OVERSIGHT HEARINGS ON NUCLEAR ENERGY—OVERVIEW OF THE MAJOR ISSUES

HEARINGS

BEFORE THE

SUBCOMMITTEE ON ENERGY AND THE ENVIRONMENT

OF THE

COMMITTEE ON INTERIOR AND INSULAR AFFAIRS HOUSE OF REPRESENTATIVES

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OVERSIGHT HEARINGS ON NUCLEAR ENERGY—OVERVIEW OF THE MAJOR ISSUES

MONDAY, APRIL 28, 1975

House of Representatives,
Subcommittee on Energy and the Environment
of the Committee on Interior and Insular Affairs,
Washington, D.C.

The subcommittee met, pursuant to notice, at 10 a.m., in the Caucus Room, Cannon House Office Building, Hon. Morris K. Udall, chairman of the subcommittee, presiding.

Mr. Udall. The Subcommittee on Energy and the Environment will be in session. We have scheduled two important and interesting witnesses this morning. We will try to divide the time equally between them, with Mr. William Anders taking from now until 11 o'clock and then we will have Mr. Nader starting around 11 or a little later until 12. I have a short introductory statement which I will abbreviate in the interests of time.

We are meeting today to begin a series of hearings which I hope over the next few months will give this subcommittee, Congress and the American people a fair, comprehensive overview of the nuclear energy debate.

The first aim of these sessions is to provide an unbiased forum in which both critics and defenders of the status quo can present their cases. I would hope that we can do more, however. I hope that we can give some direction to this debate and focus on it by identifying and separating out some of the key issues. I consider this focus on specific issues as being particularly important because the correct policy for nuclear power may perhaps lie somewhere between the two extremes which are being urged upon us today.

One extreme is to stop all nuclear power development and the other extreme is to go ahead essentially with the same policies as in the past. There is a strong case to be made for nuclear power. It is not at all certain that we can do without it, at least for the near future, and if its problems can be adequately solved, and that is a big "if", then it offers great promise of adequate supplies of energy both for the Nation and all the other Nations with whom we share the shrinking resources of this planet.

I must say I share many of the concerns raised by the critics of nuclear power, particularly concerning the disposal of waste of the radioactive products of fission power and the potential for diversion by governments or terrorist groups of nuclear materials to the manufacture of nuclear weapons.

However, I know each of our major current sources of electrical energy brings with it its own group of evils. The price of oil set by OPEC seriously threatens international economic stability.

Coal, which is our only fossil fuel resource, has many environmental drawbacks and might cause us, if we burn more than a fraction of it, to add enough carbon dioxide to the atmosphere to have to change our plans, and so on.

Certainly men are killed and damaged, our health is damaged by the mining of large quantities of coal. We do have one attractive energy option to which little attention has been paid and that is energy conservation. Experts agree that from one-fifth to one-quarter of current energy is wasted in one way or another.

The elimination of this needless waste from our strained energy economy is one of the greatest challenges we face. These hearings therefore are set in the context of a tight energy budget where this country must make every Btu count.

As we consider the advantages and drawbacks of fission energy, let us remember then exactly what options there are available and how much can be done to improve the regulation and implementation of this technology.

I might note here the chart behind the chair shows on top the distribution of those nuclear powerplants which currently operating, and, the bottom, those which are being built or planned for operation by 1985. This represents an increase in the number of nuclear powerplants from 53 to 235.

This shows the dramatic nature of the debate we are undertaking here and the impact on the country if these new plants are to be constructed. We are going to hold these hearings in segments relating to different subject areas. This morning we are going to begin with the problems caused by the regulation or posed by the regulation of nuclear power.

The shortcomings and weaknesses of governmental bureaucracy have been obvious in the past. We will ask the question today whether the combination of tremendously concentrated energy, uranium, and the often short-sighted behavior of Government institutions are a prescription for trouble.

We will hear from representatives both of Government and industry, and as the hearings proceed, from concerned citizens. This afternoon we will focus on the issue of the future electrical power thrust. Tomorrow morning we will turn to the issue of nuclear reactor safety and this is a big subject.

Tomorrow afternoon we will talk about radioactive waste disposal. We will not meet on Wednesday but on Thursday morning we will discuss the breeder reactor development program. On Thursday afternoon we will turn to the problem of export of civilian nuclear technology by the United States.

On Friday we will discuss some of the issues associated with the plutonium economy, the problems of potential theft for the manufacture of weapons.

Finally, on Friday, we will discuss the issues relating to nuclear fuel reprocessing plants. These plants are where spent fuel from a reactor is processed chemically to recover the remaining uranium and plutonium. So the issues which we will survey in the hearings this week and explore in depth during subsequent hearings in the months ahead have tremendous implications for the future of the Nation and the world.

Our civilization runs on large amounts of energy. We know that the petroleum age will end within the lifetime of our children. Fission with breeder reactors offers a now almost unlimited source of energy if we can keep the radioactivity isolated and if we can keep the energy of the nucleus from being exploited for purposes of destruction.

Albert Einstein once said that the unleashed power of the atom has changed everything save the modes of thinking and thus we drift towards unparalleled catastrophe.

The job of Congress and the American people is to discover how much has been done and what more can be done to improve on Einstein's prognosis.

Now, before we call our first witness I would like to place in the record a statement of Hon. Alan Steelman, which has been submitted for the record.

[The statement follows:]

STATEMENT OF HON. ALAN STEELMAN, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF TEXAS

Mr. Chairman, I join in strong support in the need for these oversight hearings on nuclear development. It is no secret that the whole question of nuclear development has been caught up with the issue of future energy needs and demands. However, the need for a new energy source, such as nuclear power, no matter how urgent, must take a back seat in actual industrial production and use, until the questions asked by the public and scientific community as to its safety and reliability are fully answered.

We here on this subcomittee now serve the public and scientific community in a capacity of truth searchers. It is our responsibility to hold these hearings in a truly un-biased forum and explore such questions as: "How safe is nuclear power?", "How costly is it?", "To what extent should it be limited, both domestically, as well as internationally?" "How far should we develop it?", and many other questions which have been asked as many times as there have been different answers.

It is hoped that at the conclusion of these hearings, that some if not all the questions surrounding the nuclear development issue will be answered. Perhaps, I am being overly optimistic as to what these hearings can accomplish, and I am sure there will be those who will ask "what can these hearings accomplish that other hearings had not set out to do?", and maybe at the conclusion of these hearings I will be forced to answer, "nothing". But at least I will be able to add that we tried to do so and tried with the public interest in mind. No one has ever claimed that these were easy questions to answer, and I would not like to be the first. I feel that there has been a great deal of apprehension and fear about nuclear development and that the only way to settle this is to bring what knowledge there is about nuclear development, whether it be good or bad, out into the light so that it can be undertsood. Up til now I do not think that this has been accomplished, and that this is one of the primary goals of this subcommittee.

Our subcommittee will start off on this task with these first go-around of hearings. During these four days of hearings we will first attempt to familiarize the public as well as ourselves with eight major issues surrounding nuclear development. Today we will address the questions of nuclear regulation and future electrical energy growth. These two questions go hand in hand for we know that we as a nation (and the whole world) are faced with an energy problem. It is not a shortage of energy per se, but a shortage in the supplies of some forms of energy. Thus, we will look at just what our future energy growth is, our needs, and what it will cost us, not only in terms of money, but also in terms of our safety and our environment. This leads us to the second issue and that is do we need nuclear energy and if we choose so or not, how do we regulate it.

On the second day of these introduction hearings, we will be exploring nuclear reactor safety and radioactive waste disposal.

We have all heard that by 1985, there will be some 200 nuclear reactors and that by the year 2000 there will be some 1,000 nuclear reactors. With these estimates I think it behooves us to look at the safety aspect (which is probably the most controversial issue surrounding nuclear development) of nuclear development and discuss the various reports and studies that have been done to date and possibly suggest several areas in which new studies should be done so as to assure the public and ourselves that before we go any further in nuclear development, we have all the safety facts before us. Another aspect of safety, is that of radioactive waste disposal.

There have been several proposals as to how we should handle the disposal of radioactive wastes from nuclear reactors. It is imperative that a solution to radioactive waste storage or disposal be found before our country (as well as other countries that are actively proceeding on a nuclear development program) reaches the stage of full commercial nuclear development. It is one thing to have 55 nuclear reactors and still in the decision process as to where to dispose of or handle their waste, and it is altogether another story to have 200 or 1,000 nuclear reactors and still be in the decision-making stage. A look at this issue will enlighten us as to where we are on this decision and what the known alternatives are.

Our third day of kick-off hearings will take the subcommittee on a verbal, historical, and futuristic tour of the various types of nuclear reactors, with particular emphasis on the liquid metal fast breeder reactor (LMFBR), which is as I understand, the ERDA's prime choice of the many reactor types, to be developed further so as to meet our Nation's electrical needs.

Then, our subcommittee will take up in the afternoon of the third day, the major question of the export of nuclear technology. As indicated at the subcommittee briefing last Thursday, as a result of the oil crisis, many new orders have been placed for reactors of American design by other countries (not only designs but also nuclear materials). As a result, our country and leaders must decide to what extent should we export this technology and materials and how and what types of restrictions should we impose and enforce nonproliferation.

Finally, the subcommittee will look into the issues associated with a plutonium economy and what safeguards we need to have to protect us against nuclear theft and sabotage. We will hopefully look at how our security system at present works and how and what is needed to assure that it continues to work.

And wrapping up these introduction hearings we will be discussing the nuclear fuel reprocessing plants and how these plants operate and what potential there is to eliminating this process i.e., laser defusion.

In conclusion, I would like to stress my desire that these hearings be held in full view of the public and that they be conducted in such a way so as to assure the public that this subcommittee's performance is truly in their interest and in the interest of bringing to light the problems as well as the solutions of nuclear development.

Along these lines, I hope that the subcommittee will actively pursue the truth by actually visiting those operating nuclear reactors and nuclear testing and research facilities. By visiting these places and holding public field hearings this committee will be able to obtain important information from both the public and scientific community which have the working experience with these issues.

All in all, Mr. Chairman, I state my willingness as one member, in coming into these hearings with an open mind, to produce meaningful and factual information to the public and to this subcommittee, so that we can hopefully settle the issues of nuclear development once and for all and get down to the business of securing the type of energy needed to get our economy back on the right road and to assure our Nation's advancement.

Mr. UDALL. Dr. Frank von Hippel, special staff consultant on nuclear energy, briefed the Subcommittee on April 24, 1975, on major issues relating to nuclear energy.

(His statement follows:)

STATEMENT OF DR. FRANK VON HIPPEL

A ROADMAP TO THE MAJOR ISSUES RELATING TO NUCLEAR ENERGY

(Frank von Hippel)

(As presented to the Subcommittee on Energy and the Environment of the House Committee on Interior and Insular Affairs, April 24, 1975)

Introduction:

The naturally occurring isotope Uranium-235 and a few artificial isotopes, Plutonium-239 and Uranium-233 in particular, represent marvelously concentrated energy sources. One kilogram (2 pounds) of any of these isotopes carries as much releasable energy as 2000 tons (4 million pounds) of coal. That is the attraction of nuclear energy. One kilogram of any of these isotopes also carries as much releasable energy as 20,000 tons of TNT. That is one of the troubling aspects of nuclear power. The other problems of nuclear energy stem ultimately from the radioactive ashes which are the products of the nuclear fire.

This talk will be organized in three parts:

1. Nuclear Physics: Here I shall discuss how a chain reaction works and how the radioactive products are created.

2. The Biological Effects of Radiation: Here I shall discuss briefly the hazards of radioactive materials.

3. The Nuclear Fuel Cycle: Here I shall trace the uranium from the mine through the enrichment plant and the fuel fabrication plant to the nuclear reactor and then the subsequent history of the radioactive wastes—a history which is not yet fully planned.

4. Nuclear Issues: Here I will simply list some of the issues which will be raised during the forthcoming hearings.

I. The Chain Reaction and the Creation of New Radioactive Isotopes

Isotopes: Different isotopes of the same element are atoms which have essentially the same chemical properties but different nuclear properties. Uranium-235 and Uranium-238 differ only by 3 neutrons but Uranium-235 will sustain a chain reaction and Uranium-238 will not. Similarly Iodine-131, a product of the chain reaction, is identical to normal Iodine-127 except for 4 extra neutrons. But Iodine-131 is highly radioactive—its nucleus changes into the nucleus of another element, Xenon-131, within an average of about 11 days by firing out a high energy electrons and other particles.

Chain Reaction: Figure 1 shows a Uranium-235 chain reaction and some of the other nuclear events which happen inside a reactor 100 billion billion times each second.

The magic bullet in the chain reaction is, of course, the neutron. If a neutron hits a Uranium-235 nucleus, the nucleus will usually split into two large pieces (fission) releasing an enormous amount of energy for a single atom plus a number of smaller pieces of matter—including typically 2 or 3 new neutrons.

If one of the neutrons from a fission event finds another Uranium-235, then the process can repeat itself and so on until the Uranium-235 in the reactor becomes significantly depleted after a year or so. Obviously the trick in designing a nuclear reactor is to be able to tune it—or preferably have it adjust itself automatically—so that exactly one neutron on the average finds another Uranium-235 nucleus. That way the nuclear fire will neither burn out nor flame up out of control.

Fission Products: The two large "daughter" nuclei which carry away most of the mass of their parent Uranium-235 are the so-called fission products. They are usually highly radioactive and will spit out electrons and gamma rays (high energy X-rays) until they finally achieve a stable state.

Half Lives: These radioactive nuclei are characterized by their half lives—the more radioactive a nucleus the shorter the time in which half of its numbers will have decayed radioactively into an isotope of another element. Thus, Iodine-137 has a half life of 25 seconds while some radioactive isotopes are so weakly radioactive—so long lived—that significant quantities still remain from when they were created in some star before the earth was formed. Uranium-235 and Uranium-238 are both such elements. Uranium-235 has a half life of 700 million years and Uranium-238 one of 5 billion years. (Currently there is only one Uranium-235 atom in natural uranium for every 140 Uranium-238 atoms but that is because of the shorter half life of Uranium-235. Five billion years ago when the earth was formed, natural uranium would have contained approximately equal amounts of the two isotopes.)

Plutonium-239 and Uranium-233: Radioactive nuclei are formed in other ways than as fission products in the reactor. One of these is the artificial nucleus plutonium. You can see the formation of one of these heavy isotopes in figure 1. Uranium-238 when it captures a neutron does not ordinarily fission—rather it spits out two electrons and some other particles and after a few days settles down to being Plutonium-239 which like Uranium-235 will sustain a chain reaction. In fact many of our nuclear weapons have fission triggers made out of plutonium. The proposed liquid metal cooled breeder reactor would operate on the basis of a chain reaction in plutonium.

Breeder Reactor: In fact, it is possible to understand the principle of the breeder from figure 1. As I have already explained, on the average exactly one neutron released from each fission must find and split another Uranium-235 or other fissile (fissionable) nucleus to continue the chain reaction at a steady rate. This means that there are some neutrons left over because Uranium-235, when it fissions in a standard water cooled reactor releases an average of 2 neutrons per neutron absorbed. Subtracting one of these to sustain the chain reaction leaves 1. If it could be arranged that the remaining neutron found its way to a Uranium-238 nucleus and turned it into a Plutonium-239 nucleus, then, for every fissionable Uranium-235 nucleus consumed, one new fissionable Plutoium-239 nucleus would be created and the reactor would be breeding as many fissile nuclei as it consumed. It would not be breeding them out of nothing, as the same breeder reactor sometimes seems to imply—rather it would be breeding only in the restricted sense of making new fissile nuclei out of Uranium-238—which thus becomes the ultimate fuel for this type of reactor. Another breeding process turns the nonfissionable nucleus Thorium-232 into the fissile nucleus Uranium-233 through neutron capture.

The trick of making a uranium-plutonium or thorium-uranium breeder reactor thus amounts to trying to reduce as far as possible the wastage of neutrons on nuclear processes other than the chain reacting or breeding reactions. The Naval Reactor Development Program is attempting to tune up an ordinary water cooled reactor so that it becomes a "break-even" thorium-uranium breeder reactor-breading out of the thorium almost exactly as much new uranium-233 fuel as it consumes. (Uranium-233 emits 2.25 fission neutrons for every neutron absorbed.) The liquid metal cooled fast breeder reactor is designed in such a way that the chain reacting plutonium would release 2.5 fission neutrons per neutron absorbed and the neutrons would be used effectively enough so that there would be a significant surplus of plutonium produced—probably enough to provide the initial fuel of at least one other breeder reactor over 20 years or so.

Current reactors don't do so well: The standard U.S. water cooled reactors produce a total of approximately one new fissionable atom for every two Uranium-235 atoms fissioned. The current high temperature gas cooled reactor of which only one small unit has thus far been deployed, can do somewhat better. A variant of the Canadian heavy water reactor could in principle breed approximately 9 new fissile atoms for every 10 atoms fissioned—although the current Canadian reactors are not being used in this manner. Obviously, such a reactor would be much more advantageous for a country concerned about stretching its uranium resources than are the U.S. reactors.

II. The Biological Effects of Nuclear Radiation

The principal biological damage by nuclear radiation is due to the displacement of atoms by fast changed particles traveling through living tissue. If enough atoms are displaced in a short period of time, then the tissue can no longer function and you have a "radiation burn." At a less intense level of radiation the tissue can keep functioning over the short term, but over a period of decades abnormalities may result—cancer and genetic damage in particular. Of course, nuclear radiation is not unique in this regard—many chemicals and --rays also have the same effects—in fact, it has been suggested that the majority of cancers may be due to such environmental causes. Nuclear power would at present only account for a very tiny percentage of these cancers—probably one hundredth of a percent or less.

Radiation can be delivered to man by many routes: Radioactive materials released to the air can irradiate us from the outside while the atoms are still airborne—or the radioactive gases or aerosols can be inhaled and be deposited in the lung, after which they may irradiate the lung tissue—or they may be absorbed into the body and irradiate other organs. Radioiodine, for example, is concentrated very efficiently by the body into the tiny thyroid gland. This is the reason why radioiodine is used to diagnose and treat some thyroid disorders. It is also the reason why the thyroid would be particularly at risk in case of a major release of fission prdoucts from a nuclear reactor. Radioactive material which "falls-out" of the atmosphere onto the ground can also irradiate one externally—or can become resuspended as dust and be inhaled—or can be taken up by plants and enter the human food chain. Of particular concern is the grass-cow-milk food chain. Finally radioactive material can enter the water directly and thereafter be drunk or enter the food chain.

The following three isotopes are among those of particular concern:

Iodine-131: This iodine-isotope has a half life of 8 days. It is of particular concern both because it is produced copiously in the fission process and because it concentrates in the thyroid.

Cesium-137: This isotope has a 30-year half-life. If there were a major release of fission products into the environment, Cesium-137 would probably be the most troublesome isotope as a long term land contaminant. Due to a very penetrating gamma-ray emitted in its decay, a major problem would be external radiation from contaminated ground.

Plutonium-239: This isotope has a 24,000 year half life and is intentionally produced in great abundance in most nuclear reactors.

Most of the radiation emitted by plutonium is very short range—it will be stopped by the dead epithelial layer of the human skin, for example. It is a hazard, therefore, only if it gets inside the body—particularly by inhalation.

III. The Nuclear Fuel Cycle

The nuclear fuel cycle is shown on figure 2. I will go through it step by step below—from mine to waste disposal.

Uranium Mine: The nuclear fuel cycle begins at the uranium mine.

Currently the ore which is being mined typically has only one part uranium compared to 500 parts of other elements by weight. This and the fact that Uranium-235 is only one part per 140 parts of natural uranium means that the ore itself, in terms of its uranium-235 energy content, is not such a concentrated source of energy—only about 30 times more concentrated than the available energy in coal. If you count the Uranium-238, because it can be turned into Plutonium-239, however, then the ratio goes up to 4000. This is why the breeder or other reactors which can exploit a substantial fraction of the Uranium-238 energy are of such great interest.

Resources: Estimates of the uranium resources of the U.S. vary greatly. The most recent ERDA estimates are in the range of 1-3 million tons of uranium-counting ore down to one half the average richness currently being produced. This estimate has been criticised, however, on the basis that it really only accounts for the resources in the relatively small area of the country which is currently producing and considers ore only down to an average of 400 feet depth. A study done at the Electric Power Research Institute guesses that the resulting underestimate of our uranium resources is likely to be by a factor of 10 or so.

This is an important range of uncertainty. One million tons of uranium would fuel the 200 reactors projected for 1985 for their 40 year lifetimes. If we have little more than this amount of uranium, then the future role of our current reactors is quite limited. If, on the other hand, we have 10–30 times this much intermediate and high grade uranium ore, than a uranium "crisis" is still some time off in the future.

Hazards: Both isotopes of uranium are radioactive. They ultimately turn into lead isotopes after more than ten radioactive transformations each. In any rock containing uranium, therefore, the intermediate radioactive nuclei tend to build up to a level where they come into an equilibrium in which they are decaying as fast as they are being replenished by decays further up the chain.

Among the intermediate nuclei are radium and the radioactive gas radon. Radon is released when the uranium ore is broken up. Along with its descendant nuclei which remain airbourne, it can be inhaled and irradiate the sensitive lung tissues. This is why there has been an epidemic of lung cancer among Western uranium miners who have worked in the past in inadequately ventilated mines. About half of our uranium is currently mined underground.

Milling: The uranium ore is taken to the uranium mill where it is crushed. The uranium is then ordinarily leached out of the fines with sulphuric acid—leaving the "tailings." These tailings unfortunately retain their original radium. The radium is a problem as a water pollutant where the tailing piles have been allowed to erode into western rivers. The radium in the tailings also continues to decay, releasing radon. This has resulted in particular problems for those communities in Colorado and Utah where construction companies have been allowed to take away and use the tailings for fill around the foundations of houses and schools. Radon has sometimes seeped into these buildings and reached levels which would not be tolerated nowadays in uranium mines.

Isotope Separation Plant: From the mill the uranium is taken to an isotope separation plant where much of the uranium-238 is removed. This raises the percentage of Uranium-235 in the residue from the level of 7 tenths of a percent in natural uranium to approximately 2-4 percent, the level which U.S. reactors water cooled reactors are designed to use. Some reactors such as the first generation of British gas cooled reactors and Canadian Heavy Water Reactors use unenriched uranium. U.S. high temperature gas-cooled reactors use uranium enriched up to nuclear weapons grade, 93 percent Uranium-235. This HTGR fuel currently represents the earliest stage in a nuclear fuel cycle where we have to worry about clandestine diversion of nuclear fuel materials to weapons purposes.

Current isotope enrichment plants are enormous and are owned only by nuclear weapons states. New separation technologies are being developed, however, using high speed centrifuges and lasers and it would appear that small scale uranium enrichment plants may soon be within the reach of smaller nations. Since an isotope enrichment plan can be operated to produce fully enriched weapons grade uranium as well as reactor fuel, these new technologies are of great concern to those worried about the proliferation of nuclear weapons.

Currently the isotope separation stage is comparable in cost to the mining and milling stage of the fuel cycle. With current technology it also consumes more than 90 percent of the energy used in the nuclear fuel cycle. The electrical energy consumed in the separation plant to enrich ordinary reactor fuel corresponds to about five percent of the electrical energy which that fuel will ultimately produce.

Fuel Fabrication Plant: At a fuel fabrication plant, uranium oxide is formed into small thimble-sized cylindrical ceramic pellets. These pellets are about ½ inch in diameter and approximately the same length. They are encased in a long thin can of the corrosion resistant metal zirconium to give us the long thin fuel rods (½ inch in diameter and more than 10 feet long) of a standard U.S. water cooled reactor. The fuel, like the uranium in the preceding steps of the fuel cycle is only very weakly radioactive. In fact, uranium is more toxic because of its chemistry than because of its radioactivity.

Nuclear Reactor: The typical modern commercial nuclear reactor has an electrical power rating of about a million kilowatts—or over a million horsepower. This is enough capacity to supply at full power the current electricity consumption of almost a million U.S. citizens. This enormous power is generated in the reactor core which is typically 12 feet high and 15 feet in diameter. The core consists primarily of perhaps several tens of thousands of fuel rods held in a vertical array with space between them for cooling water to circulate and carry off the heat generated in the fuel rods by the fission process.

Perhaps the simplest type of reactor to describe is the boiling water reactor. (See Figure 3). Here the heat of the core boils the cooling water at a high temperature and pressure (550 degrees Farenheit, 1000 pounds per square inch). The steam then, as at any other modern steam-electric power plant, forces its way through a turbine which spins and turns an electric generator rotor attached to the same axis. At the other end of the turbine the steam gives up its remaining heat in heat exchangers to cooling water. It is, thereby, condensed back into water which is pumped back into the reactor pressure vessel.

The principal hazard associated with the nuclear reactor stems from a scenario called the "loss of coolant" accident. It involves a break in a pipe or the pressure vessel allowing the escape of the high pressure coolant.

The loss of coolant accident doesn't by itself necessarily result in disaster because there are emergency core cooling systems designed to refill the pressure vessel if a pipe breaks. The problem arises if these emergency systems fail, or the pressure vessel falls below the level of the core and cannot hold the emergency cooling water around the core. Then the reactor core will heat up to the melting point in less than an hour.

The source of this damaging heat is surprisingly enough not the fission process—that can be turned off and in fact would turn off automatically as a result of the loss of cooling water. The source of heat is associated primarily with the radioactivity of the fission products—and this cannot be turned off. The "radioactivity decay heat" is like the still thrashing tail of a dead dragon and produces so much energy that it is impossible for even the 3–4 foot thick reinforced concrete containment building to hold in the molten core. Somehow or other much of the tremendous inventory of radioactivity contained in the molten core will get into the environment.

The nature of the consequences of a melt-down accident depends sensitively on the manner in which the containment building fails. If the building ruptures through overpressure or a steam explosion, or the isolation valves fail, the radioactive gases and aerosols boiled off from the core can be released directly into the atmosphere with consequences whose magnitude are currently under hot debate. In my own opinion the consequences could on the average include many thousands of cancer deaths and genetic defects, many tens of thousands of nonfatal thyroid cancers, and hundreds of square miles of land contaminated above levels acceptable for human habitation.

I should emphasize, however, that the large health and mortality consequences would be averaged over a population of millions and that therefore, a few tens of miles away from the reactor the increased incidence of cancer and genetic defects would probably be undetectable because of the much larger incidence of cancers and genetic effects due to other causes natural and man-made. The extra incidence of nonfatal thyroid cancers might well be detectable hundreds of miles downwind.

A large fraction of the consequences are in principle preventable. In particular, the radiation dose to the thyroids of the population downwind would be considerably reduced if they took ordinary iodide pills to block the uptake of radioactive iodine isotopes. (Arrangements for the emergency distribution of iodide tablets in case of a reactor accident existed some years ago in England.) The other mitigating measures would be techniques designed to reduce the long term radioactive contamination of populated areas. To my knowledge, the question of how much decontamination would be possible in practice has not been seriously investigated.

If the containment were to fail only as a result of the molten core melting through the base mat after a day or so then a much smaller fraction of the radioactivity will reach the atmosphere. In either case, however, there is a potentially serious problem of water contamination since most reactors are located on the shores of important lakes, rivers, or estuaries.

Obviously it is important to make sure that accidents of this magnitude are exceedingly infrequent. Recently an AEC-sponsored study made the first attempt to calculate how frequent they would really be. The conclusion (also somewhat controversial) was that, for the population of 100 reactors which are expected by 1980 or so, there would be approximately a 10 percent chance of a melt-down accident within the following decade. It was also argued in this report that the associated risk, when averaged over the population, was small relative to many other risks to which we have become accustomed. The probability of successful sabotage was not estimated.

Nuclear Fuel Reprocessing Plants: After the nuclear reactor, we come to parts of the nuclear fuel cycle which is as yet fairly undeveloped. The next stop of the fuel after the reactor would be at the fuel reprocessing plant where the "spent" fuel would be treated chemically to separate the valuable uranium and the plutonium from the highly radioactive waste products.

There was one small commercial nuclear fuel reprocessing plant owned by Nuclear Fuel Services, presently a subsidiary of Getty Oil, which operated in upstate New York beginning in 1966. The reprocessing technology is particularly difficult, however, because of the enormous amounts of radioactivity which are present in liquid and gaseous form and the Nuclear Fuel Services plant had frequent problems with leaks and high occupational radiation exposures. The plant was shut down in 1972 for improvement and enlargement and is currently not scheduled to reopen till 1979.

A second relatively small commercial fuel reprocessing plant, built by General Electric and based on a new chemical process, was to open in 1972 in Morris, Illinois. In 1974 General Electric announced that the plant was not operable as designed. The future of this plant has not been decided.

A third large commercial fuel reprocessing plant, owned by Allied-General Nuclear Services near Barnwell, South Carolina is currently nearing completion. Initial operation was originally scheduled for 1974 but it has slipped to mid-1976. At full capacity this plant is designed to be able to process the spent fuel of more than 50 large reactors.

Some observers suggest that the difficulties being experienced in starting up the reprocessing industry reflect adverse economics—that the value of the recovered uranium and plutonium will simply not pay for an adequately designed reprocessing facility with all the remote handling and maintenance technology which was required.

The principal hazards associated with reprocessing plants stem from the enormous amounts of long-lived radioactivity (hundreds of times more than in a reactor) which would be stored on site in liquid form. It is extremely important to ensure that this radioactivity does not escape into the environment as a result of acident or sabotage.

Another problem which has not been faced for reprocessing plants is that of decommissioning. These plants will be extremely radioactive after they have finished their useful lives. How difficult will it be to dispose of them? The same question applies to a lesser extent to nuclear reactors.

A final problem which will first become serious at the reprocessing plant is that of nuclear theft. How do we keep the plutonium which will be separated out of the fuel there away from people who might wish to divert it to the manufacture of terrorists' weapons? Plutonium in spent fuel is protected by the penetrating radiation from the fission waste products. In its separated form it is much easier to handle since the radiation which it emits is quite easily stopped.

A large reactor produces enough plutonium for the manufacture of tens of nuclear weapons each year.

From the reprocessing plant the plutonium could go either back into the fuel of ordinary nuclear reactors (this is called "plutonium recycle") or it could be stored for future use, for example, as the start-up fuel for liquid metal cooled fast breeder reactors. At every stage from the reprocessing plant to use in any reactor there would be concern about potential illicit deiversion of the plutonium.

Radioactive Waste Disposal: One can think of the reprocessing plant as separating the contents of the spent fuel into four streams:

Uranium,
Plutonium,
High level radioactive waste, and
Low level radioactive waste.

The uranium would probably go back to the enrichment plant. We have already discussed the questions relating to the disposition of the plutonium. What will be done with the radioactive wastes?

Here the situation is even less developed than in the reprocessing stage. Large amounts of high level radioactive waste have been accumulatd at the AEC's facilities at Richland, Washington; Savannah River, South Carolina; and the Idaho National Reactor Laboratory. These wastes are being held temporarily in tanks with no well defined plans for their ultimate disposal. They were accumulated in connection with the AEC's military program, however, and the AEC (now ERDA) considers the disposal of commercial radioactive waste an entirely separate issue.

The original idea for the disposal of the commercial high level wastes was to bury them in an abandoned salt mine in Kansas. The salt was of interest because it had not been disturbed by geologic processes in millions of years. In more recent times, however it had been disturbed—by man drilling for oil and mining salt by the solution method nearby. These disturbances gave water the access to the salt which overlying layers of rock had prevented for millions of years and ultimately made the site unusable. With the failure of this venture, the AEC went to the idea of temporary storage for high level wastes while an ultimate solution is being worked on. More recently another salt mine in New Mexico is being actively looked at by ERDA.

Radioactive wastes are made up of primarily two fractions: 1) fission products and 2) transuranic elements like plutonium which are formed as a result of neutron capture on uranium. The most important fission products (as far as most long term radioactive waste disposal considerations are concerned) are Strontium-90 and Cesium-137, both of which have half lives of about 30 years. These fission products would decay to relatively harmless levels in less than 1000 years—30+ half lives. Some of the important transuranic isotopes such as Plutonium-239, however, have half lives of tens of thousands of years and would not decay to safe levels for hundreds of thousands of years.

To many people the problems of segregating radioactive materials from the environment for a thousand years or so do not seem insuperable. When the period is extended to hundreds of thousands of years—periods over which ice ages and all sorts of other major events might be expected to occur—then the prospect looks more forbidding. The proposal has, therefore, been made to separate out the transuranic elements and give them special treatment—perhaps recycling them in reactors—although more exotic disposal schemes have been discussed. Plutonium of course would be separated out at a reprocessing plant for economic reasons. The proposal here, however, is to separate out most of the other transuranic elements and to separate out plutonium to greater degree than would be justified on economic grounds alone (about 99 percent).

In addition to high level, i.e. concentrated radioactive wastes, the nuclear industry produces large volumes of "low level waste", e.g., contaminated solvents, clothes, sweepings, machinery, etc. which are contaminated by relatively small amounts of radionuclides. These wastes represent a difficult problem because, although each cubic foot may not contain much radioactivity, the total number of cubic feet is large enough to contain in aggregate a considerable amount of radioactivity.

Currently low level wastes are disposed of by shallow burial like garbage. This may be adequate for fisson products but it probably is not for the long-lived transuranic wastes. Special treatment is, therefore, being considered for low level transuranic contaminated wastes.

IV NUCLEAR ISSUES—THE STRUCTURE OF THE HEARINGS

In this section, I will simply remind you, in order of the issues which will be addressed in the hearings.

The Regulation of Nuclear Energy: Nuclear technology requires an extraordinary level of forethought and quality control. The question to be addressed here is whether over the long term our institutions will meet the challenge.

Future Electrical Energy Growth: The rate of which our nation deploys a nuclear power electrical generating capacity depends among other things on the rate at which the future electrical energy consumption of the nation increases. The second session will focus on different perceptions of the prospects and desirability of this growth.

Nuclear Reactor Safety: The most numerous installations associated with the nuclear fuel cycle are of course, the nuclear reactors and it is their safety which has been the most widely debated. The AEC just before its demise produced a major study of the reactor safety question. The strengths and weakness of this study along with the Nuclear Regulatory Commission's plans for future safety research and improvements will be discussed in the third session.

Radioactive Waste Disposal: The fourth session will address the current plans and policy options relating to the ultimate disposal of the radioactive wastes from commercial nuclear power.

The Breeder Reactor Development Program: The fifth session will be devoted to a discussion of the importance of the timing of, and the alternatives to the introduction of the liquid metal cooled faster breeder reactor (LMFBR).

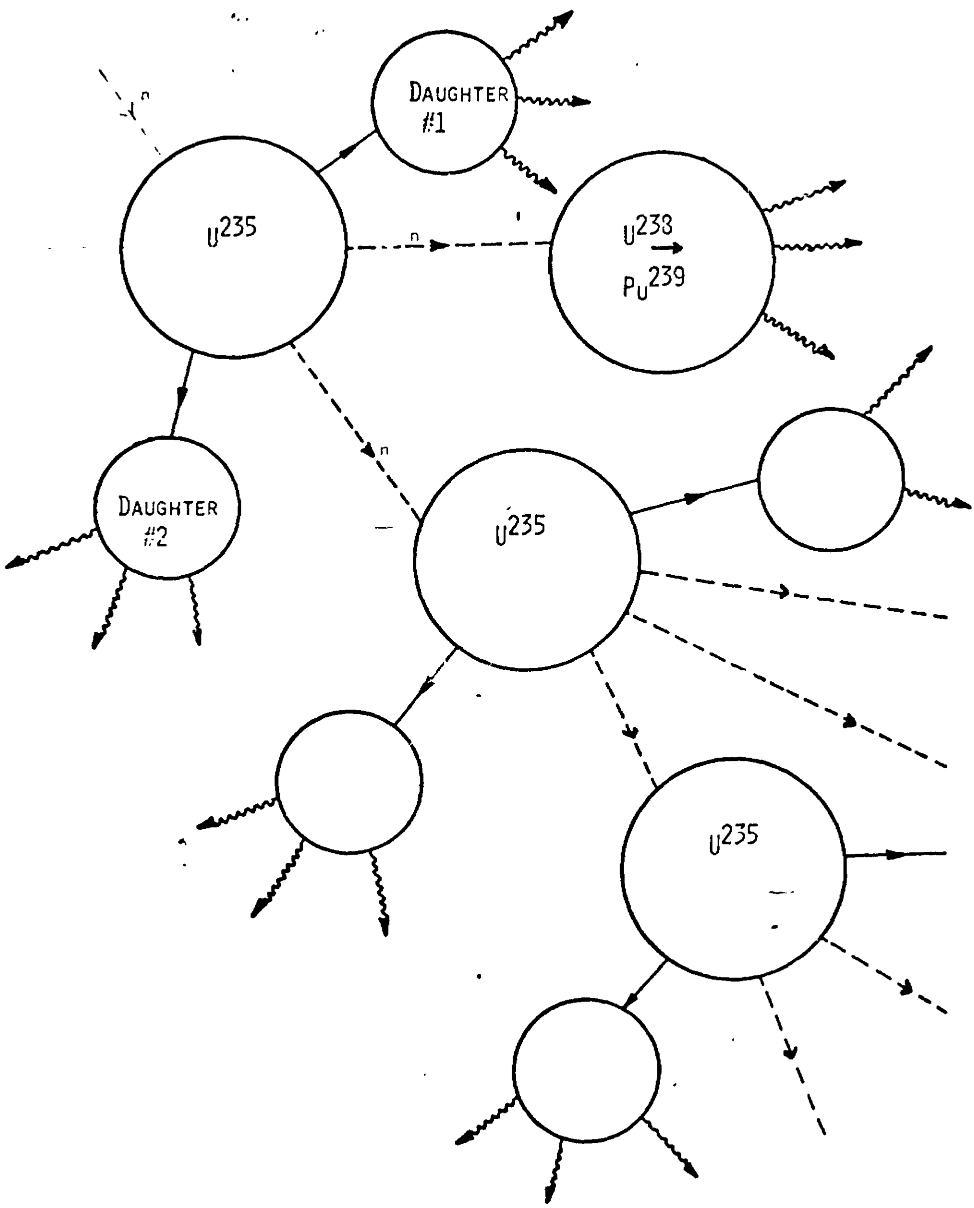
The Export of Nuclear Technology: The Nonproliferation Treaty is up for review this coming month. At the same time, as a result of the oil crisis, many new orders have been placed for reactors of American design by other countries—notably Iran—and nuclear reactors were offered by President Nixon to both Egypt and Israel. These developments raise many questions about what safeguards the U.S. and the larger community of nations should put on nuclear technology export to non-nuclear weapons states to prevent the use of this technology to make possible the manufacture of nuclear weapons.

Another issue related to proliferation which will be discussed is the problem of peaceful nuclear explosives. How can use of this technology be allowed, if it is advantageous, without undermining the Nonproliferation Treaty?

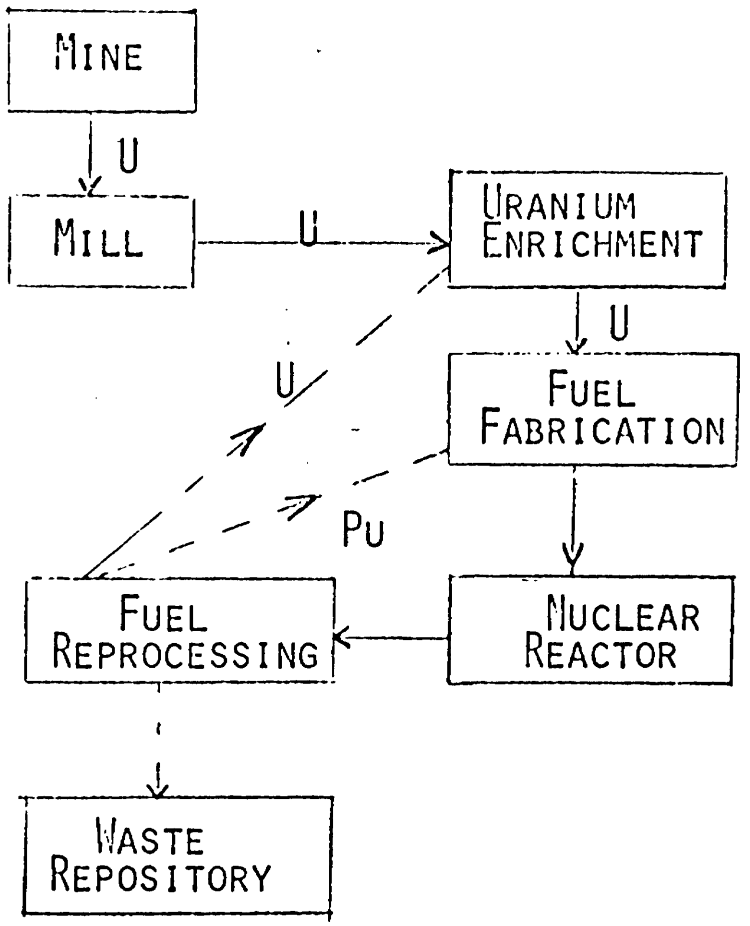
The Plutonium Economy and Nuclear Theft: If the decision is made to go ahead and recycle plutonium in our current water-cooled power reactors and, perhaps later in breeder reactors, then it will be necessary to deal with the issues associated with "the plutonium economy." These issues divide into two categories: 1) The health effects of the small percentage of plutonium which will inevitably leak into the environment and 2) the problem of preventing the theft of the plutonium for use in the illicit manufacture of nuclear weapons.

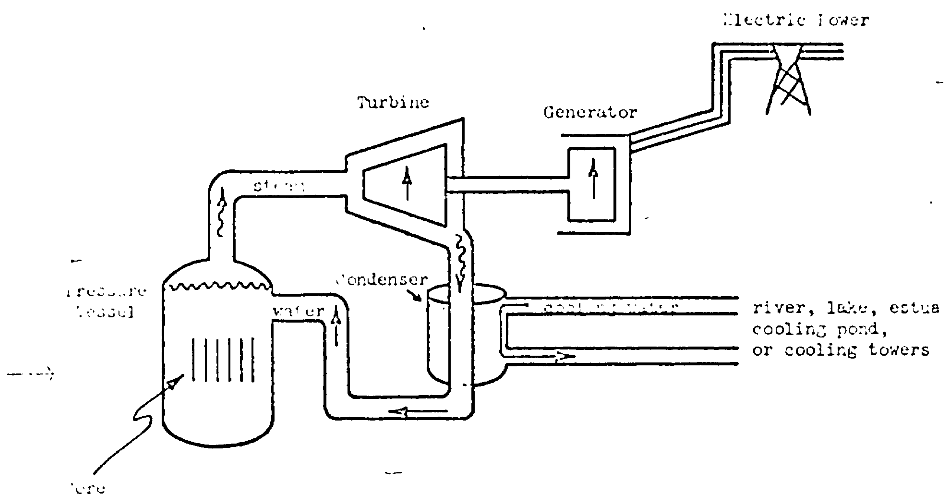
Nuclear Fuel Reprocessing Plants: The last session will be devoted to a discussion of the economics and hazards of nuclear fuel reprocessing.

THE CHAIN REACTION



III. The Nuclear Fuel Cycle





TYPICAL RATING: 1 MILLION KILOWATTS

SIZE OF CORE: 12 FEET HIGH, 15 FEET DIAMETER, TENS OF THOUSANDS OF FUEL RODS.

STEAM GENERATION RATE: WATER EQUIVALENT TO VOLUME OF PRESSURE VESSEL (70 FEET HIGH, 20 FEET DIAMETER) EVERY THREE MINUTES.

Mr. UDALL. Our first witness this morning is the Honorable William A. Anders, who is Chairman of the U.S. Nuclear Regulatory Commission.

We are pleased to have you here, Mr. Anders, and you have a very thorough and effective statement here which will help us build the kind of record we are trying to build in these hearings. It would be helpful to the chair and the subcommittee if you could summarize in 15 or 20 minutes some of the high points of your testimony in order to leave some time for the members of the subcommittee to ask questions and to engage in dialog.

It will be my hope that we can divide the morning into approximately equal segments, and we will try to divide the time accordingly. So we are pleased to have you and you may proceed.

STATEMENT OF WILLIAM ANDERS, CHAIRMAN OF THE U.S. NUCLEAR REGULATORY COMMISSION

Mr. ANDERS. Thank you very much, Mr. Chairman, and members of the subcommittee. At your request I would like to read parts of my testimony and then summarize the bulk of it. It is quite long because of the broad area of regulation we must consider.

I appear before you today as chairman of a new, independent agency of the Government, less than 4 months old, charged solely with the regulation of nuclear activities in this country to assure that the best interests of the public will be served, particularly the protection of public health and safety, environmental quality and national security.

I understand that it is your desire that I provide the subcommittee with a perspective on the regulation of nuclear power. To accomplish this plan to outline the authorities, responsibilities, functions, and operating philosophy by which the Nuclear Regulatory Commission carries out its tasks, how we are organized at this time to do this, and how we are addressing some of the more prominent issues associated with nuclear electric power that are presently matters of public concern.

Gentlemen, the Energy Reorganization Act of 1974 that was passed in October abolished the Atomic Energy Commission and established two new agencies—the Energy Research and Development Administration to carry out R. & D. in all forms of energy, including nuclear and the solar energy conversion that you mentioned, and the independent Nuclear Regulatory Commission to regulate all civilian nuclear activities.

The placing of nuclear regulatory responsibility in an independent commission and the separation of these responsibilities from developmental considerations marked a real watershed in the evolution of the control of nuclear uses in this country.

It recognized that, from a technical, economic, and social standpoint, nuclear energy had reached a stage in national life where its regulation demanded the full attention of an independent commission. It also reflected the belief that if nuclear power is to be an important energy source to our Nation, it is essential that the public, and the industry which we regulate have full confidence in its regulation.

The importance of the public duties that have been entrusted to us was underscored at our recent swearing-in ceremony by the presence of Vice President Rockefeller, other distinguished members of the executive branch, senior members of the Joint Committee of Atomic Energy, and by the administration of our oath of office by Supreme Court Justice Blackmun. Our experience as a commission during the few months since then has served to further emphasize the importance of those duties and the challenges that attend them.

I know I can speak for my Commission colleagues—and for a dedicated staff of outstanding competence—in pledging fidelity to the objectives of the Energy Reorganization Act which created this independent commission, and in pledging commitment to firm and responsible application of the regulatory requirements of the Atomic Energy Act.

As we consider our agenda for the future, we must bear in mind that the Commission has just begun to operate and is in a transitional phase. We do not have all the answers with regard to organization, staffing, resources required, or the challenges that lie ahead. But we do know that these are challenges of vital concern to our Nation and ones whose solution will require a commitment of resources, sound management, and perceptive leadership. We are making every effort to get through the transitional phase as quickly and smoothly as possible. There will be difficulties and rough spots; but with the support of the executive branch, the Congress, and the highly professional NRC staff, we are moving ahead with confidence.

Before summarizing the NRC's transitional organization and the regulatory process, let me take a moment to give you an expression of the philosophy this brand-new Commission intends to follow.

The most basic point is this. The business of the Nuclear Regulatory Commission is regulation. We must maintain a position above the fray, and not allow ourselves to be either apologists for or antagonists of nuclear power. Development or promotion of nuclear technology is the function and responsibility of others. Our job is protecting the health and safety of the public.

There has been a great deal of discussion by Members of Congress and others of the need for developing better public understanding of and public confidence in the regulation of nuclear power. We know that public confidence in our activities will follow if our performance both serves and is perceived to serve the public interest and is not prejudiced either for or against the industry we regulate. We have adopted four cardinal principles to guide us in our activities.

[Slide No. 1.]

The first of these is independence. This means we must conduct our evaluations, policy formulation, and decisionmaking in a truly independent manner. It does not mean that we will ignore the views of those affected by our actions, nor can we live in an ivory tower, oblivious to the many and often conflicting public interests involved. It does mean that we must make sound, impartial judgments, from a position of knowledge and competence, for the public we represent.

The second principle is openness. Nuclear regulation is the public's business and it must be transacted publicly and with candor. The public must be informed about, and participate in, the regulatory process to the fullest extent permitted under law.

Our third principle is efficiency. We owe the American taxpayer, the ratepaying consumer, and the industry itself the best regulatory management and administration we can provide. Decisions should be made without undue delay and should work to add stability to the nuclear planning process.

The fourth principle is effectiveness. Our responsibilities are public health and safety, safeguards, environmental compatibility, and antitrust. The NRC already has and will continue to have tough decisions to make. Effectiveness means coming to grips with the substantive issues—those which involve the product as well as the procedure of regulation—and resolving them in a firm and timely manner.

Through the application of such principles—independence, openness, efficiency, effectiveness—we believe that we can develop the reality and the perception of sound regulation for nuclear power.

Sir, the Nuclear Regulatory Commission derives its powers from three statutes.

[Slide 2.]

These are the Atomic Energy Act of 1954, the National Environmental Policy Act of 1969, and the Energy Reorganization Act of

1974. I have already mentioned the first and third and you are familiar with the middle one. Let me summarize here and talk again about the responsibilities of our Agency as shown in the next slide.

Our preeminent responsibility is the protection of the public health and safety. A good portion of our regulatory procedures are developed to do just that. Other major activities are to protect environmental quality and to safeguard nuclear materials and facilities. The latter means the prevention of the diversion of strategic nuclear material through physical security and accounting for same. In a vein somewhat different from our other activities, we also insure conformity with antitrust laws.

To give you an idea of the scope of our activities, the next slide illustrates the nuclear fuel cycle from the point uranium comes out of the ground through its various processes and uses.

[Slide No. 4.]

Quickly I would like to point out that we are not involved in the regulation of uranium mining. It falls to others. The central point on the chart, reprocessing, indicates reuse of recovered uranium and, by dotted line, how recovered plutonium could also be injected into the fuel cycle. This is not to imply that the Nuclear Regulatory Commission has made a decision with regard to the controversial and important issue of the recycling of plutonium, a reactor-made material, back into the new fuel provided for light water reactors. This is an issue currently before us.

It would be improper for me as a judicial officer to comment upon this, Mr. Chairman, at this time. We will be commenting in the next week or so on a Commission position regarding the advice we have gotten from the Council on Environmental Quality on this particular point.

Uranium moves from plants which convert it to uranium hexafluoride into enrichment facilities. As you know, light water reactors require some enriching of the uranium in the fuel above its natural isotopic abundance of seven-tenths of 1 percent of U-235 up to the area of 3 percent or so.

The high temperature gas-cooled reactor and certain other reactors require considerably higher enrichment. This is a very difficult and challenging technical process which our country is preeminently able to do.

After the material is enriched, it is converted into fuel and transported into the reactor. Many tons of this fuel are required to run one of the large power reactors in this country. Currently, the spent fuel is stored at the reactor sites in fuel storage pools and in existing storage pools at reprocessing facilities. If the spent fuel is reprocessed, the recovered uranium would be sent back to the enrichment plant and then made into new fuel to provide more energy, with the waste being sent for storage and other radioisotopes used for various purposes. Use of the recovered plutonium, as I said earlier, is in hiatus at the moment awaiting the decision particularly as it relates to the safeguarding of the plutonium once it has been reprocessed.

The next slide speaks to the Nuclear Regulatory Commission's major functions.

[Slide No. 5.]

The first one listed—in no particular order of importance—is standard-setting and rulemaking. We try to get out and look at the problems of the future; to set standards and make rules that will guide both those in the industry and those who review license applications to have a basis for their actions, to give stability for both sides.

We do considerable technical reviews and studies on various issues with nuclear regulation. A major part of our technical review activity is associated with licensing applications. Your chart that you mentioned earlier, Mr. Chairman, did show, I believe, those plants that are licensed to operate, civilian plants, and then the 235 total plants, the class shown in blue, which have either been announced or are under licensing review.

A very important function is our surveillance and enforcement activity, one that has received some discussion of late, particularly as associated with an incident that we have had concerning the appearance of some small hairline cracks in certain steel piping associated with some reactors.

I would hasten to say that the whole question of surveillance and enforcement is under review by both the Commission and the Joint Committee on Atomic Energy. It is an activity we are most interested in and which we consider a very significant part of our responsibilities.

Our main responsibility here—and the philosophy that has been ongoing for some time—is that rather than the Government actually inspecting the various details of the plant per se, the Government's main interaction has been to inspect and insure the quality assurance program of the licensee.

Each application submitted must describe a very detailed and thorough quality assurance program. This is given close review by the NRC staff and required changes are made by the applicant. Once approved and once the plant is under construction and of course later operating, our inspectors and enforcement group then spend most of their energy assuring the quality of that program rather than getting down to the details of the plant itself.

From all this we have quite an activity in evaluating the operating experience to feed back into our standards and licensing process.

Last but not least, added mainly by the Energy Reorganization Act, is the area of confirmatory assessment. I would go then to the next chart showing our transitional layout which will put some of this in perspective.

[Slide No. 6.]

The areas shown in bold lines are those features of the organization that were specified by the Energy Reorganization Act of 1974. There is a commission, composed of a Chairman and four Commissioners all appointed by the President for fixed terms and confirmed by the Senate. Normally these are 5-year terms, but because all the original Commissioners were appointed at once the present terms range from 1 to 5 years in order to provide for staggered 5-year terms as we proceed through time. The act also specified that there be a balance among political interests of the Commissioners.

I am pleased to say that in my view, my colleagues whom the President has appointed and the Senate confirmed are all very capable, expert in their particular areas, and dedicated to the responsibilities that have been entrusted to them as Commissioners.

The Energy Reorganization Act specified an Executive Director for Operations, an Executive level IV position who is to be the day-to-day coordinator of our regulatory activities. Then there are three other main functions, and I would like to speak to each one of those separately.

But before I do, there were many features that we believe the law did suggest some flexibility for the Commission.

We will not go into the details of the NRC organization beyond the major program units unless you desire, Mr. Chairman.

I would like to make an effective organization. I would like to underscore that this is a transitional organization. It was put in place the day we came on board. We were not the experts at that time. We still have a lot to learn, and we want to understand our new responsibilities and the challenges ahead before we settle on a firm organizational arrangement. I would expect this to eventuate in the next several months.

I would like to call your attention to the two small boxes off to each side of the three major boxes—the Office of Standards Development and the Office of Inspection and Enforcement. These were not specifically called out in the act. They were separate activities in the previous organization, the Atomic Energy Commission. We felt it wise to leave them separated at least initially, though there are strong arguments for the possibility and advantage of folding them into the three major activities specified by the act.

I bring up this seemingly laborious point because it has had some debate and discussion while we have been in office.

The Office of Nuclear Reactor Regulation has been the major focus of the nuclear regulatory process to date.

[Slide No. 7.]

It is broken down into Reactor Licensing, Technical Review and Antitrust and Indemnity. The functions listed in the chart include actions on applications for limited work authorizations, construction permits, operating licenses, and indemnity agreements. This requires reviews of the safety of reactors, their environmental compatibility, safeguards, and antitrust matters, on which I will go into more detail later. This office also makes recommendations for appropriate research. This organization in the former Atomic Energy Commission was essentially the focus of AEC regulatory activity.

Another important area that is more recently developing and certainly is receiving attention of late, to which the Chairman referred briefly in his opening statement, includes those activities related to the Office of Nuclear Material Safety and Safeguards.

[Slide No. 8.]

Here the framers of the Energy Reorganization Act specifically spotlighted what they thought is a real need—and I agree—to focus on this question of the nuclear fuel cycle licensing review, particularly in that area related to safeguarding of strategic nuclear materials; that is, the prevention of theft or diversion of plutonium or highly enriched uranium, particularly by subversive or terrorist groups, to illegal uses.

The main effort of this office to date, in terms of allocation of resources, has been in the licensing of the fuel cycle. The new Commission and the old Commission have been particularly vigorous in adding new resources and staff to the areas of safeguards which we expect to be one of the preeminent issues in the years to come.

The third major activity is the Office of Nuclear Regulatory Research. This has been built around the former Office of Reactor Safety Research which had been under the General Manager side of the Atomic Energy Commission.

[Slide No. 9.]

The point I referred to earlier concerning the removal of the apparent conflict of interest in the developmental or promotional and the regulatory activities of the Atomic Energy Commission was not only to separate regulation from development basically, but also to separate out of the developmental side of the nuclear activities—previously AEC and now ERDA—the Office of Reactor Safety Research, put it into the regulatory agency, and add to it not just reactor safety research, but fuel cycle research and safeguards research as well.

Now this research is very narrowly oriented, if you will. It is specified by law only to relate to the subject of what we call confirmatory assessment; that is, to assess or to confirm our ability to assess or measure the safety of the various licensing applications before us.

We are precluded by law from developing new safety gadgets for reactors. That is the responsibility of the industry or other parts of Government. The framers of the law were very specific in focusing our activities strictly to the measurement of safety. Of course, this now in itself is a considerable activity.

I will skip over the next few slides here in the interests of time. Mr. Chairman, I won't go into the details of each one of these offices. It is in the testimony.

Mr. UDALL. You might build a record from your prepared testimony. That is the purpose of this: to build a record.

Mr. ANDERS. Right. We could spend hours on each one. But I will leave it at that unless there are some specific questions.

[Slide No. 12.]

I would like to point out, Mr. Chairman, the various reactors shown by little squares on the map that are licensed to operate. There are currently 53 commercial reactors licensed to operate.

In addition, there are reactors out in Hanford and in Shippingport which were developed by AEC and whose power is utilized on the utility grids. The dots represent the applications under review for reactors in various parts of the country.

The stars represent our regional offices. We do have a rather sizable field activity broken down into five regions shown by the green lines.

Let me briefly run over some other major activities within our organization.

[Slide No. 13.]

We have an Advisory Committee on Reactor Safeguards, an independent group of eminent scientists whose job is to review each major reactor license application and give an independent evaluation as to its safety aspects. This evaluation is reported in a letter sent to the Commission. We have licensing hearing boards which actually conduct the public hearing process. There must be a positive finding by the hearing board before the license is issued. If there is an appeal, we have an additional legal process, a body called an appeal board which will hear that in public hearing.

We have a number of international information exchange agreements. We do training and assistance for foreign regulatory agencies. We have a public document room which we currently plan to upgrade and there are considerable Federal-State agreements and contracts associated with environmental monitoring, siting approval, and radiological emergency plans and training, and, of course, the various kinds of administrative support required for our agency.

I might quickly flash up the kinds of backgrounds our personnel have.

[Slide No. 14.]

They range all the way from biology and radiology to mathematics and metallurgy, to the engineering disciplines that are involved. I will now give a quick review of the resources that have been proposed for our 1976 budget.

[Slide No. 15.]

This slide breaks down into a pie chart the focus of our activities. We list our request of $198 million. Actually, getting the details out of the way, it is really a $220 million budget request because there are some goods and services on order to carry on in the next fiscal year. This is, I believe, the largest regulatory commission around.

I don't know whether that is good news or bad news, except I would like to hasten to point out that though we are often compared with such regulatory bodies as the Federal Trade Commission or the Federal Power Commission, I think a better comparison would be with the Federal Aviation Administration related to the kinds of activities that we are responsible for—a safety regulator as opposed to a rate regulator.

That is why you see the very large chunk, 49 percent, almost $100 million, related to research activities. Quite frankly, we would expect this to escalate with future budget submissions, particularly in the area of environmental research, safeguards research, and fuel cycle research.

Unless there are any questions, I will proceed. Our licensing process requires the submission of numerous reports and findings by the utility.

[Slide No. 16.]

This is a sample of what was submitted for the Virgil C. Summer Nuclear Power Plant 1. The first two large documents are the environmental report which the Commission has to review and, from this and other information submitted, prepare an environmental impact statement.

Then the remaining documents represent the preliminary safety analysis report. We might go to special chart No. 1 there.

[Slide No. 17.]

This will quickly show the licensing process. It is related in a little more detail than we might want to go into here but it does lay out essentially the three parallel paths a utility must go through in order to receive a construction permit, up at Mark "CP Decision."

The first part is the safety path. I will just mention the application must be tendered and receives a safety evaluation and ACRS review, and goes through the public hearing process. If successful and all disputes are resolved, then that at least fills the safety part of the need in the construction permit 3 phase approach.

Environmental and site suitability, based on data that have been gathered from 1½ to 2 years, is then submitted in an environmental report which again receives substantial review by the staff, and goes through the public hearing process.

Then, somewhat differently, an antitrust review where the main player here is the Justice Department. We send the antitrust information to them for an evaluation, then have a public hearing, if necessary.

If all these requirements are satisfied, then the applicant is given a construction permit. He can get in there and start his site clearing and construction.

I will go over the next details here, only to mention, though, that in our review we do spend considerable time looking at the safety backup capability that is built into the plants.

[Slide No. 18.]

Our defense-in-depth approach contains three echelons of defense. The first provides accident prevention through sound design that the plant can be built and operated with stringent quality standards, a high degree of freedom from faults and errors, a high tolerance for malfunctions should they occur, and then using tested components and materials and redundancy of instrumentation and controls.

[Slide No. 19.]

Then we demand an additional line of defense which assumes that there may be some human or equipment failure and provides protection systems to maintain safe operations or shut the plant down safely when incidents occur.

[Slide No. 20.]

Third, additional margins are provided to protect the public should severe failures occur despite the first two echelons.

Examples here are concrete containment buildings, typically four feet thick and reinforced with steel, emergency core cooling systems to flood the core with water if coolant is lost through a pipe breaking in order to prevent major radioactivity release.

[Slide No. 21.]

The review process is not a rubberstamp operation. There has never been an application that has survived intact as submitted. They are given stringent review, stringent analysis, sent back for many changes in areas like the radwaste treatment, strength of containment compartments, flood protection, and effect on safety of nonsafety equipment failure.

The list is quite long here. The same thing for the environmental review. We might put up the chart that shows the prelicensing approach and what is the critical path through the licensing process.

[Slide No. 25.]

One of the issues that has been discussed recently is the long time required to build a nuclear powerplant. Often it is charged that the regulators are jamming the system up and creating this delay.

We of course are very sensitive to this, particularly as a new Commission. We have proposed new legislation that would streamline this process while still protecting full public participation.

The present approach is depicted here. I think the main message is that from the time a utility gets serious about wanting a nuclear plant in a particular place, it has been taking almost 10 years to actually bring this to fruition. We have shown the various aspects of responsibility of the Commission—the safety, environmental, and antitrust aspects, and then below that, activities that are the responsibilities of others.

Marked with the arrows are those things which are on the so-called critical path, in other words, those are the things that would, if delayed, jam up the works or if they could be reduced would tend to facilitate the process.

Our main clock starts at the 2-year point with the docketing of a construction permit application relating to safety, environment, and antitrust. This must be preceded by a couple of years' worth of environmental data gathering by the utility.

Our target is about a 14-month review. We have been running about 18 months or more. In some cases when court litigation is involved it has been running a matter of years. Once the CP, the construction permit, is approved, if it is approved, then there is the site work, preconstruction work and then the actual construction process itself which is the responsibility of the utility. Its length varies with whether the plant is a custom-designed plant or whether it is one that has been built before—a more standardized plant that the constructors are familiar with and the inspectors are familiar with which would tend to reduce the time.

It is also a function of the labor situation and the materials situation which have not been as good as many would have liked.

Mr. UDALL. I wonder if at this point, with the very thorough record you have made and the highlights you have hit, if we could have some time for questions.

Mr. ANDERS. I can wrap it up in about 2 minutes if you would like, Mr. Chairman. Let me flash up the next chart.

[Slide No. 26.]

This shows the process for what we call a limited work authorization which would allow early site work to proceed once the environmental aspects are assured. We have not fully addressed the safety. We would not allow the applicant to proceed with any safety-related work until that CP had actually been released.

This might then reduce the time down to 7 years or so total. Mr. Chairman, if I may then, in conclusion, just state that we are well aware that safeguards and environmental compatibility are the responsibilities assigned to us by the Atomic Energy and National Environmental Policy and Energy Reorganization Acts.

We are also aware that the performance of the Nuclear Regulatory Commission will have a definite bearing on this energy crisis situation.

In that regard, the efficiency of our regulatory process is a matter that the Commission will emphasize.

Much has been done to improve nuclear regulation over the past years and we intend to build upon those achievements. We will be continually seeking ways to increase the effectiveness of our internal operations.

We will also be looking at the procedural facets of the regulatory process to seek improvements that can be made there, including legislation where necessary.

Efficiency also means coming to grips in a responsible and timely manner with the substantive issues which confront us, for instance the issue of plutonium recycle. Some of these issues are underlined in the Reorganization Act which created a Commission to reflect the congressional concern over such matters as safeguards and waste management.

Other issues include a wide variety of matters associated with the nuclear fuel cycle. We would like to get ahead of these and other issues in order to maximize the efficiency of regulation in a nationally important area while assuring that appropriate levels of the public health and safety, security, and antitrust are maintained.

We also consider this set of requirements are our preeminent charter. As I stated earlier our job is regulation, regulation in the public interest.

As we regulate, we will follow the principles of independence, openness, efficiency, and effectiveness in executing our important public responsibilities. Thank you.

Mr. UDALL. Thank you, Chairman Anders, for your comprehensive statement. We will have it all on the record, without objection.

[The statement follows:]

STATEMENT OF WILLIAM A. ANDERS, CHAIRMAN, U.S. NUCLEAR REGULATORY COMMISSION

Mr. Chairman and Members of the Subcommittee: I appear before you as the Chairman of a new, independent agency of government, less than four months old, charged solely with the regulation of nuclear activities in this country to assure that the best interests of the public will be served, particularly the protection of public health and safety, environmental quality and national security.

I understand that it is your desire that I provide the subcommittee with a perspective on the regulation of nuclear power. To accomplish this I plan to outline the authorities, responsibilities, functions and operating philosophy by which the NRC carries out its tasks, how we are organized at this time to do this, and how we are addressing some of the more prominent issues associated with nuclear electric power that are presently matters of public concern.

NRC ESTABLISHMENT

The Energy Reorganization Act of 1974 abolished the Atomic Energy Commission and established two new agencies—the Energy Research and Development Administration to carry out R&D on all forms of energy, and the independent Nuclear Regulatory Commission to regulate all civilian nuclear activities. The placing of nuclear regulatory responsibilities in an independent Commission and the separation of those responsibilities from developmental considerations marked a watershed in the evolution of the control of nuclear uses in this country. It recognized that, from a technical, economic and social standpoint, nuclear energy had reached a stage in our national life where its regulation demands the full attention of an independent Commission. It also reflected the belief that if nuclear power is to be an important energy source to our nation, it is essential that the public and the industry which we regulate have full confidence in its regulation.

The importance of the public duties that have been entrusted to us was underscored at our recent swearing-in ceremony by the presence of Vice President Rockefeller and other distinguished members of the Executive Branch, senior members of the JCAE, and by the administration of our oath by Supreme Court Justice Blackmun. Our experience as a Commission during the few months since then have served to further emphasize the importance of those duties and the challenges that attend them.

I know I can speak for my Commission colleagues—and for a dedicated staff of outstanding competence—in pledging fidelity to the objectives of the Energy Reorganization Act which created this independent Commission and in pledging commitment to firm and responsible application of the demanding regulatory requirements of the Atomic Energy Act.

As we consider our agenda for the future, we must bear in mind that the Commission has just begun to operate and is in a transitional phase. We do not have all the answers with regard to organization, staffing, resources required, or the challenges of vital concern to our nation and ones whose solution will require a commitment of resources, sound management, and perceptive leadership. We are making every effort to get through the transitional phase as quickly and smoothly as possible. There will be difficulties and rough spots; but with the support of the Executive Branch, the Congress, and the highly professional NRC staff, we are moving ahead with confidence.

NRC OPERATING PHILOSOPHY

Before summarizing the NRC's transitional organization and the regulatory process, let me take a moment to give you an expression of the philosophy this brand-new Commission intends to follow.

The most basic point is this: The business of the Nuclear Regulatory Commission is regulation. We must maintain a position above the fray, and not allow ourselves to be either apologists for or antagonists of nuclear power. Development or promotion of nuclear technology is the function and responsibility of others. Our job is protecting the health and safety of the public.

There has been a great deal of discussion by members of Congress and others of the need for developing better public understanding of and public confidence in the regulation of nuclear power. We know that public confidence in our activities will follow if our performance both serves and is perceived to serve the public interest and is not prejudiced either for or against the industry we regulate. We have adopted four cardinal principles to guide us in our activities.

(Slide #1—Operating Principles)

The first of these is *Independence*. This means we must conduct our evaluations, policy formulation and decision-making in a truly independent manner. It does not mean that we will ignore the views of those affected by our actions, nor can we live in an ivory tower, oblivious to the many and often conflicting public interests involved. It does mean that we must make sound, impartial judgments, from a position of knowledge and competence, for the public we represent.

The second principle is *Openness*. Nuclear regulation is the public's business and it must be transacted publicly and with candor. The public must be informed about, and participate in, the regulatory process to the fullest extent permitted under law.

Our third principle is *Efficiency*. We owe the American taxpayer, the rate-paying consumer, and the industry itself the best regulatory management and administration we can provide. Decisions should be made without undue delay and should work to add stability to the nuclear planning process.

The fourth principle is *Effectiveness*. Our responsibilities are public health and safety, safeguards, environmental compatibility, and antitrust. The NRC already has and will continue to have tough decisions to make. Effectiveness means coming to grips with the substantive issues—those which involve the product as well as the procedure of regulation—and resolving them in a firm and timely manner.

Through the application of such principles—independence, openness, efficiency, effectiveness—we believe that we can develop the reality and the perception of sound regulation for nuclear power.

NRC STATUTORY AUTHORITIES AND RESPONSIBILITIES

The Nuclear Regulatory Commission derives its powers from three statutes.

(Slide #2—Authorities)

Under the Energy Reorganization Act of 1974, NRC became responsible for implementing all regulatory requirements of the Atomic Energy Act of 1954, as amended. These provisions make the Commission responsible for assuring protection of the radiological health and safety of the public and the common defense and security as well as consistency with the antitrust laws in the regulation of civilian nuclear activities.

Under the National Environmental Policy Act of 1969, the NRC also is responsible, among other things, for the comprehensive evaluation and assessment of the full range of environmental effects of nuclear power reactors and certain other types of facilities proposed for licensing and for balancing the benefits to be derived from the project against its environmental costs.

The Energy Reorganization Act of 1974 conferred additional authority on the new agency and underscored certain issues arising in the nuclear regulation field.

The new Act directs the Commission to (a) conduct and report to the Congress within a year of the effective date of the Act a review and assessment of the need for, and feasibility of, establishing a security agency to perform nuclear material and facility safeguards functions, and (b) conduct a national survey to identify sites for potential nuclear energy centers where various facilities involved in the nuclear fuel cycle, possibly including power reactors, might be located in proximity, and to report the results to the Congress in October of this year.

The Reorganization Act also provides for NRC licensing and regulation of certain ERDA facilities, including liquid metal fast breeder reactors and other demonstration reactors when used on an electric utility system or to demonstrate commercial suitability, storage facilities for high-level radioactive wastes generated by licensed activities, and certain facilities authorized for long-term storage of high-level radioactive wastes.

Finally, the new Act provides for a strong program of confirmatory research, directed by the NRC, as required to carry out the Commission's licensing and regulatory responsibilities. In addition, the legislation directs ERDA and other Federal agencies to cooperate with NRC in providing research information and services deemed necessary for the performance of its duties.

Stated as simply as possible, the NRC is charged by law with four areas of responsibility with respect to civilian nuclear activities:

(Slide #3—Responsibilities)

Protection of the public health and safety, protection of environmental quality, safeguarding nuclear materials and facilities, and ensuring conformity with the antitrust laws.

SCOPE OF NUCLEAR ACTIVITIES

Mr. Chairman, many people associate the term "nuclear power" with the reactor plant that generates electricity. While this is the element of our regulatory function that most closely touches the public, and, I might add, which consumes the largest share of NRC time and effort, the range of regulatory responsibilities also covers activities and facilities related to but not part of the power stations themselves.

(Slide #4—The Nuclear Fuel Cycle)

NRC regulates most of the steps in the nuclear fuel cycle, from the milling of source materials, through their conversion, fabrication, use, reprocessing and transportation, either to final storage and disposition, in the case of wastes, or to be further processed and used in many ways, in the case of radioisotope byproducts. We do not regulate uranium mining and government enrichment plants.

(Slide #5—Major Functions)

The system of licensing and regulation devised to carry out NRC's responsibilities is implemented through rules and regulations under Title 10 of the Code of Federal Regulations. To accomplish its mission, NRC maintains broad programs of standards-setting, technical reviews and studies, licensing actions, inspections and enforcement, evaluation of operating experience, and research.

A brief overview of the NRC organization will indicate how these functions are performed.

(Slide #6—Organization, Transitional)

NRC TRANSITIONAL ORGANIZATION

The creation of the regulatory function as a separate, self-sufficient Commission entailed the development of an entirely new organizational structure. Refinement of the structure is an ongoing process which we hope will end quickly as we gain experience and resolve some of the functional uncertainties in the support area.

I first call your attention to the portions of the organization chart which you see outlined in heavy black borders.

The NRC consists of five Commissioners, each appointed by the President with the advice and consent of the Senate. One member is designated by the President as Chairman and as its official spokesman. Each Commission member, including the Chairman, has equal responsibility and authority and exercises one vote in Commission decisions.

The Executive Director for Operations is the coordinating and directing agent below the Commission for the effective performance of the Commission's day-to-day operational and administrative activities. He coordinates and directs the five principal operating offices and administrative units on behalf of the Commission. He further is responsible for coordinating the development of policy options generated by the directors of the program offices.

The Energy Reorganization Act also established within the new agency three major offices responsible to the Commission, those shown in heavy black. During this transitional phase, we also established two offices at the same organizational level to perform functions not specifically mandated by the legislation. Before describing the responsibilities and functions of each of these operating offices, let me point out three organizations which have a somewhat unique organizational status. The first is the Advisory Committee on Reactor Safeguards, established by law as a statutory adjunct to the Commission. This Committee is comprised of fifteen eminent scientists and engineers appointed by the Commission but operated independent of it. The ACRS presently is required to review and report on all applications for construction and operation of nuclear power reactors prior to the issuance of a license. And, second, I want to note the positions of the Atomic Safety and Licensing Board Panel and the Atomic Safety and Licensing Appeal Panel which conduct public hearings and perform adjudicatory functions in the licensing process.

OFFICE OF NUCLEAR REACTOR REGULATION

(Slide #7—NRR Chart)

The Office of Nuclear Reactor Regulation is responsible for the evaluation of all license applications for nuclear reactors, issuance of licenses, and regulation of the siting, design, construction and operation of these facilities. Its reviews encompass the safety, safeguards, environmental and antitrust aspects of these facilities. This office also recommends research necessary for the discharge of those functions by the Commission.

This is the largest of the NRC operating offices, carrying by far the heaviest volume of its day-to-day work.

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OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS

(Slide #8—NMSS Chart)

The office of Nuclear Material Safety and Safeguards is responsible for the safety, safeguards and environmental review of license applications for all nuclear materials and for facilities in the nuclear fuel cycle.

Centered in this office is responsibility for the development of safeguards policy options for the Commission and the overall safeguards program development. It recommends and provides guidance for safeguards research and technical development efforts, and provides coordination and program guidance for safeguards inspections and enforcement activities. NMSS handles all safeguards licensing except for reactors, performs analyses of safeguards-related information, and coordinates with ERDA on common safeguards efforts and policy matters and on the implementation of international inspections of licensee sites.

The Director of NMSS is the prime coordinator and spokesman on safeguards but this is a matter in which all major elements of the NRC are involved. For example, the Office of Standards Development is responsible for development of regulations, guides, standards and codes, and for recommending, as applicable, safeguards research. The Office of Nuclear Reactor Regulation reviews the safeguards portion of reactor license applications, and recommends safeguards research, as appropriate. The Office of Inspection and Enforcement develops detailed inspection programs, inspects licensees for compliance with regulations and license conditions, enforces those requirements, identifies and investigates abnormal occurrences including theft or diversion of special nuclear material, and recommends safeguards research as applicable. And, finally, the Office of Nuclear Regulatory Research works directly with the Office of Nuclear Materials Safety and Safeguards to determine jointly what safeguards research is to be conducted, and to plan and implement such research.

OFFICE OF NUCLEAR REGULATORY RESEARCH

(Slide #9—RES Chart)

In describing its functions relative to the NRC safeguards program, I have indicated broadly what the Office of Nuclear Regulatory Research does. That area of its functioning, however, is but a part of the full range of its important role. A large proportion of the research workload is devoted to the ongoing reactor safety research efforts; however, efforts are being initiated and expanded in other areas. The Commission recently approved the establishment within the Research Office of a new Division of Environmental, Fuel Cycle, and Safeguards Research. As an indication of the importance we attach to these multi-faceted research functions, nearly half of our FY 1976 Budget is allocated to overall research activities.

OFFICE OF STANDARDS DEVELOPMENT

(Slide #10—SD Chart)

The Office of Standards Development is responsible for the development of regulations, criteria, guides, standards and codes which cut across the board in regulatory activity. They relate to health and safety, environmental protection, safeguards, and the management and utilization of nuclear materials held by licensees. They apply to the siting, design, construction, and operation of nuclear reactors and other nuclear facilities as well as to facilities for the storage, processing, transporting and use of nuclear materials under NRC license. Standards Development is the NRC's mechanism for promulgating solutions to recurring problems to the public, the regulated industry, and to the regulators. Its goals are the stabilization of the regulatory process, to effect more efficient use of manpower by permitting licensing reviewers to concentrate on unique or special problems or issues, and to reduce industry's and the public's uncertainty concerning regulatory requirements.

OFFICE OF INSPECTION AND ENFORCEMENT

(Slide #11—IE Chart)

The Office of Inspection and Enforcement develops and administers programs and policies covering inspections and investigations to determine whether licensees are complying with license provisions, rules and regulations and whether operations are conducted safely; verifies the bases for issuance or denial of permits or licenses; investigates accidents, incidents, and theft or diversion of special nuclear materials; carries out enforcement actions, and evaluates licensee operations for needed changes in standards or regulations. This office is responsible for the issuance of reports on any of the activities within its purview both to industry and to the public. It supervises five NRC field offices in widely separated parts of the country.

(Slide #12—NRC Regions and Commercial Plants)

This slide indicates the locations of commercial power reactors operating, being built, or under review and the five regional field offices through which our Office of Inspection and Enforcement carries out its functions.

(Slide #13—Other Major NRC Activities)

I have mentioned in passing some of the activities shown on this chart, so I need not go into detail about them. I would like to point out, however, that the NRC is actively involved in intentional programs and information exchange agreements aimed at upgrading regulatory efforts, and to stimulate cooperative interest overseas in the safeguards programs. Bilateral "arrangements" have been concluded with five countries and we are negotiating arrangements with several more. These arrangements provide for systematic exchanges of regulatory information, such as safety analysis, operating experience, and safety research, among many other subjects. We are working with the Executive Branch toward an international agreement on standards for physical security of nuclear facilities and materials. In addition to such bilateral arrangements and negotiations, the United States, through the NRC and ERDA, is an active participant in a wide range of international agencies concerned with nuclear energy. Among these are the International Atomic Energy Agency, EURATOM, the OECD Nuclear Energy Agency, the Inter-American Nuclear Commission, and the International Energy Agency, formed last November.

EXPORT/IMPORT LICENSES

There has been considerable recent publicity implying that the NRC has placed a ban on exports of nuclear material. I would like to emphasize that no such ban has been imposed.

On March 28, 1975, the NRC announced that the Commissioners would review all export license applications involving reactors or significant quantities of source or special nuclear material pending completion of an ongoing review of the regulations and procedures that should be followed regarding the licensing of exports. The Commission is working to complete this review of its export license regulations and procedures within the framework of the Energy Reorganization Act. In the interim, the Commissioners will consider applications that have been submitted on as timely a basis as possible.

NRC RESOURCES

To carry out the responsibilities I have just described, the NRC has a variety of resources to draw from, including NRC employees, contractors and consultants, and other Federal agencies.

(Slide #14—Technical Disciplines)

The NRC has within its own staff both breadth and depth in the scientific and technical disciplines needed to review and regulate nuclear power plants.

(Slide #15—NRC Resources)

In our budget request for FY 1976—our first full year to operate as an independent agency—about 29% of our total staff are allocated directly to the safety, safeguards, environmental, and antitrust reviews of nuclear power reactors, 9% will be assigned to the licensing hearing boards, advisory committees, and legal services connected with licensing, and another 15% will be involved in reactor inspection and enforcement activities. Of our total budget request, almost half of our funds will be spent on regulatory research programs, principally related to seactor safety.

The reactor technical review and licensing staff has available to it, and uses, the technical expertise of a number of Federal agencies.

We also use a number of independent consultants in special fields and ERDA's national laboratories.

The NRC's research activities are conducted principally by the national laboratories and by contractors in 21 States. As you know, the Energy Reorganization Act of 1974 specifically mandated that the Energy Research and Development Agency and each other Federal agency cooperate with the NRC in providing information and research services.

THE LICENSING PROCESS

As an example of how the NRC's licensing process functions, I will focus on the process as it relates to power plants. Similar consideration is given to parts of the nuclear cycle.

Licensing decisions on nuclear power plants are based on work done by almost the entire regulatory organization on standards and criteria developed over a period of years, on experience with earlier plants during their construction and operation, and on the results of research programs. The current licensing process is performed in two stages. First, full-scale construction may not begin until issuance of a construction permit. Second, operation of the facility may not begin until NRC issues an operating license. These permits and licenses are granted only after through reviews by the staff and the ACRS have shown that proposed designs and operational procedures will result in protection of the public health and safety, and protection of the environment. Protection against sabotage and diversion of nuclear materials also must be provided, and there must be assurance of conformance with the antitrust laws.

The licensee is directly responsible for safe design, construction, and operation of a proposed plant. The NRC is responsible for assuring that the licensee takes all steps necessary to provide reasonable assurance that the health and safety of the public are not endangered.

The selection of a reactor site is the responsibility of the company proposing to build a reactor. The suitability of the site for a nuclear plant must be approved by the NRC.

As the major part of the application for a construction permit, a company files a Preliminary Safety Analysis Report (PSAR) with the NRC.

(Slide #16—Photograph of a complete set of PSARs)
(Slide #17—Principal information required in SARs)

This multivolumed document presents preliminary design information for the proposed reactor and comprehensive data on the proposed site. The utility must also submit a comprehensive Environmental Report providing a basis for the evaluation of the environmental impact of the proposed plant. Further, information must be submitted for use by the Attorney General and the NRC staff in their reviews of the antitrust aspects of the proposed facility.

SAFETY REVIEW

The NRC's review of the safety features of a proposed plant is based on the concept that we refer to as "defense in depth." Under this concept, three successive and mutually reinforcing levels of defense against accidents and their consequences are considered.

(Slide #18—First level of defense)

The first level of defense is that of accident prevention. It involves the design of the plant for safety in normal operation, including liberal allowance for the possibility of system malfunctions. Such a design involves the employment of design features inherently favorable to safe operation.

(Slide #19—Second level of defense)

The second level is based on the assumption that some failures will occur in spite of all the care exercised to prevent them. Accordingly, safety systems are required for the specific purpose of preventing or minimizing damage from such accidents. In other words, at the second level, the aim is to prevent minor incidents from escalating into major accidents.

(Slide #20—Third level of defense)

At the third level of defense, the unlikely assumption is made that certain severe failures will occur, notwithstanding the two levels of safety features operating to prevent them. Additional safety systems and features are provided to limit the consequences of such postulated major accidents.

Upon completion of the staff's review, a Safety Evaluation Report is prepared, which represents a detailed summary of the review and evaluation of the application relative to the anticipated effect of the proposed facility on the public health and safety.

I would like to emphasize that this technical review is not a passive exercise resulting in a simple approval or disapproval of the application as filed. There has, in fact, been no reactor construction application filed to date that has survived intact, as originally presented, the NRC staff's scrutiny. Its overall safety review is a rigorous, in-depth examination extending over a year or more and requiring extensive exchanges of information with the applicant, with its suppliers and contractors, with the ACRS, and with interested members of the public. Where the staff concludes during its review that features of the applicant's design or certain parts of its analyses and evaluations do not meet NRC standards or requirements, changes are required.

(Slide #21—Some areas where staff has required changes)

Many amendments to the application may be necessary before the staff is satisfied that the project can be affirmativley recommended to an Atomic Safety and Licensing Board for public hearings and an initial decision.

In addition to the staff review, the Advisory Committee on Reactor Safeguards independently reviews each application for a construction permit or an operating license for a nuclear power reactor. When the Committee has completed its review, its report is submitted to the NRC in the form of a letter to the Chairman which is made public. The staff prepares a supplemental Safety Evaluation Report to address any safety issues raised by the ACRS in its report and to include any other information made available since issuance of the staff's original Safety Evaluation Report.

ENVIRONMENTAL REVIEW

Either concurrently with or prior to the radiological safety review, an environmental review is performed by the NRC staff and its consultants to evaluate the potential environmental impact of the proposed plant. This study, as required by the National Environmental Policy Act, considers comparisons between the proposed and alternate sites, the effects of the plant on the local ecology, and evaluates the benefits expected to be derived against the possible risk to the environment.

I would stress here, as I did previously in connection with the safety review, that the NRC does not just conduct a passive "book review" on environmental matters. The final product many times entails required modifications—some of them major—to protect the environment.

(Slide #22—Some design changes required to protect environmental quality)

A partial list of plant design changes stemming from NRC environmental reviews includes redesign of intake structure, major cooling system redesign, modification of the thermal plume, augmentation of radwaste systems, modification of chemical waste systems, rerouting of transmission lines, and installation of improved fish screens.

PUBLIC PARTICIPATION

As soon as an application for a construction permit is received, copies are placed in the NRC Public Document Room, and in Public Document Rooms near the proposed site. Copies of correspondence and filings relating to the application are placed in these locations and are available to any member of the public. The NRC also publicly announces receipt of the application. Upon docketing (acceptance) of the applicant's application for a construction permit, copies of the application are sent to Federal, State, and local officials and a notice of its receipt is published in the Federal Register.

The law requires that a public hearing be held before a decision can be made to grant or deny a construction permit for a nuclear power plant. Interested members of the public may submit written statements to the licensing board to be entered into the hearing record, they may appear to give direct statements as limited participants in the hearing or they may petition for leave to intervene as full participants in the hearing. At an early stage in the review process potential intervenors are invited to meet informally and discuss with the staff their concerns with respect to the proposed facility.

The public hearing is conducted by a three-member Atomic Safety and Licensing Board (board) appointed from the NRC's Atomic Safety and Licensing Board Panel. The board is composed of one lawyer, who acts as chairman for the proceeding, and two other technically qualified persons. The Safety Evaluation and supplements and the Final Environmental Statement are offered as evidence by the staff at the public hearing. The hearing may be a combined safety and environmental hearing or these matters may be considered in separate hearings. The board considers the evidence presented by all the parties, and issues an initial decision. If the initial decision regarding safety and environmental matters is favorable, a construction permit is issued to the applicant by the Director of Nuclear Reactor Regulation. The board's initial decision is subject to review by an Atomic Safety and Licensing Appeal Board on its own motion or if exceptions are filed by a party to the proceedings. The final decision of the Appeals Board is subject to review by the NRC Commissioners.

ANTITRUST REVIEW

The NRC must also make a finding on the antitrust aspects of a nuclear power plant construction application. The antitrust information submitted by the applicant is sent to the Attorney General for his advice on whether activities under the proposed license would create or maintain a situation inconsistent with the antitrust laws. Upon receipt, the Attorney General's advice is promptly published and opportunity is provided for interested parties to raise antitrust issues and request a hearing. An antitrust hearing may be held based on the recommendation of the Attorney General or on the petition of an interested party.

CONSTRUCTION SURVEILLANCE

Power reactors are inspected by NRC representatives during construction; during the phases of preoperational testing, fuel loading, and startup testing; and during routine operation. Typically, a power reactor is inspected 35 to 40 times during construction.

(Slide #23—Photo of inspection during construction)

The main focus of such inspections is the examination of the quality assurance program established by the applicant and the degree to which this has been implemented. Also examined on a sampling basis are the licensee's purchase specifications and records relating to quality control, the control of materials, and the installation and testing of equipment. Inspectors observe construction and testing activities on a periodic basis. Construction workers, supervisors, and management personnel are interviewed to obtain first-hand information. Inspections of selected vendors of material and components important to safety are conducted to determine the extent to which the applicant's quality assurance program has been implemented through the procurement chain.

If physical defects or malfunctions in safety-related systems suggest that a failure may have occurred in quality assurance, the NRC looks closely at the licensee's program for quality assurance in order to assure improvement and preclude the recurrence of similar difficulties. The NRC, of course, verifies the adequacy of the corrective action taken concerning the specific deficiency.

Earlier, I described the licensing review of a construction permit application. To underscore the emphasis we place on quality assurance, I would note at this point that the NRC staff actually undertakes an informal, but substantive review of a proposed project well in advance of the applicant's formal filing. Meetings are held with the prospective applicant from 6 to 9 months in advance of scheduled application docketing to ensure that NRC requirements are well understood. NRC inspectors evaluate the acceptability of the utility's quality assurance techniques for the important design and procurement stage that begins before actual submittal of the completed application. Deficiencies in a utility's quality assurance program constitute grounds for rejection of a construction permit application when tendered, until the prospective applicant takes corrective action.

OPERATING LICENSE STAGE

About two years before construction is completed, the applicant submits an application for an operating license.

(Slide #24—Photo of multivolumed FSAR)

The application contains the Final Safety Analysis Report, setting forth the details on the final design of the facility including containment, the nuclear core, and waste handling system, and plans for operation and procedures for coping with emergencies. Again the staff makes a detailed review of the information. The staff again prepares a Safety Evaluation Report and, as during the construction permit stage, the ACRS again makes an independent evaluation and presents its advice to the Commission by letter. This second Safety Evaluation Report and its Supplement, and the ACRS letter to the Commission are available to the public.

A public hearing is not mandatory prior to the issuance of an operating license; however, any person whose interest may be affected by the proceeding may petition the NRC to hold a hearing.

In addition to licensing the operation of nuclear power plants, the NRC requires that individual licenses be obtained by each person who manipulates the controls of the facility.

Once an operating license is issued, a nuclear power plant remains under NRC surveillance and periodic inspections throughout its operating lifetime to assure that operations are being conducted safely in accordance with the terms of the license.

The licensee is required to file certain periodic reports describing the operation of the reactor and the results of required periodic testing. In addition, the licensee must report promptly any abnormal occurrences or incidents. These reports are all reviewed by the Office of Nuclear Reactor Regulation and the Office of Inspection and Enforcement to determine that operations are being conducted safely and within the license conditions, that appropriate corrective actions have been taken, and that the utility management maintains an effective program of review and audit of its operations.

Enforcement action is taken with respect to all identified non-compliance and safety matters. The enforcement action ranges from routine notices of violation, to imposition of fines, to the suspension or revocation of a license.

The NRC must insist that superior quality assurance programs be planned and implemented at all levels important to safety. It is a tribute to the margins required in present nuclear design, and to the defense-in-depth concept employed and enforced, that there has been no radiation fatality and no reactor accident affecting any member of the public as a result of the operation of commercial nuclear power plants which we are charged to regulate.

We intend to maintain the safety margins demanded of nuclear power, our rigorous in-depth reviews, and other regulatory measures that have protected and will continue to protect the public health and safety.

As an example of the prudent course we intend to follow, the new Commission was less than two weeks old when it was called upon to make a major decision involving regulatory judgment. This involved the discovery of hairline cracks in the core spray piping of a boiling water reactor plant. In order to determine if this was a generic problem in facilities having similar pipe arrangements, the Commission ordered prompt inspections of the piping at 23 boiling water reactors licensed to operate throughout the country.

While this required the temporary shutdown of some plants, the inspections were carried out in an effective and orderly manner, averaging about five and a half days for each inspection. One additional pipe crack was found at the plant which triggered the inspection order, and cracking was found in a Japanese reactor of the same design. Although the cracked pipes matter did not present an immediate safety hazard, the Commission's judgment was that prudence dictated timely action to assure that potential safety problems would be avoided.

At this time the NRC is conducting a special investigation into the circumstances and implications of a fire that occurred last month in electrical cabling of the Tennessee Valley Authority's Browns Ferry Nuclear Station in Alabama. NRC was informed by the licensee that the fire was started by a candle used by a workman to check for possible air flow through a seal where cables pass from one compartment to another. The fire resulted in the shutdown of two adjacent nuclear generating units at the site, where a third unit is under construction. NRC inspectors confirmed that there were no offsite effects from the fire, other than the loss of generating capacity. Although some safety systems were expected, redundant cooling capability was available to cool the reactor fuel during and after the fire. The Commission promptly appointed a special group of NRC technical experts to examine the design criteria of the affected equipment, its materials, how it was installed and maintained, and whether any modifications of NRC policies, procedures or technical requirements are indicated. Concurrently, the NRC staff instructed licensees building nuclear plants at sites where operating plants also are located to review their overall systems for control of construction activities. Subsequently, the NRC has broadened this directive to require operators of all nuclear power plants to review procedures for orderly shutdown and cooldown of the reactors in the event normal and preferred alternative systems are inoperative. The NRC's special investigation is continuing, and a full report of its results will be made public when completed.

I cite these instances to illustrate the Commission's determination to keep on the alert to incidents of potential safety significance. We intend to remain alert to information relating to safety from all sources and to factor it into our program where appropriate. Our full enforcement authority will be used to take whatever actions may be necessary to maintain a high level of protection for the public.

LICENSING SUMMARY

Looking at the licensing process itself, we find that, until recently, it has taken an average of some 10 years from the time a utility makes a decision to build a nuclear power plant until the completed facility is ready for NRC action on an operating license.

(Slide #25—Time required from conception to operation of nuclear power plants—without LWA procedure)

Licensing reviews and proceedings have been on the critical path for a considerable portion of this elapsed time. Earlier, I listed efficiency as one of NRC's cardinal operating principles wherein we owe the rate-paying consumer and the regulated industry itself the best possible management. Decisions should be made without undue delay and should contribute to stability in the nuclear planning process. Administrative actions are being taken toward this end, and we intend to build on them to the extent that we keep foremost the primary goals of our charter—preservation of public health and safety, environmental compatibility, security, and conformance with the antitrust statutes. And we must certainly maintain meaningful public participation in the process.

LIMITED WORK AUTHORIZATIONS

Our recent step to reduce the time that the licensing process occupies the critical path of the nuclear plant cycle was the institution of limited work authorizations. Under NRC regulations, limited amounts of work may be authorized to be carried out in appropriate cases prior to a decision on the construction permit. This authorization may be granted only after a full environmental impact review and a site suitability review have been completed by the staff. In addition, an Atomic Safety and Licensing Board must determine, after a public hearing on environmental and site-related matters, that there is reasonable assurance that the proposed site is a suitable location for a nuclear power reactor of the general size and type proposed.

(Slide #26—Time required from conception to operation of nuclear plants with LWA procedure)

As a result of this procedure a utility could, by also availing itself of plant standardization, expedited site selection and improved quality assurance measures, bring a nuclear power plant on line in 8 years or less for plants ordered today.

STANDARDIZED PLANTS AND PREDESIGNATED SITES

Until recently, almost every nuclear power plant design submitted for regulatory approval has contained varying features that have required a virtually customized review of each plant on a case-by-case basis. The Commission has been encouraging industry to standardize facility designs in order to permit both utilities and the NRC to more effectively allocate their manpower; shorten the time required for procurement, design, construction and regulatory review; and provide for greater concentration on assurance of safety.

The standardization concept could be optimized by combining it with the use of predesignated sites, that is, sites that have been completely approved in advance regarding all suitability with environmental aspects. Legislation toward this end was introduced in the last Congress.

The NRC has recently developed proposed legislation to improve the licensing process and enable fuller realization of the benefits of these design and siting concepts. It would provide a more efficient framework for the siting and licensing of nuclear facilities without impairing the quality or thoroughness of the NRC's safety, common defense and security, or environmental reviews, or depriving the Commission or the public of the benefits of full public participation in the process.

CONCLUSION

We are well aware that safety, safeguards and environmental compatibility are the responsibilities assigned to us by the Atomic Energy, National Environmental Policy and Energy Reorganization Acts. We are also aware that the performance of NRC will have a definite bearing on this country's energy situation. In that regard, efficiency of our regulatory process is a matter that the Commission will emphasize. Much has been done to improve nuclear regulation over the past few years and we intend to build on those achievements. We will be continually seeking ways to increase the effectiveness of our internal operations. We will also be looking at the procedural facets of the regulatory process to seek improvements that can be made there, including legislation where necessary. Efficiency also means coming to grips in a responsible and timely manner with the substantive issues which confront us. Some of those issues are underlined in the Energy Reorganization Act which created the new Commission. They reflect Congressional concern over such matters as safeguards and waste management. Other issues facing us include a wide variety of matters associated with the nuclear fuel cycle. We would like to get ahead of these and other issues in order to maximize the efficiency of regulation in a nationally important area while assuring the appropriate levels of public health and safety and security.

As I stated earlier, our job is regulation. Regulation in the public interest. As we regulate, we will follow the principles of Independence, Openness, Efficiency, and Effectiveness in executing our important public responsibilities.

Slide #1

NRC OPERATING PRINCIPLES

- Independence
- Openness
- Efficiency
- Effectiveness

Slide #2

NRC AUTHORITIES

- Atomic Energy Act of 1954
- National Environmental Policy Act of 1969
- Energy Reorganization Act of 1974

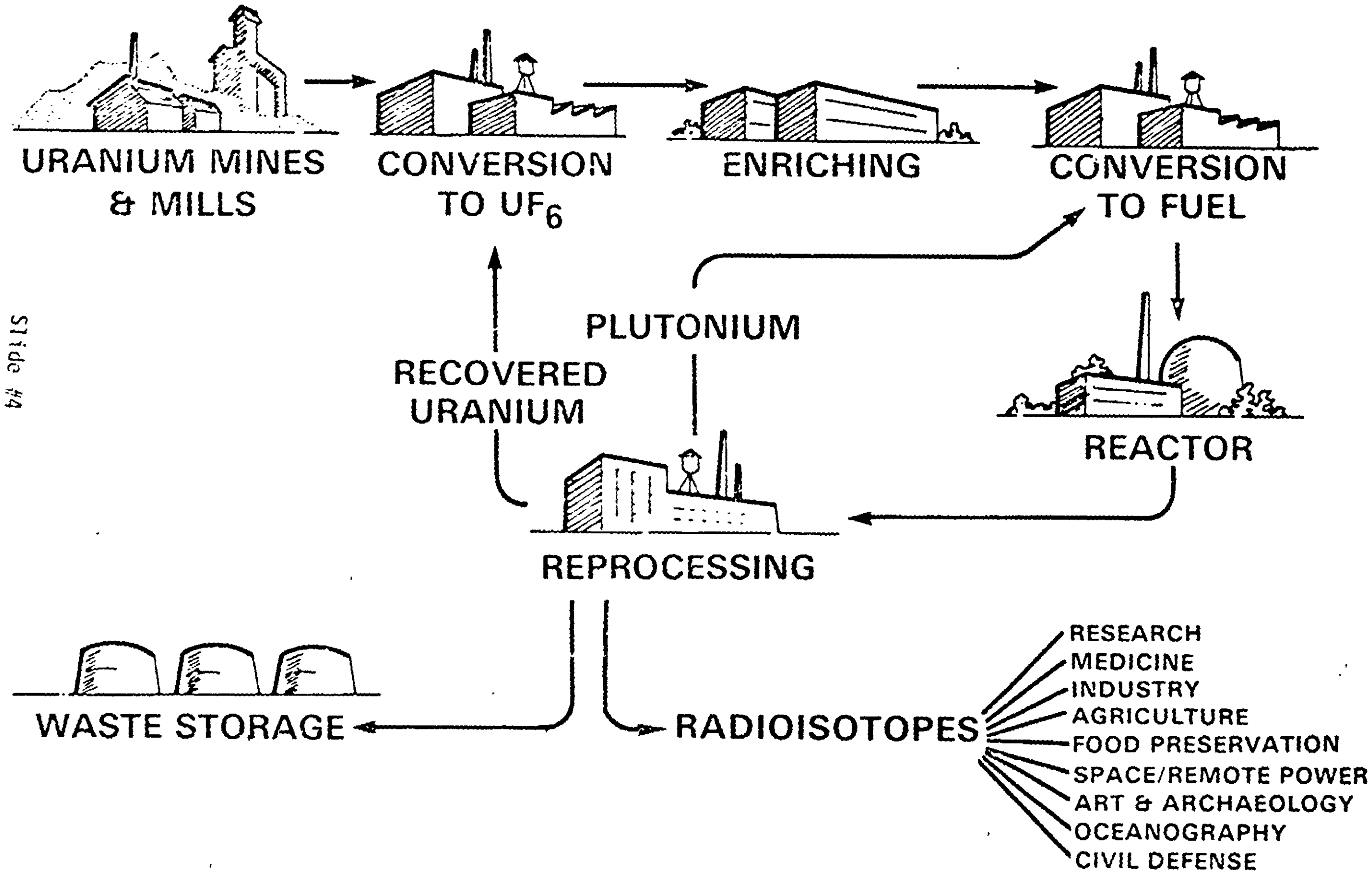
Slide #3

NRC RESPONSIBILITIES

- Protect Public Health and Safety
- Protect Environmental Quality
- Safeguard Nuclear Materials and Facilities
- Insure Conformity with Antitrust Laws

NRC RESPONSIBILITIES

THE NUCLEAR FUEL CYCLE



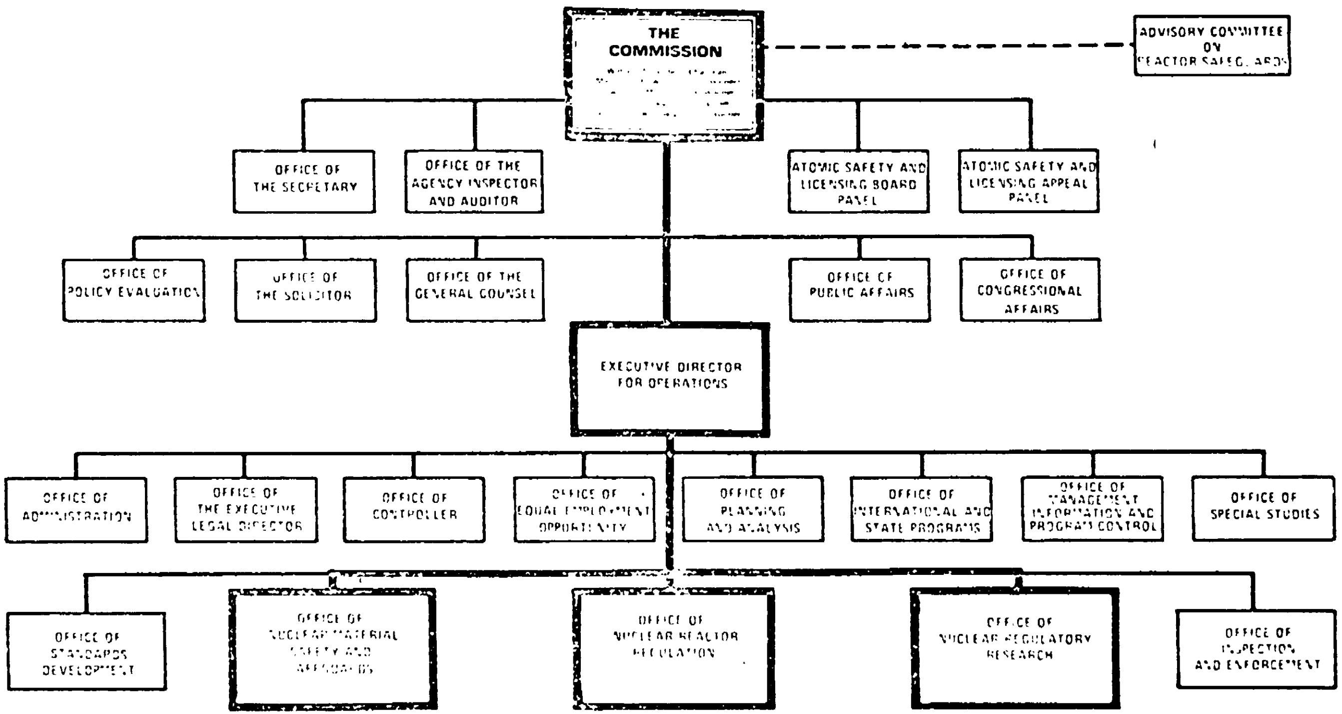
Slide #4

Slide #5

NRC MAJOR REGULATORY FUNCTIONS

- Standards-Setting and Rule-Making
- Technical Reviews and Studies
- Actions on License Applications
- Surveillance and Enforcement
- Evaluation of Operating Experience
- Confirmatory Research

NUCLEAR REGULATORY COMMISSION — TRANSITION ORGANIZATION



Slide #6

NRC ORGANIZATION
(Office of Nuclear Reactor Regulation)

- Operating Organizations:
  - Reactor Licensing
  - Technical Review
  - Antitrust and Indemnity
- Functions:
  - Issues:
    - Limited Work Authorizations
    - Construction Permits
    - Operating Licenses
    - Indemnity Agreements
  - Reviews:
    - Safety of Reactors, Materials and Activities
    - Environmental Compatibility
    - Safeguards
    - Antitrust Matters
  - Recommends Research as Appropriate

Slide #7

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NRC ORGANIZATION

(Office of Nuclear Material Safety and Safeguards)

Slide #8

- Operating Organizations:
    - Materials and Fuel Cycle Facility Licensing
    - Safeguards
- Functions:
    - Licenses:
        - Fuel Cycle Facilities
        - Transport Container Designs
        - Byproduct, Source and Special Nuclear Materials Uses
        - Exports
    - Develops Safeguards vs:
        - Theft or Diversion of Materials
        - Sabotage of Facilities
    - Recommends Research on Safety/Safeguards
    - Administers Agreement-States Program

Slide #9

NRC ORGANIZATION
(Office of Nuclear Regulatory Research)

- Operating Organizations:
  - Environmental, Fuel Cycle and Safeguards Research
  - Reactor Safety Research
  - Research Coordination
- Functions:
  - Develops NRC Research Policy Options
  - Develops, Plans and Implements NRC Research Programs
  - Interacts for NRC with Other Research Organizations

Slide #10

NRC ORGANIZATION

(Office of Standards Development)

- Operating Organizations:
  - Engineering
  - Siting, Health and Safeguards
- Functions:
  - Produces Regulations, Criteria, Guides, Standards and Codes Governing:
    - Health, Safety, Environmental and Safeguards Aspects of Siting, Design, Construction and Operation of Nuclear Facilities
    - Management, Use and Safeguarding of Nuclear Materials Held by Licensees
  - Recommends Research for These Functions