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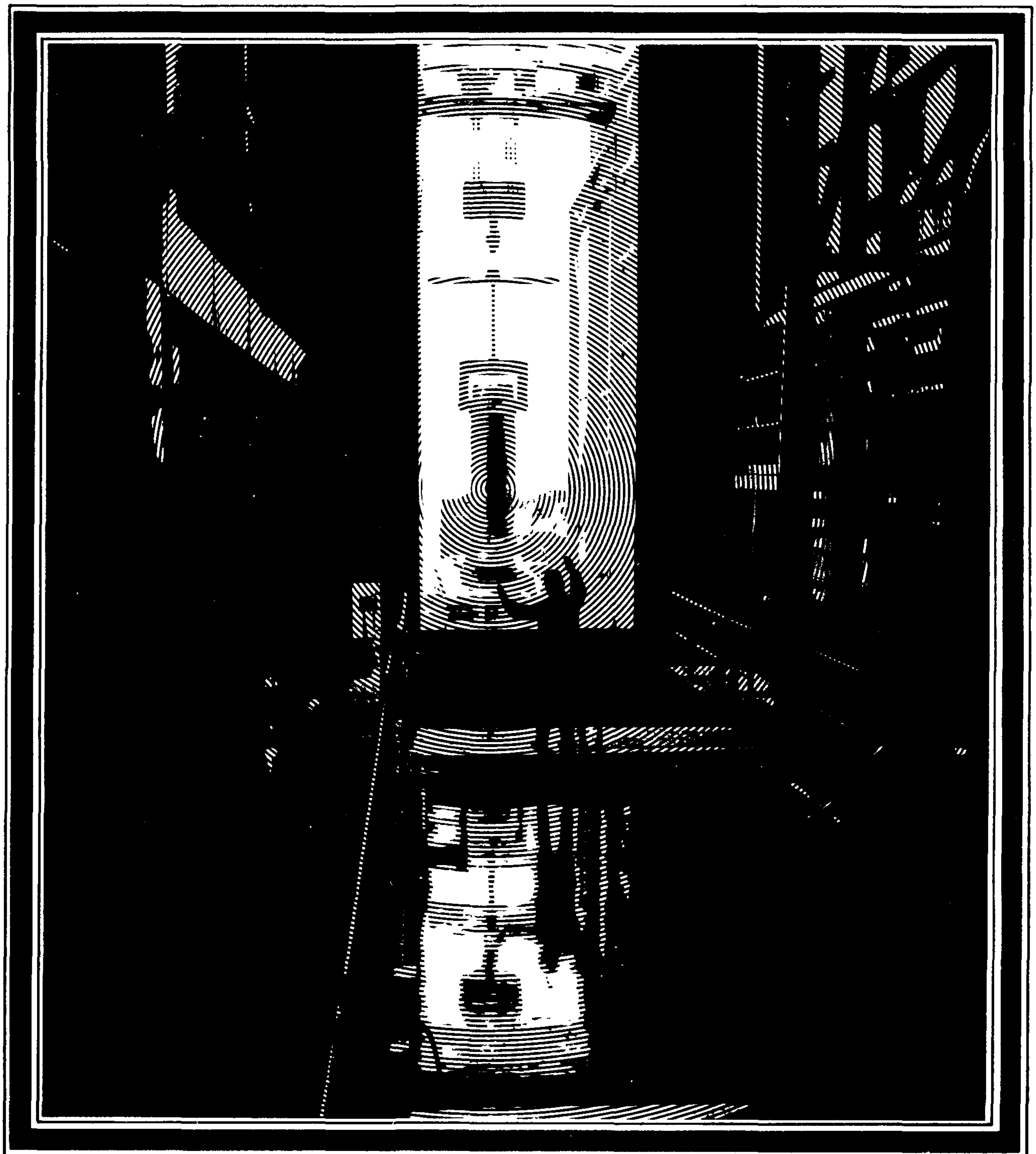
Radioactive Wastes



U.S. ENVIRONMENTAL PROTECTION AGENCY

Radioactive Wastes

Wanted: A permanent storage place for vast quantities of radioactive materials that will retain their toxicity for thousands of years. Must be earthquake-proof, leakproof, and foolproof.

This is a need that must be met, because failure to find a solution could threaten the future of the nuclear power industry.

Roger Strelow, Assistant Administrator for Air and Waste Management, told the Joint Committee on Atomic Energy last November that "EPA believes the rapid development of at least one environmentally acceptable method for the permanent disposal of radioactive wastes is essential for the continued development of nuclear power."

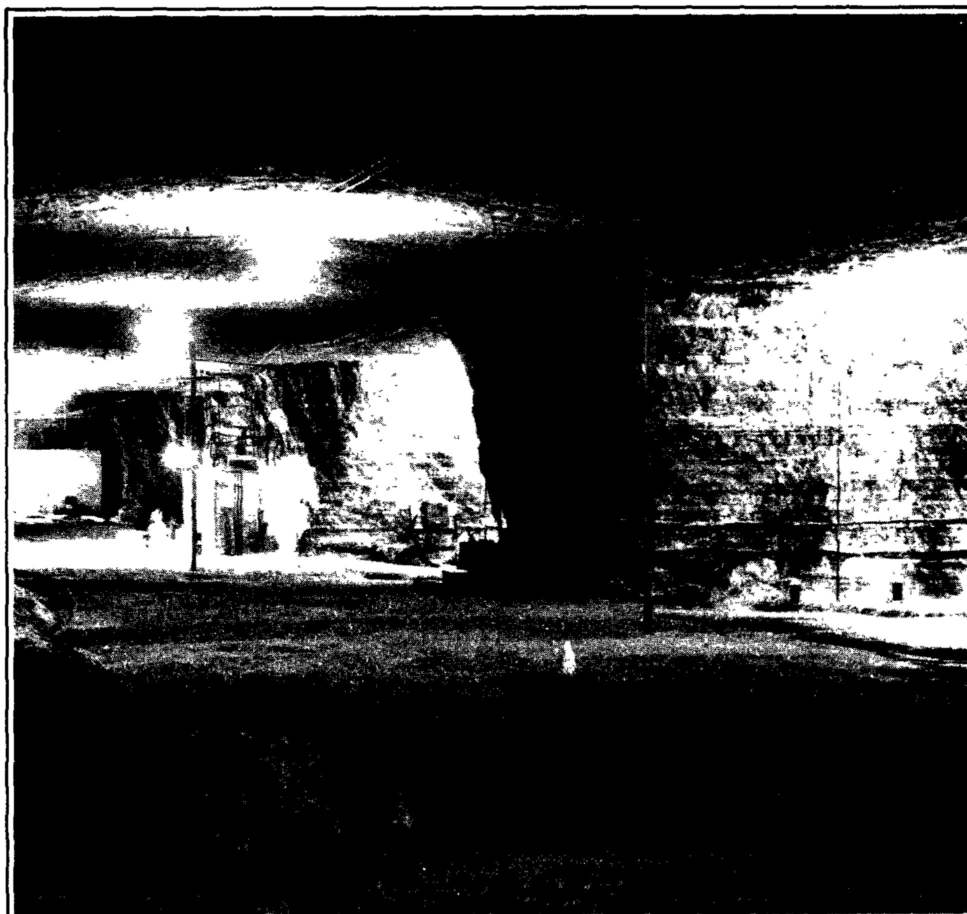
Mr. Strelow stressed that EPA is "totally committed to finding a means to ultimately dispose of high-level wastes."

He also said that the inventory of wastes from weapons production is presently in interim storage in leaking tanks, and wastes from nuclear power plants are expected to exceed current temporary storage capacity.

"The question then is not if, but when will we have an acceptable ultimate disposal method, how good it will be, and how much will it cost."

Some fission products which must be stored are cesium-137, strontium-90, iodine-131 and plutonium-239. Some decay rapidly in hours or days. Others take up to thousands and millions of years to lose their radioactive potency.

A proposal for permanent disposal of radioactive wastes is expected to be made this year by the Energy Research and Development Administration, one of the successor agencies to the Atomic Energy Commission.



This abandoned salt mine near Lyons, Kansas, was considered but rejected for permanent storage of high-level radioactive waste. Other salt-bed sites are being studied for a Pilot Plant Repository.

Many Options

Some of the possibilities which had been considered by AEC included:

Geologic Disposal: Burial in bedded salt deposits or bedrock caverns. AEC had proposed at one point use of a salt mine near Lyons, Kansas, for disposal of all commercial radioactive waste. However, this proposal was later abandoned when it was learned that nearby mining activities might have caused leaks in the abandoned mine. Another possibility, dumping wastes into a manmade cavern near the AEC's property on the Savannah River was also dropped because of concern that the wastes might reach the nearby Tuscaloosa aquifer, a huge underground reservoir that supplies fresh water to much of Georgia and South Carolina.

Outer Space: Questions of cost and safety now appear to rule out this alternative. The great concern was that wastes rocketed from earth might unexpectedly return as a result of launching or rocket malfunction.

Polar Disposal: Could the wastes be placed in uninhabited land masses such as Antarctica? Wouldn't they just melt their way down to bedrock? However, this alternative would require amending an international treaty that now bars the disposal of atomic wastes there. Also, scientists argued that too little is known yet about the movement of glaciers.

Transmutation: The concept was to bombard the wastes with neutrons inside a reactor and thus change them into shorter-lived or even harmless substances. However, some of the radioactive waste products, such as cesium-137 and strontium-90, cannot be easily changed by this bombardment process.

Seabed Disposal: European nations and the United States used to deposit relatively low-level wastes in the oceans. However, the U.S. stopped doing this many years ago. Now interest is mounting in resuming ocean dumping of radioactive wastes. The July-August issue of EPA Journal carried the first published account by Robert S. Dyer, an EPA oceanographer, with the Office of Radiation Programs, on his successful search for radioactive wastes dumped in the Pacific Ocean some 20 years ago. Since then, Mr. Dyer, who used deep submersibles to find and photograph radioactive wastes dropped on the seabed, has found radioactive wastes deposited in the Atlantic.

"These surveys," Mr. Strelow said, "were the first successful attempts at finding the actual drums of radioactive wastes, some of which had lain there for almost 30 years at depths of over 9,000 feet.

"We have taken extensive photographic documentation of the dumpsite areas and have collected many sediment samples for radioanalysis. We are still tabulating our results and hope to issue one or more technical reports in the near future and present our findings to the International Atomic Energy Agency."

Costs Will Soar

In his Congressional testimony, Mr. Strelow emphasized that interim storage of high level wastes "with only minimum planning for eventual final disposal is unacceptable because of the potential enormity of the costs that may have to be incurred."

The cost projections for interim storage of high-level wastes and for burial of low-level wastes will be about $7 billion by the year 2000, he noted. Therefore, he added, explicit attention should be given to the possibility that an interim engineered storage system may become permanent solely due to economic costs.

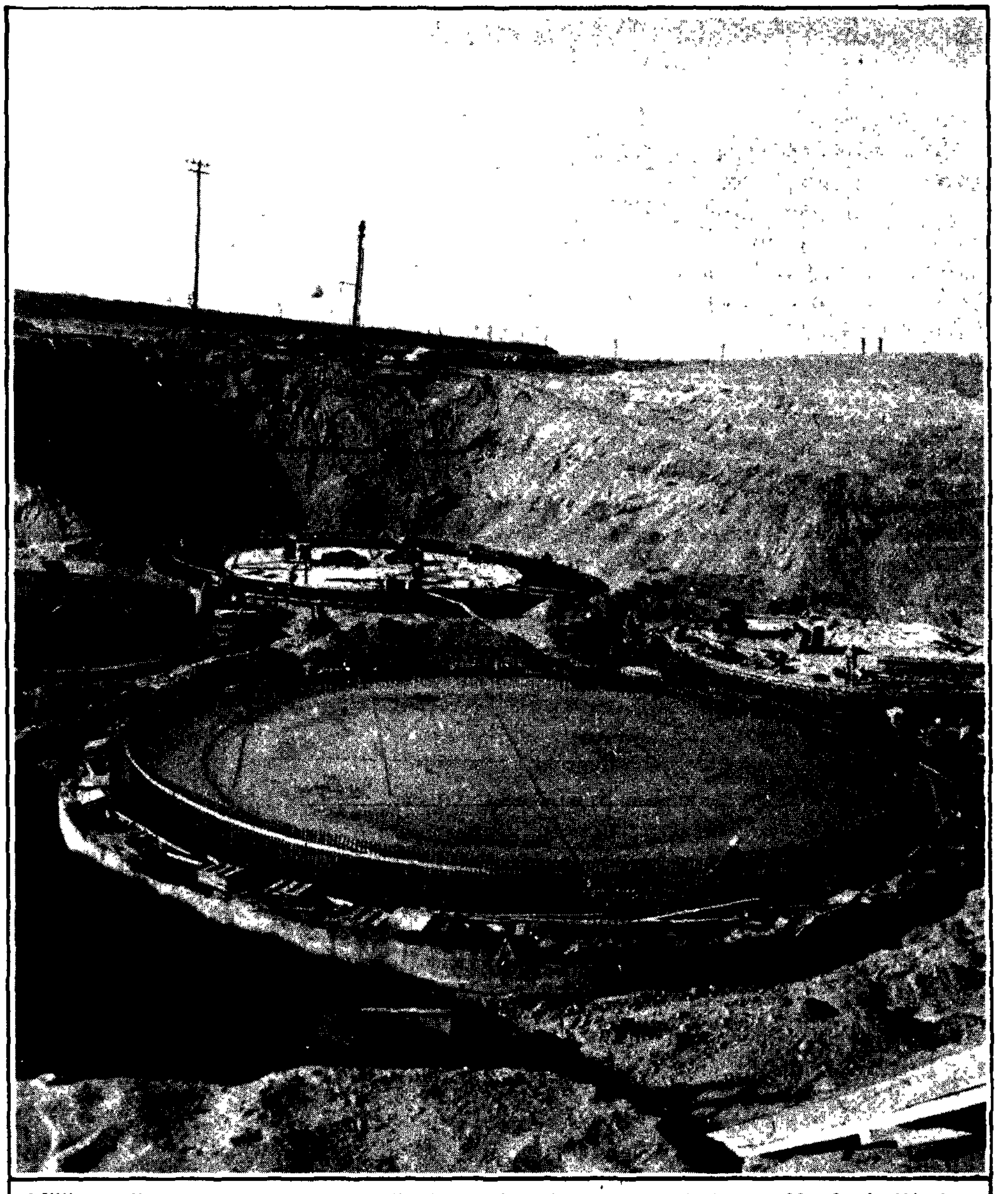
Noting that this point has been developed in detail by Dr. Rowe, in a paper entitled "The Hidden Commitment of Nuclear Wastes," Mr. Strelow said that "these potentially large costs could eventually dictate use of an interim storage method as a permanent repository, contrary to the environmental need for ultimate disposal."

The cost for ultimate disposal of high-level wastes could exceed $1 billion by the year 2000, he said.

Discussing the disposal of low-level wastes, Mr. Strelow said that EPA, in conjunction with the States involved, has been conducting environmental studies at the Maxey Flats site in Kentucky and the West Valley site in New York, where low-level wastes are buried in large earthen trenches.

He said that studies supported by the Office of Radiation Programs have shown that rainfall seeping through the earthen caps over these trenches can cause some leakage of radioactive material from the wastes.

"EPA believes it is necessary to place a high priority" on establishment of additional regulations controlling the burial of long-lived waste in shallow surface trenches, Mr. Strelow said.



Million-gallon storage tanks for liquid radioactive wastes built at Hanford, Wash. Steel-lined tanks are surrounded by thick concrete and buried 7 to 14 feet below ground surface.

Natural Radioactivity

In addition to manmade radioactive wastes, there are naturally occurring radioactive materials. This area includes the problems of radioactivity from uranium mine and mill tailings and from the mining of such materials as phosphates, fossil fuels, vanadium and other ores.

Mr. Strelow said EPA is conducting a number of projects designed to provide a comprehensive assessment of this problem, including field measurement of radioactivity at mill tailing piles.

One of these projects is the development and testing of a model to estimate population exposure from radon and its decay products or "daughters" to human beings.

EPA is also involved in assessing the radioactivity from phosphate mining and milling. The Agency recently informed the Governor of Florida that a preliminary EPA study showed the presence of high levels of radioactive radon and its decay products in residential buildings constructed on reclaimed phosphate mining lands in Polk County.

Although the health risk involved will not be fully known until further studies are completed, EPA scientists believe that continuous exposure for ten years to the highest level of radioactivity found at the Polk County site could double the normal risk of lung cancer for people living in these buildings.

Mr. Strelow emphasized that EPA is concerned with proper management and containment of all types of radioactive wastes. □

IS THIS X-RAY REALLY NECESSARY?

How are you most likely to be exposed to radiation?

If you answer "an accident at a nuclear power plant" or "the outbreak of nuclear warfare," you're wrong.

The odds-on chances are that your radiation exposure will come from an x-ray examination given by your doctor or dentist or in a hospital or clinic.

At least 90 percent of the total "dose" of manmade radiation to people in the United States comes from diagnostic x-rays, according to a report made to EPA three years ago by a special committee of the National Academy of Sciences.

EPA is developing guidance to Federal agencies for diagnostic x-ray usage to protect patients receiving health care from these agencies from unwise or excessive exposure. The first public announcement of the EPA plan is being made this month by Dr. James E. Martin of the Office of Radiation Programs at a meeting of the Health Physics Society in Denver. The plan, called "Federal Radiation Guidance for Diagnostic X-Rays," will be formally proposed by publication in the Federal Register after completion of technical review and Presidential approval. This review process is expected to begin in March.

The guidance recommended by EPA will take effect when it is implemented by various Federal agencies—such as the Department of Defense, the Veterans' Administration, and the Public Health Service—which provide medical services and operate hospitals and clinics, Dr. Martin explained.

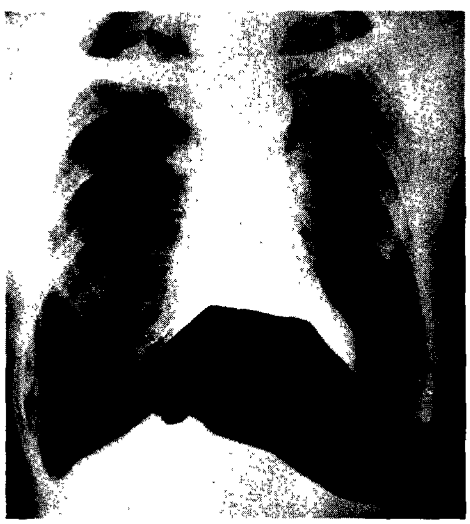
There is a broad consensus that many unproductive x-ray examinations are given, he said.

Advising the President

"EPA has no authority to tell doctors how to treat their patients nor do we want such authority," Dr. Martin said, "but we do have a statutory responsibility to 'advise the President' on radiation health matters and, with his approval, to provide guidance to 'all Federal agencies in the formulation of radiation standards.' With the population exposure to x-rays as high as it is and the potential reductions available, we feel compelled to work with Federal agencies and to recommend national goals to the President." This power goes back to the Atomic Energy Act which was amended in 1959 (PL 86-273) to establish the Federal Radiation Council and its functions. These functions were transferred to EPA, when the Agency was formed.

170 Millirems

In general, for population groups, the current Federal recommended limit is 170 millirems per year to the average individual. (A millirem is a measure of radiation's effect on living tissue.) The limit is about twice the natural background radiation to which everyone is unavoidably exposed: an average of 84 millirems per person annually in the United States. This radiation comes from minerals in the earth and from cosmic rays, so it varies in different parts of the country and at different altitudes.



"Our aim in proposing diagnostic x-ray guidance is simple," Dr. Martin said. "We want to try to make sure that x-rays are used in Federal health care activities with a minimum risk and maximum benefit to the patient.

"We believe there is no 'safe' level of radiation; all radiation is assumed to have some potential effect, and the effects are cumulative; they add up over the years. One x-ray or fluoroscopic examination can give you as much radiation exposure as several years of natural background.

"Most people don't realize that an x-ray involves a small but definite risk. Many doctors use x-rays routinely, like a blood pressure or urine test, even when there is no real indication that an x-ray is needed for the particular patient.

Dr. Martin and his colleagues, DeVaughn R. Nelson and Harry J. Pettengill, have been working for a year and a half with medical representatives of the Army, Navy, Air Force, Veterans' Administration and with consultants from universities and the Public Health Service in developing the guidelines.

3 Steps to Take

The group agreed it was desirable and possible for Federal facilities to reduce diagnostic x-ray exposure in three ways:

- Fewer x-ray examinations, eliminating those that are "clinically unproductive." The total medical x-ray usage in the United States has been increasing at about 4 percent each year. In 1970 the abdominal dose was estimated to be about 72-millirem to the average person. No x-ray should be made unless ordered by a qualified physician for a specific purpose. X-ray screening of groups of people—as chest x-rays for tuberculosis—should be avoided, likewise routine dental x-rays and breast x-rays for women under 35 who have no symptoms of possible breast cancer.
- Better techniques to assure minimum exposure when x-rays are taken. These include proper maintenance and calibration of equipment, better training of technicians, and use of image intensifiers for fluoroscopy. The guides will include recommended exposure, levels for several x-ray views.
- Equipment standards. All x-ray equipment manufactured after Aug. 1, 1974, must conform to standards set by the U.S. Food and Drug Administration, but most of the equipment now used in Federal facilities antedates these standards, and variances can be obtained for some new equipment. The guides for all Federally-owned equipment will recommend conforming to key portions of the equipment performance standards as soon as practicable; in the interim minimum levels of performance necessary to protect both patient and operator will be recommended.

Although EPA's guidance would apply only to activities of Federal agencies, it is expected to have an influence on private medical practice and general hospitals by setting an example. □

PREPARING FOR NUCLEAR ACCIDENTS

"The phone call came in mid-afternoon of Wednesday, October 5, 1966. The exact time is not recorded, because it was never entered officially on the log of the Sheriff of Monroe County, Michigan. An unidentified voice on the other end of the line spoke sharply and briefly. There was something wrong at the new Enrico Fermi Atomic Power Plant. The voice said that the situation should not be publicized, that no public alert should be given. More information would follow . . ."

This is an excerpt from a new fast-selling book about the hazards of nuclear power titled "We Almost Lost Detroit" by John G. Fuller. The book begins with a report on what happened on that October afternoon in 1966 when the control panel inside the Enrico Fermi atomic reactor near Detroit suddenly registered high radiation levels, a sign of critical danger.

The problem at this experimental breeder reactor was finally controlled, but this plant, which continued to be troubled by mishaps, was finally ordered closed.

Even though the title is exaggerated, the book does raise in a dramatic fashion a problem EPA believes must be faced and dealt with.

This is why EPA has prepared guides advising States and local governments what should be included in their emergency plans to prepare for nuclear accidents.

The types of accidents that must be planned for include those in nuclear power reactors used for generating electricity, in plants that reprocess fuel for nuclear reactors and in the transportation of spent fuel and high-level radioactive wastes.

The nuclear power industry has developed elaborate safety measures to prevent accidents and to reduce the consequences of those that occur. Because of this effort the industry has avoided any large release of radioactivity to the environment, and it claims to be one of the Nation's safest industries.

Accident Odds

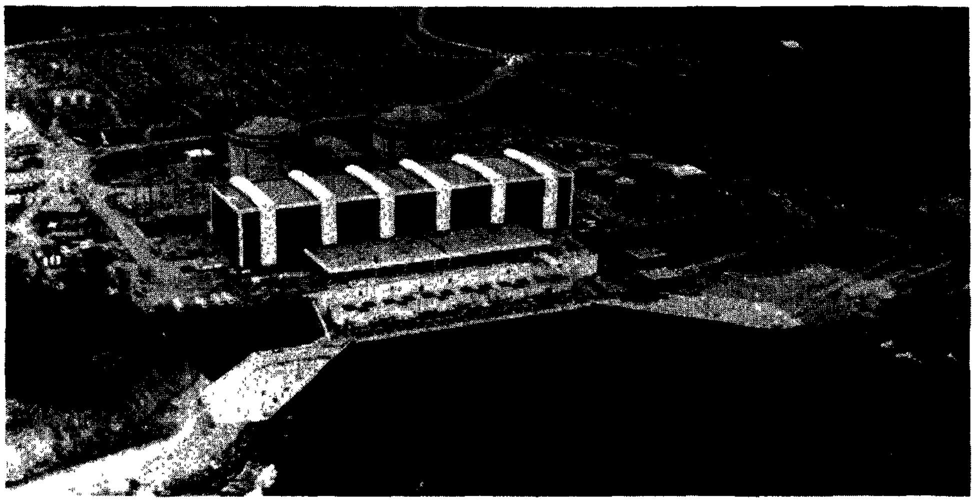
The probability of a serious accident such as a core meltdown is estimated to be one in 20,000 per reactor per year. There are also possible accidents of lesser consequences with increased probabilities (about one in 2,100 over the 30-year life time of a power reactor), according to Dr. William D. Rowe, Deputy Assistant Administrator for Radiation Programs.

"Some States," he said, "with only one or two reactors have been reluctant to spend money on the development and maintenance of an effective radiological emergency response plan for a very unlikely serious reactor accident within their State.

"However, there are about 55 operating reactors in the United States. Therefore, a serious but not catastrophic accident at a power reactor during the next 10 to 20 years is a definite possibility and the probability is increasing as the nuclear industry continues to grow.

"Furthermore, the possibility of other types of nuclear accidents, in transportation of radioactive material, for example, must be added to the growing probability of a nuclear power plant accident."

The need to protect the population within several miles of a reactor from a serious nuclear accident has prompted responsible State and local officials to seek guidance from Federal agencies for improving their radiological emergency response plans.



Baltimore Gas and Electric Co.'s Calvert Cliffs Plant is on the Chesapeake Bay near Lusby, Md.

These plans must cover several types of nuclear accidents, because each type may require a different response.

Emergency Plans

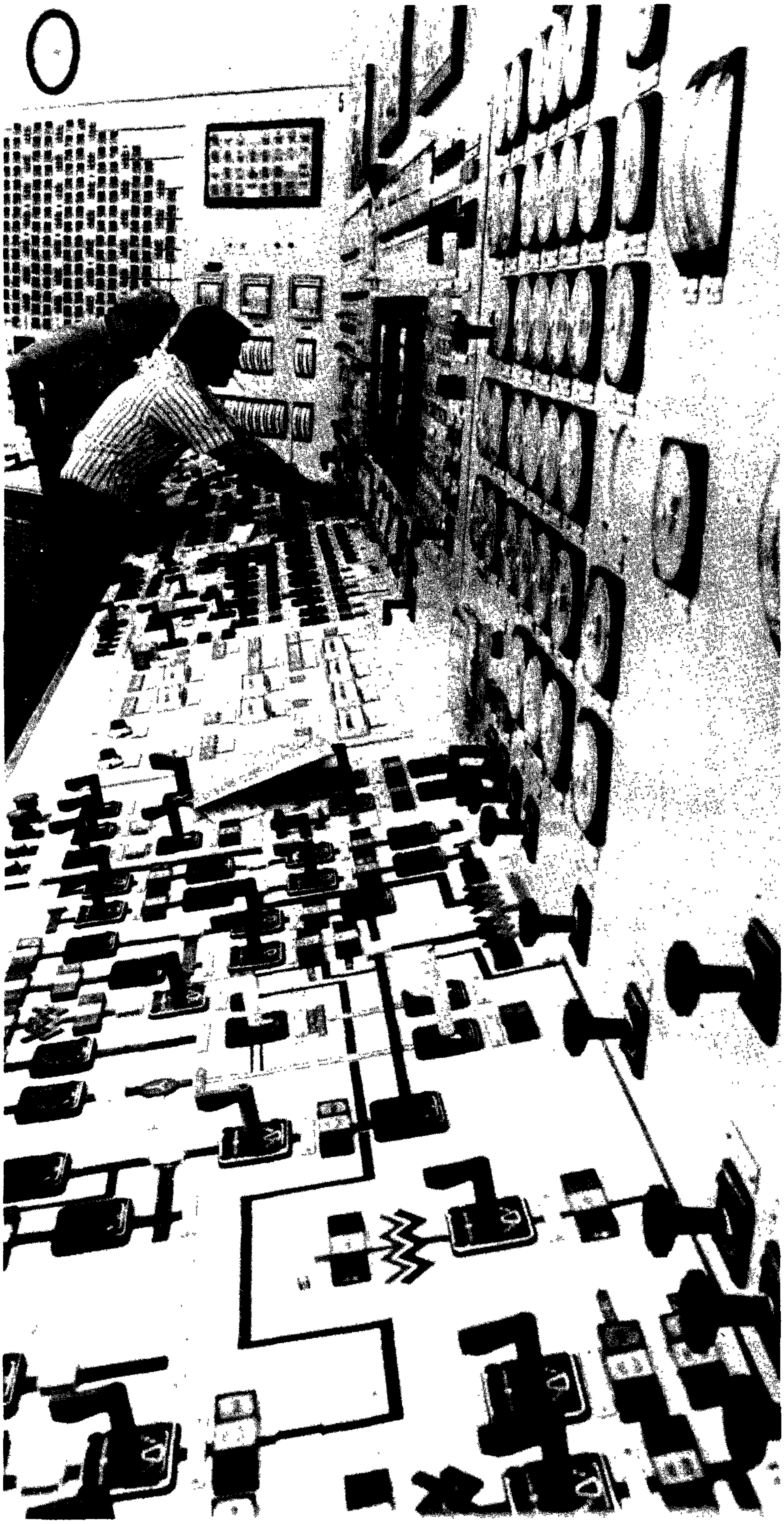
As part of a Federal interagency program for emergency response planning, EPA is preparing a manual for use by State agencies in developing their emergency response plans. The first portion of the manual has been issued. It provides guidance for protection of the population from exposure to airborne release of radioactive gases and iodine. This section of the manual was written first, because large airborne releases of radioactive materials would require immediate protective actions to minimize population exposure.

People living near or immediately downwind from a power reactor from which radioactive gases have escaped would be soon exposed to radioiodine and to gamma radiation from the gaseous cloud.

What should be done to avoid a radioactive cloud? The individual may be told to leave home at once and go to a designated safer area or be advised to remain indoors until the radioactive cloud has passed by and been dispersed.

The protective action guides recommend that action be taken when anticipated exposure reaches certain levels.

Merely publishing advice, however, will not ensure that effective plans will



Control room of the Commonwealth Edison Company's Dresden Nuclear Power Station near Morris, Ill. Three General Electric boiling water nuclear reactors are in operation at this location.

be developed by each State. The States must decide how to apply this guidance to the different needs of their communities.

Details in the State plans will vary depending on the number of people involved, the weather conditions, available transportation and many other considerations that should be worked out carefully by the responsible State officials and tailored to each locality where an accident might occur.

EPA's goal is to help each State develop emergency response plans that will save lives. This will require prompt communication between plant operators and State authorities, training of emergency workers, and testing of the whole emergency response system.

Training Courses

EPA personnel have assisted in developing courses of study for State planners at the Staff College of the Defense Civil Preparedness Agency at Battle Creek, Mich. In addition, EPA is developing a program for training State emergency response coordinators and their staffs on implementing State plans. EPA personnel are also observing and commenting on tests of State plans.

EPA's Region VIII Office in Denver has taken the lead in developing guidance for handling accidents involving the transportation of radioactive materials.

A 40-minute video tape, "The 5th Line of Containment," produced by EPA's Audiovisual and Public Support Branch, will be made available to the Regions to help explain EPA's emergency response roles.

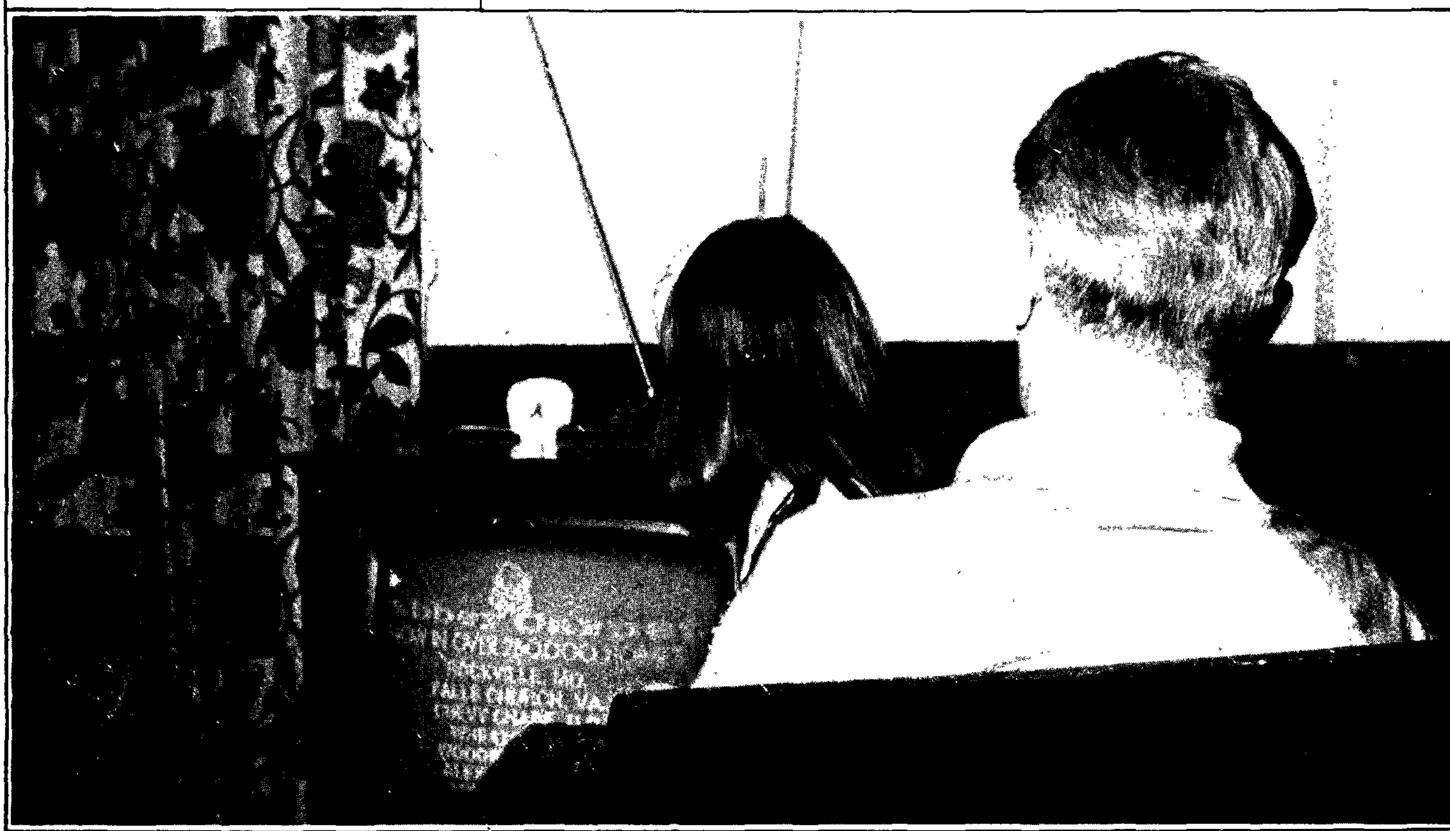
The film is introduced by Dr. Rowe and involves a panel discussion on the protective action guides. Panelists include John Abbots, National Public Interest Research Group; Ralph Lapp, nuclear energy consultant and a former member of the AEC; Margaret Reilly, Pennsylvania's emergency response coordinator; John Robinson, Yankee Electric Power Corp.; and David Smith, Director, Technical Assessment Division, Office of Radiation Programs. Carroll James, a professional actor, is moderator.

While the current issue of the manual issued by EPA on protective action guides deals only with exposures to airborne releases from nuclear power facilities, similar guidance on other types of accidental releases of radioactivity will be distributed by the Agency in the near future. □

COMMON RADIATION SOURCES

These photos show common radiation sources and their approximate average millirem (mrem) yearly doses to humans. A millirem is a measure of radiation's effect on living tissue. In general, for population groups, the current Federal recommended limit is 170 millirems per year to the average individual. EPA gathers information about radiation produced by many sources through a national monitoring network.

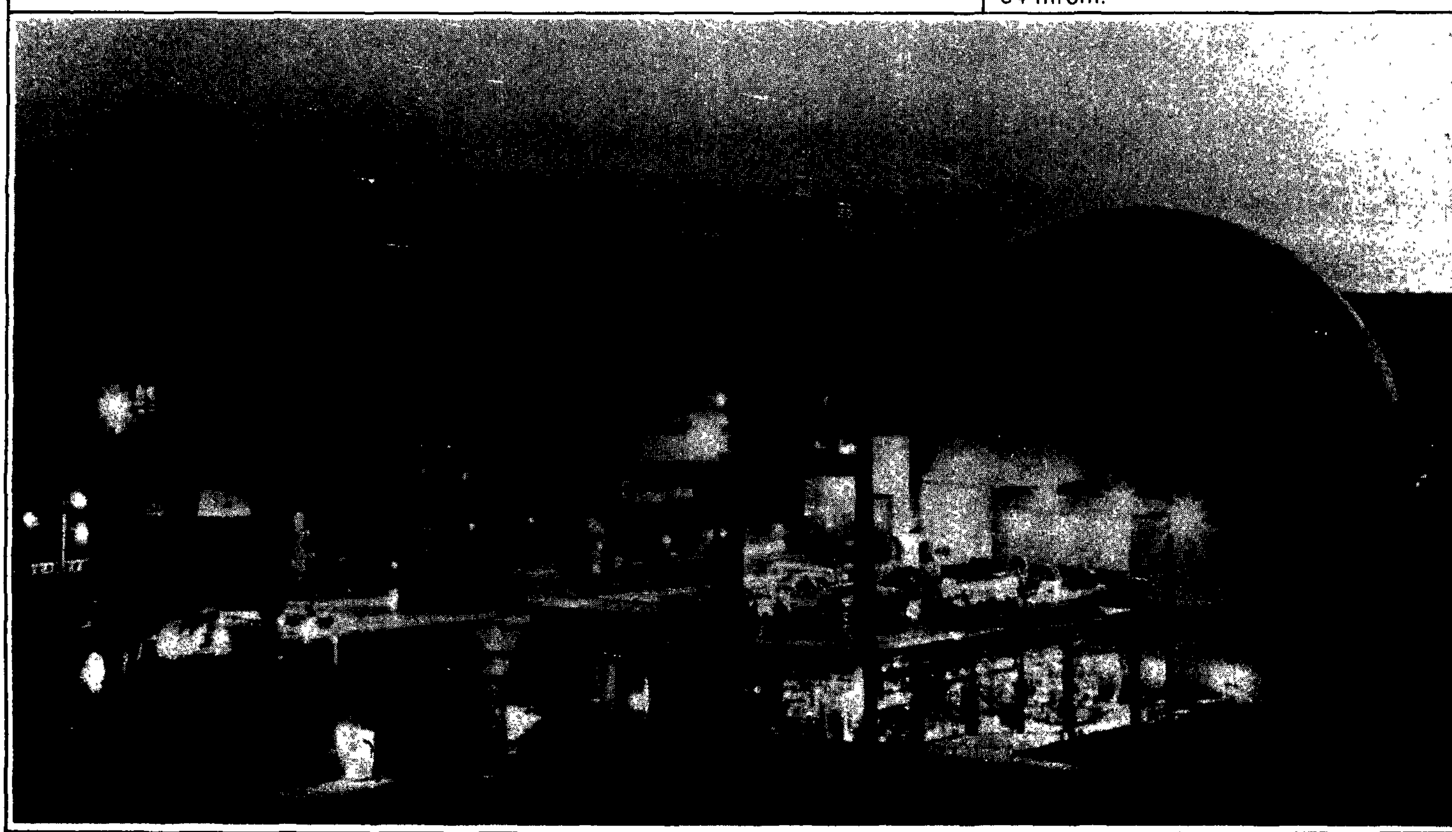
Diagnostic X-rays—72 mrem.



Radiation generated by consumer products such as a tv set—1.6 mrem.

Annual external radiation dose from nuclear tests' fallout[1]—.9 mrem.

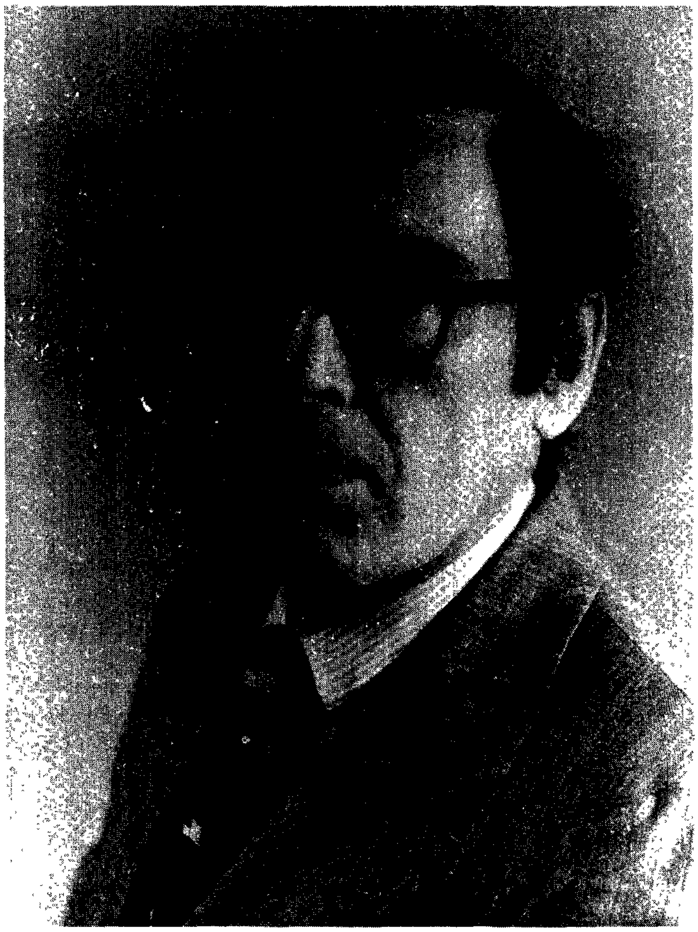
Cosmic and terrestrial radiation—84 mrem.



Average radiation dose within 50 miles of a nuclear power plant—.1 mrem.

What is EPA's role in radiation?

An interview with Dr. William D. Rowe, Deputy Assistant Administrator for Radiation Programs



What are the health hazards of radiation? Who monitors the radiation levels in the United States? How much radioactive wastes are being stored now? Will radiation problems block growth of the nuclear power industry? Dr. Rowe answers these and other questions.

QUESTION: What is EPA's basic role in the field of radiation?

DR. ROWE: We are responsible for overseeing all aspects of radiation protection. Both ionizing radiation, which is what we usually associate with nuclear power plants, medical x-rays and cosmic rays; and non-ionizing radiation, which we are more familiar with in the form of rays from radio and TV transmitters and microwave devices.

In carrying out this role, we examine all aspects of radiation including uses which are not strictly environmental. For example, presently we cover medical x-ray, and occupational uses of radiation under this broad responsibility.

In addition, we have specific legislative authority in specific areas.

QUESTION: Do you see this role growing or diminishing in the next five years? And why?

DR. ROWE: I think we see the role growing because of the expanded uses of radiation—nuclear power and emerging problems of natural radiation such as in the phosphate industry. There is also an increasing awareness of the risks incurred by radiation exposure.

I think EPA's role will grow. I don't think it will grow enormously, but I think there will be steady growth in the field since we have to cover more problems.

QUESTION: What is the most serious problem in the radiation field today?

DR. ROWE: Well, that is hard to answer, since there are many problems, and they fall into two classifications. Those which are not problems now, but which if we don't do something about them, could potentially become very great problems, such as the disposal of radioactive wastes from nuclear power plants.

And, secondly, those which we have identified as existing problems which need control.

Much of our efforts are focused on the emerging problems, especially in relation to nuclear energy. There are few immediate problems with nuclear energy; but as these uses expand, there are going to be tremendous amounts of radioactivity produced by man, and we, indeed, want to assure that controls are adequate.

In other cases where man is already exposed, such as excess exposure to medical x-rays, and certain aspects of naturally occurring radiation, we're addressing these kinds of problems directly. Radium in drinking water is a good example.

QUESTION: Does EPA have a national monitoring network to check on radiation?

DR. ROWE: Yes, we do. We call it by an acronym, ERAMS, which is the Environmental Radiation Ambient Monitoring System. It measures ambient radiation levels from different sources around the country.

In addition, we will in the near future issue a State of the Radiation Environment Report which will report all aspects of radiation throughout the country and summarize total exposure from all sources. This report will be published annually and will be based on data from other agencies and States as well as on data that we obtain ourselves.

QUESTION: Is the level of radiation growing? Have any hot spots been found by this network?

DR. ROWE: Well, we are finding hot spots, caused primarily by man's efforts, and in many cases in unsuspected areas.

These are occurring because of leaks to the environment from various activities, or the fact that man has upset nature's natural barriers in extracting materials from the earth which are themselves radioactive. The mining of phosphate is a good example.

QUESTION: What are EPA's main accomplishments in radiation control?

DR. ROWE: We've had some success in two areas.

The first is reviewing all environmental impact statements involving radiation. We have had considerable influence in persuading other agencies to take steps to assure that radiation protection is enhanced. This has been particularly true in the nuclear energy areas of waste disposal and Liquid Metal Fast Breeder Reactors.

In the second area, we are setting radiation environmental protection standards directly for the protection of individual members of the population.

In 1971 we initiated standards to protect uranium miners from overexposure to radon in the mines. These rules are now enforced by the Department of Interior's Mining Enforcement and Safety Administration.

In May, 1975, we issued proposed standards for the uranium fuel cycle. Last September we issued proposed standards for radiation in drinking water; these should be promulgated early this year.

QUESTION: What is the approximate quantity of radioactive wastes now being held in this country?

DR. ROWE: There are a number of different kinds of wastes, and different ways of summing this up, but first of all let's talk about those wastes which are generated by the Government for weapons production.

In 1974, there were about 85 million gallons of this waste in liquid form. A great deal of this waste has been solidified into cake and crystal form in a program carried out by the Energy Research and Development Administration.

The level of wastes that are being produced by nuclear energy are now rather small compared to that left from our weapons program.

In the nuclear energy industry there are about 400 gallons of high level waste produced for every ton of fuel. We have about 100,000 to 200,000 gallons of waste from this industry.

But with the growth of nuclear power we expect the commercial wastes to begin to exceed those from the weapons production by the year 2000. In addition to this, we have even larger volumes of low-level wastes, but these are a separate problem.

QUESTION: How do you distinguish between high-level wastes and low-level wastes?

DR. ROWE: High-level wastes are produced directly in the reprocessing of fuel from nuclear reactors. Their wastes are active—"hot" both from a radioactive point of view and a thermal point of view.

Low-level wastes are generated as by-products of the nuclear industry. Included are contaminated clothing, contaminated resins used to extract radioactivity, laboratory glassware, contaminated equipment, etc.

QUESTION: Is the amount of wastes over-all going to grow in the future?

DR. ROWE: Very definitely. Our projections show that wastes from weapons have generally leveled off, but the growth of nuclear power is going to increase the volume of wastes at all levels—high-level, low-level, long-half-life wastes of transuranic materials. By the year 2000 we estimate the total commitment for waste management will be about $7 billion which includes some allowance for inflation over this period.

QUESTION: Where are the high-level wastes being kept now?

DR. ROWE: Those associated with the weapons program are stored in three Government facilities: Hanford, Wash., Idaho Falls, Idaho, and Savannah River, Ga. These are large underground tanks which are considered temporary storage. And, as many of your readers may have read, the tanks in Hanford have had a variety of leaks over the past few years.

Wastes from nuclear power plants are presently being stored at the power plant, in the form of spent fuel rods. Until new capacity to reprocess spent fuel is implemented in the next few years, this will be the primary storage mechanism.

QUESTION: What are the feasible options for permanent disposal of these wastes?

DR. ROWE: There are many options being looked into: geologic disposal in a variety of different formations, including salt beds, dry rock, under old known aquifers, and geologic disposal under the seabed. This does not mean disposal in the ocean but underneath the seabed with the ocean as an extra environmental barrier. Separation of isotopes is being explored; the high-level wastes would be reduced in volume so they can be handled more easily, and at the same time separated from the long-half-life materials.

QUESTION: When is a decision going to be made as to which options will be the most advantageous?

DR. ROWE: That decision is initially up to the Energy Research and Development Administration (ERDA), and we hope it will be soon. But that decision has not been made.

QUESTION: EPA, I presume, will have an opportunity to comment on proposed final disposal options?

DR. ROWE: Not only will we have the opportunity, we are involved in developing criteria to determine if these methods will be acceptable. We have been working very closely with both ERDA and the Nuclear Regulatory Commision (NRC) to develop a program to take care of these wastes and dispose of them in a manner we know will be safe for generations to come.

Then when the plan is drafted we will be involved in reviewing not only the general methods to be used, but also the specific disposal methods when we review environmental impact statements.

QUESTION: How long a storage period are we talking about?

DR. ROWE: Well, it will have to be tens of thousands of years for long-lived wastes. However, if we go to isotopic separation, we are talking of 300 to 400 years for those fission product wastes which are very hot.

QUESTION: How about the low-level wastes, where are they being stored now?

DR. ROWE: They are now stored in six commercial burial sites throughout the country. The adequacy of the methods used for low-level storage is open to question, and we have been actually surveying some of these sites to determine what problems may be involved and what corrective action should be taken.

The present method uses open trenches which when filled are covered with soil.

QUESTION: There has been concern, has there not, about possible leakage at the Maxey Flats storage area in Kentucky?

DR. ROWE: This is one we've been investigating, and we are compiling considerable data on it.

QUESTION: Do you still see nuclear power as providing a major part of the answer to our energy needs?

DR. ROWE: I don't see any alternative in the near future. I think we will have to depend upon nuclear power as one low-cost form of energy until new, renewable sources, such as solar and geothermal energy, are developed.

I feel strongly that, with the proper environmental regulations and controls, certain forms of nuclear power can be environmentally acceptable.

QUESTION: Generally, what are the health hazards of radiation? What happens to the person who is exposed?

DR. ROWE: Well, we have to talk about exposure to radiation of two different types. First there is very high-level exposure in which there are acute effects which include radiation sickness, such as that experienced by the Japanese after the dropping of nuclear weapons at Hiroshima and Nagasaki in 1945. While we are always concerned with these, they are different than the effects which we are concerned with in most environmental sources of radiation.

At low levels we consider that all exposure to radiation carries some hazard proportional to the dose received. The ionizing radiation acts upon the various organs of the body, and the cells in the organs, to cause changes in the cells that may develop as cancer sites. This can be caused not only by radiation itself but radiation acting with other potential carcinogens in a synergistic manner to possibly cause cancer over a long time period. It may be anywhere from 10 to 20 years from the initiation of the radiation dose till the cancer develops.

A second aspect is cellular damage to the chromosomes. There is a possibility of genetic effects occurring both in the person exposed and in subsequent generations.

QUESTION: What sources of man-made radiation do you think are most dangerous?

DR. ROWE: Well, all sources of radiation are essentially equally dangerous in terms of the relation seen between exposure and dose. Alpha particles from heavy radioactive elements are much more damaging to human tissue than gamma rays. We feel that some of the long-lived alpha-particle materials, such as plutonium and radium, can indeed be very dangerous because of their long half-lives and ability to enter the body and remain there for long times.

QUESTION: What can individuals do to reduce their exposure?

DR. ROWE: Since radiation is unseen and people are not aware of it, it is very difficult for an individual by himself to reduce his radiation exposure. Therefore, it becomes the role of EPA to intercede for individuals, to explain to people what some of the risks are and what actions they may take.

QUESTION: Do you think there is adequate public understanding of the radiation received from x-rays and the possible damage?

DR. ROWE: Obviously not. x-rays are probably the single largest source of man-made radiation exposure in our country. We personally feel that we can receive the benefits of x-ray diagnosis and therapy with much lower exposures.

Many x-rays do not directly benefit the patient. These ought to be eliminated.

QUESTION: What steps could EPA take to implement those precautions?

DR. ROWE: Well, in acting for the general public, EPA, under its Federal guidance function has undertaken to look at the way x-rays are prescribed. Several Federal agencies have helped us: the Air Force, Army, Navy, and Veterans Administration hospitals and radiologists. We have come up with some general guidelines for use in Federal facilities to assure that x-rays are administered properly and with minimum exposure.

What is EPA's role in radiation?

QUESTION: What research work in radiation is EPA doing now?

DR. ROWE: Our Office of Research and Development is primarily directing their resources into two areas. One is to investigate the health effects of non-ionizing radiation, that associated with television, radio frequency sources, microwave ovens, and radar systems. The second area is investigating the biological effects from exposure to low levels of krypton 85 and tritium.

We've also been investigating the possibility that very-high-voltage power lines might have health effects We have been measuring such power-line fields around the country and exchanging data with other investigators. We've been a central source for gathering information in this area, which may or may not be a problem, depending upon the results of our findings.

QUESTION: What other Federal agencies are concerned with the radiation problem?

DR. ROWE: Well, the Nuclear Regulatory Commission is, of course, the specified regulatory agency involved with licensing nuclear energy and with radioisotopes used in medical research and therapy.

The Energy Research and Development Administration is responsible for developing our weapons systems and for conducting research and development activities towards development of new energy sources which include nuclear power and fusion energy as part of their activities.

The Bureau of Radiological Health of HEW is responsible for electronic equipment that involves radiation, including x-rays, and microwaves, lasers, and other aspects of non-ionizing radiation.

The Food and Drug Administration of HEW is responsible for specifying the limits of radioactivity in food, although EPA is responsible for specifying the limits of radioactivity in drinking water.

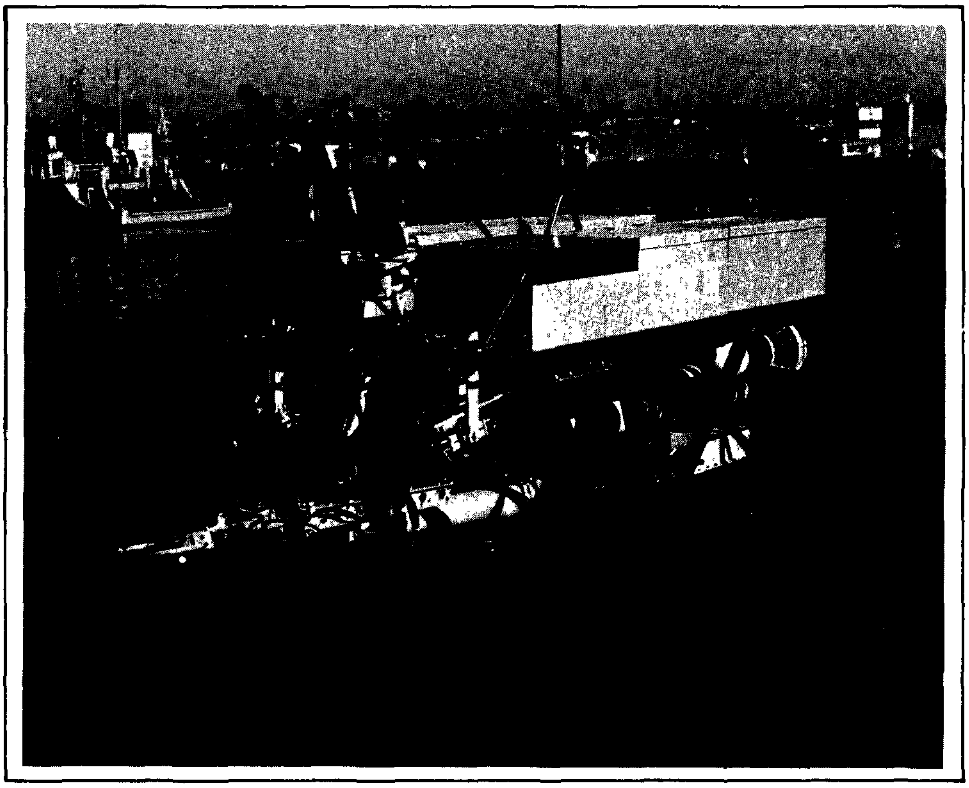
QUESTION: How would you describe EPA's mission in the radiation field?

DR. ROWE: The difficulty about radiation is that people cannot see it. You can't feel it; you can't know it is happening. It is also associated with nuclear weapons so people are indeed frightened of it.

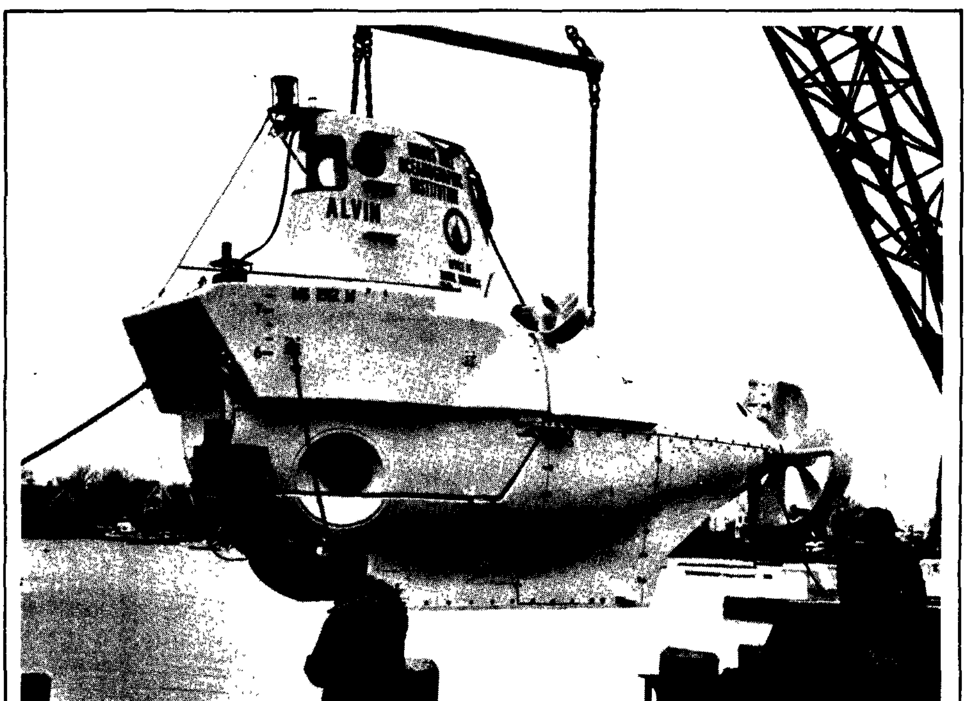
The role that we have to play at EPA is one of assuring the public that they are adequately protected from this radiation they cannot see. We must make certain that all possible steps are being taken to reduce exposure. While there are some risks to any exposure from radiation, radiation can also provide benefits which are often well worth minuscule exposures.

We have a responsibility to inform the public about all aspects of radiation, and assure that regulatory actions are taken only after participation by all parties affected by the decisions. □

Ocean Disposal of Radioactive Wastes



The CURV, an unmanned submersible with sonar "ears" and camera "eyes", which was used last summer to locate drums of radioactive waste on the floor of the Pacific Ocean.



The ALVIN, a submersible which can carry a crew of three, will be used by Robert S. Dyer, EPA oceanographer, to hunt for drums of radioactive wastes in the Atlantic Ocean this summer.

Should radioactive wastes be dumped in the ocean? If so, what types of wastes should be included, at what locations, and how should they be packaged? These are questions being asked more and more often by scientists and government officials both here and abroad. EPA is trying to find some answers.

With the passage of the Marine Protection, Research, and Sanctuaries Act of 1972 (commonly known as the Ocean Dumping Act), the Environmental Protection Agency was given the mandate to regulate dumping of all types of pollutants, including radioactive materials.

The Ocean Dumping Act prohibits ocean dumping of any high-level radioactive wastes or radiological warfare agents and the Office of Radiation Programs (ORP) was delegated the responsibility within EPA to develop criteria and standards governing ocean disposal of non-prohibited radioactive materials. As a result, ORP proposed two initial requirements regarding ocean disposal which were published in the *Federal Register*, on October 15, 1973.

These requirements are as follows: (1) radioactive wastes should be containerized, and (2) the containerized radioactive wastes must radiodecay to innocuous levels within the life expectancy of the containers and/or their inert matrix.

In order to amplify these requirements ORP has initiated field studies to find out what has happened to radioactive wastes dumped into the oceans in past years.

From 1946 to 1966 some government agencies and research organizations in the United States carried out ocean disposal of low-level radioactive wastes. This practice was gradually discontinued and supplanted by land burial.

Today, however, some states are becoming reluctant to accept any more radioactive wastes for land burial since these wastes often contain long-lived radionuclides. Such wastes require long-term surveillance at considerable cost to insure that the radionuclides are not released into the environment.

Therefore, many other nuclear waste disposal options are being investigated, particularly for the longer-lived materials.

These options include disposal into outer space, or emplacement in salt mines, polar ice caps, and under the ocean floor. But not all radioactive waste would require such ultimate disposal. For certain classes of radioactive waste ocean dumping *onto* the ocean floor under carefully controlled conditions may offer an environmentally acceptable technique as part of an overall waste management program.

Nevertheless, ocean dumping must be viewed as a form of irretrievable storage and, as such, must be considered with caution. Any ocean disposal of radioactive materials must aim at containment over their lifetime so as to prevent environmental dispersal.

A search of the records of past sea disposal operations indicates that between 1946 and 1966 almost all U.S. disposal operations consisted of packaging the radioactive wastes in 55 gallon drums filled with concrete or other experimental matrices. These drums were then dumped at depths ranging from 3,000 to 9,000 feet. But no one had ever determined what happened to the actual radioactive materials that were dumped.

Did the containers implode from the tremendous hydrostatic pressures found in the ocean deeps? Have the containers corroded away, releasing the contents? Are there any fish or invertebrates living in the disposal areas which could take up released radioactivity and transmit it through the food chain to our dinner table?

To answer these questions and others required a unique approach to oceanographic research; an approach which would allow probing of ocean waters many thousands of feet deep in search of small targets such as radioactive waste containers. Such a task could not be accomplished with the usual sampling equipment.

By Robert S. Dyer

The solution came with the availability of the deep submersibles CURV III (Cable-Controlled Underwater Recovery Vehicle) and ALVIN. The CURV III is operated by the Naval Undersea Center, San Diego, California. It is an unmanned, tethered submersible with a depth capability of 10,000 feet.

The ALVIN is operated by the Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. Named after a scientist, Allyn Vine, at Woods Hole, the ALVIN has a titanium alloy hull to withstand great pressure, can carry a crew of three, and has a depth capability of 18,000 feet. Deep submersibles differ from submarines principally in that they are much smaller, have more maneuverability, and can descend to much greater depths.

Two deep water dumpsites were selected for EPA's pilot studies since historical records indicated that they had received the majority of radioactive wastes. One site is located in the Pacific Ocean near the Farallon Islands, 40 to 50 miles offshore from San Francisco, and consists of two disposal areas at 3,000 and 6,000 feet respectively.

The other site, designated on navigational charts as a disused munitions disposal area, is in the Atlantic Ocean approximately 120 miles east of the Maryland-Delaware border at a depth of 8,000–9,000 feet.

The 3,000-foot depth site investigated by EPA off the West Coast received approximately 3,600 containers of an undetermined radioactivity inventory while the East coast site received approximately 30,000 containers with a total activity of about 45,000 curies.*

Many government agencies, companies, and research groups were involved in the organization and performance of these unique pilot studies. One comment kept recurring regarding the proposed project: "Locating these radioactive waste containers in thousands of feet of water, miles out at sea, will be like looking for the proverbial needle-in-a-haystack!" *IF* the weather holds out and *IF* there are no mechanical or electrical problems in the complex submersible system, and *IF* the bottom topography is relatively smooth so that the sonar system can find the targets, then and only then can you have the opportunity to search miles of ocean bottom to locate the containers.

These contingencies loomed very large and could not be overcome on the East

* A curie is a special unit used in measuring radioactivity and is equal to 37 billion nuclear disintegrations per second

coast operations of May and September-October, 1974, where both mechanical and weather difficulties forced cancellation of the ALVIN dives. However, with the cooperation and support of EPA's Marine Protection Branch of the Office of Water Program Operations, the Manned Underseas Science and Technology Program and the Marine Environmental Protection Office of the National Oceanic and Atmospheric Administration (NOAA), the Woods Hole Oceanographic Institution, and the Virginia Institute of Marine Science, much oceanographic data in this Atlantic region was collected by the research vessels Delaware and Albatross. Also, the existence of large populations of the potentially commercially exploitable large red crab, *Geryon quinquedens,* was verified in the Hudson Canyon approximately 90 miles north of the radioactive waste dumpsite. In addition, some munitions containers were found in the trawls near the dumpsite area confirming the relative accuracy of the published coordinates for past munitions dumping operations and providing support for the supposition that the radioactive wastes will also be found in this dumpsite area as reported.

The West coast operation near the Farallons met with remarkable success. This pilot study was a coordinated effort of EPA's Office of Radiation Programs and Water Program Operations, the Navy's Undersea Center at San Diego, and Interstate Electronics Corporation. The operation budget permitted only five days to be spent in running station lines in search of the radioactive waste containers. After two and one-half days of searching the ocean bottom the first cluster of targets was located consisting of about 150 fifty-five gallon drums nestled in a small valley between 300 foot embankments at a depth of 2,800 feet. In the subsequent two and one-half days, two more target clusters were found. After five days this mission had succeeded in: (1) taking the first videotape and 35 mm coverage documenting the conditions of the radioactive waste barrels, (2) taking the first precision-located sediment core samples in a radioactive waste disposal area using a specially-devised rosette corer attached to the CURV III's manipulating arm, (3) finding large sponges up to four feet high, (possibly a new genus) attached to the radioactive waste containers; these sponges were, in at least one case, partly responsible for biodeterioration of a metal container, and (4) documenting edible species of fish in the immediate vicinity of the containerized radioactive wastes.

We have obtained much preliminary information on container integrity and design. Through existing records and correspondence pertaining to past disposal operations in the region of the Farallon Islands, we have been able to determine the age of the photographed containers as between 20 and 22 years old. Those radioactive wastes packaged in an inner matrix of concrete have maintained relatively good integrity while those packaged in a gel matrix with a bitumen (tar) liner did not stand up as well. Radionuclide analyses for strontium, cesium, uranium, thorium, radium, plutonium, and gross gamma activity are currently being completed, and an operations report on the Farallon Islands pilot study is soon to be published. Preliminary results of radiochemical analyses of samples has detected some levels of plutonium above background in sediment at the site. The implications of these findings are under investigation and the results will be the included in a forthcoming technical report.

Since the studies conducted in 1974 were primarily pilot studies to determine the feasibility of this unique approach using deep submersibles, the Office of Radiation Programs has organized two follow-up studies for this summer to provide more specific answers to continuing questions such as:

(1) What are the hydrostatic pressure effects on containers dumped at 6,000–9,000 feet as opposed to now-documented effects at 3,000 feet? (The present internationally-recommended minimum disposal depth is 6,000 feet.)

(2) What is the speed and direction of dispersion forces in the disposal areas?

(3) What is the sediment sorption or cation exchange capacity for released radionuclides?

(4) Are the past packaging and container design specifications adequate to assure that no radioactive materials will be released when dumped in waters greater than 6,000 feet deep? If not, can these specifications be attained with current technology?

(5) What should be the design and extent of a monitoring program around any future radioactive waste dumpsites?

Only after the successful completion of the 1975 studies may enough information be available to begin answering some of these questions.□

NOTE: The International Atomic Energy Agency (IAEA) in Vienna, Austria, is developing international recommendations for ocean dumping of radioactive wastes pursuant to its responsibility as stated in the International Ocean Dumping Convention of 1972. To fulfill its responsibility the IAEA has established an international panel of experts to assist in the development of specific recommendations. EPA (Office of Radiation Programs) will present its findings to the IAEA panel of experts in its role as the United States representative to this panel.

A deep sea fish, a Thornyhead (Sebastolobus), swims past drum of radioactive wastes photographed by the CURV in the Pacific.

The dent in the middle of this drum is believed to be the result of underwater pressure.