	6	37	37	43	44	65
Wheeler	89.7	100.1	126.7	147.5	150.8	122.0	2	10	16	19	19	18
Yamhill	110.3	118.0	141.1	132.8	143.5	124.8	29	143	237	247	288	322

SOURCES: Oregon deaths due to all forms of cancer for the years 1941–44 by county were obtained from the State Registrar, Oregon State Board of Health, Portland. The remainder of the data were obtained from respective volumes of Vital Statistics of the United States.

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Table 5. Mortality rates per 100,000 population and numbers of deaths for all forms of cancer by county, in various time periods, Washington

County	Rates						Numbers					
	1934–37	1938–42	1943–47	1948–52	1953–57	1958–63	1934–37	1938–42	1943–47	1948–52	1953–57	1958–63
River:												
Benton	70.2	110.0	63.7	101.7	113.4	126.4	34	67	67	153	208	328
Cowlitz	137.0	119.3	109.2	127.7	129.3	140.0	131	175	197	274	326	486
Franklin	106.4	101.5	128.9	142.5	141.6	125.5	21	30	51	71	96	129
Klickitat	99.9	106.3	95.1	123.0	134.1	127.9	36	56	54	75	89	110
Skamania	114.2	101.8	85.2	102.4	100.7	97.1	15	21	20	27	28	34
Wahkiakum	93.3	118.8	94.5	60.4	91.1	163.9	12	21	19	13	20	44
Walla Walla	150.2	140.5	129.3	108.0	128.2	120.4	166	223	240	230	301	370
Ocean:												
Clallam	139.9	121.1	108.4	118.7	104.9	134.6	89	112	118	149	152	265
Grays Harbor	133.0	141.3	138.5	150.7	139.1	151.9	229	346	375	448	444	621
Island	131.3	112.8	97.4	161.3	117.2	124.1	37	48	49	94	83	124
Jefferson	136.7	112.3	129.5	114.6	159.6	110.9	41	47	60	58	86	76
Pacific	117.3	109.7	136.8	122.2	146.3	107.7	61	84	117	116	146	135
San Juan	118.5	104.6	95.2	113.9	120.2	111.0	17	21	20	25	29	35
Whatcom	118.3	125.9	131.7	133.5	119.4	131.6	281	422	482	531	508	714
Portland: Clark	123.9	139.4	134.1	134.9	128.1	137.5	204	345	434	541	590	857
Inland:												
Adams	108.5	111.4	115.8	85.7	125.3	96.5	23	31	35	28	47	49
Asotin	100.1	119.4	126.9	114.1	114.3	121.9	32	53	73	81	91	129
Chelan	125.5	126.4	104.4	123.4	124.2	133.4	125	188	179	240	267	376
Columbia	160.2	83.8	105.9	150.6	119.6	104.2	34	25	32	49	38	41
Douglas	77.3	117.0	89.8	94.0	92.6	103.9	21	46	39	45	53	83
Ferry	82.4	114.6	121.7	119.5	134.5	108.6	12	25	26	25	27	25
Garfield	72.0	105.5	138.3	131.3	124.9	150.7	9	18	25	25	24	35
Grant	86.6	110.9	65.0	103.4	111.1	103.0	24	52	40	79	122	177
King	164.1	146.5	142.3	149.8	153.6	148.7	2,926	3,967	4,677	5,809	6,784	8,833
Kitsap	145.6	143.9	137.8	146.0	135.2	129.4	208	317	392	511	548	714
Kittitas	154.0	117.0	127.7	124.9	117.2	137.4	94	107	130	141	136	196
Lewis	144.9	144.6	125.4	129.9	144.4	140.3	210	305	295	338	398	489
Lincoln	133.0	129.7	135.6	100.3	116.2	126.5	56	73	80	62	75	102
Mason	150.7	154.8	128.4	97.1	156.5	133.3	52	81	81	72	132	151
Okanogan	123.8	104.9	117.7	117.0	111.4	131.3	82	105	127	149	151	226
Pend Oreille	130.2	127.3	107.7	104.9	167.0	112.4	32	45	40	41	68	57
Pierce	146.1	142.6	134.8	130.9	140.4	142.8	966	1,397	1,564	1,760	2,096	2,807
Skagit	118.3	140.1	126.4	100.6	112.9	111.3	171	298	303	293	328	418
Snohomish	142.5	128.0	127.6	134.0	138.2	140.0	455	610	708	850	1,038	1,457
Spokane	151.6	137.3	125.3	131.3	138.2	132.6	955	1,271	1,368	1,655	1,960	2,506
Stevens	143.4	128.1	93.7	136.5	120.9	120.5	101	127	96	144	130	158
Thurston	114.8	126.2	134.0	133.5	137.3	146.5	141	231	282	318	372	533
Whitman	170.2	136.7	122.0	118.3	131.0	123.6	161	177	167	171	195	227
Yakima	136.8	131.2	120.5	124.8	136.0	133.8	380	560	628	771	944	1,235

SOURCES: Washington deaths due to all forms of cancer for the years 1934, 1936–38, and 1941–44 by county were obtained from the State Registrar, Washington State Board of Health, Olympia. The remainder of the data were obtained from respective volumes of Vital Statistics of the United States.

RADIOLOGICAL EFFECTS OF OPERATING
THE MONTICELLO NUCLEAR GENERATING PLANT

The application by Northern States Power Company for a permit to construct the Monticello plant was reviewed from the standpoint of radiological safety by four bodies in the Atomic Energy Commission's process of licensing and regulation, as outlined in the attached booklet, "Licensing of Power Reactors." These review groups included the AEC regulatory staff, the Commission's statutory Advisory Committee on Reactor Safeguards (ACRS), and an atomic safety and licensing board which conducted a public hearing in the matter on May 25-26, 1967, at Buffalo, Minnesota. The initial decision of the board, granting a provisional construction permit, was then reviewed by the Commission itself. The construction permit was issued on June 19, 1967. Each of these review bodies concluded that the proposed plant could be constructed and operated without undue risk to the health and safety of the public.

On November 8, 1968, the applicant applied for an operating license. Further safety reviews are now being conducted by the AEC regulatory staff. The ACRS will also review this application and advise the Commission thereon. Further, if an operating license is granted, the plant will be under AEC surveillance and undergo periodic safety inspections throughout its lifetime.

Small amounts of radioactive material are permitted by AEC regulations to be released into the environment at controlled rates and in controlled amounts from a nuclear power plant. This requires a continuous program of monitoring and control to assure that release limits are not exceeded. The release limits in AEC regulations are based on guides developed by the Federal Radiation Council, a statutory body, and approved by the President for the guidance of Federal agencies. These release limits are such that continuous use of air or water at the point of release from the site would not result in exposures exceeding national and international standards for radiation protection of the public.

The concentrations of liquid radioactive effluents released from the plant are further reduced by dilution in the body of water to which they are discharged. A survey of all operating nuclear power plants has shown that the concentrations of radioactivity in liquid releases during 1967 were only a small fraction of the release limits applicable to the radionuclides in the effluent.