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PROGRAM STATEMENT

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THE UNITED STATES
/IRONMENTAL PROTECTION AGENCY
OFFICE OF RADIATION PROGRAMS

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PROGRAM STATEMENT

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U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RADIATION PROGRAMS

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SUMMARY

The Environmental Protection Agency (EPA) has the responsibility to protect the health and welfare of man and the environment from adverse effects due to radiation exposure. This responsibility is implemented through the Agency's authorities which established EPA in a role to provide continuing Federal overview of radiation protection philosophies, policies and controls. This mandate is achieved by developing policies and controls based on the soundest available scientific and technical information, that satisfy the requirement and intent of the law, that are legally enforceable, and that reflect responsible public policy.

To meet these responsibilities in a timely manner, EPA pursues the following general strategy:

- Identify potential radiation problems by assessing their impact on public health and the environment, and determine the trends resulting from radiation source development and use.

- Assess the status of current radiation controls, and identify sources and uses with inadequate controls.

- Focus on problems based upon their criticality, potential for adverse health and environmental effects, costs, and ability to be reasonably controlled.

- Determine the importance of the radiation problem area in addressing national priorities.

- Establish radiation standards, guides, and criteria with implementation through other Federal agencies, EPA Regional Offices and cooperation with State and local agencies.

- Influence radiation policies of other agencies and promote responsible industrial development through this process and use environmental impact statement reviews and environmental radiation assessment activities to augment guides and standards.

- Assess public and private compliance with Agency radiation standards, guides, criteria, and other actions.

The programs philosophy in implementing this strategy is guided by three principles:

1. Without specific evidence to the contrary, a linear nonthreshold assumption relating radiation exposure to the potential impact on human health should be used as a prudent assumption for estimating health risks from exposure to ionizing radiation. Inherent in this assumption is the suggestion that all levels of radiation exposure involve some potential risks to health.

2. All unnecessary sources of radiation exposure should be avoided; the benefits from exposures must be justified in terms of benefits that would not otherwise have been received from the activity causing the exposures; and all doses and exposures should be maintained as low as reasonably achievable, economic and social considerations being taken into account. These imply a risk/benefit assessment of radiation sources and a cost/benefit assessment of measures which are directed at further reduction in exposures.

3. Although exposure to radiation from different sources may be associated with the same general effects on health, e.g., cancer induction, the variety of objectives different groups have in establishing radiation protection standards requires a single Federal agency, EPA, to provide national uniformity in radiation control measures from a public health protection perspective.

Radiation Standards and Criteria development are directed toward both short-lived and long-lived radioactive pollutants. Long-lived pollutants are of major concern because once released into the environment they could persist for hundreds and thousands of years, thus being potentially available in the biosphere. This occurs because of their lengthy physical half-lives and a general lack of natural occlusion mechanisms. This persistence, coupled with continued release of these materials, results in a buildup of radionuclides in the environment. The resultant irreversible buildup could have a potential health impact on current and future generations. Effective control of such pollutants is by careful control of their use and releases. In addition to planned releases, EPA has a continuing concern with the potential environmental contamination from accidents and accidental releases of radionuclides, and with the long term controlled containment of nuclear wastes.

A major facet of the Agency's role is to influence the radiation programs and policies of other Governmental agencies to provide a consistent national perspective for radiation protection. Through influence, EPA can implement its position and impact the development of the nuclear industry and other radiation related industries. EPA accomplishes this role by exercising its expertise in acquiring and analyzing information and data, developing and implementing EPA philosophy and guidance, publishing various technical reports, and through analysis of each problem area including environmental impact statement reviews. This, in effect, accomplishes one of the Agency's goals because it complements the effectiveness of the generic radiation standards-setting activities; i.e., by giving EPA a case-by-case influence over the interpretation of the standards. Since EPA has limited direct enforcement authority with respect to most radiation standards and criteria, the case-by-case analysis and review role provide EPA with an indirect enforcement authority over radiation producing activities.

A number of Federal, State, and local agencies have responsibilities with respect to radiation control. In addition, many industrial, environmental, and citizen groups have specific interests in governmental policies and programs concerned with radiation uses and protection. Consequently, these interests demand that EPA openly inform these groups of its actions, solicit and discuss their opinions and recommendations, and make its decisions in a public forum. It is in this manner that EPA implements its radiation responsibilities and in doing so, take into account and balance the technological, economic, institutional, social, and physical aspects of radiation use and releases.

INTRODUCTION

BACKGROUND

Since the discovery of x-rays in 1895, man has sought to exploit the many benefits that radiation can provide to human welfare. Although many of the health hazards from radiation exposure were recognized, voluntary compliance with recommended exposure level standards was considered adequate. However, since that time, the sources of radiation have expanded at a very rapid rate both in scope and quantity. Voluntary compliance is no longer a feasible or prudent way to handle the problem; mandatory controls are now required. To cope with this situation, various kinds of Federal and State legislation have been enacted to provide the government with authority for such mandatory controls.

Through the implementation of these legislative actions, significant strides toward control of radiation hazards have been made, including the promulgation of certain standards, criteria, and guides. However, even with these accomplishments, improved radiation control is needed in many areas for a number of reasons. First, a great deal of new information about health effects and environmental transport has been developed since adoption of some current standards. Second, radiation standards to the extent possible should be developed using the "As Low as Reasonably Achievable" (ALRA) concept. Third, improved control technologies in many areas make it feasible to reduce emissions at a reasonable cost to levels below current standards and guides. And fourth, many new technologies and applications using radiation are being developed that have either no existing or inadequate standards and controls.

With the establishment of EPA and the transfer of many Federal radiation responsibilities to the Agency, EPA has the general mandate to ensure that the public health and quality of the environment are adequately protected from radiation hazards. Currently, the radiation problems are primarily in a preventive mode since a fair degree of control has been achieved as *radiation uses* and applications have evolved. However, for the future the problems may increase as a result of rapidly growing technology, expansion of nuclear electric power, increased awareness of natural radioactive materials and nonionizing sources and the potential for hazardous irreversible environmental pollution from long-lived isotopes released through operations and accidents. To meet this responsibility the Agency, through this statement, will consider and evaluate inadequacies of controls and take appropriate control action.

PURPOSE

The "Radiation Program Statement" forms the basis for the development of detailed program plans of the Office of Radiation Programs. Its purpose is to describe the radiation control problem and to specify the significance of radiation risks in quantitative terms as these are currently understood. Further, it presents the program goal, objectives, authorities, and the operational plan. Developed through an iterative process, this edition of the "Radiation Program Statement" has its foundation on earlier documents, but has been revised and updated to reflect changes in radiation protection priorities and socioeconomic and technological conditions as well as modifications to the Agency's basic radiation protection philosophy.

THE RADIATION PROBLEM

NATURE OF THE PROBLEM

The problem associated with exposures to radiation and radioactive materials is twofold. First, because of the various social and individual benefits that are accruable there are many applications and uses of radiation today, with significant expansion anticipated for the future. Second, it has been established that exposure to radiation has the potential for causing detrimental health effects. Consequently, the focal point of the problem solution lies in the establishment of sufficient control over radiation exposure to strike an effective balance between minimizing adverse effects and maximizing accruable benefits.

There are two types of radiation which contribute to the control problem: ionizing which is produced by radioactive materials and radiation producing machines such as x-ray equipment, and nonionizing which is produced by radio and television transmitters, radars, microwave devices, ultraviolet light, lasers and high voltage transmission lines. The primary health effects associated with these two types of radiation are different; for ionizing radiation – somatic and genetic effects; for nonionizing radiation – heat stress, neurophysiological, and teratogenic effects.

HEALTH EFFECTS FROM IONIZING RADIATION

Forms of ionizing radiation of primary concern are alpha rays (helium nuclei), beta rays (electrons); and gamma rays and x-rays (high energy photons). All of these can affect living organisms by depositing energy in the organism's tissue. This energy absorption causes cell damage and destruction. The extent of the damage depends upon the total amount of energy absorbed, the type of organism involved, the time period and dose rate, and the portion of the organism exposed. Very high doses of ionizing radiation can possibly cause acute death, radiation sickness, cataracts, sterility, cancer and genetic effects. The potential induction of such effects has been derived primarily through animal investigations and epidemiologic studies of human populations exposed as victims of nuclear weapons and as patients treated medically. Lower levels of exposure (which are those of concern to EPA since they represent the expected situation) have the potential for causing some somatic and genetic effects, based on the linear nonthreshold dose-effect hypothesis, which is discussed in more detail later in this strategy.

There are also potential environmental effects or environmental risks, such as irreversible contamination of land, air, water, and natural resources, and temporary use exclusion of specific land and water areas. While human ill-health is of primary concern, there is the potential for damaging segments of the biosphere, some parts of which may have radiosensitivities comparable to that of man. It is assumed that protection of human health from radiation risks will provide adequate protection for the total ecosystem although biological concentration mechanisms and environmental transport processes must be recognized in any total assessment made.

A 1972 study was conducted by the National Academy of Sciences to review the scientific bases used for the evaluation of risk at low levels of exposure to ionizing radiation and to review

and re-evaluate existing scientific knowledge concerning the effects of radiation exposure to human populations.* The basic conclusion of the study is that any radiation exposure may involve some risk and the biological risk (particularly cancer induction) associated with low levels of exposure can for the purpose of deriving risk estimates be assumed to be proportional to risks observed at higher levels of exposure (the linear, non-threshold concept). Risk estimates are provided in the report, reflecting the most likely estimates in the judgment of the scientists involved and the assumptions used in the calculations. Actual effects could be higher or lower, but these judgments imply an adequate level of conservatism. Table 1 represents the quantitative health risk estimates of exposures to ionizing radiation based on the BEIR Report; Table 2 represents the statistical annual health effects from major radiation sources; and Figure 1 shows projected health effects attributable to long-lived radionuclides released from U.S. nuclear power production through the year 2000. The impact of EPA's proposed standards for the uranium fuel cycle is indicated. The purpose of Table 2 and Figure 1 is to provide some insight to the relative impact of different sources, *not* to provide absolute numbers.

In order to assess potential health effects on large populations, the "man-rem" concept has been introduced. This concept provides an effective tool to estimate the magnitude of the potential health problem from exposure in large populations to low levels of ionizing radiation, when such exposures are expected to be similar. The "rem" is a unit of radiation dose equivalent that, as necessary, takes into account the spatial distribution of the energy deposited and the biological effects of the radiation on the body independent of the type of radiation. The "man-rem" is an index of the total radiation burden or risk placed on a given population and is obtained by summing all the individual exposures over the population considered provided the range of exposures is not very large, i.e., within an order of magnitude at the low levels. Thus, one million man-rems could be 0.1 rem to 10 million people or 0.01 rem to 100 million people Using the linear non-threshold dose effect model, estimates of potential health effect are the same in both cases. The "man-rem" concept is not appropriate for estimating health effects when considering much larger exposures to only a few individuals.

HEALTH EFFECTS FROM NONIONIZING RADIATION

A variety of health effects have been observed or alleged to be caused by exposures to various types of nonionizing radiation. These effects have been physiologically categorized as either thermal or non-thermal. The thermal effects result from temperature increases in tissue caused by the radiation. These effects appear at relatively high levels of exposure, above 10 milliwatts per square centimeter (mW/cm^2) and include burns, cataracts and temporary sterility. Research to date has demonstrated and documented these effects at these high levels. At levels of exposure below 10 mW/cm^2 and greater than 0.01 mW/cm^2 there is some evidence of nervous system and behavioral effects. Whether these effects are actually due to heat or local temperature increases has not been established. However, an exposure level at or below 10 mW/cm^2 is not believed to put a stress on the thermoregulatory capability of normal people and hence in this sense is nonthermal.

*The study was conducted by the National Academy of Sciences Committee on the Biological Effects of Ionizing Radiation (BEIR). This study, jointly sponsored by EPA and DHEW, resulted in the report entitled "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," published in November 1972, known as the BEIR Report. The BEIR Report represents a compilation of knowledge on health effects of ionizing radiation and the integration of this knowledge into a single set of precepts based upon the collective expertise of approximately 50 knowledgeable scientists.

Table 1

ESTIMATED HEALTH RISK ESTIMATES OF IONIZING RADIATION*

EFFECT	CASES PER MILLION MAN-REMS
LETHAL CANCER	200
OTHER CANCER	200
LETHAL GENETIC	300
GENETIC ILL HEALTH	1,000- 10,000

*Based on the 1972 NAS report, "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation."

Table 2

STATISTICAL

ANNUAL HEALTH EFFECTS FROM MAJOR RADIATION SOURCES* (U.S. 1973)

NATURALLY OCCURRING RADIOACTIVE MATERIALS AND RADIATION	
NATURAL BACKGROUND	13,000
CONSTRUCTION MATERIALS	1,000
AIR TRAVEL	100
RADIATION IN HEALING ARTS	8,000
(REDUCIBLE COMPONENT 3,000)	
NUCLEAR ACTIVITIES	
POWER GENERATION	20
WEAPONS	700
OCCUPATIONAL	100
CONSUMER PRODUCTS	200

*These estimates of potential health effects are limited to cancers (including leukemia), and serious genetic effects (these include congenital abnormalities leading to serious disability, and increases in diseases that are specifically genetic, such as certain forms of mental defects, dwarfism, diabetes, schizophrenia, epilepsy, and anemia. (P. 82–83, UFC DEIS) They do not provide absolute bases for risk but imply an adequate level of conservatism.

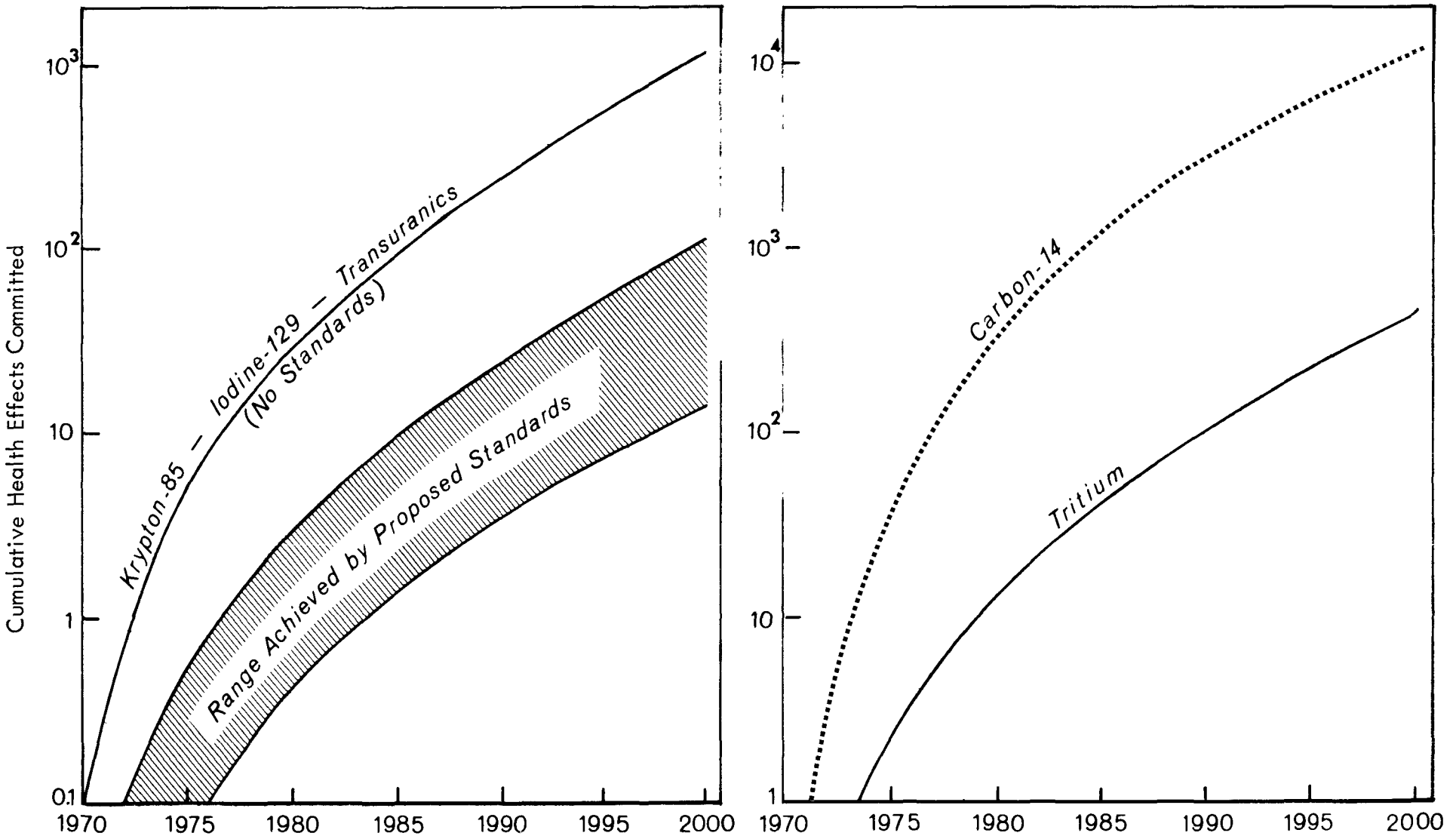

Figure 1. Projected health effects attributable to releases of long-lived radionuclides from U.S. nuclear power production. Health effects are projected for 100 years following release only, and the exclusive use of uranium fuel is assumed.

The evidence for nonthermal effects has been reported primarily by investigators in certain European countries which significantly have adopted some standards for microwave exposure one-thousandth of the current standard used in the United States. However, any significant nervous system and behavorial effects have not been observed in this country, although several research programs have been initiated, both within EPA and outside, to determine the existence and significance of such effects.

The other major category of effects from nonionizing radiation is related primarily to electrical interference. Of concern are critical communications systems, electronic life support systems, such as heart pacemakers, and inadvertant triggering of detonations (blasting).

Concern with the environmental nonionizing radiation arises from two exposure situations. One is related to the relatively high levels of exposure in the vicinity of individual high-powered sources, such as satellite communications, airport radars, broadcast TV, industrial process applications, and military electronic applications. The other is related to the superposition or overlapping of radiation from many sources. Both of these types of situations can result in exposure of large populations to significant ambient levels of nonionizing radiation. The radiation from these sources is currently regulated by a number of Federal agencies, such as the Federal Communications Commission and the Office of Telecommunications Policy which issue the frequency authorizations for privately owned and government owned sources, respectively; Occupational Safety and Health Administration which issues an occupational exposure standard for frequencies between 10 MHZ and 100 GHZ; and the Bureau of Radiological Health which has authority to set emission standards for electronic products under PL 90–602. However, with respect to environmental effects, there is yet no control on the ambient level of nonionizing radiation resulting from either point sources or the combination of low level multiple sources. The EPA radiation program is providing information on the scope of any environmental problem and along with other Federal agencies attempting to assess the magnitude of the potential effects on populations. The underlying principles on the need for this activity are shown in Table 3.

EPA POLICY ON RELATIONSHIP BETWEEN DOSE AND EFFECT

The actions taken by the Environmental Protection Agency to protect public health and the environment require that the impacts on contaminants in the environment or released into the environment be prudently examined. When these contaminants are radioactive materials and ionizing radiation, the most important impacts are those ultimately affecting human health. Therefore, the Agency believes that the public interest is best served by the Agency providing its best scientific estimates of such impacts in terms of potential ill health.

To provide such estimates, it is necessary that judgments be made which relate the presence of ionizing radiation or radioactive materials in the environment, i.e., potential exposure to the intake of radioactive materials in the body, to the absorption of energy from the ionizing radiation of different qualities, and finally to the potential effects on human health. In many situations, the levels of ionizing radiation or radioactive materials in the environment may be measured directly, but the determination of resultant radiation doses to humans and their susceptible tissues is generally derived from pathway and metabolic models and calculations of energy absorbed. It is also necessary to formulate the relationships between radiation dose and effects; relationships derived primarily from human epidemiological studies but also reflective of prospective research utilizing animals and other biological systems.

Although much is known about radiation dose effect relationships at high levels of dose, a great deal of uncertainty exists when high level dose effect relationships are extrapolated to lower

levels of dose, particularly when given at low dose rates. These uncertainties in the relationships between dose received and effect produced are recognized to relate, among many factors, to differences in quality and type of radiation, total dose, dose distribution, dose rate, and radiosensitivity, including repair mechanisms, sex, variations in age, organ, and state of health. These factors involve complex mechanisms of interaction among biological, chemical, and physical systems, the study of which is part of the continuing endeavor to acquire new scientific knowledge.

Because of these many uncertainties, it is necessary to rely upon the considered judgments of experts on the biological effects of ionizing radiation. These findings are well documented in publications by the United Nations Scientific Commitee on the Effects of Atomic Radiation (UNSCEAR), the National Academy of Sciences (NAS), the International Commission on Radiological Protection (ICRP), and the National Council on Radiation Protection and Measurements (NCRP), and have been used by the Agency in formulating a policy on relationship between radiation dose and effect.

It is the present policy of the Environmental Protection Agency to assume a linear, non-threshold relationship between the magnitude of the radiation dose received at environmental levels of exposure and ill health produced as a means to estimate the potential health impact of actions it takes in developing radiation protection as expressed in criteria, guides, or standards. This policy is adopted in conformity with the generally accepted assumption that there is some potential ill health attributable to any exposure to ionizing radiation and that the magnitude of this potential ill health is directly proportional to the magnitude of the dose received.

In adopting this general policy, the Agency recognizes the inherent uncertainties that exist in estimating health impact at the low levels of exposure and exposure rates expected to be present in the environment due to human activities, and that at these levels the actual health impact will not be distinguishable from natural occurrences of ill health, either statistically or in the forms of ill health present. Also, at these very low levels, meaningful epidemiological studies to prove or disprove this relationship are difficult, if not practically impossible, to conduct. However, whenever new information is forthcoming, this policy will be reviewed and updated as necessary.

It is to be emphasized that this policy has been established for the purpose of estimating the potential human health impact of Agency actions regarding radiation protection, and that such estimates do not necessarily constitute identifiable health consequences. Further, the Agency implementation of this policy to estimate potential human health effects presupposes the premise that, for the same dose, potential radiation effects in other constituents of the biosphere will be no greater. It is generally accepted that such constituents are no more radiosensitive than humans. The Agency believes that this is a proper policy.

In estimating potential health effects it is important to recognize that the exposures to be usually experienced by the public will be annual doses that are small fractions of natural background radiation to, at most, a few times this level. Within the United States, the natural background radiation dose equivalent varies geographically between 40 to 300 mrem per year. Over such a relatively small range of dose, any deviations from dose effect linearity would not be expected to significantly affect actions taken by the Agency, unless a dose effect threshold exists.

While the utilization of a linear, non-threshold relationship is useful as a generally applicable policy for assessment of radiation effects, it is also EPA's policy in specific situations to utilize the best available detailed scientific knowledge in estimating health impact when such information is available for specific types of radiation, conditions of exposure, and recipients of the exposure. In

Table 3

UNDERLYING PRINCIPLES

(Nonionizing Radiation)

ADVERSE THERMAL EFFECTS ON BIOLOGICAL SYSTEMS OCCUR AT LEVELS GREATER THAN 10 MILLIWATTS PER SQUARE CENTIMETER POWER DENSITY FOR RADIOFREQUENCY AND MICROWAVE RADIATION.

ADVERSE NONTHERMAL EFFECTS ON BIOLOGICAL SYSTEMS HAVE BEEN REPORTED TO OCCUR AT LEVELS ORDERS OF MAGNITUDE BELOW THERMAL EFFECT POWER DENSITY.

ENVIRONMENTAL LEVELS OF NONIONIZING RADIATION CAN SIGNIFICANTLY INTERFERE WITH THE OPERATION OF CRITICAL ELECTRICAL SYSTEMS.

such situations, estimates may or may not be based on the assumptions of linearity and a non-threshold dose. In any case, the assumptions will be stated explicitly in any EPA radiation protection actions.

The linear hypothesis by itself precludes the development of acceptable levels of risk based solely on health considerations. Therefore, in establishing radiation protection positions, the Agency will weigh not only the health impact, but also social, economic, and other considerations associated with the activities addressed.

SOURCES OF RADIATION EXPOSURE

In order to identify radiation program objectives, consideration was given to the types of radiation sources, their current and projected potential for exposing the population, and the adequacy of existing and potential controls. While it is quite evident that exposure to radiation can come from a multitude of activities and source types, there are four general source categories which encompass all of these potential sources of exposure.

Healing Arts and Industrial Applications – This area includes all ionizing radiation used for diagnostic and medical applications, such as dental radiography, diagnostic radiography, therapy, and nuclear medicine. It also includes industrial uses of radiation, such as nondestructive testing, radiography and leak identification.

Nonionizing Sources – Includes sources such as radars, television and radio transmitters, microwave transmitters, laser devices, and high voltage transmission lines.

Natural Radiation Sources – These sources include both terrestrial and cosmic background radiation, construction materials containing significant concentrations of radionuclides, fertilizer phosphates and mine, milling and processing residues, energy production involving fossil fuels and geothermal systems.

Nuclear Energy Applications – This broad category includes all activities relating to the production of electric power via either fission or fusion. These include the conversion, enrichment, fuel fabrication, reactor operation, fuel reprocessing, and waste management modes of the uranium, plutonium, and thorium fuel cycles. It also includes the manufacture and use of nuclear explosives as they apply both to weapons devices and peaceful uses, such as gas stimulation products.

Identification of these four source categories facilitates organization and management of the complex radiation problem. In general, the kinds of projects developed to provide control and the types of expertise required by the control activities are unique to each of these areas; consequently, grouping in these four areas is appropriate.

RADIATION PROBLEM TRENDS

The estimated total radiation dose to the population from ionizing radiation and from nonionizing radiation is increasing. This is due to a number of factors:

- Increasing population
- Increasing variety of radiation related applications
- Proliferation of existing applications
- Changes in social behavior and lifestyle causing increasing exposure to certain sources.

TRENDS IN USE AND APPLICATIONS OF IONIZING RADIATION

Historically, the nation's demand for electricity has been doubling every 10 years. As a result of economic conditions and conservation efforts this growth rate may not continue. However, the share of electric output from nuclear power is projected to increase from the current 39.6 gigawatts generating capacity to an estimated 800 gigawatts capacity for the year 2000, assuming an 80 per cent capacity factor.

With the existing prevalence of light-water-cooled reactors (LWR), most of the potential radiation problems associated with LWR's are understood and technologies have been developed to control them. There still are, however, questions concerning accident probabilities and consequences, and the adequacy of engineered safeguards for the LWR. Reactors using mixed oxide fuel reactors (GESMO) and breeder reactors (LMFBR), may provide a share of the nation's nuclear electric generating output depending upon satisfactory resolution of environmental, safety, and economic problems. For instance, the breeder's future depends largely on demonstration of its economic and technical feasibility. These reactor types mean new plant designs, operating criteria, siting criteria and associated radiation control problems.

The radiation control problems resulting from nuclear electric power generation are not limited to the nuclear reactor. Associated activities, such as uranium mining and milling, conversion, enrichment, fuel fabrication, fuel reprocessing, waste disposal, and all transportation of radioactive material, have radiation problems that require evaluation and control. The growth in these activities projected for the year 2000 shows the need for adequate controls to govern their construction and operation. Table 4 compares the number of fuel cycle facilities operable in 1975 versus those projected for the year 2000.

As more power reactors and associated facilities begin operation, increasing quantities of radioactive waste will be generated. Radioactive waste disposal involves major problems in five different areas: High Level Waste, Transuranium Contaminated Waste, which includes plutonium, Low Level Waste, Natural Radioactive Waste including Mill Tailings, and Decommissioning of Facilities. While high-level waste poses a programmatic problem of increasing concern to the public and to the government, actual exposures to population groups from natural, transuranic waste, and low-level waste involve more immediate public health problems. Decommissioning of radioactive facilities is a problem that has yet to be addressed in depth.

EPA's responsibilities lie in the area of setting basic environmental criteria and guidance for use by other Federal agencies. These are in turn used in regulating management of radioactive wastes from nuclear energy applications. In addition, EPA is involved in developing standards,

Table 4

COMPARISON OF THE NUMBER OF FUEL CYCLE FACILITIES OPERABLE IN 1975 VERSUS THOSE PROJECTED FOR THE YEAR 2000

Type	1975	Planned	Estimated by Year 2000
Uranium Mills**	18	6	69
UF Production Plants	2	1	9
Enriched Uranium Fuel Processing and Fabrication Plants	17	2	53
Plutonium Fuel Processing and Fabirication Plants	5	1***	
Fuel Reprocessing Plant	0	3	17
Irradiated Fuel Storage Facilities	2	3	
Waste Burial Grounds	6	0	10
Enrichment Plants	3	4	18

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* U.S. Nuclear Regulatory Commission Annual Report 1975.

** Some of the mills and waste burial grounds are under Agreement State Licenses.

***Firm plans affected by Pu Recycle Question.

criteria or guidance in the area of management and disposal of naturally radioactive materials found interspersed in minerals, ores, fossil fuels and other materials mined and processed for use in non-radioactive applications. Ocean disposal and deep bed ocean emplacement of radioactive wastes are also areas in which EPA is involved and has primary regulatory authority. Finally, EPA along with NRC has responsibilities for environmental surveillance to evaluate leakage problems, including those related to low-level commercial waste burial sites.

In developing criteria for radioactive waste management and carrying out our regulatory roles in ocean disposal and natural radioactive waste areas, EPA's underlying philosophy is that waste management means containment of radioactive materials until they have decayed to unnocuous levels. The objective is to minimize exposure to present and future populations and to avoid dilution into the biosphere. Containment may involve burial, storage, or some form of assuring that dispersion into the biosphere does not take place.

EPA further believes that effective and efficient solutions to problems in all five radioactive waste disposal areas will require close coordination and cooperation among all Agencies involved. In this regard, EPA is participating with the Energy Research and Development Administration, the Nuclear Regulatory Commission, the Council on Environmental Quality, and the U.S. Geological Survey to lay the groundwork for the development of a consolidated national radioactive waste disposal plan. EPA's role in this plan will be the development of performance criteria for the containment and control of radioactivity from waste disposal sites.

The release of long-lived radionuclides to the environment will be of major concern if there is a continuing growth in nuclear power and nuclear industries. Because of their persistent natures, these environmental pollutants not only tend to build up in the environment over time, but those released to the environment today will continue to be potentially available to expose the population for thousands of years. Thus, there is an environmental dose commitment which results in some commitment, uncertain but estimatable, of future adverse health effects for many years from the discharge of small quantities of such persistent environmental pollutants.* Currently, the environmental dose commitment is small. However, a lack of adequate controls to prevent environmental buildup coupled with the anticipated growth in the generation of long-lived radionuclides could result in emissions from the nuclear power industry representing a large contribution to total population dose.

In addition to projected increases in the generation of nuclear electric power, many other energy sources are receiving increased development effort in order to achieve energy independence for the United States. One of these is geothermal energy. There is currently only one commercial geothermal electric power plant in operation in the United States. However, because of the high potential promise of geothermal sources, a number of such demonstration and commercial facilities are being planned for the near future. These plants rely on directing steam that is produced deep in the earth to turbines where the thermal energy is converted to electricity. The steam flowing from the earth carries radioactive radon gas with it. This radon could expose the workers at the plant, the local environs, and the general population. Because of the newness and limited use of this energy source, the radiation problem is currently being defined and identified.

*A detailed discussion of this problem is presented in the EPA publication *Environmental Radiation Dose Commitment: An Application to the Nuclear Power Industry*, EPA 520/4–73–002, February 1974.

There are many terrestrial products, such as metallic ores and phosphates, which contain concentrations of naturally occurring radioactive materials. While the materials are in the earth, they are of little adverse consequence to man because of natural containment within the earth. However, materials, like gypsum, are extracted for construction applications; other materials, like phosphates, are used as fertilizers to grow food. The result is that these radioactive materials removed from the earth can expose the people working in plants making these products, and as waste effluents and by-products can enter the biosphere for exposure of man.

The use of x-rays, isotopes, and other radiation in medical, therapeutic, and diagnostic treatment has greatly expanded in recent years and is expected to continue to increase. Although FDA reported in 1975 that the genetically significant dose is lower than originally estimated (primarily due to a correction in the dose model), nevertheless, the dose from the application of radiation in the healing arts remains rather large as a manmade source. There is agreement that reductions in exposure can be attained without any significant loss in the obvious benefits of this application.

It is estimated that the total radiation dose to the United States population from natural, medical, occupational, fallout, nuclear power, and other sources will fall in the range from 46.7 million to 93.4 million man-rems in the year 2000.* This compares with the estimated 43.3 million man-rems dose in 1970. The lower prediction for the year 2000 reflects an aggressive national radiation control program using up-to-date techniques and equipment. The higher value might be expected to result from present practices which are possible but not yet fully implemented.

An illustrative example of what may be the potential radiation exposure trends in man-rems for the year 2000, compared with the same estimate for 1970, is shown in Appendix A. It should be noted that the data for both figures in the appendix are gross estimates to provide comparison of trends and do not represent actual predictions of what may happen. From this example it is evident that there must be a well planned and executed Federal radiation protection control program to reduce the exposure trends to their lowest practicable level. It is also evident that there must continue to be a high degree of cooperative effort between the Federal Government, the nuclear power industry, the medical profession, State and local Goverments and the other components of our society to prevent and reduce wherever possible the radiation exposure to our workers, patients and the general population.

TRENDS IN USE OF NONIONIZING RADIATION

There exists a potential risk to personnel and equipment from such nonionizing radiation sources as radar, radiofrequency communication devices, microwave ovens, medical diathermy devices, high voltage transmission lines and industrial heating equipment. Until about 1945, the environmental levels of nonionizing radiation were not considered significant. Since then, the electronics, navigation, and communications industries have flourished. There are thousands of sources currently operating and the number of radiofrequency and microwave sources alone are estimated to be increasing at 15% annually. Because of the numbers of competing sources, television and radio station owners are increasing their power output in order to reach larger audiences without having their signals obliterated by interference. Thus, there could be increases in ambient levels of nonionizing radiation at these frequencies.

*U.S. Environmental Protection Agency, *Estimates of Ionizing Radiation Doses in the United States, 1960–2000*, ORP/CSD 72–1, August 1972.

Initial examination of this country's most powerful sources indicates that there are now 86 sites capable of producing a power density of 10 milliwatts per square centimeter at a distance of approximately one mile from the source. There are 2,368 sources capable of producing a power density of 10 microwatts* per square centimeter at the same distance.* The difference in these values points out that the magnitude for control depends upon the levels which are chosen for environmental standards. These two power densities also represent the probable extremes of the range of acceptable power densities for environmental criteria. Table 5 identifies the high power sources and shows the growth rate of some applications of nonionizing radiation.

UNCERTAINTIES AFFECTING THE RADIATION PROGRAM

Although the strategic operational program is based upon the best knowledge available and the current prevailing conditions, consideration must be given to the many important uncertainties affecting the Agency's ability to establish effective controls. These unknowns lie primarily in the areas of health effects and ecological processes knowledge; the availability of effective control technologies for specific radionuclides, nuclear facility operations, and industrial processes, and policy and responsibility uncertainties. The significance of these unknowns is that, as the program is implemented, developments in these areas could require minor or major modifications, such as changing control procedures, establishing more or less stringent standards, and changing basic control philosophies and approaches.

IONIZING RADIATION UNCERTAINTIES

A tremendous body of research knowledge has developed over the years about ionizing radiation. The types of health effects attributable to radiation exposure are well known; however, the specific probabilities of occurrence at low environmental levels have not been clearly demonstrated. Consequently, at this time only a conservative hypothesis can be used to estimate the number of potential health effects. The current and projected quantities of many radionuclides including plutonium and actinides in the environment and their environmental transport modes and mechanisms are also highly uncertain. The consequence of these uncertainties is that the environmental impact cannot be precisely projected; therefore, conservatism in judgments is necessary in developing appropriate standards and other controls so that the nation does not find itself with large-scale irreversible and unacceptable contamination from these materials.

Although technologies regarding effluent controls and engineered safeguards have been improving since the introduction of the nuclear industry, a number of uncertainties still remain. The majority of these lie in the determination of the acceptable levels of risk from accidents at nuclear facilities; the reliability of emergency systems to mitigate adverse effects in the event of an accident; the development of an environmentally acceptable method for long term disposal of radioactive waste; and the development of systems to control effluents, such as krypton-85, carbon-14 and tritium. *The Reactor Safety Study, An Assessment of Accident Risks in U.S. Commerical Nuclear Power Plants (WASH 1400)* published by NRC in November 1975 helps define the uncertainties in accident consequences.

*A milliwatt is one thousandth of a watt, a microwatt is one millionth of a watt.

*Environmental Radiation Exposure: A Preliminary Analysis of the Problem and Continuing Work Within EPA, R. A. Tell, Environmental Exposure to Nonionizing Radiation, EPA/ORP 73–2.

Table 5

NONIONIZING RADIATION EXPOSURE CONSIDERATIONS

HIGH POWERED SOURCES

- SATELLITE COMMUNICATIONS
- AIRPORT RADARS
- BROADCAST TV
- INDUSTRIAL PROCESSING APPLICATIONS
- MILITARY ELECTRONIC APPLICATIONS

HIGH GROWTH RATE OF APPLICATIONS

- MICROWAVE OVENS (1,000,000 in 1974)
- LAND-MOBILE COMMUNICATIONS (459,000 in 1972)
- SMALL BOATS
- PRIVATE PLANES
- MICROWAVE DIATHERMY
- RADARS, BOTH MILITARY AND PRIVATE

NONIONIZING RADIATION UNCERTAINTIES

In the nonionizing radiation area there are three major uncertainties. First is the determination of the existing ambient environmental levels and their rates and patterns of growth. Second is the determination of criteria which can be used to specify acceptable environmental levels, e.g., thermal stress, non-thermal health effects, interference with electronic life support systems, or interference with television and radio reception. Lastly is the determination of the existence of non-thermal effects, which are detrimental to public health and welfare.

POLICY AND RESPONSIBILITY UNCERTAINTIES

The policy and responsibility uncertainties fall primarily into four categories:

1. The enactment of new legislation, such as the Safe Drinking Water Act of 1974, has required EPA to undertake a substantial workload in developing an information base, objectives, and criteria for radioactive contaminants in drinking water. It will also vastly increase EPA's responsiblities in monitoring and compliance; hard data will be needed based on surveillance measurements with analytical and instrumentation quality control.

2. EPA has the capability to respond to incidents or accidents at nuclear facilities or during the shipment of radioactive materials by providing on-the-spot emergency teams and in evaluating the accident to determine the cause, the extent of the hazard, and recommend control measures. These support services are available to other Federal agencies through the Interagency Radiological Assistance Plan (IRAP).

In a Federal Register notice, Vol. 40 No. 248 dated December 24, 1975, the GSA's Federal Preparedness Agency published the interagency responsibilities in Radiological Incident Emergency Response Planning; Fixed Facilities and Transportation. This notice sets forth the responsibilities as agreed between the certain Federal agencies and is also intended to provide a continuing stimulus to State and local government in developing their plans for responding to radiological incidents. Under this agreement EPA is responsible for (1) Establishment of Protection Action Guides (PAG) in coordination with appropriate Federal agencies. These guides will be in terms of projected radiation doses which might result from radiological incidents at fixed nuclear facilities or in the transportation of radioactive materials; (2) Recommendations as to appropriate protective actions which can be taken by governmental authorities to ameliorate the consequences of a radiological incident at a fixed nuclear facility or from an incident involving transportation of radioactive materials; (3) Providing assistance, following the guidance issued by NRC, to State agencies with radiological emergency response responsibilities in the development of their emergency plans relative to nuclear facilities and transportation incidents involving radioactive materials; and (4) The establishment of emergency radiation detection and measurement systems guidelines in cooperation with NRC.

Such incidents frequently arise, particularly at the low end of the spectrum of possible consequences, and therefore, while the time of their occurrence is not predictable, a temporary realignment of priorities may be necessary as incidents occur in order to provide technical assistance and field support at the incident site to reduce the consequence of such incidents and to assure protection of the public health.

EPA also has responsibilities to take actions involving spills of oil and hazardous materials as required by sections 307 and 311 of the Federal Water Pollution Control Act, as amended.

Radioactive material under certain conditions could be designated as a hazardous substance and as such could impact on program priorities.

3. Policy changes may occur as a result of judicial decrees arising from suits against EPA. One current example involves a suit filed in February 1974, in the United States District Court for the District of Colorado by the Colorado Public Interest Research Group, Incorporated (COPIRG) Plaintiffs versus Russell Train, Administrator, Environmental Protection Agency Defendant. The COPIRG raised the legal issue that all radioactive effluents are subject to regulations pursuant to the 1972 amendment to the FWPCA. The District Court ruled in favor of the Federal Government. Subsequently, on appeal of the lower Court decision, the United States Court of Appeals, Tenth Circuit, on December 9, 1974, reversed the decision. In April 1975, the Solicitor General, on behalf of the Environmental Protection Agency and its Administrator, submitted a petition to the Supreme Court of the United States for a writ of certiorari to review the judgments of the United States Court of Appeals for the Tenth Circuit. Arguments were heard on this case in December 1975. Pending the Supreme Court decision, there is a considerable quantity of additional analysis and procedural involvement by EPA in order to be prepared to comply with the lower Court's ruling in the event the Federal Government loses the case.

4. New Nuclear Regulatory Commission (NRC) and Energy Research and Development Administration (ERDA) initiatives, including those resulting from petitions and suits, may require EPA to review unanticipated environmental impact statements, regulations, and other policy directives. These initiatives may have a major impact on the environment. Consequently, EPA would have to redirect priorities to ensure that the initiatives are fully assessed and appropriate action taken by the Agency to maintain the quality of the environment and protect the public.

PROGRAM OVERVIEW

The purpose of this chapter is to provide a program overview by stating protection goals, objectives, and the authorities. Because of the Agency's authorities, the many different kinds of sources, the different media through which radioactive materials flow, and the varied people receiving exposures, no single point of control or type of standard could comprehensively minimize the radiation exposure. Therefore, to complete the overview the different potential points of EPA control or influence will be discussed.

GOALS AND OBJECTIVES

The overall goal of the Environmental Protection Agency implemented through the Office of Radiation Programs is to protect public health and the environment by assuring that no avoidable risks occur to individuals, and the population at large, or the environment due to radiation exposure without the existence of offsetting benefits; and within this framework, to minimize risk in a cost-effective manner. In accomplishing this goal EPA will be fully responsive, within the limit of resources available to current problems by cooperating with other Federal agencies, the States, the public and industry.

The achievement of this goal will be attained by directing resources to specific source related objectives. These objectives are to minimize radiation exposures to that necessary from (1) healing arts, (2) industrial applications, (3) nonionizing radiation, (4) natural radioactivity, and (5) nuclear energy applications.

EPA RADIATION AUTHORITIES

EPA has the mandate to protect public health and the environment from any adverse effects due to radiation exposure. Fortunately, its authorities afford the flexibility to attack the radiation problems in the order of their relative importance. Table 6 lists these authorities. In addition, EPA's general authorities include research and monitoring, and the authority to perform ecological studies provided by the transfer of the Council on Environmental Quality (CEQ) authority under the President's Reorganization Plan No. 3 of 1970. The two principal authorities for setting radiation standards are as follows:

- On August 22, 1959, eight days after the Federal Radiation Council was established by Executive Order, the President designated the Secretary of Health, Education, and Welfare as Chairman of the FRC. In the same press release announcing this decision, the President directed that the Department of Health, Education, and Welfare intensify its radiological health efforts and have primary responsibility within the executive branch for the collation, analysis, and interpretation of data on environmental radiation levels such as natural background, radiography, medical and industrial use of isotopes and x-rays and fallout, so that the Secretary of Health, Education, and Welfare may advise the President and the general public. Although not specifically stated in Reorganization Plan No. 3 of 1970, these responsibilities were also transferred from DHEW to EPA.

- Authority transferred from the Atomic Energy Commission to establish generally applicable environmental standards for the protection of the general environment from radiation and radioactive materials.

Table 6

RADIATION PROTECTION AUTHORITIES OF EPA STANDARDS

- Reorganization Plan #3

  General Radiation Protection Guidance Function for Federal Activities (42 USC 20221 (H))

  Generally applicable Environmental Standards Outside AEC-Licensed Facilities

- Ocean Dumping Act of 1972

  Radiation Wastes

- Federal Water Pollution Control Act of 1972, as amended

  Effluent, Water Quality, Toxic & Hazardous Material, & Federal Facilities for Radiation Discharges in Water

- Clean Air Act of 1970

  Ambient & Emission Standards for Radiation Discharges

- Safe Drinking Water Act of 1974

TECHNOLOGY ASSESSMENT

- NEPA – Section 102 (C)

- Clean Air Act of 1970 – Section 309

- Federal Water Pollution Control Act of 1972, as amended – Sections 301 & 304

  Best Practicable & Best Available Technology

MONITORING

- Reorganization Plan #3

- General Federal Guidance (FRC)

- Public Health Service Act (42 USC 241) – Section 301

TRAINING & ASSISTANCE TO STATES

- Reorganization Plan #3

- Public Health Service Act (42 USC 243) – Section 311

Under these authorities, EPA acts as the Federal "overseer" of radiation protection philosophies, policies, and controls. In this respect, EPA has broader responsibilities in the radiation area than it has in other environmental areas for it may consider public health protection related not only to the environment, but also to healing arts and occupational exposures.

POLICIES AND DECISION ISSUES

EPA has the responsibility for directing its resources and expertise to problems that can provide the greatest public protection for the nation from the perspective of reducing adverse health impact while maintaining a proper socioeconomic balance. Implementing this responsibility is difficult because of the technical complexity of the radiation problems, the delineation of the relative roles and responsibilities of various Federal agencies, and the degree of interface among Federal, State, and local governments in certain areas. However, in order to most effectively direct the Agency's resources toward the control of radiation hazards, the following basic policies have been established to direct the national radiation protection program strategy.

ACCEPTANCE OF THE BEIR HEALTH RISK ESTIMATES

It has been concluded that for EPA's radiation standard-setting responsibilities, it is prudent to generally accept the linear, nonthreshold hypothesis as a dose effect relationship for assessing health impact in the dose level range of primary concern. However, where specific evidence for a dose-effect relationship does exist then EPA will use the more appropriate relationship. Delaying programs until all uncertainties are resolved by expensive and long-term research would not be in the best public interest for many activities.

ACCEPTANCE OF A BENEFIT-RISK-CONTROL-COST APPROACH

The health risks incurred by radiation exposure are most frequently associated with some individual or social benefit the radiation use or application affords. For this reason it is not necessarily prudent to establish radiation standards or other control measures based on some "acceptable" degree of health risk alone. Rather, the benefits attributable to the radiation use or application must be at least qualitatively examined as being more advantageous to individuals or society than any health risks estimated from the exposure. In many cases where the benefit of an activity is determined to warrant the risk, it might be found that for an incremental cost increase for additional controls over the radiation releases, a large reduction in health risk could be achieved. In such instances the cost of additional control versus the reduction in risk achieved must also be considered and evaluated.

ESTABLISHMENT OF SPECIFIC PROGRAM PRIORITIES

In order to allocate resources in the best possible manner it is necessary to develop a priority-setting methodology to weigh the various radiation problems and establish a general scheme of relative priorities. The priority setting methodology employed both qualitative and quantitative analysis through consideration of six basic factors as shown in Table 7. This methodology was applied to the overall problem of radiation protection and the results of this application are described in subsequent sections.

TYPES AND APPLICATIONS OF STANDARDS

Generally, there are three kinds of standards (standards is used here as a generic word); namely, scientific and technical, industrial, and regulatory. Examples of scientific and technical

Table 7

FACTORS DIRECTING THE PRIORITY-SETTING METHODOLOGY

The range of potential health effects and the extent of potential environmental dose commitments from various activities and sources.

The degree and probability of health risk associated with accident situations.

The overall national costs to reduce health risks versus the magnitude of the reduction.

The type of control function available (i.e., guidance, standards, enforcement) for each problem and the EPA role in the application of the controls.

The degree of EPA discretion in the magnitude of resources applied.

The magnitude of public awareness and concern.

standards are the recommendations for radiation protection established by the National Council on Radiation Protection and Measurements, and the International Commission on Radiological Protection. Industrial and professional standards are established by groups like the American Nuclear Society and the American National Standards Institute for the purpose of obtaining some specific benefit to the group members although general society may benefit as well. Establishment of standardized reactor parts is an example of this type of activity.

Regulatory standards are legal, enforceable enactments by Government (including State and local) agencies which are directed to protection of the public from various detrimental impacts. There are two types of regulatory standards – permissive and restrictive. Permissive standards are established by Government to enable particular activities to operate in the public interest, such as activities where Government intervention of financing is involved, like nuclear energy. Regulations and standards set in this regard are controls to protect the public health, safety, economic interests, etc. Restrictive standards are established by Government solely to protect the public from adverse action from a variety of causes. The interests of the agencies that establish these types of standards are evidenced in that a permissive regulator tends to ask dissenters to identify and quantify any actions that may have detrimental effects on society whereas a restrictive regulatory standard asks the promoter of the action to prove the opposite, namely, no detrimental effects resulting from the activity above the level set by Government.

While the medical, natural, and nonionizing radiation areas do not have both permissive and restrictive regulators, like nuclear energy, they do have all three types of standard-setting bodies. To provide effective coordination among these bodies requires that one Federal agency exert an overview role with respect to public health and environmental protection. That responsibility lies with EPA.

OVERVIEW RELATIONSHIP WITH FEDERAL AGENCIES

EPA is emphasizing the Federal radiation protection overview role provided by the authorities of the Federal Radiation Council transferred to EPA by Reorganization Plan #3 of 1970. This role has been carried out in a coordinated manner by formation of a number of interagency committees to address specific problems that are of mutual concern to the involved agencies. This approach is being pursued in the areas of medical x-rays, occupational exposures, plutonium cleanup and restoration, management of radioactive wastes, and publication of the Annual Report on Radiation Protection Activities. The exercise of EPA authority to set generally applicable radiation protection standards requires other Federal agencies to implement or enforce EPA's standards and guides under other authorities. EPA is responsible for enforcing standards such as those set forth under the FWPCA, Clean Air Act, and Ocean Dumping Act. In the case of Federal Guidance, it is up to the Federal agencies to adopt the guidance and to establish enforcement procedures. Thus, in establishing this relationship, it will minimize Federal duplication and maximize the effectiveness of all Federal radiation control programs.

Radiation research requirements fall into two categories: research programs and operational programs. The research programs fall under EPA's Office of Research and Development, and operational programs are conducted under the direction of the Office of Radiation Programs. This split is similar to the research programs undertaken by the ERDA and confirmatory research undertaken by the NRC. The EPA research and operational needs are developed by means of a matrix analysis which identifies radionuclides of public health concern and sources of environmental radiation in relation to specific research, laboratory efforts, and field studies. Such a technique not only identifies the specific research and operational needs, but also provides a means to take into account radiation research efforts by other Federal agencies. This

coordination eliminates duplication of efforts and identifies complementary research needs. In this manner, not only does the Office of Research and Development provide response to identified research needs, but to ERDA and NRC research programs as well. An operating, working relation with ERDA and NRC has been established to implement coordinated research undertakings.

Nonionizing radiation research is carried out by FDA/BRH, DOD and EPA. The BRH efforts are directed toward research needed to set equipment performance standards. EPA's efforts are oriented toward ambient and environmental and health effects, and DOD's efforts are directed toward research on bioeffects.

In attaining coordination of activities, each Federal agency must retain its legislative mandates, independence of action, and own points of view. Nevertheless, mutual understanding of commonalities and differences in all areas and interchange on technical levels should not in any way compromise the respective roles of the involved agencies.

DEVELOPMENT OF WORKING RELATIONSHIPS WITH STATES

A key aspect to the radiation program is the acquisition of information developed by State radiation control agencies to use in standard-setting activities and environmental assessment projects, such as the Environmental Radiation Ambient Monitoring System (ERAMS) and ORP's annual State of Environmental Radiation Report. In this regard, the EPA radiation program is highly dependent upon the EPA Regional Offices who have primary contact with the States themselves.

Further, in certain areas, such as medical x-ray guidance, where EPA guides apply only to Federal agencies, the effectiveness of these guides on a national basis is dependent upon the willingness of the States to accept and promulgate them. At present, only State laws exist in these areas and promulgation of standards and their enforcement rests with the States. Consequently, in many radiation areas the Agency's national impact is directly related to its technical and policy credibility with the States. This credibility can be acquired only through working closely with our Regional Offices, the States, and the Conference of Radiation Control Program Directors, Inc., (jointly sponsored by EPA, DHEW and NRC) to identify radiation problems, develop solutions, and assist the States in the implementation of the solutions.

POINTS OF EPA INFLUENCE

In order to exercise its responsibilities wisely, EPA must examine the points in the exposure chain where EPA influence and control will be most useful. Because of the different sources and uses of radiation, a variety of groups receive exposure. The most significant of these are:

Persons exposed in their work environment, such as uranium miners, x-ray technicians, and nuclear facility workers.

Patients exposed in diagnostic or medical treatment.

Persons exposed because they live near a radiation producing activity, such as a nuclear facility.

The general population which is exposed to an accumulation of sources and activities.

The best approach in controlling pollutants is to curb them at the source and not allow them to enter the environment. However, in many cases this is not practicable because of cost constraints, environmental mechanisms which concentrate pollutants, or other technical and societal reasons. Therefore, in these cases it is necessary to examine the complete pathways of radiation flow from the source through the environment and finally to the recipient. In doing this, all significant factors which affect the eventual health impact can be identified and from this, appropriate controls developed and applied to the most significant point or points in the chain. Figure 2 depicts the generalized flow of potential radiation exposure through the environment. From the example shown in the figure, it can be seen that each source type can have different situations, a different mechanism of release, be related to a variety of radionuclides, enter the environment in different modes, and as previously indicated, have impact on different recipients. It is this multiplicity of potential flow patterns that increases the complexity of the radiation problem.

In many cases, control at a single point in the flow will not provide adequate radiation protection or could be too costly or socially unacceptable to implement. Although EPA will consider such single point controls as siting criteria, protective action guides, specific radionuclide standards, and occupational exposure guidance, to be most effective, multiple point controls will have to be implemented for the total flow pattern in many cases.

THE MANAGEMENT PLAN

The problem of radiation control is multifaceted with technical, social, economic, and institutional aspects. Consequently, to arrive at satisfactory solutions, the work program must address all these facets. Managing such a broad-based program is a difficult and complex task. To bring order to this situation, and also to provide for flexible management of resources, a matrix of program interaction is depicted in Figure 3. This system will insure that each radiation problem is properly involved with four functions, as follows:

1. Emerging radiation producing activities must be studied and the problem defined and identified to determine future courses of action to control the source and provide public health protection.

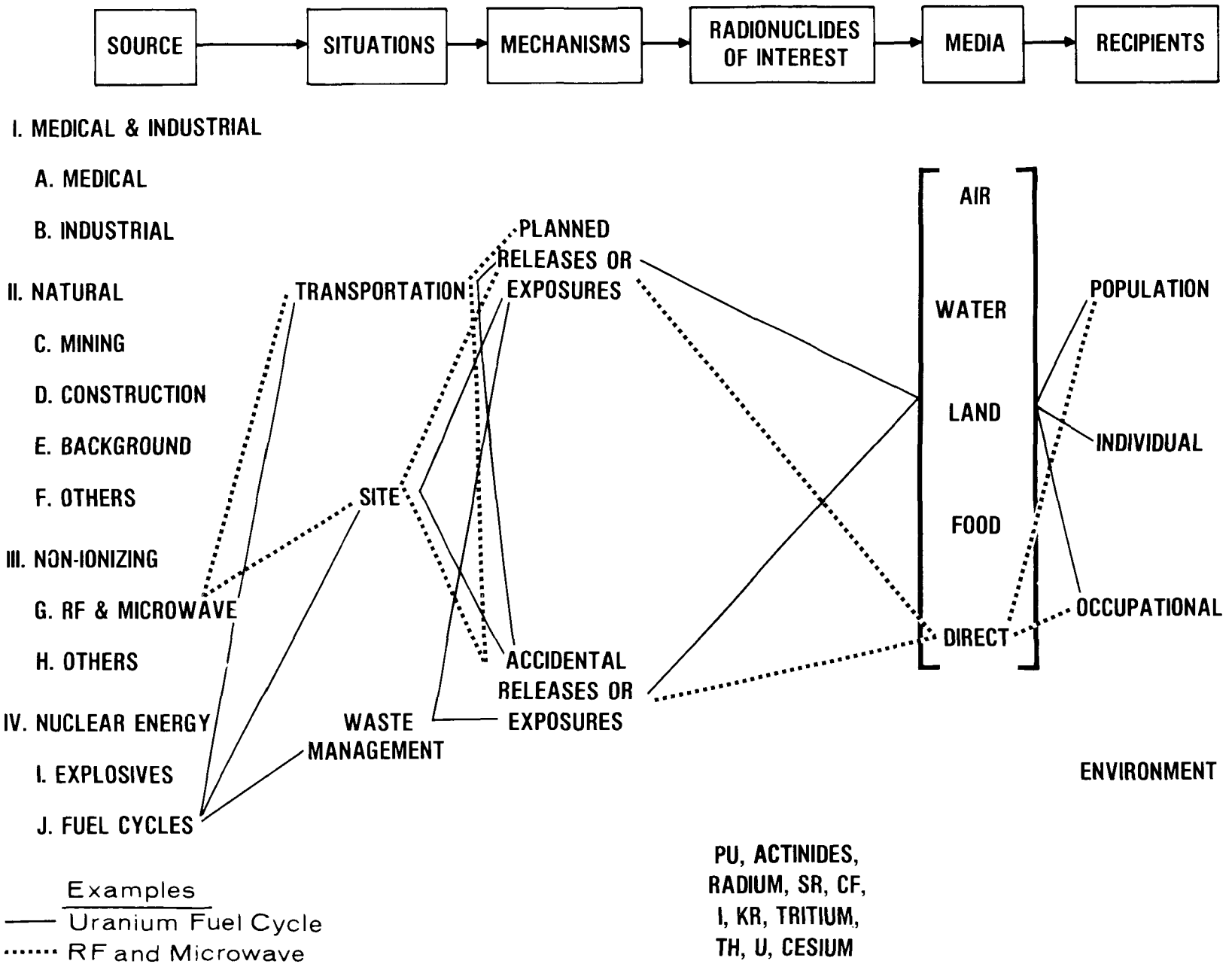
2. Environmental quality information must be acquired and analyzed so that the current status of the environment can be determined. When this status is compared to the quality determined to exist a few years ago, projections can be made of future trends and emerging problems defined.

3. Technologies using radiation must be assessed to determine if they are having adverse impact on human health and the environment and whether it is feasible to reduce this impact.

4. Radiation standards, criteria and guides are prepared using best available information to make an analysis of controls, health effects, cost/risk estimates and economics. This results in specific standards and promulgation by due process. An EIS is also prepared and the resulting standard, guidance or criteria published in the *Federal Register*.

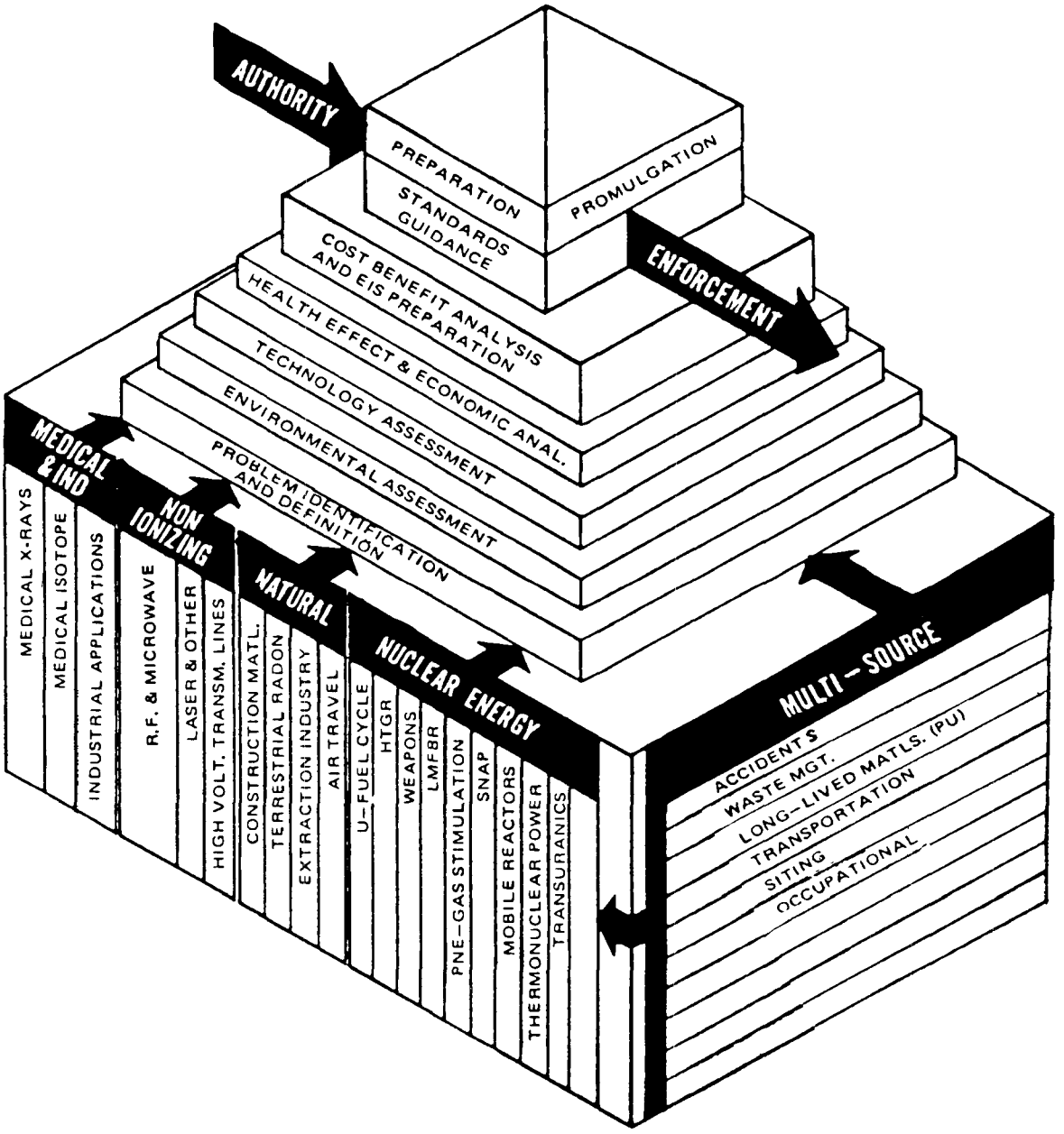
These four functions comprise the responsiblities of the EPA radiation control program regardless of the type of source or use under consideration. These functions also represent the basis of resource allocation, as well as the lines along which headquarters components are organized to allow it to function as a unified program. A fifth function, assistance and support, is composed of service activities necessary to tie the control program together and allow it to function as a unified program for identification of problems, analysis of their significance,

FIGURE 2
RADIATION IMPACT FLOW CHART



PROGRAM INTERACTION

FIGURE 3



establishment of controls, measurement of compliance, and maintenance of emergency response capabilities.

ORP has initiated a Work Breakdown Structure (WBS) type of management control system. This system breaks down the overall problem of radiation protection into component areas and assigns responsibility for work in each area (along with time schedules, manpower commitments, and specific work outputs to be accomplished). Such a procedure facilitates systematic assessment and rapid recording of monthly inputs from the operational organizations and provides a mechanism for prompt feedback of any resulting program changes that may occur.

THE OPERATIONAL PROGRAMS

Analysis of all the sources and points of influence in Figure 3 was used to break down the radiation protection program into three discrete operational program areas: criteria and standards, technology assessment, and environmental assessment. Within each of the areas, specific projects are conducted to meet the program objectives on a timely basis and are classified as high and medium priority. The priorities are basically set by addressing those areas in which health effects reduction can be most effectively implemented. Such priorities are modified based on the need for standards, guidance, and criteria as expressed by other Federal agencies and the public and on the ability of EPA to constructively contribute to resolving the problems. In conduct of its operational program ORP relies on its Eastern Environmental Radiation Facility and Las Vegas Facility located in Montgomery, Alabama, and Las Vegas, Nevada, respectively, to provide technical support and field study capability to the Headquarters Division projects. The program areas and related major projects are described below.

CRITERIA AND STANDARDS

The purpose of this program is to protect, cost-effectively, the health and welfare of man and the environment from adverse effects due to radiation exposure and in balance with the benefits of the particular radiation producing activity. There are potential sources of radiation exposure where existing controls are deficient or non-existent and where there is a need to promulgate generally applicable radiation protection standards to provide this protection. Federal Radiation Guidance is being developed for certain areas where there is a demonstrated need to use the Federal Radiation Council transferred authority. Such guidance to other Federal agencies provides the technical basis for reducing unnecessary radiation exposure and keeping the exposure of the general public "as low as reasonably achievable." Other activities for protecting cost-effectively the health and safety of the public are carried out under the authorities set forth under the Safe Drinking Water Act of 1974, the Ocean Dumping Act of 1972, as amended, and the Federal Water Pollution Control Act of 1972, as amended.

High Priority Projects

Uranium Fuel Cycle Standards

The objective is to promulgate standards for levels of planned releases that meet acceptable public health and environmental criteria for the total light water reactor fuel cycle such that continued operation of the industry is acceptable.

Proposed standards have been published in the *Federal Register* and an accompanying environmental impact statement has been issued. Public comments are being evaluated, public

hearings will be held to elicit additional information, and the standards will be developed in the latter part of FY-76.

Environmental Plutonium Standards

The objective is to determine health impacts from exposures to levels of radioactivity from plutonium and other transuranic elements; to develop standards for cleanup and resotration of already contaminated areas; and to develop standards for plutonium releases based on controlled containment philosophy. Release of long-lived radionuclides represents a long-term commitment and control is only practicable at the point of release. Representatives from ERDA, NRC, NASA, DOD, State, DOT, DOI, DOC, and EPA have been appointed to an interagency committee chaired by EPA. This committee will supply information inputs, will assist in evaluation of data, and will act in an advisory capacity in the preparation of guidelines, criteria, and standards.

Public hearings have been held to solicit technical information and viewpoints, and a technical "Statement of the Problem" and several analyses have been prepared to define the scope of the problem. The project outputs include: (1) analysis of available data on biological effects of inhalation, ingestion, or other exposure to plutonium, and development of a model of damage function versus body or organ, (2) cleanup, restoration, and occupancy guidelines to be completed during FY-76 and issued in FY-77, (3) development of a "controlled containment" philosophy by the end of FY-77 for use in regulation to keep future additions of plutonium to the environment at an absolute minimum, (4) development of preliminary guidelines for LMFBR, defense-related facilities, and for commercial applications of plutonium in FY-77, and (5) development of generally applicable environmental standards for plutonium in FY-77 and issuance in FY-78.

Natural Radioactivity Guidance

The objective is to define the extent of the problem by assessment of the factors involved and determine means for implementation of controls for naturally-occuring radioactive materials; such as uranium, thorium, and their radioactive decay products. Potential sources of population exposure are: (1) ore mining and milling, (2) phosphate fertilizer industry, (3) building materials, (4) fossil fuels, (5) ground water, and (6) other industrial activities. The possible need for legislation and radiation protection guidance will be determined depending upon the findings.

EPA is continuing field studies at inactive uranium mill sites to determine the radon emissions and to verify the dose model for estimating population dose from uranium mills. ERDA, in cooperation with EPA, is investigating methods and techniques for stabilizing uranium mill tailings piles.

The radiation exposure from the phosphate rock mining and milling industry is a new area requiring studies to verify the scope of the problem. Because the phosphate fertilizer business is growing rapidly, EPA is assessing the environmental problem and determining effectiveness of control options to prevent any potential excessive exposures. Interim guidance is under preparation.

Major outputs from these and longer-range programs include: (1) field studies and analyses, and issuance of uranium and thorium mining and milling effluent guides in FY-76; (2) phosphate findings and policy statement in FY-76; (3) study of radioactivity in coal in FY-76, and (4) study of construction materials in FY-77.

Protective Action Planning Guidance

The objective is to assess the environmental consequences of unplanned nuclear releases from fixed facilities and to develop protective action guides for use in emergency response planning for such incidents. As part of an interagency task force on nuclear incident planning for fixed facilities and transportation, EPA has provided interim numerical dose guidance on when protective actions following a nuclear incident are warranted, and interim guidance on what protective actions would be applicable. EPA also has issued a manual on this subject, which provides guidance on planning for accidental gaseous releases. Major outputs in FY-76 include issuance of additional sections of the manual containing guidance on airborne particulate materials and preparation of the Interagency Task Force report on Offsite Emergency Instrumentation Systems. In FY-78 and FY-79, Federal Radiation Protection Guidance will be issued for food and water, and property and equipment.

Radiation Criteria and Drinking Water Standard

The objective is to preserve and restore the quality of water used in the United States. The Adminstrator has mandates under the Federal Water Pollution Control Act of 1972 to develop criteria for the radiological quality of ambient waters and under the Safe Drinking Water Act of 1974, to develop drinking water regulations to protect health to the extent cost-effectively feasible.

Draft Water Quality Criteria have been supplied to the Office of Water Planning and Standards, and Interim Primary Drinking Water Regulations were published in the Federal Register on August 14, 1975. Final Interim Regulations will be published in the *Federal Register* in FY-76. Promulgation of Primary Regulations is scheduled for FY-77 following a study and report to the Administrator by the National Academy of Sciences.

Medical X-Ray Guidance

The objective is to reduce the doses being received from medical diagnostic radiology (at least 90% of the total man-made radiation dose to which the population is exposed) without jeopardizing diagnostic effectiveness.

EPA's approach in this program is to work cooperatively with other Federal agencies concerned with x-ray exposures to the population. An Interagency Committee, chaired by EPA, has been established to develop guidance applicable to Federal health care programs on optimal procedures to assure that the radiation dose, from exposures, is as low as reasonably achievable while maintaining desirable image-quality and concomitantly to assure the efficacy of such procedures. The FDA/BRH is responsible for programs to reduce unnecessary patient exposure by setting performance standards for medical x-ray equipment.

In FY-76, detailed proposed guidance to Federal health care programs will be prepared and published in the *Federal Register*. In FY-77, public comments will be reviewed and final guidance will be issued.

"As Low As Reasonably Achievable" Guidance

The objective is to develop methodology guidance for use in quantifying "as low as reasonable" levels of radiation exposure. Effective consideration of ALRA involves judgments or trade-offs between public health considerations, cost of effluent controls, and overall benefit

considerations. EPA is preparing proposed methodology guidance in order to insure proper interpretation and implementation by Federal agencies. It will be published in the *Federal Register* for comment in FY-76 and final guidance will be issued in FY-77.

Medium Priority Project

Occupational Exposure Guidance

The objective is to update and revise the original FRC guidance on occupational exposures to take into account new information, source problems, and perspectives which have emerged from increased nuclear energy applications.

In carrying out this program, EPA has established the Interagency Committee on Federal Guidance for Occupational Exposures to Ionizing Radiation. In addition to EPA, membership consists of representatives from the following Federal agencies: ERDA, NRC, DOD, NASA, DOT, DOI, and NBS. Consultants and representatives from other public and private sources also will be used.

The basic approach will be to evaluate information on exposures, their trends and resulting effects, and the involved social and economic factors in updating the guidance. Major outputs include completion of draft guidance in FY-76, publication of proposed guidance in the *Federal Register* in FY-77, and issuance of final guidance in FY-78.

Low Priority Projects

NPDES Permits for Radioactivity

On December 10, 1974, the United States Court of Appeals, Tenth Circuit, vs. the Fort St. Vrain Nuclear Power Plant Case (Colorado Public Interest Research Group vs. Train) ruled that the EPA must control radioactive discharges under the provisions of the Federal Water Pollution Control Act of 1972, as amended. In essence, the decision states that EPA's legal interpretation was too narrow and instead should include all radioactive material. This decision by the Tenth Circuit Appeals Court has been reviewed by the Justice Department and sent by the U.S. Solicitor General to the Supreme Court. Arguments on this case were heard by the Court in December 1975. Depending upon the Court's decision, the priority of this project could change.

ORP activities in this area are to develop water effluent guidelines as required to comply with the court decision. This requires ORP, through the Water Program, to: (1) issue permits in a timely manner, (2) ensure permit conditions reflect quality technical considerations, and (3) minimize unnecessary duplication of Federal regulatory restrictions. Priorities for meeting these objectives have been established as a function of the magnitude of the insult, potential for delaying national energy requirements, availability of technical data, and the status of pending permit applications. In the event of the Federal Government losing the case, first priority will be given to nuclear power reactors. Priorities for other facilities have been established and plans are being developed to implement the program for such facilities depending on resource allocation. Included in this program is the responsibility for operating a monitoring program and assuring overall compliance.

In addition, it may be required to list some radioactive materials as toxic substances under Section 307 of the FWPCA and designate such materials as hazardous under Section 3ll. However, as a high priority effort, discharge permits for radium in surface water are being issued

by the Regional Office's Enforcement Division in a cooperative effort with ORP Regional Representatives.

TECHNOLOGY ASSESSMENT PROGRAM

The purpose of the program is to assess nuclear energy applications and documentation for EPA's radiation protection standards and to prepare technical guidance. The programs of other Federal agencies are influenced to assure protection of the environment and public health by review of their environmental impact statements, regulations, and proposed legislation as required by the National Environment Policy Act, Section 309 of the Clean Air Act of 1970, and Section 511 of the Federal Water Pollution Control Act of 1972, as amended. Advanced reactor systems and new applications of nuclear energy are evaluated on a case-by-case basis to learn in the development stage about potential environmental radiation problems. From such assessments EPA's position on the environmental and economic impact will evolve.

High Priority Projects

Radioactive Waste Management

EPA's goal for the management of radioactive wastes is to assure that no unwarranted risks are imposed upon present or future generations through the establishment of environmental criteria for all aspects of the management process.

The objective is to assure that the storage and disposal of all radioactive waste materials is implemented in a manner to ensure effective isolation of the wastes from the biosphere during their hazardous lifetimes. All radioactive wastes are included; i.e., high-level, low-level, and alpha particle wastes from the nuclear industry; wastes containing natural radioactivity, and wastes resulting from the decommissioning of nuclear facilities. In carrying out its radioactive waste management effort, EPA is working with NRC and ERDA to coordinate Federal activities in the development of an integrated national plan for the management of radioactive wastes. Federal agencies with major efforts or responsibilities in waste management have agreed on the need for a coordinated Federal program. In addition, ORP will work quite closely with the EPA Office of Solid Waste Management Programs and other appropriate EPA organizations in this activity.

Outputs in FY-76 include evaluating methods for shallow land burial for low-level wastes and deep emplacement in land or ocean for both low- and high-level wastes. Studies will be conducted involving radiological monitoring, waste container technology, site characterization, and food chains to man. EPA also is responsible for acting on requests for ocean disposal permits domestically and representing the United States internationally as the lead Federal agency at IAEA meetings concerned with the ocean dumping of radioactive wastes.

EPA is participating in the development of a national waste management plan and has provided other Federal agencies with a proposed criteria for Federal Waste Management Activities. In FY-76 efforts will be directed towards defining the responsibilities of the agencies for developing specific criteria and plans for gathering the necessary information. EPA's efforts will focus on developing the overall rationale to be used for determining environmental acceptability and defining the levels of release which would indicate that remedial action should be taken.

In FY-77, decommissioning criteria will be developed for facilities operating or under construction and for future facilities. In FY-77, FY-78 and FY-79, environmental criteria and guidance will be developed for disposal of low-level wastes, TRU wastes, high-level wastes, alpha

wastes and natural radioactivity. Monitoring requirements will be established for these categories of waste to provide technical guidance to NRC and States for enforcement of the regulations.

Environmental Impact Statement Reviews

The objective is to provide comprehensive technical reviews of environmental impact statements (EIS) for facilities and programs which have a potential radiological impact. Through this activity potential environmental radiation problems are identified and comments submitted on the draft EIS so that there is time to modify the facilities and/or programs to prevent or minimize such problems cost-effectively.

EPA Regions are now in the process of implementing Agency policy of assuming the complete responsibility for reviews of environmental impact statements for conventional light water nuclear power plants. EPA Headquarters will update EIS review guidance as better dose models and data become available and will continue to work to resolve generic issues and, as required, will provide policy guidance on generic issues.

Outputs for FY-76, FY-77 and FY-78 include review and analysis on non-routine environmental impact statements. In addition, ORP will work with the Regions and the Office of Federal Activities to develop guidelines for interaction with NRC under the Second Memorandum of Understanding between EPA and NRC. This procedure will enable EPA to fulfill its NEPA responsibilities as required under the Federal Water Pollution Control Act of 1972, Section 511 for new source permits.

Environmental Impacts of Operating Facilities and of New Technology Projects

The objective is to evaluate the effectiveness of radioactive effluent control systems currently in use and to compare the environmental impacts of nuclear and non-nuclear energy projects for use in supporting standards and in evaluating EIS's.

In addition to information being supplied by the EPA Office of Research and Development, in FY-76 ORP is preparing technical information documents on effluent control systems, reviewing standardized reactor designs for generic applications management facilities, and is preparing technology performance reviews for confirmation of predictive evaluation techniques with operational data. In FY-77, ORP will prepare a summary evaluation of advanced reactor energy systems and of some non-fission energy systems and will evaluate the potential environmental impacts of advanced nuclear energy systems.

Medium Priority Projects

Accident Analysis

The objective is to review safety considerations for nuclear fuel cycles and to assess the environmental and public health implications of possible accidents. This effort will be directed toward examining the available information on equipment failures and nuclear incidents severe enough to cause potential release of radioactivity, with emphasis on the probability of such events and their potential consequences. Although previous efforts have been concentrated on severe accidents, the whole range of potential inadvertant releases of radioactive materials will be considered, so that each class of release can be properly weighed. To date, EPA has completed contract studies on accident risks from non-nuclear, man-originated activities and on potential risks from a generic fuel reprocessing facility.

Major outputs will include: review of the Reactor Safety Study (WASH 1400) in FY-76; and in FY-77 and beyond, preliminary examination of low-consequence/high probability accidents to consider their contribution to overall reactor risks and evaluate techniques for determining acceptable levels of risk; examination of the risks associated with other nuclear technology applications; and comparison of safety implications of advanced reactor systems. Related efforts will be directed at relative risk determination at real sites with respect to emergency response planning.

Plutonium Recycle Evaluation

The objective is to determine technically the potential radiological impact of the proposed use of recycled plutonium in light-water reactor fuel. The need for additional standards or guidance, beyond the proposed uranium fuel cycle standards, will also be considered.

Licensing by NRC will be required for commercial use of plutonium in the reactor fuels, even in LWR's already licensed for full power operation with uranium fuel. EPA is concerned with the potential changes in reactor technical specifications and operations to accommodate plutonium bearing fuel and with the potential environmental impact from plutonium fuel fabrication facilities as they progress from small scale laboratory-type facilities to large-scale industrial facilities and operations. In evaluating this problem, and consistent with the EPA approach in handling the overall environmental plutonium standards program, close coordination will be maintained with other Federal Agencies through the established interagency plutonium committee. A detailed standards development program with milestones will be specified after NRC decides whether to approve the commercial use of plutonium recycle, and will be based on EPA's independent analysis of the need for any additional standards.

Liquid Metal Fast Breeder Reactor (LMFBR) Evaluation

The objective is to maintain up-to-date technical expertise in the developing LMFBR technology and to consider the need for additional standards or guidance for potential LMFBR fuel cycles.

EPA has reviewed and commented on a draft EIS for the initial LMFBR demonstration plant concept and on another draft and proposed final EIS for the overall proposed LMFBR program. In addition, EPA has reviewed and commented on the draft generic EIS on low ratio (4%) plutonium-uranium mixed oxide facilities and operations in conjuction with the LWR plutonium recycle program.

During FY-76, the review of the final LMFBR Program EIS will be completed, as well as the EIS review of the Clinch River Breeder Reactor Demonstration plant. These reviews, supported by information developed by EPA and through contracts, will provide the major technical support required for a decision on the need for EPA to propose and issue LMFBR fuel cycle standards or guidance for facilities and operations involving high ratio (16%) plutonium-uranium oxide mixtures. The need for any additional information, and a development plan with milestones, will be specified at this decision point. Subsequently, depending on technology developments, similar decisions may be needed for fuels containing plutonium carbides and plutonium nitrides.

Transportation Guidance

The objective is to evaluate the accident hazards of shipping radioactive material via different modes of transportation, and to provide guidance for protection of passengers and the

public. Results of this program will be factored into other ORP programs concerning generally applicable environmental standards, Federal radiation guidance, accident risk assessment, siting criteria, and emergency response planning.

To date, recommendations for the radiation protection of passengers on aircraft have been completed and sent to FAA; and studies have been completed on accident hazards, and on routine exposures to the public, from shipments of radioactive materials in the uranium fuel cycle. In FY-76, decisions will be made on the desirability of requesting EIS's on cask licensing and on the need for Federal radiation guidance on transportation of radioactive materials.

Siting of Nuclear Facilities

The objective is to develop the methodology for determining the criteria needed to evaluate the environmental acceptability of proposed sites from a radiological perspective for nuclear power plants, for nuclear energy centers, and for advanced nuclear energy systems.

Based on ORP's accident analysis effort on the assessment of the potential impacts of accidental releases from nuclear power plants, and additional information concerning long-term as well as short-term effects from normal releases, ORP will make continuing evaluation of NRC's siting criteria. ORP is actively participating in interagency efforts relative to the siting of nuclear facilities and in the NRC-sponsored State-Federal Siting Committee. An EPA position relative to nuclear facility siting will be recommended when sufficient information is available.

ENVIRONMENTAL QUALITY ANALYSIS

The objective is to determine individual and population doses from all sources of ionizing and nonionizing environmental radiation. The gathering of such a total radiation data base is unique to EPA. The rationale for analyzing environmental radiation in the most cost-effective manner is to maximize the use of available data reported by others and validated by EPA. Information from this program is used by EPA in five ways: (1) to analyze trends in environmental radionuclide concentrations, (2) to identify radiation problems, (3) to support standard setting activities, (4) to provide guidance for public health protection, and (5) to provide public information. One output of this program is the publication of an Annual Report on Radiological Quality of the Environment. In-depth reports evaluating the radiation exposure from individual classes of sources and guidance in the conduct of surveillance and surveillance data analysis are also issued.

High Priority Projects

Nonionizing Radiation Guidance

The objective is to determine the health and environmental impact of radiofrequency and microwave radiation in order to assess the need for providing guidance for controlling environmental exposure to such radiation.

Field measurements at three major metropolitan areas are being made in FY-76 with measurements at three additional areas in FY-77. In parallel, information that can be obtained on biological effects of various levels of nonionizing radiation will be assessed and any necessary proposed guidance will be developed during FY-77 and FY-78, with issuance of final guidance in FY-78 or FY-79. Throughout this entire effort, interagency liaison and cooperative efforts will be carried on with other cognizant activities, such as OTP-ERMAC-IRAC, OSHA, BRH, ANSI, and IEEE. Field studies have been initiated to measure and evaluate health and environmental

impacts from extra high voltage power transmission lines. A notice published in the *Federal Register* solicited information on environmental impact, health effects, and instrumentation techniques evaluations associated with extra high voltage (EHV) power transmission lines. An analysis of this information in 1976 will assist in determining the scope of the problem. EPA plans to complete field studies in 1976 at selected EHV power transmission lines to measure environmental parameters and assess the potential health problem.

Environmental Radiation Ambient Monitoring System (ERAMS)

The purpose is to operate a comprehensive and coordinated system to determine the ambient levels of radioactivity in the environment. Sampling locations are selected to provide coverage of the United States. The frequency of collection and types of laboratory analysis has been determined by cost-effective analysis of data requirements. The environmental radiation data from this project will be made available to the public in a quarterly report and will be summarized annually in the State of the Environmental Radiation Report.

The ERAMS and special studies conducted at operating nuclear facilities are the only independent assessment of environmental radiation and estimates of population exposure carried out as a continuing activity outside of the energy producing industry.

Radiological Quality of the Environment

The objective is to publish an annual report of radiation in the environment beginning with data from calendar year 1973. The first report will be a prototype for future reports in that it will primarily describe the available data base and present dose information estimated by others. For subsequent reports, additional data will be included on reported environmental contamination levels and ORP estimates of population dose from this data. The first report will contain information on ionizing radiation in the ambient environment from natural sources and from fallout, nuclear fuel cycle operations, Federal facilities, medical, occupational and industrial sources. Nonionizing radiation sources will also be included. This report, in conjunction with the report on Radiation Protection Activities in the U.S.-1975, will provide a comprehensive evaluation of radioactivity in the environment and indicate trends and problems.

Medium Priority Project

Facility Data Analysis

The objective is to develop techniques for data analysis and to apply these techniques to evaluate facility surveillance programs. Based on these findings updated surveillance guidance for use by facilities, States, and others will be prepared. This guidance would include all aspects of surveillance programs from sampling methodology, to sample preparation and analyses, to data reduction, interpretation, reporting, and quality assurance.

The project output includes (1) develop ambient criteria in FY-76, (2) develop data analysis methods in FY-76, (3) complete prototype study of a selected facility in FY-76, (4) develop surveillance program evaluation criteria, (5) acquire data and analyze several facilities for completion in FY-77, and (6) prepare surveillance guidance in FY-78.

RADIATION REGIONAL PROGRAM

The role of the Regional Offices in the radiation program is a combination of prime functions, some general activities, a national regional output and some specific outputs related to radiation

problems unique to each region. A prime activity is the regionalization of routine nuclear power plant EIS reviews which was initiated in FY-76 and should be operational in FY-77. This activity requires involvement of the Regional Offices on a frequent basis with national programs that have an impact at the State and local levels. Technical and program consultation with States is a continuing effort directed toward the goal of greater State self-sufficiency in the environmental radiation protection area. This applies particularly to those States that are developing capability to assume responsibilities in implementing the monitoring provisions of the Safe Drinking Water Act of 1974.

The radiation protection program strategy provides for centralized headquarters management of priority projects for standard setting, technology assessment and environmental assessment. To the maximum extent possible the Regions and States are requested to participate in the development of standards to assure that their views have been adequately considered. In this approach, specific problem area requirements and resources may be assigned to certain Regions on a case-by-case basis. As the headquarters develops specific standards and guides, continuous study will reveal those functions or problem areas that can be decentralized to the Regions. Emphasis is also being placed on coordination of, involvement in, and utilization of State radiation control programs in the national program as a means to effectively and efficiently integrate environmental radiation programs. Regional-specific radiation programs are developed through consultation between headquarters and each Regional Office when such programs are related to ORP priority projects.

Because of the necessity to act from a unified position on radiation issues which involve other Federal agencies with responsibilities in the radiation area it is important that the Regional Office coordinate with the Office of General Council and the ORP prior to taking any action on Regional issues that impact on national policy.

High Priority Projects

Conduct the technical review and review management of routine nuclear power plant EIS's (or other assigned technical reviews). Initiate in Fy-76 and complete in Fy-77.

Implement the radiological portion of the EPA Drinking Water Standards in support of the Water Supply Program. Assist States in development of their capability to assume responsibility for implementing the Drinking Water Standards.

Perform environmental reviews of radiological aspects of selected Federal activities pursuant to E.O. 11752.

Provide the following services:

a. Provide technical and program consultation and assistance to States where required.

b. Respond to public and Congressional inquiries.

c. Stimulate productive functioning of Regional Training Committees to meet State training needs.

d. Facilitate and coordinate ORP activities with States.

e. Participate in EIS reviews of non-routine nuclear activities to extent delegated and/or capable.

Obtain, compile, and report technical information on selected nuclear and radiation facilities, including facilities with potential naturally-occuring radioactivity problems.

Medium Priority Projects

Assist States in FY-76 in the development testing, evaluation, modification, and maintenance of State radiological emergency response plans, and, as warranted, promote the development of interstate, intraregional, and interregional emergency response coordination. Such assistance to States will be primarily through Regional participation on the Regional Steering Committees and in the Federal Cadre operation. Particular emphasis should be placed on working with States to assure integration of EPA Protective Action Guidance into the State plans. In addition, the Regional Office provides Regional radiological emergency response coordination should an emergency occur within the Region.

Initiate activities in FY-77 for implementation of EPA radiation standards and guidance, such as generally applicable environmental standards for the uranium fuel cycle, plutonium cleanup and restoration and Federal Radiation Guidance in the healing arts use of radiation and in occupational exposures to radiation.

Supporting the Regional National Pollution Discharge Elimination System (NPDES) program for those activities involving radioactivity (a change in Regional priorities may be required depending upon the Supreme Court ruling in the case of COPIRG vs. Train).

RESEARCH AND OPERATIONAL STUDIES

The radiation control program requires a vigorous scientific research effort. The purpose of research and operational investigations is to eliminate many of the uncertainties associated with health effects and environmental processes that currently face the program. In addition, field studies will be directed toward evaluating technical radiation control alternatives and overall program alternatives. It is anticipated that the results of these studies will direct the Agency's future radiation program thrusts and also point out specific areas where legislation is needed.

The scientific research program, which covers both ionizing and nonionizing radiation studies, will have its thrust in two major areas. The first area involves operational research in ecological processes and environmental transport, and investigation of specific health effects from exposure to radionuclides such as plutonium, tritium and krypton. Work in this area is necessary to reduce the uncertainties in migration patterns, resuspension factors, and other general pathway parameters. With these uncertainties reduced, more definitive action can be taken in preparing Standards and Federal Guidance. The second is health effects research which will be primarily directed toward the establishment of definitive knowledge in the area of nonthermal health effects of nonionizing radiation.

Operational studies are necessary to adequately reflect socioeconomic and control technology considerations in the Agency's actions. Studies will be undertaken in key areas including the following:

Development of methodologies for risk/cost analyses.

Development of a basis for evaluating environmental risks associated with nuclear power.

Comparison of the relative environmental impact of electric power sources.

Comparison of control alternatives for specific categories of sources and their resultant costs and degrees of health risk reduction.

Examination of the need for control in various areas of background radiation and socioeconomic feasibility of instituting controls.

Determination of the viability of new equipment and technologies for controlling specific effluents, such as tritium and krypton, and the implication of instituting guidance of standards demanding their use.

A morphological approach is being used to identify the ORP research and operational needs for FY-77. This method will utilize information on research acitvities of other Federal agencies to maximize use of available resources, avoid duplication of efforts, and permit development of complementary research programs. An operating, working relationship with ERDA and NRC has been established to implement coordinated research undertakings.

PUBLIC INVOLVEMENT PLAN

The final major thrust of the radiation strategy is the conduct of a program to encourage public involvement in the Agency's radiation protection activities and to inform the public about the radiation problems, EPA's concerns and policies. EPA will develop its philosophy and rationale for its standards, criteria, and guides in a manner that will openly allow public participation and scrutiny. Further, this approach is directed toward always explaining the EPA radiation protection in terminology and language readily comprehensible by the public.

In order to provide for these objectives, EPA will publish notice of its proposed standards, criteria and guides in the *Federal Register*, conduct open hearings during various phases of standard-setting procedures, and allow public comment and input to our proposed standards and guides. Further, materials will be developed for use through television, exhibits, and general distribution to inform the public about EPA's radiation responsibilities, programs, and accomplishments. The goal is to have specific pamphlets and films that explain all facets of the radiation control program.

APPENDIX A

An Illustrative Example of the Radiation Exposure Trends in Man-Rems for the Years 1970 and 2000

The potential radiation exposure flows in man-rems for the year 2000 versus those in 1970 in the United States are shown in Figures 1 and 2. These figures identify the important parameters governing radiation exposure and graphically denote the relative importance of these parameters to the potential radiation exposure. The data for both figures are gross estimates to provide comparison of trends and do not represent actual predictions of what happens. The characteristic parameters considered are:

Source of exposure (nuclear power, medical, etc.)

Release mechanism (planned or unplanned)

Mode or media (air, terrestrial/water, direct, food chain)

Situation causing exposure (site, transportation, waste disposal)

In Figure 1, the current exposure case, the flow of potential exposure is shown from its origins to the final recipients where the health impact is imposed. The flow is depicted as potential "manrems." The purpose of the graph is to illustrate relative magnitudes and flow patterns.

Outside the dotted line are located three major ionizing radiation sources – medical radiation, natural radiation, and nuclear power radiation. For both medical and nuclear power, we observe that much of the potential exposure flows from the site where the source is generated or used through transportation as it is moved from place to place to a waste disposal site and a final sink where it is completely removed from the biosphere. From the width of the flow lines on the graph, it is evident that much more potential exposure flows to the sink in the nuclear power base than in the medical case. It should be noted that the medical exposures arise primarily from direct exposures to x-rays, i.e., the equipment (or site) whereas for nuclear power it is from radioactive materials, primarily intakes and therefore away from the site.

Inside the dotted boundary (which indicates the million-to-one scale change) flow lines indicate that there is potential exposure to various recipients through each of the situations for medical, natural and nuclear power sources.

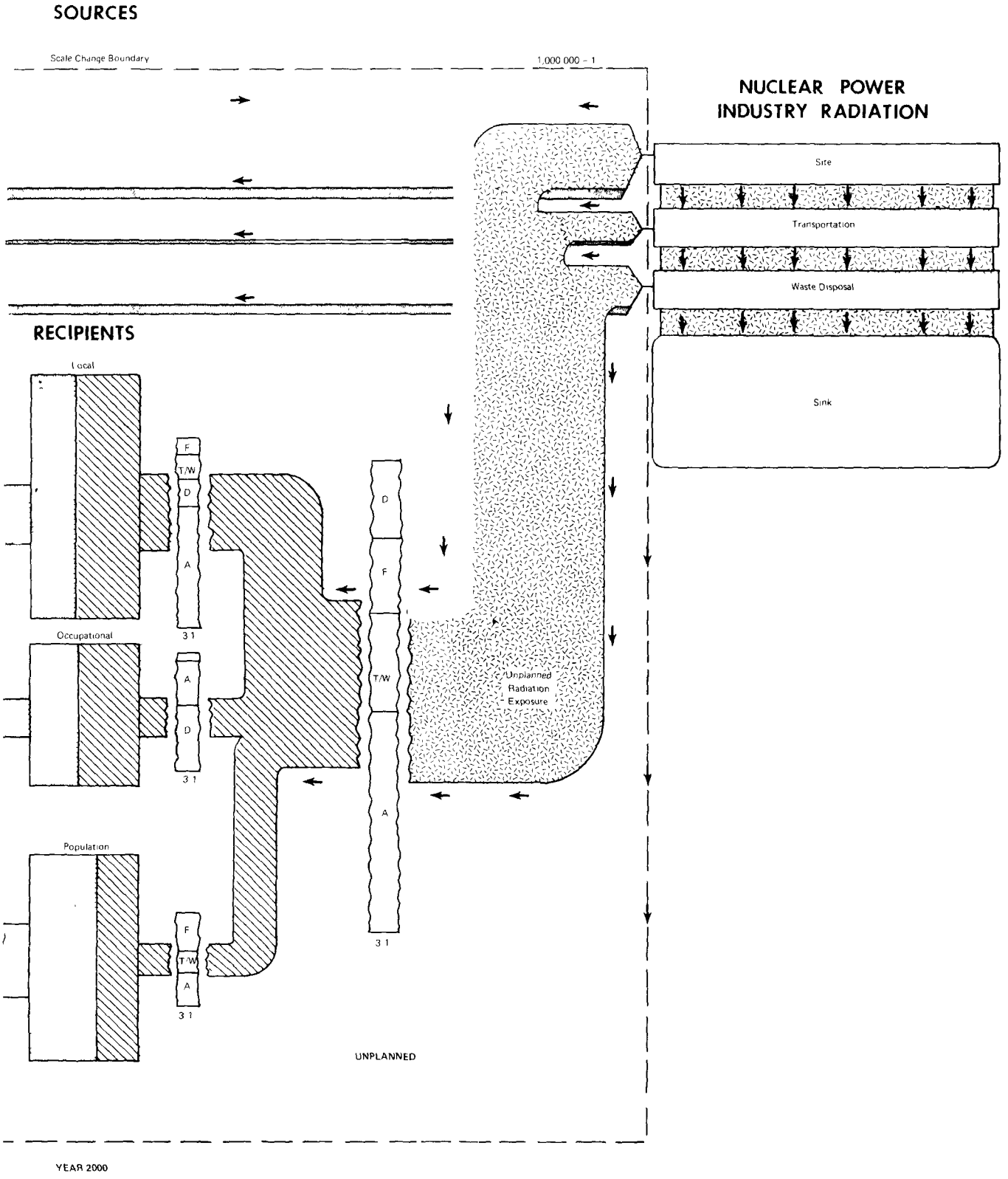
The flow patterns of both planned and unplanned releases can be observed. On the planned side, most of the exposure is shown to come from natural sources, with a smaller though comparable amount coming from medical sources. The smallest amount arises from nuclear power production. By taking the total planned exposure and, for clarity, expanding the scale, it can be seen that of the exposure modes or media, the air and direct modes are the most significant. Because the natural and medical sources constitute the major exposure sources, the primary recipients of this exposure are patients, general population, and occupational workers. Around specific sources like nuclear facilities, the exposures are generally limited to local populations.

The right-hand side of Figure 1 depicts the unplanned release mechanism. To derive the estimates for the accidental exposures a number of assumptions were made. For medical sources the exposure was assumed to arise from improper maintenance of x-ray equipment or releases of radionuclides due to mishaps at the medical facilities, or during transportation, or waste disposal. For nuclear power sources, the unplanned exposure was assumed to occur due to either a single waste disposal or fuel reprocessing accident or a particular design-basis nuclear plant accident. Comparison between the planned and unplanned case will show that the composition of the media dispersion is quite different. In addition, the composition of the recipient exposure is different from that of the planned case. Here, most of the exposure is directed toward the occupational personnel and the residents of the area around the sources although the general population and patients would receive some exposure.

For the year 2000, the situation may have substantial changes, as indicated by Figure 2 which has been drawn to the same scale as Figure 1. The potential exposure flow through the nuclear power industry is now increased by a factor of approximately 30, however, the majority of this still flows to a removal sink. The planned medical and natural radiation potential exposures have increased only slightly, that is, proportional to population, whereas because of industry expansion, the nuclear power industry planned potential exposure has increased significantly. Thus, the nuclear power potential exposure, though still only a relatively small portion of the total planned potential exposure, has now become significant.

The unplanned potential exposure for the nuclear industry is estimated to triple in the year 2000 over 1970. Although the medical unplanned exposure has slightly increased over 1970, the effect of it has diminished relative to the unplanned nuclear industry potential exposure. Because of the potential for large unplanned exposure from the nuclear industry, the problem of radiation containment is shown to be very acute. The projected amount of planned vs. unplanned exposure for the nuclear power industry already includes a high degree of control on releases from nuclear power sources. Any failure of the nuclear power industry to maintain these high levels of release control would greatly increase the planned radiation exposure from the nuclear power industry. The extent to which actual accidents will occur will be highly dependent upon the control and regulatory steps which are currently being implemented. The expected possible range of the unplanned radiation is quite high. It can range from about the level indicated to many times greater.

In the year 2000, the general trend in terms of recipient exposure will be primarily an increase in the exposure to nearby residents from both planned and unplanned nuclear industry releases.

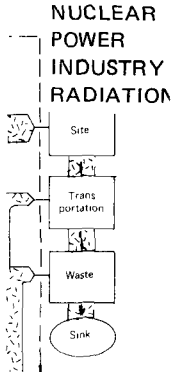


EXPOSURE FLOWS IN MAN-REMS FOR THE YEAR 2000

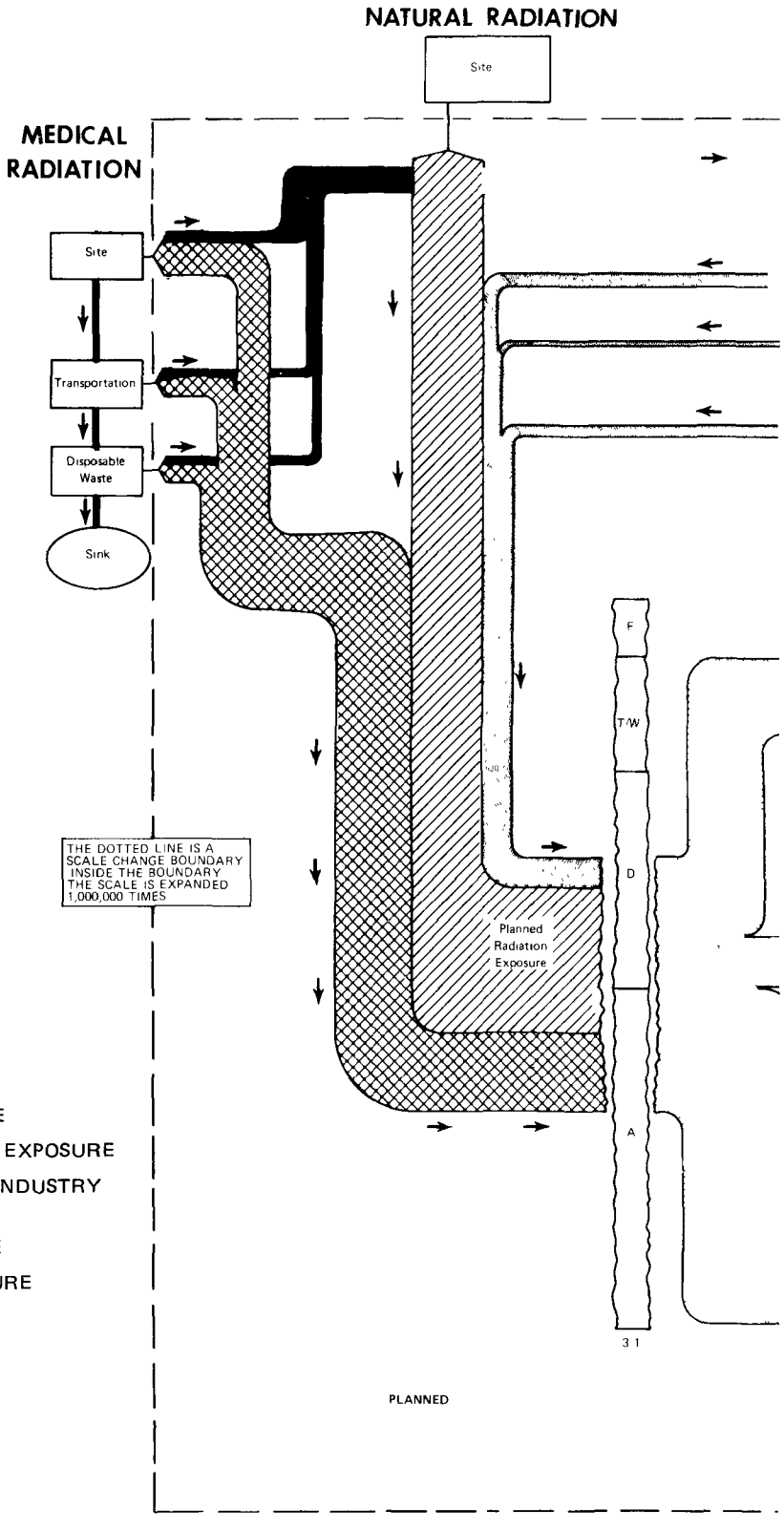
(Large)

TENTIAL RADIATION

970



BOTH DRAWINGS ARE ON THE SAME SCALE. THE OVERALL POTENTIAL EXPOSURE FOR THE YEAR 2000 IS MUCH LARGER THAN THAT FOR 1970



Legend:

- NATURAL RADIATION EXPOSURE
- PLANNED MEDICAL RADIATION EXPOSURE
- UNPLANNED NUCLEAR POWER INDUSTRY RADIATION EXPOSURE
- PLANNED RADIATION EXPOSURE
- UNPLANNED RADIATION EXPOSURE
- UNPLANNED EXPOSURE
- PLANNED N.P.I. RADIATION

EXPOSURE MEDIA:

F	FOOD CHAIN
T/W	TERRESTRIAL WATER
A	AIRBORNE
D	DIRECT

FIGURE 2 POTENTIAL RADI
(With 1,000,000:1 S

COMPARATIVE REPRESENTATION OF THE MAGNITUDES OF PO
FLOWS BY THE YEAR 2000 VERSUS THOSE IN '

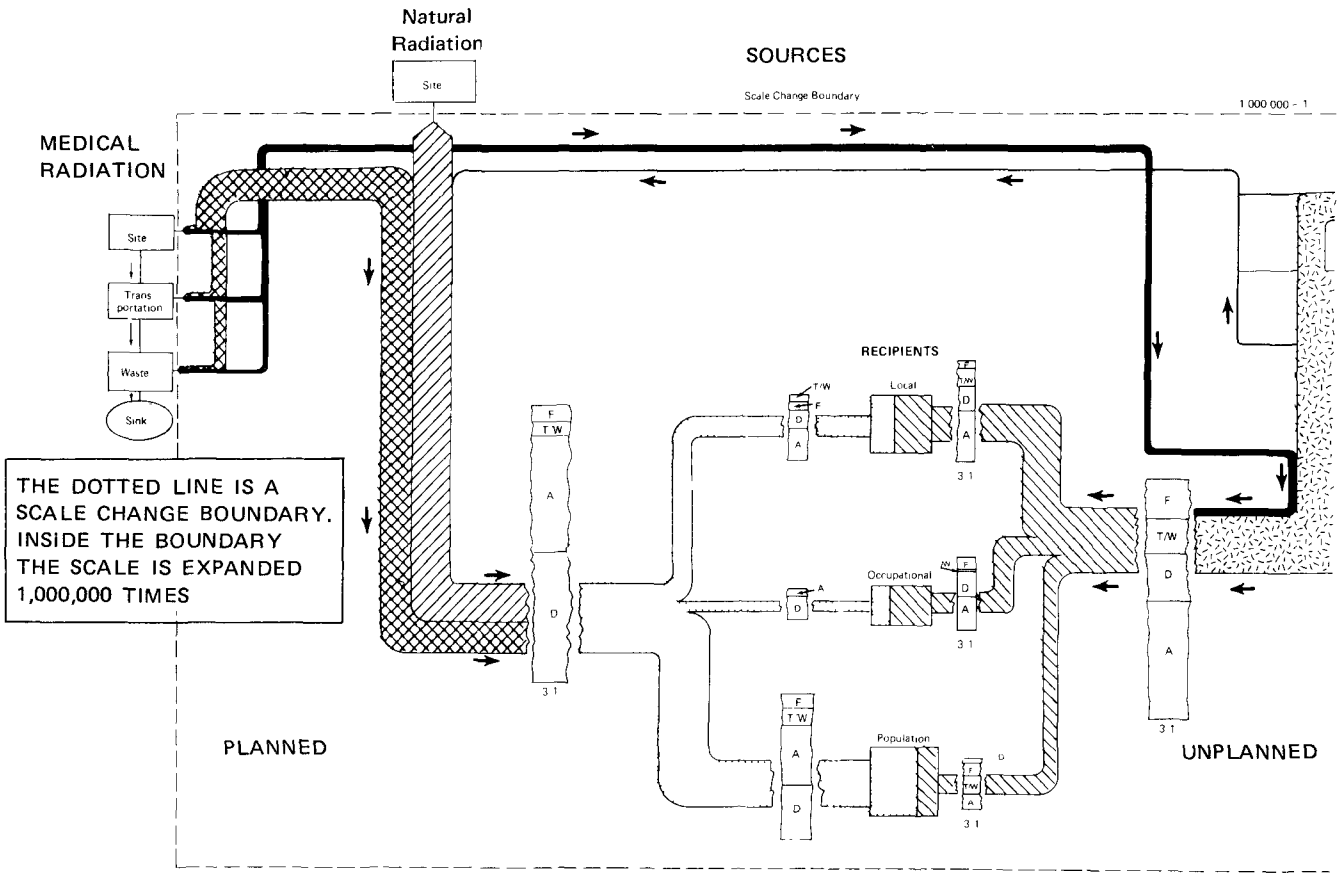


FIGURE 1 POTENTIAL RADIATION EXPOSURE FLOWS IN MAN-REMS FOR THE YEAR 19
(With 1,000,000:1 Scale Charge)